Going Digital: Shaping Policies, Improving Lives

OECD

Going Digital: Shaping Policies, Improving Lives

BETTER POLICIES FOR BETTER LIVES

This report was declassified by the OECD Committee on Digital Economy Policy (CDEP), the lead Committee of the OECD Going Digital project, on 7 January 2019 by written procedure and prepared for publication by the OECD Secretariat.

This document, as well as any data and any map included herein, are without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries and to the name of any territory, city or area.

Please cite this publication as:
OECD (2019), *Going Digital: Shaping Policies, Improving Lives,* OECD Publishing, Paris, *https://doi.org/10.1787/9789264312012-en*.

ISBN 978-92-64-31200-5 (print)
ISBN 978-92-64-31201-2 (pdf)
ISBN 978-92-64-31203-6 (HTML)
ISBN 978-92-64-31202-9 (epub)

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

Photo credits: Cover © Sylvain Fraccola and Christoph Schmid.

Corrigenda to OECD publications may be found on line at: *www.oecd.org/about/publishing/corrigenda.htm*.

Foreword

Economies, governments and societies across the globe are going digital. Although already underway for nearly half a century, the pace of change has quickened, as digital technologies develop rapidly and combine in novel and innovative ways, pushing digital transformation in new and often unpredictable directions. At the same time, the further deployment of communications infrastructure, the proliferation of digital technologies such as smart phones that allow ubiquitous computing, and the generation of huge volumes of data of all kinds, are turning data into an important, strategic asset. Digital technologies and large-scale data flows fundamentally change how people live and work, interact with one another, participate in the economy, and engage with the government.

Many now compare digital transformation with earlier industrial transformations propelled by general-purpose technologies like steam or electricity. Whether it is the Second Machine Age, the Third Wave, Industrie 4.0 or Society 5.0, significant shifts are underway. Digital transformation affects all countries across the globe, and the importance of digital technologies is underscored in the United Nations Sustainable Development Goals, where access to information and communication technologies and universal and affordable access to the Internet is one of the key targets to transform our world.

The ongoing digital transformation of the economy and society holds many promises to spur innovation, generate efficiencies, and improve services, and in doing so boost productivity growth. Digital technologies also make it easier for people to participate in economic and social activities. Yet such benefits come with new challenges as digital transformation changes the nature and structure of organisations, markets and communities, and raises concerns around jobs and skills, privacy and security, as well as notions of equity and inclusion.

Realising the opportunities and addressing the challenges is not automatic and may require policy action to make digital transformation work for growth and well-being. There is currently a window of opportunity for individuals, governments and all stakeholders to shape a digital future that makes the most of the immense opportunities that digital transformation holds to improve people's lives, while ensuring that no one is left behind.

This report brings together what we know about how policy can help – as well as areas and issues we need to better understand – to ensure that digital transformation benefits all by increasing growth and improving well-being. It reflects the work undertaken in the OECD's Going Digital project over 2017-18 as well as other relevant OECD work on digital transformation. It aims to increase an understanding of the drivers of digital transformation, and offers a whole-of-economy and society perspective on key digital trends, impacts, and issues that require co-ordinated policy action. It also sets out an ambitious future digital agenda for the OECD and beyond.

Acknowledgements

This report presents key insights and policy messages from the OECD Going Digital project, which was carried out over 2017-18 under the leadership of the OECD Committee on Digital Economy Policy, chaired by Wonki Min (Korea). The OECD Going Digital project is led by the OECD Directorate for Science, Technology and Innovation, under the leadership and guidance of Andrew Wyckoff, Director; Dirk Pilat, Deputy Director; and Anne Carblanc, Head of the Digital Economy Policy Division. Molly Lesher served as the Project Co-ordinator of the first phase (2017-18) of the project.

This report was co-ordinated and drafted by Molly Lesher, David Gierten and Angela Attrey. It draws on contributions from the OECD Secretariat from nine OECD Directorates, including the Directorate for Science, Technology and Innovation (Brigitte Acoca, Matej Bajgar, Laurent Bernat, Frédéric Bourassa, Sarah Box, Sara Calligaris, Flavio Calvino, François Chantret, Agnès Cimper, Alessandra Colecchia, Chiara Criscuolo, Gallia Daor, Timothy DeStefano, Michael Donohue, Alexia Gonzalez-Fanfalone, Dominique Guellec, Peter Horvát, Nick Johnstone, Daniel Ker, Elif Köksal-Oudot, Anna-Sophie Liebender, Christopher Lomax, Luca Marcolin, Pierre Montagnier, Alistair Nolan, Sam Paltridge, Caroline Paunov, Karine Perset, Lorrayne Porciuncula, Carthage Smith, Vincenzo Spiezia, Christian Reimsbach-Kounatze, Elettra Ronchi, Mariagrazia Squicciarini, Jonathan Timmis, Kila Walser, Colin Webb, Verena Weber and Jeremy West); the Centre for Tax Policy and Administration (Andrew Auerbach, David Bradbury, Julien Jarrige, Giorgia Maffini, Caroline Malcolm and Anna Milanez); the Statistics and Data Directorate (Nadim Ahmad, Fabienne Fortanier, John Mitchell, Fabrice Murtin, Jennifer Ribarsky, Paul Schreyer, Vincent Siegerink, Peter van de Ven and Jorrit Zwijnenburg); the Economics Department (Peter Gal, Giuseppe Nicoletti, Stéphane Sorbe and Christina Timiliotis); the Directorate for Education and Skills (Stéphanie Jamet, Deborah Roseveare and Stéphan Vincent-Lancrin); the Directorate for Employment, Labour and Social Affairs (Stijn Broecke and Paolo Falco); the Directorate for Financial and Enterprise Affairs (Sean Ennis, Stephen Lumpkin, Mathilde Mesnard, Flore-Anne Messy and Gert Wehinger); the Directorate for Public Governance (Jack Radisch, Jacob Arturo Rivera Pérez, Barbara Ubaldi and João Vasconcelos); and the Trade and Agriculture Directorate (Rachel Bae, Francesca Casalini, Gwendolen Deboe, Janos Ferencz, Javier López González, Marie-Agnes Jouanjean, Julia Nielson and Hildegunn Kyvik Nordås). Other OECD Directorates and bodies that were actively involved in the OECD Going Digital project include the Environment Directorate (Shardul Agrawala, Elisabetta Cornago and Tobias Udsholt); the International Energy Agency (Jan Bartos, Simon Bennett, Laura Cozzi, George Kamiya, Luis Munuera and Dave Turk); the Centre for Entrepreneurship, SMEs, Regions and Cities (Marco Bianchini and Lucia Cusmano); the Foresight Unit of the Office of the Secretary-General (Duncan Cass-Beggs, Joshua Polchar and Julia Staudt); and the International Transport Forum (Tom Voege).

This report also benefited from editing and formatting assistance from Jennifer Allain, Sarah Ferguson and Angela Gosmann. Sylvain Fraccola designed the infographics and Christoph Schmid (Interactive Things) created the graphic designs. Thanks also go to Vincent Finat-Duclos and Shayne MacLachlan from the OECD Public Affairs and Communications Directorate for broader assistance on communication, messaging and publication.

The OECD Going Digital project involved 14 OECD Committees: the Committee on Digital Economy Policy; Competition Committee; Committee on Consumer Policy; Committee on Fiscal Affairs; Committee on Industry, Innovation and Entrepreneurship; Committee on Financial Markets; Committee on Statistics and Statistics Policy; Committee on Scientific and Technological Policy; Economic Policy Committee; Education Policy Committee; Employment, Labour and Social Affairs Committee; Insurance and Private Pensions Committee; Public Governance Committee and the Trade Committee. This report was also reviewed by the Going Digital Steering Group, composed of representatives from the above mentioned OECD Committees, OECD member countries, as well as four stakeholder groups: Business at the OECD, the Civil Society Information Society Advisory Council, the Internet Technical Advisory Committee and the Trade Union Advisory Committee.

The OECD Going Digital project greatly benefited from discussions in the Friends of Going Digital group, composed of the Ambassadors of OECD members and partners, and in the Going Digital Expert Advisory Group, members of which include Marjory Blumenthal, Nicolas Colin, Peter Gluckman, Yuko Harayama, Nicola Hazell, Malavika Jayaram, Janis Karklins, Kevin Lynch, Ann Mettler, Diego Molano Vega, Geoff Mulgan, Diego Piacentini, David Weil and Lan Xue.

Editorial: Making digital transformation work for growth and well-being

How do we – as citizens, governments and businesses – shape digital transformation so that it benefits society and leaves no one behind? This is a key question as digital technologies and data become increasingly present in our lives. From the government perspective, a key to unleashing the promise of digital transformation is to develop an integrated and coherent policy response across all areas. It also requires policies that seize the opportunities and maximise the benefits while addressing the challenges and minimising the costs.

Now is the time to act. We are at the beginning of the digital age where computing and data are ubiquitous. Designing and implementing an integrated policy framework fit for the digital age is a complex challenge, but one that we must all embrace given the many potential benefits. Digital technologies and data spur innovation, generate efficiencies, and improve many goods and services. They enable more trade and investment, and facilitate technology transfer. They help push out the productivity frontier, leading to more growth and economic opportunities. It is essential to realise this potential and ensure that it is broadly shared.

Addressing the seeming digital productivity paradox is important in this regard because productivity gains are essential for improved standards of living. As digital transformation has progressed, aggregate productivity growth has slowed, raising questions about the ability of digital technologies to raise productivity growth. But the aggregate productivity slowdown masks a widening performance gap between more and less productive firms, with the gap especially strong in information and communication technology services sectors (see Chapter 3). Frontier firms continue to increase productivity and benefit from digital transformation, but laggard firms do not always have the capabilities and incentives to adopt state-of-the-art technologies and best practices. It is essential to allow frontier firms to grow, while at the same time help laggards catch up or easily exit, if necessary.

It is also important to promote the diffusion of digital technologies and related knowledge – which remains well below its potential – to boost productivity growth (see Chapter 3). While most firms across the OECD now have access to broadband networks, more advanced, productivity-enhancing digital tools and applications – such as cloud computing or big data analytics – have diffused to far fewer firms. Moreover, significant cross-country differences, even among the most advanced economies, raise important questions about why some countries are more successful at adopting digital technologies than others.

Effective use of digital technologies often involves experimentation, as it takes time to reorganise production processes, introduce new business models, and find or provide workers and management with new skills. Digital transformation also requires complementary investments in skills, organisational change, process innovation, as well as new systems and business models (see Chapter 4). The growing scale and complexity of these complementary investments make digital transformation particularly difficult for non-frontier firms, such as small and medium-sized enterprises in less digital-intensive sectors.

On the jobs front, we know that digital transformation leads to some job losses and some job gains (see Chapter 5). To date, however, employment rates are at record high levels in many countries and over the past decade four out of ten new jobs were created in digital-intensive sectors. But it is important to ensure that all workers benefit more equally from digital transformation and are empowered with the right mix of skills as well as provided with social protection. Over the past two decades, real median wage growth in most OECD countries has decoupled from labour productivity growth, suggesting that productivity gains no longer automatically translate into wage gains for all workers.

Beyond their economic and social impacts on productivity and the world of work, the use of digital technologies has also improved people's lives and broader well-being in a relatively short time. Digital technologies, such as the smartphone, enable more people to access government services, promote civic engagement and allow more people to connect than ever before. They also increase consumer choice and convenience.

But the societal effects of digital transformation are complicated because overall impacts are often not clear-cut (see Chapter 6). For example, digital technologies provide opportunities to enhance access to information, interpersonal communications and a host of services (a free and interconnected Internet), advance science and improve healthcare (e.g. tele-medicine), and enrich education (e.g. massive open online courses). On the other hand, they can bring challenges related to work-life imbalances; foster the segregation of people into relatively isolated, like-minded groups; diminish privacy and lead to screen addiction, depression and cyberbullying, including among children (see Chapter 6).

To ensure that digital transformation supports and growth and well-being, it is important to and reduce any inequalities that may be exacerbated by technological progress. While each country has its own social preferences and specific context, there are some policy actions that can be taken that are relevant for all countries, particularly investing in education and skills, among others (see Chapters 3, 5 and 6).

Shaping an inclusive digital economy and society is not easy, but it is vital. The OECD Going Digital project makes the case for a flexible, forward-looking and integrated approach to policy making in the digital era. Such an approach is crucial because digital transformation affects different aspects of the economy and society in complex and interrelated ways, making trade-offs between public policy objectives difficult to navigate. Moreover, the borders between policy areas are becoming blurred, making stronger co-operation and collaboration across policy silos essential, including for policy development and implementation.

The Going Digital Integrated Policy Framework helps governments develop well-suited and resilient digital policies. It also ensures a coherent and cohesive whole-of-government approach to fully realise the potential of digital transformation and address its challenges. The framework includes seven policy dimensions to: 1) enhance access; 2) increase effective use; 3) unleash innovation; 4) ensure good jobs for all; 5) promote social prosperity; 6) strengthen trust; and 7) foster market openness (see illustration below).

Going Digital Integrated Policy Framework

Source: OECD (forthcoming[5]), "Going Digital: An integrated policy framework to make the transformation work for growth and well-being".

Each of these integrated policy dimensions brings together multiple policy areas that do not stand in isolation, but are interrelated. This configuration underscores that leveraging the benefits and addressing the challenges of digital transformation requires identifying policy areas that are jointly affected and that need to be co-ordinated. It also highlights that all policy dimensions are needed to make digital transformation work for prosperity. Recommendations emerging in these policy dimensions need to be considered by policy makers when putting the framework into practice, including for the development of a digital transformation strategy.

Governments and stakeholders must work together to shape a digital future that harnesses the immense opportunities of digital transformation to improve the lives of all people. This requires a balancing act that will not be the same for all countries, as cultural and other factors will influence the most suitable policy environment. The OECD Going Digital Integrated Policy Framework and this report are designed to help countries strike this balance, make better policies in the digital era and ensure that no one is left behind.

Wonki Min
Vice-Minister, Ministry of Science and Information Communication Technology, Korea
Chair, OECD Committee on Digital Economy Policy

Table of Contents

Foreword ... 3
Acknowledgements ... 4
Editorial: Making digital transformation work for growth and well-being ... 6
Acronyms and abbreviations ... 13
Executive Summary ... 15

Chapter 1 **UNDERSTANDING DIGITAL TRANSFORMATION**
- Introduction ... 18
- The digital technology ecosystem ... 18
- The data revolution ... 22
- Key properties ("vectors") of digital transformation and evolving business models ... 26
- Notes ... 32
- References ... 32

Chapter 2 **ENHANCING ACCESS**
- *Enhancing access: What matters most for policy?* ... 37
- Prepare for more people and things going online than ever before ... 38
- Invest in broadband to empower future technologies ... 39
- Promote competition and remove barriers to investment to boost connectivity ... 41
- Expand access in rural and remote areas to connect everyone ... 43
- Enhance access to data to unleash its potential ... 45
- Notes ... 47
- References ... 47

Chapter 3 **INCREASING EFFECTIVE USE**
- *Increasing effective use: What matters most for policy?* ... 51
- Foster more sophisticated Internet usage for all ... 52
- Realise the potential of digital government ... 53
- Boost adoption, diffusion and effective use of digital tools in firms, especially small and medium-sized enterprises ... 54
- Leverage skills for people, firms and governments to thrive in the digital age ... 58
- Address mistrust to increase online engagement ... 60
- Notes ... 62
- References ... 63

Chapter 4 **UNLEASHING INNOVATION**
- *Unleashing innovation: What matters most for policy?* ... 67
- Promote start-ups and young firms ... 68
- Mobilise the public and private sectors to support science and digital innovation ... 70
- Provide support and incentives to all innovators ... 72
- Realise open government data's potential to drive digital innovation ... 74
- Prepare to reap the promises of digital innovation in sectors ... 75
- Notes ... 78
- References ... 79

Chapter 5 **ENSURING GOOD JOBS FOR ALL**
Ensuring good jobs for all: What matters most for policy? 85
Digital transformation is creating many new job opportunities, but is also challenging many existing jobs 86
Prepare workers for many new jobs and changes to existing ones 88
Empower people with a mix of skills to succeed in a digital world of work 89
Get ready for a massive training challenge 91
Improve social protection to ensure that no one is left behind 93
Address concerns around emerging forms of work 94
Notes 97
References 99

Chapter 6 **PROMOTING SOCIAL PROSPERITY**
Promoting social prosperity: What matters most for policy? 103
Address digital divides to increase inclusiveness 104
Use digital tools to tackle collective challenges 106
Boost civic engagement through digital government strategies 108
Assess the societal impacts of digital technologies by striking a balance between opportunities and risks 109
Notes 113
References 113

Chapter 7 **STRENGTHENING TRUST**
Strengthening trust: What matters most for policy? 119
Adopt a risk management approach to ensuring trust 120
Develop strong, inclusive and interoperable privacy frameworks 121
Manage digital security risk rather than trying to eliminate it 124
Protect consumers as the online and offline worlds converge 125
Notes 129
References 129

Chapter 8 **FOSTERING MARKET OPENNESS**
Fostering market openness: What matters most for policy? 133
Prepare for digital technologies to continue reshaping international trade 134
Reduce barriers to investment and promote open financial markets 137
Monitor changing competitive dynamics 139
Address tax challenges arising from the digitalisation of the economy 141
Notes 143
References 143

Chapter 9 **DEVELOPING A DIGITAL TRANSFORMATION STRATEGY**
Developing a digital transformation strategy: What matters most? 146
Establish a governance approach that supports effective co-ordination 147
Articulate a strategic vision and ensure coherence 149
Assess key digital trends, related policies and regulations 150
Develop a comprehensive and coherent strategy 151
Implement the strategy successfully 152
Notes 155
References 155

Chapter 10 **DEFINING A FUTURE DIGITAL AGENDA**
A future digital agenda 158
Notes 163
References 163

List of Figures 165

List of Tables 166

List of Boxes 166

Acronyms and abbreviations

AI	Artificial intelligence
APEC	Asia-Pacific Economic Cooperation
BEPS	Base Erosion and Profit Shifting
BIAC	Business at OECD
CBPR	Cross-Border Privacy Rules
CDN	Content delivery network
CRM	Customer relationship management
DSTRI	Digital Services Trade Restrictiveness Index
DTS	Digital transformation strategy
EB	Exabyte
EDI	Electronic data interchange
ERP	Enterprise resource planning
FDI	Foreign direct investment
GB	Gigabyte
GDP	Gross domestic product
GDPR	General Data Protection Regulation
GST	Goods and services tax
GVC	Global value chain
HPC	High-performance computing
ICT	Information and communication technology
IoT	Internet of Things
IP	Internet protocol
IPRs	Intellectual property rights
IXP	Internet exchange point
KBC	Knowledge-based capital
M2M	Machine-to-machine
Mbps	Megabits per second
MNO	Mobile network operator
MOOC	Massive open online course
P2P	Peer-to-peer
PIAAC	Programme for the International Assessment of Adult Competencies
PISA	Programme for International Student Assessment
PPP	Public-private partnership
QC	Quantum computing
R&D	Research and development
RFID	Radio-frequency identification
RRI	Regulatory Restrictiveness Index
SCM	Supply-chain management
SMEs	Small and medium-sized enterprises
STEM	Science, technology, engineering and mathematics
STRI	Services Trade Restrictiveness Index
TUAC	Trade Union Advisory Committee
USD	United States dollar
VAT	Value-added tax
VC	Venture capital
WTO	World Trade Organization

Executive Summary

Digital technologies and data are transformational. People, firms and governments live, interact, work and produce differently than in the past, and these changes are accelerating rapidly. How can we realise the immense promises of digital technologies and data for growth and well-being in a fast evolving world? This report charts the road ahead. It identifies seven policy dimensions that allow governments – together with citizens, firms and stakeholders – to shape digital transformation and improve lives: 1) access; 2) use; 3) innovation; 4) jobs; 5) social prosperity; 6) trust; and 7) market openness. It also highlights key opportunities, challenges and policies related to each dimension; offers new insights, evidence and analysis; and provides recommendations for better policies in the digital age.

Access to communications infrastructures, services and data

Demands on networks are growing as more people, things and activities go online. By 2022, there will be three connected devices per person around the globe. Nevertheless, network capacity lags behind in many countries, with only 7% of people in the OECD having a fibre broadband connection. To enhance access to networks, services and data, governments should lower barriers to trade and investment, promote competition, simplify administrative procedures, and boost connectivity in rural and remote areas. Data also increasingly serve as a foundation of digital transformation, and enhancing access to data is essential, including through sharing mechanisms that reflect legitimate national, private and security interests.

Effective use of digital technologies and data

Most people and organisations use digital tools, but often far from their full potential. While nearly all firms are connected to the Internet, only 33% of large and 11% of small firms perform big data analysis. Closing the gap requires developing needed skills: only 31% of adults have sufficient problem-solving skills to succeed in a world of ubiquitous technologies. To increase effective use, policies should empower everyone with a mix of skills to thrive and trust in a digital world; boost adoption and diffusion of digital tools to drive productivity growth in firms, and small and medium-sized enterprises in particular; promote business dynamism and structural change; foster investment in intangible assets (e.g. patents, software); and make digital government services more user-centred.

Data-driven and digital innovation

Data-driven and digital innovation are on the rise. In the first half of 2018, artificial intelligence start-ups received 12% of private equity investment worldwide and the share is increasing in all major economies. But not all countries innovate in the same way or to the same extent: over 2013-16, about 60% of the People's Republic of China's patents were in information and communications technologies compared to 33% of OECD countries' patents. To unleash digital innovation, policies should promote entrepreneurship; facilitate access to finance; support basic research, knowledge diffusion and open science; and open up government data. Policies should also encourage experimentation and new business models across sectors, including by promoting the flexible application or enforcement of regulation (e.g. regulatory "sandboxes").

Good jobs for all

The world of work and labour markets are transforming. An estimated 14% of jobs across the OECD face a high likelihood of automation and another 32% are likely to face significant change over the next 10-20 years. However, over the past decade, four out of ten jobs

were created in highly digital-intensive sectors and new forms of work arose in tandem. To ensure good jobs for all, we must get ready for a massive training challenge. Policies need to facilitate successful and fair transitions into new jobs and prepare for changes to existing ones by striking a balance between flexibility and mobility, on the one hand, and job stability on the other, including through social dialogue. Polices must also empower people with the mix of skills needed to succeed, improve social protection to ensure no one is left behind and address concerns about emerging forms of work.

Social prosperity and inclusion

Society is going digital too, as digital technologies and data empower people by increasing access to information and enabling new avenues of engagement. On average, 12% of people post civic or political opinions online. However, divides persist along a range of dimensions; for example, less than half of young women compared to young men are able to program. To promote social prosperity, policies should reduce divides by strengthening foundational skills and life-long learning and include everyone – notably women, the elderly and low-income individuals – while tackling risks like cyberbullying and disinformation. Digital technologies can also help to address collective challenges, for example by promoting energy efficiency and reducing healthcare costs, e.g. through mobile health technologies.

Trust in the digital age

Trust fundamentally underpins digital transformation. Almost 30% of Internet users do not provide personal information to social networks because of security or privacy concerns. Moreover, only 17% of peer platform (e.g. home-sharing) users read the terms and conditions in full, suggesting that more effective measures are needed to protect consumers online. To strengthen trust, policies should encourage people and organisations to better manage digital security and privacy risks and improve consumer protection online. National privacy strategies can help promote a whole-of-society perspective and facilitate cross-border data flows, e.g. through interoperable privacy frameworks.

Market openness in digital business environments

Digital technologies and data transform how firms compete, trade and invest. Cross-border acquisitions of digital-intensive firms grew 20 percentage points more than those in other sectors over 2007-15. Firms in highly digital-intensive sectors also enjoyed a 55% higher mark-up – the wedge between the price a firm charges for its output and the cost the firm incurs to produce one extra unit of output – than other firms. To foster market openness and dynamism in digital business environments, policies should: reduce barriers to trade and investment; promote open financial markets; tackle changing competition dynamics, including issues related to increasing concentration; and address tax challenges through more effective international co-operation.

None of these policies can be successful on their own. Governments need a comprehensive digital transformation strategy and governance approach that supports effective co-ordination across policy areas and among all stakeholders. A strategic vision, clear priorities and objectives, measurable targets, sufficient budget, and thorough monitoring of progress and policy evaluation are essential elements of a successful digital transformation strategy.

While this report addresses some of the most pressing and difficult questions societies face to make digital transformation work for growth and well-being, it also maps out a future global digital agenda to better understand and address new and complex issues. This agenda includes changing competition dynamics; privacy; data and cross-border data flows; growing inequalities and their relationship with digital transformation; restoring trust in government; democracy in the digital age; and the future of the firm. Finally, it remains essential to better measure digital transformation to provide sound evidence on which to base future policy decisions.

Chapter 1

UNDERSTANDING DIGITAL TRANSFORMATION

Introduction

Reaping the benefits and addressing the challenges of the digital age requires narrowing the gap between technological developments and public policies. Many policies are the legacy of the pre-digital era, and difficulties in understanding the changes underway and their implications may delay the review and adaptation of these policies. Such an understanding is imperative as digital transformation affects the entire economy and society.

1.1. What is digital transformation?

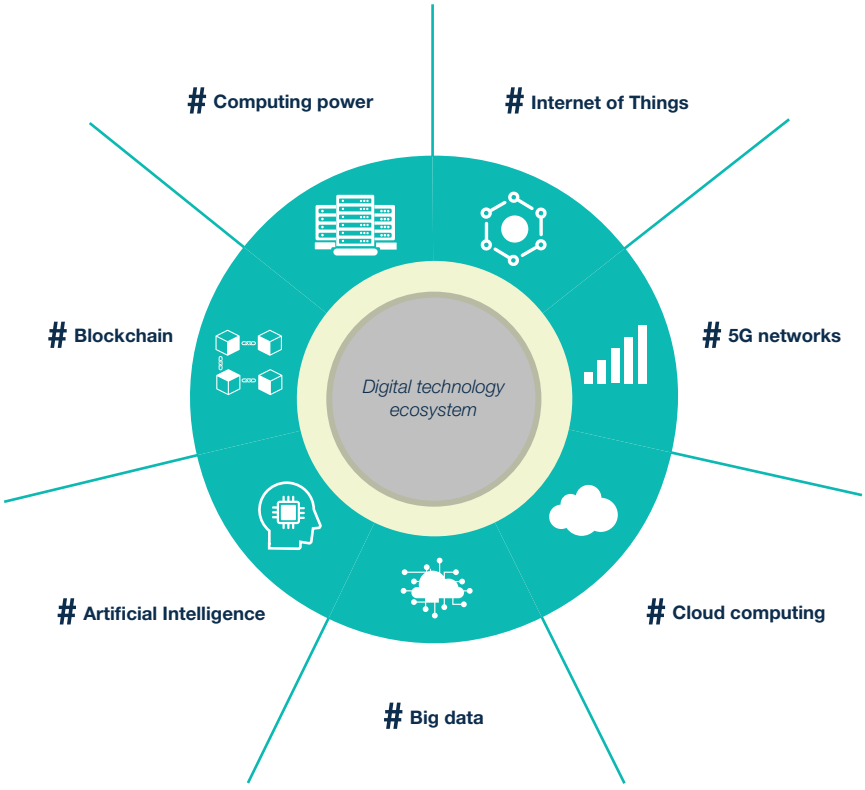
Digitisation is the conversion of analogue data and processes into a machine-readable format. Digitalisation is the use of digital technologies and data as well as interconnection that results in new or changes to existing activities. Digital transformation refers to the economic and societal effects of digitisation and digitalisation.

To develop policies fit for the digital age, it is critical to be aware of the main elements of the evolving digital technology ecosystem and some of the opportunities (and challenges) resulting from their application. Second, it is essential to understand the data revolution that is taking place, and how data and data flows affect individuals, the economy and society more broadly. Third, it is important to identify the key properties of digital transformation, including how they are driving new and evolving business models, and what their implications are for public policy.

The digital technology ecosystem

Dramatic increases in computing power and a simultaneous decline in related costs over the last 60 years has driven the rapid advance of digital technologies (OECD, 2015[1]; Moore, 1965[2]). Today, an ecosystem of interdependent digital technologies underpins digital transformation and will evolve to drive future economic and societal changes (Figure 1.1).

1.1. An ecosystem of interdependent digital technologies



This ecosystem is much stronger and functional than its individual components because they interoperate with and complement one another, opening up new possibilities. Some of these technologies have already arrived and are part of our daily lives. Others are still on the horizon. All of these technologies hold potential benefits for growth and well-being.

Internet of Things

The Internet of Things (IoT) enables a host of new business models, applications and services based on data collected from devices and objects, including those that sense and interface with the physical world. IoT devices involve those with both short- and long-range communication connectivity. Massive machine-to-machine (M2M) communications which are composed of sensors for smart cities, agriculture, manufacturing and the like are a subset of the IoT.

The IoT includes automations from smart home devices and appliances, wearables and health monitors, to advanced applications like connected and autonomous vehicles. In fact, today airplane turbines constantly gather data and can relay them when a problem arises. When the plane lands, a maintenance crew is ready with the right parts and knowledge of what the issue is, alleviating delays. Remote mining and surgery, for example, will also become practical thanks to the IoT. Utilities will be interconnected with millions of networked devices, allowing them to take more informed decisions autonomously and in real time. Moreover, Internet-connected sensors and actuators will monitor the health, location and activities of people and animals, the state of the environment, and much more (OECD, 2016[3]).

Next-generation wireless networks: "5G" and beyond

While the international standard is not yet finalised, 5G will be the first generation of wireless networks conceived mainly for a future in which tens of billions of devices and sensors are connected to the Internet.[1] Major improvements upon previous network generations include higher speeds (i.e. 200 times faster than 4G), faster data transfer (i.e. 10 times less than 4G), and networks that better support diverse applications through the virtualisation of the physical layers (i.e. "network slicing"). Trials are underway in multiple countries, including through collaborations between network operators and vertical industries such as the automotive industry (OECD, forthcoming[4]).

A major difference with 5G is that it is designed to connect not just people, but things, underpinning a world of M2M communication that takes place largely hidden from human eyes. 5G networks will improve communication between self-driving vehicles, roads and traffic lights, making "platooning" feasible – the automatic linking of vehicles on highways in a convoy so that they are much closer together than what would be safe with human drivers. This could ease road congestion as well as improve safety and fuel efficiency. In addition, sensors embedded throughout farms will be able to communicate crops' water and fertilisation needs directly to agricultural machinery and systems. Personal devices will download data at far higher speeds even in crowded areas, realising the potential coverage of on-demand media from almost any location reached by 5G networks.

Cloud computing

Cloud computing is a service model that provides clients with flexible, on-demand access to a range of computing resources (OECD, 2014[5]). Clients access such resources (e.g. software applications, storage capacity, networking and computing power) online. The resources can be used (and priced) in a scalable and adaptable manner, enabling customers to transform substantial fixed costs for information and communication technologies (ICTs) into lower marginal costs, and to more easily match their supply of ICTs with their evolving business needs. In other words, cloud computing allows users to rent the ICTs they need at any given time rather than having to buy them outright. Cloud computing increases the affordability, availability, capacity, variety and ubiquity of computing resources in a way that facilitates other digital technologies, such as artificial intelligence (AI), autonomous machines, big data and 3D printing, as well as the wider digital transformation (OECD, 2015[1]; OECD, 2017[6]).

Cloud computing applications abound and go well beyond simple storage of personal files, photos and videos; they also allow remote access and enable people to collaborate on documents at a distance. For example, personal CD and DVD collections are becoming things of the past as we migrate to

streaming audio and video services like Deezer, YouTube and Netflix, all of which are made possible by cloud computing. We can carry access to our entire personal libraries around with us on a single tablet, thanks to ebooks that are stored in the cloud. Duplicating copies of computer files onto a locally connected hard drive and then manually moved off-site for disaster recovery purposes is no longer needed. Instead, backup and disaster recovery services are directly accessible in the cloud. Mobile apps reside in the cloud and often rely on it to function even after they are downloaded. Smart thermostat systems use cloud computing to monitor, analyse and adjust to temperature trends in homes, leading to less energy consumption, lower utility bills and "greener" living.

Big data analytics

The term "big data" commonly refers to data characterised by high volume, velocity and variety. It benefits from the IoT, among other technologies, as a source of data and from cloud computing as a source of processing power. While large quantities of data can have value in themselves, namely when commercialised, most of their value depends on the capacity to extract information from the data. Big data analytics techniques and software tools are used, for example, for data (text) mining, profiling and machine learning. By fostering new products, processes, organisational methods and markets, and improving existing ones, the use of (big) data analytics enables data-driven innovation and the potential to improve productivity and well-being (OECD, 2015[1]).

Big data analytics have enormous potential, some of which has already been realised. For example, retailers routinely use big data analytics to make tailored suggestions to customers based on the customers' interests as revealed by their prior browsing and shopping behaviour. In a quite different setting, neonatal units monitor the heartbeats and breathing patterns of premature and sick babies, feed the data into an ever-growing database and, with the assistance of analytics, can predict infections 24 hours before the babies show any physical symptoms.

With enough data from developing countries, governments and aid organisations can maximise their impact by using big data analytics to identify areas where people will benefit the most from better access to education, healthcare and infrastructure. Epidemiologists can take big data from search engines into account when finding and tracking contagious disease outbreaks. Competition authorities can fight corrupt business practices such as bid rigging more effectively with the help of big data, which can be used to identify suspicious bidding patterns. Physicists also benefit from big data, which has made projects such as the *Conseil européen pour la recherché nucléaire*'s (CERN's) Large Hadron Collider (LHC) possible. The LHC produces 30 petabytes[2] of data per year. The CERN's data centre contains 65 000 processors, but it also uses thousands of other computers across 170 other data centres to analyse its data. Big data also underlies AI.

Artificial intelligence

AI is the ability of machines and systems to acquire and apply knowledge, including by performing a broad variety of cognitive tasks, e.g. sensing, processing language, pattern recognition, learning, and making decisions and predictions. Much recent progress in applying AI is driven by machine learning (when machines make decisions based on probability functions derived from past experiences), big data analytics, dramatically increased processing power and cloud computing, all of which enable AI to process data at enormous scales and to accelerate the discovery of patterns in data. AI drives new kinds of software and robots that are increasingly: 1) "autonomous" or semi-autonomous, meaning they make and execute decisions with no or little human input; and 2) capable of learning, evolving and improving throughout their life cycle to customise and improve functionality and performance based on the analysis of data collected from their environment.

AI is already part of daily life in many countries. Learning algorithms detect patterns in our digital behaviour and use them to influence the search results and advertisements we see, the news we read and the entertainment we consume. For instance, recommendations on Amazon, Netflix and Spotify are based on machine learning technologies. AI helps doctors to detect, track and treat diseases. Robotic surgeons are already in use. Furthermore, algorithms now conduct more stock market trades autonomously than humans in the United States (OECD, 2015[1]). AI applications still hold many promises for the future as well. For example, AI will eventually give robots the ability to adapt to new working environments with no need for reprogramming.

Someday, AI-powered robots might care for elderly people, tending to their physical needs while interacting with them. In the future, AI might sift through databases of medical histories to develop tailored treatment plans that are most likely to work for individuals with a given set of characteristics, replacing one-size-fits-all approaches. Some people find some of AI's future prospects unsettling, though, such as its use in driverless cars or in robots that could displace significant portions of today's workforce.

Blockchain

Blockchain is a technology that enables applications to authenticate ownership and carry out secure transactions for a variety of asset types. It is a ledger or a spreadsheet that is maintained and stored across a network of computers. The network regularly updates the database in every place it exists, so that all copies are always identical. This means the records are visible and verifiable to everyone else in the network and there is no need for intermediaries to serve as authenticators. New events and transactions are automatically stored in "blocks" which are then chained to one another chronologically using advanced cryptography, creating a digital record. Should someone try to change information stored in the block, the "chain" is broken and all nodes in the network are aware of it. It is for this reason that this technology is called blockchain and that it is often described as tamper resistant.

Blockchains can be public, called "unpermissoned", whereby access and transfer occur between parties unknown to one another (e.g. Bitcoin). In contrast, private or "permissioned" blockchains enable access and transfer between specific parties, and are executed much more quickly. Some blockchains can also execute software in a decentralised manner, without the need for intervention from a central operator. This means that some applications, often known as "smart contracts", can execute in a pre-defined and strictly deterministic manner. The third generation of blockchain technology, which is currently unfolding, allows interoperability across different blockchains.

One of blockchain's most widespread application so far has been for cryptocurrencies (e.g. Bitcoin, Ripple), but it is starting to affect many other sectors, including agriculture, manufacturing, retail, healthcare, energy, transport and the public sector. Eventually, a major application of blockchain may be securing data in the cloud. It could also be used to make everything from charitable donations to elections more verifiable and secure. However, the immutability of blockchain may impact the "right to be forgotten" in some jurisdictions.

Computing power

High-performance computing (HPC) is the aggregation of processing power to deliver far higher performance than would be possible with an ordinary computer. HPC is typically used to solve big science, engineering or business problems. It can also be used for other purposes, such as in the well-known case of DeepMind's AlphaZero, to run software that trains itself how to play board games. In fact, it took only nine hours of training for AlphaZero to defeat world champion Go and chess programmes. HPC is growing more important for firms in a wide variety of industries, including construction, pharmaceuticals, the automotive sector and aerospace. The ways in which HPC is used in manufacturing are also growing, as they now include not only applications such as design and simulation but also real-time control of complex production processes.

Quantum computing (QC) takes a fundamentally different approach. Traditional computing processes data in an exclusive binary state at any point in time (that is, bits take a value of either 0 or 1 and cannot be a superposition of 0 and 1). In contrast, QC relies on "qubits" which are organised in "states" that represent some combination of 0 and 1 (Metodi, Faruque and Chong, 2011[7]). The qubits, even when separated by huge distances, can interact with each other instantaneously (they are not limited to the speed of light). "Entangled" with each other in pairs through a process known as correlation, they can be used together with an algorithm to answer questions. This is an emerging field and substantial obstacles still need to be overcome. For example, most of today's experimental quantum devices must operate in temperatures near absolute zero and require the development of new materials. However, if it succeeds, QC would be an enormous leap in processing power due to its ability to operate in multiple states and to perform tasks using all possible permutations simultaneously.

QC's ability to process information at almost unthinkably fast speeds versus today's ICTs would make it perfect for AI and cloud computing. This is because they require network systems that do not get

bogged down with heavy use. In addition, if blockchain secures much of what is stored in the cloud, QC would become even more useful in light of the formidable computing power and electricity required to complete blockchain transactions. Quantum computers could also be used in simulators that replicate real physical systems, allowing manufacturers to design things such as better batteries and satellites or new materials for airplanes. While QC may challenge existing digital security technologies such as cryptography, it could also be used to support new ones.

The combination of technologies in one digital ecosystem multiplies their potential

Each technology alone can bring its own opportunities and challenges, but the biggest potential lies in their combination within one digital technology ecosystem. For example, cloud computing's effectiveness requires always-on, everywhere-available and high-speed Internet connectivity and is essential to big data analytics, which also relies on powerful computing. The use of billions of devices and sensors in the IoT generates big data that are a key resource for sophisticated algorithms and machine learning, enabling AI to be used in an ever-growing range of areas, and turning AI itself into a resource.

Thanks to a confluence of technologies, machines can view and understand images and videos ("computer vision"). Consequently, a machine in the cloud using AI can communicate with drones over 5G networks, enabling them to identify anything from license plates on a vehicle to a leak in a pipeline in real time. Finally, the smartphone illustrates how the use of many key digital technologies, e.g. fast connectivity, access to cloud services, multiple sensors, AI, etc., have already become ubiquitous and play an increasingly important role in everyday life. Assessing the opportunities and challenges created by the use of each of these technologies alone and in combination is thus essential to developing policies well-suited to the digital age.

The data revolution

The digital technology ecosystem relies on data. Data increasingly underpin digital transformation and have become an important source of value, for example for decision-making and production. While issues around data span across policy areas and are addressed throughout the report, it is important to first understand data as a critical resource and a source of value, as well as some transversal policy challenges related to data.

Recognising data as a critical resource

Data have been collected ever since humans recorded facts as symbols such as numbers, but the volume of data collected in the past is a drop in today's growing data ocean. Every day, more data are produced than since the dawn of civilisation up until the early 2000s (Siegler, 2010[8]): roughly 5 Exabytes, which corresponds to 1.25 billion DVDs (CISCO, 2017[9]). Until recently, humans recorded most data themselves and often on rigid materials such as paper. Today, most data are collected by machines that are equipped with great storage capacity, powered by fast processors, and connected to the Internet.

Key technologies that produce and use data have become so ubiquitous, small and inexpensive that over a third of the global population carries a smartphone. In turn, connected devices, and smartphones in particular, are central platforms for data collection and consumption, alongside the IoT with its growing number of sensors and actuators embedded in devices, infrastructures and environments.

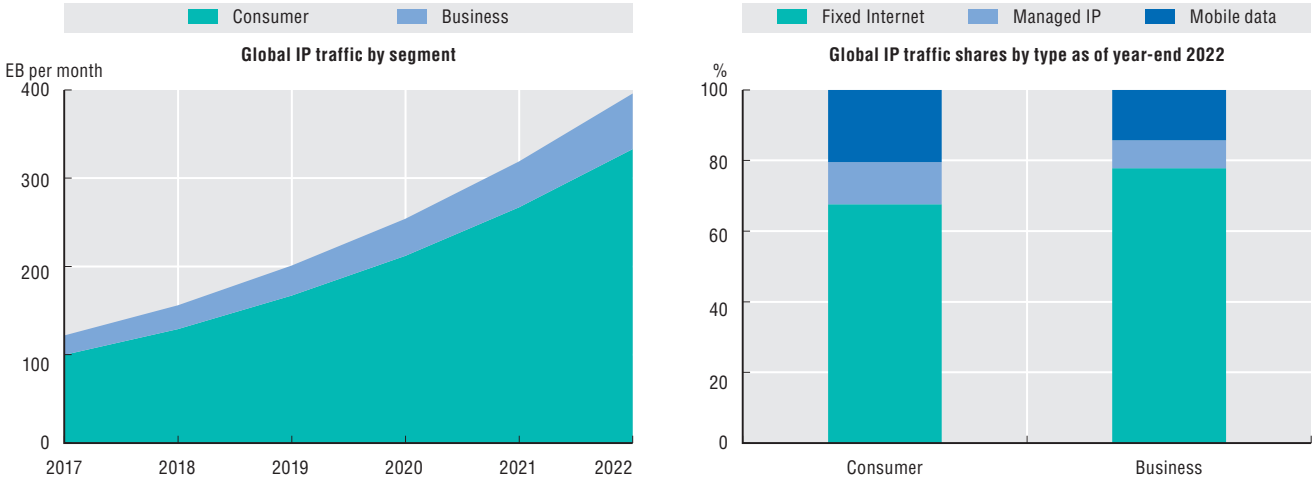
While data sources are multiplying, a majority of the data exchanged over global Internet protocol (IP) networks, notably the Internet, is created and used by consumers, in particular Internet videos. In 2018, Internet videos represented 49% of global IP traffic and 76% of global consumer Internet traffic; by 2022 the respective shares are projected to reach 61% and 82%. Meanwhile, the fastest growth in Internet traffic is expected to occur on mobile networks, driven by 47% annual growth (compound annual growth rate) of mobile consumer Internet traffic between 2017 and 2022 (Figure 1.2).

Data have become an important and valuable resource. Data are not a natural resource like oil, water, or air: they are created by humans and produced through human (and increasingly machine) activity. Data can be characterised as being of general purpose, non-rivalrous, and a capital good[4] (OECD, 2015[1]). In contrast to natural resources, the volume of data increases with its collection and

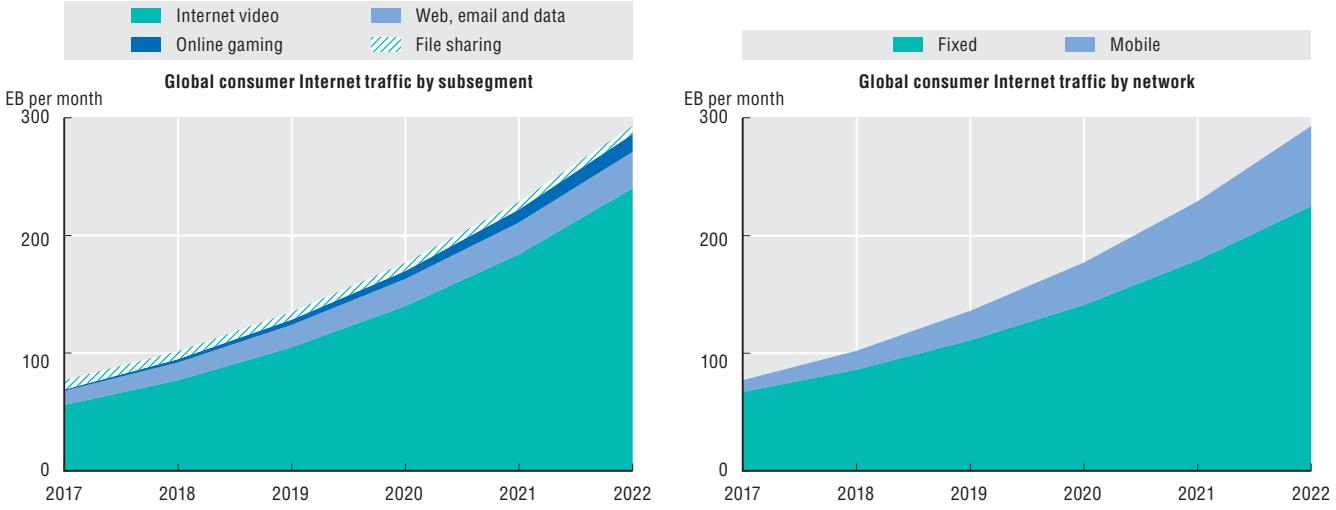
use. Digital data can be copied and re-used endlessly, enable economies of scale and scope, power AI, and be used to improve existing or invent new products and (virtual) reality. This also means that the economy's function of allocating scarce resources may be affected would data as an abundant resource be accessible by all.

1.2. Consumer Internet videos make up almost half of global IP traffic

Global IP traffic in Exabytes per month, 2017-22



Global consumer Internet traffic in Exabytes per month, 2017-22



Notes: EB = Exabyte. See Chapter notes.[3]

Source: CISCO (2018[10]), "Visual Networking Index: Forecast and trends", *https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/complete-white-paper-c11-481360.html* (accessed January 2019).

StatLink https://doi.org/10.1787/888933914784

Digital data differ from analogue insofar that they can be used, re-used, copied, moved, and processed cheaply, without degradation, and very fast. Again, in contrast to natural resources, processing and movement of data are neither constrained by gravity nor by material resistance. Data can flow at the speed of light, underpinning its velocity, between people, businesses and machines, across borders and the globe in milliseconds, thanks to the first truly global infrastructure ever built, the Internet. Delivering exploding volumes of data around the globe, the Internet has evolved as a network of networks, made up of cables, exchange points, masts, etc.; however, fast data delivery increasingly relies on local caching of data, close to where people demand and expect it, at their fingertips (Box 1.2).

1.2. Content delivery networks and local caching of data

Content delivery networks (CDNs) serve as aggregators of content, systems for the delivery of traffic directly to the terminating network, and providers of quality-enhancing inputs, such as caching of data close to the end user. CDNs are useful to providers of online services, such as the BBC, Google, Netflix and Hulu, which seek to improve their customers' experience. More direct delivery, fewer intermediate loops, and local caching reduce latency and improve the quality of service.

Local caching of data reduces the volume of traffic that needs to be delivered to the terminating network. Caching refers to the storage of data locally so that data requests can be referenced to previous results and responded to faster. This means that it isn't necessary to access the same data, potentially far away, in response to a similar previous request. As such, CDNs are used by YouTube for fast delivery of high-quality videos via local caches close to the consumer.

Source: Weller and Woodcock (2013[11]), "Internet traffic exchange: Market developments and policy challenges", *http://dx.doi.org/10.1787/5k918gpt130q-en*.

Data are not homogenous. In theory, the variety of different types of data is infinite. In practice, many approaches are being developed to distinguish between different types of data and data flows, including by the OECD (Box 1.3). Other distinctions include, for example: public sector versus private sector data; personal versus non-personal data (Hofheinz and Osimo, 2017[12]); user-created versus machine-generated data; data distinguished by the actors exchanging it, such as business to business (e.g. financial or IoT), business to consumer (e.g. media, consumer), government to user (e.g. services), or consumer to consumer (e.g. communications, social) (Kommerskollegium, 2014[13]); qualitative versus quantitative data; structured versus unstructured data; or data distinguished by their origin, e.g. whether data is provided, observed, derived, or inferred, etc. (OECD, forthcoming[14]).

1.3. Disentangling different types of data

Among multiple ways to possibly break down data into different types, one approach developed by the OECD with relevance for policy making distinguishes the following:

- **Personal data** include data that allow for the identification of an individual data subject (OECD, 2013[15]). They can cover public and private sector data, e.g. user-generated content (i.e. blogs, photos, tweets) or geo-location data from mobile devices as well as public sector data (i.e. police records, social security numbers).
- **Public sector (government) data** include data that are generated, created, collected, processed, preserved, maintained, disseminated, or funded by or for the government or public institutions and include open government data.
- **Private sector data** complement public sector data, namely as data that is generated, created, collected, processed, preserved, maintained, disseminated and funded only by private sector.
- **Proprietary (private) data** include public or private sector data protected by intellectual property rights (IPRs) (e.g. copyright and trade secrets) or by other rights with similar effects (e.g. provided by contract or cyber-criminal law).
- **Research data** include factual records (numerical scores, textual records, images and sounds) used as primary sources for scientific research, and that are commonly accepted in the scientific community as necessary to validate research findings.
- **Public (domain) data** are not protected by IPRs (or other similar legal rights) and therefore lie in the "public domain" and are publicly available, free for use by anyone for any purpose without any legal restrictions.
- **Data of public interest** include public or private sector as well as personal or non-personal data needed to fulfil well-defined societal objectives that otherwise would be impossible or too costly to fulfil.

Source: OECD (forthcoming[14]), *Enhanced Access to Data: Reconciling Risks and Benefits of Data Sharing and Re-use*.

Extracting insights from data creates value

Data by themselves do not necessarily have intrinsic value. Their value not only depends on volume, variety and velocity of data (i.e. "big data"), but also depends on their veracity, quality or fitness for use, and other factors inherent to the data (OECD, 2011[16]). Specific characteristics of data may be more valuable for some users than for others, e.g. velocity is crucial for an application providing traffic updates, but much less so for an online genealogy service. This illustrates that the value of data depends on the context and the potential benefit of their use. More specifically, data become valuable when information can be derived from them, and such information is always context-dependent (OECD, 2013[17]).

Data analytics are essential to extract insights from data and to create value. Data analytics include a set of techniques, tools – software, AI, visualisation tools, etc. – that help extract information from data by revealing the context in which the data are embedded and their organisation and structure. Effectively analysing data with such tools crucially requires human capacity, notably skills, such as data analytic and management skills. Data analytics help extract information from data, which can be used to generate knowledge and/or support decision making. Rather than being a linear process, value creation from data takes place in a value cycle with feedback loops at several stages of value creation. This value cycle reflects an ongoing process of: datafication and data collection, structuring big data, extracting insights through analytics, constituting a knowledge base, making decisions and adding value (OECD, 2015[1]).

A key purpose of creating value from data is to improve decision making and drive innovation. Data become valuable if used to improve social and economic processes, products, organisational methods, and markets. Data-driven innovation underpins many new business models that transform markets and sectors such as agriculture, transport and finance, driving productivity growth (OECD, 2015[1]). More generally, data and data analytics are a key pillar of knowledge-based capital (KBC). KBC increasingly supports production in service and knowledge economies, and also includes intellectual property (e.g. patents, copyrights, designs and trademarks) and economic competencies (e.g. firm-specific human capital, networks of people and institutions, and organisational know-how) (OECD, 2013[18]). Finally, value creation from data can be leveraged, for example by enhancing access to and sharing of data and thus fostering data reuse (see Chapter 2).

Identifying key challenges related to data

As data become a social and economic resource, including for value creation, decision-making, innovation and production, policy makers are facing a number of issues. Selected important issues include the value, ownership, flows and protection of personal data, as well as potential data concentration and divides.

It is difficult to assess the value of data in itself, given that value is essentially created when data are contextualised and analysed to derive information. In addition, the environment in which some data are used tends to be uncertain, complex and dynamic (e.g. research) (OECD, 2013[17]). The value of data furthermore depends on their structure and the capacity to derive insights from them, notably analytic techniques and technology for data analysis, as well as prior knowledge and skills (OECD, 2015[1]). Attempts to nevertheless impute the value of data remain imperfect proxies so far. For example, one estimate suggests that considerable consumer surplus is generated by digital products – and indirectly by the data used for and by them (Brynjolfsson, Eggers and Collis, 2018[19]).

The concept of "data ownership" is controversial. The right to control access, copy, use and delete data – the main rights associated with the concept of data ownership – are affected in different ways, notably by different legal frameworks, e.g. copyright and related rights, and applicable *sui generis* database rights and trade secrets or, where personal data are concerned, privacy protection law (OECD, 2015[1]; OECD, forthcoming[14]). In practice, the intricate net of legal frameworks, combined with the involvement of multiple parties in the creation and reuse of data, including across national borders, motivates many stakeholders to rely on contract law as the primary legal means for defining proprietary rights related to data access and use (OECD, forthcoming[14]).

Data increasingly underpin trade in the digital age and any measures affecting data flows are likely to have trade consequences, among others. Such measures may, for example, result from data-related regulation, such as local storage requirements, personal data protection agreements or trade agreements that cover cross-border data flows. A number of existing measures already make some cross-border data flows conditional or ban others altogether (Casalini and López González, 2019[20]). Many of them concern

personal data, in relation to which the OECD 1980 *Recommendation of the Council concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data* recommends that: "Any restrictions to transborder data flows of personal data should be proportionate to the risks presented, taking into account the sensitivity of the data, and the purpose and context of the processing" (OECD, 2013[21]).

Protecting data requires managing risk. The benefits of storing, using, accessing and sharing data come with potential risks that may arise from any of these activities, and risks need to be managed well to maximise benefits (OECD, 2015[22]). This balancing act involves costs and legitimate private, national, and public interests, in particular the rights and interests of the stakeholders involved in producing and using data. Privacy and IPRs need to be protected and enforced; otherwise incentives to contribute data and to invest in data-driven innovation may be undermined, in addition to direct harm that may occur to rights holders (including data subjects) (OECD, forthcoming[14]).

Data may also not be equally distributed. Concentration of data is visible, for example, in countries with many domestically hosted sites and high numbers of co-location data centres, often countries with a large population and uniform policies. Concentration is also present at sectoral and/or firm level, with some companies holding disproportionally more data than others. The same companies also tend to concentrate the capacity needed to create value – information and knowledge – from data. Information and knowledge asymmetries may in turn affect the distribution of power, with shifts: 1) away from individuals to organisations (including consumer to business, and citizen to government); 2) from traditional businesses to data-driven businesses; 3) from governments to data-driven businesses; and 4) from lagging economies to data-driven ones. These shifts in turn result in new divides, with implications for social cohesion and economic resilience (OECD, 2015[1]).

National data strategies can help realise the potential of data, including through sharing and reuse. Strategies aimed to balance the issues mentioned above and achieve a social contract that unleashes the potential of data are uncommon today. However, some countries are in the process of developing such a strategy, and some data-related aspects are already addressed in open government data strategies as well as in national digital economy and/or security strategies, and others are on the verge of being addressed in emerging national privacy strategies (OECD, forthcoming[23]). Building on these existing strategies, governments could consider developing consolidated broader data strategies as a comprehensive and coherent approach to leverage the potential of data for value creation while addressing the related challenges (OECD, 2018[24]).

Key properties ("vectors") of digital transformation and evolving business models

The use of digital technologies and data underpins digital transformation across many sectors and policy areas. To better understand the cross-cutting effects of the transformation, the OECD has identified seven "vectors of digital transformation" that describe key properties of digital transformation (OECD, 2019[25]). The vectors of digital transformation offer an overarching perspective by describing the underlying and cross-cutting nature of the changes induced by digital transformation and their implications across different sectors and policy domains. As a result, they help overcome an often fragmented understanding of policy issues and facilitate a whole-of-government approach to shaping digital transformation (see Chapter 9).

Many properties of digital transformation, e.g. new sources value creation, impact business models and organisations. Firms that make use of digital technologies and data often compete in areas previously dominated by large incumbents. In some cases, new players create entirely new markets; in other cases, they shake up existing ones, driving structural change and incentivising traditional businesses to reinvent themselves. Recent business models that have emerged include those using online platforms and those combining online and offline features. The development of new payment mechanisms, which support digital transactions in a range of business models, represents another business innovation.

Scale, scope and speed

Digital technologies and data enable firms to create digital products or digitise existing ones, to digitalise business processes, to buy and sell online, and to implement new business and organisational models. These opportunities underpin the digital transformation of products, firms and markets. Three key properties of that transformation include economies of scale without mass, new economies of scope in digital environments, and speed and have a range of policy implications (Table 1.1).

1.1. Vectors of digital transformation: Scale, scope and speed

Vectors	Description	Examples of policy implications
Scale without mass	Core digital products and services, notably software and data, have marginal costs close to zero. Combined with the global reach of the Internet, these products and the firms and platforms that use them can scale very quickly, often with few employees, tangible assets and/or no geographic footprint.	The scale effect of being digital may allow the rapid acquisition of market share – which may be fleeting – suggesting that policies should ensure that barriers to entry and innovation are low, and adjust size-based approaches such as de *minimis* thresholds and categorisation based on number of employees.
Panoramic scope	Digitisation facilitates the creation of complex products that combine many functions and features (e.g. the smartphone) and facilitate extensive versioning, recombination and tailoring of services. Interoperability standards enable the realisation of economies of scope across products, firms, and industries.	Policies may need to span multiple policy domains, requiring co-ordination across historically separate issue areas and a more multidisciplinary perspective. This may argue for high-level principles as opposed to narrow rules, a shift from strict harmonisation to interoperability, and the convergence of policy oversight authority.
Speed: Dynamics of time	Digitally accelerated activities may outpace deliberative institutional processes, set procedures and behaviours, and limit human attention. Technology also allows the present to be easily recorded and the past to be probed, indexed, repurposed, resold and remembered.	Guiding policy principles may be preferred to specific rules that may be quickly rendered obsolete. New approaches such as the use of regulatory sandboxes and the exploitation of data flows and big data analytics may both accelerate and enable more iterative and agile policy making.

Source: OECD (2019[25]), "Vectors of Digital Transformation", *https://dx.doi.org/10.1787/5ade2bba-en*.

A first characteristic of many firms that sell digital products is the ability to quickly reach large scale without accumulating much mass. Unlike physical products, which tend to have high fixed costs and substantial marginal costs that decline with scale, digital products tend to have mainly fixed costs and low, close to zero, marginal costs. This characteristic, combined with the global distribution enabled by the Internet, allows successful firms and platforms to scale quickly, internationally and sometimes with very few employees or tangible assets, and thus "without mass" (Brynjolfsson and McAfee, 2014[26]). While no firm can scale entirely without mass, digital products allow firms to go global without establishing many (if any) plants or hiring many employees. This is in stark contrast to brick-and-mortar industries, where global expansion requires at least some physical presence.

A second characteristic are new economies of scope in digital environments. Once viewed as a benefit realised by conglomerates that could support many product lines by sharing common costs such as legal, finance, accounting, and marketing, or through vertical integration, economies of scope in the digital era come with the ability to categorise, code and store information in standardised digital form, which provides the basis for efficient interaction and reduces transaction costs (Goldfarb and Tucker, 2017[27]). In turn, firms can tailor digital products to individuals in near real-time, establish and maintain customer relations over time, and sell different products, while blurring sectoral boundaries (e.g. a firm operating in retail, ICT services and fulfilment/logistics).

Economies of scope also reflect the capacity of digital technologies to combine many functionalities through efficient combination, integration, miniaturisation and virtualisation. This in turn facilitates combinatorial innovation and engineering which allows functional expansion, such as in a smartphone that typically combines telephony, navigation, photography and music, and allows people to add a host of other applications all in one device (Varian, 2017[28]). As data-driven business models proliferate across sectors from agriculture to finance to transportation to retail, data savvy firms have a comparative advantage, enabling and inducing them to broaden their scope and expand to additional sectors either as new entrants or through acquisitions of existing firms.

A third characteristic is speed, expressed by accelerated economic and social activity: markets clear faster, ideas spread more quickly, the time buffer associated with distance shrinks, as does the time it takes to engage and develop a community or to bring a product to market. Advantage increasingly goes to first movers and fast followers, and to agility supported by rapid, iterative learning. This underpins three business practices that have been associated with the digital era: 1) those that promise to "move fast and break things" (Taplin, 2017[29]); 2) those that achieve scale before profits,[5] facilitated by the near zero marginal cost of digital communication and information sharing; and 3) those that launch an idea before it is perfected with the assumption that iterative learning will come from its use in the market. These characteristics motivate firms to learn quickly – including how best to exploit a slow-moving policy environment.

1.4. Business models based on digital payment innovations

While many firms benefit from either scale, scope or speed, some benefit from any combination of the three. For example, the financial sector was an early adaptor of digital technologies and has seen significant innovation in data-driven business models recently. Digital solutions have started "unbundling" many of the functions previously carried out primarily by banks, such as payment – notably via cash, debit and credit cards or wire transfer – credit, trading and securitisation (OECD, 2018[30]; OECD, 2018[31]).

Digital payment innovations, like mobile money (e.g. M-Pesa), mediated by mobile network operators, are becoming more established, particularly in less-developed financial markets. Some cryptocurrencies promise transparency and immutability of transactions, and digital wallets increasingly enable connected devices to withdraw and transfer money on demand, thereby enabling frictionless payments in the real world.

Such solutions can be scaled up without investing in credit card readers, ATMs or physical banks, including across borders (scale); they can be embedded in online point of sales as well as increasingly in physical stores (scope); and some can be deployed fast and widely, often delivering faster service than traditional payment solutions (speed).

Ownership, assets and economic value

The advantages of scale, scope and speed enabled by digitisation and digitalisation of products, processes and organisations create incentives for firms to invest in intangible assets and new sources of value. Such firms can be digital pure players that start and run their business entirely online. Traditional firms also increasingly invest in intangible assets to enhance their physical products with digital features and/or ancillary services. Finally, some firms that started entirely digital are now expanding into the physical world as well. As a result, firms are increasingly exploiting intangible capital and tapping into new sources of value creation, with implications for policy (Table 1.2).

1.2. Vectors of digital transformation: Ownership, assets and economic value

Vector	Description	Examples of policy implications
Intangible capital and the new sources of value creation	Investment in intangible forms of capital like software and data is growing. Sensors that generate data allow machinery and equipment (e.g. jet engines, tractors) to be packaged with new services. Platforms enable firms and individuals to monetise or share their physical capital easily, changing the nature of ownership (e.g. from a good to a service).	Policy makers may want investment incentives to be more aligned with the economics of digital innovation and production (e.g. R&D, data, intellectual property). The ability to efficiently market services derived from capital equipment (as opposed to direct investments) may have implications for incentives to invest as well as measures of investment and productivity.

Note: R&D = research and development.

Source: OECD (2019[25]), "Vectors of digital transformation", *https://dx.doi.org/10.1787/5ade2bba-en*.

Since the mid-2000s, a growing share of business investment consists of intangible assets rather than traditional physical capital (OECD, 2013[32]). Investments in intangible assets have grown quickly and now match or exceed traditional capital in a number of developed economies (Corrado, Hulten and Sichel, 2006[33]). As they are intangible, assets in the form of know-how or business processes can be wholly or partially digitised and – encoded in data and software – enable firms to adopt new forms of organisation, new sources and processes of value creation, and new business models.

Investment in intangible assets and digital products have long started to deliver returns. While only a decade ago many viewed such investments as a long shot, firms selling digital products have in more recent years become the most valuable companies on the globe. In 2018, seven of the ten largest companies in the world gained much, if not all of their revenue from digital products, and six out of the ten most valuable Internet firms were digital pure players that either operated an online platform, sold software or provided digital financial services (Meeker, 2018[34]).

More traditional firms selling physical goods, as well as capital owners, can also tap into new sources of value creation. For example, firms such as Rolls Royce and John Deere use sensors embedded in their tangible capital goods (e.g. jet engines, tractors) to collect and use the data about the performance

of the equipment and the conditions of its operation; this enables them to provide ancillary services, often sold in a package with the good (OECD, 2017[6]). Furthermore, owners of assets like real estate, cars and computing power can increasingly utilise their capital by providing access to their assets and monetising it as a service via online platforms.

Another example is digitised factory floors and production process that incorporate a "digital twin" that operates in parallel to the physical process (OECD, 2017[35]). This enables the collection and analysis of data that improves the performance of the production process. Plant operators can optimise the control of the plant to increase efficiency, make informed decisions regarding trade-offs between performance and durability, assign loads and line-ups, perform the maintenance tasks at the right moment, head off costly problems before they occur, and explore the future through simulations.

1.5. Business models that combine online and offline features

Many traditional firms are increasingly moving online and combining both digital and physical components. While traditional firms are going digital, some firms that started online are now moving in the other direction. This extends beyond traditional firms simply having a website; instead it relates to viewing online environments as a seamless extension of the brick-and-mortar store and vice versa. On the one hand, traditional retailers make use of websites, mobile applications, self-check-outs, electronic kiosks and smart shelf technology; on the other hand, online retailers are starting to build digitally enhanced physical stores, removing frictions from traditional purchase processes and offering the option to "click and collect".

In turn, consumer behaviour is changing. For example, consumers may research a product online before purchasing it in brick-and-mortar stores, while still reading reviews and comparing prices online. Similarly, other firms blend online and offline elements to sell goods of variable quality (e.g. fruits and vegetables) or goods that require a specific fit that is otherwise difficult to judge online (e.g. bespoke clothing) (OECD, forthcoming[36]).

Relationships, markets and ecosystems

Digitisation and digitalisation would not be game-changers without the Internet. The Internet allows digital interaction, relationships and movement of value to take place at any distance and time; it enables markets to migrate or to be created from scratch online; and it facilitates the creation of ecosystems featuring multitudes of often interdependent actors, communities, products and markets. The transformation of space, empowerment of the edges, and platforms and ecosystems all have implications for policy (Table 1.3).

1.3. Vectors of digital transformation: Relationships, markets and ecosystems

Vectors	Description	Examples of policy implications
Transformation of space	Thanks to their intangible and machine-encoded nature, software, data, and computing resources can be stored or exploited anywhere, decoupling value from borders, and challenging traditional principles of territoriality, geographically based communities and sovereignty. This separation creates opportunities for jurisdictional arbitrage.	Policies relying on geographical specifications like nexus, rules of origin or defined markets may need to be revised, to consider other points along the process of value creation and distribution (e.g. location of value creations vs. value delivery). This separation of value creation from use increases the need for policy interoperability between countries and regions.
Empowerment of the edges	The "end-to-end" principle of the Internet has moved the intelligence of the network from the centre to the periphery. Armed with computers and smartphones, users can innovate, design and construct their own networks and communities through mailing lists, hyperlinks and social networks.	Public policies need to consider reorientation away from central (large institutions) toward more granular units like individuals. This includes policies ranging from digital security to labour and social policies.
Platforms and ecosystems	Lower transaction costs of digital interactions reflect the development not only of direct relationships but also digitally empowered multi-sided platforms, which in turn contribute to further reducing transaction costs in many markets. Several of the largest platforms essentially serve as proprietary ecosystems with varying degrees of integration, interoperability, data sharing and openness.	Public policies need to consider the market dynamics of online platforms, which may increase efficiencies but also re-intermediate and concentrate activities, which may have implications for maintaining sufficient competition. Governments may also need to rethink the provision of public services to take advantage of platforms.

Source: OECD (2019[25]), "Vectors of digital transformation", *https://dx.doi.org/10.1787/5ade2bba-en*.

The Internet affects previously existing networks, triggers a migration of intelligence from the centre to the edges, and drives convergence. Thirty years ago networks were specific to the type of service or content they provided. For example, switched telephony networks were used to transmit voice while broadcasting networks were used to transmit video. Such networks had an intelligent centre but "dumb" end-user devices like an analogue phone or a TV. The Internet changed this through the "end-to-end" principle that is at the heart of the Internet protocol[6]. Intelligence of the network has moved from the centre to the edges where "application-specific functions reside in the end hosts of a network (e.g. a smartphone) rather than in intermediary nodes" (Saltzer, Reed and Clark, 1984[37]; Estrin, 12 August 2015[38]). The Internet also allows transmitting different kinds of data and information, for example text, voice and video, driving the convergence of previously distinct networks.

As the Internet becomes more pervasive and the cost of its use declines, individual users can communicate with many others, in effect setting up new networks built on the Internet. Such "many-to-many" communications sidestep other hierarchical or "command-and-control" structures of processing information. Just as the industrial revolution led to the invention of the modern limited liability corporation, so might the digital era lead to new, flexible forms of organisation, configured from an array of quasi-independent small enterprises and individuals. Decomposing and recombining smaller components of value may further reduce the distinction between economic categories such as business and consumer, work and leisure, and home and office.

This functional decentralisation leads to the empowerment and broadening of networks, markets, and communities and affects where power and influence reside as well as interactions among people, firms and governments. Reduced information asymmetries offer new opportunities for individuals and communities; regions can connect to global value chains; entrepreneurs can connect to potential clients, funders and suppliers around the world; and individuals can become publishers or journalists. But many-to-many communication and decentralisation also fragment control over information and erode the influence of traditional arbiters of information or "one-to-many" institutions such as newspapers, broadcast TV and radio, and governments.

1.6. Business models using online platforms

While many definitions of an online platform exist, a consensus is emerging that online platforms are a "digital service that facilitates interactions between two or more distinct but interdependent sets of users (e.g. firms or individuals) who interact through the service via the Internet" (OECD, forthcoming[39]). Online platforms are increasingly used to facilitate and structure online interactions and transactions, match supply and demand in markets for information, goods and services, and bring together one or multiple networks (also called "sides") (OECD, 2016[40]). For example, search engines help people find information, while also matching advertisers to users; ride-sharing platforms match passengers to drivers; social networks enable dialogue, content sharing, and commerce between individuals, businesses and advertisers; and e-commerce platforms match buyers and sellers.

In particular multi-sided platforms centralise online interactions, even if they happen independently within (seemingly) separate networks. Such platforms benefit from network effects: direct effects whereby the value of a service provided increases with the number of users, and indirect effects, whereby the number of users of one service increases the value of complementary services. By reducing information asymmetries and transaction costs online platforms can also make markets more efficient. This in turn allows firms that traditionally would "rather make than buy" (Coase, 1937[41]) when information and input prices are uncertain to rather buy directly on the market.

Sources: OECD (forthcoming[39]), *Online Platforms: A practical approach to their economic and social impacts*; OECD (2016[40]), "New forms of work in the digital economy", *https://dx.doi.org/10.1787/5jlwnklt820x-en*; Coase (1937[41]), "The nature of the firm", *https://www.jstor.org/stable/2626876?seq=1#page_scan_tab_contents*.

While the shift of intelligence from the centre to the edges promotes decentralisation, online intermediation also creates opportunities for centralisation. In particular, online platforms provide intermediation on the Internet, enabling e-commerce, content distribution, search and storage services, and social networks (Box 1.6). On the one hand, online platforms promote decentralisation by lowering the barriers to participation, often furthering empowering the edges. For example, platforms like

Amazon, MercadoLibre and Alibaba lower the cost of starting a business by providing fast, easy ways to set up online storefronts, reach customers and fulfil orders. On the other hand, platforms can also concentrate control in a proprietary service that owns the underlying technology, sets the ground rules for interaction, and collects data from and about users.

Beyond the emergence of online platforms, digital technologies are enabling the development of digital ecosystems and related business models. Such ecosystems include combinations of applications, operating systems, platforms, and/or hardware that interoperate in certain ways to enhance the user experience and/or aggregate data (e.g. Amazon's Fire tablets, the Fire OS fork of the Android operating system, and interoperable apps and ebooks; Apple's iPhones and iPads, their iOS operating system, and interoperable apps from the Apple App Store). Ecosystems can offer users ease of use, convenience, and a familiar look and feel with which they may grow comfortable, but they may also limit interoperability outside the ecosystem. While this can create advantages for businesses exploiting a model that stretches across a whole ecosystem, it may also raise users' switching costs if and when a better product comes along, thereby helping incumbents to fend off market entrants and competition from one another.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. The industry standard setting process is led by 3GPP. A major milestone on the standardisation process of 5G was reached in June 2018, with the first phase of the standard intended for enhanced mobile broadband concluded. The second phase is expected to conclude in 2019 that will be designed to enhance the 5G Ecosystem for massive M2M and critical IoT applications.
2. One petabyte is roughly the amount of data produced by 3.4 years of continuous full high-definition video recording.
3. Figure 1.2: "Consumer" includes fixed IP traffic generated by households, university populations, and Internet cafés; "business" includes fixed IP WAN or Internet traffic generated by businesses and governments; "Internet" denotes all IP traffic that crosses an Internet backbone; "Managed IP" includes corporate IP WAN traffic and IP transport of TV and video-on-demand; "Mobile" includes mobile data and Internet traffic generated by handsets, notebook cards, and mobile broadband gateways; "Internet video" includes short-form Internet video (for example, YouTube), long-form Internet video (for example, Hulu), live Internet video, Internet video to TV (for example, Netflix through Roku), online video purchases and rentals, webcam viewing, and web-based video monitoring (excludes peer-to-peer [P2P] video file downloads); "Web, email, and data" includes web, email, instant messaging, and other data traffic (excludes file sharing); "Gaming" includes casual online gaming, networked console gaming, and multiplayer virtual-world gaming; "File sharing" includes P2P traffic from all recognised P2P systems such as BitTorrent and eDonkey, as well as traffic from web-based file-sharing systems.
4. Capital goods include goods, other than material inputs and fuel, used in the production of other goods and/or services.
5. "Since inception, the Company [AMAZON.COM, INC.] has incurred significant losses, and as of March 31, 1997 had an accumulated deficit of USD 9.0 million. The Company believes that its success will depend in large part on its ability to (i) extend its brand position, (ii) provide its customers with outstanding value and a superior shopping experience, and (iii) achieve sufficient sales volume to realize economies of scale. Accordingly, the Company intends to invest heavily in marketing and promotion, site development and technology and operating infrastructure development. The Company also intends to offer attractive pricing programs, which will reduce its gross margins. Because the Company has relatively low product gross margins, achieving profitability given planned investment levels depends upon the Company's ability to generate and sustain substantially increased revenue levels. As a result, the Company believes that it will incur substantial operating losses for the foreseeable future, and that the rate at which such losses will be incurred will increase significantly from current levels" (United States Securities and Exchange Commission, 1997[43]).
6. "[…] every device on the Internet should be able to exchange data packets with any other device that was willing to receive them" (Drake, Vinton and Kleinwächter, 2016[42]; Estrin, 12 August 2015[38]).

References

Brynjolfsson, E., F. Eggers and A. Collis (2018), "Using massive online choice experiments to measure changes in well-being", *NBER Working Paper* No. w24514, *https://ssrn.com/abstract=3163281*. [19]

Brynjolfsson, E. and A. McAfee (2014), *The Second Machine Age: Work, Progress, and Prosperity in a Time of Brilliant Technologies*, WW Norton & Company, New York. [26]

Casalini, F. and J. López González (2019), "Trade and Cross-Border Data Flows", *OECD Trade Policy Papers*, No. 220, OECD Publishing, Paris, *https://doi.org/10.1787/b2023a47-en*. [20]

CISCO (2018), "Visual networking index: Forecast and trends", *https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html* (accessed 4 January 2019). [10]

CISCO (2017), *The Byte Scale*, CISCO, *https://www.cisco.com/c/dam/assets/sol/sp/vni/qa_c67-482177-1.jpg* (accessed 4 October 2018). [9]

Coase, R. (1937), "The nature of the firm", *Economica, New Series*, Vol. 4, No. 16, pp. 386-405, *https://www.jstor.org/stable/2626876?seq=1#page_scan_tab_contents*. [41]

Corrado, C., C. Hulten and D. Sichel (2006), "Intangible capital and economic growth", *NBER Working Paper* No. 11948, *https://www.nber.org/papers/w11948*. [33]

Drake, W., C. Vinton and W. Kleinwächter (eds.) (2016), *Internet Fragmentation: An Overview*, World Economic Forum, Davos, *https://www.zora.uzh.ch/id/eprint/121102/1/WEF_FII_Internet_Fragmentation_An_Overview_2016.pdf*. [42]

Estrin, J. (12 August 2015), *Kodak's first digital moment*, The New York Times, *https://lens.blogs.nytimes.com/2015/08/12/kodaks-first-digital-moment/?_r=0* (accessed 21 February 2019). [38]

Goldfarb, A. and C. Tucker (2017), "Digital economics", *NBER Working Paper* No. w23684, *https://www.nber.org/papers/w23684*. [27]

Hofheinz, P. and D. Osimo (2017), *Making Europe a Data Economy: A New Framework for Free Movement of Data in the Digital Age*, The Lisbon Council, Brussels, *https://lisboncouncil.net/publication/publication/143-a-new-framework-for-free-movement-of-data.html* (accessed 21 February 2019). [12]

Kommerskollegium (2014), *No Transfer, No Trade: The Importance of Cross-border Data*, National Board of Trade, Stockholm, *https://www.kommers.se/Documents/dokumentarkiv/publikationer/2014/No_Transfer_No_Trade_webb.pdf*. [13]

Meeker, M. (2018), *Internet Trends*, *https://www.kleinerperkins.com/files/INTERNET_TRENDS_REPORT_2018.pdf*. [34]

Metodi, T., A. Faruque and F. Chong (2011), *Quantum Computing for Computer Architects*, Morgan & Claypool Publishers, San Rafael, CA. [7]

Moore, G. (1965), "Cramming more components onto integrated circuits", *Proceedings of the IEEE*, Vol. 86, No. 1, pp. 82-85, *http://www.cs.utexas.edu/~fussell/courses/cs352h/papers/moore.pdf*. [2]

OECD (2019), "Vectors of digital transformation", *OECD Digital Economy Papers*, No. 273, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5ade2bba-en*. [25]

OECD (2018), *Financial Markets, Insurance and Pensions: Digitalisation and Finance*, OECD, Paris, *https://www.oecd.org/finance/private-pensions/Financial-markets-insurance-pensions-digitalisation-and-finance.pdf*. [30]

OECD (2018), *Going Digital in a Multilateral World*, OECD, Paris, *www.oecd.org/mcm/documents/C-MIN-2018-6-EN.pdf*. [24]

OECD (2018), *OECD Equity Market Review: Asia 2018*, OECD, Paris, *http://www.oecd.org/daf/ca/OECD-Equity-Market-Review-Asia-2018.pdf*. [31]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268821-en*. [35]

OECD (2017), *The Next Production Revolution: Implications for Governments and Business*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264271036-en*. [6]

OECD (2016), "New forms of work in the digital economy", *OECD Digital Economy Papers*, No. 260, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlwnklt820x-en*. [40]

OECD (2016), "The Internet of Things: Seizing the benefits and addressing the challenges", *OECD Digital Economy Papers*, No. 252, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlwvzz8td0n-en*. [3]

OECD (2015), *Data-driven Innovation: Big Data for Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264229358-en*. [1]

OECD (2015), "Recommendation of the Council on digital security risk management for economic and social prosperity", in *Digital Security Risk Management for Economic and Social Prosperity: OECD Recommendation and Companion Document*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264245471-1-en*. [22]

OECD (2014), "Cloud computing: The concept, impacts and the role of government policy", *OECD Digital Economy Papers*, No. 240, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jxzf4lcc7f5-en*. [5]

OECD (2013), "Exploring data-driven innovation as a new source of growth: Mapping the policy issues raised by 'big data'", *OECD Digital Economy Papers*, No. 222, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k47zw3fcp43-en*. [32]

OECD (2013), "Exploring the economics of personal data: A survey of methodologies for measuring monetary value", *OECD Digital Economy Papers*, No. 220, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k486qtxldmq-en*. [17]

OECD (2013), "Privacy Expert Group report on the review of the 1980 OECD Privacy Guidelines", *OECD Digital Economy Papers*, No. 229, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k3xz5zmj2mx-en*. [21]

OECD (2013), *Recommendation of the Council Concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data*, OECD, Paris, *http://www.oecd.org/sti/ieconomy/2013-oecd-privacy-guidelines.pdf*. [15]

OECD (2013), *Supporting Investment in Knowledge Capital, Growth and Innovation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264193307-en*. [18]

OECD (2011), *Quality Framework and Guidelines for OECD Statistical Activities*, OECD Publishing, Paris, *http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=std/qfs(2011)1&doclanguage=en*. [16]

OECD (forthcoming), *A Dynamic E-commerce Landscape: Developments, Trends and Business Models*, OECD Publishing, Paris. [36]

OECD (forthcoming), *Enhanced Access to Data: Reconciling Risks and Benefits of Data Sharing and Re-use*, OECD Publishing, Paris. [14]

OECD (forthcoming), *Online Platforms: A Practical Approach to their Economic and Social Impacts*, OECD Publishing, Paris. [39]

OECD (forthcoming), "The road to 5G networks: Experience to date and future developments", *OECD Digital Economy Policy Papers*, OECD Publishing, Paris. [4]

OECD (forthcoming), "Towards national privacy strategies", *OECD Digital Economy Policy Papers*, OECD Publishing, Paris. [23]

Saltzer, J., D. Reed and D. Clark (1984), "End-to-end arguments in system design", *ACM Transactions on Computer Systems*, Vol. 2, Issue 4, pp. 277-288, *http://dx.doi.org/10.1145/357401.357402*. [37]

Siegler, M. (2010), *Eric Schmidt: Every 2 Days, We Create As Much Information As We Did up to 2003*, Tech Crunch, *https://techcrunch.com/2010/08/04/schmidt-data/?guccounter=1* (accessed 4 October 2018). [8]

Taplin, J. (2017), *Move Fast and Break Things: How Facebook, Google, and Amazon Cornered Culture and Undermined Democracy*, Little, Brown and Company, Boston. [29]

United States Securities and Exchange Commission (1997), *Amazon Annual Report 1997*, *https://www.sec.gov/Archives/edgar/data/1018724/0000891020-97-000603.txt*. [43]

Varian, H. (2017), *Measurement Challenges in High Tech*, *https://www2.census.gov/adrm/fesac/2017-06-09/Varian-Presentation.pdf*. [28]

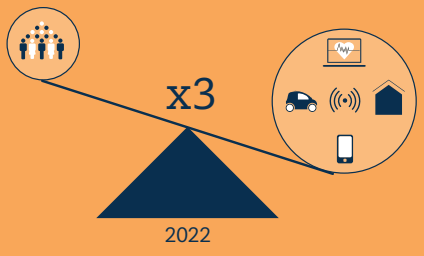
Weller, D. and B. Woodcock (2013), "Internet traffic exchange: Market developments and policy challenges", *OECD Digital Economy Policy Papers*, No. 207, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k918gpt130q-en*. [11]

Chapter 2

ENHANCING ACCESS

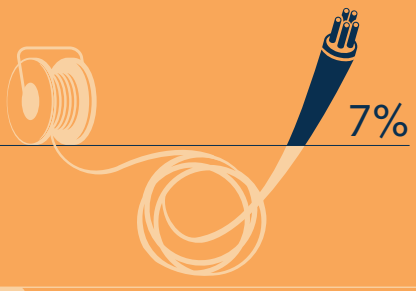
ACCESS

By 2022, **three devices per person** will be connected around the globe.



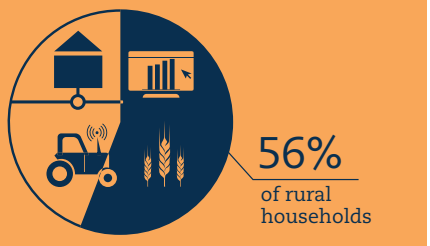
Prepare for a massive increase of connected people, devices and demand on networks.

Only 7% of people accross the OECD have a **fibre broadband subscription**.



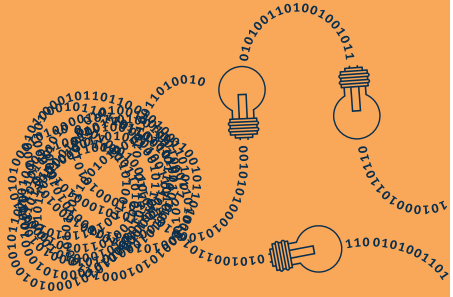
Invest in broadband infrastructure, especially fibre, to unlock digital technologies' potential.

56% **of rural households have access to fast fixed broadband**, in comparison to over 85% of households in urban and other areas.



Improve access in rural and remote areas to connect everyone and everything.

Access to data drives innovation, new products, organisational models and markets.



Enhance access to and sharing of data to unleash its potential, balancing benefits and risk.

ENHANCING ACCESS: WHAT MATTERS MOST FOR POLICY?

Invest in broadband to prepare for ever more people, things and technologies going online

- Demand for connectivity remains strong in the OECD, with over 100 million new mobile broadband subscriptions in 2017 and a doubling of data downloaded per subscription. Looking ahead, an estimated three devices per person will be online worldwide by 2022.
- Meeting such demand requires ongoing investment in fixed networks, including fibre. At the end of 2017, only 7% of inhabitants across the OECD had access to a fibre broadband subscription.

Promote competition and remove barriers to investment to boost connectivity

- Competition among network operators drives investment. Although markets vary, some countries with more mobile network operators (MNOs) (e.g. four rather than three) have experienced competitive and innovative services as a result. Other mechanisms, like passive infrastructure sharing and co-investment, can help expand coverage, depending on local market conditions.
- Internet exchange points (IXPs), efficient allocation of spectrum, and new generation Internet protocol (IP) addresses are critical to attracting investment.
- Simplifying administrative procedures facilitates the roll-out of key infrastructures, such as towers and masts.

Expand access in rural and remote places to connect everyone

- While rural areas are increasingly connected to broadband, much of this access is not high-quality. In all OECD countries, rural areas lag behind urban and other areas in their access to fixed broadband access with a minimum download speed of 30 megabits per second (Mbps), a speed needed to use advanced connected devices and services.
- Governments may invest directly in high-speed fixed networks or incentivise private investment, including by competitive tendering, tax exemptions, low-interest loans or lower spectrum fees. Satellite broadband technologies also hold promise.

Enhance access to data to unleash its potential

- Enhancing access to data requires balancing its benefits with the risks, taking into account legitimate private, national, and public interests.
- Approaches to foster access to data include contractual agreements, restricted data sharing arrangements, data portability and open government data initiatives.
- It is important to encourage the provision of data through coherent incentive mechanisms and sustainable business models while acknowledging the limitations of data markets and the risks of mandatory access regimes.

Communications infrastructures and services underpin the use of digital technologies, and facilitate interactions between connected people, organisations and machines. They serve as the basis for an open, interconnected and distributed Internet that enables the global free flow of information (OECD, 2011[1]). High-quality access to communication networks and services at competitive prices is fundamental to digital transformation. Data are emerging as similarly vital. Data are a driver of economic activity and a general-purpose input of production in many contexts, but these benefits are predicated on data availability and accessibility. Enhancing access to and the sharing of data is thus important, although such decisions should be balanced with considerations of data privacy and security, among others.

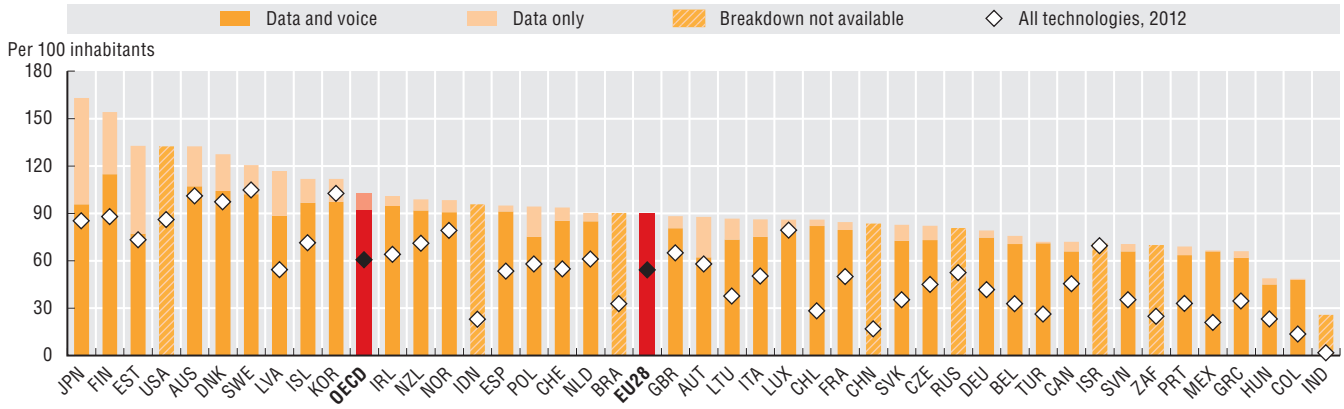
Prepare for more people and things going online than ever before

Increasing connections rely on the Internet's openness, in particular its distributed and interconnected nature, while respecting applicable legal and institutional frameworks (OECD, 2016[2]). While there are legitimate reasons for setting certain boundaries, drifting away from a general preference for Internet openness is economically and socially costly.

Pathways to the Internet continue to increase, while other modes of communication, such as traditional fixed telephone lines, have been in decline since the 1990s. In 2017 alone, the total number of fixed and mobile broadband subscriptions across the OECD grew by 95 million. This growth was driven by an increased uptake of mobile broadband subscriptions, reflecting continued growth in the use of connected devices like smartphones and tablets. In December 2017, mobile broadband subscriptions rose to 1.377 billion for a population of 1.344 billion people across the OECD, rising above 100 subscriptions per 100 inhabitants for the first time (Figure 2.1). This represents an increase of 79 million mobile broadband subscriptions since December 2016, with the fastest growth experienced by Chile (15%), Poland (15%), Greece (13%) and Latvia (13%).

2.1. There are more mobile broadband subscriptions than people in the OECD

Mobile broadband subscriptions, per 100 inhabitants, by package type, December 2017



Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD[4], *Broadband Portal*, *www.oecd.org/sti/broadband/broadband-statistics*; ITU[11], World Telecommunication ICT Indicators Database, *http://handle.itu.int/11.1002/pub_series/dataset/64cb0e71-en*; European Union[12], Digital Scoreboard, *https://ec.europa.eu/digital-single-market/en/digital-scoreboard* (accessed September 2018).

StatLink https://doi.org/10.1787/888933914974

The use of connected devices, and their demands on communication networks, also grew dramatically over the same period. Between 2015 and 2017, mobile data usage more than doubled in two-thirds of the countries for which data were available. For example, over this period in Finland, data downloaded per mobile broadband subscription per month doubled, from 7.23 Gigabytes (GB) to almost 16 GB. This gain was particularly dramatic in comparison to the OECD average, which was just 3 GB per month per mobile subscription.

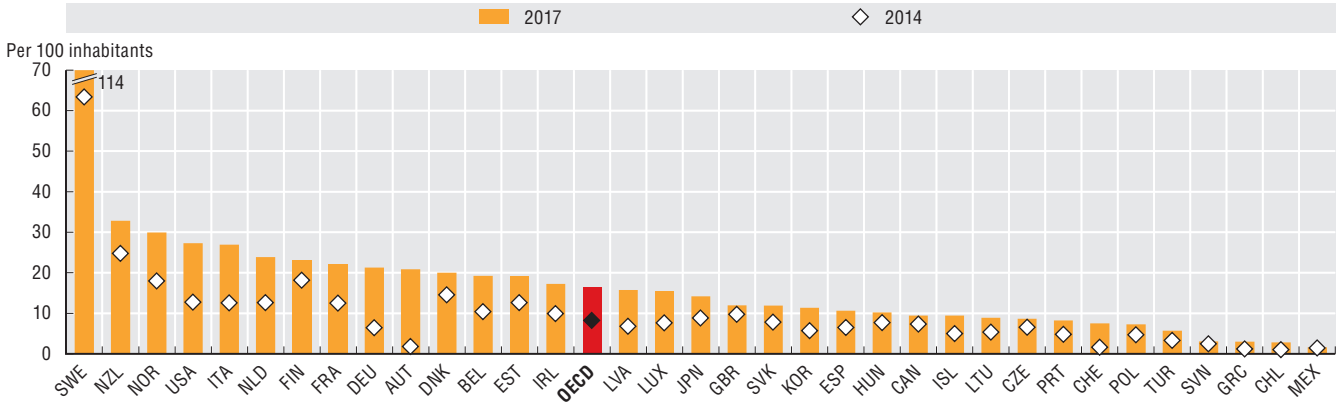
Connected objects, not just people, will be a key characteristic of the digital future. The Internet of Things (IoT) enables digital technologies to expand further across economies and societies, including in sectors such as agriculture, education, health, transportation, manufacturing and energy systems

(see Chapter 1). One estimate suggests that the IoT will include up to 20 billion devices worldwide by 2022 (more than three objects per person), representing global growth of more than 400% over five years (CISCO, 2018[5]).

Machine-to-machine (M2M) interactions capture a subset of the IoT that communicates using wired and wireless networks. M2M subscriptions refer to the SIM card subscriptions used in some connected machines and devices, such as in connected vehicles and smart metres (OECD, 2018[6]). The number of M2M subscriptions across the OECD almost doubled between 2014 and 2017 (Figure 2.2). Beyond the OECD, the People's Republic of China accounted for 61% of worldwide M2M SIM card subscriptions in September 2018 (OECD, 2019[3]).

2.2. Connected devices are on the rise

M2M SIM cards, per 100 inhabitants, 2017



Note: See Chapter notes.[1]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD[4], *Broadband Portal*, *www.oecd/sti/broadband/oecd/broadbandportal.htm* (accessed September 2018).

StatLink https://doi.org/10.1787/888933914993

As more people and things connect, new demands will be placed on networks. Many connected devices, including those that are powered by emerging digital technologies like artificial intelligence (AI), will require real-time transmission of huge amounts of data. For example, autonomous cars are expected to generate up to 4 000 GB of data per day by 2020, equivalent to approximately 2 700 average Internet users (Waring, 2016[7]).

Similarly, as connected devices become widespread in critical sectors such as health or energy, the safe and reliable functioning of related systems will depend on the reliability of communication networks. In particular, these applications may require time-sensitive upload and download of data, with rapid transmission of data between two devices in the network. As demands for reliable and fast connection are expected to increase, policy makers must invest in high-quality communication infrastructures and services.

Invest in broadband to empower future technologies

As more people and things go online, continued investment in communication networks is necessary to ensure that connections and transfers of data between connected devices can take place quickly. Indeed, high-speed broadband uptake underpins the adoption of some technologies, like cloud computing (see Chapter 3) (Sorbe et al., 2019[8]). In particular, it is becoming increasingly critical to deploy fibre further into fixed networks to support increases in speed and capacity across all next-generation technologies, including 5G networks (see Chapter 1).

5G networks are intended to support enhanced mobile broadband; intelligent devices with fully automatic data generation, exchange and processing; and critical communications and applications (ultra-reliable communications with very rapid upload and download of data). 5G holds many promises,

including 100 times the current data-transfer capacity at 10 times the current network speed. 5G networks will be able to process more connections, enabling more devices to go online without the need for wired connections (OECD, forthcoming[9]).

But even as more connections are made wirelessly, the speed and rate of download of these connections ultimately depends on the capacity of fixed networks, which take on the "heavy lifting" of the increasing demands on wireless networks. In 2016, about 60% of data uploaded and downloaded on devices such as smartphones used fixed networks through Wi-Fi or small, low-power cellular base stations (OECD, 2018[6]; CISCO, 2017[5]). Alternative access paths and the offloading of data reduces the amount of data that needs to be transferred across cellular bands, freeing capacity to improve cellular access for other users. As a result, fixed and wireless networks act as both compliments and substitutes.

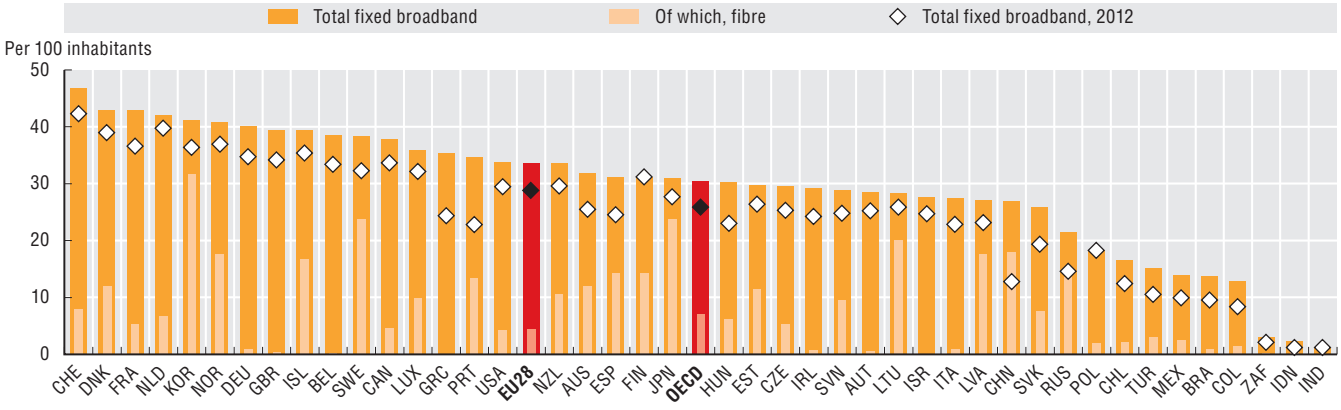
Backbone facilities, or the core network infrastructures that underpin other fixed networks, have been made up almost entirely of fibre optic networks (OECD, 2017[10]). But investment in fibre backhaul is increasingly important, namely the intermediate connections between communication network backbones and wireless towers, or end users. In particular, taking fibre backhaul closer to the end user, whether a business or a residence, is important for increasing Internet speed across all technologies, including for final connections using co-axial cable or copper.

Cable broadband networks are also being upgraded to provide higher speed services through the adoption of new standards and, like xDSL, through the deployment of fibre in these networks. Various types of xDSL remain the prevalent technology in communication networks across the OECD, with 41% of fixed broadband subscriptions, but they are slowly being replaced by fibre, which now accounts for 23% of fixed broadband subscriptions (up 15% in 2017).

At the end of 2017, only 7% of inhabitants across the OECD had access to a fibre broadband subscription. However, the average share of fibre masks significant cross-country differences (Figure 2.3). Japan and Korea are the only OECD countries where fibre subscriptions account for more than 75% of total fixed broadband subscriptions; they are also two of the few OECD countries with operators that offered 10 GB download speeds for residential services in 2018. In contrast, Austria, Belgium, Germany, Greece, Italy, Ireland and the United Kingdom recorded less than 10% of fibre in fixed broadband subscriptions in December 2017.

2.3. Investing in fibre backhaul can increase speeds across all technologies

Fixed broadband subscriptions, per 100 inhabitants, by technology, December 2017



Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD[4], *Broadband Portal*, *www.oecd.org/sti/broadband/broadband-statistics*; ITU[11], *World Telecommunication ICT Indicators Database*, *http://handle.itu.int/11.1002/pub_series/dataset/64cb0e71-en*; European Union[12], *Digital Scoreboard*, *https://ec.europa.eu/digital-single-market/en/digital-scoreboard* (accessed September 2018).

StatLink https://doi.org/10.1787/888933915012

Many countries are catching up. Ireland experienced an astonishing 420% growth of fibre subscriptions in the year to December 2017, while Australia and Colombia also had growth rates over 100%. However, the average growth in fibre subscriptions across the OECD in the year to December 2017 was just 14.6%. While this low average partially reflects lower growth in countries with already high shares of fibre

penetration, including Japan, Latvia and Lithuania, the low average indicates a lack of sufficient growth in fibre to support projected capacity demands (OECD, 2018[4]).

The emergence of 5G networks also represents an impetus for investment in next-generation network deployment. While technical and industry standards have not been fully realised, many expect that deploying 5G networks will require smaller cell sites, complementing traditional large cell towers. Such cells will need to be connected to backhaul, again underlining the need for increased investment in next-generation communications infrastructures.

Widespread trials of 5G are currently underway, enabling the technology to evolve and new business cases to emerge, including in the area of fixed wireless services. In the United States, commercial operators have proposed offers of fixed wireless 5G access while operators in Japan and Korea have proposed offers of commercial mobile 5G services by 2019. Some countries have also implemented dedicated plans and strategies associated with the roll-out of 5G networks (OECD, forthcoming[9]).

While the technology and business cases are still rapidly evolving, it is likely that some of the traditional telecommunication regulatory issues will become even more relevant for the successful deployment of this new generation of wireless technologies. For example, telecommunication operators often have to secure "rights of way" to dig up streets; lay cables; and install masts, antennae and other infrastructure (European Commission, 2018[13]). Streamlining such rights of way may become increasingly important to deploy massive numbers of small cells for 5G and backhaul to connect the cells.

Similarly, all wireless connections depend on the use of the electromagnetic spectrum. The efficient allocation of the spectrum into radio frequency bands is also essential for the development of 5G wireless networks. Other issues, including access to backhaul and backbone facilities, and new forms of infrastructure sharing, may also become more important (OECD, forthcoming[9]).

Promote competition and remove barriers to investment to boost connectivity

In the past, communication networks across the OECD were typically stand-alone endeavours, with separate firms and business models operating on independent fixed, wireless and broadcasting networks. These services have increasingly converged on IP-based networks or the Internet. This means that market players are able to offer combinations of telephony, broadband Internet access, wireless services and television.

As convergence continues, policy makers must promote competition to ensure that users benefit from greater choice from network and service providers, either through bundled or simple voice, data and video offers. Promoting competition can positively influence investment and pricing decisions and can drive up the overall quality and speed of broadband offers, including to underserved populations. Sharing network components, for example through passive infrastructure sharing, can also sometimes reduce costs. It is a critical decision for each country to determine the balance between end-to-end infrastructure competition and the joint provisioning of facilities by rivals to support greater retail competition.

Convergence is contributing to increased merger and acquisition activity between cable network operators and MNOs across the OECD, as players aim to offer bundled services and compete against rivals (OECD, 2017[10]). Some suggest that concentration in the wireless telecommunication networks has increased (Werden and Froeb, 2018[14]). On the other hand, new MNOs have regularly entered markets in countries such as France and Italy in recent years, with the result of lowering prices and increasing innovation.

Similarly, in the near future, new players are poised to enter OECD markets, such as Digi.Mobi in Hungary, Rakuten in Japan, and TPG in Singapore. Moreover, in some countries it is the mobile players that are providing greater competition through the use of wholesale fixed networks (e.g. Salt's 10 GB offer in Switzerland or Verizon's plans for 5G fixed wireless in the United States over its own facilities). Both of these developments underscore the importance of deeper deployment of fibre networks to support any technology to promote competition.

Broadband has emerged as modular general-purpose networks that support a variety of traffic types, applications and devices, including transformative technologies like cloud computing and the IoT. The emerging range of over-the-top applications include those that provide voice and video services that may directly compete with the service offerings of network operators, particularly those with significant broadcasting interests. In light of the changing relationship between innovation, competition and investment in a converging market, policy makers should aim to promote frameworks that foster investment in broadband networks, protect consumers, promote competition and enable opportunities for all (OECD, 2016[2]).

Policy makers should exercise caution with potential mergers that would reduce the number of MNOs in a given market considering available studies regarding the price and non-price effects of such mergers. This is because experience has shown that countries with a larger number of MNOs, for example those going from three to four operators, are likely to offer more competitive and innovative services (OECD, 2014[15]), although local conditions vary. Further, proposed remedies should be assessed in terms of whether they effectively ensure competition. Some countries have opted for behavioural remedies such as obtaining commitments from merging parties, while others have facilitated the presence of mobile virtual network operators. Still others have applied structural remedies (e.g. divestment) when other options have been deemed as not effective enough to promote competition. Policy makers should also promote sufficient competition in international mobile roaming (Bourassa et al., 2016[16]).

Infrastructure sharing is another way to promote competition in telecommunication markets, particularly where markets are characterised by a dominant player. Such policies typically relate to access to passive infrastructure deployed by other actors, whether for operators deploying fibre to gain access to the infrastructure of public utilities (e.g. railways, energy companies and municipal facilities), or for new entrants seeking access to passive infrastructure owned by other operators themselves (e.g. dark fibre, ducts and masts). In Spain, passive infrastructure sharing has helped to increase deployment of fibre closer to the end user (OECD, 2017[10]).

Infrastructure-sharing provisions like these could reduce costs for network and services providers while enabling the development of new and innovative services for end users (OECD, 2017[10]). As 5G networks are deployed, many expect that infrastructure sharing will become increasingly important to accommodate transmission sites (namely, cell towers or other sites where electronic communications equipment can be placed), which are expected to increase one hundred fold to achieve the lower latency standards of 5G while using a shorter wave spectrum (OECD, forthcoming[9]).

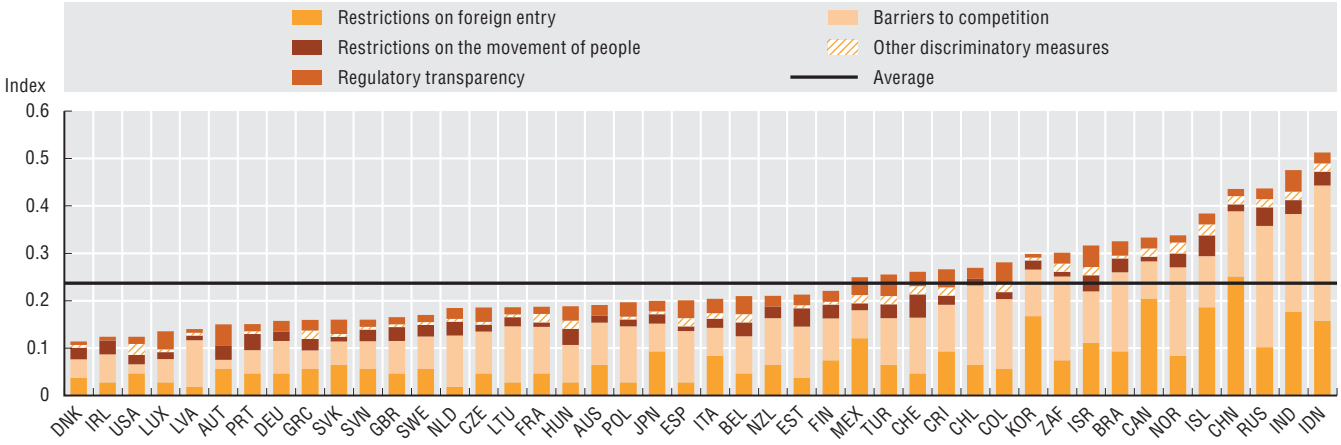
Co-investment arrangements, whereby two or more operators co-invest in network deployment could, in some circumstances, spur coverage and increase competition. Such arrangements have emerged in countries like the Netherlands, Portugal, Spain and Switzerland as a means of sharing risk and overcoming financing constraints. However, the impacts of such arrangements and the ideal conditions for network access for third parties depend on local market conditions and factors such as the number of operators and the areas of co-investment, and the overall effect is unclear at this stage (Godlovitch and Neumann, 2017[17]).

Other barriers to investment can include a lack of technical enablers. First, it is important to ensure the development of, access to and use of IXPs, to better enable the local exchange of traffic, unburden interregional links and stimulate investment in local networks. Second, it is important to ensure efficient allocation of spectrum, a scarce natural resource that is increasingly important with the large amounts of data transmitted over wireless networks. Third, as the pool of existing unassigned IP addresses is close to exhaustion, the relatively slow uptake of the new generation of IP addresses (IPv6)[2] could limit the connection of more devices and machines (Perset, 2010[18]), although some Internet service providers have developed short-term solutions for IPv4 reuse. Other administrative barriers to investment can include licensing requirements and overly complex rights of way permissions to install towers or masts.

International services trade barriers also reduce investment in the telecommunications sector, with restrictions on foreign entry and barriers to competition being the most prevalent (Figure 2.4). Reforms in recent years to reduce such barriers have been mixed. Compared to 2014, restrictions on trade in telecommunications services went up in about a third of the countries surveyed in 2017, a third reduced restrictions and a third were unchanged (OECD, 2017[19]).

2.4. Barriers to entry and competition are the most common telecommunication services trade restrictions

OECD Telecommunication Services Trade Restrictiveness Index, 2017



Notes: The Services Trade Restrictiveness Indices take values between zero and one, with one being the most restrictive. StatLink contains more data. See Chapter notes.[3]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *Services Trade Restrictiveness Index*, *http://oe.cd/stri-db* (accessed September 2018).

StatLink https://doi.org/10.1787/888933915031

Pro-competitive reforms in the telecommunication sector are associated with a substantial reduction in trade costs for business services. In 2017, however, the largest overall increase in services restrictiveness for the 22 sectors analysed was in the telecommunications sector (OECD, 2018[20]). This was primarily due to increased restrictions on foreign investment and operations in the sector, including increases in residential and nationality requirements for board members of telecommunications operators.

The country with the greatest change from 2014 is Mexico, which recently introduced a range of pro-competitive reforms in the telecommunication and broadcasting sectors, including lowering barriers to foreign direct investment. While the Mexican telecommunication market structure did not greatly change, these reforms drove increased connectivity, lower prices and better quality services, including an increase of over 50 million mobile broadband subscriptions (OECD, 2017[21]).

Expand access in rural and remote areas to connect everyone

Ensuring adequate access to communications infrastructures across all geographic areas is essential to ensuring that all citizens can benefit from the opportunities of digital transformation. However, entrenched divides in broadband connection across geography persist across the OECD. The rural-urban divide not only includes access to broadband, but also access to broadband that is of sufficient quality. The persistence of this divide raises questions about inclusiveness and opportunity in the digital age.

While the share of households with broadband access has been consistently increasing across the OECD to near complete penetration rates, these gains have not been evenly shared across households. Across a majority of OECD countries, the share of households with broadband connections in rural areas is less than the share in urban and other areas. However, encouragingly, the gap between these two shares has declined in almost all OECD countries since 2010. In some countries, like Luxembourg, the share of households in rural areas with broadband access has now exceeded the share in urban areas.

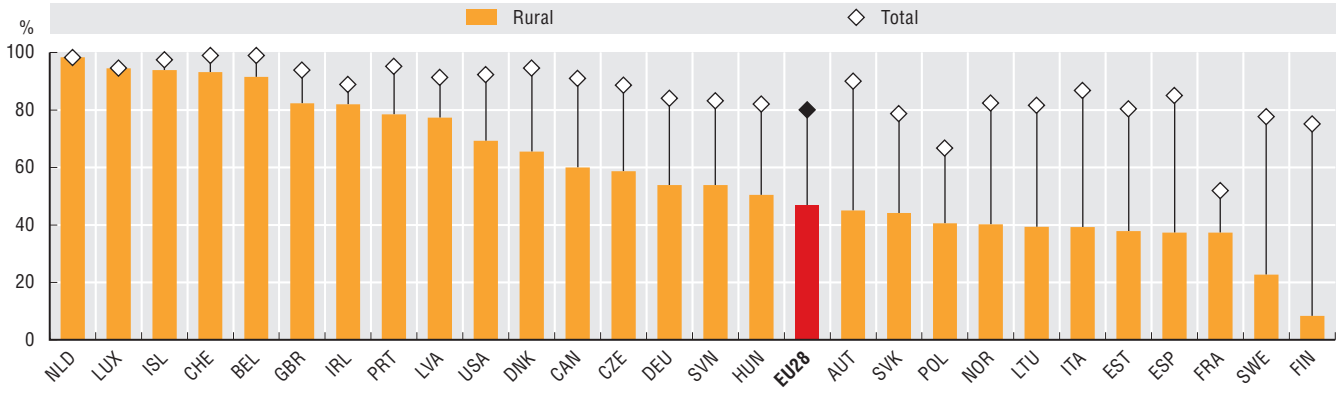
Nevertheless, access does not capture the quality of broadband connections, which must be high in all places to realise the potential of digital transformation. Quality access is a multi-dimensional concept that involves connection speed, the time taken to transfer data between users or devices and fewer errors in data transfer. In their choice of operator, some consumers may also value trust in a particular operator, or a preference for a particular mode of access (OECD, forthcoming[22]).

All OECD countries, with the exception of Japan, have set national targets for broadband availability, which are typically established in terms of the speed of service and the percentage of coverage. The vast majority of such targets aim for the majority of the population (usually nearly 90%) to have access at download rates of more than 20 Mbps, or approximately the speed necessary to stream a movie in ultra high-definition quality or support advanced tele-medicine applications (OECD, 2018[23]).

By including a speed dimension into metrics of access, gaps in access across geography become more significant. In 2016, just 56% of rural households had access to fixed broadband with a minimum speed of 30 Mbps, in comparison to over 85% of households in other areas (Figure 2.5). Measures of fixed broadband coverage with a minimum speed of 30 Mbps in rural areas can contrast sharply with overall broadband access data measured by surveys that do not take into account minimum speeds or technology categories. Finland is a case in point, where while almost 90% of households in rural areas had access to broadband in 2017, just 8.3% of Finnish rural households had access to fixed broadband with a minimum speed of 30 Mbps. In Finland, mobile technologies such as 4G are key to providing broadband coverage, particularly in rural areas.

2.5. Rural areas lag behind urban and other areas in broadband access at sufficient speeds

Households in areas where fixed broadband with a contracted speed of 30 Mbps or more is available, as a percentage of households in the total and rural categories, June 2017



Note: See Chapter notes.[4]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on CRTC, *Communications Monitoring Report, 2017* (Canada); EC, *Study on Broadband Coverage in Europe 2017* (European Union); FCC, *2018 Broadband Deployment Report* (United States).

StatLink https://doi.org/10.1787/888933915050

Addressing geographical digital divides is challenging because backbone networks are typically located closer to densely populated areas. Areas with low population density may be prone to natural monopolies, as commercial operators may assess that there is insufficient demand to invest. In some countries, a lack of basic infrastructure, including electricity, roads and ports, can present further challenges to high-speed infrastructure development in rural and remote areas.

In the majority of OECD countries, private investment is the largest source of investment in communications infrastructures. However, in some instances, governments may be better placed to take a longer-term and broader view of returns, and may choose to invest alongside private actors through public-private partnerships to share the risks associated with the creation, development and operation of an infrastructure asset.

Often, such investment takes place through national broadband plans. In September 2016, the United Nation's Broadband Commission for Sustainable Development reported that over 80% of countries have established or are planning to introduce national broadband plans or digital strategies. These are generally set in terms of speed of service offered and percentage of coverage, penetration and specific focus groups, and should ideally include measurable targets to address the policy challenges associated with ensuring competition and investment. The majority of OECD countries have included specific components related to the expansion of broadband in rural and remote areas in their broadband

plans (OECD, 2018[23]). Such national broadband strategies should address all of the key barriers to the deployment of high-speed networks and services, and should be revisited and reviewed regularly.

Many national broadband plans include strategies for public infrastructure investment; governments may choose to solve critical bottlenecks to private operation in rural areas by investing in high-speed backbones or backhaul infrastructure (OECD, 2017[24]), albeit often with the proviso of implementing open access policies so as to not encourage monopoly power in underserved areas (OECD, 2017[25]).

Given scarce public resources and the potential to crowd-out commercial roll-out of high-speed networks, another option is to promote private investment through a variety of incentives to reduce the cost of investment and network deployment in rural areas. These can include competitive tendering for partial tax exemption, changes to spectrum license arrangements, or loans at a reduced interest rate (OECD, 2018[23]), although competing objectives should be considered before policy changes are made. Many countries across the OECD have adopted universal service frameworks, while innovative hybrid approaches using satellite broadband technologies also have potential for improving access in rural and remote areas (OECD, 2017[25]).

Enhance access to data to unleash its potential

Communication infrastructures and services underpin digital transformation. However, the data that flow through these digital networks are also emerging as foundational. Such data are a source of economic value, and their effective and innovative use and reuse can spur economic and social benefits. However, these benefits are predicated on the availability and accessibility of data. Enhancing access to data for a variety of actors may therefore be a useful consideration for policy makers.

Value creation from data can be leveraged, for example by fostering data reuse. Overall, the available evidence shows that enhanced access and sharing can benefit data users as well as data providers (and suppliers), provided their respective legitimate interests and rights are taken into account. However, data are not homogenous, and their value depends on their context. Data on traffic flow differs in their use cases to data that could personally identify the user, and their treatment should differ accordingly.

Allowing access to and sharing of data requires a certain degree of openness, which can be thought of as a continuum of different degrees, ranging from closed (access only by the data controller) to discriminatory (access by stakeholders) to open (access by the public). In principle, all types of data can be shared or accessed for reuse, but not under the same conditions; there is no single optimal level of data "openness". Ultimately, the optimal level of openness for any given dataset depends on its characteristics, including with respect to its domain, security considerations and the relevant legal and cultural environment.

Opening access to data can bring important benefits to economies, societies and governments. For example, when publicly funded organisations make their data available, they improve transparency and accountability of institutions, and can help anti-corruption efforts (OECD, 2017[26]), while also empowering users to make more informed personal decisions (OECD, 2018[27]). The OECD has identified the benefits of opening access to scientific data, particularly when the research is publicly funded (OECD, 2007[28]), in view of its benefits for enabling collaboration, dissemination, reproduction and application of the results of scientific endeavours. But openness can carry risks, and it is important for data governance frameworks to strike an appropriate balance between the social benefits of greater access to and reuse of data, and public policy concerns such as privacy and intellectual property rights (IPRs), among others.

Enhancing access to data involves efforts to enable individuals and organisations to share their data more widely, and many approaches, including market-based approaches, exist (G7, 2017[29]). Pricing models are similarly varied and can include completely free, at marginal cost, and on commercial terms. However, the value of data depends on the context of their use and the information and knowledge that can be extracted (OECD, 2015[30]), which can challenge some forms of market-based pricing.

Open data efforts are perhaps the best known approach and the most extreme form of data openness, whereby all users enjoy non-discriminatory access (OECD, forthcoming[31]). Meanwhile, efforts to make public sector data collection freely available, often known as "open government data" initiatives, have the potential to spur innovation and new business models (see Chapter 4). For example, recent efforts

from the municipal transport authority of London to release consistent, up-to-date information have been estimated to yield savings up to GBP 130 million per year for customers, road users, the city of London and the municipal transport authority itself (Deloitte, 2017[32]).

In contrast to open data initiatives, other approaches to enhancing access to data include sharing data with fewer or specific users or organisations. For example, many firms actively commercialise proprietary data, which they may gain access to through contractual agreements with other firms. Similarly, market-based approaches for encouraging data access and sharing, like data markets and platforms that provide additional services, can enable the collection and commercialisation of data.

Similarly, "data portability mechanisms" enable users to access data they have given to an organisation in a commonly used, machine-readable and structured format, or to transmit those data to a chosen third-party. Other restricted forms of data sharing also exist, including partnerships for data sharing between organisations and initiatives to open data for social good.

While enhancing access to and sharing of data can drive value creation, there are also many challenges and legitimate concerns to such initiatives. Like many other aspects of digital transformation, the benefits of enhanced access to data may not be excludable; namely, those that increase access to their data may not capture all of the economic and societal benefits, or the costs of capturing those benefits may be high. Where gains cannot be captured by the data holder, there may be disincentives to increase access. This is particularly true where there are high costs to facilitating access, including with respect to the collection, cleaning and curation of data. Data are also increasingly recognised as a source of value, and organisations may be tempted to try to limit access to valuable data assets. However, the cost of enhancing access to data should be considered, so as not to disincentivise data collection and analysis. Contractual mechanisms through commercial agreements may help to address these challenges, which are not unique to issues related to the enhanced access to and sharing of data.

Finally, there may be legitimate restrictions of the flow and/or reuse of data, including private interests of individuals and organisations as well as national security and public interests (see Chapters 7 and 8) (OECD, forthcoming[31]). For example, incentives may be misaligned between actors, and some kinds of mechanisms for enhancing access may heighten digital security risk or the violation of privacy and IPRs. In turn, some kinds of data cannot be legally shared across borders, while uncertainties about the nature and the IPRs associated with particular kinds of data may skew incentives and decision making.

As digital transformation continues apace, data will continue to be created exponentially as more people and devices become interconnected. Similarly, as production becomes more knowledge-intensive, demand for data will also increase. Finally, many emerging digital technologies, AI, rely on access to data (OECD, forthcoming[33]). Balancing the risks and opportunities of enhancing access to and sharing of data will continue to be a policy priority going forward.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 2.2: Data on M2M subscriptions are collected separately from other mobile subscriptions (e.g. subscriptions for users of smartphones, watches and tablets). Such data notes the country from which a mobile network operator or mobile virtual network operator allocates the SIM to the end user, and may not reflect the penetration of the IoT within each home country (e.g. a SIM card embedded in a vehicle may be sold and used outside that country). For Hungary, Latvia and Mexico, data refers to 2015 instead of 2014. For Switzerland, 2017 data are based on OECD estimates.
2. One potential challenge for the future of the Internet is its ability to scale to connect tens of billions of devices and machines, and a key aspect of that scalability is the use of the Internet Protocol (IP). The Internet Protocol specifies how communications take place between one device and another through an addressing system. There are two versions of the Internet Protocol in use, one which is largely exhausted in terms of the distribution of unassigned addresses (IPv4) and another that is plentiful but has had a slower than desirable rate of adoption (IPv6).
3. Figure 2.4: The Services Trade Restrictiveness Indices are calculated on the basis of the STRI regulatory database which records measures on a most-favoured-nation basis. Preferential trade agreements are not taken into account.
4. Figure 2.5: Rural areas: For EU countries, rural areas are those with a population density less than 100 per square kilometre. For Canada, rural areas are those with a population density less than 400 per square kilometre. For the United States, rural areas are those with a population density less than 1 000 per square mile or 386 people per square kilometre.
   Fixed broadband coverage: For EU countries, coverage of NGA technologies (VDSL, FTTP, DOCSIS 3.0) capable of delivering at least 30 Mbps download was used. For the United States, coverage of fixed terrestrial broadband capable of delivering 25 Mbps download and 3 Mbps upload services was used; data refer to 2016.

References

Bourassa, F. et al. (2016), "Developments in international mobile roaming", *OECD Digital Economy Papers*, No. 249, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jm0lsq78vmx-en*. [16]

CISCO (2018), "Visual networking index: Forecast and trends", *https://www.cisco.com/c/en/us/solutions/collateral/service-provider/visual-networking-index-vni/white-paper-c11-741490.html* (accessed 25 February 2019). [5]

Deloitte (2017), *Assessing the Value of Tfl's Open Data and Digital Partnerships*, Deloitte, London, *http://content.tfl.gov.uk/deloitte-report-tfl-open-data.pdf* (accessed 2 March 2018). [32]

European Commission (2018), *Digital Single Market: Rights of Way*, *https://ec.europa.eu/digital-single-market/en/rights-way* (accessed 10 October 2018). [13]

European Union (2018), *Digital Scoreboard*, *https://ec.europa.eu/digital-single-market/en/digital-scoreboard* (accessed September 2018). [12]

G7 (2017), *G7 ICT and Industry Ministers' Declaration: Making the Next Production Revolution Inclusive, Open and Secure*, *http://www.g8.utoronto.ca/ict/2017-ict-declaration.html*. [29]

Godlovitch, I. and K. Neumann (2017), *Co-investment and Incentive-based Regulation*, proceedings of the 28th European Regional Conference of the International Telecommunications Society (ITS): "Competition and Regulation in the Information Age", Passau, Germany, *http://hdl.handle.net/10419/169463*. [17]

ITU (2019), *ICT Indicators (Edition 2018)* (database), *http://handle.itu.int/11.1002/pub_series/dataset/64cb0e71-en* (accessed 2 October 2018). [11]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [3]

OECD (2018), "Bridging the rural digital divide", *OECD Digital Economy Papers*, No. 265, OECD Publishing, Paris, *https://dx.doi.org/10.1787/852bd3b9-en*. [23]

OECD (2018), *Broadband Portal*, OECD, Paris, *www.oecd.org/sti/broadband/broadband-statistics* (accessed 15 December 2018). [4]

OECD (2018), "IoT measurement and applications", *OECD Digital Economy Papers*, No. 271, OECD Publishing, Paris, *https://dx.doi.org/10.1787/35209dbf-en*. [6]

OECD (2018), *OECD Services Trade Restrictiveness Index: Policy Trends up to 2018*, OECD, Paris, *http://www.oecd.org/trade/services-trade/STRI-Policy-trends-up-to-2018.pdf*. [20]

OECD (2018), *Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact*, OECD Digital Government Studies, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264305847-en*. [27]

OECD (2017), *Compendium of Good Practices on the Use of Open Data for Anti-corruption: Towards Data-driven Public Sector Integrity and Civic Auditing*, OECD, Paris, *http://www.oecd.org/corruption/g20-oecd-compendium-open-data-anti-corruption.htm*. [26]

OECD (2017), *Key Issues for Digital Transformation in the G20*, OECD, Paris, *https://www.oecd.org/g20/key-issues-for-digital-transformation-in-the-g20.pdf*. [24]

OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264276284-en*. [10]

OECD (2017), *OECD Telecommunication and Broadcasting Review of Mexico 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264278011-en*. [21]

OECD (2017), *Services Trade Restrictiveness Index Sector Brief: Telecommunications Sector Brief*, OECD, Paris, *http://www.oecd.org/tad/services-trade/STRI_telecommunications.pdf*. [19]

OECD (2017), "The evolving role of satellite networks in rural and remote broadband access", *OECD Digital Economy Papers*, No. 264, OECD Publishing, Paris, *https://dx.doi.org/10.1787/7610090d-en*. [25]

OECD (2016), *The OECD Ministerial Declaration on the Digital Economy: Innovation, Growth and Social Prosperity*, OECD, Paris, *https://www.oecd.org/internet/Digital-Economy-Ministerial-Declaration-2016.pdf*. [2]

OECD (2015), *Data-driven Innovation: Big Data for Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264229358-en*. [30]

OECD (2014), "Wireless market structures and network sharing", *OECD Digital Economy Papers*, No. 243, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jxt46dzl9r2-en*. [15]

OECD (2011), *OECD Recommendation of the Council on Principles for Internet Policy making*, OECD, Paris, *https://www.oecd.org/internet/ieconomy/oecd-principles-for-internet-policy-making.pdf*. [1]

OECD (2007), *OECD Principles and Guidelines for Access to Research Data from Public Funding*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264034020-en-fr*. [28]

OECD (forthcoming), *Artificial Intelligence in Society*, OECD Publishing, Paris. [33]

OECD (forthcoming), *Enhanced Access to Data: Reconciling Risks and Benefits of Data Sharing and Re-use*, OECD Publishing, Paris. [31]

OECD (forthcoming), *The Operators of the Future: Facilitators of Digital Transformations of Economies and Societies?*, OECD Publishing, Paris. [22]

OECD (forthcoming), "The road to 5G networks: Experience to date and future developments", *OECD Digital Economy Policy Paper*, OECD Publishing, Paris. [9]

Perset, K. (2010), "Internet addressing: Measuring deployment of IPV6: Measuring deployment of IPV6", *OECD Digital Economy Papers*, No. 172, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5kmh79zp2t8w-en*. [18]

Sorbe, S. et al. (2019), "Digital dividend: Policies to harness the productivity potential of digital technologies", *OECD Economic Policy Papers*, No. 26, OECD Publishing, Paris, *https://doi.org/10.1787/273176bc-en*. [8]

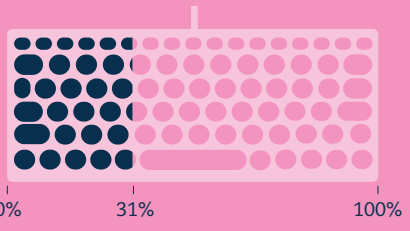
Waring, J. (2016), *Intel CEO: 5G Crucial to Manage Coming M2M Data Flood*, *http://www.mobileworldlive.com/asia/asia-news/intel-ceo-says-coming-m2m-data-floodrequires-5g/* (accessed 25 September 2017). [7]

Werden, G. and L. Froeb (2018), "Don't panic: A guide to claims of increasing concentration", *Antitrust Magazine* Fall, *http://dx.doi.org/10.2139/ssrn.3156912*. [14]

Chapter 3

INCREASING EFFECTIVE USE

31% of adults **have sufficient problem-solving skills** for technology-rich environments.



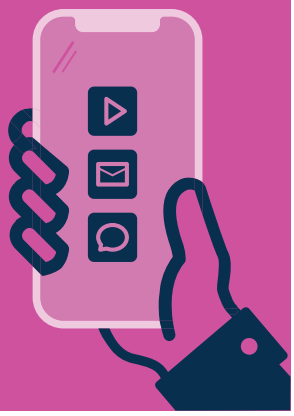
Invest in skills to empower everyone to thrive in the digital age.

74% of people **use e-mail** ...

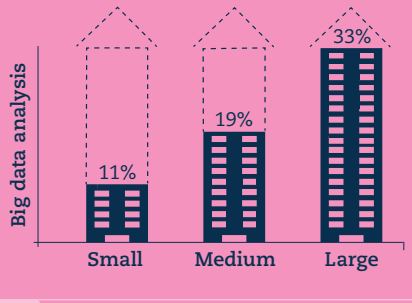
... more sophisticated activities, like **online courses** (9%), still have great potential to grow.

Foster more sophisticated Internet use for all to benefit from digital technologies.

USE

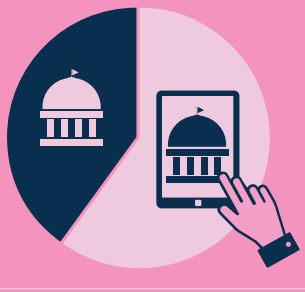


Great potential could be unleashed if more firms, especially **SMEs**, would perform **big data analysis**.



Boost diffusion of advanced digital tools, especially for SMEs, to drive productivity.

Less than 60% of people **visit or interact with public authorities' websites**.



Design user-centred digital public services to enhance usage and inclusion.

INCREASING EFFECTIVE USE: WHAT MATTERS MOST FOR POLICY?

Foster more sophisticated Internet usage for all

- Promote the uptake of more sophisticated online activities; today, 74% of individuals use the Internet for email, but only 9% take online courses.
- Close the significant usage gap between individuals with high versus low education levels for many key online activities, such as Internet banking.

Realise the potential of digital government

- Shift from an e-government to a holistic and user-driven digital government approach, while further improving online public services; less than 60% of people across the OECD visit or interact with public authorities' websites.
- Ensure coherent use of digital technologies and data across all parts and levels of government and stimulate public sector innovation and civic engagement.

Boost adoption, diffusion and effective use of digital tools in firms, especially small and medium-sized enterprises

- Boost the adoption, diffusion and effective use of advanced digital tools which drive productivity in firms; today, big data analysis is performed by 33% of large firms, but only by 19% of medium-sized and by 11% of small firms.
- Promote investment in information and communication technologies (ICTs) and intangible assets, foster business dynamism and structural change, and support small and medium-sized enterprises (SMEs) to overcome challenges in adopting advanced digital tools.

Leverage skills for people, firms and governments to thrive in the digital age

- Ensure everyone has the skills needed for a digital world; currently, only 31% of adults have sufficient problem-solving skills for technology-rich environments.
- Review education and training systems to empower people to prosper and workers to succeed, and better exploit the possibilities of digital learning.

Address mistrust to increase online engagement

- Raise awareness and empower people and businesses to manage digital risks to (re)gain trust in online environments.

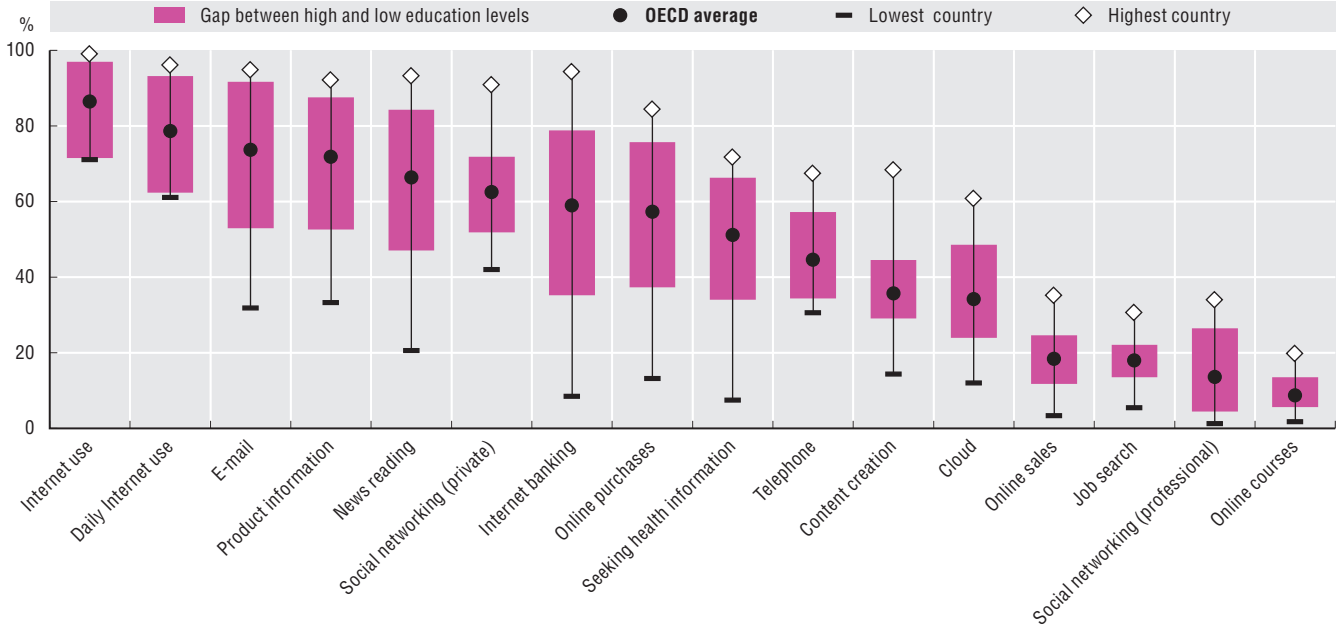
The power and potential of digital technologies and data for individuals, governments and firms depend on their effective use. To foster more sophisticated usage, public policy should focus on narrowing the education gap. Governments should realise the potential of digital government, adopt a user-driven approach and make digital government services digital by design. To boost productivity, it is essential to promote the adoption, diffusion and effective use of advanced digital tools, especially in SMEs, including by promoting investment in ICTs and intangible assets, notably skills, and by fostering business dynamism. At the same time, policies need to strengthen trust in digital environments, for example by raising awareness and empowering people and organisations to better manage digital risk.

Foster more sophisticated Internet usage for all

Simple Internet use among individuals is widespread across the OECD. However, less than 80% of individuals are daily Internet users so far and more sophisticated online activities are less common in most countries. Typically, usage rates decline with the degree of sophistication of an online activity. For example, 74% of individuals use the Internet for email, but only 9% take online courses (Figure 3.1). In addition, most users tend to perform only a limited number of simple activities rather than a diversified range of activities, including sophisticated ones (OECD, forthcoming[1]). Strikingly, activities related to personal and professional development, such as online courses or professional social networking, are among the least performed. Large differences in use also remain across countries, with a gap of over 80 percentage points, for example, in Internet banking between the countries with the highest and the lowest usage rates.

3.1. Significant scope remains for more people to become sophisticated Internet users

Diffusion of selected online activities among individuals, by education levels, as a percentage of individuals aged 16-74, 2018



Note: See Chapter notes.[1]

Source: OECD[2], *ICT Access and Usage by Households and Individuals* (database), *http://oe.cd/hhind* (accessed January 2019).

StatLink https://doi.org/10.1787/888933914803

One key factor affecting individuals' usage is educational attainment (and skills, further discussed below). The usage gap between high and low-educated individuals is over 40 percentage points for some activities, such as Internet banking. Users that perform many different activities, including more sophisticated ones such as online courses and content creation, are more likely to have a tertiary degree, whereas low-educated individuals more commonly carry out simple activities and use the Internet for communication and leisure (OECD, forthcoming[1]). Other important factors influencing usage (that might be related to education levels) include age, employment status, income, gender

as well as (non-)acceptance of using digital technologies. Policies that empower people, notably with the skills needed for more complex usage, are thus crucial to foster sophisticated Internet use for all (see Chapter 6).

Realise the potential of digital government

It is now imperative for governments to go digital themselves. For many countries, this implies a shift from e-government towards the more holistic and user-centred approach of digital government. Beyond digital public service provision, digital government includes the promotion of innovation in the public sector and expanded civic engagement (see Chapters 4 and 6).

A core principle of digital government is to leverage digital technologies more fully for a user-driven approach, i.e. to design, develop, deliver and monitor public policies and services centred around people and user needs (citizens and businesses), rather than based on top-down assumptions (OECD, 2018[3]). Digital technologies should not only be used to digitise analogue processes and services, but as an opportunity to fundamentally rethink and reorganise government processes, procedures and services as being digital by design, and facilitate the involvement of people's preferences and user needs as drivers of change. In line with this approach, countries are increasingly adopting a "mobile first" approach to digital government.

Digital technologies offer opportunities to increase access to, reach and quality of public services, and to improve policy making and service design. One key enabler of wider uptake of digital services across the economy and society are eIDs and electronic and/or digital signatures (OECD, 2018[4]). For example, the Estonian government introduced a mandatory eID card that can be used for giving one's digital signature. This has not only facilitated the use of digital government services, but has also required many Estonian businesses to upgrade their digital technologies to comply with the sophisticated digital security requirements of the eID card.

Many countries have digitalised at least some aspects of their public administration or services. For example, in 29 OECD countries, tenders are announced and contract awards notified via a national central e-procurement system, and in an increasing number of countries all tax filings for personal and corporate income tax returns are submitted online (OECD, 2017[5]; OECD, 2017[6]). Many OECD countries have advanced in using digital tools not only within and by the government, but in partnership with the private sector (Box 3.1).

3.1. Public-private co-operation on the collection of value-added tax on online sales

Digital technologies create new opportunities for co-operation between the public and private sectors. For example, such co-operation has taken place in the context of more efficient and effective tax collection. Several countries have introduced liability regimes for digital platforms related to value-added tax or goods and services tax (VAT/GST), with the objective to reduce the costs and risks for tax authorities of administering, policing and collecting VAT/GST on the ever-increasing volumes of online sales.

Some countries have introduced a regime that makes digital platforms liable for assessing, collecting and remitting the VAT/GST due on online sales facilitated by the platforms. While being implemented by a growing number of jurisdictions, this regime is still relatively new, in particular with regards to online sales that involve the importation of low-value goods. Some of these countries have complemented this approach with voluntary or obligatory information-sharing arrangements between platforms and tax authorities, as well as educational measures targeted to sellers on platforms. Other countries have chosen to limit requirements for digital platforms to information-sharing and specific measures to tackle possible fraud by online sellers.

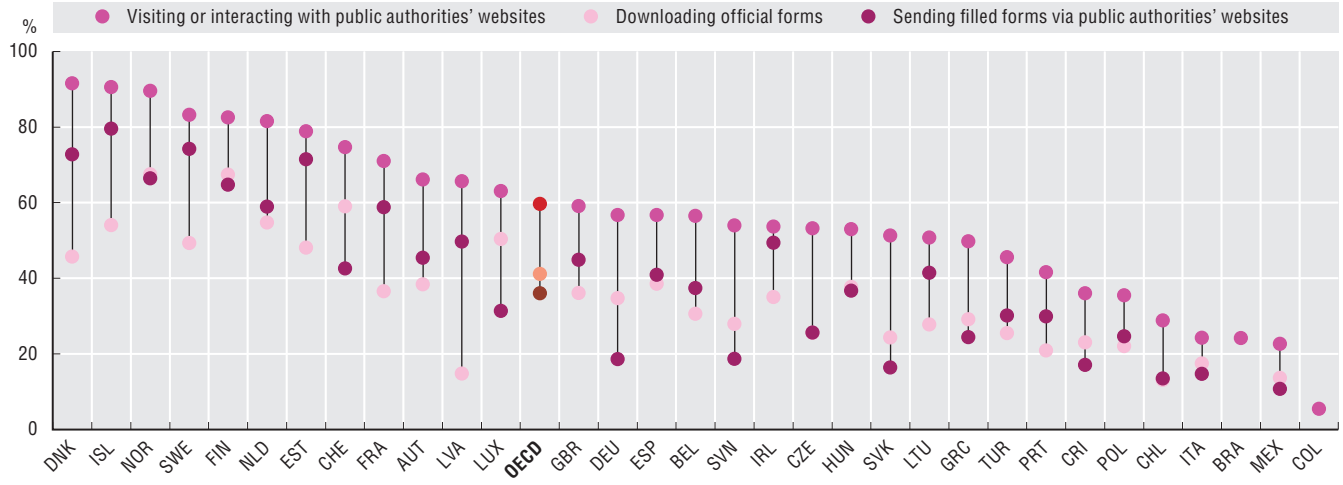
Source: Ongoing project by the OECD's Working Party 9 on Consumption Taxes.

However, at a much more basic level, significant potential still remains in many countries for general use and wider uptake of digital government services. Less than 60% of people across the OECD visit or interact with public authorities' websites and many fewer use the Internet to download or send filled

forms via public authorities' websites (Figure 3.2). The available data on the use of digital technologies by governments are still largely limited to the uptake of digital government services by individuals.

3.2. The uptake of digital government services differs significantly across countries

Use of digital government services by individuals, as a percentage of all individuals aged 16-74, 2018



Note: See Chapter notes.[2]

Source: OECD[2], *ICT Access and Usage by Households and Individuals* (database), *http://oe.cd/hhind* (accessed January 2019).

StatLink https://doi.org/10.1787/888933914822

Going beyond digital government services, digital government strategies are useful in promoting the effective use of digital tools within the public sector (OECD, 2014[7]). For example, digital government strategies can help to more fully integrate digital technologies in decision-making processes, for shaping strategic agendas and for public sector, legal and regulatory reforms. A digital government strategy should also address major cross-cutting challenges governments face when going digital and help put in place key enablers of digital transformation. For example, coherent use of digital technologies across different parts and levels of government and public sector organisations as well as interoperable digital solutions and data standards, is essential.

Boost adoption, diffusion and effective use of digital tools in firms, especially small and medium-sized enterprises

A key condition for using digital technologies in firms is investment in ICTs. For example, investment in high-speed broadband (see Chapter 2) has strong positive effects on the adoption of digital tools (Andrews, Nicoletti and Timiliotis, 2018[8]). While in 2017 average ICT investment as a share of gross domestic product (GDP) in OECD countries was 2.4%, many observers have pointed to a decrease since its peak in 2000, some of which may be attributable to the growing use of cloud computing by firms (OECD, 2019[9]).

Indeed, the nominal value of ICT investment as a share of GDP for computer hardware and telecommunication equipment decreased between 1999 and 2015. However, investment in computer software and databases increased by 44% relative to GDP over the same period. Furthermore, the ratio of ICT investment to GDP increased in volume, i.e. when controlling for the increase in ICT prices relative to GDP prices. The increase in investment in ICT equipment relative to GDP was equal to 65% in volume over 1999-2015, i.e. the same as the increase in computer software and databases in volume (OECD, forthcoming[10]).

Countries promote ICT investment through a variety of policy measures. For example, financial schemes tend to provide monetary support or incentives for the purchase of ICT equipment or towards ICT development. Non-financial support is often provided through targeted training, mostly focused on the digitalisation of business services, e-commerce, or on the effective use of digital media (see more on skills and training below) (OECD, forthcoming[10]). Other approaches used across OECD countries include,

in the order of frequency: measures to facilitate data (re)use across organisations and sectors, promotion of e-health applications and e-commerce, digital content creation and diffusion and measures to foster the uptake of the Internet of Things (IoT) and machine-to-machine communication (OECD, 2017[11]).

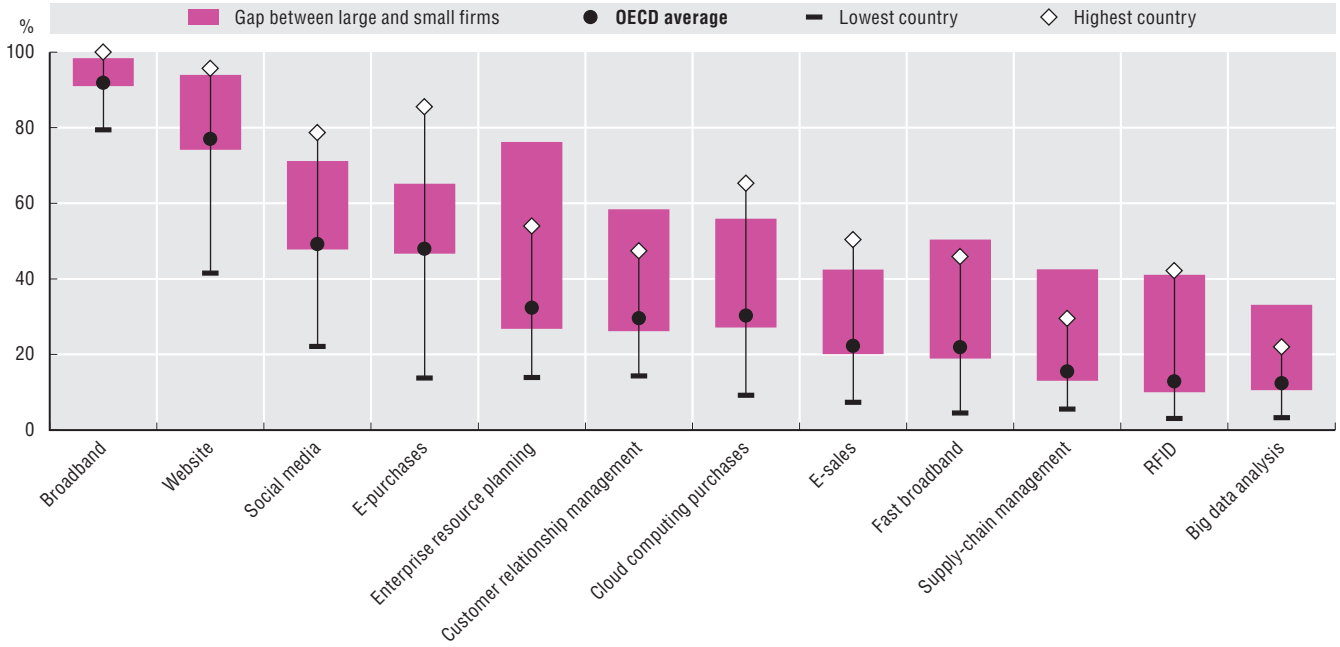
Investment in ICTs is a necessary but not a sufficient condition for the diffusion of digital tools; a second essential condition is investment in complementary assets, knowledge-based capital (KBC) in particular, including research and development (R&D), data, design, new organisational processes, and firm-specific skills (see Chapter 4). For example, incentives to invest in R&D appear to be associated with greater adoption of customer relationship management (CRM) software and cloud computing (Andrews, Nicoletti and Timiliotis, 2018[8]). For a number of years already, investment in KBC has increased faster than investment in physical capital (machinery, equipment, buildings) in many countries and significantly exceeds investment in physical capital in some (OECD, 2013[12]). Today, investment in computer software and databases account for between two-thirds and a half of total ICT investment (OECD, forthcoming[10]).

ICTs are only productive when firms effectively use the digital tools they invest in. Most firms across the OECD use at least a "basic"[3] broadband connection and simple digital tools such as websites. However, significant scope remains for more widespread usage of more advanced digital tools, for example, for deeper digital market integration (i.e. e-purchases, e-sales, social media, customer relationship management software), digitalisation of business processes and firm re-organisation (i.e. enterprise resource planning [ERP] software, cloud computing, supply-chain management [SCM] software), or to leverage the IoT (i.e. radio-frequency identification [RFID]).

While, on average, almost 80% of firms have a website, only 30% purchase cloud computing. Wider diffusion is crucial given that many advanced digital tools are found to be productivity-enhancing, especially when combined with complementary investments in managerial and technical skills (Gal et al., 2019[13]; Sorbe et al., 2019[14]; OECD, 2015[15]). Large potential could be unleashed in particular in SMEs. Currently, important differences exist for all digital tools by firm size; for example, big data analysis is performed by 33% of large firms, but only by 19% of medium-sized and by 11% of small firms (Figure 3.3).

3.3. Large potential remains for diffusion of digital tools among firms, especially small and medium-sized enterprises

Diffusion of selected digital tools among firms, by firm size, as a percentage of all firms, 2018



Note: See Chapter notes.[4]

Source: OECD[16], *ICT Access and Usage by Businesses* (database), *http://oe.cd/bus* (accessed January 2019).

StatLink https://doi.org/10.1787/888933914841

Many of these digital tools are most widely diffused in ICT-intensive and services sectors; however, large potential also lies in their usage in manufacturing and industrial production. Two major trends have made digital technologies an increasingly transformational force for industrial production: 1) cost reduction, enabling wider technology diffusion; and 2) the combination of different technologies, enabling innovation and new types of applications.

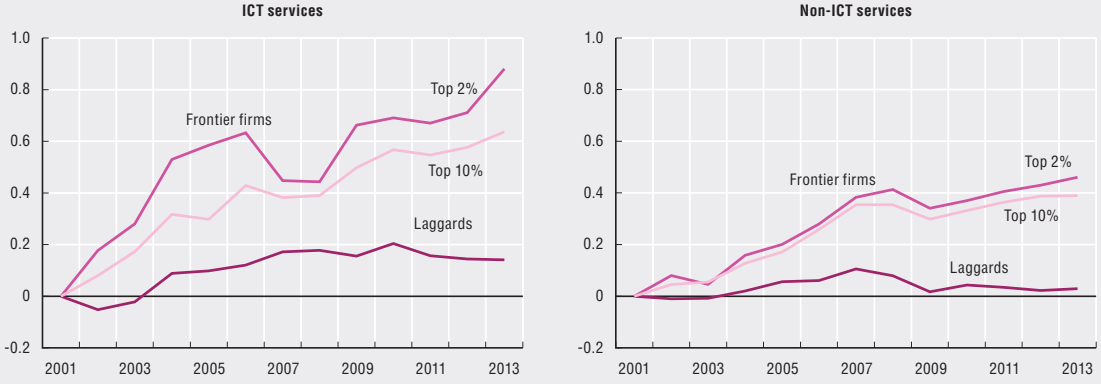
3.2. Uneven adoption and diffusion of digital technologies help explain the digital "productivity paradox"

One of the great promises of digital transformation is to drive productivity growth by enabling innovation and reducing the costs of business processes (Goldfarb and Tucker, 2017[18]). But despite the diffusion of digital technologies since the mid-1990s, aggregate productivity growth has slowed over the past decade or so, sparking a lively debate about the potential for digital technologies to raise productivity. While some have suggested that this digital "productivity paradox" may partly be explained by inadequate measurement, OECD work suggests that this does not explain the slowdown (Ahmad, Ribarsky and Reinsdorf, 2017[19]). Moreover, the adoption and diffusion of digital tools is not uniform across firms, industries, sectors and countries (Calvino and Criscuolo, forthcoming[20]; OECD, 2017[21]).

Importantly, the aggregate productivity slowdown masks a widening gap in multi-factor productivity growth among firms, with firms in ICT-intensive services sectors leading at the frontier (Figure 3.4). Throughout the economy, this divergence is driven not only by some leading firms pushing out the productivity frontier, but also by the stagnating productivity of a long tail of laggard firms with limited capabilities of, or lack of incentives for, adopting new technology and best practices (Andrews, Criscuolo and Gal, 2016[22]).

These signs suggest that the main source of the productivity slowdown may not be so much a slowing of innovation by the most globally advanced firms, but an uneven uptake and diffusion of these innovations throughout the economy (OECD, 2015[23]). This could also reflect being at the cusp of a new technological wave where only a few front-runners have mastered the new opportunities created by digital technologies, and the know-how needed to exploit these opportunities has not yet been codified for easy dissemination. Adoption and diffusion of digital technologies remain well below potential, but can be facilitated by public policies.

3.4. The gap in multi-factor productivity growth is widening



Note: See Chapter notes.[5]

Source: Andrews, D., C. Criscuolo and P. Gal (2016[22]), "The best versus the rest: The global productivity slowdown, divergence across firms and the role of public policy", *https://dx.doi.org/10.1787/63629cc9-en*.

StatLink https://doi.org/10.1787/888933914860

Sources: Goldfarb and Tucker (2017[18]), "Digital economics", *https://www.nber.org/papers/w23684*; Ahmad, Ribarsky and Reinsdorf (2017[19]), "Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth?", *https://dx.doi.org/10.1787/a8e751b7-en*; Calvino and Criscuolo (forthcoming[20]), "Business dynamics and digitalisation: A progress report"; OECD (2017[21]), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, https://dx.doi.org/10.1787/9789264268821-en ; Andrews, Criscuolo and Gal (2016[22]), "The Best versus the Rest: The global productivity slowdown, divergence across firms and the role of public policy", *https://dx.doi.org/10.1787/63629cc9-en*; OECD (2015[23]), *The Future of Productivity*, *https://dx.doi.org/10.1787/9789264248533-en*.

While key digital technologies like big data analytics, cloud computing, and the IoT each by themselves have started to transform business and production models in many industries, including less digital-intensive sectors, their potential is even larger when used in combination. Building on these technologies, additive manufacturing (i.e. 3D printing), autonomous machines and systems, artificial intelligence (AI), robotics, and human-machine integration create additional potential for applications, productivity effects, and possibly disruption in a range of industries. Together, advanced application of these and possibly other technologies are likely to enable more and more fully automated production processes, from design to delivery (OECD, 2017[17]).

Unleashing the potential of digital tools for firms to increase productivity requires successful diffusion (Box 3.2). Recognising the limitations of a linear technology diffusion model of the past for a dynamic and networked digital environment, approaches to boost diffusion should take into account not only the individual firm, but also their networks of suppliers, users and customers. Key actors and institutions for technology diffusion include government technology transfer offices, universities, other non-governmental stakeholders and test beds which can help to de-risk prospective investments. Examples of diffusion mechanisms used in different countries include industrial extension programmes, technology transfer, technology-oriented business services, applied technology centres, R&D centres, knowledge exchange and demand-based instruments. In addition, networks, partnerships, and open-source collaborations are increasingly important in orchestrating diffusion (OECD, 2017[17]).

Digital tools can help SMEs develop more efficient business processes and diverse product lines, as well as scale up and internationalise. However, their current underuse by SMEs highlights important barriers to adoption, which can include a lack of collateral to take risk and to access finance to invest in technologies and complementary assets, or a lack of key capabilities, e.g. human resources and management expertise. For instance, lack of investment in in-house innovation and organisational capabilities limits the capacity of SMEs to take full advantage of data analytics, engage in e-commerce and participate in knowledge networks. To help SMEs overcome barriers to effective use of advanced digital tools, governments need to support and better target policies to SMEs (Box 3.3).

3.3. Support and better target policies to small and medium-sized enterprises

To help SMEs overcome barriers to the use of advanced digital tools, policy makers can create favourable conditions for ICT adoption, such as policies that foster ICT investment, skills development and business dynamism. They must also address specific challenges faced by SMEs through more targeted policies. Examples of policy approaches include:

- Support schemes to facilitate the adoption of tools that are particularly beneficial and may be new to SMEs, such as cloud computing, which requires limited up-front investment and offers flexible upscaling or downscaling of activities.
- Measures to help SMEs overcome obstacles to better exploit and protect intellectual property and leverage other intangibles. This may include, for example, targeted skills development or measures to overcome hurdles to accessing intellectual property, such as administrative burdens and complex and costly litigation and enforcement mechanisms.
- Policies targeting firms by size should avoid creating disincentives for SMEs to scale up. For instance, in the case of regulatory simplification for SMEs, efficient firms may choose to remain small to avoid the additional regulatory burden that may come with a certain size threshold.
- Exemptions of certain rules for SMEs to facilitate regulatory compliance. For example, the EU General Data Protection Regulation includes a derogation for organisations with fewer than 250 employees with regards to data record-keeping.
- Programmes that raise awareness of and create opportunities for linkages and partnerships between SMEs and larger firms, domestically and internationally, can help SMEs to exploit their potential in producing intermediate goods and digital services.

These and other policy measures to support SMEs may be taken into account in the context of a digital transformation strategy (see Chapter 9) to ensure coherence and co-ordination across different SME related measures implemented across different policy areas.

Sources: OECD (2017[5]), *Government at a Glance 2017*, *https://dx.doi.org/10.1787/gov_glance-2017-en*; OECD (2018[24]), "Enabling SMEs to scale up", *https://www.oecd.org/cfe/smes/ministerial/documents/2018-SME-Ministerial-Conference-Plenary-Session-1.pdf*.

A business environment that encourages the most efficient allocation of resources and facilitates structural change also encourages the adoption and diffusion of digital technologies, with higher diffusion of selected digital technologies in sectors with higher firm turnover (i.e. entry and exit) (Calvino and Criscuolo, forthcoming[20]). This is in part because the digitalisation of firms involves experimenting with digital technologies, with some firms successfully adopting digital tools and rapidly scaling-up, and others scaling-down and potentially exiting the market (Andrews and Criscuolo, 2013[25]). However, data for the past decade shows that business dynamism has been declining in many OECD countries (Criscuolo, Gal and Menon, 2014[26]) and resource misallocation is on the rise (Adalet McGowan, Andrews and Millot, 2017[27]; Berlingieri, Blanchenay and Criscuolo, 2017[28]).

Structural reforms can help boost business dynamism. In some countries, existing frameworks may implicitly or explicitly favour incumbents and hinder experimentation with new ideas, technologies and business models that underpin successful small and large firms. Policies that can affect competitive pressure and business dynamism, and in turn technology diffusion and better resource allocation, include: labour market regulations, employment protection legislation, and the design of insolvency regimes, e.g. less penalising sanctions for bankruptcy and lower barriers to corporate restructuring of insolvent firms (Andrews, Nicoletti and Timiliotis, 2018[8]; Adalet McGowan and Andrews, 2018[29]; Sorbe et al., 2019[14]).

Leverage skills for people, firms and governments to thrive in the digital age

People need the right mix of skills to use digital technologies effectively in life and at work. The available evidence shows that the diffusion of online activities is more widespread among individuals with higher education levels than among less educated individuals (see Figure 3.1). Individuals with sound cognitive skills, notably numeracy, literacy, and problem-solving skills in technology-rich environments, are found to be most likely to perform a more diversified range of activities, including more complex/sophisticated online activities (OECD, forthcoming[1]).

While a mix of skills is crucial (see Chapters 5 and Chapter 6), many adults, the elderly in particular, lack sufficient problem-solving skills in technology-rich environments. Only 31% of 16-64 year-olds perform at a medium or high level in problem-solving in technology-rich environments (Figure 3.5). If one considers a mix of skills that includes literacy and numeracy, the number of adults lacking basic cognitive skills to be productive in digital environments is close to one in five adults in several countries (OECD, forthcoming[1]).

Additional skills are required for effective use of digital tools in firms or other organisations, including governments and the public sector. While the range of all skills or the precise combination of several specific skills needed differs depending on the usage, e.g. the online activity to be undertaken or the task that needs to be performed at work, and may further evolve over time, important skills include generic ICT,[6] ICT specialist[7] and data specialist[8] skills, as well as complementary skills and competences that enable high-performance work practices[9] (OECD, 2017[11]; OECD, 2015[15]), such as team work, autonomy, problem solving, creative thinking, communication, collaboration, and emotional intelligence and a strong ability to continue learning (see Chapter 5).

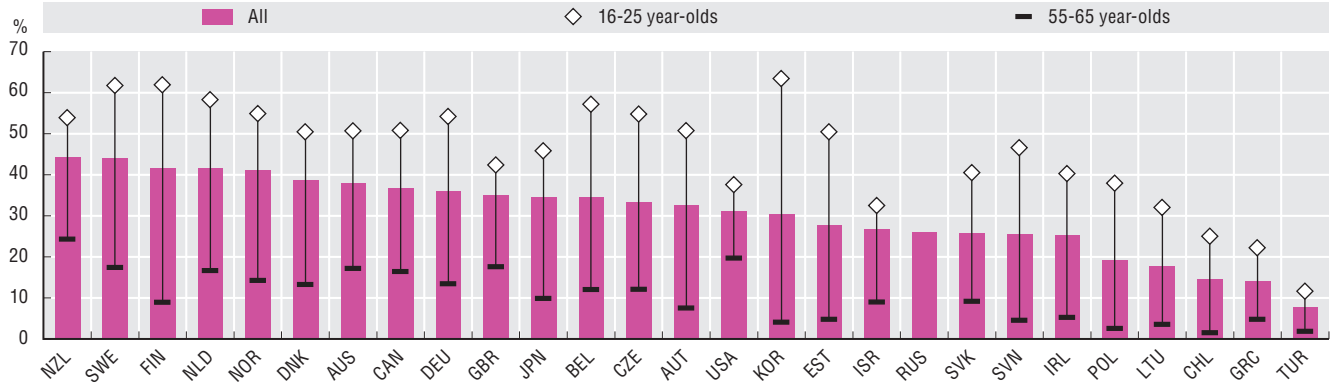
Several of these skills are directly associated with higher adoption of digital tools in firms. For example, the quality of management,[10] ICT skills and the participation in life-long learning and on-the-job training are associated with higher adoption of CRM and cloud computing by firms (Andrews, Nicoletti and Timiliotis, 2018[8]). While the right skills are equally important for digital government and the public sector (OECD, 2017[31]), public employers, as well as smaller and laggard firms, tend to face challenges in recruiting talent, which is often lured by competitive offers from leading and large private firms (OECD, 2017[32]).

Ensuring the long-term provision of skills that are needed in the digital age requires a fresh look at education systems. In addition to the central role of fundamental literacy and numeracy skills, every student needs access to education that delivers ICT and complementary skills, including problem-solving skills in technology-rich environments, to effectively navigate a digital world (of work). Curricula, in tertiary education in particular, need to ensure a sufficient number of courses for ICT

and data specialists as well as options to acquire important complementary competences, such as social, communication or management skills. The acquisition of some important skills starts with early childhood education, which in turn should be considered to ensure equal access to key skills for all.

3.5. Many adults lack sufficient problem-solving skills for technology-rich environments

Proficiency in problem solving in technology-rich environments, by age, as a percentage of 16-65 year-olds scoring at levels 2 and 3 in each age group, 2012 or 2015



Notes: StatLink contains more data. See Chapter notes.[11]

Source: OECD (2019), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD[30], *Survey of Adult Skills (PIAAC)*, *www.oecd.org/skills/piaac/publicdataandanalysis* (accessed September 2018).

StatLink https://doi.org/10.1787/888933915069

In view of faster returns to investment in skills, training is crucial, in particular the training of low-skilled workers. Whether publicly or privately provided, taken out of or on-the-job, firms and individuals alike may need incentives to provide and undergo training. While training high-skilled workers can foster technology diffusion, the greatest diffusion effects come from providing training to low-skilled workers. These workers also tend to face a higher likelihood of automation and are most in need of training (see Chapter 5), and the marginal benefit of training for technology adoption is twice as large for low-skilled than for high-skilled workers. This also implies that measures to train low-skilled workers are likely to entail a double dividend for productivity and inclusiveness (Andrews, Nicoletti and Timiliotis, 2018[8]).

Important potential for making education and training more effective lies in better using of digital technologies for teaching and learning. Over the past decade, different approaches to digital learning have evolved and often improved access to and flexibility of learning, including by allowing access to education and training over the Internet (see Chapter 5), and/or by unbundling and personalising it. Examples include:

- digital learning materials and open educational (online) resources, which create new possibilities such as digital annotations, machine-scorable online quizzes, links to tutorials, etc. and can greatly reduce cost per learner
- blended or hybrid learning, which may take the form of digital face-to-face learning or flipped classrooms courses
- personalised instructions and adaptive learning, including through games and enhanced through data collection, predictive analytics and AI
- digital immersive learning that can facilitate faculty-student and student-student interactions and substitute for "hands-on" educational experiences.

While these approaches have much potential, when teachers are involved, the skills, motivations and attitudes of teachers are keys for the success of digital learning. For example, teachers' problem-solving skills in technology-rich environments have a significant positive relationship with students' performance in computer problem solving and computer mathematics (OECD, forthcoming[1]).

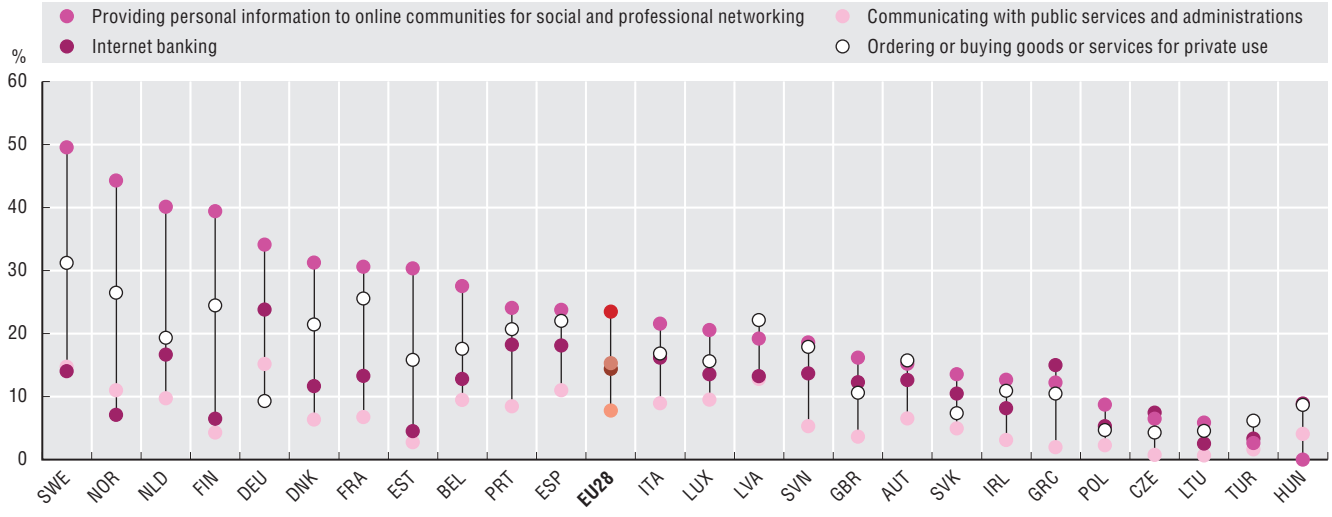
Besides having enough of the right skills, allocating skilled workers to the jobs they are best equipped for is important to foster usage. Reducing skills mismatch is found to relate positively to economic performance and technology diffusion. For example, a lower skills mismatch is associated with disproportionately higher adoption rates of CRM software and cloud computing in knowledge-intensive sectors compared to other sectors (Andrews, Nicoletti and Timiliotis, 2018[8]). While the best-performing firms, especially multinational ones, tend to have access to multiple labour markets and talent pools, and can attract talent with better paid and more attractive jobs, SMEs, laggard firms, and the public sector tend to face greater challenges in finding and competing for the human capital they need.

Address mistrust to increase online engagement

Trust underpins most digital relationships and transactions and a lack of trust is an important barrier to diffusion and effective use (see Chapter 7). Concerns about digital security and/or the protection of personal information can severely hamper individuals' propensity to carry out online activities. In several OECD countries, over 30% of individuals report that they do not provide personal information on online social networks and, on average (EU28), 14% do not order goods or services online and refrain from Internet banking because of security concerns (Figure 3.6).

3.6. Security concerns deter online engagement

Individuals refraining from selected online activities because of security concerns, as a percentage of individuals aged 16-74, 2015



Source: OECD calculations based on Eurostat[33], *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed September 2018).

StatLink https://doi.org/10.1787/888933914879

Such concerns can be grounded in negative experiences, such as being the victim of financial loss from a fraudulent online payment or from phishing/pharming; trust can also be compromised by re-occurring personal data breaches that have been increasing in terms of scale and profile over recent years (OECD, 2017[11]). For businesses as well, trust is a key factor affecting the use of digital tools. For example, the risk of a security breach and uncertainty about the location of stored data are key reasons for businesses not to use cloud computing, and these concerns are reflected in cloud computing usage rates that are below potential, notably among SMEs (see Figure 3.3).

Mistrust is exacerbated by digital security incidents, including in the public sector, that have increased in terms of both sophistication and magnitude of impact over the past decade, as well as by privacy risks that increase with the collection and use of big data and the challenge to fully comply with relevant privacy regulation (OECD, 2017[11]). These hurdles are particularly important for SMEs, which

often lack the awareness and/or the resources to adequately manage digital security and privacy risks. Finally, governments may also face challenges to manage risk with regards to securing digital assets and services and privacy, for example when linking initially separate data sets or when opening up government data to the public. To address mistrust as a barrier for use requires all actors to better manage digital risk, i.e. build capacities to assess digital risk and reduce it to an acceptable level, including through risk mitigation and/or transfer (see Chapter 7).

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 3.1: For "News reading", "Content Creation", "Job search", "Social networking (professional)" and "Online course", data refer to 2017.
2. Figure 3.2: For Chile, Colombia, Costa Rica, Mexico and Switzerland, data refer to 2017.
3. A "basic" broadband connection has an advertised download rate of at least 256 kilobits per second (kbps). In contrast, "fast" broadband features download speeds of at least 100 Megabits per second (Mbps).
4. Figure 3.3: Broadband includes fixed connections with an advertised download rate of at least 256 kbps.
   Fast broadband refers to the share of businesses with a broadband download speed at least 100 Mbps.
   E-purchases and e-sales refer to the purchase and sales of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing of orders (i.e. web pages, extranet or electronic data interchange [EDI], but not orders by telephone calls, fax or manually typed e-mail). Payment and delivery are not considered.
   Enterprise resource planning (ERP) systems are software-based tools that can integrate the management of internal and external information flows, from material and human resources to finance, accounting and customer relations. Here, only sharing of information within the firm is considered. The most recent year for ERP is 2017 for the majority of countries.
   Cloud computing refers to ICT services used over the Internet as a set of computing resources to access software, computing power, storage capacity and so on.
   Supply-chain management (SCM) refers to the use of automated data exchange (ADE) applications.
   Customer/Supplier relationship management software (CRM) is a software package used for managing a company's interactions with customers, clients, sales prospects, partners, employees, and suppliers. Data for CRM relate to the year 2017.
   Big data analysis refers to the use of techniques, technologies and software tools for analysing big data, which relates to the huge amount of data generated from activities that are carried out electronically and from machine-to-machine communications.
   Social media refers to applications based on Internet technology or communication platforms for connecting, creating and exchanging content online with customers, suppliers or partners, or within the enterprise. Social media might include social networks (other than paid advertisement), blogs, file sharing and wiki-type knowledge-sharing tools.
   Radio frequency identification (RFID) is a technology that enables contactless transmission of information via radio waves. RFID can be used for a wide range of purposes, including personal identification or access control, logistics, retail trade and process monitoring in manufacturing.
5. Figure 3.4: In Panels A and B, the global frontier group of firms is defined by the top 5% of companies with the highest MFPR levels within each 2-digit industry, while Panels C and D employ two definitions of the global frontier based on the top 2%, and 10% of the MFPR distribution to emphasize a growing dispersion at the top of the productivity distribution. Laggards capture all the other firms.
   Unweighted averages across 2-digit industries are shown for sales and MFPR, separately for services and ICT services, normalized to 0 in the starting year. Time period is 2001-2013. Services refer to non-financial business services. ICT-intensive services refer to the information and communication sector (industry code J in NACE Rev. 2) and postal and courier activities (53). MFPR uses the Wooldridge (2009) methodology based production function estimation. See also: Wooldridge (2009[34]).
6. ICT skills used at work include, for example, basic computer skills, communication and information search skills, and proficiency in using office productivity software

7. ICT specialists include ICT service managers, ICT professionals, ICT technicians, Electro-technology engineers, and Electronics and telecom installers and repairers.
8. Data specialists include mathematicians, actuaries, statisticians, and database and network professionals.
9. High performance work practices include skills and competences such as team work, autonomy, task discretion, mentoring, job rotation, and applying new learning, as well as management practices including bonus payments, training, and flexible working hours.
10. Proxied by the share of workers involved in management practices that stimulate employee and organisational performance and the training received by future managers in management schools.
11. Figure 3.5: The data for the following 21 countries from the first round of PIAAC refer to the year 2012: Australia, Austria, Belgium (Flanders), Canada, Czech Republic, Denmark, Estonia, Finland, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Russian Federation (excluding Moscow), Slovak Republic, Sweden, the United Kingdom (England and Northern Ireland) and the United States. Data for the remaining countries refer to 2015 and are sourced from the second round of the first wave of the PIAAC survey. For the United Kingdom, data refer to England only. For the Russian Federation, the PIAAC sample does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65, but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area.

References

Adalet McGowan, M. and D. Andrews (2018), "Design of insolvency regimes across countries", *OECD Economics Department Working Papers*, No. 1504, OECD Publishing, Paris, *https://dx.doi.org/10.1787/d44dc56f-en*. [29]

Adalet McGowan, M., D. Andrews and V. Millot (2017), "The walking dead?: Zombie firms and productivity performance in OECD countries", *OECD Economics Department Working Papers*, No. 1372, OECD Publishing, Paris, *https://dx.doi.org/10.1787/180d80ad-en*. [27]

Ahmad, N., J. Ribarsky and M. Reinsdorf (2017), "Can potential mismeasurement of the digital economy explain the post-crisis slowdown in GDP and productivity growth?", *OECD Statistics Working Papers*, No. 2017/09, OECD Publishing, Paris, *https://dx.doi.org/10.1787/a8e751b7-en*. [19]

Andrews, D. and C. Criscuolo (2013), "Knowledge-based capital, innovation and resource allocation", *OECD Economics Department Working Papers*, No. 1046, OECD Publishing, Paris, *https://doi.org/10.1787/5k46bj546kzs-en*. [25]

Andrews, D., C. Criscuolo and P. Gal (2016), "The Best versus the Rest: The global productivity slowdown, divergence across firms and the role of public policy", *OECD Productivity Working Papers*, No. 5, OECD Publishing, Paris, *https://dx.doi.org/10.1787/63629cc9-en*. [22]

Andrews, D., G. Nicoletti and C. Timiliotis (2018), "Digital technology diffusion: A matter of capabilities, incentives or both?", *OECD Economics Department Working Papers*, No. 1476, OECD Publishing, Paris, *https://dx.doi.org/10.1787/7c542c16-en*. [8]

Berlingieri, G., P. Blanchenay and C. Criscuolo (2017), "The great divergence(s)", *OECD Science, Technology and Industry Policy Papers*, No. 39, OECD Publishing, Paris, *https://dx.doi.org/10.1787/953f3853-en*. [28]

Calvino, F. and C. Criscuolo (forthcoming), "Business dynamics and digitalisation: A progress report", *OECD Science, Technology and Industry Working Papers*, OECD Publishing, Paris. [20]

Criscuolo, C., P. Gal and C. Menon (2014), "The dynamics of employment growth: New evidence from 18 countries", *OECD Science, Technology and Industry Policy Papers*, No. 14, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jz417hj6hg6-en*. [26]

Eurostat (2018), *Digital Economy and Society Statistics*, *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed December 2018). [33]

Gal, P. et al. (2019), "Digitalisation and productivity: In search of the holy grail – Firm-level empirical evidence from EU countries", *OECD Economics Department Working Papers*, No. 1533, OECD Publishing, Paris, *https://doi.org/10.1787/5080f4b6-en*. [13]

Goldfarb, A. and C. Tucker (2017), "Digital economics", *NBER Working Paper* No. w23684, *https://www.nber.org/papers/w23684*. [18]

OECD (2019), "ICT Access and Usage by Households and Individuals", *OECD Telecommunications and Internet Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/b9823565-en* (accessed 28 January 2019). [2]

OECD (2019), "ICT Access and Use by Businesses", *OECD Telecommunications and Internet Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/9d2cb97b-en* (accessed 31 January 2019). [16]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *http://dx.doi.org/10.1787/9789264311992-en*. [9]

OECD (2018), "Enabling SMEs to scale up", discussion paper, SME Ministerial Conference, OECD, Paris, *https://www.oecd.org/cfe/smes/ministerial/documents/2018-SME-Ministerial-Conference-Plenary-Session-1.pdf*. [24]

OECD (2018), *Going Digital in a Multilateral World*, OECD, Paris, *www.oecd.org/mcm/documents/C-MIN-2018-6-EN.pdf*. [3]

OECD (2018), *OECD Regulatory Policy Outlook 2018*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264303072-en*. [4]

OECD (2018), *Survey of Adult Skills (PIAAC)*, OECD, Paris, *http://www.oecd.org/skills/piaac* (accessed in September 2018). [30]

OECD (2017), *Core Skills for Public Sector Innovation*, OECD, Paris, *https://www.oecd.org/media/oecdorg/satellitesites/opsi/contents/files/OECD_OPSI-core_skills_for_public_sector_innovation-201704.pdf*. [31]

OECD (2017), *Government at a Glance 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/gov_glance-2017-en*. [5]

OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264276284-en*. [11]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268821-en*. [21]

OECD (2017), *Report on the Implementation of the Recommendation of the Council on Digital Government Strategies*, internal document, OECD, Paris. [32]

OECD (2017), *Tax Administration 2017: Comparative Information on OECD and Other Advanced and Emerging Economies*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/tax_admin-2017-en*. [6]

OECD (2017), *The Next Production Revolution: Implications for Governments and Business*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264271036-en*. [17]

OECD (2015), *Data-driven Innovation: Big Data for Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264229358-en*. [15]

OECD (2015), *The Future of Productivity*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264248533-en*. [23]

OECD (2014), *Recommendation of the Council on Digital Government Strategies*, OECD, Paris, *https://www.oecd.org/gov/digital-government/Recommendation-digital-government-strategies.pdf*. [7]

OECD (2013), *New Sources of Growth: Knowledge-based Capital. Key Analyses and Policy Conclusions – Synthesis Report*, OECD, Paris, *http://www.oecd.org/sti/inno/knowledge-based-capital-synthesis.pdf*. [12]

OECD (forthcoming), "ICT investments in OECD and partner countries: Trends, policies and evaluation", *OECD Digital Economy Papers*, OECD Publishing, Paris. [10]

OECD (forthcoming), *OECD Skills Outlook 2019*, OECD Publishing, Paris. [1]

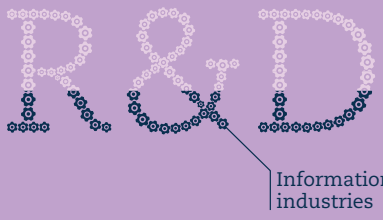
Sorbe, S. et al. (2019), "Digital dividend: Policies to harness the productivity potential of digital technologies", *OECD Economic Policy Papers*, No. 26, OECD Publishing, Paris, *https://doi.org/10.1787/273176bc-en*. [14]

Wooldridge, J.M. (2009), "On estimating firm-level production functions using proxy variables to control for unobservables", *Economics Letters*, Vol. 104, Issue 3, p. 112-114 *http://dx.doi.org/10.1016/j.econlet.2009.04.026*. [34]

Chapter 4

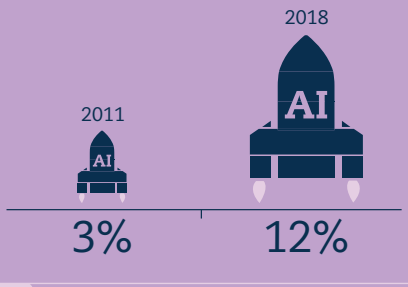
UNLEASHING INNOVATION

Almost **one third of business R&D expenditure** is **in information industries**.



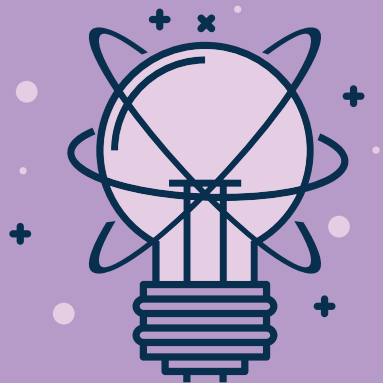
Foster innovation through investment in R&D, especially in information industries.

AI start-ups attracted 12% of worldwide **private equity investments** in the first half of 2018, up from 3% in 2011.

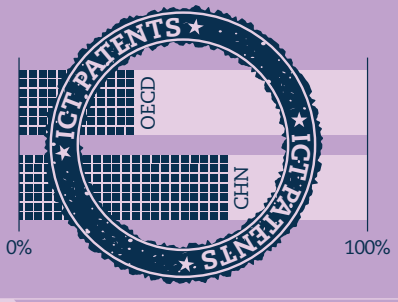


Harness the potential of digital technologies for innovation and science.

INNOVATION



Over 2013-16, about 33% **of OECD countries' patents were ICTs**, compared to about 60% of China's.



Stimulate digital innovation by investing in intangible assets, e.g. patents or software.

Open government data boost innovation in the public and private sectors.

Realise open government data's potential to foster digital innovation.

UNLEASHING INNOVATION: WHAT MATTERS MOST FOR POLICY?

Promote start-ups and young firms

- Foster entrepreneurship by reducing regulatory burdens for start-ups. Re-evaluate regulations that may not fit the digital age, such as those that require a physical presence or a minimum scale, or seek to address information asymmetries.
- Artificial intelligence (AI) start-ups attracted 12% of all worldwide private equity investments in the first half of 2018, up from 3% in 2011, and the share is increasing. Consider the promise of new digital financing solutions, such as peer-to-peer (P2P) and platform-based lending, to complement venture capital (VC) and traditional debt and equity financing options for small and young firms.

Mobilise the public and private sectors to support science and digital innovation

- Innovation in the digital age relies on a range of inputs from the public and private sectors, including basic research, research and development (R&D), skills, and intangibles, including data and organisational capital. Business R&D spending amounted to 1.6% of gross domestic product (GDP) on average across the OECD in 2016, with information industries contributing significantly to overall business R&D expenditure.
- Intangible assets (e.g. patents, organisational capital and software) boost digital innovation. About one-third of OECD country patents were in digital-related technologies compared to about 60% in the People's Republic of China over 2013-16.

Provide support and incentives to all innovators

- To boost digital innovation, consider support and incentives such as R&D tax credits and intellectual property systems that are adapted to the digital age. Foster knowledge diffusion through open innovation and open science initiatives.

Realise open government data's potential to drive digital innovation

- Open government data holds much potential to boost digital innovation for firms and the public sector alike. "Open by default" policies and a whole-of-government approach can help.

Prepare to reap the promises of digital innovation in sectors

- Digital technologies offer promise to improve productivity in sectors; policy experimentation, including agile regulation and regulatory sandboxes, can promote innovation while protecting consumers.

Innovation pushes out the frontier of what is possible, driving job creation, productivity and sustainable growth and development. Digital innovation is a fundamental driver of the digital transformation, leading to radical changes in the ways people interact, create, produce and consume. Digital innovation not only gives rise to new and novel products and services, but it also creates opportunities for new business models and markets, and it can drive efficiencies in the public sector and beyond. Digital technologies and data also drive innovation in a wide range of sectors, including education, health, finance, insurance, transportation, energy, agriculture, fisheries and manufacturing, as well as the information and communication technology (ICT) sector itself.

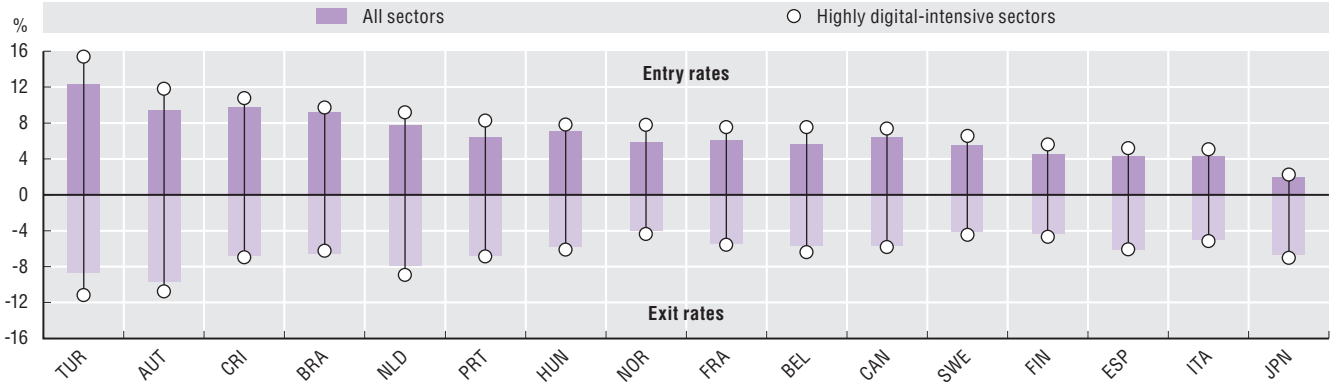
Promote start-ups and young firms

Young firms are an essential part of the digital innovation landscape. They create a disproportionate number of jobs relative to their size and they underpin broader economic growth across the economy (Criscuolo, Gal and Menon, 2014[1]; Calvino, Criscuolo and Menon, 2016[2]). A high share of young firms spur productivity-enhancing reallocation within these sectors as resources flow from inefficient laggards to smaller, dynamic enterprises, enabling them to grow faster.

Moreover, new entrants can drive digital innovation. Digital-intensive sectors like the ICT sector, which have higher shares of young firms than other sectors in most countries across the OECD (OECD, 2017[3]), tend to be more dynamic and more innovative. Digital-intensive sectors have higher entry rates on average, and they also have higher exit rates in most of the countries considered, though the magnitude of these differences is smaller than for entry rates (Figure 4.1). Cross-country differences for the countries considered in the sample are significant. Austria, the Netherlands and Turkey show the highest difference between the most digital-intensive and less digital-intensive sectors.

4.1. Digital-intensive sectors have higher churn

Business dynamism, average entry and exit rates, highly digital-intensive sectors and all sectors, 1998-2015



Note: See Chapter notes.[1]

Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD, *DynEmp3* (database), *http://oe.cd/dynemp* (accessed January 2019).

StatLink https://doi.org/10.1787/888933915088

New and young firms drive innovation in part because they play an important role in commercialising new technologies (Henderson, 1993[5]; Tushman and Anderson, 1986[6]), and are often able to promote radical and sometimes disruptive innovations in their industries (Schneider and Veugelers, 2010[7]). This has been the case, for example, in the software, nanotechnology, biotechnology and clean technology industries (OECD, 2018[8]). Young firms are also often better placed to commercialise knowledge generated by research organisations (OECD, 2010[9]; Baumol, 2002[10]), enabling broader knowledge diffusion across the economy.

New and young firms may also be more able to make complementary investments in business processes and knowledge-based capital (KBC), including software, R&D, organisational capital and training, needed to take advantage of digital transformation as they do not suffer from the "organisational inertia" of older and more established firms (Henderson and Clark, 1990[11]). Helping entrepreneurs

start innovative new businesses requires attention to structural factors that support ventures and do not excessively penalise entrepreneurial failure (Adalet McGowan, Andrews and Millot, 2017[12]).

Market concentration in a digitalised economy can represent another barrier to innovation. Young firms serve as important sources of competition for other, established firms, which can spur economy-wide innovation. At the same time, there have been significant increases in the acquisitions of start-ups by larger firms in comparatively more digital-intensive industries. In particular, the data processing and software publishing sectors saw large increases in the acquisition of data processing start-ups between 2005 and 2016, with the top 1% of acquirers accounting for about 70% of total deal value in 2016 (Bajgar et al., forthcoming[13]).

Regulatory frameworks can constrain the entry of new players, which are essential for driving competition, innovation and technological diffusion across the economy. A recent OECD survey on the relationship between vertical regulation, digitalisation and competition found 92 regulations across OECD countries that had an adverse effect on competition (OECD, 2018[14]). Vertical regulations were identified that constrain market entry for digital competitors in specific sectors, with potential impacts for sector-wide innovation, productivity and growth, with the transport, accommodation and pharmaceutical sectors identified as the sectors with the most regulations with potentially restrictive impacts on competition, although consumer protection, as well as labour market and safety standards, are important in these sectors (OECD, 2018[14]).

In particular, regulations that require a physical presence or a minimum scale were found to constrain the emergence of businesses that focus on bringing together buyers and sellers via online platforms, including those from overseas (OECD, 2018[14]). Similarly, a high regulatory burden in some industries, such as banking, can become so large so as to be only affordable for incumbent firms of a certain size, constraining the emergence of smaller, digitally enabled business models. Regulations that mandate a large minimum scale can mean that only few digital enterprises would be able to reach such scale. Finally, the review found that regulations previously intended to address market failures related to information asymmetries (for example, standardised star rating systems for hotels) may no longer be necessary to the degree that digital products (e.g. user-provided ratings and reviews) are able to distinguish quality.

Encourage diversified financing options for new firms

The current decline in rates of entrepreneurship across the OECD is a cause for concern, particularly for digital innovation, because this reduces dynamism and pressure on incumbents to innovate (Berlingieri, Blanchenay and Criscuolo, 2017[15]). The lack of dynamism affects aggregate productivity growth, suggesting that industries may not be fully taking advantage of the potential of digital technologies. Research also suggests that structural barriers may be one reason for declining rates of firm entry (Criscuolo, Gal and Menon, 2014[1]; Hathaway and Litan, 2014[16]).

Start-ups and innovative young firms in digital industries face a particularly uncertain future. Only about 5% of start-ups typically grow and innovate (Calvino, Criscuolo and Menon, 2015[17]), and access to finance is essential to enable those firms to improve their post-entry performance (Rajan and Zingales, 1998[18]), scale up and spread their productivity benefits across the wider economy, which can be significant.

But many small and medium-sized enterprises (SMEs) report having insufficient collateral, which is exacerbated for start-ups in the ICT sector whose business models rely on intangible assets that may be difficult to value or liquidate in the event of firm exit (OECD, 2015[19]). Coupled with high-risk profiles and the dynamism of the ICT sector, start-ups in the ICT sector often do not receive asset-based financing and traditional debt financing and those that do face higher transaction costs than incumbents (OECD, 2015[19]).

Equity financing is one traditional mechanism for firms with high-risk profiles. Recent research finds that equity financing is the most popular instrument to support access to finance for innovative firms across OECD countries (European Commission/OECD, 2017[20]). AI start-ups attracted 12% of all worldwide private equity investments in the first half of 2018, a significant increase from just 3% in 2011. This share is increasing in all major economies. However, corporate tax regimes often treat equity and other forms of financing less preferentially than debt financing.

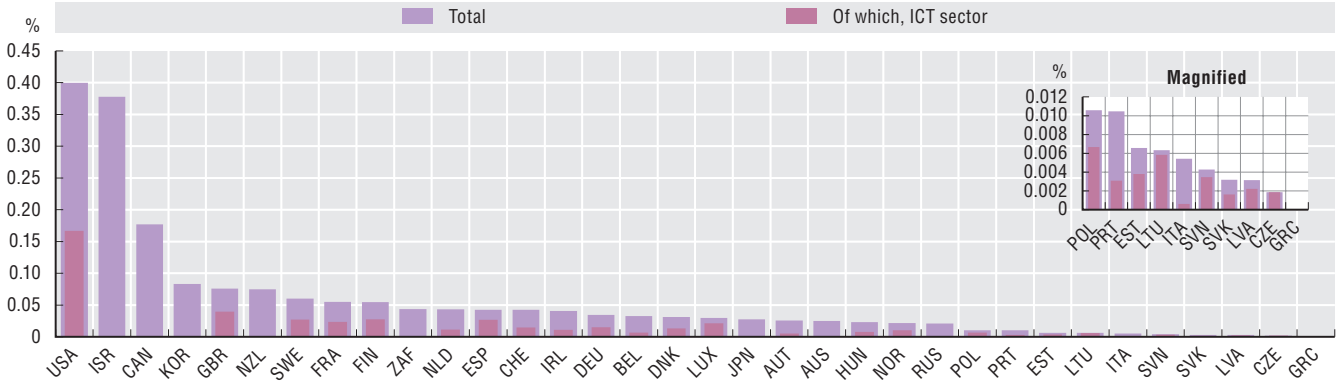
Venture capitalists can help bridge the financing gap that arises from the fact that early adopters (e.g. young firms) often lack internal funds and a track record to signal their "quality" to investors (Hall and Lerner, 2009[21]). Research has shown that cross-country differences in the availability of risk capital are significant and positively related to the speed of technological diffusion (Saia, Andrews and Albrizio, 2015[22]; Andrews, Criscuolo and Gal, 2015[23]).

The VC industry also appears to evolve quickly – the People's Republic of China (hereafter "China"), for example, went from having almost no venture capital investments in AI in 2015 to being the second largest recipient in 2017 (OECD, forthcoming[24]). Some estimates have found that up to 50% of VC-backed start-ups receive some form of government support, typically through "funds of funds", but also sometimes through direct government ownership of VC funds (Brander, Du and Hellmann, 2015[25]).

While venture capital investments involve less than 1% of firms (OECD, 2018[26]), venture capital investment in the ICT sector varies considerably among countries for which data are available. The United States reports not only the largest amount of VC investment overall but also in the ICT sector (Figure 4.2).

4.2. The ICT sector attracts VC investment

VC investment in the ICT sector, as a percentage of GDP, 2017



Note: See Chapter notes.[2]

Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *Entrepreneurship Financing Statistics*, *http://www.oecd.org/industry/business-stats/* (accessed November 2018).

StatLink https://doi.org/10.1787/888933915107

Overall, there is a need for more diversified financing options for start-ups, including alternative forms of debt and hybrid tools (OECD/G20, 2015[27]). Some also point to digital technologies and their ability to reduce the main barriers encountered by small and young firms in capital markets, namely information asymmetry and collateral shortage (OECD, 2017[28]). New digital financing solutions, such as peer-to-peer lending and crowdfunding (OECD, 2018[26]), as well as more recent innovations like initial coin offerings (ICOs), may also help, but require further study to assess overall benefits and risks (OECD, 2019[29]). Likewise, platform-based lending (e.g. Amazon, Alibaba), which uses trading history and business behaviour on the platform to proxy for other metrics of firm risk, has potential to help expand financing options, especially for small and young firms.

Mobilise the public and private sectors to support science and digital innovation

Digital innovation relies on continually building the knowledge base, and basic research into science and technology is critical in this respect. Support for universities and other institutions conducting basic research can help sow the seeds of future innovation; indeed, basic research has underpinned most of the general-purpose technologies that drive the current phase of digital transformation (OECD, 2015[30]; OECD, 2015[31]). The public sector plays an important role in supporting such research since

the private sector is often reluctant to invest in projects where the costs are high and the returns uncertain. For example, some of the earliest digital technologies, such as the Internet, the global positioning system (GPS) and voice recognition technology, are the result of extensive public R&D efforts (OECD, 2016[32]).

Despite the importance of basic research, in 2017 government spending on R&D across the OECD was 8% below the levels in 2009 in real terms (OECD, 2018[33]). This may reflect the increasing importance of higher education and public research institutions, which account for less than 30% of total OECD R&D, but perform more than three-quarters of basic research (OECD, 2016[32]). Encouragingly, from 2016 to 2017, higher education R&D expenditure grew by 1% in real terms across the OECD. Over the last decade, OECD countries have increased expenditure on tertiary education by approximately 9% (OECD, 2017[3]).

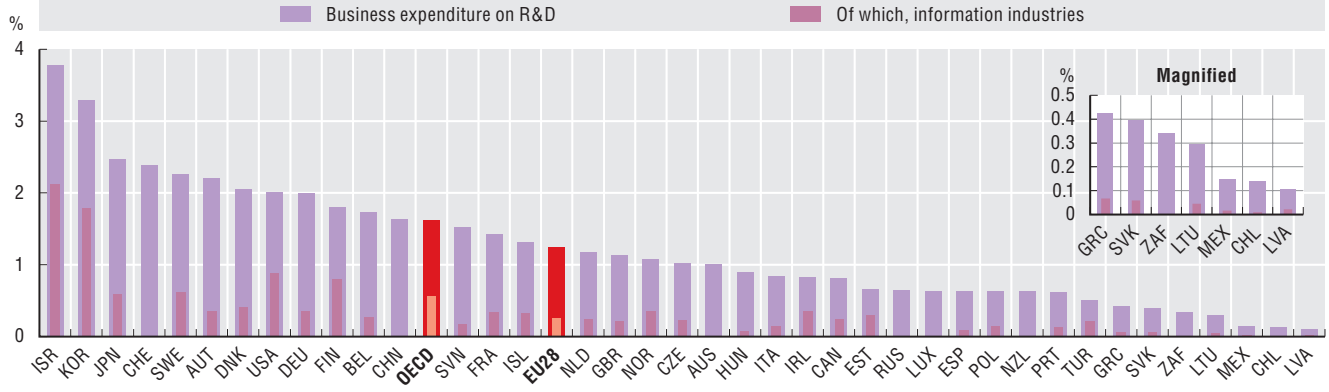
The public sector also helps drive innovation beyond research. For example, the government has an important role in helping SMEs to understand and eventually adopt emerging technologies. Further downstream, government certification of technologies, such as 3D printing, will support their diffusion by controlling for possible negative impacts, e.g. related to the risk of environmental damage (OECD, 2018[34]). Partnerships between universities, industry and government can also help provide start-ups with the know-how, equipment and initial funding to test and scale new technologies, so that investments are more likely to attract venture funding (OECD, 2018[34]).

Public-private partnerships (PPPs) spur innovation by sharing both the risks and rewards of digital innovation. In many fields of advanced production, innovation in the business sector is closely linked to the science system and the process of discovery. Few individual companies – even the largest – have the full range of resources needed to advance the knowledge frontier alone. This reality has led to increasingly sophisticated PPPs aimed at generating and diffusing cutting-edge science and innovation. PPPs can also help spur the commercialisation of research (OECD, 2018[34]).

The private sector is responsible for the lion's share of R&D conducted across the OECD. In 2016, private sector R&D represented almost three-quarters of all R&D expenditure (OECD, 2018[33]). Business R&D spending amounted to 1.6% of GDP on average across the OECD in 2016, with information industries contributing significantly to overall business R&D expenditure (Figure 4.3). Notably, these data do not capture digital R&D occurring in other sectors. Digital innovation is widely spread across the economy. For example, ICT firms in both the manufacturing and services sectors report introducing more innovations to market than the average firm in both sectors (OECD, 2017[3]).

4.3. R&D, especially in information industries, is a key driver of digital innovation

Business R&D expenditure, total and information industries, as a percentage of GDP, 2016



Notes: StatLink contains more data. See Chapter notes.[3]

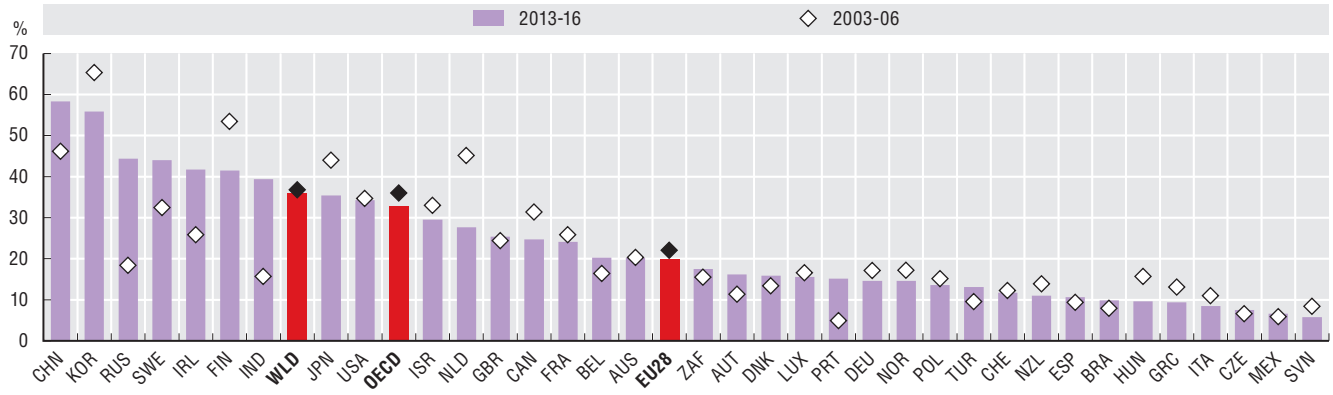
Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *ANBERD* (database), *http://oe.cd/anberd* (accessed December 2018); OECD, *Main Science and Technology Indicators* (database), *http://oe.cd/msti* (accessed July 2018).

StatLink *https://doi.org/10.1787/888933915126*

About one-third of OECD country patents were in digital-related technologies compared to about 60% in China over 2013-16 (Figure 4.4). In addition, ICT patents were concentrated in a small number of firms, with the top 2 000 corporate R&D investors accounting for the ownership of 75% of global ICT-related patents in 2014 (Daiko et al., 2017[35]). More than 10% of the world's top 2 000 R&D corporate investors in 2014 were ICT firms headquartered in the United States (Daiko et al., 2017[35]).

4.4. Many countries lag behind in ICT patenting

Patents in ICT-related technologies, as a percentage of total IP5 patent families, by country of ownership, 2003-06 and 2013-16



Notes: IP5 = five largest intellectual property offices. StatLink contains more data. See Chapter notes.[4]

Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *STI Micro-data Lab: Intellectual Property Database*, *http://oe.cd/ipstats* (accessed November 2018).

StatLink *https://doi.org/10.1787/888933915145*

Across the OECD, businesses are placing increasing importance on investments in KBC, including software, R&D, organisational capital and training, compared to investments in fixed capital assets, including machinery and equipment (OECD, 2017[3]). This is in part because organisational and business practices, process innovation and skills are complementary to digital investment (Brynjolfsson, Hitt and Yang, 2002[36]). Research finds that US management practices in combination with ICT investment drove higher productivity gains in comparison to domestic European firms (Bloom, Sadun and Van Reenan, 2012[37]).

In 2015, investments in KBC accounted for 15% of total business value added (OECD, 2017[3]). In countries like Finland, the United Kingdom and the United States, investment in KBC outstrips tangible investments. One estimate finds that KBC may comprise up to 80% of firm value in the United Kingdom (Corrado et al., 2016[38]). As KBC becomes increasingly relevant to firms, their ability to be valued and potentially leveraged as collateral to access financing becomes more important.

As the scale and complexity of these complementary investments grows, traditional SMEs may find it increasingly difficult to compete. Moreover, the costs associated with experimentation – e.g. with new business models, technologies or business processes – can make productivity growth in these firms low, or even negative (Brynjolfsson, Rock and Syverson, 2017[39]). Innovation in the digital age often relates not only the successful introduction of digital technologies, but also their successful synergies with other intangible assets (Haskel and Westlake, 2017[40]). Chief among these intangible assets is data, an input and an output of digitalisation.

Provide support and incentives to all innovators

It is essential to provide support and incentives to all innovators in the interconnected layers of industries and global data value chains that make up the digital innovation ecosystem. Policy should enable all market players to develop and commercialise their innovations as this will improve the digital ecosystem's capacity to maximise economic and social value from technological innovations.

There are a range of tools to provide support and incentives for innovating. For example, well-designed incentives to support R&D and innovation can be helpful in this regard, including tax-based incentives such as R&D tax credits. Ensuring the impacts of such investments will also require efforts to foster

knowledge diffusion across the economy, including by strengthening exchanges between science and business. New models are emerging, including the provision of digital platforms that enable access to research infrastructures, which hold promise for science in the digital age (OECD, 2017[41]). Open innovation – opening up the innovation process to all – and open science initiatives (Box 4.1) can also be useful for boosting digital innovation.

4.1. Open science

Open science (OECD, 2015[42]) promises greater access to scientific information and data and more effective engagement of businesses, policy makers, citizens and other interested parties in the processes of public research. Ultimately, this should lead to more efficient and effective science, accelerated innovation and new knowledge and technologies to drive social and economic development. However, fully realising the potential benefits of open science requires judicious policy action and careful management of expectations and risks (OECD, 2016[43]; Dai, Shin and Smith, 2018[44]).

Open access is enabled by digital technologies, which means that it is now possible to distribute published scientific information worldwide with only marginal additional costs. Greater access to scientific information can help to make science more inclusive and accelerate the uptake and translation of this information into societal benefits. Public research is published in scientific journals using a variety of models, including subscription and "author-pays" models. The open access movement shifts the focus away from the subscription model.

New business models for open access publishing are constantly evolving. However, while immediate open access, based on an author-pays model, is steadily increasing in popularity, it is worth bearing in mind that the traditional subscription model is still by far the most popular, representing over 80% of the total number of articles published globally last year. At the same time, research evaluation systems largely depend on the current publishing paradigm and the use of bibliometrics, journal impact factors and citations. An effective transition to the open access of scientific information will require policy mandates and incentives and must ensure that all the many research communities are able to publish in high-quality journals and that the quality of scientific publication is maintained.

As with journal articles, access to research data (both data used in research and produced by research) has been severely limited to date, but digital transformation could change this. Unlike scientific publishing, financial interests have not been a major determinant of research data access, although this may change as data emerge as a valuable asset in the digital age. Instead, the main obstacles to sharing public research data relate to the cultural practices and norms of the research community coupled with a lack of capacity and infrastructure.

There is little incentive for scientists to share data beyond their immediate collaborators and the emphasis on competition between groups can be a deterrent to openness. In certain fields, particularly where personal data are involved, there are also important legal and ethical considerations that impose legitimate constraints on access. However, the recent "reproducibility crisis" – lack of reproducibility of published results – is shifting attitudes and behaviour. Research funders sometimes impose mandates to invest in scientific data repositories and associated infrastructure, and train data scientists to enhance access to research data and exploit the benefits of their use.

Opening up public research to engage stakeholders beyond the academic research community is also important but complex. In some research areas, such as clinical trials, the engagement of patient groups and other stakeholders in defining research priorities, designing protocols and conducting research is routine. In chemistry, the links between basic public research and industry are well established. However, in many other research areas, legitimate concerns about preserving academic freedom have tended to discourage the opening up of science. This is now changing as the need for public accountability grows with the scale of the public investment in science and as scientists realise the benefits of engaging the public. Digital transformation is enabling large-scale public dialogues on issues from priority setting to ethics (OECD, 2017[45]; OECD, 2016[43]), and citizen science and crowdsourcing are opening up new opportunities for collecting and analysing data.

Intellectual property rights (IPRs) encourage new ideas and affect innovation performance. IPRs provide incentives for firms and individuals to invest in innovation and creativity and to exploit economically their creations, and for universities to transfer knowledge. IPRs also impact how individuals and firms can access and exploit existing knowledge on efficient terms. As a result, intellectual property policy is a critical component of innovation policies. The challenge is to create a well-functioning intellectual property system, which navigates various legal and economic objectives and constraints, finds compromises among innovation actors, and ensures a balance between the promotion of innovation and creativity, and diffusion of ideas and underlying knowledge.

In the digital age, intellectual property systems that were developed primarily with tangible products in mind bring new challenges that may require adaptation (Guellec and Paunov, 2018[46]). Issues around incentives to produce data, which may involve some measure of exclusivity, and pressures to increase access to data, could prompt intellectual property expert agencies to consider changes to existing intellectual property regimes. Other challenges – such as whether AI can create patentable inventions and digital technologies' role in helping (or hindering) counterfeiting – may prompt intellectual property expert agencies and organisations to review whether adaptations to intellectual property regimes that were developed in a largely analogue world are needed (Guellec and Paunov, 2018[46]).

Realise open government data's potential to drive digital innovation

A characteristic feature of innovation today is that it is increasingly driven by the collection, processing and analysis of vast amounts of data. As noted in Chapter 2, digital technologies increasingly connects people, firms and things. Each interaction and transaction produces a variety of data and meta-data from which useful insights can be gleaned. These data can often be stored easily and at low cost, and the tools to derive insights from data are becoming increasingly easy to access. These insights, and their potential to significantly improve products, processes, organisational methods and markets, are referred to as "data-driven innovation" (OECD, 2015[30]).

Digital businesses are able to collect and analyse enormous amounts of data provided to them by their customers, or derived about their customers based on their online behaviour, and draw useful insights that can be used to automate decision making or processes. Many firms with an online presence, from stockbrokers to Internet search firms, automate and personalise their core functions based on data-driven insights.

Firms can also innovate by experimenting more easily in an iterative way. For example, Amazon, Microsoft, Google and Facebook routinely conduct millions of online experiments to better understand consumer preferences and behaviour with a view to improving the user experience (Brynjolfsson, Eggers and Collis, 2018[47]). Netflix, an Internet streaming company, assesses the impacts of product changes on user behaviour. These insights can in turn improve adaptive streaming and content delivery network algorithms to further enhance the user's experience. Even relatively minor changes in the image of a particular Netflix video or movie can result in 20% to 30% more viewing for that particular item (Netflix, 28 April 2016[48]).

The importance of data and data analytics as a source of innovation has been increasingly recognised by policy makers and statistical offices. Recently, the development and analysis of databases and computerised information were recognised as a business innovation activity in the 4th edition of the *Oslo Manual* (OECD/Eurostat, 2018[49]), which outlines the international statistical standard for measuring innovation.

The opportunities for digital innovation are not limited to the private sector. The public sector is one of the most data-intensive sectors; the United States' public sector is estimated to be the fifth most data-intensive sector in the economy (OECD, 2013[50]). As the public sector both produces and consumes large amounts data, there is significant potential for governments to use digital technologies to innovate.

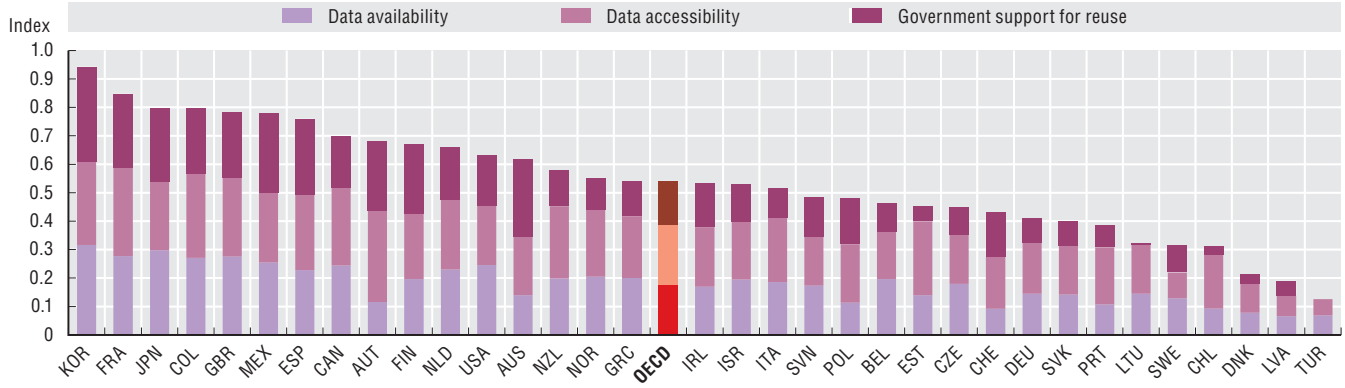
One of the most important things that the public sector can do to drive innovation is to enhance access to public sector data. Efforts to open government data involve making information collected using public funds freely available and in common formats such that they can be easily queried and interrogated (Ubaldi, 2013[51]). Open government data initiatives foster transparency and can increase civic trust, but also take on particular significance in a knowledge-based economy, where data and information are fundamental to innovation.

Firms, in particular, have much to gain from open government data. As more open access to data removes competitive advantage by reducing information asymmetries, firms can produce, innovate and compete on a level playing field. For example, NASA's decision to make granular satellite data publicly available led to an increase in gold exploration activity, with firms almost twice as likely to report the discovery of new gold deposits when regions had been successfully mapped (Nagaraj, 2016[52]). Some studies also suggest that opening government data fosters the development of new start-ups. The innovative use of open municipal data on transport patterns in London, for example, enabled the development of innovative new start-ups and applications, including those that mixed publicly collected data with other sources to allow multi-modal analysis. Firm-level studies estimate that open data added GBP 12 million to GBP 15 million per year for firms (OECD, forthcoming[53]).

Despite the increasing case for making public sector data freely accessible and easily queried and interrogated, countries vary substantially in the degree to which they have put in place measures to do so (Figure 4.5).

4.5. Much potential exists to further open up public sector data

Open-Useful-Reusable Government Data Index (OURdata), 2017



Note: The OURdata indices take values between zero and one, with one being the most open. Each component can score a maximum of 0.33.

Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD (2018[54]), *Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact*, *https://doi.org/10.1787/9789264305847-en*.

StatLink https://doi.org/10.1787/888933915164

While most countries have implemented an "open by default" policy, where all government data should be open unless there are legitimate reasons for not doing so, first movers like France, Korea, the United Kingdom and the United States have scored relatively higher in terms of the introduction and implementation of policies to promote data availability (OECD, 2017[55]). The most commonly cited challenges to opening government data are institutional and organisational (OECD, 2017[56]), indicating that non-technical constraints, including resistance to change in the public sector, may constrain the potential of digital innovation. This challenge underscores the need for a whole-of-government approach to policy making in the digital age, and the need for a coherent policy framework that reaches across silos (OECD, forthcoming[57]).

Prepare to reap the promises of digital innovation in sectors

While data and data analytics underpin digital innovation, digital technologies and data do not affect all sectors of the economy equally. Using data on a range of technological, market and human-capital related features,[5] a taxonomy was developed that outlines the different ways in which industries are responding to digital transformation. This taxonomy (Calvino et al., 2018[58]) shows that while almost no business today is run without some form of digital technology, some sectors appear to be at a higher level of digital intensity than others.

Perhaps unsurprisingly, the ICT and the telecommunications sectors appear to have incorporated digital assets and know-how across the breadth of their businesses, although ICT services outstrip their manufacturing counterparts. Finance is another digital-intensive sector. Innovation in financial services based on digital technologies, or "Fintech", is having some potentially disruptive effects in

the financial industry, cutting across a wide variety of financial services, including banking, consumer and small business financing, payments, insurance ("Insurtech"), pension provision and investment management (Box 4.2). Others show significant heterogeneity across indicators, pointing to different degrees of digital intensity.

4.2. The Fintech revolution

Although the level and pace of Fintech innovations differ across sectors, products and geography, their main drivers are similar. These involve efficiency ("nimbleness" and speed, and often "cutting out the middle man"), simplicity, transparency and streamlined margins stemming mainly from lower operating costs and scale effects. For example, Fintech based on blockchain and distributed ledger technology allows transactions between two parties without a trusted intermediary. Applications of distributed ledger technology can range from payments and settlement to "smart" contracts, compliance and more. The benefits of Fintech innovations to customers include a better and seamless customer experience, a wider range of products and services at lower cost, and potential access to financial services for underserved customers (such as some SMEs) or the underbanked.

Fintech innovations pose specific challenges to privacy, digital security and operational risk. New technologies potentially increase digital security vulnerabilities that could undermine the privacy of financial consumer and businesses, and undermine critical financial infrastructure which could have systemic implications. Lending and underwriting practices could become discriminatory when big data analysis is used to evaluate the insurability or creditworthiness of consumers, or to target product advice and marketing.

Fintech also brings a number of potential structural implications that pose challenges for financial policy objectives, including concerns about the applicable regulation and maintaining financial stability, adequate protection of financial consumers, and ensuring market integrity. In addressing these challenges, policy makers need to: 1) balance innovation and consumer protection and market integrity; 2) protect and equip consumers and micro and small businesses through better risk awareness, as well as robust financial consumer protection and financial education; 3) provide a level playing field applied fairly and without favour to domestic and foreign firms; and 4) facilitate international co-ordination of regulation for Fintech solutions which are potentially borderless.

Regulators and policy makers also need to consider changes brought by Fintech and build their capacity to understand and deal with these innovations. "Regulatory sandboxes", which introduce a limited amount of regulatory flexibility for new business models, provide a useful regulatory approach that fosters innovation while safeguarding financial stability, market integrity and consumer protection.

Source: OECD (2018[59]), *Financial Markets, Insurance and Pensions: Digitalisation and Finance*, *https://www.oecd.org/finance/private-pensions/Financial-markets-insurance-pensions-digitalisation-and-finance.pdf*.

Looking ahead, digital technologies (AI, online platforms, ICTs) offer vast potential to improve productivity in service activities, including less knowledge-intensive activities (e.g. personal transport and accommodation) where productivity has traditionally been sluggish (Sorbe, Gal and Millot, 2018[60]). In the health sector, for example, connecting historical patient data together with real-time patient data using connected devices could drive increasingly personalised care and sector-wide innovation, including through better measurement of treatment costs, better detection of unsafe practices, fraud and waste in the healthcare system. However, digital literacy of workers in the health sector and non-fragmented data governance systems are needed to realise the benefits of digital transformation in the health sector (Oderkirk, 2017[61]; Australian Digital Health Agency, 2018[62]).

Some sectors, like agriculture, are consistently at the bottom of the taxonomy of sectors, suggesting that they may not be benefiting from digital transformation as much as they might. The potential for digital technologies in the agriculture sector, for example, to spur innovation and growth is immense (Box 4.3).

In the education sector, significant investments have been made in the use of technology to improve educational outcomes for students both at school and at home. Digital transformation creates significant

opportunities, from enhancing access to knowledge to driving new skills development. However, the benefits of access to and use of digital technologies appear to depend on whether digital tools are used as substitutes or complements to traditional education (Bulman and Fairlie, 2016[65]; Escueta et al., 2017[66]). At school, computer-assisted instruction seems to have more positive effects on students' educational outcomes than ICT investment when the use of computers is supplemented with additional instruction and with investment in teacher skills to deploy digital tools effectively.

4.3. The digitalisation of agriculture

The digital transformation of the food and agricultural system has proved complex. The agricultural sector involves many stakeholders operating in a wide variety of contexts, including remote areas which often face issues related to connectivity (see Chapter 2). Nevertheless, digital innovation in agriculture holds many promises, and advances in digital technologies could help boost productivity and potential savings in terms of seed, fertiliser, space, water and time.

Advances in remote sensing technologies have enabled increasingly granular data about soil, weather and environmental conditions. As the cost of digital technologies and the analysis of the data that they collect have fallen, farmers are now better able to draw insights about a range of aspects of agricultural production that wasn't possible before.

Farms of the future could be autonomous, with machines tending livestock and harvesting food without much human intervention. In October 2017, a team of British researchers used commercially available agricultural machines and software to enable amateur drones and tractors to operate autonomously. The project culminated in the completely automated harvest of approximately 5 tonnes of spring barley, which had never been touched by human hands (OECD, 2018[63]; Hands Free Hectare, 2018[64]).

Policy experimentation supports digital innovation in sectors

Digitally enabled and innovative products and business models – particularly in specific sectors – often differ significantly from those in traditional markets, and in some cases they do not fit well with existing regulatory frameworks. Policy makers across the world have recognised the regulatory challenges associated with digital transformation, and have responded in a variety of ways, ranging from "wait and see" to banning digitally enabled business models (OECD, 2018[67]). Between these two extremes, some regulators have opted to experiment.

Digital technologies and data can help with policy experimentation. The analysis of data can help enable more risk-based regulatory delivery that responds to potential regulatory breaches in real time (OECD, 2018[67]). Digital technologies and data can also enable a more effective, risk-based approach to regulating digital innovations. One example is the forthcoming implementation of the Digital Health Innovation Plan from the United States Food and Drug Administration, which aims to use a risk-based approach to regulate the increasing proliferation of software-based medical technologies, including mobile medical applications (United States Food and Drug Administration, 2018[68]).

Another example is the rise of outcome or performance-based regulation, which specifies required outcomes or objectives, rather than the means by which they must be achieved (OECD, 2002[69]), potentially enabling firms to be free to innovate while remaining within the spirit of the law. Australia, for example, has adopted performance-based guidelines for the use of autonomous vehicles (Australian National Transport Commission, 2018[70]).

One approach to developing mechanisms that promote the flexible application or enforcement of policies is the use of regulatory "sandboxes", which may be particularly useful for certain kinds of digitally enabled innovation. A regulatory sandbox refers to a limited form of regulatory waiver or flexibility for firms, enabling them to test new business models with fewer regulatory requirements. Sandboxes often include mechanisms intended to ensure overarching regulatory objectives, including consumer protection. Regulatory sandboxes are typically organised and administered on a case-by-case basis by the relevant regulatory authorities. Regulatory sandboxes have emerged in a range of sectors across the OECD and beyond, notably in finance but also in health, transport, legal services, aviation and energy.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 4.1: Figures for each country report unweighted averages of entry and exit rates across STAN a38 industries and available years for the time period 1998-2015, focusing separately on sectors in the "Highly digital-intensive" and "All sectors" groups. A coverage table is available in Calvino and Criscuolo (forthcoming[71]). Figures are based on data covering manufacturing and non-financial market services, and exclude self-employment and the Coke and Real estate sectors. Data for Japan are for manufacturing only. The classification of sectors according to digital intensity is based on Calvino et al. (2018[58]) (top quartiles in either of the two periods considered in the study). Owing to methodological differences, figures may deviate from officially published national statistics. Data for some countries are still preliminary.
2. Figure 4.2: For Israel, data refer to 2014. For Japan and South Africa, data refer to 2016. For the United States, data include VC investments done by other investors alongside VC firms, but exclude investment deals that are 100% financed by corporations and/or business angels. Data providers are: Invest Europe (European countries), ABS (Australia), CVCA (Canada), KVCA (Korea), NVCA/Pitchbook (United States), NZVCA (New Zealand), PwCMoneyTree (Israel), RVCA (the Russian Federation), SAVCA (South Africa) and VEC (Japan).
3. Figure 4.3: "Information industries" are defined according to ISIC Rev.4 and cover ICT manufacturing under "Computer, electronic and optical products" (division 26), and information services under "Publishing, audiovisual and broadcasting activities" (divisions 58 to 60), "Telecommunications" (division 61) and "IT and other information services" (divisions 62 to 63).
   Data on total business expenditure on R&D (BERD) refer to 2016, except for Australia (2015), New Zealand (2015), South Africa (2015) and Switzerland (2015).
   Estimates on R&D expenditure in information industries are not available for Australia, China, Luxembourg, New Zealand, the Russian Federation, South Africa and Switzerland. Figures on information industries correspond to the same reference year as total BERD or, in their absence, are based on shares for the most recent available year: Austria (2015), Belgium (2015), Canada (2015), Chile (2015), France (2013), Greece (2015), Ireland (2015), Korea (2015), Latvia (2015), Poland (2015) and Sweden (2015).
   Zone estimates (OECD and EU28) correspond to member countries' R&D intensity averages weighted by GDP in purchasing power parity. For information industries, they exclude countries where no data are available: Australia, Luxembourg, New Zealand and Switzerland for the OECD aggregate, and Bulgaria, Croatia, Cyprus, Luxembourg and Malta for the EU28.
4. Figure 4.4: Data refer to IP5 families, by filing date, according to the applicants' residence using fractional counts. Patents in ICT are identified using the list of IPC codes in Inaba and Squicciarini (2017[72]). Only economies with more than 250 patents families in the periods considered are included. Data for 2015 and 2016 are incomplete. It should be noted that statistical data on Israeli patents and trademarks are supplied by the patent and trademark offices of the relevant countries.
5. These features include but are not limited to the share of ICT and intangible investment, the share of ICT specialists in total employment and the share of turnover from online sales.

References

Adalet McGowan, M., D. Andrews and V. Millot (2017), "The walking dead?: Zombie firms and productivity performance in OECD countries", *OECD Economics Department Working Papers*, No. 1372, OECD Publishing, Paris, *https://dx.doi.org/10.1787/180d80ad-en*. [12]

Andrews, D., C. Criscuolo and P. Gal (2015), "Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries", *OECD Productivity Working Papers*, No. 2, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jrql2q2jj7b-en*. [23]

Australian Digital Health Agency (2018), *Australia's National Digital Health Strategy*, Australian Government, Canberra, *https://conversation.digitalhealth.gov.au/sites/default/files/adha-strategy-doc-2ndaug_0_1.pdf*. [62]

Australian National Transport Commission (2018), *Safety Assurance System for Automated Vehicles*, *https://www.ntc.gov.au/current-projects/safety-assurance-system-for-automated-vehicles*. [70]

Bajgar, M. et al. (forthcoming), "Acquiring innovation in the digital economy", *OECD Productivity Working Papers*, OECD Publishing, Paris. [13]

Baumol, W. (2002), *The Free-Market Innovation Machine: Analyzing the Growth Miracle of Capitalism*, Princeton University Press, Princeton, NJ. [10]

Berlingieri, G., P. Blanchenay and C. Criscuolo (2017), "The great divergence(s)", *OECD Science, Technology and Industry Policy Papers*, No. 39, OECD Publishing, Paris, *https://dx.doi.org/10.1787/953f3853-en*. [15]

Bloom, N., R. Sadun and J. Van Reenan (2012), "Americans do IT better: US multinationals and the productivity miracle", *American Economic Review*, Vol. 1, pp. 167-201, *http://dx.doi.org/10.1257/aer.102.1.167*. [37]

Brander, J., Q. Du and T. Hellmann (2015), "The effects of government-sponsored venture capital: International evidence", *Review of Finance*, Vol. 19, Issue 2, pp. 571-618, *http://dx.doi.org/10.1093/rof/rfu009*. [25]

Brynjolfsson, E., F. Eggers and A. Collis (2018), "Using massive online choice experiments to measure changes in well-being", *NBER Working Paper* No. w24514, *https://ssrn.com/abstract=3163281*. [47]

Brynjolfsson, E., L. Hitt and S. Yang (2002), "Intangible assets: Computers and organizational capital", *Brookings Papers on Economic Activity* 1:2002, pp. 137-198, *https://www.brookings.edu/wp-content/uploads/2002/01/2002a_bpea_brynjolfsson.pdf*. [36]

Brynjolfsson, E., D. Rock and C. Syverson (2017), "Artificial intelligence and the modern productivity paradox: A clash of expectations and statistics", *NBER Working Paper* No. 24001, *https://www.nber.org/chapters/c14007.pdf*. [39]

Bulman, G. and R. Fairlie (2016), "Technology and education: Computers, software and the internet", *NBER Working Paper* No. 22237, *https://www.nber.org/papers/w22237*. [65]

Calvino, F. and C. Criscuolo (forthcoming), "Business dynamics and digitalisation", *OECD Science, Technology and Industry Policy Papers,* OECD Publishing, Paris. [71]

Calvino, F. et al. (2018), "A taxonomy of digital intensive sectors", *OECD Science, Technology and Industry Working Papers*, No. 2018/14, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f404736a-en*. [58]

Calvino, F., C. Criscuolo and C. Menon (2016), "No Country for Young Firms?: Start-up Dynamics and National Policies", *OECD Science, Technology and Industry Policy Papers*, No. 29, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jm22p40c8mw-en*. [2]

Calvino, F., C. Criscuolo and C. Menon (2015), "Cross-country evidence on start-up dynamics", *OECD Science, Technology and Industry Working Papers*, No. 2015/6, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jrxtkb9mxtb-en*. [17]

Corrado, C. et al. (2016), "Intangible investment in the EU and US before and since the Great Recession and its contribution to productivity growth", *EIB Working Papers* 2016/08, European Investment Bank, *https://ideas.repec.org/p/zbw/eibwps/201608.html*. [38]

Criscuolo, C., P. Gal and C. Menon (2014), "The dynamics of employment growth: New evidence from 18 countries", *OECD Science, Technology and Industry Policy Papers*, No. 14, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jz417hj6hg6-en*. [1]

Daiko, T. et al. (2017), *World Corporate Top R&D Investors: Industrial Property Strategies in the Digital Economy. A JRC and OECD common report*, Publications Office of the European Union, Luxembourg, *http://publication.jrc.ec.europa.eu/repository/bitstream/JRC107015/kjna2865enn.pdf*. [35]

Dai, Q., E. Shin and C. Smith (2018), "Open and inclusive collaboration in science: A framework", *OECD Science, Technology and Industry Working Papers*, No. 2018/07, OECD Publishing, Paris, *https://dx.doi.org/10.1787/2dbff737-en*. [44]

Escueta, M. et al. (2017), "Education technology: An evidence-based review", *NBER Working Paper* No. 23744, *http://dx.doi.org/10.3386/w23744*. [66]

European Commission/OECD (2017), *STIP Compass: International Database on STI Policies*, April 2018 version, *https://stip.oecd.org*. [20]

Guellec, D. and C. Paunov (2018), "Innovation policies in the digital age", *OECD Science, Technology and Industry Policy Papers*, No. 59, OECD Publishing, Paris, *https://dx.doi.org/10.1787/eadd1094-en*. [46]

Hall, B. and J. Lerner (2009), "The financing of R&D and innovation", *NBER Working Paper* No. 15325, *https://www.nber.org/papers/w15325*. [21]

Hands Free Hectare (2018), *Automated Harvest Time*, press release, 22 August, *http://www.handsfreehectare.com/press-releases*. [64]

Haskel, J. and S. Westlake (2017), *Capitalism without Capital: The Rise of the Intangible Economy*, Princeton University Press, Princeton, NJ. [40]

Hathaway, I. and R. Litan (2014), "Declining business dynamism in the United States: A look at states and metros", *Economic Studies at Brookings*, May, *https://www.brookings.edu/wp-content/uploads/2016/06/declining_business_dynamism_hathaway_litan.pdf*. [16]

Henderson, R. (1993), "Underinvestment and incompetence as responses to radical innovation: Evidence", *The RAND Journal of Economics*, Vol. 24, No. 2, pp. 248-270, *https://www.jstor.org/stable/2555761?seq=1#metadata_info_tab_contents*. [5]

Henderson, R. and K. Clark (1990), "Architectural innovation: The reconfiguration of existing product technologies and the failure of established firms", *Administrative Science Quarterly*, Vol. 35, No. 1, pp. 9-31, *http://dx.doi.org/10.2307/2393549*. [11]

Inaba, T. and M. Squicciarini (2017), "ICT: A new taxonomy based on the international patent classification", *OECD Science, Technology and Industry Working Papers*, No. 2017/01 OECD Publishing, Paris, *https://doi.org/10.1787/ab16c396-en*. [72]

Nagaraj, A. (2016), "The private impacts of public maps: Landsat satellite imagery and gold exploration", *Job Markets Paper*, *http://web.mit.edu/nagaraj/files/nagaraj_jmp_nov6.pdf*. [52]

Netflix (28 April 2016), *It's All A/Bout Testing: The Netflix Experimentation Platform*, *https://medium.com/netflix-techblog/its-all-a-bout-testing-the-netflix-experimentation-platform-4e1ca458c15*. [48]

Oderkirk, J. (2017), "Readiness of electronic health record systems to contribute to national health information and research", *OECD Health Working Papers*, No. 99, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9e296bf3-en*. [61]

OECD (2019), *Initial Coin Offerings for SMEs*, OECD, Paris, *http://www.oecd.org/finance/ICOs-for-SME-Financing.pdf*. [29]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [4]

OECD (2018), "Enhanced SME access to diversified financing instruments", discussion paper, SME Ministerial Conference, OECD, Paris, *https://www.oecd.org/cfe/smes/ministerial/documents/2018-SME-Ministerial-Conference-Plenary-Session-2.pdf*. [26]

OECD (2018), *Financial Markets, Insurance and Pensions: Digitalisation and Finance*, OECD, Paris, *https://www.oecd.org/finance/private-pensions/Financial-markets-insurance-pensions-digitalisation-and-finance.pdf*. [59]

OECD (2018), *How Digital Technologies are Impacting the Way we Grow and Distribute Food*, OECD, Paris, *http://www.oecd.org/tad/events/Background%20note_Website.pdf*. [63]

OECD (2018), "Main science and technology indicators", *OECD Science, Technology and R&D Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/fe401804-en* (accessed 28 January 2019). [33]

OECD (2018), *Maintaining Competitive Conditions in Era of Digitalisation*, OECD, Paris, *http://www.oecd.org/g20/Maintaining-competitive-conditions-in-era-of-digitalisation-OECD.pdf*. [14]

OECD (2018), *OECD Regulatory Policy Outlook 2018*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264303072-en*. [67]

OECD (2018), *OECD Science, Technology and Innovation Outlook 2018: Adapting to Technological and Societal Disruption*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/sti_in_outlook-2018-en*. [34]

OECD (2018), *Open Government Data Report: Enhancing Policy Maturity for Sustainable Impact*, OECD Digital Government Studies, OECD Publishing, Paris, *https://doi.org/10.1787/9789264305847-en*. [54]

OECD (2018), *Strengthening SMEs and Entrepreneurship for Productivity and Inclusive Growth*, OECD, Paris, *http://www.oecd.org/cfe/smes/ministerial/documents/2018-SME-Ministerial-Conference-Key-Issues.pdf*. [8]

OECD (2017), "Digital platforms for facilitating access to research infrastructures", *OECD Science, Technology and Industry Policy Papers*, No. 49, OECD Publishing, Paris, *https://dx.doi.org/10.1787/8288d208-en*. [41]

OECD (2017), *Fostering Innovation in the Public Sector*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264270879-en*. [56]

OECD (2017), "Fostering markets for SME finance: Matching business and investor needs", in *Financing SMEs and Entrepreneurs 2017: An OECD Scoreboard*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/fin_sme_ent-2017-6-en*. [28]

OECD (2017), *Government at a Glance 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/gov_glance-2017-en*. [55]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268821-en*. [3]

OECD (2017), "Open research agenda setting", *OECD Science, Technology and Industry Policy Papers*, No. 50, OECD Publishing, Paris, *https://dx.doi.org/10.1787/74edb6a8-en*. [45]

OECD (2016), *OECD Science, Technology and Innovation Outlook 2016*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/sti_in_outlook-2016-en*. [32]

OECD (2016), "Research ethics and new forms of data for social and economic research", *OECD Science, Technology and Industry Policy Papers*, No. 34, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jln7vnpxs32-en*. [43]

OECD (2015), *Data-driven Innovation: Big Data for Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264229358-en*. [30]

OECD (2015), "Making open science a reality", *OECD Science, Technology and Industry Policy Papers*, No. 25, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jrs2f963zs1-en*. [42]

OECD (2015), *New Approaches to SME and Entrepreneurship Financing: Broadening the Range of Instruments*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264240957-en*. [19]

OECD (2015), *The Future of Productivity*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264248533-en*. [31]

OECD (2013), "Exploring data-driven innovation as a new source of growth: Mapping the policy issues raised by 'big data'", *OECD Digital Economy Papers*, No. 222, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k47zw3fcp43-en*. [50]

OECD (2010), *SMEs, Entrepreneurship and Innovation*, OECD Studies on SMEs and Entrepreneurship, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264080355-en*. [9]

OECD (2002), *Regulatory Policies in OECD Countries: From Interventionism to Regulatory Governance*, OECD Reviews of Regulatory Reform, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264177437-en*. [69]

OECD (forthcoming), *Artificial Intelligence in Society*, OECD Publishing, Paris. [24]

OECD (forthcoming), *Enhanced Access to Data: Reconciling Risks and Benefits of Data Sharing and Re-use*, OECD Publishing, Paris. [53]

OECD (forthcoming), "Going Digital: An integrated policy framework for making the transformation work for growth and well-being", *OECD Digital Economy Papers*, OECD Publishing, Paris. [57]

OECD/Eurostat (2018), *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition*, OECD Publishing, Paris/Eurostat, Luxembourg, *https://dx.doi.org/10.1787/9789264304604-en*. [49]

OECD/G20 (2015), *Progress Report on G20/OECD High Level Principles on SME Financing*, OECD, Paris, *https://www.oecd.org/finance/private-pensions/G20-OECD-High-level-Principles-on-SME-Financing-Progress-Report.pdf*. [27]

Rajan, R. and L. Zingales (1998), "Financial dependence and growth", *American Economic Review*, Vol. 88, No. 3, pp. 559-586, *https://www.jstor.org/stable/116849*. [18]

Saia, A., D. Andrews and S. Albrizio (2015), "Productivity spillovers from the global frontier and public policy: Industry-level evidence", *OECD Economics Department Working Papers*, No. 1238, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5js03hkvxhmr-en*. [22]

Schneider, C. and V. Veugelers (2010), "On young highly innovative companies: Why they matter and how (not) to policy support them", *Industrial and Corporate Change*, Vol. 19, Issue 4, pp. 969-1007, *http://dx.doi.org/10.1093/icc/dtp052*. [7]

Sorbe, S., P. Gal and V. Millot (2018), "Can productivity still grow in service-based economies? Preliminary evidence and scoping for further research", *OECD Economics Department Working Papers*, No. 1531, OECD Publishing, Paris, *http://dx.doi.org/10.1787/4458ec7b-en*. [60]

Tushman, M. and P. Anderson (1986), "Technological discontinuities and organizational environments", *Administrative Science Quarterly*, Vol. 31, No. 3, pp. 439-465, *https://www.jstor.org/stable/2392832?seq=1#metadata_info_tab_contents*. [6]

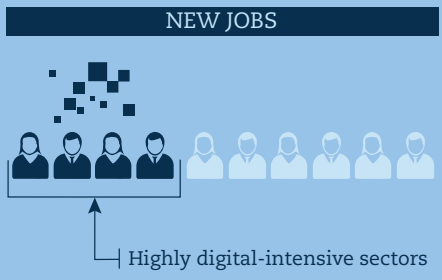
Ubaldi, B. (2013), "Open government data: Towards empirical analysis of open government data initiatives", *OECD Working Papers on Public Governance*, No. 22, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k46bj4f03s7-en*. [51]

United States Food and Drug Administration (2018), *Digital Health Innovation Action Plan*, United States Food and Drug Administration, Washington, DC, *https://www.fda.gov/downloads/medicaldevices/digitalhealth/ucm568735.pdf*. [68]

Chapter 5

ENSURING GOOD JOBS FOR ALL

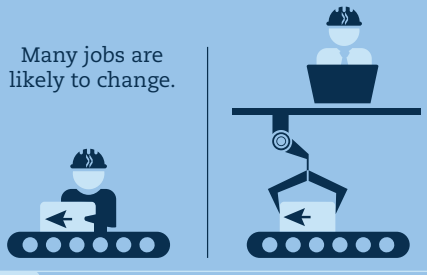
Over the past decade, **4 out of 10 new jobs** in the OECD were **created in highly digital-intensive** sectors.



Promote education and training to deliver a mix of skills to succeed in a digital world of work.

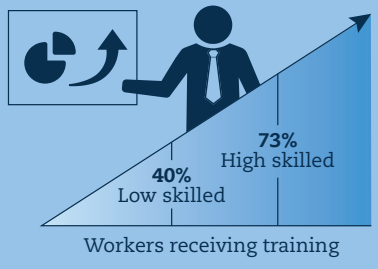
An estimated **14%** **of jobs face high likelihood of automation** and another **32% are likely to face significant change** in how they are carried out.

Many jobs are likely to change.



Support workers to facilitate their transition into jobs with a low likelihood of automation.

Despite **high returns on training the low-skilled**, firms provide more training to high-skilled **workers**.



Step up and target training, especially for the low-skilled.

Only 0.13% **of GDP on average is spent on training** of the unemployed and of workers at risk of involuntary unemployment.

Ensure that nobody is left behind as labour markets transform.

ENSURING GOOD JOBS FOR ALL: WHAT MATTERS MOST FOR POLICY?

Prepare workers for many new jobs and changes to existing ones

- Digital transformation leads to creative destruction, with jobs being lost and others being created. Estimates of possible automation of tasks suggest that 14% of jobs face a high likelihood of automation and another 32% are likely to face significant change over the next 10 to 20 years.
- To date, concerns around massive technological unemployment have not materialised; employment rates are at a record high in many countries and the digital revolution has contributed significantly to job creation: four out of ten jobs were created in highly digital-intensive sectors over the past decade.
- As labour markets transform, it is imperative to promote successful and fair transitions from declining to expanding jobs, e.g. by striking a balance between flexibility and mobility, on the one hand, and job stability on the other, including through social dialogue.

Empower people with a mix of skills to succeed in a digital world of work

- Ensure that people develop the skills they need to succeed in the digital world of work, notably sound cognitive skills, information and communication technology (ICT) skills, complementary skills, specialist skills and the ability to cope with change and keep learning, including out of work.
- Improve the accessibility, quality and equity of education for young people and of training systems for adults throughout their working life, including through better use of digital technologies for learning.

Get ready for a massive training challenge

- With nearly half of the labour force facing a significant likelihood of automation where the tasks performed in different occupations may change, the provision of up-skilling and re-skilling opportunities looms large. Training opportunities need to be life-long and with incentives for training of those most in need, notably low-skilled workers, only 40% of which receive firm-based training.
- Address barriers to adult learning, e.g. through policies supporting informed learning choices, new techniques such as distance learning and promoting adult learning, and strengthening financing of life-long learning as well as systems of skills validation.

Improve social protection to ensure that no one is left behind

- Strengthen and adapt social protection, including for non-standard forms of work; average spending on training for unemployed and workers at risk of involuntary unemployment across OECD countries is only 0.13% of gross domestic product (GDP).
- Leverage active labour market programmes to support displaced workers and design effective income support schemes to provide income security without undermining work incentives.

Address concerns around emerging forms of work

- Ensure good outcomes for all workers through a mixture of applying and, where necessary, reviewing and extending labour market regulation, as well as improving social protection and strengthening workers' voice.
- Reduce the risk of arbitrage between forms of employment and work by ensuring neutrality in terms of regulation, taxes and benefits.

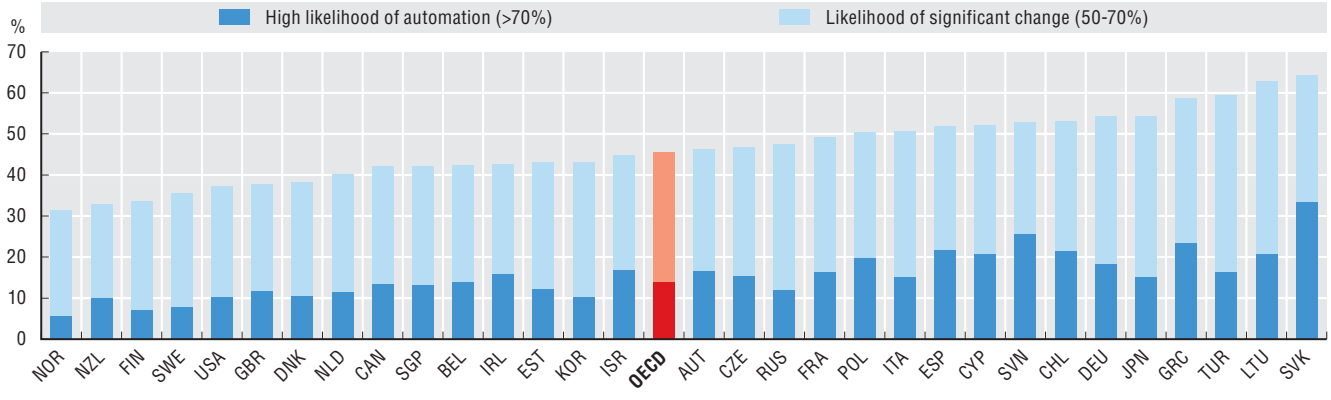
Digital transformation leads to creative destruction, with jobs being lost and others being created; however, employment rates are at record high levels in many countries. As labour markets transform, many of the new jobs are likely to differ from the ones we know. Empowering people with the mix of skills needed to succeed in a digital world of work, including by improving education and training systems throughout the life cycle, facilitating job-to-job transitions and ensuring adequate social protection, is essential. Some workers are likely to benefit more from digital transformation than others: policies aimed at prosperous economies and inclusive societies need to ensure a successful and fair transition for all.

Digital transformation is creating many new job opportunities, but is also challenging many existing jobs

Much attention has focused on estimations of the number of jobs that may be affected by automation in the future. While bounded by uncertainty, the percentage of jobs that face a high likelihood of automation, based on an estimation of the tasks that could be automated over the next 10 to 20 years, is 14% on average in the countries that participated in the OECD Survey of Adult Skills. In addition, an estimated 32% of jobs are likely to face significant change in how they are carried out, due to automation of some tasks within these jobs. In total, almost half of all jobs might thus face significant change (Figure 5.1). Viewed through the lens of skills, computers are already now considered to be close to reproducing the proficiency of literacy skills used by 62% of workers every day in OECD countries (Elliott, 2017[1]).

5.1. A significant share of jobs could be affected by automation

Likelihood of automation or significant change to jobs, as a percentage of all jobs, 2012 or 2015



Notes: StatLink contains more data. See Chapter notes.[1]

Source: Nedelkoska and Quintini, (2018[2]), "Automation, skills use and training", *http://dx.doi.org/10.1787/2e2f4eea-en*.

StatLink https://doi.org/10.1787/888933915183

However, it is unclear how much of the likelihood of automation will actually materialise. There seems to be a large gap between what can be automated from a technical point of view and what is currently being automated by firms. A host of factors can affect technology adoption, including policy, economic, industry, legal, ethical and social factors. For example, market forces driving the relative prices of capital and labour; market structure and the presence of big, medium or small firms in a location or industry; institutional norms and regulations; and consumer, societal preferences and ethical norms all shape technology adoption (OECD, 2018[3]). In addition, a range of skills and organisational changes are needed to effectively put digital technology to work. Robots might even contribute to containing job losses that occur through offshoring in some developed economies by decreasing the need for relocating certain activities (De Backer et al., 2018[4]).

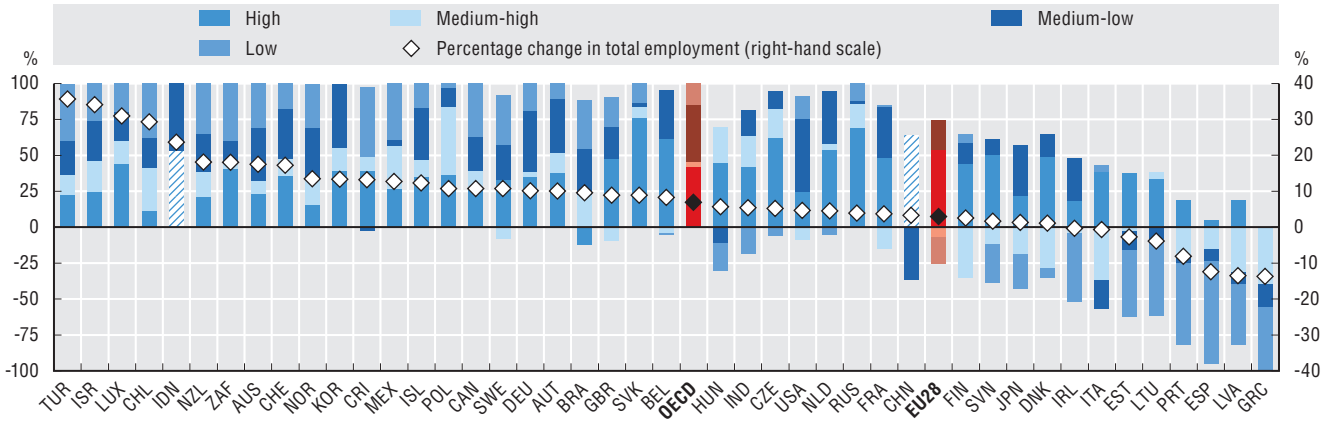
The likelihood of automation is not equally distributed across countries, regions and socio-demographic groups. For example, important geographical disparities exist in both the likelihood of digitally induced job creation and job automation within many countries. This implies that digital transformation may

exacerbate inequalities between regions, as new jobs might appear in places other than where jobs may be lost (Sorbe, Gal and Millot, 2018[5]). Evidence from the United States shows that new industries have mainly appeared in urban areas that have a large share of high-skilled workers (Berger and Frey, 2015[6]), and that regions which are most exposed to the adoption of robots have seen negative effects on employment and wages (Acemoglu and Restrepo, 2017[7]). This is in line with the finding that regions that face a lower likelihood of automation tend to have a larger share of workers with tertiary education, more jobs in services, and are highly urbanised (OECD, 2018[8]).

Turning to evidence on job creation and destruction over the past decade, digital transformation was a contributor to overall job creation across the OECD. Between 2006 and 2016, total employment in the OECD grew by 6.9%, a net gain of about 38 million jobs. While digital transformation may have destroyed some jobs, highly digital-intensive sectors (Calvino et al., 2018[9]) contributed 42% or 16 million jobs of these net job gains (Figure 5.2). This finding is in line with the theoretical assumption that in addition to direct job creation, investment in or use of ICTs should result in indirect job creation by contributing to rising productivity, lower prices and new products that lead to higher final demand and in turn employment (OECD, 2016[10]). In contrast to the job creation in digital-intensive sectors, a large majority of job losses that took place over the same period in some countries occurred in sectors of low or medium digital intensity.

5.2. Digital-intensive sectors contribute to job creation

Contributions to changes in total employment, by digital intensity of sectors, 2006-16



Notes: StatLink contains more data. See Chapter notes.[2]

Source: OECD (2019[11]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD, *STAN Database*, *http://oe.cd/stan*; National Accounts Statistics; national sources; and OECD, *Inter-Country Input-Output Database*, *http://oe.cd/icio* (accessed October 2018).

StatLink https://doi.org/10.1787/888933915202

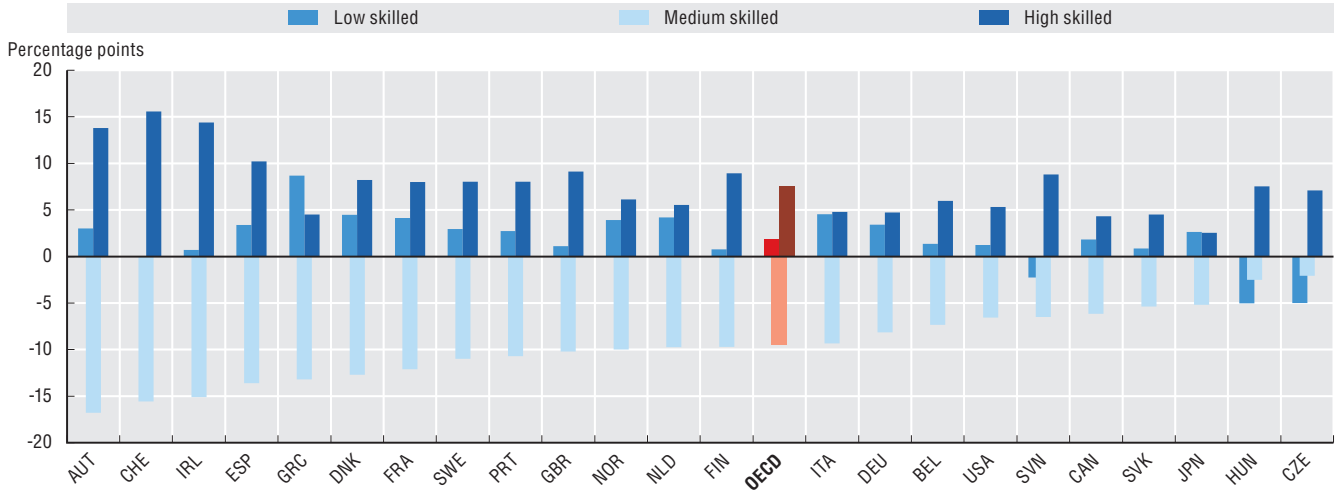
New job creation combined with likely changes to and possible destruction of existing jobs transforms labour markets. Governments, together with social partners, need to help workers transition into new jobs. Adapting to technological progress and new forms of organisations and work requires policies to facilitate the transition of workers across businesses, industries, regions and occupations. An important condition for workers to transition to new jobs are well-functioning labour markets. The 2018 OECD Jobs Strategy provides guidance on how to improve labour market performance along three dimensions: more and better jobs; inclusive labour markets; and adaptability and resilience. Adaptability and resilience are particularly important in the context of digital transformation since they require flexibility for firms and the mobility of workers, investments in skills and training, the provision of well-set minimum wages and adequate social safety nets, combined with strong activation policies, targeted support for displaced workers, social dialogue and collective bargaining at different levels (OECD, 2018[12]).

Prepare workers for many new jobs and changes to existing ones

Over the past two decades, labour markets in most OECD countries have polarised; that is, the share of employment in high-skilled (and to some extent in low-skilled) jobs has increased, while the share of employment in middle-skilled jobs has decreased (Figure 5.3). This corresponds with the finding that the labour market demand for cognitive skills such as written and oral expression, numeracy, reasoning and complex problem solving has increased in the last decade, while demand for routine and physical abilities has dropped significantly (OECD, forthcoming[13]).

5.3. Labour markets have polarised in nearly all OECD countries

Percentage point change in share of total employment, by skill level, 1995 to 2015



Note: See Chapter notes.[3]

Source: OECD (2017[14]), *OECD Employment Outlook 2017*, *https://doi.org/10.1787/empl_outlook-2017-en.*

StatLink https://doi.org/10.1787/888933914898

Workers that are the most likely to benefit from high-skilled job opportunities, notably in digital-intensive sectors, are workers with skills that complement technology and can perform non-routine tasks. Looking ahead, the ones that may bear much of the potential costs of digital transformation are likely to be low-skilled workers in jobs that are likely to face automation, increased competition from middle-skilled workers, and difficulties to adapt to new skills needs (OECD, 2017[14]).

Regardless of skill level, it is important to ensure that workers benefit from the productivity gains associated with digital transformation. Over the past two decades, this has not necessarily been the case, as real median wage growth in most OECD countries has decoupled from labour productivity growth (OECD, 2018[15]). As a result, productivity gains no longer appear to automatically translate into wage gains for all workers.

To help ensure positive outcomes for workers, it is imperative to facilitate successful and fair transitions from declining to expanding jobs, e.g. by striking a balance between the flexibility of firms and the mobility of workers, on the one hand, and job stability on the other, including through social dialogue (OECD, 2018[12]). This includes the ease with which entrepreneurs can start or liquidate a business, firms can adjust their workforce in response to changing business conditions, and workers can move between firms and places in search of better matches for their skills and career ambitions. The functioning and regulation of financial, housing and product markets also matter, including through policies that affect entry and exit.

Labour market policies and institutions play a critical role by determining the flexibility with which firms can adjust their workforces (while giving workers adequate protection) and the ease with which workers can move across firms. The latter depends to an important extent on the transferability of skills, the portability of benefits, and the availability of effective employment services and active labour market programmes to facilitate job-to-job transitions. Worker mobility also depends on wage

incentives for workers to move from low to high-productivity firms, highlighting the importance of allowing sufficient scope to adjust wages to business conditions at the firm level, especially in countries where collective bargaining predominantly takes places at the sector or national level. Finally, it is also important to design education and training policies to facilitate transitions across occupations, while ensuring quality jobs that make maximal use of workers' skill sets and offer attractive compensation.

Empower people with a mix of skills to succeed in a digital world of work

People need the right mix of skills to succeed in technology-rich work environments and to be prepared for new and changing jobs. Evidence shows the importance of cognitive skills such as literacy, numeracy and problem solving for workers in any industry to thrive in a digital and interconnected global economy (Grundke et al., 2017[16]; Grundke et al., 2018[17]). There is a growing consensus that transversal skills, such as thinking critically and creatively, solving problems, making informed decisions while using technology and behaving collaboratively, are critical.

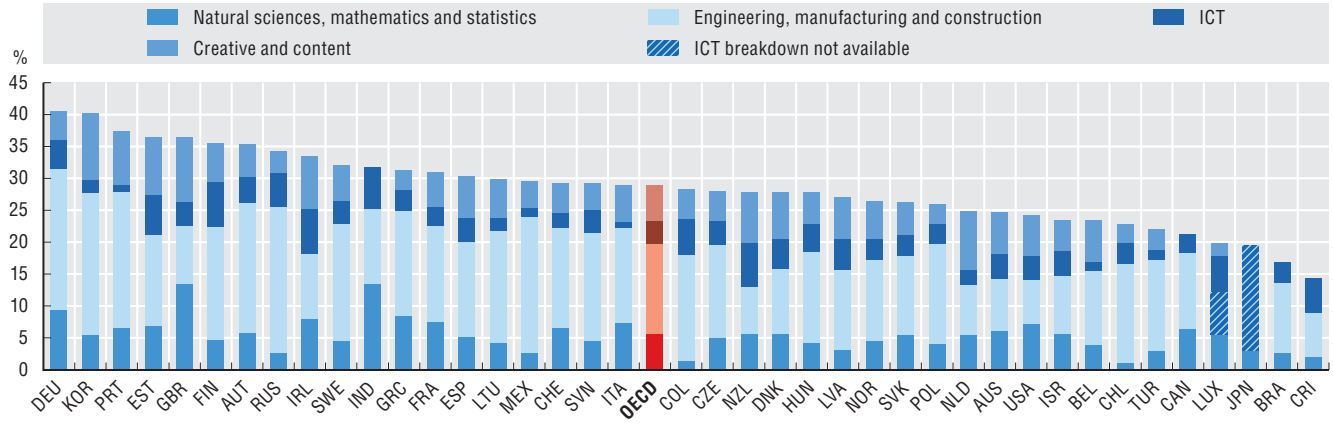
At the same time, developing these skills cannot come at the expense of content knowledge, as working in a digital environment requires a deep grasp of substance (OECD, forthcoming[13]). Furthermore, complementarities between technology and workers are likely to grow with the digitalisation of workplaces, which is expected to lead to greater use of cognitive skills, for example advanced numeracy skills. In addition, more freedom in the planning and organisation of work, linked to the fact that much work is likely to involve fewer routine tasks, requires better management and communication skills to successfully work in teams (OECD, forthcoming[13]).

While uncertainty remains about the exact changes in skills needed to thrive in a digital world of work, the following skills are among those that seem crucial: general cognitive skills, notably literacy, numeracy and ICT skills;[4] complementary skills and competencies,[5] such as complex problem solving, critical and creative thinking, autonomy, team work, complex social interaction skills, emotional intelligence and a strong ability to continue learning. Many jobs, notably in digital-intensive sectors and occupations, also require ICT specialist[6] and/or data specialist[7] skills that are in high demand in many countries (OECD, 2017[18]).

While skills are acquired in multiple ways and at different stages of life and work, primary to tertiary education are essential to provide people with the skills that form the foundation for their (working) life, including for life-long learning. When it comes to tertiary graduates in fields of study that are key in the digital age, important differences emerge among countries. The proportion of graduates in ICT, science, mathematics, engineering, and creative fields of study vary importantly, from over 40% in the country with the highest shares to 20% or less in the countries with the lowest shares (Figure 5.4).

5.4. Key fields of study to prepare people for a digital world of work

Tertiary graduates, by field of education, as a percentage of all tertiary graduates, 2016



Note: See Chapter notes.[8]

Source: OECD (2019[11]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD, *Education Database*, *http://www.oecd.org/education/database.htm* (accessed September 2018).

StatLink https://doi.org/10.1787/888933915221

Some skills are particularly rewarded in digital work environments: workers in digital-intensive industries with high science, technology, engineering and mathematics skills and high levels of self-organisation or management and communication skills tend to earn a wage premium relative to those in non-digital intensive industries (Grundke et al., 2018[17]). On the other hand, low-skilled workers seem to experience downward pressure on their wages as a result of digital transformation (Acemoglu and Restrepo, 2017[7]; Dauth et al., 2017[19]; Graetz and Michaels, 2017[20]; Nedelkoska and Quintini, 2018[2]).

Wages are also affected by the skills workers acquire through formal education as well as training and learning throughout their working life. On average 8% of workers train towards a formal qualification, although such training tends to result in lower wages, which may reflect the time taken off work by workers to take formal courses. In contrast, 41% of workers engage in non-formal learning, with an associated 11% increase in wages, and about 70% take part in informal learning activities, which results in a 3.5% rise in wages (Quintini, forthcoming[21]).

Everyone should have the chance to acquire needed skills and effectively use and continuously improve them. Starting from early childhood education, the accessibility, quality and equity of education for young people and of training for adults along their working life need to improve, including through better use of digital technologies for digital learning (Box 5.1).

5.1. Digital learning tools for adult and life-long learning

Digital technologies create new possibilities for education and training. Digital learning and open education comes in many forms (e.g. post-secondary, undergraduate and graduate education, continuing education, short-term training and professional development). It can be offered by formal educational institutions, industry, or new entrants in the education and training fields. Digital learning can lower the cost of training, increase flexibility in training provision, and better meet individual needs, among others (OECD, forthcoming[13]). Digital learning and open education holds much promise to foster adult and life-long learning.

One form of digital learning is online learning, which notably enables distance learning and can be open to a large number of students. Online learning includes tutorials, recorded lectures, online educational resources, as well as small, private online courses or massive open online courses (MOOCs). MOOCs have attracted much attention over recent years, but the return on experience on their potential for education and training is still limited. Other forms of digital learning are discussed in Chapter 3.

While the first popular MOOCs were offered by formal post-secondary educational institutions and focused on traditional academic subject areas, more recently the number of MOOCs that aim at enhancing skills and providing professional development have increased. Some of these skills-oriented MOOCs have been created by, or in co-operation with, multinationals that help set the curricula or are prepared to accept certificates of successful MOOC completion in their hiring processes. For firms, MOOCs may provide a potentially cost-effective means of investing in their employees. Users of open education are largely employees that combine it with formal education and, to a lesser extent, workers on the job (OECD, 2016[22]; OECD, forthcoming[13]).

One key challenge with many MOOCs is that completion rates are very low, and that patterns of participation and completion seem to replicate offline learning patterns, i.e. the highly educated and highly skilled are more likely to participate in and finalise courses than low-skilled ones. It is thus unclear whether MOOCs will reduce or actually reinforce inequalities in adult learning (OECD, forthcoming[13]). For those who complete online courses, certification and/or their recognition remains a challenge, despite many innovative approaches to certification that have evolved with digital learning, e.g. digital badges, nano and micro degrees, and other alternative forms of credentials.

Sources: OECD (2016[22]), *Massive Open Online Courses (MOOCs): Trends and Future Perspectives*, *http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/CERI/CD/RD(2016)5&docLanguage=En;* OECD (forthcoming[13]), OECD *Skills Outlook 2019*.

Occupations requiring formal training and related curricula need to evolve with a long-term vision, and the conditions and quality of teaching need to improve. In addition, policies should help individuals navigate uncertain and evolving work environments by promoting comprehensive information about skills and learning opportunities; making learning opportunities flexible and affordable for both individuals and employers; and establishing mechanisms to ensure the quality and credibility of learning. It also important that policies foster engagement in learning for all, notably those most at risk of having their skills become obsolete. Overall, people's readiness to learn, which is strongly correlated with cognitive skills, is a crucial determinant of participation in training programmes but also of learning from experience and expanding opportunities of digital learning (OECD, forthcoming[13]).

As the provision and forms of education, training and learning expand and diversify, a key question to be addressed is how to design and organise the certification of learning, including digital learning, to provide clarity to firms and individuals and to facilitate the recognition of skills acquired formally and informally. Many labour markets are characterised by a pool of workers with similar educational attainment but very different skills. In addition, firms are not only demanding more in terms of workers' skills requirements but also increasingly testing skills on their own rather than relying on diplomas.

Similarly, skills acquired by workers through non-formal and informal learning are not often certified and not easily recognised by other employers, which is likely to weaken learning incentives and the ability of workers to fully benefit from such learning (OECD, forthcoming[13]; Quintini, forthcoming[21]). It is therefore crucial to develop better accreditation mechanisms that complement the traditional diploma, including certifications that are independent from the completion of years of education, and to move towards a reliable assessment of skills rather than only a certification of participation in learning activities (OECD, forthcoming[13]).

To develop a holistic approach to improving education and training systems, governments need to invest strategically. To help governments do so, the 2019 OECD Skills Strategy, currently being reassessed, provides an integrated, cross-government strategic framework to help countries identify the strengths and weaknesses of their national skills systems, benchmark them internationally, and develop policies that can transform better skills into better jobs, economic growth and social inclusion. The OECD Skills Strategy identifies three imperatives – life-long learning, fostering equitable opportunities and outcomes, and making better use of digital technology as a learning device. It advocates for three core areas of policy action: 1) Developing relevant skills across the life course; 2) Using skills effectively in all facets of work and society; and 3) Strengthening the governance of the skills system (OECD, forthcoming[23]).

In addition, co-ordination among education and training institutions, employers, and social partners and institutions is crucial to make education and training programmes more responsive to changing needs and help target those who need learning opportunities the most. This should include high-quality and independent orientation and counselling on life-long learning for all workers and the unemployed over their whole career span.

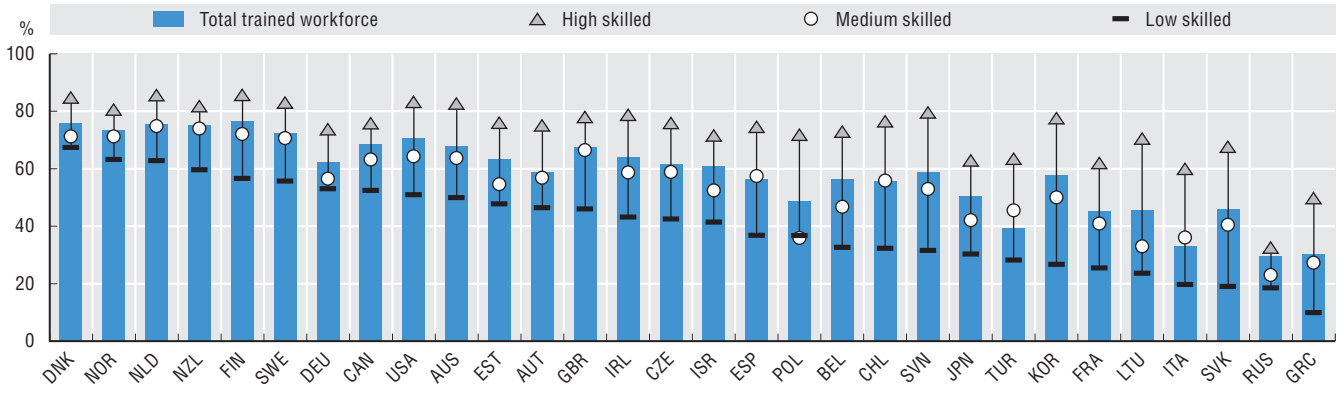
Get ready for a massive training challenge

Low-skilled workers tend to face the greatest urgency to up-skill or re-skill because their jobs are more likely to be automated, as more routine-intensive occupations tend to require lower skills, although this correlation is not necessarily very strong (Marcolin and Squicciarini, 2018[24]). Conversely, higher skilled workers tend to benefit relatively more from technological change, because their skills are more easily transferable to other jobs or more likely to complement technology.

Nevertheless, low-skilled workers are less likely to receive firm-based training than medium- and high-skilled workers (Figure 5.5). This may be partly explained by barriers that hamper participation in adult learning for the lower skilled, notably the lack of basic skills to meet entry requirements, as well as time constraints and low motivation (OECD, 2019[25]). Important potential could be realised if the share of low-skilled workers receiving firm-based training (40%) increased to the share of high-skilled workers receiving training (73%), in particular given that the training of low-skilled workers can significantly improve the diffusion and use of digital technologies in firms and, in turn, productivity (see Chapter 3) (Andrews, Nicoletti and Timiliotis, 2018[26]).

5.5. Fewer low-skilled workers receive training than medium- and high-skilled workers

Workers receiving firm-based training, by skill level, as a percentage of workers in each category, 2012 or 2015



Note: See Chapter notes.[9]

Source: OECD (2019[11]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on (OECD[27]), *Survey of Adult Skills (PIAAC)*, *www.oecd.org/skills/piaac/publicdataandanalysis* (accessed October 2018).

StatLink https://doi.org/10.1787/888933915240

Facing greater likelihood of automation, low-skilled workers also face greater difficulties than high-skilled workers to move to occupations that are not affected by automation. However, retraining low-skilled workers would be less costly than re-training high-skilled workers, taking into account the opportunity cost of training. On the one hand, high-skilled workers move more easily from one job to the next than low-skilled workers, because cognitive skill distances[10] between different high-skilled occupations are smaller than between different low-skilled occupations as well as between medium-skilled and high-skilled occupations (Bechichi et al., 2018[28]). On the other hand, the move of a high-skilled worker from a job at high likelihood of automation to a job at lower likelihood of automation is more costly than the same move of a low-skilled worker, because high-skilled workers' opportunity cost of leaving employment for training is higher than the opportunity cost for low-skilled workers (Marcolin, Squicciarini and Jamet, forthcoming[29]).

Transitions into occupations at low or medium likelihood of automation seem to be possible for all workers, but not necessarily acceptable in that some transitions may entail important human-capital losses and/or wage cuts. After a retraining spell of six months or less, workers in almost all occupations could possibly transition to another occupation that is relatively similar in terms of cognitive skill requirements, task-based skills and knowledge areas. But not all transitions that are in principle possible are necessarily acceptable to workers. In fact, with training efforts of at most one year, few acceptable transitions exist for low-skilled occupations, as all other occupations are characterised by higher skills requirements. Acceptable transitions for high-skilled occupations are also rare with the same training efforts, in particular because several of the possible transitions would entail important wage cuts or the acceptance of jobs for which workers are overqualified (Squicciarini and Jamet, forthcoming[30]).

All workers and people looking for employment should have the opportunities and incentives to up-skill and/or re-skill throughout their lives – whether through formal education or training or through non-formal and informal learning. Several key aspects should be considered to make life-long learning a reality, especially for low-skilled individuals. This includes designing effective incentives for investments in training (e.g. personal training accounts, or life-long training rights) and developing mechanisms to allow for the portability of training rights between employers so that accumulated rights are not lost when workers change jobs. In addition, it is important to motivate workers and remove time and other constraints to increase participation in education and training. This is also important for workers in non-standard forms of work who can face particular challenges to access life-long learning opportunities and are often less likely than standard workers to participate in training.

Well-performing adult training systems play a crucial role in ensuring that workers at all skill levels and ages receive the training they need to be resilient to changes in jobs and benefit from new opportunities. Adult learning remains a weak link in the life-long learning agenda. Average participation in adult

learning is only about 40% in OECD countries. This share is even lower for those most in need of up-skilling and re-skilling: adult learning participation of those with low skill levels is 23 percentage points lower than for those with medium and high skills. While it should be in the interest of firms to understand the training needs of their employees, on average only two out of three firms assess their future skill needs and those who do, do not always align their training policy with this assessment. These shortcomings are likely to increase the pressure on adult learning systems to deliver (OECD, 2019[25]).

Policy action can improve the future readiness of adult learning systems by:

- making adult learning systems more inclusive, for example through providing better information and guidance, flexible learning provision, and the recognition of prior education and training
- more closely aligning adult learning with skill needs, for example by ensuring high-quality information on skill needs to help shape learning systems
- improving the quality of training, for example by setting and monitoring quality standards, ensuring that training leads to certification, and regularly evaluating adult learning programmes
- ensuring adequate financing of adult learning, including by calling upon employers and individuals, in addition to governments, to contribute to training costs in line with the benefits they obtain
- improving governance to enable effective vertical and horizontal co-ordination on adult learning within the government, as well as co-operation with social partners and other stakeholders (OECD, 2019[25])
- raising aspirations for learning, strengthening systems of skills validation and certification, and encouraging the development of education and training markets that are responsive to the needs of adults (OECD, forthcoming[13]).

The scale of the challenge to empower everyone with the skills needed to succeed in a digital world of work goes beyond the capabilities of governments. The aggregate cost alone for retraining all workers in jobs that face a high likelihood of automation in a given country looms large (Marcolin, Squicciarini and Jamet, forthcoming[29]). However, the cost does not need to be incurred all at once, since jobs losses in occupations that face a high likelihood of automation are likely to be gradual. Importantly, countries have yet to determine how to split the cost between employers, governments and workers. Finally, money is not the only question. For example, governments should encourage employers to invest in training, provide incentives for the private sector to invest in the development of transferable skills, build work-based learning into educational programmes, and create an environment where people have greater discretion over learning activities.

Improve social protection to ensure that no one is left behind

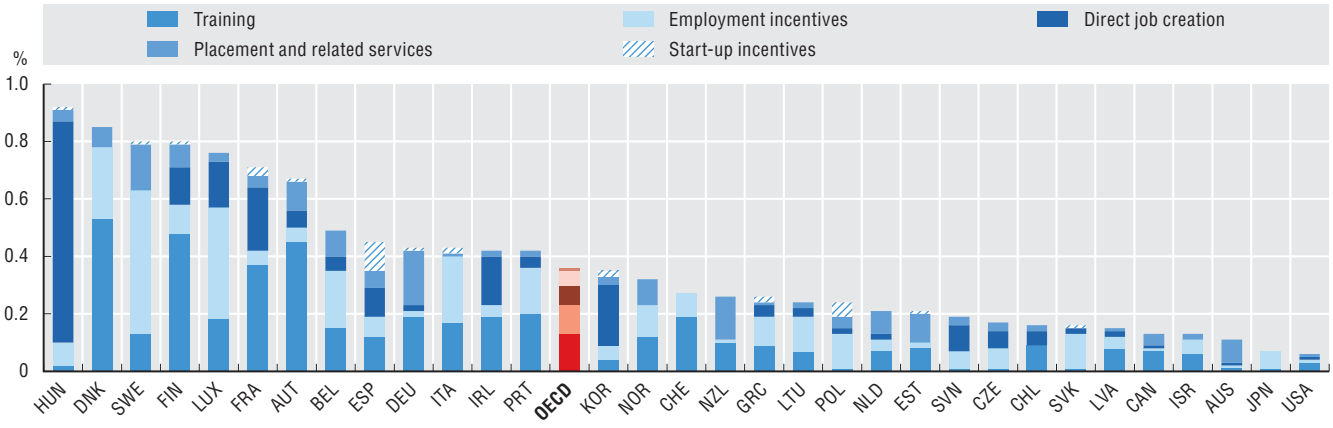
Not all workers who transition into new occupations or those that try to enter the labour market for the first time or after an unemployment spell will necessarily find a new job immediately. Adequate social protection is thus crucial to enable a successful and fair transition for all, including for displaced workers. A starting point for improving (re-)employment prospects and income security, especially for displaced workers, is a system of well-designed and adequately resourced active and passive labour market programmes, which are implemented often as a part of national activation strategies (OECD, 2018[3]).

Active labour market programmes should provide all displaced workers timely access to basic job search services and target the workers that require more intensive (re)employment services or retraining. Public spending on active labour market programmes differ significantly across countries and are quite low in some, considering the important effects of such spending on the services for displaced workers, such as re-employment assistance (Figure 5.6). Average spending on training for the unemployed and workers at risk of involuntary unemployment across OECD countries is only 0.13% of GDP, which seems low in view of the expected costs of retraining workers in jobs that face a high likelihood of automation.

Some workers may temporarily require support in the form of unemployment benefits. A well-designed unemployment benefits scheme is crucial to providing adequate income security. Income support schemes should be designed with the general objective in mind to provide income security and compensate for lost earnings without undermining work incentives. For example, the provision of a temporary wage supplement to displaced workers who return to work rapidly by accepting a new job at a lower pay level can be helpful in this regard (OECD, 2018[3]).

5.6. Active labour market spending differs significantly across countries

Public expenditure on active labour market policies, as a percentage of GDP, 2016



Note: See Chapter notes.[11]

Source: OECD (2019[11]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *Labour Market Programmes Database*, *https://doi.org/10.1787/0305a59d-en* (accessed October 2018).

StatLink https://doi.org/10.1787/888933915259

Overall, governments may need to make social protection more sustainable, effective and adaptable. Given that many countries already struggle to provide adequate social protection for workers with non-standard work contracts (e.g. temporary contracts, self-employed, on-call labour), the advent of work in platform-mediated work may increase the burden on social protection systems. (OECD, 2018[31]).

An increasing number of people only work occasionally and/or have multiple jobs and income sources, with frequent transitions between dependent employment, self-employment and work-free periods. Many people work informally and are not protected under existing rules. All this is adding to the challenges faced by existing social security systems, which are still largely predicated on the assumption of a full-time, regular, open-ended contract with a single employer. As a result of these challenges, more workers risk falling through the cracks, although the scale of the problem that lies ahead is difficult to predict at this stage.

Several countries are experimenting with various forms of basic income schemes which, besides being simple, have the advantage of not leaving anyone without support. However, an unconditional payments to everyone at meaningful but fiscally realistic levels would require tax hikes as well as reductions in existing benefits, and would often not be an effective tool for reducing poverty. In addition, some disadvantaged groups would lose out when existing benefits are replaced by a basic income, illustrating the downsides of social protection without any form of targeting at all (OECD, 2017[32]).

Address concerns around emerging forms of work

Evolving use of digital technologies and new business models, among other drivers, have given rise to online platforms that facilitate the emergence of platform-mediated work, such as "crowd work", "gig work", and other forms of often on-demand labour. Workers in platform markets often benefit from low entry barriers and flexibility, which can facilitate the labour market integration of under-represented groups (and may promote inclusiveness). Most of such work seems to be carried out as some form of non-standard work, notably by independent self-employed or own-account workers and in many cases as a part-time job. While this diverse group of workers appears to have grown fast over recent years, it is estimated to be a very small share of overall employment (OECD, 2016[33]; Schwellnus, forthcoming[34]), and measuring the exact size and more specific characteristics of this population still remains a challenge (OECD, 2019[11]).

Labour market outcomes vary greatly across non-standard workers, in particular in terms of pay, job security and social protection. For example, own-account workers are significantly more likely than employees to earn less than the minimum wage (OECD, 2018[3]). Such workers are also less likely to

be covered by collective bargaining arrangements and/or some labour regulations, tend to receive less training and tend to be more exposed to job strain. Some platforms also go beyond being a mere facilitator or marketplace, e.g. in determining prices, working times, or details of services provision, which can undermine the flexibility and autonomy associated with genuine self-employment (OECD, 2018[31]). Ensuring good outcomes for all workers requires a mixture of reviewing labour market regulation; making social protection more sustainable, effective and adaptable; and promoting workers' voice. In some cases, new business models facilitated by technological change may have spurred growth in false self-employment, which needs to be addressed.

Different forms of platform-mediated work may also be facilitated by and have implications for taxation. Labour taxes are the largest tax category in almost all OECD countries. Tax differentials across employment types therefore have the potential to significantly affect labour markets as well as revenue. On the one hand, this raises questions about the extent to which the changes in labour markets are tax-driven, and on the other hand it raises the question whether and how tax systems need to adapt to a rise in non-standard work.

The first best outcome of optimal tax theory is the principle of neutrality: policy makers must ensure that tax systems are neutral across employment forms. However, achieving this objective may be complicated if other policy priorities take precedence. Different forms of work have different characteristics that may merit different tax treatment, for example differences in entrepreneurial risk, rights to social benefits and business expenses (Milanez, forthcoming[35]). However, if certain forms of employment are subject to lower non-wage labour costs, this should be a deliberate policy choice (OECD, 2018[31]).

Given that certain groups seem to be over-represented in non-standard forms of work (typically women, youth, the least-skilled, workers with disabilities, workers in small firms and migrants), increasing the quality of on-demand jobs can help reduce the risk of increased labour market segmentation. The design of platform markets themselves, in particular review and reputation systems, may also have adverse effects, such as barriers to entry, which could be addressed, for example, by increasing the portability of reputations across platforms (OECD, 2016[33]). Also, if firms use such forms of work to avoid tax and other financial obligations, there is a risk that such work would result in a transfer of fiscal responsibilities from employers onto governments and individuals.

As digital transformation may further promote non-standard forms of work, this may result in reduced job security for many workers. Many might not be protected at all by the standard rules for hiring and firing that apply to open-ended contracts. Oftentimes, more flexible rules apply (e.g. in cases of temporary employment or dependent self-employment) while in other cases, workers are excluded from employment protection legislation altogether (e.g. the self-employed). For some of the emerging forms of work, it is not even clear what the status of workers is, who the employer is and what rules should apply to them.

In some cases, governments may wish to consider whether tax and benefit systems need to be extended and/or adapted to new forms of work so that all workers are both provided with some minimum protection and their various sources of income are brought into the tax system. Portability of social security entitlements can help prevent the loss of benefit entitlements when workers move between jobs, contract types, and into and out of employment. Governments may also consider expanding the role of non-contributory schemes so that no one is left without social protection as a result of their contract status. Labour market regulation and tax policy should thus be reviewed to ensure neutrality between various forms of work and to avoid non-standard forms of work that create dependencies. In addition, it is important to avoid regulatory arbitrage, resulting in employers and workers choosing non-standard contracts solely to circumvent taxes and regulations on regular contracts.

It is essential for countries not only to ensure that existing regulations are properly enforced, but also to examine their legal frameworks to determine whether they need to be updated and/or adjusted so that all workers, regardless of contract type, receive adequate rights, benefits and protections. This includes employment protection legislation, minimum wage laws, policies that determine working time, and occupational health and safety regulations. Countries should also consider how existing regulations can be more effectively enforced in the face of new business models, and what complementary legal and regulatory measures can help.

Last but not least, governments can foster social dialogue and collective bargaining. Anticipating future challenges and opportunities, finding solutions, managing change proactively, and shaping the future world of work can be achieved more easily and effectively if employers, workers and their representatives work closely together with governments in a spirit of co-operation and mutual trust. It should be noted that since the 1980s, the process of collective representation and negotiation has been challenged in the OECD; union membership declined from 30% to 17% and the proportion of workers covered by collective agreements decreased from 45% to 33%. Platform-mediated forms of work add to the challenge of organising and strengthening workers' voice since individuals are increasingly working alone, separated by geography, language and legal status or a lack of the necessary information, and in many countries independent workers (self-employed contractors) cannot unionise since it would violate competition law (OECD, 2018[31]). Going forward, it is important to understand how to promote workers' representation in a world where flexible forms of employment may become more common.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 5.1: Jobs face a high likelihood of automation if their likelihood of being automated is at least 70%. Jobs that are likely to face significant change are those with a likelihood of being automated estimated at between 50% and 70%. Data are sourced from (Nedelkoska and Quintini, 2018[2]). The data for the following 24 countries from the first round of PIAAC refer to the year 2012: Australia, Austria, Belgium (Flanders), Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Russian Federation (excluding Moscow), Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland) and the United States. Data for the remaining countries refer to 2015 and are sourced from the second round of the first wave of the PIAAC survey. For the Russian Federation, the PIAAC sample does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65, but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area.
   Note by Turkey
   The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
   Note by all the European Union Member States of the OECD and the European Union
   The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.
2. Figure 5.2: Digital intensity is defined according to taxonomy described in (Calvino et al., 2018[9]). For the People's Republic of China, Costa Rica, Brazil, India, Indonesia and the Russian Federation, data refer to 2006-15. Low digital-intensive sectors are defined according to ISIC Rev.4: Agriculture, hunting, forestry and fishing (Divisions 01 to 03), Mining and quarrying (05 to 09), Food products, beverages and tobacco (10 to 12), Electricity, gas and water supply; sewerage, waste management and remediation activities (35 to 39), Construction (41 to 43), Transportation and storage (49 to 53), Accommodation and food service activities (55 to 56), Real estate activities (68) and Activities of households as employers; undifferentiated activities of households for own use (97 to 98). Medium-low digital-intensive sectors include: Textiles, wearing apparel, leather and related products (ISIC Rev. 4 Divisions 13 to 15), Chemical, rubber, plastics, fuel products and other non-metallic mineral products (19 to 23), Basic metals and fabricated metal products, except machinery and equipment (24 to 25), Education (85) and Human health and social work activities (86 to 88). Medium-high digital-intensive sectors include: Wood and paper products; printing (ISIC Rev. 4 Divisions 16 to 18), Machinery and equipment (26 to 28), Furniture; other manufacturing; repair and installation of machinery and equipment (31 to 33), Wholesale and retail trade, repair of motor vehicles and motorcycles (45 to 47), Publishing, audiovisual and broadcasting activities (58 to 60), Public administration and defence; compulsory social security (84) and Arts, entertainment and recreation (90 to 93). High digital-intensive sectors include: Transport equipment (ISIC Rev. 4 Divisions 29 to 30), Telecommunications (61), IT and other information services (62 to 63), Financial and insurance activities (64 to 66), Professional, scientific and technical activities; administrative and support service activities (69 to 82) and Other service activities (94 to 96).
3. Figure 5.3: High-skill occupations include jobs classified under the ISCO-88 major groups 1, 2, and 3. That is, legislators, senior officials, and managers (group 1), professionals (group 2), and technicians and associate professionals (group 3). Middle-skill occupations include jobs classified under the ISCO-88 major groups 4, 7, and 8. That is, clerks (group 4), craft and related trades workers (group 7), and plant and machine operators and assemblers (group 8). Low-skill occupations include jobs classified under the ISCO-88 major groups 5 and 9. That is, service workers and shop

and market sales workers (group 5), and elementary occupations (group 9). As agricultural, fishery and mining industries were not included in the analysis, those occupations within ISCO-88 group 6 (skill agricultural and fisheries workers) were likewise excluded. The above chart includes 15 of the 18 listed industries. The excluded industries are the following: Agriculture, hunting, forestry and fishing (1), Mining and quarrying (2), and Community, social and personal services (18). As a result of unavailable data for 1995, a different starting year was used for some countries. Norway, Slovenia, and Hungary used 1996; Finland, Sweden and the Czech Republic used 1997, while the Slovak Republic used 1998. The OECD average is a simple unweighted average of the selected OECD countries. Data for Japan over the period examined is reported under four different industry classifications and highly aggregate occupation groups. a) European employment data beyond 2010 was mapped from ISCO-08 to ISCO-88 using a many-to-many mapping technique. This mapping technique is described in Annex 3.A4 (OECD, 2017[14]). Data for Japan is for the period 1995 to 2010 due to structural break in the data. b) Employment data by occupation and industry for the United States prior to 2000 were interpolated using the occupation-industry mix for the years between 2000 and 2002, and matched with control totals by occupation and by industry for the years 1995 to 1999. Employment data for Canada, and the United States were transposed from the respective occupational classifications (SOC 2000) into corresponding ISCO-88 classifications. c) EU-LFS data contains a number of country specific structural breaks which were corrected by applying the post-break average annual growth rates to the pre-break data by skill level (high, middle, low). Adjustments were performed for all relevant documented breaks in the ISCO occupational coding between 1995 and 2009. That is Portugal (1998), the United Kingdom (2001), France (2003), and Italy (2004). Undocumented breaks in the data for Finland (2002) and Austria (2004) were not adjusted. d) Underlying industrial data for Switzerland are classified according to the General Classification of Economic Activities (NOGA 2008). Swiss data for 1995 are derived from representative second quarter data, while data for 2015 is an annual average.

4. ICT skills used at work include, for example, basic computer skills, communication and information search skills, and proficiency in using office productivity software.

5. The concept of competency involves the mobilisation of knowledge, skills, attitudes and values to meet complex demands (OECD, 2018[36]).

6. ICT specialists include ICT service managers, ICT professionals, ICT technicians, electro-technology engineers, and electronics and telecommunications installers and repairers.

7. Data specialists include mathematicians, actuaries, statisticians, and database and network professionals.

8. Figure 5.4: The "Creative and content" field includes arts (including graphic design), journalism and information. For Japan, "Creative and content" fields of education are not presented due to data availability.

9. Figure 5.5: The percentages of trained people are calculated as the ratio of total employed persons displaying a given skill level and receiving training at least once in the year, over the number of a country's workers displaying a given skill level. Training refers to formal, on-the-job or both types as defined in Squicciarini et al. (2015[37]). Low-skilled individuals refers to persons who have not completed any formal education or have attained 1997 ISCED classification level 1 to 3C degrees (if 3C is lower than two years). Medium-skilled individuals have attained a 3C (longer than two years) to 4-level degree. High-skilled individuals have attained a higher than ISCED-1997 category 4 degree. Values are reweighted to be representative of the countries' populations. The total trained workforce is the proportion of workers in a country who engaged in training at least once in the year. The data for the following 23 countries from the first round of PIAAC refer to the year 2012: Australia, Austria, Belgium (Flanders), Canada, Czech Republic, Denmark, Estonia, Finland, France, Germany, Ireland, Italy, Japan, Korea, the Netherlands, Norway, Poland, the Russian Federation (excluding Moscow), Slovak Republic, Spain, Sweden, the United Kingdom (England and Northern Ireland) and the United States. Data for the remaining countries refer to 2015 and are sourced from the second round of the first wave of the PIAAC survey. For the Russian Federation, the PIAAC sample does not include the population of the Moscow municipal area. The data published, therefore, do not represent the entire resident population aged 16-65, but rather the population of the Russian Federation excluding the population residing in the Moscow municipal area.

10. Skill distances between different jobs are measured in terms of underlying skill needs and task contents of different jobs.

11. Figure 5.6: For Greece, Italy, Luxembourg and Spain, data refer to 2015. OECD data on public expenditure on labour markets are based mainly on information about individual labour market programmes appearing in state budgets and the accounts and annual reports of bodies implementing the programmes. See: *http://www.oecd.org/els/emp/Coverage-and-classification-of-OECD-data-2015.pdf*. Public expenditure on active labour market policies relates to spending by central and local public authorities on schemes aimed at the following "targeted persons": unemployed (i.e. not in work, actively seeking), inactive (i.e. would like to work, not actively seeking) or employed but at risk of involuntary job loss. Placement and related services are typically provided by the public employment service or other publicly financed bodies. They include employment counselling and case-management, referral to opportunities for work, information services and so on. Training includes targeted institutional and workplace-based training of

targeted persons. Employment incentives include incentives where the employer covers the majority of the labour cost, and job rotation/sharing schemes where a targeted person substitutes for an employee for a fixed period. Direct job creation relates to new jobs where the labour cost is majority funded by public funds for a limited period. Start-up incentives encourage targeted persons to start businesses or to become self-employed.

References

Acemoglu, D. and P. Restrepo (2017), "Robots and jobs: Evidence from US labor markets", *NBER Working Paper* No. 23285, *https://www.nber.org/papers/w23285*. [7]

Andrews, D., G. Nicoletti and C. Timiliotis (2018), "Digital technology diffusion: A matter of capabilities, incentives or both?", *OECD Economics Department Working Papers*, No. 1476, OECD Publishing, Paris, *https://dx.doi.org/10.1787/7c542c16-en*. [26]

Bechichi, N. et al. (2018), "Moving between jobs: An analysis of occupation distances and skill needs", *OECD Science, Technology and Industry Policy Papers*, No. 52, OECD Publishing, Paris, *https://dx.doi.org/10.1787/d35017ee-en*. [28]

Berger, T. and C. Frey (2015), "Industrial renewal in the 21st century: Evidence from US cities", *Regional Studies*, Vol. 51, Issue 3, pp. 404-413, *http://dx.doi.org/10.1080/00343404.2015.1100288*. [6]

Calvino, F. et al. (2018), "A taxonomy of digital intensive sectors", *OECD Science, Technology and Industry Working Papers*, No. 2018/14, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f404736a-en*. [9]

Dauth, W. et al. (2017), "German robots: The impact of industrial robots on workers", *CEPR Discussion Paper* No. DP 12306. [19]

De Backer, K. et al. (2018), "Industrial robotics and the global organisation of production", *OECD Science, Technology and Industry Working Papers*, No. 2018/03, OECD Publishing, Paris, *https://dx.doi.org/10.1787/dd98ff58-en*. [4]

Elliott, S. (2017), *Computers and the Future of Skill Demand*, Educational Research and Innovation, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264284395-en*. [1]

Graetz, G. and G. Michaels (2017), "Robots at work", *CEP Discussion Paper* 1335, *http://personal.lse.ac.uk/michaels/Graetz_Michaels_Robots.pdf*. [20]

Grundke, R. et al. (2017), "Skills and global value chains: A characterisation", *OECD Science, Technology and Industry Working Papers*, No. 2017/05, OECD Publishing, Paris, *https://dx.doi.org/10.1787/cdb5de9b-en*. [16]

Grundke, R. et al. (2018), "Which skills for the digital era?: Returns to skills analysis", *OECD Science, Technology and Industry Working Papers*, No. 2018/09, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9a9479b5-en*. [17]

Marcolin, L. and M. Squicciarini (2018), "To be (routine) or not to be (routine), that is the question: A cross-country task-based answer", *Industrial and Corporate Change*, dty020, *http://dx.doi.org/10.1093/icc/dty020*. [24]

Marcolin, L., M. Squicciarini and S. Jamet (forthcoming), "Occupational transitions: The cost of moving to a 'safe haven'", *OECD Science, Technology and Industry Policy Papers*, OECD Publishing, Paris. [29]

Milanez, A. (forthcoming), "The taxation of non-standard work", *OECD Taxation Working Papers*, OECD Publishing, Paris. [35]

Nedelkoska, L. and G. Quintini (2018), "Automation, skills use and training", *OECD Social, Employment and Migration Working Papers*, No. 202, OECD Publishing, Paris, *https://dx.doi.org/10.1787/2e2f4eea-en*. [2]

OECD (2019), *Getting Skills Right: Future-ready Adult Learning Systems*, Getting Skills Right, OECD Publishing, Paris, *https://doi.org/10.1787/9789264311756-en*. [25]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [11]

OECD (2018), "Decoupling of wages from productivity: What implications for public policies?", in *OECD Economic Outlook, Volume 2018, Issue 2*, OECD Publishing, Paris, *https://doi.org/10.1787/eco_outlook-v2018-2-3-e*. [15]

OECD (2018), *Good Jobs for All in a Changing World of Work: The OECD Jobs Strategy*, OECD, Paris, *https://www.oecd.org/mcm/documents/C-MIN-2018-7-EN.pdf*. [12]

OECD (2018), *Job Creation and Local Economic Development 2018: Preparing for the Future of Work*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264305342-en*. [8]

OECD (2018), *OECD Employment Outlook 2018*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/empl_outlook-2018-en*. [3]

OECD (2018), *Survey of Adult Skills (PIAAC)* (database), OECD, Paris, *http://www.oecd.org/skills/piaac* (accessed September 2018). [27]

OECD (2018), *The Future of Education and Skills: Education 2030*, OECD Publishing, Paris, *https://www.oecd.org/education/2030/E2030%20Position%20Paper%20(05.04.2018).pdf*. [36]

OECD (2018), *The Future of Social Protection: What Works for Non-standard Workers?*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264306943-en*. [31]

OECD (2017), *Basic income as a policy option: Can it add up?*, Policy Brief on the Future of Work, OECD, Paris, *https://www.oecd.org/social/Basic-Income-Policy-Option-2017.pdf*. [32]

OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264276284-en*. [18]

OECD (2017), *OECD Employment Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/empl_outlook-2017-en*. [14]

OECD (2016), "ICTs and jobs: Complements or substitutes?", *OECD Digital Economy Papers*, No. 259, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlwnklzplhg-en*. [10]

OECD (2016), *Massive Open Online Courses (MOOCs): Trends and Future Perspectives*, OECD, Paris, *http://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=EDU/CERI/CD/RD(2016)5&docLanguage=En*. [22]

OECD (2016), "New forms of work in the digital economy", *OECD Digital Economy Papers*, No. 260, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlwnklt820x-en*. [33]

OECD (forthcoming), *Draft Skills Strategy update*, OECD, Paris. [23]

OECD (forthcoming), *OECD Skills Outlook 2019*, OECD Publishing, Paris. [13]

Quintini, G. (forthcoming), "Returns to different forms of job-related training: Factoring in informal learning", *OECD Social, Employment and Migration Working Papers*, OECD Publishing, Paris. [21]

Schwellnus, C. (forthcoming), "Gig economy platforms: Boon or bane?", *OECD Economics Department Working Papers*, OECD Publishing, Paris. [34]

Sorbe, S., P. Gal and V. Millot (2018), "Can productivity still grow in service-based economies? Preliminary evidence and scoping for further research", *OECD Economics Department Working Papers*, No. 1531, OECD Publishing, Paris, *http://dx.doi.org/10.1787/4458ec7b-en*. [5]

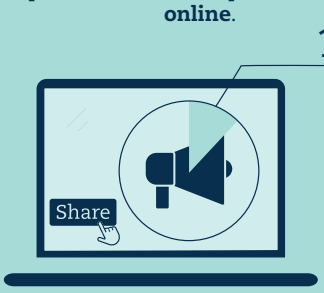
Squicciarini, M., L. Marcolin and P. Horvát (2015), "Estimating cross-country investment in training: An experimental methodology using PIAAC data", *OECD Science, Technology and Industry Working Papers*, No. 2015/09, OECD Publishing, Paris, *http://dx.doi.org/10.1787/5jrs3sftp8nw-en*. [37]

Squicciarini, M. and S. Jamet (forthcoming), "Occupational mobility, skills and training needs", *OECD Science, Technology and Industry Working Papers*, OECD Publishing, Paris. [30]

Chapter 6

PROMOTING SOCIAL PROSPERITY

About 12% of people post **opinions on civic or political issues online**.



Use digital technologies to increase civic and political engagement.

SOCIETY

More than twice as many young men than women **are able to program**.

Address digital divides, e.g. by gender, age and level of education.

About 9% of 15-year olds say they **are subject to cyberbullying**.

Balance the opportunities and risks of using digital applications for mental health.

Digital technologies can help **tackle key domestic and international issues**, e.g. improve environmental protection and health care for all.

Harness the potential of digital technologies to address great societal challenges.

PROMOTING SOCIAL PROSPERITY: WHAT MATTERS MOST FOR POLICY?

Address digital divides to increase inclusiveness

- Divides by gender, age, educational attainment and income level reduce digital inclusion. Thirty-two percent of 55-65 year-olds have no computer experience or have failed core information and communication technology (ICT) tests, compared with 5% of 16-24 year-olds. More than twice as many young (16-24 year-old) men than women in the OECD can program.
- Promote foundational skills (e.g. literacy, numeracy) for all, including by offering incentives for and easing access to adult learning and improving the recognition of skills acquired after initial education so that everyone can participate in a digital society. Social policies that support mobility and redistribution can also reduce digital divides.

Use digital tools to tackle collective challenges

- Harness the potential of digital technologies and data to address collective challenges like environmental protection and healthcare.

Boost civic engagement through digital government strategies

- In 2017, the number of people posting opinions on civic or political issues online ranged from 4% to 24% across the OECD.

Assess the societal impacts of digital technologies by striking a balance between opportunities and risks

- Societal impacts of digital technologies are complex and involve both opportunities and risks. Over half of people in the OECD use social networking to increase personal connections, but about 9% of 15-year olds say they have been cyberbullied.
- All stakeholders, including the technical community, the business community, trade unions and civil society, have a role to play in understanding societal issues and developing appropriate responses as digital transformation progresses.

Digital transformation affects society and culture in complex and interrelated ways as digital technologies dramatically change the ways in which individuals, firms and governments interact among and with one another. Societal effects of digital transformation are complex because overall impacts are often not clear-cut and may vary across countries. For example, digital technologies provide opportunities to enhance access to information (a free and interconnected Internet), improve health care (e.g. tele-medicine), and enrich education (e.g. massive open online courses). On the other hand, challenges arise related to work-life imbalances; the segregation of people into relatively isolated, like-minded groups; negative mental health outcomes such as screen addiction, depression and cyberbullying, including among children; and the emergence of digital divides (e.g. in skills). For digital transformation to work for growth and well-being, it is essential that public policies support a positive and inclusive digital society.

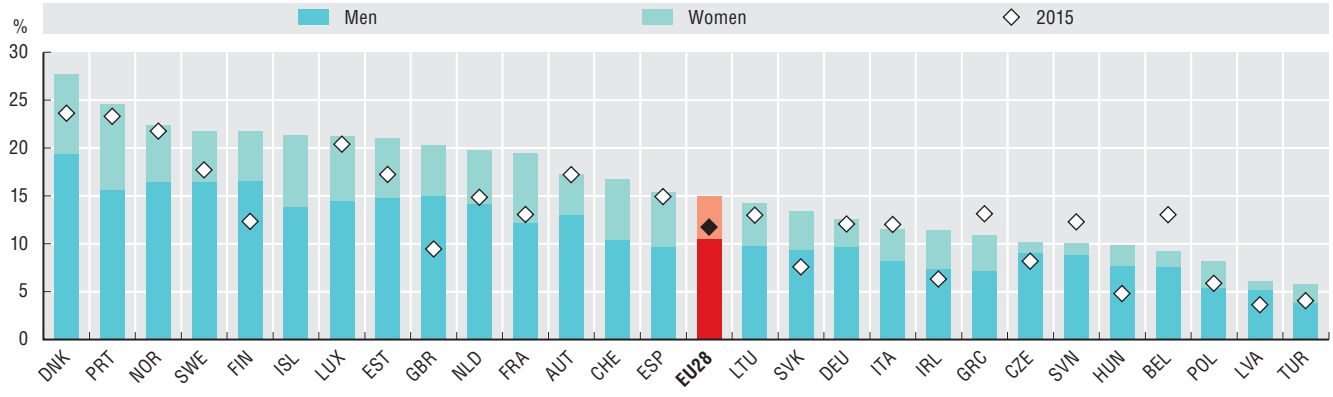
Address digital divides to increase inclusiveness

Despite the rapid overall uptake of digital technologies, divides still persist along different dimensions including gender, age, income and educational level. Across the OECD in 2016, 83% of women on average used the Internet, slightly less than men (85%), but with significant variation across countries (OECD, 2019[1]). The gap in Internet usage was highest in Turkey (18 percentage points), which also exhibited the largest usage gap between young and elderly users of the Internet (over 66 percentage points). Across the world, over 250 million fewer women than men are online, although advances are being made in many countries to close this gap (OECD/G20, 2018[2]).

The gender gap is starker when considering programming skills. Across the European Union, more than twice as many young men (aged 16-24) than women have learnt to program (Figure 6.1). Only those with programming skills will be able to shape the development of digital technologies (e.g artificial intelligence), which could create biases.

6.1. More young men than women can program

Share of 16-24 year-olds who can program, by gender, as a percentage of all Internet users, 2017



Note: See Chapter notes.[1]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on Eurostat[4], *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed September 2018).

StatLink *https://doi.org/10.1787/888933915278*

Women are also less likely to study science, technology, engineering and mathematics (STEM) or to pursue careers in the ICT sector. These divides seem to emerge early; by the age of 15, only an average of 0.5% of girls across the OECD wish to become ICT professionals, compared to 5% of boys, while twice as many boys as girls hope to become engineers, scientists and architects. This gap persists later in life, with women representing about 30% of all tertiary graduates in the natural sciences, engineering or ICT fields in the OECD in 2015 (OECD, 2017[5]). Perhaps unsurprisingly, there are fewer women in STEM professions (OECD/G20, 2018[2]) and fewer female entrepreneurs (OECD/EU, 2017[6]) – and those women that do start businesses in the ICT sector face socio-cultural gender bias when raising capital (Breschi, Lassébie and Menon, 2018[7]).

Looking beyond gender, age is another a determinant of Internet usage. Older people (aged 55-74) were less likely than those aged 16 to 24 to use the Internet in every OECD country for which data were available in 2016 (OECD, 2019[1]). Still, just over 60% of women aged 55-74 across the OECD reported that they used the Internet in 2017, with similar outcomes reported by men of the same age bracket. Data on adult competences find that on average, 32% of those aged 55-65 have no computer experience or have failed core ICT tests, compared with just 5% of 16-24 year-olds (OECD, 2017[8]). As populations age and more public services move online, including health services, lower participation from older people could emerge as a policy concern. For older people, the use of digital tools like the Internet can also be an important source of social engagement and information (OECD, 2019[9]).

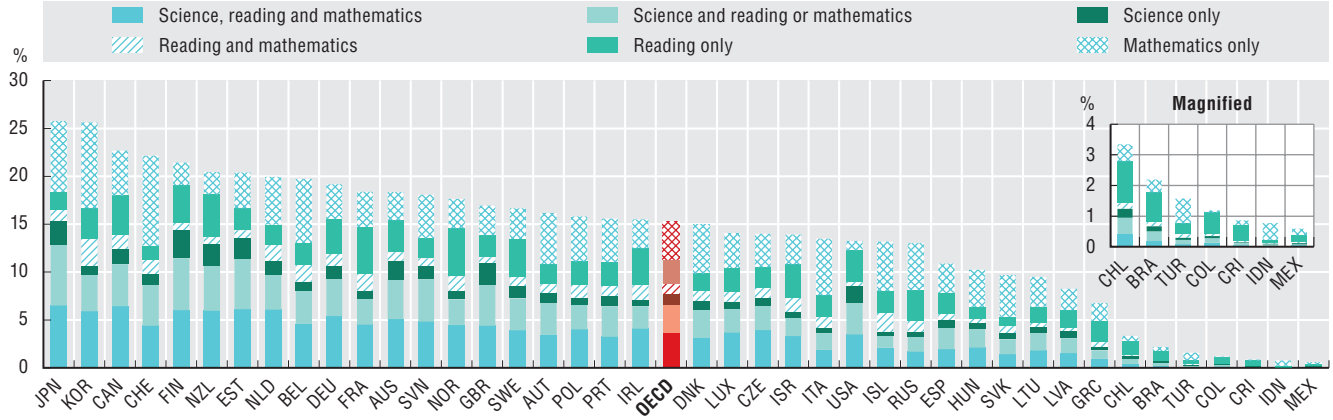
Similar divides persist along other dimensions. For example, digital divides exist with respect to geography, especially when considering rural and urban populations (see Chapter 2). In addition, those with low or no formal education reported lower rates of Internet usage than those with tertiary education in every OECD country for which data were available (OECD, 2017[5]), but the gap ranged from just 4 percentage points in Norway to 60 percentage points in Greece. Similarly, those with higher formal education tend to use the Internet for more productive and professional activities than those with lower levels of education (see Chapter 3), underscoring the necessity of boosting skills to improve the inclusiveness of digital transformation for all groups.

In a fast-moving digital landscape, ensuring foundational skills in science, literacy and numeracy can help enable all groups to participate in a digital society. Those who use the Internet in a diverse and complex way also tend to have better literacy and numeracy skills than those who use the Internet mainly for communication and leisure activities (OECD, forthcoming[10]), suggesting that these foundational skills are necessary for sophisticated personal activities in the digital age. A minimum level of proficiency in reading and numeracy serves as a basis for using digital technologies and to thrive in digital-intensive workplaces (see Chapters 3 and 5).

However, performance in reading and mathematics varies considerably across countries (Figure 6.2). These differences have implications not only for cross-country comparative performance, but also for existing digital divides, as those with the foundational skills to use the Internet for more sophisticated activities, like learning or seeking jobs and information, are better placed to thrive in the digital age.

6.2. Foundational skills, like science, numeracy and literacy, are essential skills for life

Top performers in science, mathematics and reading, as a percentage of 15 year-old students, 2015



Note: Top performers in science, mathematics and reading are students aged 15-16 who achieved the highest levels of proficiency (i.e. Levels 5 and 6) on the OECD PISA's assessment.

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *PISA 2015* (database), *https://www.oecd.org/pisa/data/* (accessed December 2018).

StatLink https://doi.org/10.1787/888933915297

Other complementary skills (e.g. social and emotional skills) are increasingly valued by employers (see Chapter 5) but also more generally by societies. These skills can be developed through strategies that focus on students' feelings and relationships, like role-playing, collaborative-based pedagogies, gaming, case studies, social problem-solving approaches and through extracurricular activities, such as sports and the arts (Le Donné, Fraser and Bousquet, 2016[11]). These strategies can also help re-engage low-performing students who lack motivation at school.

Divides in the distribution of skills may be somewhat compensated for by holistic education and skills policies that support learning and skills development throughout the life cycle. Governments and firms can promote adult learning by offering incentives (e.g. through the tax system), easing access to formal education for adults, and improving the recognition of skills acquired after initial education (see Chapter 5) (OECD, 2017[12]). This issue is also highlighted in the first pillar of the OECD Framework for Policy Action on Inclusive Growth (Box 6.1).

6.1. Making growth inclusive in the digital age

Inequalities of income, wealth and opportunity are increasing both within and across countries in the OECD and beyond (OECD, 2017[13]). These changes are linked to declining productivity growth, with implications for broad-based economic growth and development (OECD, 2018[14]). To address these inequalities, the OECD launched the Inclusive Growth Initiative in 2012 to respond to the worldwide increase in inequality and help governments put well-being at the centre of policy making.

One central tool of this initiative is the Framework for Policy Action on Inclusive Growth (OECD, 2018[15]), which aims to help governments ensure a more equitable distribution of the benefits from economic growth along three major axes:

- Invest in people and places that have been left behind, which highlights the promotion of life-long learning and the acquisition of skills, increasing social mobility, improving health and enhancing access to affordable housing, promoting regional catch-up and investing in community well-being.
- Support business dynamism and inclusive labour markets, which underscores the need to improve technology diffusion, innovation and entrepreneurship, as well as resilient labour markets and good jobs for all.
- Build efficient and responsive governments, which advocates for good governance and people-centred digital government strategies, as well as a whole-of-government approach to designing economic and development policies.

The Framework for Policy Action on Inclusive Growth addresses policies through the lens of economic and social actors, a complementary perspective to the OECD Going Digital Integrated Policy Framework, which takes a policy domain approach.

Source: OECD (2018[15]), *Opportunities for All: A Framework for Policy Action on Inclusive Growth*, *https://dx.doi.org/10.1787/9789264301665-en*.

Social policies can also help to address a range of digital divides. For instance, while highly skilled workers are often already (internationally) mobile and able to follow higher returns for wages (OECD, 2008[16]), attention should focus on social policies, like housing, that can facilitate geographic mobility for low-skilled workers. Redistribution policies, such as tax and benefit policies, can also help ensure that no one is left behind, and that the benefits of digital transformation are broadly shared. Beyond financial support, it is also important that in-kind transfers are used to help those that benefit relatively less from digital transformation. Patterns of redistribution may also need to be reconsidered in light of changes to the nature of work (Causa, Vindics and Akgun, 2018[17]), which intersects with the challenges for workers in the digital age (see Chapter 5).

Use digital tools to tackle collective challenges

Digital technologies hold promise for better environmental management and protection. In particular, digital technologies can directly affect energy consumption by promoting smarter and more continuous management of electricity, for example through the widespread use of so-called "smart" metres.

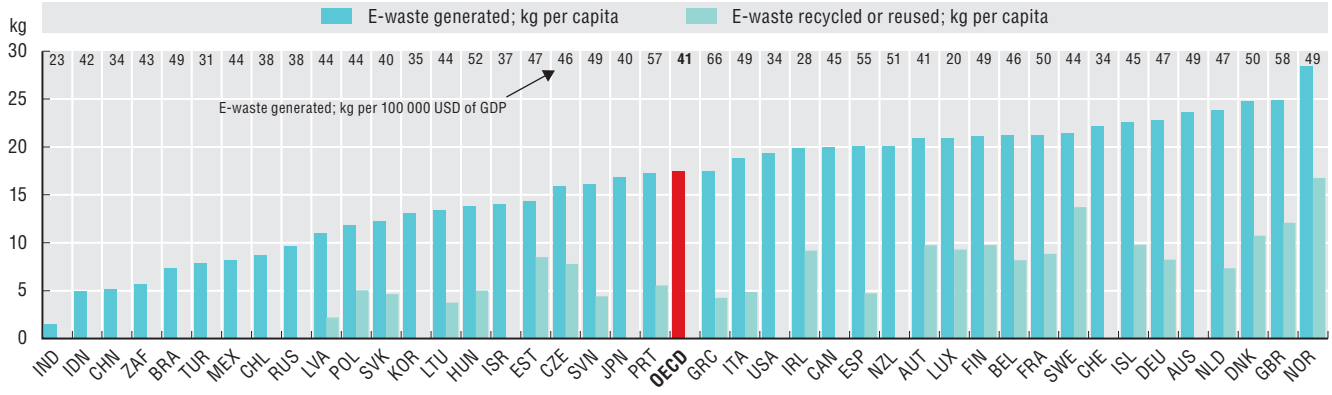
Digitalised energy systems can also better identify who and how energy should be delivered, with potential impacts on long-term sustainable energy production.

The increased digitalisation of energy-intensive sectors (see Chapter 4) also holds promise to increase the energy efficiency and sustainability of many economic and social activities. For example, the transport sector currently accounts for 28% of global final energy demand and 23% of global carbon dioxide emissions from fuel combustion. The largest share of this transport energy demand (36%) comes from road freight vehicles like long-haul trucks (OECD/IEA, 2017[18]; ITF, 2017[19]). But applying digital and data-driven solutions to trucking operations and logistics could reduce the need to take such trips, with potential reductions in road freight energy use of 20% to 25% (OECD/IEA, 2017[18]; ITF, 2017[19]).

On the other hand, digital transformation enables more purchases across borders (see Chapter 8), which could change the global distribution of environmental footprints (De Backer and Flaig, 2017[20]), and nationally implemented recycling regimes and principles like extended producer responsibility may also be affected (Börkey, 2017[21]). Similarly, demand for digital technologies may increase energy and resource demands associated with ICT production and use, offsetting some of the environmental gains they can bring. Global electronic waste (e-waste), including mobile phones and the growing number of sensors and other technical components embedded in a variety of connected products, has been increasing since 2014 as ICT uptake increases and replacement cycles for digital technologies become shorter (Baldé et al., 2017[22]). However, e-waste production differs across countries (Figure 6.3) and, encouragingly, data available for European countries indicates that they recycled or re-used approximately 40% of the volume of e-waste produced in 2016.

6.3. E-waste production and recycling varies across countries

E-waste generation and recycling or reuse, kg per capita and per 100 000 USD of GDP, 2016



Notes: kg = kilogramme; GDP = gross domestic product. See Chapter notes.[2]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on Baldé et al. (2017[22]), *The Global E-Waste Monitor 2017. Quantities, Flows, and Resources*, *https://www.itu.int/en/ITU-D/Climate-Change/Documents/GEM%202017/Global-E-waste%20Monitor%202017%20.pdf*; Eurostat, *Waste electrical and electronic equipment (WEEE) Statistics;* OECD, *Annual National Accounts* (database), *www.oecd.org/sdd/na* (accessed December 2018).

StatLink https://doi.org/10.1787/888933915316

Health care is another collective challenge where digital technologies hold great potential. For example, health care providers can improve care and potentially reduce costs by digitising health records, using new surgery machinery, expanding tele-care and tele-consultation, and implementing mobile health technologies. Digital technologies also hold particular promise for the long-term care of the elderly, a concern as societies across the OECD age (OECD, 2017[8]).

At the same time, big data and data analytics drive personalised care, while increasingly mobile digital technologies help improve knowledge about health status, disease progress and levels of motor and cognitive function. Canada, Denmark, Finland, New Zealand, Singapore, Sweden, the United Kingdom (England and Scotland) and the United States are the most advanced OECD countries in connecting health data and reaping the benefits (OECD, 2017[23]). However, data-driven health services also raise

new challenges related to personal data protection and privacy, security, control and ownership, transparency and accountability, and quality and safety, many of which can be addressed through good health data governance. To date, the benefits of digital technologies have been hindered by fragmented data governance systems (Oderkirk, 2017[24]).

A hallmark of digital transformation is the increased availability of information for users. This is also the case for health information; in recent years, online business models have emerged that make use of this information to educate patients, explain diseases and ailments and enable the delivery of health advice. Across the OECD, 45% of Internet users look for health information online (OECD, 2019[9]), ranging from 71% in the Netherlands to under 20% in Australia.

The use of digital technologies could also have uncertain impacts on the mental and emotional well-being of people, including children. For many people aged below 18-years old, being online is normal; the typical 15-year old in the OECD spent more than two hours every weekday online after school in 2015 (OECD, 2017[25]). Approximately 62% of 15-year olds in the OECD chat online and 73% participate in a social network daily or almost daily (OECD, 2017[5]). While it is difficult to draw a clear connection between the use of digital technologies and health impacts (OECD, 2018[26]), more than half (54%) of 15-year olds surveyed across the OECD in 2015 reported agreeing or strongly agreeing with the statement "I feel really bad if no Internet connection is possible" (OECD, 2018[26]). This might simply reflect how central digital technologies are to modern social life, particularly for so-called "digital natives", but these and other findings have raised concerns among parents and policy makers (OECD, 2018[26]), and require monitoring in the future.

Boost civic engagement through digital government strategies

When governments first began experimenting with digital tools, they largely focused on digitising public services ("e-government"), ranging from the digital collection of taxes, payments of fines and dues, applications for public benefit programmes, permits and licenses, etc. (Warf, 2014[27]). Recently, governments have designed digital government strategies to increase civic engagement (OECD, 2017[28]).

The shift from e-government towards digital government strategies underscores the need to move away from top-down assumptions about citizens' and businesses' needs and to foster greater openness and public engagement to bring people into the design, development, delivery and monitoring of public policies and services (citizen-driven approaches). It also involves the establishment of organisational and governance frameworks to further collaboration with internal and external stakeholders to improve the delivery of better policies and services by letting the needs of the users drive decisions on services.

Digital tools impact civic engagement in a variety of ways, notably by enabling governments, citizens and other stakeholders to interact in a more open and transparent way. In 2017, the share of people posting opinions on civic or political issues online ranged from 4% to 24% across the OECD (OECD, 2019[3]), suggesting that citizens may be receptive to this form of engagement.

A majority of OECD countries have started using ICTs to engage with stakeholders, and over 30 OECD countries use ICTs to conduct public consultations over the Internet (OECD, 2018[29]), with potential impacts on their coverage and efficiency (OECD, 2018[29]). Regulators can use digital tools to liaise with consumer organisations, academics and the technical and business communities to monitor trends and remain abreast of technological developments. As information is increasingly gathered by private organisations, there may be increased need for collaboration among stakeholders to achieve public policy goals.

The use of digital technologies by governments enables the development of more people-centric and user-driven policies. Digital government strategies can empower users to access digital public services at their convenience and in new ways, including through enhanced interaction with public administrations within and across tiers of government. When the provision of services is fragmented across disparate public agencies, many governments have adopted the "once-only" principle, which seeks to reduce the burden on individuals, institutions and companies by ensuring they only have to provide certain standard information to public authorities once (European Commission, 2017[30]). Digital one-stop shops can also ease access to information and assistance, such as for job seekers. More detailed information that governments can gather through interacting with citizens online can also allow more personalisation of public services and better targeting of public policies.

Assess the societal impacts of digital technologies by striking a balance between opportunities and risks

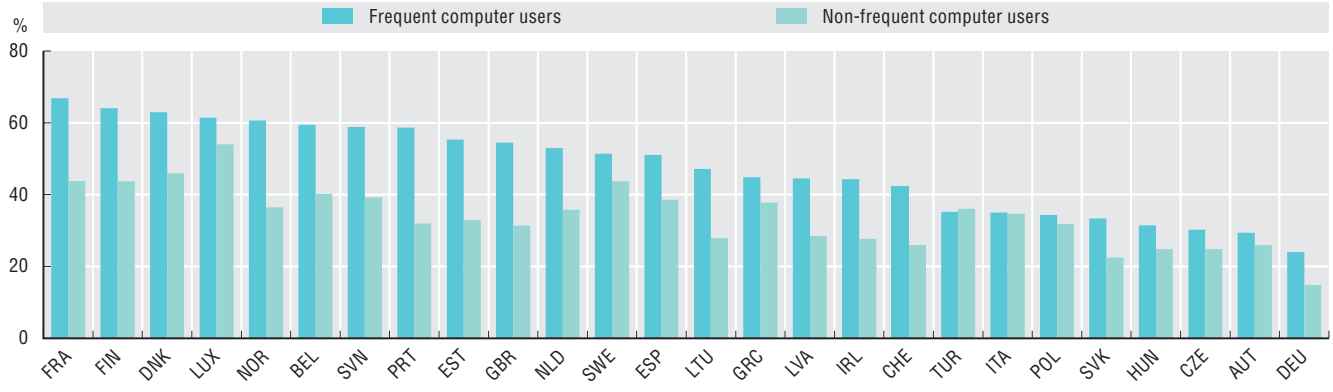
Digital transformation also introduces new or heightens existing social issues, whose overall or aggregate impacts may not be clear. As digital transformation progresses, the onus is on stakeholders, including governments, the business community, trade unions, the technical community and civil society, to collaborate and manage these issues as they evolve.

There are a range of social issues that have emerged or become heightened as digital transformation progresses. For one, the ubiquity of digital technologies means that people can engage in more flexible working arrangements, such as teleworking, which can help families manage schedules that do not map well to a regular working day. However, research suggests that telework opportunities are largely available to the high-skilled (Billari, Giuntella and Stella, 2017[31]), and more than 80% of people in Austria, the Czech Republic, Germany, Greece, Hungary, Italy, Latvia, Poland, Portugal, Slovakia, Spain, and Turkey report that they have never tele-worked (OECD, 2019[9]).

At the same time, the fact that it is possible for workers to connect to work from home during all hours can lead to high levels of stress. For example, a study of working adults in the United States suggests that time spent on emails and the expectation for workers to monitor their emails after working hours reduced job satisfaction with their work-life balance (Belkin, Becker and Conroy, 2016[32]). In addition, recent work (OECD, 2019[9]) finds a positive and significant relationship between the frequent use of computers at work and the share of European workers who experience work-related worry at home (OECD, 2019[9]). Overall, workers who frequently use a computer are 7.8% more likely to experience worries about work at home than those who do not (Figure 6.4).

6.4. Computers and work stress go hand-in-hand

Individuals worrying about work outside working time, as a percentage of individuals using computers at work, 2015



Note: See Chapter notes.[3]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on Eurofound (2015[33]), "European Working Conditions Survey 2015", *https://www.eurofound.europa.eu/surveys/* (accessed November 2018).

StatLink *https://doi.org/10.1787/888933915335*

Digital technologies and the data they use and create also raise complex questions about their impact on society. Artificial intelligence (AI) has the potential to generate enormous societal benefits in many arenas (OECD, 2016[34]). For example, some may find that smart home appliances such as Alexa, Google Assistant and Siri make their lives easier, and other AI applications hold promise including to ease the loneliness of the elderly. But the ability of AI algorithms to learn, analyse and produce output that may be opaque even to its creators raises new policy challenges (OECD, 2018[35]). As a result, AI has risen to the top of policy agenda, with issues around ethics, fairness, transparency, accountability, safety and privacy featuring prominently (Box 6.2) (OECD, forthcoming[36]).

6.2. Artificial intelligence in society

AI systems detect patterns in enormous volumes of data, radically improving the accuracy and lowering the cost of predictions, generating productivity gains and spurring innovation to address many pressing problems.

Yet alongside its tremendous benefits, AI – notably some types of machine learning – raises new types of concerns compared to previous technologies. First, abstract mathematical relationships can become "black boxes" that are too complex for any person to understand, even the person that designed the AI system. Second, some AI systems iterate and evolve over time and can even change their own behaviour in unforeseen ways. Third, a specific outcome or prediction may only appear when an AI system encounters specific conditions and data, and is not necessarily repeatable. Finally, evolving and increasingly autonomous products and services raise new types of safety issues.

A major focus of discussions in AI policy circles relates to fairness and to the data that AI systems rely on. Machine learning algorithms reproduce the biases implicit in the training data used (e.g. racial and gender biases as well as stereotypes). Much focus today is placed on accidental impacts of AI, for example potential bias in the operation of machine learning algorithms estimating the probability of recidivism (OECD, forthcoming[36]).

Safety and accountability are also major policy issues. Driverless vehicles may well make driving safer, improve quality of life and reduce environmental impacts, but they also raise questions about jobs, safety, liability, security, privacy and transparency, as well as possible ethical choices (e.g. which person to "save" in the event of an unavoidable fatal accident) (OECD, forthcoming[36]; OECD, 2018[35]). More broadly, there is often a trade-off between designing AI systems for accuracy and designing systems that are transparent and accountable.

There is also clear tension between the accuracy of AI systems – which require vast quantities of representative and curated data – and data protection. At the same time, algorithmic correlations weaken the distinction between personal and other data: AI systems can often infer sensitive and personal data and correlations from proxy variables. Developments in the Internet of Things (IoT) further exacerbate challenges to privacy protection. In particular, the ubiquity of IoT devices in public spaces (smart cities, work places), for example, may have a chilling effect on individual liberties, as individuals become aware, or are under the impression, that they may be identified and their activities monitored, leading to a perceived form of surveillance (OECD, forthcoming[36]). Privacy concerns also come to the fore with the increasing use of connected IoT devices of a highly personal nature (wearable devices, smart homes and "quantified self") that facilitate the gathering of personal data unbeknownst to the individual.

High-level guiding principles agreed among the widest number of countries can help ensure that AI contributes to social prosperity. The OECD created an international multi-stakeholder AI expert group (AIGO) in July 2018 to scope principles to guide a human-centric approach to AI in society that fosters trust in, and adoption of, AI (OECD, 2018[37]). Achieving the right balance – weighing the benefits of AI and mitigating the risks – is at the heart of the expert group's task and the overall efforts of the OECD to develop and share principles for AI in society.

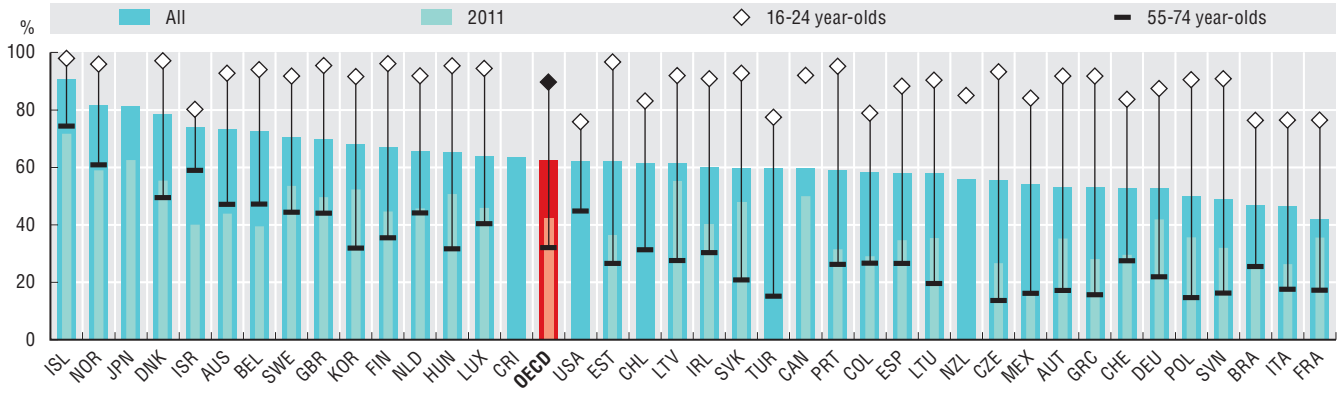
Digital technologies, and particular digital applications like social networking, may lead to a softening of the distinction between public and private space. Social networking typically enables personal interactions between people, while also allowing individuals to communicate to many people at once. Across the OECD, just over 60% of people used the Internet to access social networks in 2018. Social network usage increased in every OECD country for which data were available between 2011 and 2018, with an average increase of over 20 percentage points (Figure 6.5). On average in the OECD, almost 90% of people aged between 16 and 24 used social network sites in 2018, in comparison to just 32% of older people.

Digital transformation changes the ways in which people communicate with one another, as many offline interactions increasingly have an online component. There is competing evidence about whether online interactions supplement, complement or displace offline social contacts (OECD, 2019[9]). On the one hand, an increase in the use of online social interactions can help users to communicate

with each other and decrease the cost of staying in touch, thereby reinforcing existing relationships or establishing new ones, regardless of distance. This can have potential positive impacts on identity, belonging and feelings of loneliness.

6.5. Social networking is prevalent

Individuals who used the Internet to access social networking sites, by age, as a percentage of Internet users in each age group, 2018



Note: See Chapter notes.[4]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD[1], *ICT Access and Usage by Households and Individuals* (database), *http://oe.cd/hhind* (accessed December 2018).

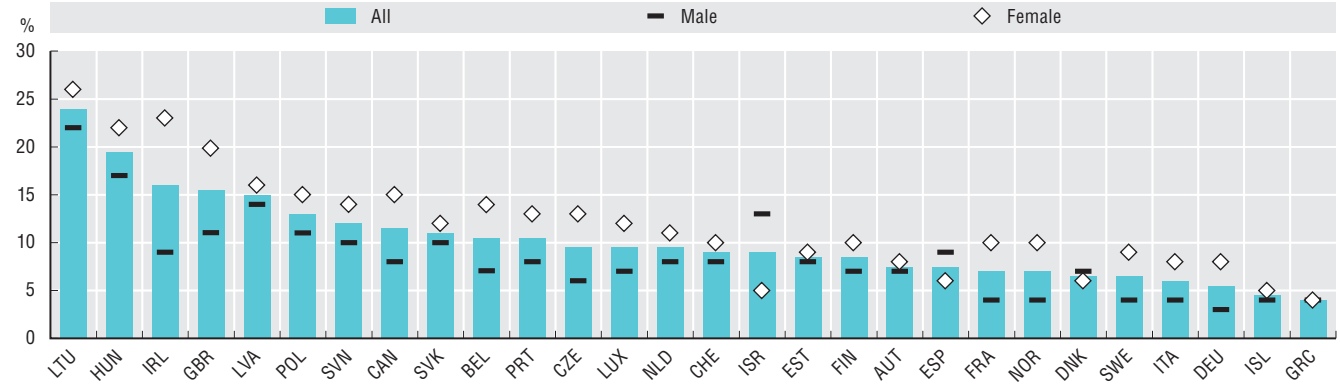
StatLink https://doi.org/10.1787/888933915354

On the other hand, digital transformation also enables the easier and faster dissemination of potentially negative social interactions, including cyberbullying, hate speech and discrimination against specific groups. Many forms of online interactions are comparatively more detached than those undertaken in real-life, but the barriers to participation may also be lower.

Children and those who are most vulnerable may face the most risks and experience the most damaging outcomes as a result of negative online interactions. Children use the Internet for a variety of purposes, including receiving content, interacting with social networks or engaging in participatory activities like blogging or gaming (Hooft Graafland, 2018[38]). About 9% of 15-year olds in the OECD reported being subject to cyberbullying (Figure 6.6) although the share could be higher as victims are often reluctant to self-report. In 24 of the 28 countries for which data were available, young girls aged were more likely than boys to report having been cyberbullied, but they are also more likely to chat online daily or almost daily than boys (OECD, 2017[5]).

6.6. Many children across the OECD report having experienced cyberbullying

Children's exposure to cyberbullying through messages, by gender, as a percentage of all children aged 15 in each group, 2013



Note: See Chapter notes.[5]

Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on WHO (2016), *Growing up unequal: gender and socioeconomic differences in young people's health and well-being, Health Behaviour in School-aged Children (HBSC) study: international report from the 2013/2014 survey, Copenhagen.*

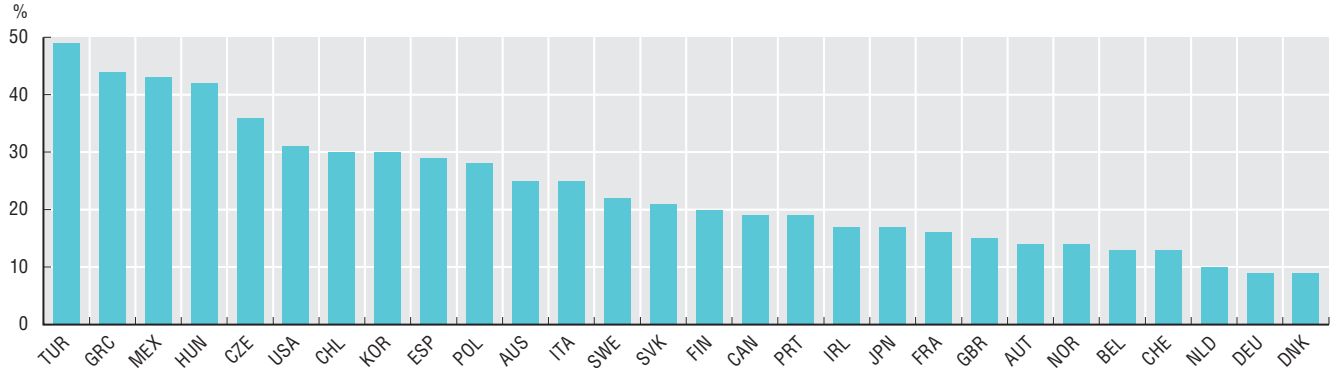
StatLink https://doi.org/10.1787/888933915373

Digital technologies enable communications across geographically dispersed communities, and have created new opportunities for people to share and consume news and interact with the political process. They also enable new forms of organisation and identification, and empower individuals to take part in social or political discussions (OECD, 2019[9]). At the same time, as individuals increasingly consume information online or through social network intermediaries, the rapid spread and potential algorithmic reinforcement of particular views has become a topical issue.

Disinformation is a related concern that has gained attention recently, as digital technologies facilitate its faster and wider dissemination. Disinformation is defined as all forms of false, inaccurate, or misleading information designed, presented and promoted to intentionally cause public harm or for profit (European Commission, 2018[39]). While disinformation is neither new nor necessarily illegal, some have raised concerns that it negatively impacts individuals and society more broadly (European Commission, 2018[39]; UK House of Commons, 2018[40]; Ministry of Foreign Affairs of Denmark, 2018[41]; Swedish Civil Contingencies Agency, 2018[42]). While difficult to measure precisely, one measure of the extent of disinformation is self-reported exposure to "completely made-up stories" (Figure 6.7), which shows that many individuals across the OECD have reported being exposed to disinformation. However, this share varies substantially across countries, from nearly 50% of respondents in Turkey to under 10% in Germany and Denmark, and trends are unclear.

6.7. Reported exposure to disinformation varies across the OECD

Share of individuals who reported having come across completely made-up stories in the last week, 2018



Source: OECD (2019[3]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on Newman, N. et al. (2018 [46]), *Reuters Institute Digital News Report 2018*, *http://media.digitalnewsreport.org/wp-content/uploads/2018/06/digital-news-report-2018.pdf?x89475*.

StatLink https://doi.org/10.1787/888933915392

It should be noted, moreover, that self-reported measures can be misleading, and this particular measure captures the individual's perception of the veracity of information provided in the story, rather than the actual degree of accuracy. This measure also does not necessarily capture the overall aggregate impact of disinformation, as it does not measure how many people have actually read these stories or have been affected by them. Although the extent of disinformation is not yet clear, it has risen high on the policy agenda in many countries. Some of the most popular social network sites have implemented measures against disinformation (Facebook, 2018[43]), while some governments are considering changes to communication and broadcasting laws to combat disinformation (Funke, [2019[44]], cited in UNESCO, [2018[45]]). Addressing the challenges posed by disinformation in the digital age and preserving the opportunities in the information environment will require broad, whole-of-society efforts involving individuals, firms and governments.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 6.1: For Italy, data refer to 2016.
2. Figure 6.3: Electronic waste (or e-waste) refers to all items of electric and electronic equipment and its parts that have been discarded by its owner as waste, without the intent of reuse. In this analysis, it covers six waste categories: 1. Temperature equipment; 2. Screens, monitors; 3. Lamps; 4. Large equipment; 5. Small equipment; and 6. Small IT and telecommunication equipment. E-waste ratios per USD are based on the GDP expressed in current PPPs for the year 2016. E-waste collection data are available at: *http://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=env_waselee&lang=en*. For Italy and Slovenia, data refer to 2015. Data on recycling or reuse are only available for the European Union countries and Norway.
3. Figure 6.4: Frequent computer use refers to workers who use digital devices at work at least three quarters of the time.
4. Figure 6.5: Unless otherwise stated, Internet users are defined as individuals who accessed the Internet within the last 3 months. For Korea and New Zealand, the recall period is 12 months. For the United States, the recall period is 6 months. For Australia, data refer to the fiscal years 2016/17 and 2010/11 ending on 30 June. The information provided is drawn from responses to a question whose wording differs slightly to that requested: "Activities of Internet access at home, in the previous 3 months – Social networking". For Brazil, data refer to 2010 and 2016. For Canada, data refer to 2010 and 2012. For Chile, data refer to 2017. For Colombia, data refer to 2012 and 2017. For Costa Rica, data refer to 2017 and to individuals aged 18 to 74 instead of 16-74. For Israel, data refer to 2010 and 2016 and relate to Internet usage for discussion and communication groups, such as: chats, forums, WhatsApp, Facebook, Skype, Twitter, etc. Data refer to individuals aged respectively 20 and more instead of 16-74 and 20-24 instead of 16-24. For Japan, data refer to 2012 and 2016 and to individuals aged 15-69 instead of 16-74. For New Zealand, data refer to 2012. For Korea and Switzerland, data refer to 2010 and 2017. For Mexico, data refer to 2013 and 2017. For the United States, data refer to 2017.
5. Figure 6.6: Children's exposure to cyberbullying refers to the share of children aged 15 who report having been cyberbullied by messages once.

References

Baldé, C. et al. (2017), *The Global E-Waste Monitor 2017. Quantities, Flows, and Resources*, United Nations University (UNU), International Telecommunication Union (ITU) and International Solid Waste Association (ISWA), Bonn/Geneva/Vienna, *https://www.itu.int/en/ITU-D/Climate-Change/Documents/GEM%202017/Global-E-waste%20Monitor%202017%20.pdf*. [22]

Belkin, L., W. Becker and S. Conroy (2016), "Exhausted, but unable to disconnect: After-hours email, work-family balance and identification", *Academy of Management Proceedings*, Vol. 2016, No. 1, *http://dx.doi.org/10.5465/ambpp.2016.10353abstract*. [32]

Billari, F., O. Giuntella and L. Stella (2017), "Does broadband Internet affect fertility?", *IZA Discussion Paper Series* No. 10935, *http://ftp.iza.org/dp10935.pdf*. [31]

Börkey, P. (2017), *Extended Producer Responsibility (EPR) and the Impact of Online Sales*, OECD, Paris, *https://www.oecd.org/officialdocuments/publicdisplaydocumentpdf/?cote=ENV/EPOC/WPRPW(2017)2/FINAL&docLanguage=En*. [21]

Breschi, S., J. Lassébie and C. Menon (2018), "A portrait of innovative start-ups across countries", *OECD Science, Technology and Industry Working Papers*, No. 2018/02, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f9ff02f4-en*. [7]

Causa, O., A. Vindics and O. Akgun (2018), "An empirical investigation on the drivers of income redistribution across OECD countries", *OECD Economics Department Working Papers*, No. 1488, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5cb47f33-en*. [17]

De Backer, K. and D. Flaig (2017), "The future of global value chains: Business as usual or 'a new normal'?", *OECD Science, Technology and Industry Policy Papers*, No. 41, OECD Publishing, Paris, *https://dx.doi.org/10.1787/d8da8760-en*. [20]

Eurofound (2015), *European Working Conditions Survey*, *https://www.eurofound.europa.eu/surveys/*, (accessed November 2018). [33]

European Commission (2018), *Final Report of the High Level Expert Group on Fake News and Online Disinformation*, European Union, Brussels, *http://ec.europa.eu/newsroom/dae/document.cfm?doc_id=50271*. [39]

European Commission (2017), *The "Once-Only" Principle (TOOP) Project Launched in January 2017*, *https://ec.europa.eu/digital-single-market/en/news/once-only-principle-toop-project-launched-january-2017*. [30]

Eurostat (2018), *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed December 2018). [4]

Facebook (2018), *Increasing our Efforts to Fight False News*, *https://newsroom.fb.com/news/2018/06/increasing-our-efforts-to-fight-false-news*. [43]

Funke, D. (2019), *A Guide to Anti-misinformation Actions around the World*, Poynter, *https://www.poynter.org/news/guide-anti-misinformation-actions-around-world*. [44]

Hooft Graafland, J. (2018), "New technologies and 21st century children: Recent trends and outcomes", *OECD Education Working Papers*, No. 179, OECD Publishing, Paris, *https://dx.doi.org/10.1787/e071a505-en*. [38]

ITF (2017), *Managing the Transition to Driverless Road Freight Transport*, International Transport Forum, Paris, *https://www.itf-oecd.org/managing-transition-driverless-road-freight-transport*. [19]

Le Donné, N., P. Fraser and G. Bousquet (2016), "Teaching strategies for instructional quality: Insights from the TALIS-PISA link data", *OECD Education Working Papers*, No. 148, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jln1hlsr0lr-en*. [11]

Ministry of Foreign Affairs of Denmark (2018), *Strengthened Safeguards against Foreign Influence on Danish Elections and Democracy*, Ministry of Foreign Affairs, Copenhagen, *http://um.dk/en/news/newsdisplaypage/?newsid=1df5adbb-d1df-402b-b9ac-57fd4485ffa4*. [41]

Newman, N. et al. (2018), "Reuters Institute Digital News Report 2018", Reuters Institute for the Study of Journalism, Oxford, *http://media.digitalnewsreport.org/wp-content/uploads/2018/06/digital-news-report-2018.pdf?x89475*. [46]

Oderkirk, J. (2017), "Readiness of electronic health record systems to contribute to national health information and research", *OECD Health Working Papers*, No. 99, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9e296bf3-en*. [24]

OECD (2019), *How's Life in the Digital Age?: Opportunities and Risks of the Digital Transformation for People's Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311800-en*. [9]

OECD (2019), "ICT Access and Usage by Households and Individuals", *OECD Telecommunications and Internet Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/b9823565-en* (accessed 28 January 2019). [1]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [3]

OECD (2018), "AI: Intelligent machines, smart policies: Conference summary", *OECD Digital Economy Papers*, No. 270, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f1a650d9-en*. [35]

OECD (2018), *Children & Young People's Mental Health in the Digital Age: Shaping the Future*, OECD, Paris, *http://www.oecd.org/els/health-systems/Children-and-Young-People-Mental-Health-in-the-Digital-Age.pdf*. [26]

OECD (2018), *OECD Creates Expert Group to Foster Trust in Artificial Intelligence*, OECD, Paris, *http://www.oecd.org/innovation/oecd-creates-expert-group-to-foster-trust-in-artificial-intelligence.htm*. [37]

OECD (2018), *OECD Regulatory Policy Outlook 2018*, OECD Publishing, Paris, *https://doi.org/10.1787/9789264303072-en*. [29]

OECD (2018), *Opportunities for All: A Framework for Policy Action on Inclusive Growth*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264301665-en*. [15]

OECD (2018), *The Productivity-Inclusiveness Nexus*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264292932-en*. [14]

OECD (2017), *New Health Technologies: Managing Access, Value and Sustainability*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264266438-en*. [23]

OECD (2017), *OECD Ministerial Council Statement: Making Globalisation Work: Better Lives For All*, OECD, Paris, *http://www.oecd.org/mcm/documents/2017-ministerial-council-statement.htm*. [13]

OECD (2017), *OECD Recommendation of the Council on Open Government*, OECD, Paris, *https://legalinstruments.oecd.org/instruments/OECD-LEGAL-0438*. [28]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268821-en*. [5]

OECD (2017), *OECD Skills Outlook 2017: Skills and Global Value Chains*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264273351-en*. [12]

OECD (2017), *PISA 2015 Results (Volume III): Students' Well-Being*, PISA, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264273856-en*. [25]

OECD (2017), *Preventing Ageing Unequally*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264279087-en*. [8]

OECD (2016), *OECD Science, Technology and Innovation Outlook 2016*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/sti_in_outlook-2016-en*. [34]

OECD (2008), *The Global Competition for Talent: Mobility of the Highly Skilled*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264047754-en*. [16]

OECD (forthcoming), *Artificial Intelligence in Society*, OECD Publishing, Paris. [36]

OECD (forthcoming), *OECD Skills Outlook 2019*, OECD Publishing, Paris. [10]

OECD/EU (2017), *The Missing Entrepreneurs 2017: Policies for Inclusive Entrepreneurship*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264283602-en*. [6]

OECD/G20 (2018), *Bridging the Digital Gender Divide*, OECD, Paris, *http://www.oecd.org/going-digital/bridging-the-digital-gender-divide.pdf*. [2]

OECD/IEA (2017), *The Future of Trucks*, OECD/IEA, Paris, *https://www.iea.org/publications/freepublications/publication/TheFutureofTrucksImplicationsforEnergyandtheEnvironment.pdf*. [18]

Swedish Civil Contingencies Agency (2018), *Countering Information Influence Activities: The State of the Art*, Swedish Civil Contingencies Agency, Stockholm, *https://rib.msb.se/filer/pdf/28697.pdf*. [42]

UK House of Commons (2018), *Disinformation and "Fake News": Interim Report*, UK House of Commons, London, *https://publications.parliament.uk/pa/cm201719/cmselect/cmcumeds/363/363.pdf*. [40]

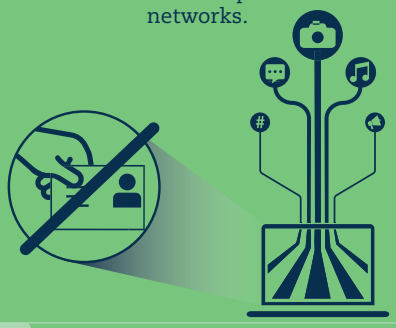
UNESCO (2018), *Journalism, Fake News and Disinformation*, United Nations Educational, Scientific and Cultural Organization, Paris, *https://en.unesco.org/sites/default/files/journalism_fake_news_disinformation_print_friendly_0_0.pdf*. [45]

Warf, B. (2014), "E-government in the OECD: A comparative geographic analysis", in Baum, S. and A. Mahizhnan (eds.), *E-Governance and Social Inclusion: Concepts and Cases*, IGI Global, Hershey, PA, *http://dx.doi.org/10.4018/978-1-4666-6106-6.ch009*. [27]

Chapter 7

STRENGTHENING TRUST

Almost 30% **of Internet users mistrust** social and professional networks.



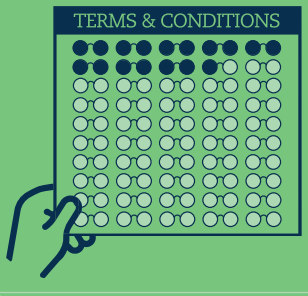
Address digital security, privacy and consumer protection concerns to improve trust.

One in four Internet users in the European Union is **concerned about payment security**.

Empower everyone to assess and better manage digital security risk.

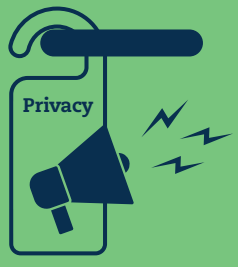
TRUST

Only 17% of peer platform users **read terms and conditions** in full.



Design and implement more effective measures to protect consumers online.

A majority of **privacy measures** aims to raise awareness and **empower individuals**.



Develop and implement a national privacy strategy with a whole-of-society perspective.

STRENGTHENING TRUST: WHAT MATTERS MOST FOR POLICY?

Adopt a risk management approach to ensuring trust

- Use risk management as a framework to develop policies to increase trust, including to assess and manage risks related to technologies, data and cross-border flows.
- Help small and medium-sized enterprises (SMEs) realise digital opportunities by increasing awareness and promoting good risk management practices through public and private efforts.

Develop strong, inclusive and interoperable privacy frameworks

- Privacy frameworks enable the free flow of personal data, spurring growth and social prosperity. Measures to increase transparency on the purpose and use of personal data collections and to enhance user access and control over their data are needed. Technological solutions can help increase trust through "privacy by design".
- National privacy policies should be supported at the highest levels of government and take a whole-of-society perspective. More than half of privacy measures across OECD countries aim to raise awareness and empower individuals.
- Encourage interoperability of privacy frameworks across jurisdictions, including through national privacy strategies and other practical approaches.

Manage digital security risk rather than trying to eliminate it

- Digital security concerns, including malicious interference, are rising, and hold back almost 30% of Internet users from providing personal information to online social and professional networks. In addition, one in four Internet users in the European Union is concerned about payment security.
- Digital security needs to be a strategic priority for individuals, firms and governments, not a technical question. Managing digital security risk is the responsibility of everyone online.

Protect consumers as the online and offline worlds converge

- Digital consumers face challenges related to information disclosure, misleading and unfair commercial practices, confirmation and payment, fraud and identity theft, product safety, and dispute resolution and redress, including when using connected devices where offline and online experiences are blurring.
- Terms and conditions are not effective to communicate important information to consumers. For example, only 17% of people read the terms and conditions of peer platforms (such as Airbnb and BlaBlaCar) in full. Other approaches are needed to protect consumers online.

To fully embrace and benefit from digital transformation, individuals, firms and governments need to be confident that engaging in the digital environment to conduct their social and economic activities will bring more benefits than downsides. Such downsides can arise from various sources of uncertainties affecting digital technologies, data and cross-border flows. Many are related to potential digital security incidents (e.g. breaches of availability, integrity or confidentiality of data, systems or networks). Other downsides are related to information asymmetries, power imbalances or jurisdictional challenges exacerbated by the digital environment. These may translate into breaches of laws and regulations such as privacy, consumer protection or product safety, intended to reduce these imbalances and challenges. To ensure trust, it is critical to mitigate as much as possible such uncertainties.

Adopt a risk management approach to ensuring trust

The consequences of undesirable events, for example the theft of business assets or of an individual's identity, or the misuse of personal data, can affect all actors' reputation, finances, freedom, autonomy, health, well-being, safety, competitiveness or efficiency, and ultimately limit their willingness to fully engage in the digital environment. They can also affect the functioning of our society as critical infrastructure and essential services such as energy, finance and transport can be disrupted by digital security incidents.

In practice, the most effective way to deal with uncertainties is to manage digital risks. Because uncertainties cannot be entirely eliminated, some degree of risk has to be accepted. In other words, digital risk needs to be reduced to an acceptable level in light of the objectives and benefits to be achieved. This requires learning to assess risks and to manage them, which eventually includes deciding whether to accept, reduce, transfer or avoid risk, the latter by not engaging in digital activities.

7.1. What is trust?

Trust can be considered in many facets of life – trust in political institutions, government, statistics, the rule of law (institutional trust) or trust in other people (interpersonal trust) (see Chapter 6). While there is no universally agreed definition of trust, the OECD has broadly defined trust as "a person's belief that another person or institution will act consistently with their expectations of positive behaviour", and has contributed to its better measurement through guidelines for national statistical offices (OECD, 2017[1]) and through experimental work (Murtin et al., 2018[2]).

Digital transformation adds a new dimension to the concept of trust for individuals, societies and the economy. This chapter addresses trust from the perspective of uncertainties and interdependences (Mayer, Davis and Schoorman, 1995[3]) because digital environments encapsulate these factors. Trust in digital environments depends on the context and varies with what is at stake, including opportunities and challenges.

From an individuals' point of view, trust in the digital age is about the willingness to risk time, money and disclosure of personal data to engage in commercial and social activities, and to become vulnerable if a purchase goes wrong or if their data are stolen or if they are used to monitor their behaviour, to discriminate against them or to violate their privacy. From an organisations' point of view, trust is also about accepting a certain level of risk resulting from possible digital security, privacy, consumer protection or other incidents, to benefit from digital transformation. Trust is therefore a key condition to fully realise the potential growth and social progress in the digital age.

Digital risk management applies to individuals as well as organisations, from small businesses to large firms to public entities. All actors share some responsibility to manage the digital risks of their activities according to their roles, ability to act and the context, and they need to be equipped with the right skills to do so. As risk is a cross-boundary, cross-sector and multi-stakeholder issue, digital risk management provides a common reference framework for different policy communities to consider trust policies in an integrated and holistic manner, building on the fundamental components of a risk management cycle. These components include:

- establishing the objectives and the context of an activity and determining the acceptable level of risk in light of the expected benefits
- assessing risk by identifying risk factors, and evaluating the likelihood and severity of risk occurrence
- treating risk, including through accepting some, reducing it to an acceptable level through appropriate measures, sharing or transferring some, and/or avoiding some altogether
- monitoring and reviewing on an ongoing basis the risk management cycle to adapt it to a constantly changing environment.

Policies that foster digital risk management are crucial to increase trust and enable individuals and organisations to maximise their economic and social objectives. Risk management practices are likely to differ according to whether the objective is digital security, privacy, consumer protection or product safety, but policies need to account for interrelations between different categories of risks. Any measures to manage digital risk should be appropriate to and commensurate with the risk and the objectives at stake for the actors concerned. Measures that may be appropriate for an individual may not be the same for a large private firm, even though both actors may pursue the same objective.

Among private sector firms, start-ups and SMEs merit particular attention from policy makers, not only given their crucial role for the economy, but also in view of limited capacity to sustain major incidents and manage digital risk effectively. SMEs, and early-stage start-ups in particular, are critical to economic growth and they contribute to competition, innovation and job creation. However, they also face distinct challenges in managing digital risk. For example, a digital security incident that results in a loss of consumer trust, damage to reputation or a drop in revenue, may be more damaging for SMEs than for larger firms because SMEs are more likely to find it difficult to weather a temporary loss of revenue.

Typically, SMEs also lack the awareness, resources and expertise to effectively assess and manage risk. On the positive side, awareness of digital risk and robust risk management practices may bring them competitive advantage when seeking partnership opportunities with larger organisations. To help SMEs realise these opportunities, and to avoid that unmanaged risks from putting an SME and/or its business partner(s) in danger, it is essential to increase awareness and promote good practices.

Develop strong, inclusive and interoperable privacy frameworks

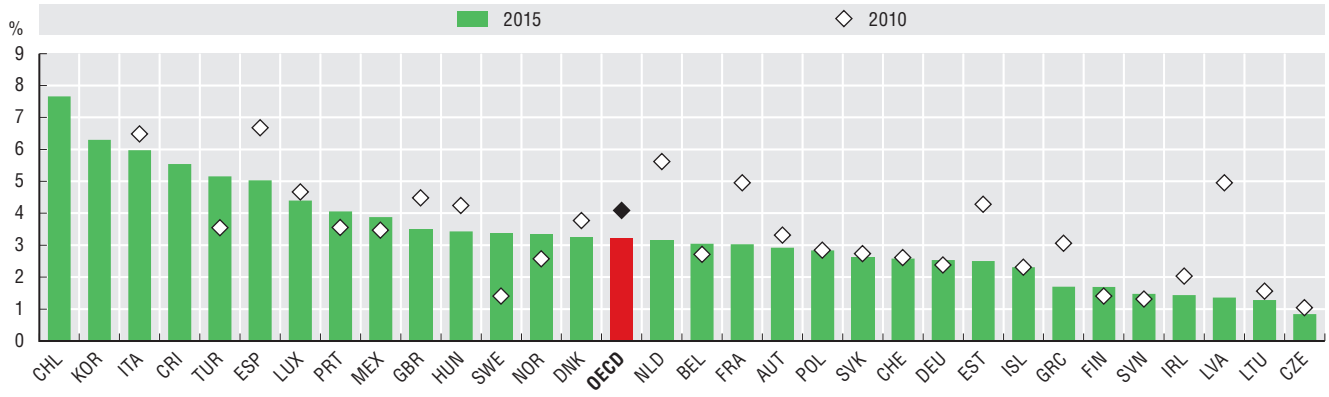
As digital transformation progresses, privacy, and the protection of personal data in particular, is emerging as an ever more critical influence on trust. Personal data have come to play an increasingly important role in our economies, societies and everyday lives, and new technologies and responsible data use are yielding great societal and economic benefits. At the same time, the abundance of personal data gathered, processed and exchanged has elevated the risks to individuals' privacy.

As firms, Internet service providers and governments increasingly collect and store personal data, privacy risks increase. About 3% of individuals on average in OECD countries reported experiencing a privacy violation in the past three months (Figure 7.1), although large variation exists across countries. In Chile, for example, about 7.5% of individuals reported a privacy violation, whereas in the Czech Republic the share was less than 1%. Personal data breaches are a major source of privacy violations, and digital technologies are increasingly being used to derive personal data by matching and "mining" datasets (OECD, 2017[4]).

Personal data are being increasingly used in ways unanticipated at the time of collection, including in ways that allow sensitive information to come to light or to link supposedly anonymous data to specific individuals. With the growth in use and value of data, personal data breaches have become more common (OECD, 2017[4]). These risks implicate not only the individuals concerned, but the core values and principles which privacy and personal data protection seek to promote, including individual autonomy, equality and free speech, which may have a broader impact on society as a whole. Privacy and personal data risks therefore need to be better managed to provide effective safeguards.

7.1. Privacy violations vary considerably across countries

Individuals who experienced privacy violations, as a percentage of Internet users, 2015



Note: See Chapter notes.[1]

Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD[6], *ICT Access and Usage by Households and Individuals* (database), *http://oe.cd/hhind* (accessed September 2018).

StatLink https://doi.org/10.1787/888933915411

Privacy is not only a recognised fundamental value that merits protection, but a condition for the free flow of personal data across organisations and borders, and with it data-driven innovation, economic growth and social prosperity (OECD, 2016[7]). Individuals, at home and on the job, share more personal data today than ever before – willingly, on social networks and elsewhere, but also unknowingly, through web-browsing tracking or smartphones. As a result, more than half of privacy measures across OECD countries aim to raise awareness and empower individuals (OECD, forthcoming[8]). At the same time, individuals seek more assurance and control of the way their data are handled: they want to know if and what personal data about them are collected and stored, how they are used, and whether they can delete or correct data, or control any secondary uses.

In other words, individuals want to know whom they can trust with their data. Measures to increase transparency on the purposes and uses of personal data collections and to enhance user access and control over their data are particularly relevant to trust in the digital age. Technological advances can help increase trust through "privacy by design" processes whereby privacy implications are considered at the initial design phase of a product or service rather than as an afterthought. This may enable privacy-protective approaches to be embedded or coded in technologies, or help minimise personal data collection from the start. For example, encryption can play an important role for privacy as mobile devices and the Internet of Things (IoT) expand (OECD, 2017[4]). Another response to privacy concerns may be the re-decentralisation of the web, a set of technological innovations that enable the distribution of personal data storage among Internet users themselves instead of its centralisation in a small number of companies.

While technology can play a positive role to help protect privacy and personal data, domestically there is a need for national data strategies, supported at the highest levels of government, that incorporate a whole-of-society perspective to strike the right balance between various individual and collective interests. Such strategies would provide clear direction to reap the social and economic benefits of enhanced reuse and sharing of data while addressing individuals' and organisations' concerns about the protection of privacy and personal data, and intellectual property rights. They would also facilitate interoperability of national frameworks and thus the free flow of data.

Towards interoperable privacy and data protection frameworks

While countries apply different privacy frameworks, they are largely pursuing the same outcomes, and frequently use similar approaches, as demonstrated by agreement on high-level guiding principles and good practices or legislation. The need to develop mechanisms that foster interoperability among data protection and privacy frameworks is also well-recognised (OECD, 2016[7]; OECD, 2013[9]). While interoperability provisions should be a characteristic of national privacy strategies, most countries across the OECD have yet to implement national privacy strategies (OECD, 2017[4]), and other mechanisms to ensure interoperability can be identified.

Regional convergence and harmonisation of privacy frameworks

Instruments with a harmonising effect include the recently updated Convention 108 of the Council of Europe which binds 47 Council of Europe member states and is also open to non-members. Another example is the European Union's General Data Protection Regulation (GDPR), which harmonises data protection laws of all countries in the European Economic Area. Non-binding arrangements can also encourage convergence of privacy laws and facilitate privacy-respecting data flows. The Asia-Pacific Economic Cooperation (APEC) organisation has implemented a voluntary but enforceable system of Cross-Border Privacy Rules (CBPR), through which participating APEC economies work to lift the overall standard of privacy across the region. Approaches differ: for example, the APEC CBPR system establishes baseline privacy standards without changing domestic laws, while the EU GDPR harmonises laws through a directly applicable regulation.

Recognition of "equivalency" or "adequacy" of privacy measures

National authorities responsible for data and privacy protection can certify that other countries have principles that are adequate or equivalent to the protection afforded under domestic privacy regimes. For example, Article 45 of the EU GDPR enables flows of personal data from the European Union to third-party countries that have been deemed adequate, such as Israel and New Zealand. Other types of measures include model contracts, binding corporate rules for multinationals, and certification mechanisms to enable cross-border data flows along with enforceable protections for individuals whose data are transferred. One example of the latter mechanism is the US-EU Privacy Shield, which enables participating companies to transfer data between the two economic areas after making an enforceable commitment to comply with a set of principles aligned with EU data protection requirements.

Cross-border co-operation between privacy enforcement authorities

Mutually agreed upon high-level principles, such as those in the 2011 *OECD Recommendation on Cross-border Co-operation in the Enforcement of Laws Protecting Privacy* (OECD, 2007[23]), can help ensure that privacy enforcement authorities align in safeguarding the personal information of individuals no matter where it is located. Participation in fora such as the Global Privacy Enforcement Network, which enables information sharing and co-operation and has also led to some joint initiatives, or bilateral co-operation between privacy enforcement authorities, is also useful to increasing cross-border co-operation. Ensuring the effectiveness of interoperability mechanisms also highlights the importance of co-operation and cross-border enforcement. For example, for an economy to participate in the APEC CBPR mechanism it must also commit to APEC's framework for enforcement co-operation. Other forms of co-operation can include memoranda of understanding and information-sharing agreements (Casalini and López González, 2019[8]).

Regional trade agreements

Countries are also beginning to address data flow issues in bilateral or regional trade agreements with privacy-related provisions, typically to enable cross-border data flows. For example, the United States-Mexico-Canada Agreement (Article 19.8) – which has not yet been ratified by legislatures – references the adoption or maintenance of a legal framework that provides for the protection of personal information, while mentioning that no party should restrict the cross-border transfer of information subject to limited exceptions for legitimate public policy objectives (Article 19.11) (Casalini and López González, 2019[10]).

Measures for companies and entities in countries that do not recognise each other's data protection systems

The GDPR, which includes mechanisms for multinational enterprises to implement "binding corporate rules" on all affiliates to enable transfers of data between them, even if the sub-entities are based in countries that have not forged a specific mechanism or agreement, is a practical example of how privacy rules can work for countries that do not recognise each other's data protection laws. Similarly, some privacy enforcement authorities have developed standard contractual clauses that can be used in any contract or agreement mediating transfers of data between entities in countries that do not recognise each other's data protection or privacy arrangements. However, some firms believe these clauses carry onerous obligations and can lead to high administrative costs (Casalini and López González, 2019[10]).

Manage digital security risk rather than trying to eliminate it

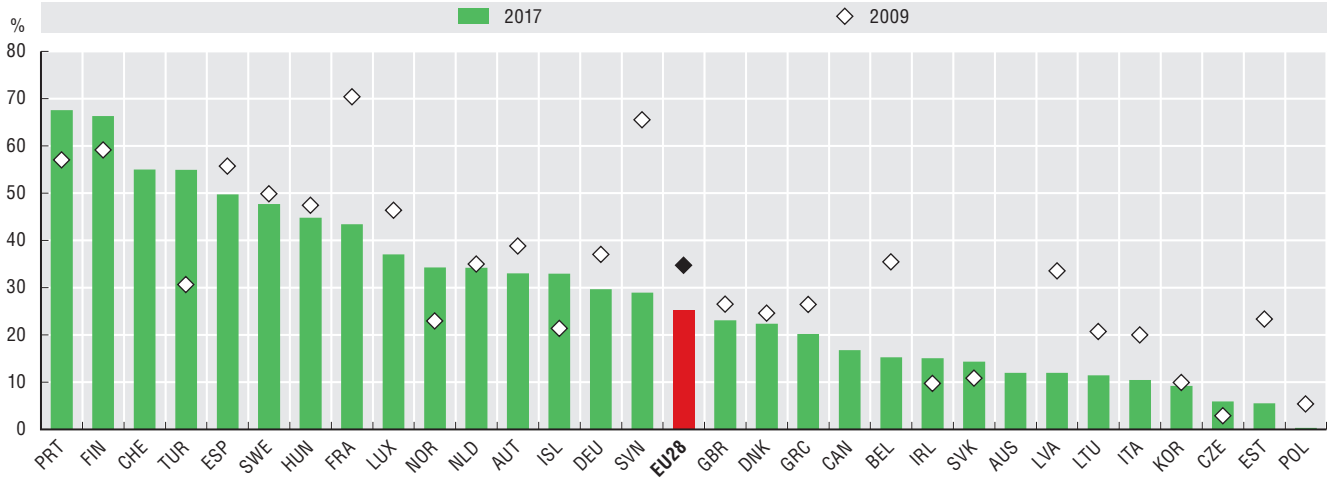
One important issue inherent to digital transformation is the need for resilience and better security to mitigate possible disruption of economic and social activities by digital security incidents. Digital security incidents take advantage of the global nature of the Internet to rapidly spread across jurisdictional, organisational and sectoral boundaries, as demonstrated by the recent Wannacry, NotPetya and Dyn attacks. Digital security incidents can disrupt the activities of all businesses, both SMEs and larger firms, governments and individuals, and generate financial and reputational harm. For example, NotPetya caused a temporary production shutdown at several global companies (e.g. Merck) which had to borrow doses of its vaccines from the US Center for Disease Control and Prevention stockpile to fulfil customer orders, reducing the company's third-quarter sales by USD 240 million (Merck, 2017[11]; Hufford and Loftus, 2017[12]).

Incidents can also cause physical damage, as demonstrated by a digital security incident that caused electricity service outages in Ukraine affecting approximatively 225 000 customers in 2015 (NCCIC, 2016[13]; Popescu and Secrieru, 2018[14]). Such incidents could evolve into large-scale crises affecting infrastructures critical to the functioning of the economy and society such as finance, energy, transport and essential government services. In addition to such catastrophic scenarios, digital security incidents can also have subtle but long-term negative effects by undermining trust in the digital environment, limiting innovation, slowing down the adoption of new technologies and hampering digital transformation and its related benefits.

The risk of digital security incidents grows as digital transformation deepens. Digital security concerns hold back almost 30% of Internet users from providing personal information to online social and professional networks (OECD, 2017[4]). Payment security and privacy concerns remain persistent in many countries, with more than half of Internet users in Portugal (68%), Finland (66%), Switzerland (55%) and Turkey (55%) reporting such concerns in 2017 (Figure 7.2). Individuals in Poland (less than 1%), Estonia (6%), the Czech Republic (6%) and Korea (9%) were the least concerned about payment security and privacy during that period.

7.2. Payment security and privacy concerns remain prevalent in many countries

Individuals who did not buy online for payment security or privacy concerns, as a percentage of Internet users who ordered goods or services over the Internet more than a year ago or who never did, 2017



Note: See Chapter notes.[2]

Source: OECD calculations based on Eurostat[15], *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database*; national sources (accessed December 2018).

StatLink https://doi.org/10.1787/888933914917

Given that it is impossible to create an entirely safe and secure digital environment, businesses, other organisations and individuals always take some security risk when deciding to go digital. They should be thus encouraged to understand how to manage risk in a manner that does not reduce the economic and social opportunities of using digital technologies. This can include, for example, the implementation

of security standards (e.g. ISO 27000 series) to increase resilience and maintain business continuity by mitigating the consequences of potential security incidents. Because all stakeholders are interdependent in the digital environment, as well as across borders, it is key to foster partnerships among them to help reduce risk and promote good risk management practices, in particular through information sharing about threats, vulnerabilities, incidents and risk management practices, including for SMEs.

Public policies to foster digital security can play an important role in creating the conditions for organisations to adopt digital security risk management frameworks, for firms to develop less vulnerable and more secure technologies, and for individuals to better understand risks and use digital devices more responsibly. Public policies can also address the growing digital security skills shortage affecting both technical security experts and business managers, encourage digital security innovation and help foster a vibrant digital security industry. Cyber insurance can be an important element of managing risk by enabling the transfer of some digital security risk and creating incentives for better risk management practices.

Digital security and resilience of critical infrastructure and services that are essential for the functioning of our economies and societies are a particularly important aspect of digital security policy, at the crossroads of economic prosperity and national security. Digital transformation significantly increases the interdependencies and complexity of these crucial systems, and the risk of systemic failures cascading across sectors and borders. Governments must adopt policies to support and encourage critical infrastructure and services operators to strengthen their digital security. In doing so, they need to enable them to make the most of digital transformation, including through the adoption of technologies such as IoT, artificial intelligence, big data and blockchain, and to take into account existing sector-specific market, regulatory and cultural specificities. While critical infrastructure and essential services often rely on large and often private sector operators, digital transformation also empowers SMEs to take part in essential services' value chains (OECD, forthcoming[16]).

One important challenge of digital transformation across the finance, energy and transportation sectors is the increasing role taken on by smaller actors such as SMEs, which extends digital security risks beyond the realm of large central players such as banks or electricity companies. Such SMEs include start-ups offering innovative payment systems, blockchain-based energy trading technologies or mobility services in the area of transport. Besides start-ups, well-established SMEs involved in providing essential services play an increasingly important role in managing digital security risk to mitigate risks to larger firms in their value chains.

Digital security is a multifaceted policy area that includes issues related to economic and social prosperity, technology and criminal law enforcement, as well as national and international security. From the economic and social perspective, digital security risk has traditionally been approached as a technical problem calling for technical solutions, but the changing nature and scale of digital security risk is driving governments to re-evaluate their strategies in order to call for a cultural change in this area.

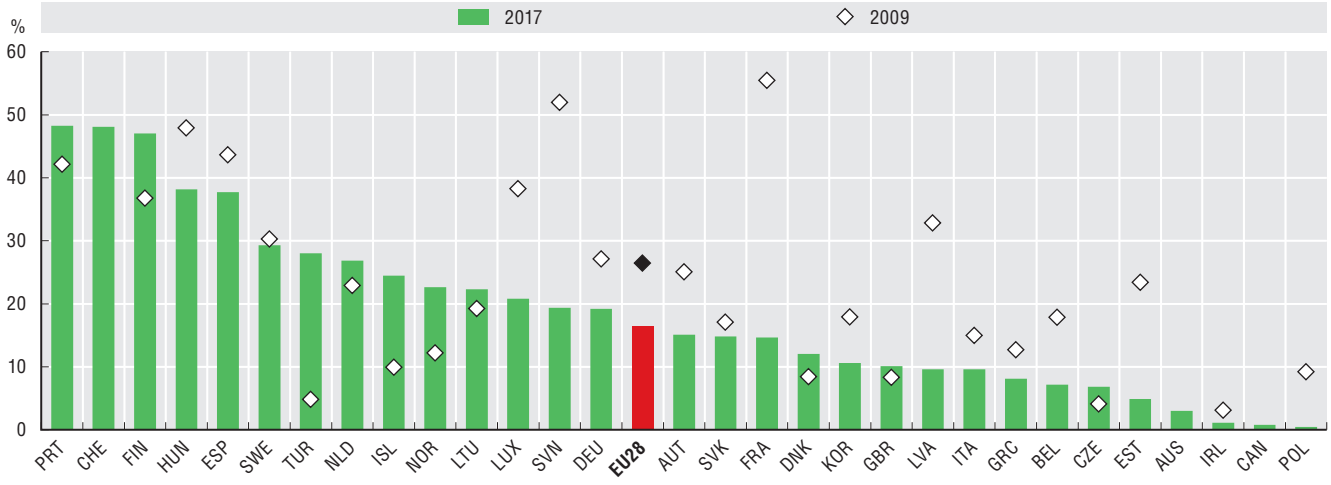
Protect consumers as the online and offline worlds converge

Protecting consumers in the digital environment is another essential aspect of ensuring trust, whether in e-commerce or in the use of new technologies like IoT (see Box 7.2). It opens up possibilities for new customers and markets, bringing broader economic benefits as well. Establishing a flourishing e-commerce marketplace requires more than broadband infrastructure, hosting and payment facilities, and specialised software. It requires a willingness on the part of consumers to overcome doubts about transacting at a distance where goods cannot be examined in advance, fears about the risks of entering payment details online, and concerns about whether there can be remedies or redress or if something goes wrong.

While consumer protection concerns about receiving or returning goods, complaint or redress have on average decreased over the past decade, they still remain important (Figure 7.3). Such concerns were the highest in Portugal (48%), Switzerland (48%), Finland (47%) and Hungary (38%). In contrast, less than 1% of Internet users in Poland and Canada shared these consumer protection concerns, which were also low in Ireland (1%) and Australia (3%).

7.3. Goods ordered online still raise consumer protection concerns for many people

Individuals who did not buy online due to concerns about receiving or returning goods, complaint or redress, as a percentage of Internet users who ordered goods or services over the Internet more than a year ago or who never did, 2017



Note: See Chapter notes.[3]

Source: OECD calculations based on Eurostat[15], *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database*; national sources (accessed December 2018).

StatLink https://doi.org/10.1787/888933914936

Concerns have also been raised over a growing range of non-compliant and unsafe products, which are available for sale online domestically and internationally, while being prohibited from sale or recalled from the market. As part of its annual global awareness campaigns on consumer product safety, in 2018 the OECD conducted an awareness campaign on the safety of products sold online[4] aiming to inform online platforms, online sellers and consumers about ways to identify product safety risks and navigate product safety regulations across jurisdictions.

It is important to effectively protect consumers engaged in e-commerce and other online activities for the digital economy to flourish. Transactions involving digital content and blurred boundaries between consumers and businesses can also complicate traditional ideas of ownership, liability, rights and obligations. Key challenges relate to information disclosure, misleading and unfair commercial practices, confirmation and payment, fraud and identity theft, product safety, and dispute resolution and redress.

For example, consumers increasingly acquire "free" goods and services in exchange for their personal data through non-monetary transactions, which can challenge traditional mechanisms of consumer dispute resolution (OECD, 2016[17]). Similarly, novel forms of asset and content usage, including through rental, asset-sharing and subscription services, pose challenges for consumer understanding of their rights and obligations (Box 7.2). Limitations on the functionality and interoperability of digital products are likewise often not made clear. Similarly, pricing practices can be problematic for consumers, for example when businesses fail to disclose all elements of the price up front ("drip pricing") or use misleading reference prices to exploit consumers' behavioural biases.

7.2. Trust in peer platform markets

Peer-to-peer transactions have long played a role in commerce, but online platforms enable them on a much greater scale. Early examples include platforms for the sale of goods (e.g. online auction sites). Newer models cover accommodation, transport and mobility services. Other areas being transformed by these platforms involve small jobs, meal services and financial services. These business models are often described as the "sharing" economy or "collaborative consumption", but those terms do not well capture the commercial exchange dimension that is commonplace in these markets.

7.2. Trust in peer platform markets *(cont.)*

These business models open up economic opportunities for the individuals supplying the goods or services ("peer providers") and for the platforms making the connections ("peer platforms"). Consumers can encounter issues of trust in their use of peer platforms in many different contexts: trust in the reliability and qualifications of the peer provider; trust in the asset or service; and trust in the guarantees and safeguards offered by the peer platform. Terms and conditions, for example, may not always suffice to communicate important information to consumers, as only 17% of people read terms and conditions of peer platforms (such as Airbnb and BlaBlaCar) in full.

Platforms have developed a number of practical, innovative mechanisms to address concerns and barriers to consumer engagement. The most notable trust mechanisms are review and reputation systems. Others include guarantees or insurance; verified identities; pre-screening; secure payment systems; and education, checklists and forms (OECD, 2016[18]).

To understand better the drivers of consumer trust in peer platform markets, the OECD conducted an online survey of 10 000 consumers across ten OECD member countries (OECD, 2017[19]). Survey findings include the fact that consumers generally trust peer platform markets, often more so than conventional businesses in the same market. The survey shows that at least 30% of consumers who went ahead with a purchase despite being unsure whether to trust the seller did so because they trusted the platform (Figure 7.4).

7.4. Consumers tend to trust peer platforms

Reasons for purchasing on a peer platform despite being unsure whether to trust the seller/provider, as a percentage of all purchasers on a peer platform who went ahead with purchase while unsure of seller/provider, 2017

Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD (2017[19]), "Trust in peer platform markets: Consumer survey findings", *https://dx.doi.org/10.1787/1a893b58-en*.

StatLink https://doi.org/10.1787/888933915430

Although there is no single key to trust, secure payment, data security and the ability to see pictures of goods and services are the top drivers. Strangely, however, peer platform market consumers do not always read the platforms' terms and conditions or the privacy policies in detail, despite claiming that the privacy and security of their data are important to them. This factor does not, however, appear to significantly undermine consumers' trust that these platforms are using their personal data responsibly, especially when they compare peer platform markets to other types of online businesses.

Source: OECD (2017[19]) "Trust in peer platform markets: Consumer survey findings", *https://dx.doi.org/10.1787/1a893b58-en*.

In financial markets, individuals (notably groups with low levels of digital literacy) will need new skills and knowledge to be able to use new digital products and services effectively, and understand the potential ramifications of sharing data with institutions. Further, as consumers increasingly rely on automated processes and non-human support (e.g. robo-advice, chatbots), governance and controls must be put in place to ensure financial consumer protection, as they are in the offline world.

Increasingly, frictionless transactions also reinforce pre-existing offline questions with respect to the degree to which consumers understand the terms and the nature of the transactions being made, an issue even more important as more digital activities are undertaken on mobile phones.

7.3. Consumers and the Internet of Things

Consumers purchase and interact with a growing range of connected devices in their homes and everyday life, which are part of the IoT. These include wearables (such as fitness activity trackers, smart watches and glasses), smart home devices and appliances (such as smart locks and thermostats that can inform consumers of their energy usage and patterns), connected toys and childcare equipment.

Convenience, customisation and the ability to remotely control connected devices via a smartphone are among the many IoT benefits which consumers enjoy (OECD, 2018[20]). In addition, the market is expected to revolutionise the way product design, manufacturing and delivery processes are improved over time, and to bring a number of product safety benefits. For example, connected devices like smart thermostats or smoke alarms can be remotely monitored and updated or disabled to manage product safety risks (including recalls) that emerge after installation (OECD, 2018[21]; OECD, 2018[22]).

Despite its promise, the IoT raises risks and challenges, which may affect trust in this emerging market. For example, software updates may introduce new problems to IoT products, or raise compliance issues. Digital security risks and vulnerabilities can also affect the safety of connected products. The complexity of IoT supply chains can create uncertainties about who is liable for consumer harms caused by a connected product and raise broader questions about whether consumer protection and product safety frameworks may need to be adapted to address such challenges.

Overall, to strengthen trust it is crucial to establish risk management as a common reference framework to develop coherent policies to enhance trust, involving the policy communities around digital security, privacy, consumer protection and product safety. In particular, policy makers should consider interrelations between digital risks in each of the areas. For example, a digital security incident where consumer data are stolen to commit fraud can violate privacy and consumer rights. Such interrelations underscore the importance of co-ordinating policies among these areas as a basis of a more comprehensive approach to trust in the digital era.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 7.1: Except otherwise stated, Internet users are defined as individuals who accessed the Internet within the last 12 months. For Chile, data refer to 2014. For Costa Rica, data refer to individuals aged 18-74 instead of 16-74. For Korea, data refer to 2017 and include both private and business-related purposes. For Mexico, data refer to 2017 instead of 2015. From 2015 onwards, information was collected through an independent thematic survey, unlike previous years during which information was obtained through a module administered in various surveys. This methodological change must be taken into account when comparing data prior to 2015. In 2017, data refer to the following response item: "Fraud with information (financial, personal, etc.)". For Switzerland, data refer to 2014 instead of 2015. In 2014, data relate to individuals "Having experienced a security problem within the last 12 months".
2. Figure 7.2: For Australia, data refer to the fiscal year 2012/13 ending on 30 June 2013. For Canada, data refer to 2012. For countries included in the European Statistical System, in 2017 "Payment security and privacy concerns" does not include "privacy concerns".
3. Figure 7.3: For Australia, data refer to the fiscal year 2012/13 ending on 30 June 2013. For Canada, data refer to 2012.
4. *http://oe.cd/safe-products-online*.

References

Casalini, F. and J. López González (2019), "Trade and Cross-Border Data Flows", *OECD Trade Policy Papers*, No. 220, OECD Publishing, Paris, *https://doi.org/10.1787/b2023a47-en*. [10]

Eurostat (2018), *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed December 2018). [15]

Hufford, A. and P. Loftus (2017), *Merck Swings to Loss as Cyberattack Hurts Sales*, *https://www.wsj.com/articles/merck-swings-to-loss-as-cyberattack-hurts-sales-1509107269*. [12]

Mayer, R., J. Davis and D. Schoorman (1995), "An integrative model of organizational trust", *The Academy of Management Review*, Vol. 20, No. 3, pp. 709-734, *http://www.jstor.org/stable/258792*. [3]

Merck (2017), *Merck Announces Second-quarter 2017 Financial Results*, press release, 28 July, *https://www.mrknewsroom.com/news-release/corporate-news/merck-announces-second-quarter-2017-financial-results* (accessed 21 February 2019). [11]

Murtin, F. et al. (2018), "Trust and its determinants: Evidence from the Trustlab experiment", *OECD Statistics Working Papers*, No. 2018/2, OECD Publishing, Paris, *https://dx.doi.org/10.1787/869ef2ec-en*. [2]

NCCIC (2016), *Cyber-attack against Ukrainian Critical Infrastructure*, *https://ics-cert.us-cert.gov/alerts/IR-ALERT-H-16-056-01* (accessed 21 February 2019). [13]

OECD (2019), "ICT Access and Usage by Households and Individuals", *OECD Telecommunications and Internet Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/b9823565-en*. (accessed 28 January 2019) [6]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [5]

OECD (2018), "Consumer policy and the smart home", *OECD Digital Economy Papers*, No. 268, OECD Publishing, Paris, *https://dx.doi.org/10.1787/e124c34a-en*. [20]

OECD (2018), "Consumer product safety in the Internet of Things", *OECD Digital Economy Papers*, No. 267, OECD Publishing, Paris, *https://dx.doi.org/10.1787/7c45fa66-en*. [21]

OECD (2018), "Enhancing product recall effectiveness globally: OECD background report", *OECD Science, Technology and Industry Policy Papers*, No. 58, OECD Publishing, Paris, *https://dx.doi.org/10.1787/ef71935c-en*. [22]

OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264276284-en*. [4]

OECD (2017), *OECD Guidelines on Measuring Trust*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264278219-en*. [1]

OECD (2017), "Trust in peer platform markets: Consumer survey findings", *OECD Digital Economy Papers*, No. 263, OECD Publishing, Paris, *https://dx.doi.org/10.1787/1a893b58-en*. [19]

OECD (2016), *OECD Recommendation of the Council on Consumer Protection in E-Commerce*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264255258-en*. [17]

OECD (2016), "Protecting Consumers In Peer Platform Markets: Exploring The Issues", No. 253, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlwvz39m1zw-en*. [18]

OECD (2016), *The OECD Ministerial Declaration on the Digital Economy: Innovation, Growth and Social Prosperity*, OECD, Paris, *https://www.oecd.org/internet/Digital-Economy-Ministerial-Declaration-2016.pdf*. [7]

OECD (2013), *Recommendation of the Council Concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data*, OECD, Paris, *http://www.oecd.org/sti/ieconomy/2013-oecd-privacy-guidelines.pdf*. [9]

OECD (2007), *OECD Recommendation on Cross-border Co-operation in the Enforcement of Laws Protecting Privacy*, OECD, Paris, *http://www.oecd.org/internet/ieconomy/38770483.pdf*. [23]

OECD (forthcoming), "Digital security and resilience in critical infrastructure and essential services", *OECD Digital Economy Papers*, OECD Publishing, Paris. [16]

OECD (forthcoming), "Towards national privacy strategies", *OECD Digital Economy Policy Papers*, OECD Publishing, Paris. [8]

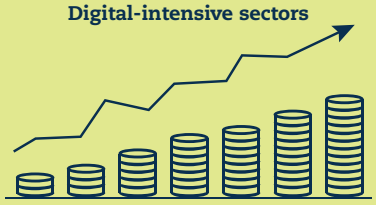
Popescu, N. and S. Secrieru (2018), "Hacks, leaks and disruptions: Russian cyber strategies", *Chaillot Paper* No. 148, *https://www.iss.europa.eu/sites/default/files/EUISSFiles/CP_148.pdf*. [14]

Chapter 8

FOSTERING MARKET OPENNESS

Firms in the most **digital-intensive sectors** enjoy a 55% **higher mark-up** than firms in less digital-intensive sectors.

Digital-intensive sectors

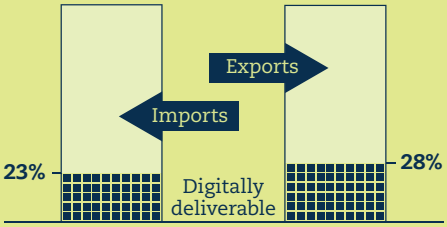


Strengthen competition for firms in all sectors to benefit from digital opportunities.

MARKET OPENNESS

Digitally deliverable services make up about a **quarter of total services trade**.

Total services trade



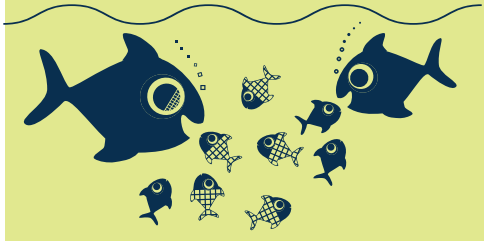
Encourage the spread of digital technologies and cross-border data flows to boost trade.

45% of EU firms undertook **cross-border e-commerce sales** in 2016, up from 42% in 2010.

Facilitate cross-border e-commerce to push out the trade frontier.

Cross-border acquisitions of **digital-intensive firms** grew by **20 percentage points more** than those in other sectors over 2007-15.

Mergers & acquisitions



Consider industry concentration when reviewing M&As, especially of digital-intensive firms.

FOSTERING MARKET OPENNESS: WHAT MATTERS MOST FOR POLICY?

Prepare for digital technologies to continue reshaping international trade

- E-commerce is expanding across borders, with 45% of EU firms having undertaken cross-border e-commerce sales in 2016, up from 42% in 2010.
- Trade restrictions on services that enable digital delivery primarily take the form of measures that affect infrastructure and connectivity (e.g. inefficient regulations on interconnection).
- As digital technologies affect international trade, market openness policies must be holistic. Multi-stakeholder dialogue to ensure interoperability across regulatory regimes, including for cross-border data flows and related privacy and security considerations, is needed.

Reduce barriers to investment and promote open financial markets

- Investment regimes that mobilise investment in communications infrastructures, digital technologies and knowledge-based capital (KBC) (e.g. business models, software, data), coupled with open financial markets, drive inclusive growth.

Monitor changing competitive dynamics

- Global acquisitions of digital-intensive firms grew by more than 40% over 2007-15, compared to 20% growth for acquisitions in less digital-intensive sectors. Firms in the most digital-intensive sectors enjoy a 55% higher mark-up than firms operating in less digital-intensive sectors. Competition authorities should consider these and related trends when assessing dominance.
- Digital technologies and data lead to greater competition in many markets, but can tilt others towards greater concentration, market power and dominance. Competition authorities must be prepared with flexible tools and co-operate across borders to address transnational competition issues.

Address tax challenges arising from the digitalisation of the economy

- Ensuring that tax systems are fit-for-purpose in the digital age requires continued international co-operation towards a consensus-based, global solution.

Digital technologies are transforming the environment in which firms compete, trade and invest. Market openness enables digitalisation to flourish by creating a business-friendly environment that allows foreign and domestic firms to compete on an equal footing and without excessive restrictions or burdensome conditions (OECD, 2010[1]). Open trade and investment regimes can create new avenues to rapidly upgrade technologies and skills, and increase specialisation, as frontier technologies, applications and processes diffuse through open markets (Andrews, Criscuolo and Gal, 2015[2]). Market openness also fosters competition and helps firms, domestic and foreign, reap the benefits of trade and investment, contributing to economic growth (Romalis, 2007[3]).

Prepare for digital technologies to continue reshaping international trade

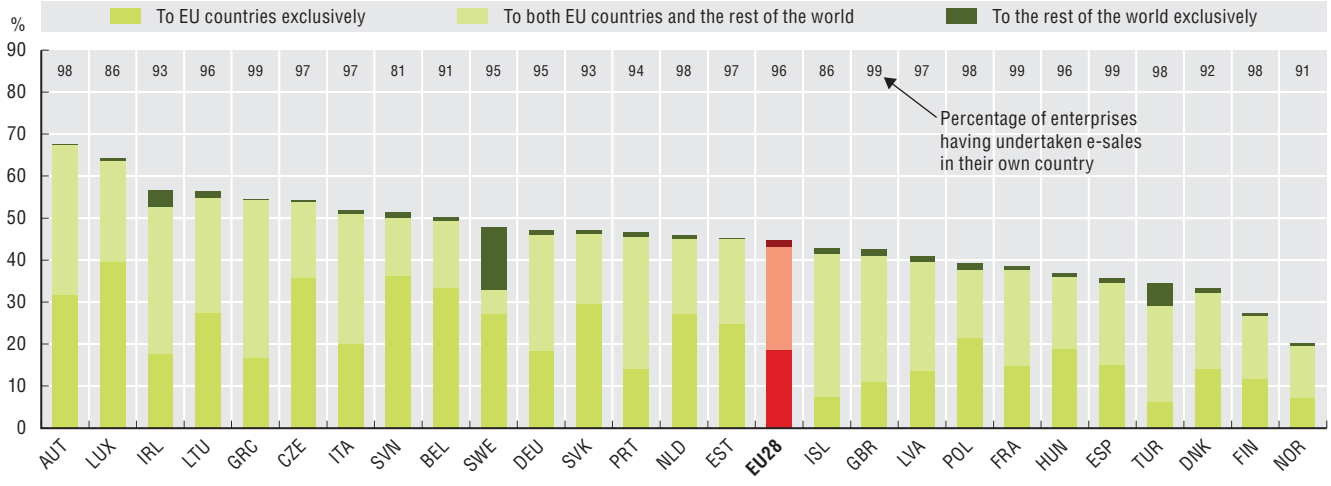
Digital technologies and data profoundly impact international trade by reducing trade costs; facilitating the co-ordination of global value chains (GVCs); diffusing ideas and technologies across borders; and connecting greater numbers of businesses and consumers globally, all of which push out the trade frontier. New technologies and an open, non-fragmented Internet ecosystem are potentially creating new opportunities for trade, enabling new value chains with new players and new business models, and spurring innovation.

Innovative business models that use digital technologies and services like digital matching services, logistical support and secure online payment systems are providing solutions that enable firms to sell their products online and in new markets (OECD, forthcoming[4]). For instance, online platforms have lowered barriers to entry for firms to trade, including by allowing smaller firms to pay for and use the platform's logistics and customer service infrastructure to sell in global markets. Other digital-intensive firms combine their online services with local or offline activities to profitably sell new types of products globally (OECD, forthcoming[4]). This can also affect outsourcing and offshoring dynamics.

As digital transformation has accelerated, the cross-border e-commerce landscape, a key component of digital trade, has become increasingly dynamic. E-commerce transactions are progressively taking place across borders, with 45% of EU firms having undertaken cross-border e-commerce sales in 2016, up from 42% in 2010 (Figure 8.1). But there are differences across countries, which underscores the importance of better understanding the drivers of e-commerce, and digital trade more specifically, in view of boosting growth and consumer welfare.

8.1. E-commerce is expanding across borders

Enterprises having undertaken cross-border e-commerce sales, as a percentage of all enterprises having undertaken e-commerce sales, 2016



Notes: StatLink contains more data. See Chapter notes.[1]

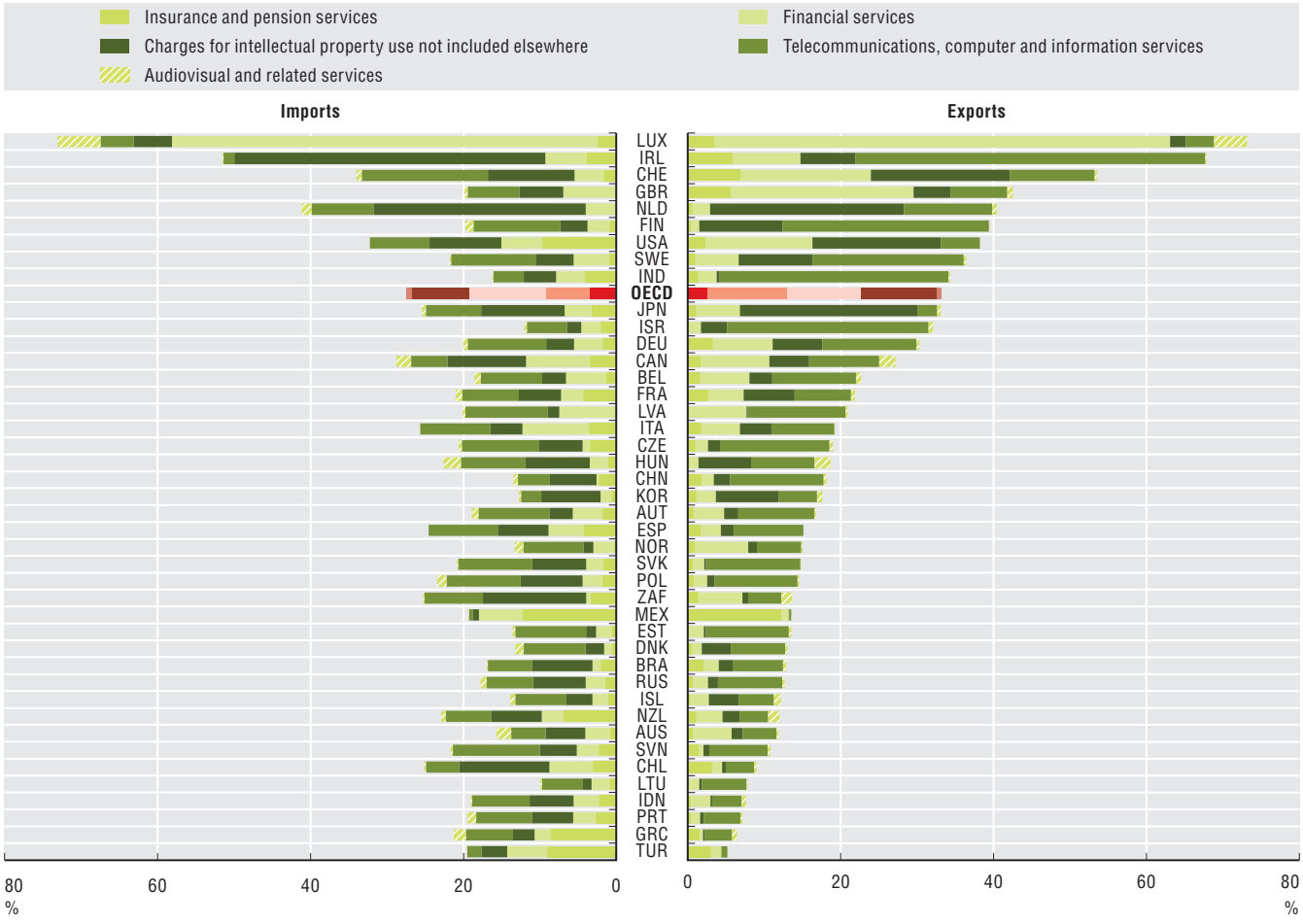
Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on Eurostat[6], *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed September 2018).

StatLink *https://doi.org/10.1787/888933915449*

Digitalisation has allowed trade to take place through digital means entirely, increasing exports of digitally deliverable services, and enabled more traditional trade, especially in more complex manufactures but also in agricultural goods (López González and Ferencz, 2018[7]). Across the OECD, trade in digitally deliverable services represents 23% of total services imports and 28% of total services exports (Figure 8.2).

8.2. Trade is strong in digitally deliverable services

Trade in predominantly digitally deliverable services, as a percentage of total services exports and imports respectively, 2017



Notes: StatLink contains more data. See Chapter notes.[2]

Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD calculations based on OECD, *International Trade in Service Statistics* (database), *http://www.oecd.org/sdd/its/international-trade-in-services-statistics.htm*; EBOPS 2010, *https://www.oecd.org/sdd/its/EBOPS-2010.pdf*; WTO, *Trade in Commercial Services* (database), *https://www.wto.org/english/res_e/statis_e/tradeserv_stat_e.htm* (accessed October 2018).

StatLink https://doi.org/10.1787/888933915468

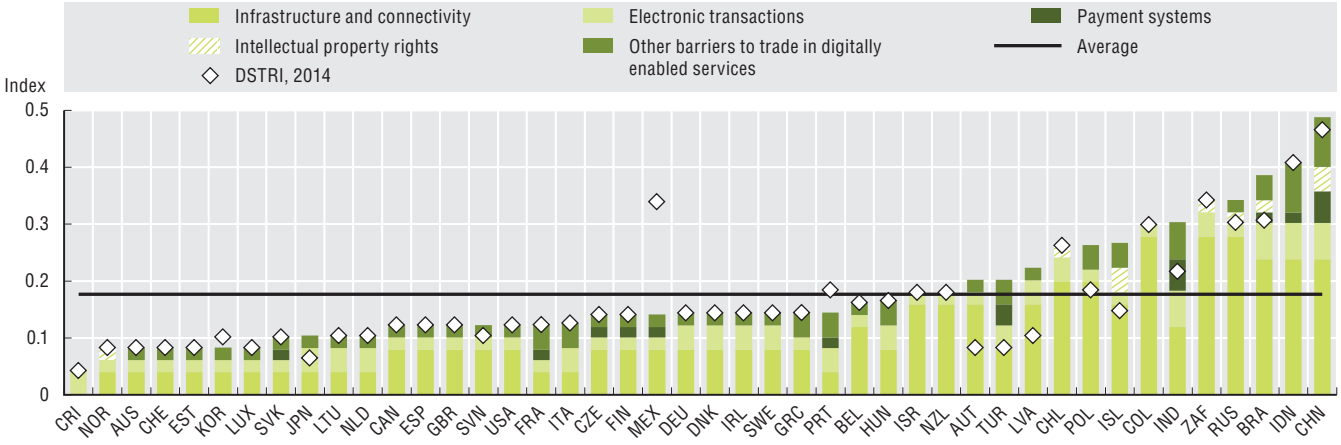
Digital transformation has not only changed how we trade but also what we trade: a larger number of smaller and low-value packages of physical goods, as well as digital services, are now crossing borders; goods are increasingly bundled with services; and new and previously non-tradable services are now being traded across borders. The rise of services in international cross-border trade is closely linked to rapid technological developments. Services that traditionally required close proximity to customers now can be traded at a distance, allowing firms to reach global markets at lower costs.

Yet services regulations remain fragmented by borders, and regulatory frictions create trade costs for services providers, particularly for small and medium-sized enterprises (SMEs). As a result, the benefits of digital technologies may be diminished by existing and emerging trade barriers that hold back innovation and create obstacles to the movement of services that enable digital delivery across borders.

Recent data suggest that trade restrictions on services that enable digital delivery are primarily due to measures that affect infrastructure and connectivity (e.g. inefficient regulations on interconnection and restrictions on cross-border data flows beyond those imposed to ensure the protection and security of personal data) (Figure 8.3). Other measures restricting trade in such services include restrictions on electronic transactions (e.g. discriminatory measures affecting licenses for e-commerce) and payment systems (restrictions on electronic signatures), among others.

8.3. Measures restricting trade in services that enable digital delivery are primarily related to infrastructure and connectivity

OECD Digital Services Trade Restrictiveness Index, 2018



Notes: The Digital Services Trade Restrictiveness indices take values between zero and one, with one being the most restrictive. StatLink contains more data. See Chapter notes.[3]

Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *STRI* (database), *http://oe.cd/stri-db* (accessed December 2018).

StatLink https://doi.org/10.1787/888933915487

8.1. What is digital trade?

Digital trade transactions, be they in relation to goods or services, have been part of the landscape for many years and often raise the same, or similar, issues as non-digital transactions. This is because digital trade is not just about digitally deliverable services, but also about more traditional – including supply-chain – trade enabled by growing digital connectivity. What is new in digital trade is the scale of transactions and the emergence of new (and disruptive) players transforming production processes and industries, including many that were previously little affected by globalisation.

While all digital trade is enabled digitally, not all digital trade is digitally delivered. Digital trade also involves digitally enabled but physically delivered goods and services (such as a purchase of a good on an online marketplace or the booking of a hotel through a matching service).

While there is no single recognised and accepted definition of digital trade, there is a growing consensus that it encompasses digitally enabled transactions in trade in goods and services, whether digitally or physically delivered. This characterisation, drawing on the OECD's (OECD, 2011[8]) and the World Trade Organization's (WTO, 1998[9]) definition of an e-commerce transaction, lends itself to decomposing the digital trading environment into a number of distinct categories of transactions each of which raises different questions for trade and investment policy as well as for measurement.

Source: López González and Ferencz (2018[7]), "Digital trade and market openness", *https://doi.org/10.1787/1bd89c9a-en*.

While digital trade was introduced into the World Trade Organization (WTO) as early as 1998 through the work programme on e-commerce (WTO, 1998[9]), progress has been slow apart from a temporary moratorium on imposing customs duties on electronic transmissions. At the 11th Ministerial Conference

in Buenos Aires in 2017, WTO members agreed to "maintain the current practice of not imposing customs duties on electronic transmissions" until the next ministerial (WTO, 2017[10]). A group of 71 members further agreed to "initiate exploratory work together towards future WTO negotiations on trade-related aspects of electronic commerce" (WTO, 2017[11]).

Existing multilateral trade rules were negotiated when digital trade was in its infancy and, even if conceived to be technologically neutral, questions have arisen as to whether they might require clarifications to reflect new forms of, and issues raised by, digital trade. For example, trade rules are traditionally predicated on identifying whether products are goods or services and the borders they cross, but new business models and the global nature of the Internet blur these distinctions. Firms can flexibly service markets from different locations and the products they sell bundle goods with services (such as a fitbit or a smart speaker). This makes it increasingly difficult to identify the particular trade rules that apply to specific transactions (López González and Ferencz, 2018[7]).

Market openness therefore needs to be approached more holistically. For example, Internet access may be a necessary but not sufficient condition for digitally enabled trade in goods to flourish. If logistics services in the receiving (or delivering) country are costly due to service trade restrictions increasing prices, or if goods are held up at the border by cumbersome procedures, then the benefits of digital transformation may not materialise. Platform-enabled trade transactions might be curtailed or might not take place at all.

The nature of the measures that affect how modern firms engage in digital trade is changing – some relate to accessing and using digital networks or supporting digital services; others are old trade issues with new consequences; and some are new measures which raise new issues. For instance, digital trade can change or amplify the importance of "old" issues. Trade in low-value goods ordered online is still subject to traditional physical connectivity constraints. However, since trade costs can represent a sizeable share of the value of small consignments, how fast and at what cost a physical good can clear customs is especially important. At the same time, growing trade in digitally ordered parcels poses new challenges for customs authorities and other border agencies, from workload to adapting clearance and risk management processes, to revenue issues related to tariffs or the collection of value-added tax.

Cross-border data flows support trade transactions. They underpin trade by enabling control and co-ordination along GVCs, or by enabling implementation of trade facilitation measures. Reaping the benefits of digital trade requires multi-stakeholder dialogue on regulatory approaches that ensure the interoperability of differing regulatory regimes, particularly for transversal issues such as cross-border data flows (see Chapter 7). On the one hand, emerging measures impacting cross-border data flows raise concerns for business activity and the ability to benefit from digital trade; on the other hand, important public policy objectives, such as the protection of privacy, security and intellectual property rights, must be taken into account. The challenge is to address public policy objectives in a manner that is not arbitrary or discriminatory so as to preserve the significant economic and trade benefits flowing from data-enabled trade. To support this dialogue one important step will be to better understand the nature and composition of data flows which are highly heterogeneous, as well as the scope of the public policy objectives being pursued.

Trade agreements – multilateral, plurilateral and bilateral – offer some useful insights into managing exchanges across countries with different standards, reflecting different cultural and political contexts. In trade agreements, and as reflected in market openness principles, combining the benefits of trade with countries' right to regulate has rested on principles that: 1) standards are transparent; 2) these standards are applied to everyone in the same way (i.e. that they are non-discriminatory); and 3) in achieving their legitimate public policy objectives, countries do not use measures that restrict trade more than is necessary to achieve the objective.

Reduce barriers to investment and promote open financial markets

Investment regimes that mobilise private investment in communications infrastructures, technologies and KBC (e.g. business models, software, data), coupled with open financial markets, attract foreign direct investment (FDI) and underpin digital transformation as a driver of inclusive growth. They also

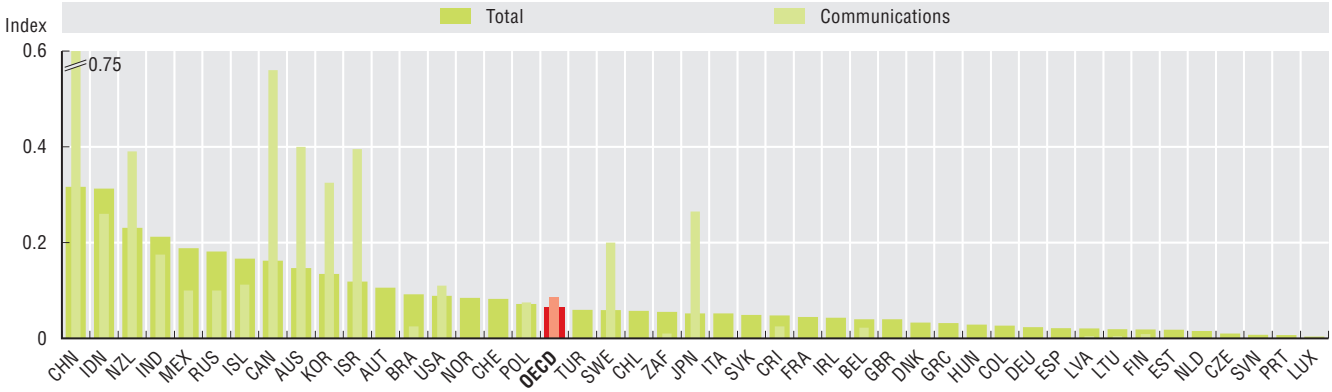
help channel resources to more productive uses and, through competitive pressure and the discipline imposed by shareholders and creditors, ensure that all firms strive to improve their efficiency and allow inefficient firms to exit (OECD, 2015[12]).

Reducing barriers to international investment is thus important to supporting the broader digital transformation. The OECD FDI Regulatory Restrictiveness Index (RRI) measures statutory barriers to foreign investment in a range of countries. While it focuses on regulatory barriers to FDI on the books, and not at how rules are implemented, it provides a useful – albeit partial – indication of how global policy trends are affecting foreign investment (Thomsen and Mistura, 2017[13]). Over time and across countries, policies have tended to move towards greater openness for foreign investors (Thomsen and Mistura, 2017[13]).

Overall, FDI restrictiveness still varies greatly across countries and regions (Figure 8.4). Both OECD and non-OECD countries in the Asia-Pacific region tend to have higher FDI RRI scores, with a greater propensity to screen inward investment and more frequent use of foreign equity limits at a sectoral level. EU countries show relatively fewer restrictions and large countries – with their big domestic markets – can afford to impose more and broader restrictions than smaller countries. Across the OECD, the communications component of the RRI is higher (more restrictive) than the average RRI score.

8.4. Barriers to FDI vary across countries

OECD FDI RRI, 2017



Notes: The FDI RRI take values between zero and one, with one being the most restrictive. StatLink contains more data. See Chapter notes.[4]

Source: OECD (2019[5]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *FDI Regulatory Restrictiveness Index* (database), *http://www.oecd.org/investment/fdiindex.htm* (accessed December 2018).

StatLink *https://doi.org/10.1787/888933915506*

In addition, multinational enterprises – which by definition operate across borders – can make extensive use of digital technologies and data to organise their business operations and improve processes and procedures (see Chapter 3). Use of such technologies also promotes market-based international technology transfer, although knowledge-related spillovers from FDI vary across sectors, with services sectors enjoying the strongest productivity-enhancing effects of FDI (Lesher and Miroudot, 2008[14]).

Intensive use of digital technologies and data may also impact a firm's decision of whether to export or establish a local presence insofar that exporting may become more attractive if products are relatively easily delivered digitally (UNCTAD, 2017[15]). Moreover, as digital technologies have helped support the spread of GVCs (De Backer and Flaig, 2017[16]), the infrastructures and services needed to support GVCs may become a new variable in a firm's decision of whether and where to invest (Gestrin and Staudt, 2018[17]).

Investment regimes also need to facilitate investment in KBC – such as business models, software, data, intellectual property, economic competences (e.g. firm-specific skills such as management, brand management, new organisational processes and structures) and skills (see Chapters 3 and 4). Such investment is now larger than investment in machinery and equipment in many OECD countries (OECD, 2017[18]). Business investment in KBC not only helps boost both growth and productivity (OECD, 2013[19]), but it also supports the broader digital transformation by promoting market innovation.

Open financial markets facilitate investment

Efficient, stable and open financial markets, based on high levels of transparency, confidence and integrity, help allocate financial resources to firms investing in digital transformation. Open financial markets also ensure that domestic financial services firms remain competitive in the face of foreign competition. Increased competition should make domestic firms more efficient and transparent. Financial flows can lower the cost of capital for firms in countries in which capital is scarce, which in turn can raise investment in digital technologies and data.

Regulatory frameworks that are sector-based (e.g. bank-focused) can present barriers for more targeted services (e.g. payments) to enter the market. Regulators and supervisors need to build capacity to align to the objective of promoting safe and beneficial digitalisation of financial services. In this respect, inter-sectoral and international regulatory co-operation is needed for consistent regulation and information sharing.

Digital technologies also underpin new forms of external funding, the most prominent of which is crowdfunding, whereby external finance is raised through online platforms from a relatively larger pool investors. Although it still represents a minor share of all business financing (and serves to finance specific projects rather than enterprises as a whole), crowdfunding may play a growing role, including for the financing of innovative ventures, as online interactions with large numbers of customers may help entrepreneurs to validate untested products. In addition, venture capital investors, business angels and institutional investors are increasingly finding investment opportunities through crowdfunding platforms, usually through the largest and more developed platforms (see Chapter 4) (OECD, 2017[20]).

Monitor changing competitive dynamics

Strengthening competition, including by opening access to markets, benefits consumers through lower prices and a greater variety of goods and services, and supports trade and investment. Competitive markets also underpin digital transformation by spurring innovation, new business models, business dynamism and productivity, driving structural change across the economy.

Digital transformation promotes greater competition in a large variety of product and service markets, both domestically and internationally. In the digital age, geographic market boundaries matter less because the Internet has facilitated the entry and growth of digitally based suppliers and retailers (e.g. Amazon, Rakuten, Alibaba) that do not need to have a physical presence in all markets in which they sell, which has helped increase competition and expand GVCs. In turn, digitally enabled business models have increased competitive pressure on offline incumbents.

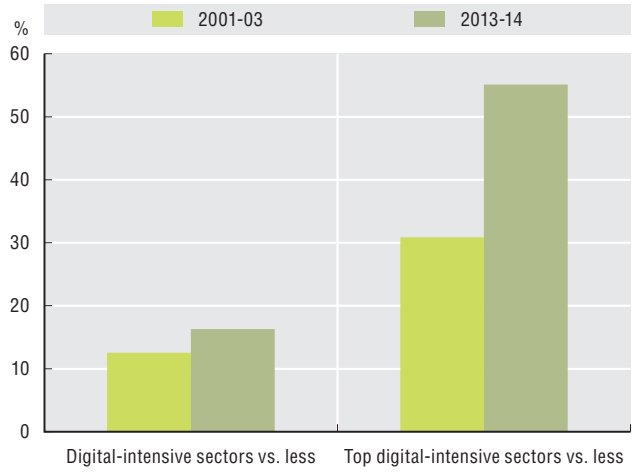
Digital technologies enable new types of products and services to compete with existing ones (e.g. services that stream television content over the Internet versus cable and satellite TV providers, online-only publications versus traditional print media, etc). In some cases, these new products and services have greatly reduced prices (e.g. financial and brokerage services) and improved services (e.g. movie rentals). Occasionally, digital technologies and data have helped to make possible new products and services that disrupt well-established markets (e.g. film cameras replaced by digital cameras, digital cameras supplanted by smartphones, compact discs superseded by digital downloads and streaming).

But even as digital technologies and data lead to greater competition in many markets, they have also demonstrated a potential to tilt others towards greater concentration, market power and even dominance. For instance, in online platform markets, network effects and the possibility to achieve "scale without mass" can drive winner-take-all or winner-take-most outcomes. While network effects – the phenomenon that some products, such as the telephone, become more useful as the number of users increases – are widely understood, scale without mass refers to a feature of many digital markets that allows companies to add new users at virtually no cost (see Chapter 1).

Mark-ups – the wedge between the price a firm charges for its output on the market and the cost the firm incurs to produce one extra unit of output – are one indication of the level of competition in a particular market. Mark-ups have been increasing on average across firms and countries, especially for firms at the top of the mark-up distribution and those in digital-intensive sectors (Figure 8.5). On average, firms in the most digital-intensive sectors enjoy a 55% higher mark-up than firms operating in less digital-intensive sectors all else equal (elaboration based on Calligaris, Criscuolo and Marcolin, 2018[21]). This gap is persistent, even after controlling for productivity and firm patent stock.

8.5. Firms in digital-intensive sectors have higher and growing mark-ups than other firms

Mark-up growth in digital-intensive and less digital-intensive sectors, 2001-03 and 2013-14



Note: See Chapter notes.[5]

Source: Elaboration based on Calligaris S., C. Criscuolo and L. Marcolin (2018[21]), "Mark-ups in the digital era", *http://dx.doi.org/10.1787/4efe2d25-en*, based on Orbis® data (accessed July 2018).

StatLink https://doi.org/10.1787/888933914955

Industry concentration – while imperfect – can serve as a proxy to help understand the degree of competition in a given sector or market, as well as changes in the structure of industries. Mergers and acquisitions are associated with increases in industry concentration. Over 2003-15, the number of global mergers and acquisitions doubled, with a strong increase in cross-border mergers and acquisitions of firms in digital-intensive sectors (Bajgar et al., forthcoming[22]). The number of cross-border acquisitions of digital-intensive firms grew by more than 40% over 2007-15, compared to 20% growth of acquisitions of less digital-intensive firms (Bajgar et al., forthcoming[22]). These developments may not necessarily be a source of concern, as they may be inherent to the nature of digital transformation, but they should be further examined and considered by policy makers.

Ensuring a competitive environment for both domestic and cross-border transactions is essential. In the cross-border context, regulatory restrictions on products can be assessed for being excessive or insufficient compared to restrictions on domestically supplied products (OECD, 2018[23]). Such an assessment may consider whether national standards are followed by products sold across borders and ensure that illegal products are not made available (OECD, 2018[23]). Competition in the cross-border context includes single firms seeking to sell products across a border and limits on rivalry by a dominant firm or cartels.

The absence of regulation may also discourage digital innovation. Truly new and innovative business models may emerge in between traditional sector delineations, or transform the relationships among different actors. In the absence of adequate regulation, outlining basic minimum requirements for such business models may discourage investors as well as first-to-market innovators. Similarly, a common understanding of the rights and responsibilities of parties to a transaction might be beneficial for transactions taking place between "peers" in the platform economy (OECD, 2016[24]). "Free" transactions, whereby consumers receive goods and services in exchange for use of their personal data (including for advertising purposes and to provide customised content), may be considered less reliable in the absence of suitable redress mechanisms for those who may encounter a problem with such transactions (OECD, 2016[24]). In cases like these, the absence of some kinds of horizontal regulations, including consumer safety and consumer protection, could restrict the emergence of innovative products or business models.

As digital transformation continues to affect competition, it may lead to some new challenges for competition policy frameworks that were designed with traditional products in mind. One such challenge is that digitalisation may introduce new dimensions of competition in markets, as well as new ways to achieve anticompetitive outcomes, such as the use of algorithms to collude. In addition, a

range of issues will require competition authorities to enhance their advocacy efforts and deepen their co-operation with consumer protection, data protection and other regulators. These include the use of consumer data under the relevant data protection safeguards as a competitive asset when providing products at no cost, or when developing personalised prices.

Co-operation may be needed across borders to ensure that common standards are applied and that information is available to regulators. Bilateral and regional enforcement may also be useful, for example joint decision making between jurisdictions, although it is important that clear rules exist to indicate how enforcement actions are to be addressed if there are bodies with overlapping responsibilities.

Address tax challenges arising from the digitalisation of the economy

The taxation system is an important factor firms consider when deciding whether to invest domestically or abroad, and can distort competition and resource allocation if cross-border firms have a competitive advantage over domestic firms through international tax planning. Digital transformation has a wide range of implications for taxation, impacting tax policy and tax administration at both the domestic and international levels, offering new tools and introducing new challenges for policy makers. As a result, the digitalisation of the economy has been at the centre of the recent global debate over whether current international tax rules continue to be "fit-for-purpose" in an increasingly global business environment.

Under the auspices of the OECD/G20 Base Erosion and Profit Shifting (BEPS) Project and the Inclusive Framework on BEPS, work has been undertaken that recognises that digitalisation and some of the business models that it facilitates present important challenges for international taxation (OECD, 2015[25]). This analysis acknowledges that it would be difficult, if not impossible, to "ring-fence" the digital economy from the rest of the economy for tax purposes because of the increasingly pervasive nature of digitalisation.

This work has also identified a number of key features of digitalisation that are potentially relevant from a tax perspective. There was recognition that digitalisation has also accelerated and changed the spread of GVCs in which multinational enterprises integrate their worldwide operations. More specifically, new phenomena such as the collection and exploitation of data, network effects and the emergence of new business models, such as multi-sided platforms, were identified as presenting additional challenges to the existing tax rules (OECD, 2018[26]).

Building on the 2015 Action 1 Report, an Interim Report on the *Tax Challenges Arising from Digitalisation* was delivered to the G20 Finance Ministers in March 2018. The interim report presents an in-depth analysis of value creation across different digitalised business models, and describes the main characteristics of digital markets (OECD, 2018[26]). These have significantly evolved, especially for some enterprises. In particular, it identified three characteristics that are frequently observed in certain highly digitalised business models: 1) scale without mass; 2) reliance on intangible assets; and 3) reliance on data and user contributions. Further, it was acknowledged that these characteristics are expected to become common features of an even greater number of businesses as digitalisation progresses.

The interim report highlighted the importance of considering the implications of these three characteristics for the international tax system. They raise important issues concerning the rules relating to the allocation of taxing rights between jurisdictions (the "nexus" rules) and on the determination of the relevant share of a multinational enterprise's profits that will be subject to tax in a given jurisdiction (the "profit allocation" rules). There is a question whether the existing nexus rules, which govern the extent of a jurisdiction's right to tax a non-resident enterprise, may be outdated as an enterprise can now be heavily involved in the economic life of a jurisdiction but with a presence that, under existing tax rules, attracts only minimal or no taxing rights for that jurisdiction.

The rules relating to "profit allocation" are based on the "arm's-length" principle, described in the OECD Transfer Pricing Guidelines, and focus on the functions performed, assets used and risks assumed by each entity. There is a question of whether, and the extent to which, the existing profit allocation rules continue to produce appropriate results, including in cases where some or all of the three characteristics mentioned are present.

While work on a global, consensus-based solution is underway, a number of jurisdictions are considering the introduction of interim measures. In the Inclusive Framework on BEPS, there is no consensus on either the merit or need for interim measures and the interim report does not make a recommendation for their introduction. A number of countries consider that an interim measure will give rise to risks and adverse consequences irrespective of any limits that may be imposed on the design of such a measure and, therefore, oppose such a measure.

Other countries acknowledge these challenges, but consider that they do not outweigh the need to ensure that tax is paid in their jurisdictions on certain digital services supplied in their jurisdictions and consider that at least some of the possible adverse consequences can be mitigated through the design of the measure. This latter group of countries is of the view that a proliferation of different types of interim measures would be undesirable and, therefore, the interim report sets out guidance agreed by those countries on the design considerations that need to be taken into account when considering the introduction of interim measures.

Ensuring that tax systems are ready to meet the changes brought about by the increasingly global business models enabled by digitalisation, as well as to leverage opportunities and provide protection from potential risks, is a critical challenge. The impact of digitalisation on the international tax system will be a significant component of this work, and has important ramifications for multinational enterprises and governments, as well as the future of tax systems. Members of the Inclusive Framework on BEPS have agreed to undertake a coherent and concurrent review of the two key aspects of the existing tax framework – the profit allocation and nexus rules – that would consider the impacts of digitalisation on the economy, relating to the principle of aligning profits with underlying economic activities and value creation.

Since publication of the interim report in March 2018, the more than 120 members of the Inclusive Framework on BEPS have made significant progress to bridge the gaps in their positions with a number of countries bringing forward new proposals. By the end of 2018, the dynamic of the discussions shifted, with a renewed impetus for a potential agreement. The challenge now is to identify how the various proposals intersect – finding a solution that incorporates elements of these proposals could have a mutually reinforcing effect. The Inclusive Framework will meet again in 2019 to take these proposals forward, and a strong showing of unity and commitment to work together at the highest political level will be a key ingredient in finding common ground. It is hoped that there could be agreement on the sense of direction by then so that technical work on agreed solutions could be delivered by the end of 2020.

Notes

Israel
The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. Figure 8.1: For Iceland, data refer to 2012. For Turkey, data refer to 2014.
2. Figure 8.2: This figure covers the EBOPS items SF: Insurance and pension services; SG: Financial services; SH: Charges for the use of intellectual property not included elsewhere; SI: Telecommunications, computer and information services; and the sub-item SK1 Audiovisual and related services. For Chile, China, Indonesia, Mexico, New Zealand and Switzerland, Audiovisual and related services include Other personal, cultural, and recreational services.
3. Figure 8.3: The STRI indices are calculated on the basis of the STRI regulatory database which records measures on a most-favoured-nation basis. Preferential trade agreements are not taken into account.
4. Figure 8.4: The FDI RRI measures statutory restrictions on FDI in 68 countries, including all OECD and G20 countries, and covers 22 sectors. Four types of measures are covered: (i) foreign equity restrictions, (ii) screening and prior approval requirements, (iii) rules for key personnel and (iv) other restrictions on the operation of foreign enterprises. The score for each sector is obtained by adding the scores for all four types of measures, and re-scaling this to a maximum value of 1. The 22 sector scores are then averaged to yield the overall score for each country. The main source of information is the list of countries' reservations under the OECD Code of Liberalisation of Capital Movements and their lists of exceptions and other measures reported for transparency under the National Treatment instrument (NTI). Additional sources include official national publications and information gathered by the Secretariat in the preparation of OECD Investment Policy Reviews, as well as by other international organisations.
5. Figure 8.5: The figure reports the estimates of a pooled OLS regression explaining firm log-mark-ups in the period, on the basis of the firm's capital intensity, age, productivity and country-year of operation, as well as a dummy variable with value 1 if the sector of operation is digital-intensive vs less digital-intensive (specifications on the left in the graph), or if the sector of operation is among the top 25% of digital-intensive sectors vs not (specifications on the right in the graph). Sectors are classified as "digital-intensive" or "highly digital-intensive" according to the taxonomy developed in Calvino et al. (2018[27]). Estimates using mark-ups based on a Cobb Douglas production function. With respect to Calligaris et al. (2018[21]), in this elaboration the parameters of the production function have been estimated at the 3-digit industry level (rather than 2-digit), and including year dummies. Moreover, mark-ups lower than 1 but greater than 0.95 have been winsorized (rather than trimmed) to 1. Standard errors are clustered at the company level. All coefficients are significant at the 1% confidence level.

References

Andrews, D., C. Criscuolo and P. Gal (2015), "Frontier firms, technology diffusion and public policy: Micro evidence from OECD countries", *OECD Productivity Working Papers*, No. 2, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jrql2q2jj7b-en*. [2]

Bajgar, M. et al. (forthcoming), "Acquiring innovation in the digital economy", *OECD Productivity Working Paper*, OECD Publishing, Paris. [22]

Calligaris, S., C. Criscuolo and L. Marcolin (2018), "Mark-ups in the digital era", *OECD Science, Technology and Industry Working Papers*, No. 2018/10, OECD Publishing, Paris, *https://dx.doi.org/10.1787/4efe2d25-en*. [21]

Calvino, F. et al. (2018), "A taxonomy of digital intensive sectors", *OECD Science, Technology and Industry Working Papers*, No. 2018/14, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f404736a-en*. [27]

De Backer, K. and D. Flaig (2017), "The future of global value chains: Business as usual or 'a new normal'?", *OECD Science, Technology and Industry Policy Papers*, No. 41, OECD Publishing, Paris, *https://dx.doi.org/10.1787/d8da8760-en*. [16]

Eurostat (2018), *Digital Economy and Society Statistics* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/comprehensive-database* (accessed December 2018). [6]

Gestrin, M. and J. Staudt (2018), *The Digital Economy, Multinational Enterprises and International Investment Policy*, OECD, Paris, *http://www.oecd.org/investment/the-digital-economy-mnes-and-international-investment-policy.htm*. [17]

Lesher, M. and S. Miroudot (2008), "FDI spillovers and their interrelationships with trade", *OECD Trade Policy Papers*, No. 80, OECD Publishing, Paris, *https://dx.doi.org/10.1787/235843308250*. [14]

López González, J. and J. Ferencz (2018), "Digital trade and market openness", *OECD Trade Policy Papers*, No. 217, OECD Publishing, Paris, *https://dx.doi.org/10.1787/1bd89c9a-en*. [7]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [5]

OECD (2018), *Maintaining Competitive Conditions in Era of Digitalisation*, OECD, Paris, *http://www.oecd.org/g20/Maintaining-competitive-conditions-in-era-of-digitalisation-OECD.pdf*. [23]

OECD (2018), *Tax Challenges Arising from Digitalisation – Interim Report 2018: Inclusive Framework on BEPS*, OECD/G20 Base Erosion and Profit Shifting Project, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264293083-en*. [26]

OECD (2017), *Financing SMEs and Entrepreneurs 2017: An OECD Scoreboard*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/fin_sme_ent-2017-en*. [20]

OECD (2017), *OECD Science, Technology and Industry Scoreboard 2017: The Digital Transformation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268821-en*. [18]

OECD (2016), *OECD Recommendation of the Council on Consumer Protection in E-Commerce*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264255258-en*. [24]

OECD (2015), *Addressing the Tax Challenges of the Digital Economy, Action 1 – 2015 Final Report*, OECD/G20 Base Erosion and Profit Shifting Project, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264241046-en*. [25]

OECD (2015), *Policy Framework for Investment, 2015 Edition*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264208667-en*. [12]

OECD (2013), *Supporting Investment in Knowledge Capital, Growth and Innovation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264193307-en*. [19]

OECD (2011), *OECD Guide to Measuring the Information Society 2011*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264113541-en*. [8]

OECD (2010), *OECD Market Openness Principles*, OECD Innovation Policy Platform, OECD, Paris, *http://www.oecd.org/innovation/policyplatform/48137680.pdf*. [1]

OECD (forthcoming), *A Dynamic E-commerce Landscape: Developments, Trends and Business Models*, OECD Publishing, Paris. [4]

Romalis, J. (2007), "Market access, openness and growth", *NBER Working Paper* No. w13048, *http://dx.doi.org/10.3386/w13048*. [3]

Thomsen, S. and F. Mistura (2017), *Is Investment Protectionism on the Rise?*, OECD, Paris, *http://www.oecd.org/investment/globalforum/2017-GFII-Background-Note-Is-investment-protectionism-on-the-rise.pdf*. [13]

UNCTAD (2017), *World Investment Report 2017: Investment and the Digital Economy*, United Nations Conference on Trade and Development, Geneva, *http://unctad.org/en/PublicationsLibrary/wir2017_en.pdf*. [15]

WTO (2017), *Joint Statement on Electronic Commerce*, World Trade Organization, Geneva. [11]

WTO (2017), *Work Programme on Electronic Commerce: Draft Ministerial Decision of 13 December*, World Trade Organization, Geneva. [10]

WTO (1998), *Work Programme on Electronic Commerce*, World Trade Organization, Geneva, *https://www.wto.org/english/tratop_e/ecom_e/wkprog_e.htm*. [9]

Chapter 9

DEVELOPING A DIGITAL TRANSFORMATION STRATEGY

DEVELOPING A DIGITAL TRANSFORMATION STRATEGY: WHAT MATTERS MOST?

Establish a governance approach that supports effective co-ordination

- Establish a governance approach that supports effective steering and co-ordination of digital transformation policies, in light of the country's culture and institutions.
- Assign clear responsibilities for strategic co-ordination (e.g. the head of government or a lead minister) and operational co-ordination (e.g. chief digital officers in implementing bodies) for the development and implementation of a national digital transformation strategy (DTS).

Articulate a strategic vision and ensure coherence

- Articulate a strategic vision that provides direction on identifying the main priorities and scoping the main objectives of a DTS.
- Ensure coherence between a DTS and other related domestic and international digital strategies and/or policy objectives.

Assess key digital trends, related policies and regulations

- Monitor key digital trends, including by international benchmarking, to identify opportunities and challenges and related priorities to be addressed by a DTS.
- Evaluate the effectiveness of current strategies and/or policies, identify gaps and/or incoherence, and scope objectives for a DTS.

Develop a comprehensive and coherent strategy

- Leverage the governance approach, the strategic vision, and insights from monitoring and evaluation to develop a comprehensive and coherent DTS.
- Engage all relevant actors in developing a DTS, including different parts and levels of government, non-governmental stakeholders and international partners.

Implement the strategy successfully

- Anticipate and address implementation challenges related to existing institutions and policy frameworks, social preferences and (lack of) administrative capacity.
- Issue an action plan with specific measures, clear responsibilities, budget, timeframes, and measurable targets to successfully implement the DTS.

To put into practice the whole-of-government approach to digital transformation presented above, governments need to develop and successfully implement a Digital Transformation Strategy (DTS). Many countries already have a digital economy strategy or an equivalent policy in place, but most of these are still rather narrow in scope; only a few countries are explicitly promoting a whole-of-government approach to digital transformation (OECD, 2017[1]). Such an approach is a key characteristic of a DTS, which must be comprehensive and coherent in addressing the range of inter-related policy issues discussed in Chapters 2 to 8 to ensure co-ordination of policies across all domains and sectors involved in shaping digital transformation. This chapter discusses key aspects of governing, developing and implementing a DTS.

Establish a governance approach that supports effective co-ordination

Digital transformation policies need to be co-ordinated among all policy domains and actors affected by (and affecting) digital transformation. However, governments identify co-ordination as one of the major challenges to coherent and effective digital policies (OECD, 2017[1]), despite the fact that the importance of co-ordination in other cross-cutting policies (e.g. innovation) is well-recognised (OECD, 2015[2]). Such co-ordination should involve a wide range of actors in multiple parts and at multiple levels of government, as well as non-governmental stakeholders and international partners.

While well-designed governance is fundamental for effective co-ordination, there is no one-size-fits all approach to the governance of a DTS. Different approaches can reflect, for example, variations in countries' institutions, government organisation, or administrative culture and capacity. In addition, governance arrangements are likely to evolve over time, for example with changes in government, technological progress and shifts in the constellation of actors driving digital transformation.

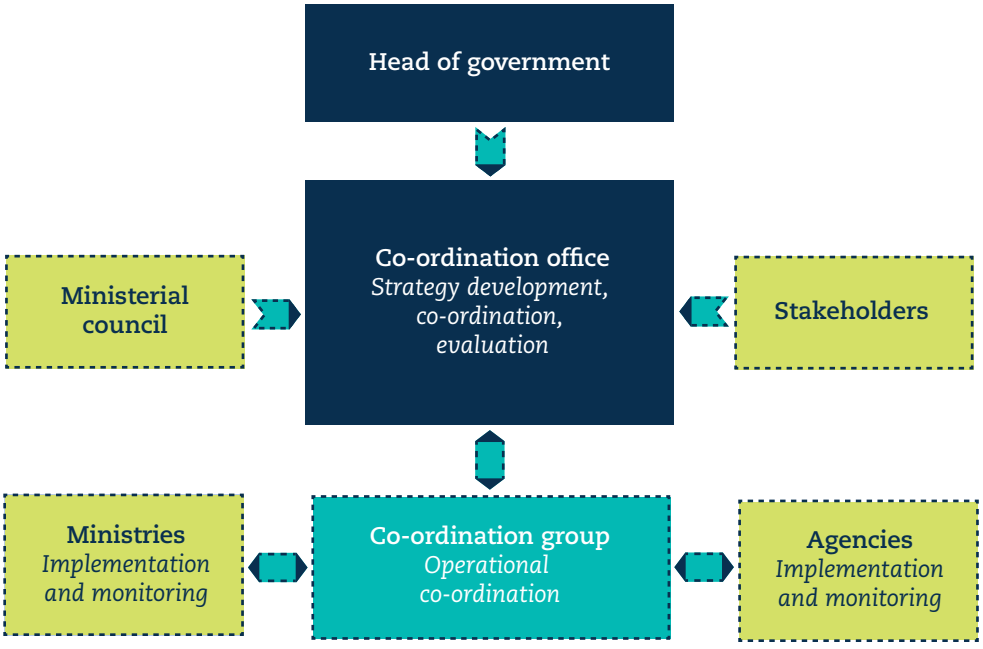
Almost all OECD countries have a national digital strategy in place, and most governments have developed some form of governance; however, the allocation of key responsibilities, such as for strategy development, co-ordination, implementation, and monitoring and evaluation, differs significantly across countries (OECD, 2017[1]). More recent research by the OECD confirms this finding, and identifies two main approaches distinguished notably by their respective allocation of responsibility for strategic co-ordination. The first approach assigns responsibility at a high (above ministerial) level and the second approach at the level of one or several ministries. The discussion below is not intended to promote any particular approach, but rather documents the current governance landscape.

High-level leadership and centralised responsibility for strategic co-ordination above ministerial level, i.e. in most cases by the head of government, characterise the first approach (Figure 9.1). In this approach, the head of government also tends to be pro-active in promoting the country's digital strategy domestically and abroad. Countries currently using this approach include Mexico and the Slovak Republic, where the Prime Minister holds a strong mandate for digital issues, including for the drafting of the strategy, executed through a dedicated co-ordination office. Other countries using this approach include Brazil, Chile, Estonia, Korea and Luxembourg, where certain functions are ensured by the Prime Minister, notably for strategic co-ordination, but where ministers still play an important role, both in providing input to strategy development and in the strategy's implementation.

In all countries with high-level strategic co-ordination, stakeholders are involved in strategy development, usually through the co-ordination office. Operational co-ordination in the context of implementing the strategy tends to be ensured via focal points (e.g. chief digital officers) within each of the implementing ministries and agencies. The latter two usually also monitor implementation and report to the co-ordinating office, which in most cases ensures overall evaluation of the strategy, with oversight by the head of government.

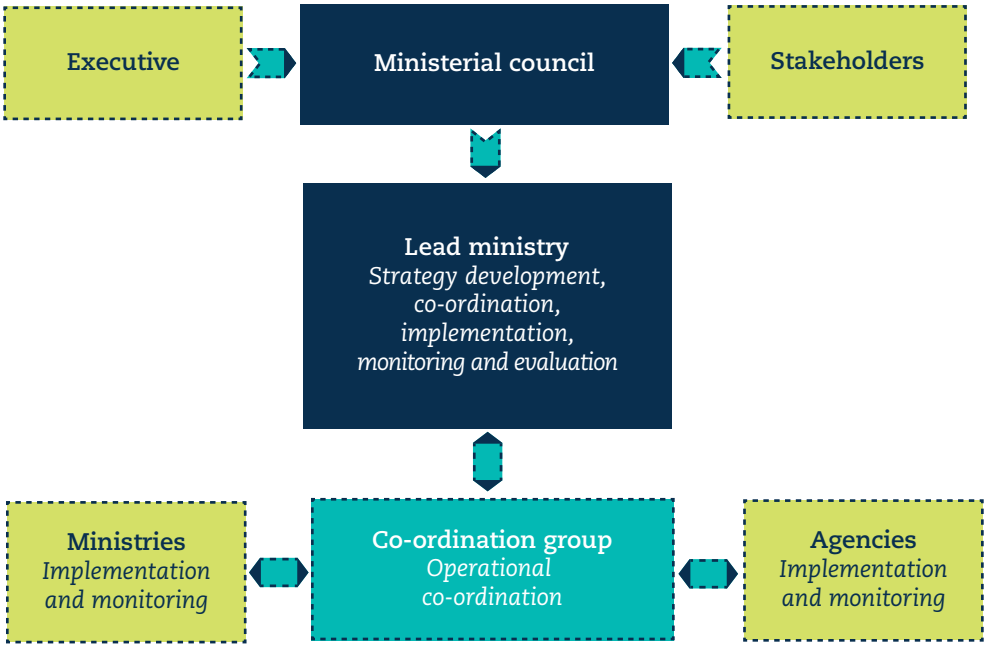
Among the countries that centralise responsibility for strategic co-ordination above ministerial level, the central co-ordination office may be (part of) the centre of government. The centre of government usually supports the highest level of the executive branch of government. Examples include the German Chancellery, the UK Cabinet Office and the White House Executive Office (OECD, 2014[4]). Centres of government tend to play a leadership role on strategic priorities and co-ordination, as well as on designing action plans in co-operation with relevant government departments.

9.1. High-level strategic co-ordination of digital transformation policies



A distinguishing feature of the second approach is the allocation of responsibility to a lead ministry for strategic co-ordination (Figure 9.2). In several countries, the lead ministry is exclusively dedicated to digital affairs, including in Belgium, the People's Republic of China, Japan, Poland, Portugal and Slovenia. In other 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.[1]

9.2. Ministry level strategic co-ordination of digital transformation policies



In addition to strategic co-ordination, the lead ministry tends to be responsible for drafting as well as in some cases for implementing and monitoring the strategy. Strategy development tends to involve stakeholders, under the auspices of a ministerial council, which is usually hosted by the lead ministry and

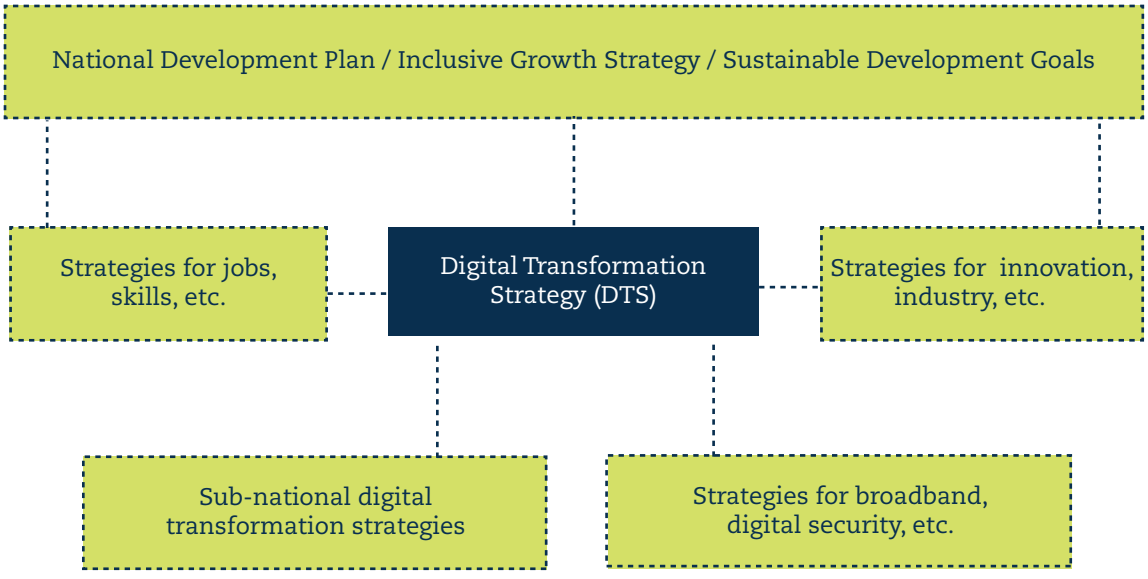
sometimes chaired by the head of government. Similar to the first approach, operational co-ordination is usually ensured by a dedicated co-ordination group made up of focal points from the implementing ministries and agencies. The latter two also tend to monitor implementation, reporting to the lead ministry and/or the ministerial council, which often also ensures overall evaluation of the strategy.

Irrespective of the actual design of a country's governance approach, successful development and implementation of a DTS crucially depends on the skills and capacity of the people and institutions involved in its formulation and implementation. In general, the skills needed for a digital world of work (see Chapters 3 and 5) and life (see Chapter 6) are essential. More specific skills and capacity needed for a high-performing civil service and for public sector innovation include, for example, the skills to develop policy, such as the ability to define policy problems, design solutions and influence the policy agenda. In addition, skills to manage networks, for example to engage with citizens or stakeholders, such as public relations, knowledge and project management, co-ordination, communication and conflict resolution skills, are likewise important (OECD, 2017[5]).

Articulate a strategic vision and ensure coherence

The development of a coherent DTS benefits strongly from a strategic vision (or direction) for the digital transformation of a country. Such a vision helps shape the main priorities and objectives of a DTS and facilitates coherence among different policy issues addressed within the strategy. A strategic vision may also clarify how digital transformation can contribute to economic growth and social prosperity, address "grand challenges" such as those related to health or climate change, and help achieve high-level policy objectives such as inclusive growth, well-being and sustainable development. Some of these high-level objectives may be included in other agendas or strategies (Figure 9.3). An important condition for shaping a strategic vision is to gain a holistic understanding of digital transformation. This involves identifying key properties ("vectors") of digital transformation that affect policies and regulation across a range of areas (see Chapter 1).

9.3. Ensuring coherence between a digital transformation strategy and other strategies



To ensure coherence, existing national and/or international strategies and policy objectives need to be taken into account when developing a DTS. For example, a government may have a national development plan or an inclusive growth strategy. At the international level, governments may consider overarching agendas such as the United Nations' Sustainable Development Goals or, in the case of European countries, the Digital Agenda for Europe.

A DTS also needs to be coherent with other higher and/or lower level strategies and/or policy objectives relevant to digital transformation. This concerns strategies and policies on any key issue covered by a

DTS, such as jobs, skills and innovation. It is crucial to avoid overlaps and conflicting approaches and to identify possible synergies, including ways in which a DTS may help co-ordinate elements of other strategies that strongly relate to digital transformation. In addition, a DTS is likely to cover topics that are also addressed in more specific strategies and policies, for example broadband development or digital security. Finally, sub-national digital economy/transformation strategies and/or policies should complement and increase the effectiveness of a national DTS.

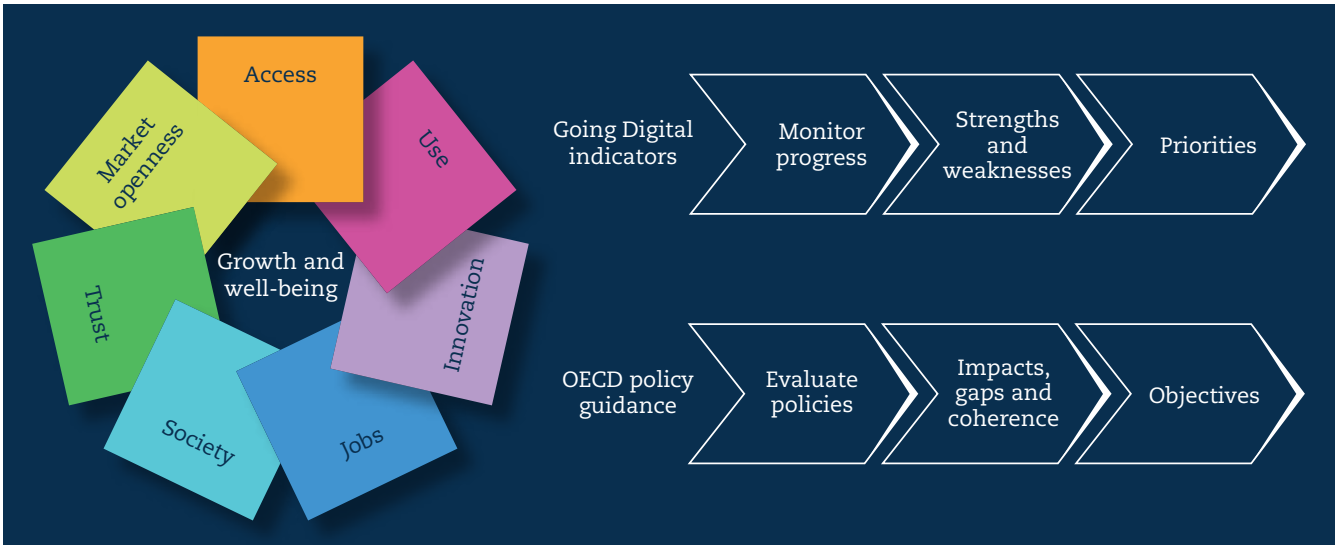
Assess key digital trends, related policies and regulations

Each country is at a different stage of digital development. Understanding where a country stands requires thorough monitoring and analysis of relevant trends, and effective evaluation of policy impacts. Measurement, monitoring and evaluation are critical for the design and governance of digital policy, and allow policy makers and analysts to: 1) assess the contribution of digital transformation to achieving social and economic objectives and stimulate informed debate (e.g. among key stakeholders); 2) understand drivers of and obstacles to digital transformation, which is crucial for designing effective policies; 3) evaluate the effectiveness of different policy approaches, thereby enabling governments to make informed decisions about priorities, policy measures and instruments, and the allocation of funds; and 4) continuously improve the design and administration of programmes and enhance accountability, legitimacy and credibility of government interventions (OECD, 2015[2]).

Within the overall policy cycle, monitoring and evaluation follows the implementation of a strategy and/or policies. It should enable learning, prioritisation and improvement of policies over time and, in turn, form the basis of any new strategy and/or reform of existing policies. The vast majority of OECD countries are currently implementing a national digital strategy and many will soon need to evaluate and either update their current approach or develop a new DTS (OECD, 2017[6]). Any new strategy should include a plan for monitoring and evaluation to ensure continuous improvement of the quality and effectiveness of public policy and expenditures (OECD, 2015[2]).

Wherever a country stands within the implementation cycle of its current strategy and/or policies, the OECD's Going Digital Integrated Policy Framework provides practical guidance on the policy areas to be considered for monitoring and evaluation (OECD, forthcoming[7]). This approach not only helps to ensure a comprehensive assessment of all relevant trends and policies, some of which may not have been covered by an existing digital strategy. It also enables policy makers to systematically prepare a new DTS. The two main elements of the assessment are: 1) quantitative monitoring of key trends; and 2) evaluation (quantitative and/or qualitative) of the impacts and effectiveness of policies implemented to date (Figure 9.4).

9.4. Assessing where your country stands: Monitoring and evaluation



The monitoring of key trends helps governments identify strengths and weaknesses in the digital development of their country and scope main priority areas to be addressed by a DTS. The indicators defined in the monitoring and evaluation plan of an existing strategy, as well as more generally national statistics and alternative data sources that help quantify and monitor key trends and developments, serve as a starting point for the monitoring exercise.

International benchmarking, for example with the indicators produced by the OECD that map to the Integrated Policy Framework (OECD, forthcoming[7]), is also important. A comprehensive set of indicators is presented in the accompanying publication *Measuring the Digital Transformation: A Roadmap for the Future* (OECD, 2019[8]). These indicators and the underlying data can be accessed and downloaded on the Going Digital Toolkit portal,[2] which allows countries to self-assess and benchmark domestic trends to other countries.

Policy evaluation helps governments understand the impacts of existing policies, including through regulatory impact assessment, and to evaluate their success in reaching their strategic objectives (OECD, 2017[9]). This exercise also pinpoints gaps in existing policy and/or regulatory frameworks as well as issues of in-coherence (OECD, 2014[10]).

Policy evaluation may in the first place rely on domestic analysis, including feedback from stakeholders, but should also take into account international comparisons and practices. Policy evaluation can be significantly improved by making better use of digital technologies, for example by directly monitoring policy outcomes (Box 9.2).

Develop a comprehensive and coherent strategy

Leveraging a governance approach that supports effective co-ordination, a strategic vision that ensures coherence, and key insights from monitoring and evaluation of previous strategies and/or policies, a comprehensive and coherent DTS should be developed. The process of strategy development may be different in each country, however, involving all relevant stakeholders is essential, e.g. to vet key priorities and objectives, identify policy measures to achieve the objectives, and develop an action plan to implement the strategy successfully (see next section). Key actors to involve include officials from all relevant parts and levels of government, non-governmental stakeholders, as well as international partners.

Co-ordination across a wide range of national and subnational government bodies and public entities can be challenging. For example, high transaction costs, power and information asymmetries, and different governance approaches across levels of government can make co-ordination and negotiations cumbersome. The person (and body) in charge of strategic co-ordination, e.g. the head of government or the lead minister responsible for strategic co-ordination and drafting the strategy, holds important responsibility for effective co-ordination. In turn, each body involved in developing and/or implementing the strategy requires a focal point to ensure co-ordination and continuous engagement in the strategy.

Digital transformation is not only driven by governments, but also by people, businesses and other non-governmental stakeholders. An inclusive process of strategy development needs to involve non-governmental stakeholders, including business associations, civil society organisations, trade unions, and technical and scientific communities (Box 9.1). Stakeholder dialogue can help identify barriers, exchange best practices, and create opportunities for self-regulation, stakeholder-led standard setting, and public-private partnerships. Widely used forms of stakeholder engagement include feedback from the general public, advisory groups and preparatory committees, and formal consultations with selected groups such as social partners. The use of digital technologies increasingly facilitates stakeholder engagement, for example through web-based consultations (OECD, 2018[11]).

While international partners are usually not directly involved in the development of national strategies, they can determine some outcomes of a DTS. Issues on which international partners may be consulted, including private actors, include trade, cross-border data flows, foreign direct investment, regulation as well as questions related to Internet governance. While some of these may be addressed in the context of multilateral co-operation and agreements, for example in multilateral institutions, other issues may be agreed upon in bilateral co-operation, formal agreements, treaties or common standards.

9.1. The multi-stakeholder model: A key to good policy making in the digital age

A key to a successful strategy or policy and its implementation is the engagement of stakeholders from the early stages of strategy and policy development. Multi-stakeholder co-operation brings tangible benefits that lead to better policies and outcomes. Government actors involved in drafting a strategy and designing policies can never by themselves have a full view and understanding of all opportunities, challenges and issues to be considered. In the interest of getting strategic priorities and objectives right, of choosing and designing the best possible policy measures, and of making a strategy and policies inclusive and useful for all, governments need to reach out and ensure that the views and needs of all stakeholders are considered and addressed.

One example of successful stakeholder engagement at the national level is regulatory policy making. Involving those that are affected by regulations to ensure that regulations are user-centred and in the public interest is established practice in many countries. It improves the quality of rulemaking through ideas, expertise and evidence from stakeholders and creates a sense of ownership in and enhances the legitimacy of policies and regulations. In turn, it can increase trust in government and compliance with regulations. To monitor the evolution of stakeholder engagement in regulatory policy, the OECD has developed Indicators of Regulatory Policy and Governance (iREG), which cover 38 OECD member and accession countries and the European Union and provide a wealth of information on regulatory management practices; for example, on stakeholder engagement in the development of primary laws or in the development of subordinate regulation.

An example of successful international stakeholder engagement is the OECD's approach and practice of broad stakeholder consultation to enrich debates, shed new light on complex issues, and ultimately enable better policy outcomes. Being rather unique among its peers, right from the beginning the OECD established institutional relations with trade unions and business through two advisory committees: Business at OECD (BIAC) and the Trade Union Advisory Committee (TUAC). BIAC and TUAC have become integral players in the OECD ecosystem and contribute actively, across the board, to the work of the Organisation, and the 2011 *OECD Council Recommendation of the Council on Principles for Internet Policy Making* (OECD, 2011[3]) recommends all adherents to "encourage multi-stakeholder co-operation in policy development processes".

The OECD's policy making process, however, goes far beyond these institutional relations to include other interlocutors. At the OECD Ministerial meeting on the digital economy in 2008 in Seoul, both the Civil Society Information Society Advisory Council and the Internet Technical Advisory Committee were formally recognised in the work of the Committee on Digital Economy Policy. Seoul was a first step toward creating the unified, inclusive multi-stakeholder model that has served so well since. It has helped improve the quality of OECD outputs, including reports and recommendations, with the technical, social and business insights, and has helped shape an approach to digital policy development that has grown from the Internet's own DNA: open, distributed, borderless, multi-stakeholder and global.

Sources: OECD (2017[9]), *Government at a Glance 2017*, *https://dx.doi.org/10.1787/gov_glance-2017-en*; OECD (2018[11]), *OECD Regulatory Policy Outlook 2018*, *https://dx.doi.org/10.1787/9789264303072-en*.

Implement the strategy successfully

The main value of any strategy lies in its successful implementation. Even if a DTS is well co-ordinated and widely supported, challenges to implementation may arise, for example, from poor strategy design, such as unrealistic objectives, or from rigid institutions and organisational structures that impede efficient resource allocation. Administrative capacity, a clear division of labour, and complementarity among different parts and levels of government are crucial. Existing policy frameworks and social preferences can also hinder implementation (OECD, 2015[2]).

An important condition for successful implementation is broad-based support for the strategy. This requires stakeholder engagement and may include an electorate mandate. Effective communication,

constructive negotiation, and co-operation with stakeholders during the implementation, is crucial. In addition, the targeting and sequencing of measures must be well-thought through, e.g. by acting first on those that are a prerequisite for the success of others to minimise trade-offs and enable synergies between policies (OECD, 2018[12]). Improving several aspects of policy making and implementation, digital technologies offer opportunities to improve the conditions for success (Box 9.2).

9.2. Using digital technologies to improve policy making, implementation and evaluation

Digital technologies allow policy makers to improve policy making, implementation and evaluation, including by becoming more reactive to fast-changing environments, risks and opportunities. For example, using digital technologies effectively holds the potential to improve:

- **Monitoring and better targeting of policies**. Digital technologies allow more comprehensive and cost-effective monitoring of policy outcomes. This facilitates better targeting, implementation and enforcement of policies. In agriculture, for example, remote sensing and digital land parcel identification systems facilitate the targeting of subsidies.
- **Policy design and evaluation**. Digital technologies broaden the suite of policy instruments available to governments and can lower the costs of policy experimentation and evaluation. In cities, for example, digital cameras that automatically register vehicle license plates have enabled the implementation of congestion zones and enforcement of pricing schemes. The effects of urban transport policies can be evaluated more precisely by using and linking different database with increasingly fine-grained information on urban mobility.
- **Government-citizen interaction and stakeholder engagement**. Many OECD countries are making more data freely available to enhance accountability in the public sector. For instance, making pollutant release and transfer registers publicly available online can facilitate civil society oversight of regulated entities, making compliance efforts more transparent and breaches more open to public scrutiny.

In addition, policy makers could consider the role of digital technologies more systematically across the whole policy cycle. To do so, a new mind set is needed to exploit the potential of digital technologies, including algorithms and artificial intelligence, and automation to redesign government processes, services and public policies. To make policies more digital by design, governments need to attract technologically savvy people; for example, ICT and data specialists, data scientists and system architects.

Source: OECD (2019[13]), "Using digital technologies to improve the design and enforcement of public policies", *https://doi.org/10.1787/99b9ba70-en*.

In more operational terms, successful implementation requires a sufficiently detailed translation of the strategic objectives into actions, i.e. specific policy measures and instruments, generally provided by an action plan. Measures and instruments include advocacy (e.g. awareness raising and education), investment, incentives and/or taxation, public services and programmes, and legislation and/or regulation, among others. Importantly, for all measures the action plan should allocate clear responsibility for implementation. This concerns not only officials and departments in ministries, agencies and other bodies implementing the strategy, but also non-governmental stakeholders, especially in the case of public-private partnerships.

All policy measures in the action plan that involve public spending or investment should identify the required amount and the source(s) of funding. While most OECD governments have a budget associated with their current digital strategy, approaches to budgeting differ widely across countries (OECD, 2017[6]). For example, some countries have a budget specifically dedicated to their digital strategy, while others fund implementation measures via different budget lines of the ministries and agencies involved. In rare cases, the entity in charge of overall co-ordination has a budget to finance measures that are at least partially financed by implementing ministries and agencies. This can facilitate additional steering of the implementation and can be used to incentivise co-operation among different actors to work towards the same objective (OECD, 2018[14]).

Finally, two crucial ingredients of successful implementation are a clear time-frame for the implementation of each measure and quantifiable targets and related indicators to monitor progress. Progress should be monitored using the specific targets identified in the action plan that underpins the overarching objectives stated in the strategy, as well as other related high-level policy objectives at the domestic and international levels. In addition, some countries closely link the timeline for implementation with their annual budgets and periodically re-assess their initial budgetary assumptions and revise as needed. At the end of the strategy's implementation cycle, systematic monitoring and assessment is needed to enable an overall evaluation of the strategy in view of updating the existing strategy or preparing a new one.

Notes

1. Some countries (not considered in either of the two groups) also assign co-ordination to several if not all actors involved in the strategy.
2. *www.oecd.org/going-digital-toolkit*.

References

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [8]

OECD (2019), "Using digital technologies to improve the design and enforcement of public policies", *OECD Digital Economy Policy Papers*, No. 274, OECD Publishing, Paris, *https://doi.org/10.1787/99b9ba70-en*. [13]

OECD (2018), *Good Jobs for All in a Changing World of Work: The OECD Jobs Strategy*, OECD, Paris, *https://www.oecd.org/mcm/documents/C-MIN-2018-7-EN.pdf*. [12]

OECD (2018), *OECD Regulatory Policy Outlook 2018*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264303072-en*. [11]

OECD (2018), *OECD Reviews of Digital Transformation: Going Digital in Sweden*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264302259-en*. [14]

OECD (2017), *Government at a Glance 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/gov_glance-2017-en*. [9]

OECD (2017), *OECD Digital Economy Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264276284-en*. [6]

OECD (2017), *OECD Employment Outlook 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/empl_outlook-2017-en*. [1]

OECD (2017), *Skills for a High Performing Civil Service*, OECD Public Governance Reviews, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264280724-en*. [5]

OECD (2015), *The Innovation Imperative: Contributing to Productivity, Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264239814-en*. [2]

OECD (2014), *Centre Stage: Driving Better Policies from the Centre of Government*, OECD, Paris, *http://www.oecd.org/gov/Centre-Stage-Report.pdf*. [4]

OECD (2014), *OECD Framework for Regulatory Policy Evaluation*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264214453-en*. [10]

OECD (2011), *OECD Council Recommendation of the Council on Principles for Internet Policy Making*, OECD, Paris, *https://www.oecd.org/sti/ieconomy/49258588.pdf*. [3]

OECD (forthcoming), "Going Digital: An integrated policy framework for making the transformation work for growth and well-being", *OECD Digital Economy Papers*, OECD Publishing, Paris. [7]

Chapter 10

DEFINING A FUTURE DIGITAL AGENDA

Digital transformation is complex and evolving rapidly. Policy decisions must increasingly be made under uncertainty about future digital and other developments. This report underscores the necessity of working with a wide range of stakeholders and co-ordinating across policy silos and levels of government to steer policies towards an inclusive and sustainable digital future. While progress has been made in answering some of the most pressing and difficult policy questions that governments face today, more work is needed to better understand some complex issues and to design resilient policy frameworks in response. New issues have also arisen that are an important part of a future global digital agenda.

A future digital agenda

The future digital agenda must address these new and difficult policy issues to realise the immense promise of digital technologies for growth and well-being. Such issues include changing competition dynamics, privacy in the digital age, data and cross-border data flows, inequalities and digitalisation, the future of the firm, democracy in the information age, measurement of digital transformation, as well as issues that will be addressed in Going Digital Phase 2 and beyond.[1]

Changing competition dynamics

Firms increasingly use digital intangible assets that can be reproduced easily and at low cost. Some firms, such as those that operate online platforms, exhibit strong positive direct and indirect network effects. When coupled with economies of scale and scope and very low marginal costs, some argue that the characteristics of certain digital firms inexorably lead to so-called "winner-take-most" dynamics, whereby markets are characterised by, at most, a few major players. This changing landscape has consequences not only for competition, innovation, technology diffusion and inequalities, but also for growth and social cohesion. Such dynamics, where they exist, raise a range of questions, including:

- Are traditional tools to assess the abuse of market dominance fit-for-purpose in the digital age? In particular, competition authorities often look at market share and indicators of market power as expressed through price. As intangible products and digital services are often offered at zero price, such considerations may become less useful.
- Should existing intellectual property rights (IPRs) be reviewed, including by intellectual property expert agencies and organisations (e.g. the World Intellectual Property Organization)? Such a review would ensure that IPRs provide sufficient incentives for innovation and do not unduly impede the diffusion of technology across society, as well as continued protection of the fundamental right inherent in patents to exclude (e.g. the unconditional refusal to license a valid patent).
- Do data confer market power and will the increased power of data analytics and the range of data that can be collected enable dominant players to consolidate a competitive advantage to the detriment of new entrants and other players? Issues around the opportunities for small and medium-sized enterprises to thrive and how they can best be harnessed are also important in this regard.
- When markets are multi-sided, how should such multi-sidedness impact the understanding of competitive dynamics or what a dominant position is? For example, simply determining what the relevant market is can be difficult when firms operate on multiple sides of a market and are also able to cross-subsidise growth on any one side.

Privacy in the digital age

In view of the growing quantity, diversity and level of detail of data collected about individuals' activities and relationships, as well as the significant advances in the capacity of data analytics to provide insights on people's preferences and behaviours, concerns about privacy and information asymmetries are increasing. OECD governments recognise privacy as a fundamental value (OECD, 2013[1]) and have outlined principles governing privacy and frameworks for the collection and handling of personally identifiable data. However, challenges persist for several of these principles to be fully implemented, raising questions about how best to protect privacy in the digital age:

- How can privacy provisions be adapted to better reflect the concerns of those online? In particular, how can policy help address the so-called "privacy paradox" whereby people report privacy concerns and worries about tailored advertising, but do not change privacy settings when given

the opportunity to do so (European Commission, 2015[2]; Acquisti, Brandimarte and Loewenstein, 2015[3]; Barth and de Jong, 2017[4])?

- How can terms and conditions best inform and empower people about the use of their personal data? For example, most digital applications require users to accept terms and conditions, but these have proven ineffective in communicating important information to consumers (see Chapter 7). Moreover, even if consumers are well-informed about the use of their data, the only alternatives such users may see is to use the service despite disagreeing with terms and conditions, or to fully opt out.
- How can privacy regimes address the challenges that data analytics – and the linking of disparate data sources to individuals – pose to data protection? The linking of large datasets facilitates (re) attributing data to individuals, even if such data were previously anonymised and held in separate databases (OECD, 2015[5]). Questions remain whether inferred or observed data of this nature can be considered personal or "personally identifiable", and therefore fall under the remit of privacy frameworks (OECD, 2013[6]).

Inequalities and digitalisation

Digital transformation holds much potential to effect positive change across the economy. For example, digital technologies make it easier to access markets and start a business, as well as increase access to goods and services – including education, health and financial services – for marginalised groups (especially those living in remote areas). Digital technologies also help governments and firms to become more responsive to citizens and consumers. At the same time, digital transformation may have unintended social consequences, including the exacerbation of inequalities, raising a number of questions to be addressed:

- To what extent will wage inequality increase due to skill-biased technological change? Digital transformation may increase the relative demand for high-skilled workers and contribute to job polarisation as routine jobs decline, affecting mainly workers with low- and medium-level skills. At the same time, the available evidence points to a narrow rising of top earners' wages rather than a broad increase of high-skilled workers' wages.
- How do digital transformation and trade with low-income countries affect labour shares and wage inequality?

Data and cross-border data flows

Data are an increasingly important resource for economies to flourish and societies to prosper (see Chapter 1). However, to unleash the full benefits of data for people, firms and governments, a range of important questions still need to be further analysed and addressed:

- How to disentangle the different types of data collected and used? This may involve developing data taxonomies for different purposes, such as personal data protection (enforcement), data governance and trade (cross-border data flows). The question then becomes: how do these taxonomies interact when policy questions cut across different areas?
- How to measure the value of (different types of) data and cross-border data flows? This will be crucial to understand and, if needed, steer the evolution of data markets and enhance the potential of data for production and value chains. It is also relevant in the international tax context, where identifying and measuring value creation is a key policy issue.
- How to develop national data strategies that unleash the potential of data while effectively protecting fundamental values such as privacy and personal data protection, as well as IPRs, to achieve a digital social contract?

The future of the firm

Digital transformation decreases costs, including transaction costs (e.g. finding reliable information, bargaining prices and contracts, and monitoring and enforcing contracts); costs related to replicating and transporting digital products; and the costs of verifying the identity and reputation of economic actors. As these costs decline, new business models and organisational structures emerge. Important questions to address in this context include:

- How will organisational models and firm-market boundaries evolve as products, processes and markets become increasingly digital? For example, where firms usually make rather than buy when information and input prices are uncertain (Coase, 1937[7]), online platforms facilitate buying rather than making by providing more information about prices, products and providers than in the past.
- What are the implications of evolving organisational structures for labour and product markets? If firms increasingly resemble agile networks, they may be able to more easily (re)allocate resources, scale up and down, and enter and exit markets, including internationally. Depending on policy settings, this could affect the broader business environment and market dynamics, as well as the form of the work carried out in future firms and/or markets.
- What are the broader implications of evolving firm and market organisation on society and well-being? More fluid markets and agile firms may favour mobile and flexible workers, including across jurisdictions, but many people may prefer stability and predictability, including in local communities. How can needed skills to succeed be best provided, and what broader social issues may arise, for example those affecting redistribution and social benefit policies?

Democracy in the information age

Digital technologies facilitate the faster dissemination of information to more people and places, but such information may be inaccurate or misleading. The increasing ubiquity of digital technologies like smartphones enables more and different kinds of social, political and civic connections between institutions and people. A related uncertainty is that even though societies are going digital very quickly, the norms and values governing behaviour online are still evolving. Finally, valid concerns persist regarding the use of personal data to target political messaging, raising concerns about the impact of digital technologies and data on democracy, including:

- How can governments build trust in institutions in the digital age? Public confidence in national governments across the OECD has been declining over time (OECD, 2017[8]), but the relationship between this trend and the use of digital technologies, and the consumption of information, is unclear.
- How to better address the spread of disinformation in the digital age? Deliberate campaigns to spread misleading or false information online with the explicit aim of influencing the democratic process have occurred in some countries, but their effectiveness or impact is not well understood. Advances in techniques to alter photographs, audio and video could potentially amplify such campaigns.
- How can individuals, governments and firms promote fundamental values and develop new cultural norms in an era of digitally driven cultural change? The ways in which people interact have changed fundamentally, but agreed upon standards for public discourse online have not yet emerged. Online, for example, laws governing freedom of expression are at least partially dependent on private firms for enforcement, raising questions about whether and to what extent private actors should be governing speech in public spaces.

Measuring digital transformation

Measurement frameworks are challenged by the global and interconnected nature of digital transformation, but potential lies in the granular use of firm-level data to complement traditional statistics (e.g. national surveys), particularly for new digitally enabled activities that were unforeseen when developing traditional measurement frameworks. In addition, it is likely that national statistical frameworks fail to capture many of the benefits of digital transformation for well-being, leading to biases (e.g. low productivity growth may fail to reflect welfare gains from digital technologies). The following questions need to be addressed both by researchers and policy makers:

- How to measure and track new digitally enabled activities, including e-commerce, cloud services and the Internet of Things, when their provenance may be uncertain? This may become increasingly difficult as digital activities become progressively inseparable from analogue activities.
- How can statistical frameworks best capitalise on data in the digital age, particularly if these data are held in private hands? Digital transformation could hold new potential for the development of new proxy measures or drive changes and efficiencies in traditional data collection methods.
- How should traditional metrics and statistical frameworks evolve in the digital age? For example, digital transformation enables more connections across borders, making it harder to allocate economic activity to a particular jurisdiction.

- How can the impacts of digital technologies on well-being be better measured, especially in the absence of suitable prices, and how can they be better reflected in core measurement tools?
- How can the international community best implement the Going Digital measurement roadmap (OECD, 2019[9])?

Reinforcing trust in government

Digital technologies have the potential to enhance societal well-being and help rebuild trust in government. Digital government strategies can increase civic engagement, while new data-driven tools can improve the responsiveness of both the public and private sector by helping tailor services to individuals' needs, for example in the provision of health care. To realise this potential for greater inclusiveness, digital divides need to be reduced, opportunities of digital transformation more widely shared, and risks better managed, particularly regarding labour market impacts and access to health care. Key challenges to address include:

- How can the provision of public goods and services evolve with changing risks and demands for protection and empowerment? The overall effects of digital transformation may be positive, but possible costs and risks may be unevenly distributed across generations (income and job tenure), regions (large and well-connected urban areas benefiting most due to agglomeration effects) and occupations (exposure to the likelihood of automation).
- How are citizens' expectations of government changing as a result of digital transformation? To regain public trust, governments must understand how individual needs are evolving and how public policy can best address these needs. Governments must also recognise how digital technologies are reshaping the perceptions, beliefs, values and norms that bind societies together and underpin support for tax and benefit systems.
- How can civic engagement give rise to more inclusive forms of policy making? Digital technologies can facilitate greater participation by citizens in all stages of the policy cycle, including the design and implementation phases, but it is important to ensure that such engagement is inclusive to avoid reinforcing existing or creating new digital divides.

Going Digital Phase 2 and beyond

As many questions remain unanswered, work is envisaged to continue under the OECD Going Digital project over 2019-20. This will enable more work to be undertaken on particular dimensions of the project. It will also open up new avenues of policy analysis and research, including with respect to the implications of two emerging technologies: blockchain and artificial intelligence.

An additional component of future work under the Going Digital project will include OECD Reviews of Digital Transformation, which assess national performance and readiness for the digital future. These reviews are based on the Going Digital Integrated Policy Framework (OECD, forthcoming[10]), which lies at the conceptual heart of the Going Digital project and structures many of its synthetic outputs, including this report and its companion publication, *Measuring the Digital Transformation: A Roadmap for the Future*. The framework should be revisited to ensure it remains a relevant and useful guide to developing and implementing policies in the digital age.

Another stream of work in Going Digital Phase 2 includes further work on online platforms. This work could focus on some of the main policy issues related to online platforms, such as the evolving nature of platform competition around the world, and the associated questions about the interface with policies governing privacy, taxation and consumer protection. What the new competitive landscape will likely be and how policy makers can best prepare to meet new challenges is an important area to study. Other possibilities include policy challenges related to online platforms' effects on human health, filtering to meet private and/or public standards, and the misuse of online platforms to spread misinformation and undermine democratic processes.

Finally, the Going Digital Toolkit will be elaborated. The toolkit will enable users to interactively engage with the Going Digital indicators as well as find practical advice on policy implementation, including innovative approaches and examples. Two potential promising areas to cover include:

- **Policy experimentation**. Digital business models may fall between the cracks of policy and regulatory frameworks, but developing new frameworks can be difficult in a fast-moving digital landscape. Jurisdictions across the OECD and beyond are experimenting with new regulatory approaches in the digital age, such as anticipatory regulation, performance-based regulation, agile regulation and regulatory sandboxes. Future work for the toolkit will evaluate such regulatory approaches and include innovative policy practices.
- **Education and training systems**. Skills have emerged as an important cross-cutting component that influences not only the use of digital technologies, but also work in the digital age and the ability to adequately participate in a digital society. However, countries are actively grappling with the question of how to develop mechanisms to build skills, not only in formal education and training systems, but throughout the life cycle. Policy approaches from across OECD countries and beyond would describe specific programmes and tools to boost skills development and the lessons learnt.

Note

1. Important issues related to the taxation of the digital economy are currently being addressed under the auspices of the OECD/G20 Base Erosion and Profit Shifting (BEPS) project and the Inclusive Framework on BEPS (see Chapter 8).

References

Acquisti, A., L. Brandimarte and G. Loewenstein (2015), "Privacy and human behavior in the age of information", *Science*, Vol. 347, Issue 6221, pp. 509-514, *http://dx.doi.org/10.1126/science.aaa1465*. [3]

Barth, S. and M. de Jong (2017), "The privacy paradox: Investigating discrepancies between expressed privacy concerns and actual online behavior – A systematic literature review", *Telematics and Informatics*, Vol. 34, Issue 7, pp. 1038-1058, *http://dx.doi.org/10.1016/j.tele.2017.04.013*. [4]

Coase, R. (1937), "The nature of the firm", *Economica, New Series*, Vol. 4, No. 16, pp. 386-405, *https://www.jstor.org/stable/2626876?seq=1#page_scan_tab_contents*. [7]

European Commission (2015), *Data Protection*, Special Eurobarometer 431, European Union, Brussels, *http://ec.europa.eu/commfrontoffice/publicopinion/archives/ebs/ebs_431_en.pdf*. [2]

OECD (2019), *Measuring the Digital Transformation: A Roadmap for the Future*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264311992-en*. [9]

OECD (2017), *Government at a Glance 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/gov_glance-2017-en*. [8]

OECD (2015), *Data-driven Innovation: Big Data for Growth and Well-being*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264229358-en*. [5]

OECD (2013), "Privacy Expert Group report on the review of the 1980 OECD Privacy Guidelines", *OECD Digital Economy Papers*, No. 229, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5k3xz5zmj2mx-en*. [6]

OECD (2013), *Recommendation of the Council Concerning Guidelines Governing the Protection of Privacy and Transborder Flows of Personal Data*, OECD, Paris, *http://www.oecd.org/sti/ieconomy/2013-oecd-privacy-guidelines.pdf*. [1]

OECD (forthcoming), "Going Digital: An integrated policy framework for making the transformation work for growth and well-being", *OECD Digital Economy Papers*, OECD Publishing, Paris. [10]

List of Figures

Chapter 1 **UNDERSTANDING DIGITAL TRANSFORMATION**
1.1. An ecosystem of interdependent digital technologies 18
1.2. Consumer Internet videos make up almost half of global IP traffic 23

Chapter 2 **ENHANCING ACCESS**
2.1. There are more mobile broadband subscriptions than people in the OECD 38
2.2. Connected devices are on the rise 39
2.3. Investing in fibre backhaul can increase speeds across all technologies 40
2.4. Barriers to entry and competition are the most common telecommunication services trade restrictions 43
2.5. Rural areas lag behind urban and other areas in broadband access at sufficient speeds 44

Chapter 3 **INCREASING EFFECTIVE USE**
3.1. Significant scope remains for more people to become sophisticated Internet users 52
3.2. The uptake of digital government services differs significantly across countries 54
3.3. Large potential remains for diffusion of digital tools among firms, especially small and medium-sized enterprises 55
3.4. The gap in multi-factor productivity growth is widening 56
3.5. Many adults lack sufficient problem-solving skills for technology-rich environments 59
3.6. Security concerns deter online engagement 60

Chapter 4 **UNLEASHING INNOVATION**
4.1. Digital-intensive sectors have higher churn 68
4.2. The ICT sector attracts VC investment 70
4.3. R&D, especially in information industries, is a key driver of digital innovation 71
4.4. Many countries lag behind in ICT patenting 72
4.5. Much potential exists to further open up public sector data 75

Chapter 5 **ENSURING GOOD JOBS FOR ALL**
5.1. A significant share of jobs could be affected by automation 86
5.2. Digital-intensive sectors contribute to job creation 87
5.3. Labour markets have polarised in nearly all OECD countries 88
5.4. Key fields of study to prepare people for a digital world of work 90
5.5. Fewer low-skilled workers receive training than medium- and high-skilled workers 92
5.6. Active labour market spending differs significantly across countries 94

Chapter 6 **PROMOTING SOCIAL PROSPERITY**
6.1. More young men than women can program 104
6.2. Foundational skills, like science, numeracy and literacy, are essential skills for life 105
6.3. E-waste production and recycling varies across countries 107
6.4. Computers and work stress go hand-in-hand 109
6.5. Social networking is prevalent 111
6.6. Many children across the OECD report having experienced cyberbullying 111
6.7. Reported exposure to disinformation varies across the OECD 112

Chapter 7 **STRENGTHENING TRUST**
7.1. Privacy violations vary considerably across countries 122
7.2. Payment security and privacy concerns remain prevalent in many countries 124
7.3. Goods ordered online still raise consumer protection concerns for many people 126
7.4. Consumers tend to trust peer platforms 127

Chapter 8 **FOSTERING MARKET OPENNESS**
8.1. E-commerce is expanding across borders 134
8.2. Trade is strong in digitally deliverable services 135
8.3. Measures restricting trade in services that enable digital delivery are primarily related to infrastructure and connectivity 136
8.4. Barriers to FDI vary across countries 138
8.5. Firms in digital-intensive sectors have higher and growing mark-ups than other firms 140

Chapter 9 **DEVELOPING A DIGITAL TRANSFORMATION STRATEGY**
9.1. High-level strategic co-ordination of digital transformation policies 148
9.2. Ministry level strategic co-ordination of digital transformation policies 148
9.3. Ensuring coherence between a digital transformation strategy and other strategies 149
9.4. Assessing where your country stands: Monitoring and evaluation 150

List of Tables

Chapter 1 **UNDERSTANDING DIGITAL TRANSFORMATION**
1.1. Vectors of digital transformation: Scale, scope and speed 27
1.2. Vectors of digital transformation: Ownership, assets and economic value 28
1.3. Vectors of digital transformation: Relationships, markets and ecosystems 29

List of Boxes

Chapter 1 **UNDERSTANDING DIGITAL TRANSFORMATION**
1.1. What is digital transformation? 18
1.2. Content delivery networks and local caching of data 24
1.3. Disentangling different types of data 24
1.4. Business models based on digital payment innovations 28
1.5. Business models that combine online and offline features 29
1.6. Business models using online platforms 30

Chapter 3 **INCREASING EFFECTIVE USE**
3.1. Public-private co-operation on the collection of value-added tax on online sales 53
3.2. Uneven adoption and diffusion of digital technologies help explain the digital "productivity paradox" 56
3.3. Support and better target policies to small and medium-sized enterprises 57

Chapter 4 **UNLEASHING INNOVATION**
4.1. Open science ... 73
4.2. The Fintech revolution ... 76
4.3. The digitalisation of agriculture ... 77

Chapter 5 **ENSURING GOOD JOBS FOR ALL**
5.1. Digital learning tools for adult and life-long learning ... 90

Chapter 6 **PROMOTING SOCIAL PROSPERITY**
6.1. Making growth inclusive in the digital age ... 106
6.2. Artificial intelligence in society ... 110

Chapter 7 **STRENGTHENING TRUST**
7.1. What is trust? ... 120
7.2. Trust in peer platform markets ... 126
7.3. Consumers and the Internet of Things ... 128

Chapter 8 **FOSTERING MARKET OPENNESS**
8.1. What is digital trade? ... 136

Chapter 9 **DEVELOPING A DIGITAL TRANSFORMATION STRATEGY**
9.1. The multi-stakeholder model: A key to good policy making in the digital age ... 152
9.2. Using digital technologies to improve policy making, implementation and evaluation ... 153

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where governments work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, Chile, the Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The European Union takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

OECD PUBLISHING, 2, rue André-Pascal, 75775 PARIS CEDEX 16
(92 2019 02 1 P) ISBN 978-92-64-31200-5 – 2019

Going Digital: Shaping Policies, Improving Lives

Digital technologies and data are transformational. People, firms and governments live, interact, work and produce differently than in the past, and these changes are accelerating rapidly. How can we realise the immense promises of digital technologies and data for growth and well-being in a fast evolving world? This report charts the road ahead. It identifies seven policy dimensions that allow governments – together with citizens, firms and stakeholders – to shape digital transformation to improve lives. It also highlights key opportunities, challenges and policies related to each dimension, offers new insights, evidence and analysis, and provides recommendations for better policies in the digital age.

Contents

- Chapter 1. Understanding digital transformation
- Chapter 2. Enhancing access
- Chapter 3. Increasing effective use
- Chapter 4. Unleashing innovation
- Chapter 5. Ensuring good jobs for all
- Chapter 6. Promoting social prosperity
- Chapter 7. Strengthening trust
- Chapter 8. Fostering market openness
- Chapter 9. Developing a digital transformation strategy
- Chapter 10. Defining a future digital agenda

A companion report, *Measuring the Digital Transformation: A Roadmap for the Future*, includes additional related indicators and outlines a future measurement agenda (*https://doi.org/10.1787/9789264311992-en*). The Going Digital Toolkit allows users to visualise and explore further key Going Digital indicators, as well as browse policy guidance and read related publications: *www.oecd.org/going-digital-toolkit*.

This publication is a contribution to the OECD Going Digital project which aims to provide policy makers with the tools they need to help their economies and societies prosper in an increasingly digital and data-driven world.

For more information, visit ***www.oecd.org/going-digital***

#GoingDigital

OECD*publishing*
www.oecd.org/publishing

ISBN 978-92-64-31200-5
92 2019 02 1P