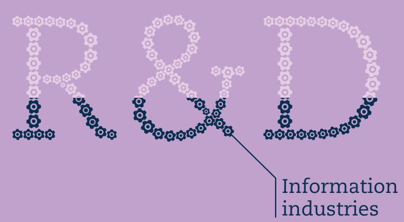
Chapter 4

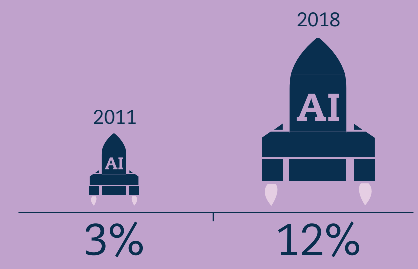
UNLEASHING INNOVATION

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



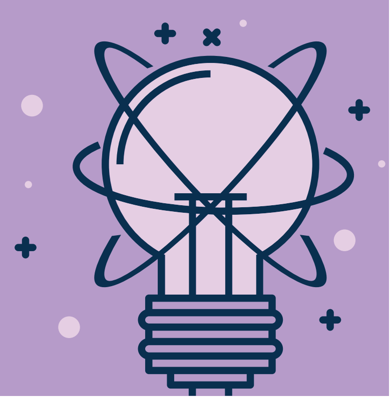
Foster innovation through investment in R&D, especially in information industries.

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

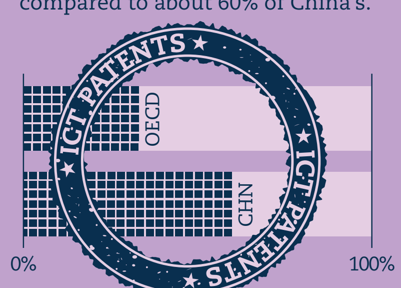


Harness the potential of digital technologies for innovation and science.

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.

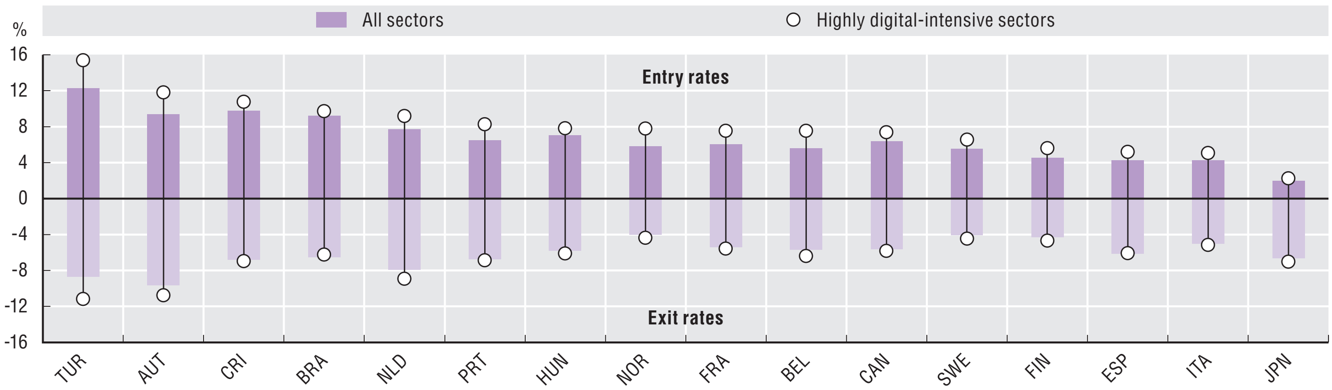
Promote start-ups and young firms

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).

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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.

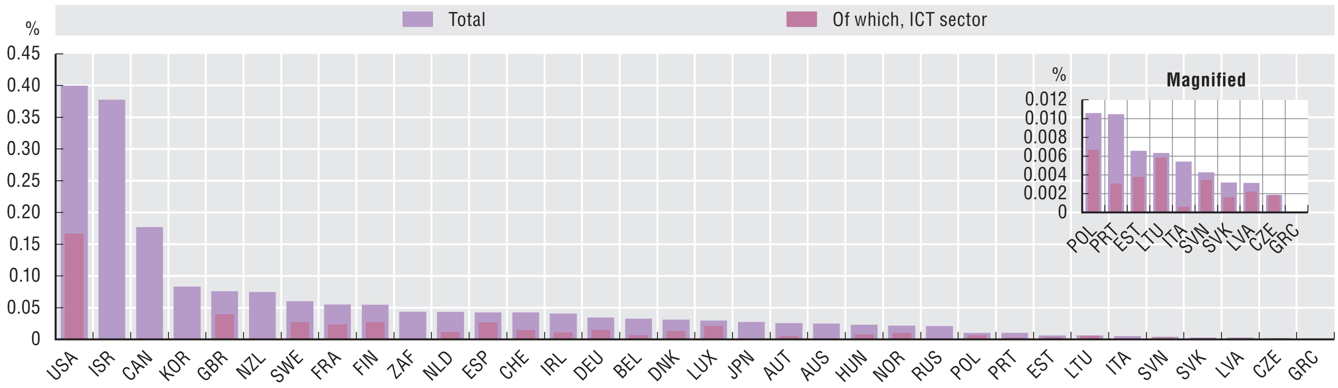
Venture capitalists can help bridge the financing gap that arises from the fact that early adopters (e.g. young firms) often lack internal funds and a track record to signal their "quality" to investors (Hall and Lerner, 2009[21]). Research has shown that cross-country differences in the availability 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).

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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]).

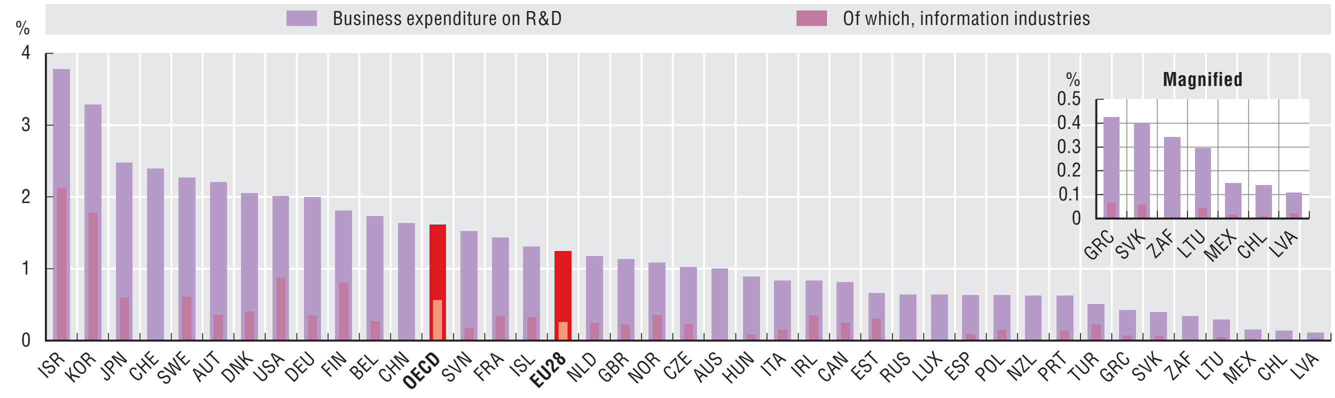
The public sector also helps drive innovation beyond research. For example, the government has an important role in helping SMEs to understand and eventually adopt emerging technologies. Further downstream, government certification of technologies, such as 3D printing, will support their diffusion by 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]

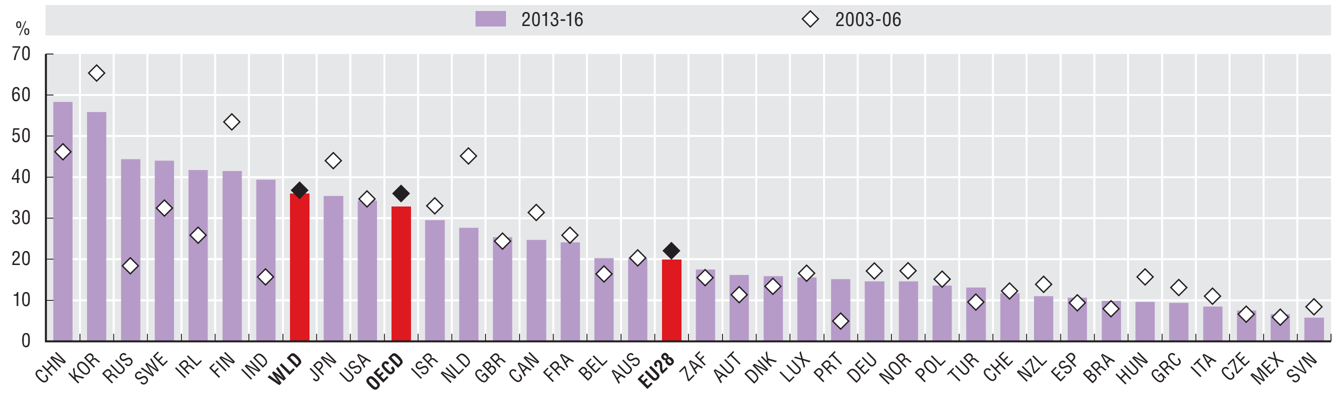
Source: OECD (2019[4]), *Measuring the Digital Transformation*, *https://dx.doi.org/10.1787/9789264311992-en*, based on OECD, *ANBERD* (database), *http://oe.cd/anberd* (accessed December 2018); OECD, *Main Science and Technology Indicators* (database), *http://oe.cd/msti* (accessed July 2018).

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).

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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.

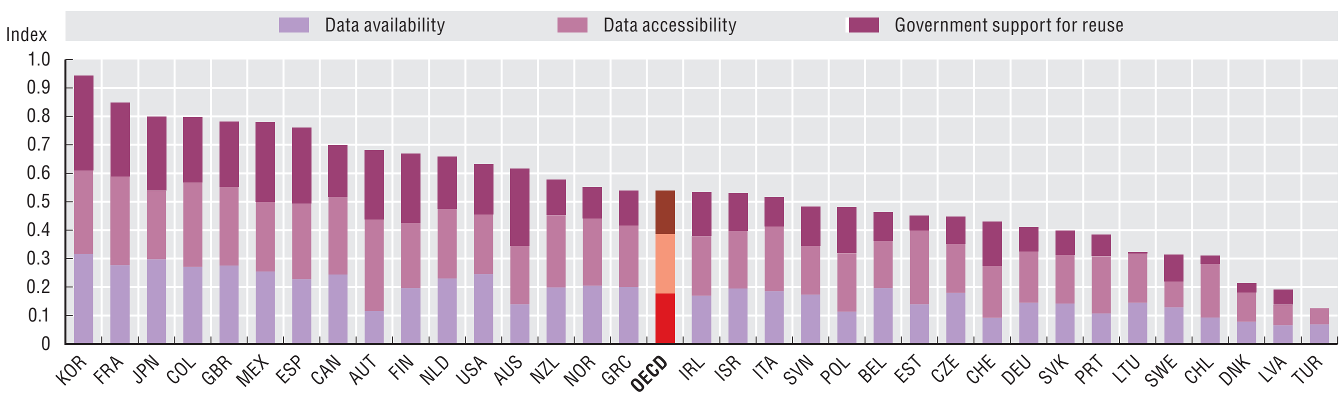
One of the most important things that the public sector can do to drive innovation is to enhance access to public sector data. Efforts to open government data involve making information collected using public funds freely available and in common formats such that they can be easily queried and interrogated (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.

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