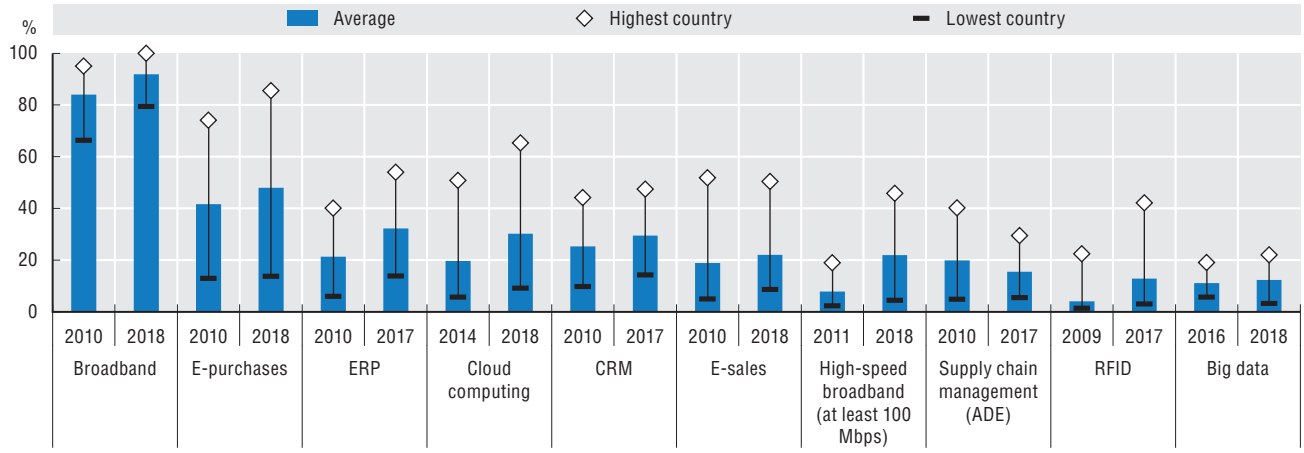
Fast adopters and the diffusion of technology

Most organisations use digital tools, but often not to their full potential. A number of major transformations – often collectively referred to as the "next production revolution" – are anticipated over the coming decade. The technological drivers of this revolution include the development of digital infrastructure and applications, such as high-speed broadband, Big data, cloud computing, 3D printing and the Internet of Things (IoT). Such technologies are increasingly affordable for smaller businesses. However, for technology diffusion to lead to productivity gains, firms must integrate the technology into their business processes and make complementary investments in skills and business models.

Recent surveys of ICT technology show that broadband access has reached saturation in large businesses. However, on average, only 20% of businesses in OECD countries benefited from high-speed broadband (100 Mbps or greater) in 2018. The adoption of digital technologies in business value chains, whether for purchases, sales or the automation of back office functions (ERP), has progressed smoothly, albeit with large differences between countries and sectors. Cloud computing services has registered the fastest increase in uptake – 50% over the four years to 2018 – when, on average, 56% of large businesses and 27% of small businesses purchased cloud computing services. A recent OECD study (Galindo-Rueda et al., 2019) based on analysis of micro-data from the Statistics Canada Survey of Advanced Technologies finds that larger firms tend to make greater use of advanced technologies, especially automated production process technologies, for which scale appears to be very important. In contrast, software and infrastructure service technologies (including cloud computing) register similar rates of uptake in both small and large Canadian firms.

18. Diffusion of selected ICT tools and activities in enterprises, OECD, 2010 and 2018

As a percentage of enterprises with ten or more persons employed

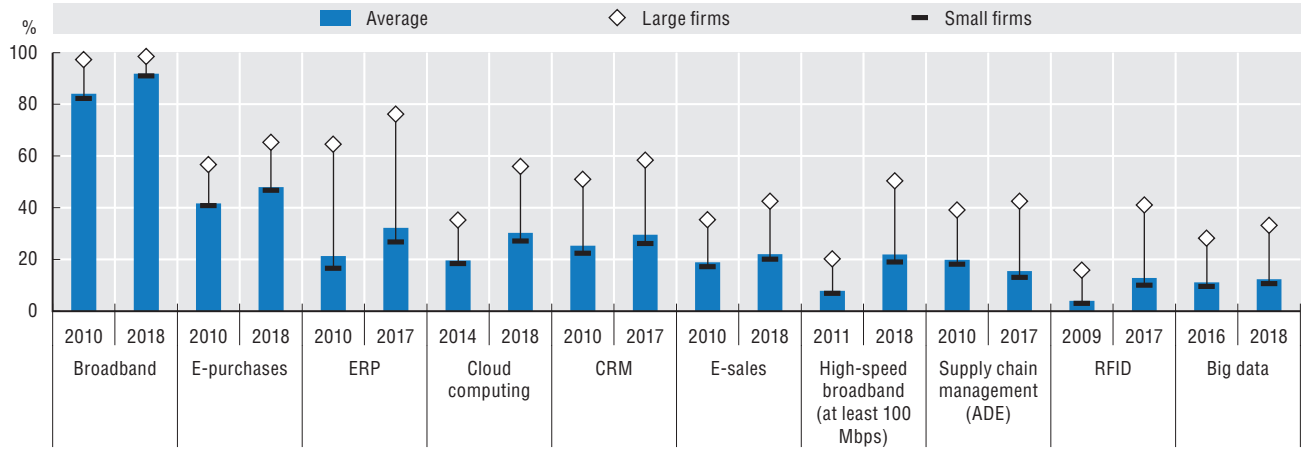


Source: OECD, ICT Access and Usage by Businesses Database, http://oe.cd/bus, January 2019. See chapter notes. StatLink contains more data.

StatLink https://doi.org/10.1787/888933928597

19. Diffusion of selected ICT tools and activities in large and small businesses, OECD, 2010 and 2018

As a percentage of enterprises with ten or more persons employed



Source: OECD, ICT Access and Usage by Businesses Database, http://oe.cd/bus, January 2019. See chapter notes. StatLink contains more data.

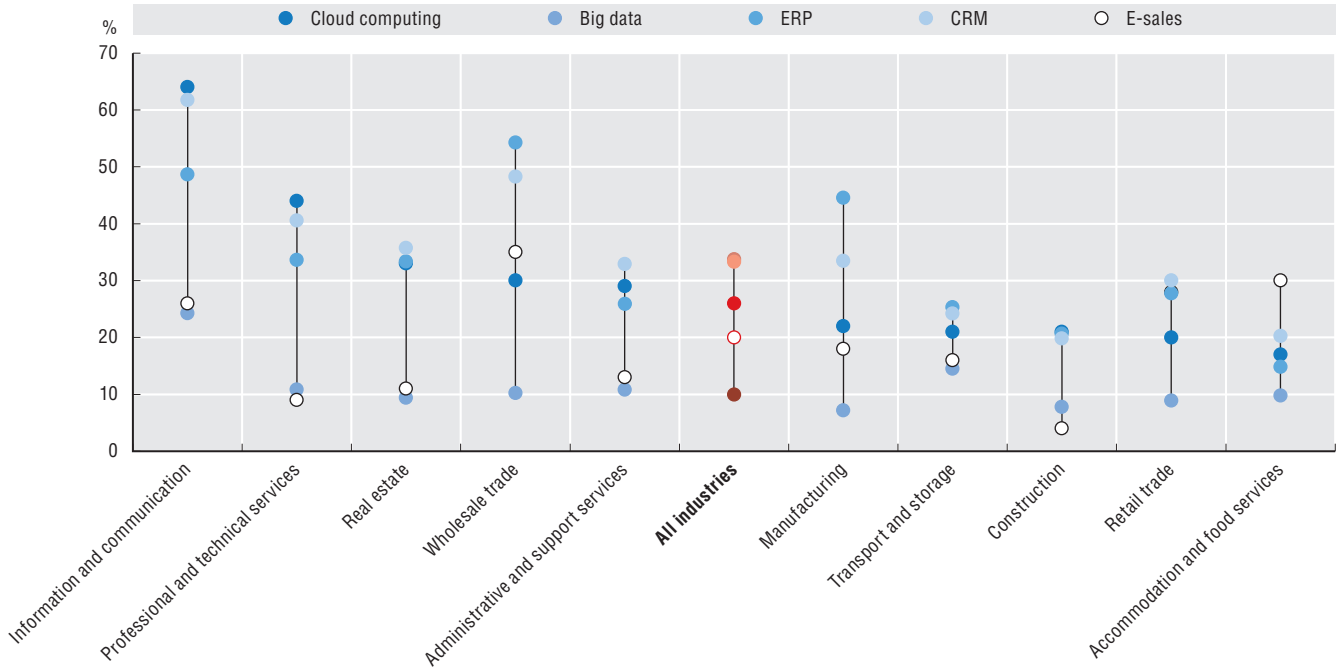
StatLink https://doi.org/10.1787/888933928616

Digital transformation in industry

Every industry is affected by the digital transformation but no single metric is able to capture its pace and extent. Due to their pervasive nature, digital technologies are profoundly transforming economies and societies. The innumerable ways in which the digital transformation is affecting production activities, both manufacturing and services, impede efforts to provide an all-encompassing definition of this multifaceted phenomenon. Recent OECD work (Calvino et al., 2018) assesses the digital intensity of sectors by looking at the technological components of digitalisation (tangible and intangible ICT investment, purchases of intermediate ICT goods and services, robots), the human capital required to embed technology in production (ICT specialist intensity), and the ways in which digital technology impacts how firms interface with the market (online sales). While the digital transformation progressively touches all sectors in the economy, it does so with differing speeds and extents. Only one sector, ICT services, stands out as being the most digital-intensive, as measured by the seven different metrics of sector digital intensity (OECD, 2017). European data from ICT use in business surveys, which allows a granular look at uptake of digital technologies along business value chains, shows that ICT services is the most digital-intensive sector. The presence of websites is rather high for businesses in every sector, and hence does not explain sectoral variations, while the use of Big data analytics is still in its infancy in almost all industries. What really discriminates digital intensity across sectors is the use of more sophisticated digital tools such as cloud computing, enterprise resource planning (ERP), and customer relations management (CRM).

20. ICT uptake by industry, EU28, 2018

As a percentage of enterprises with ten or more persons employed in each industry



Source: OECD, based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes. StatLink contains more data.

StatLink https://doi.org/10.1787/888933928635

Calculating indexes of digital maturity: an experiment

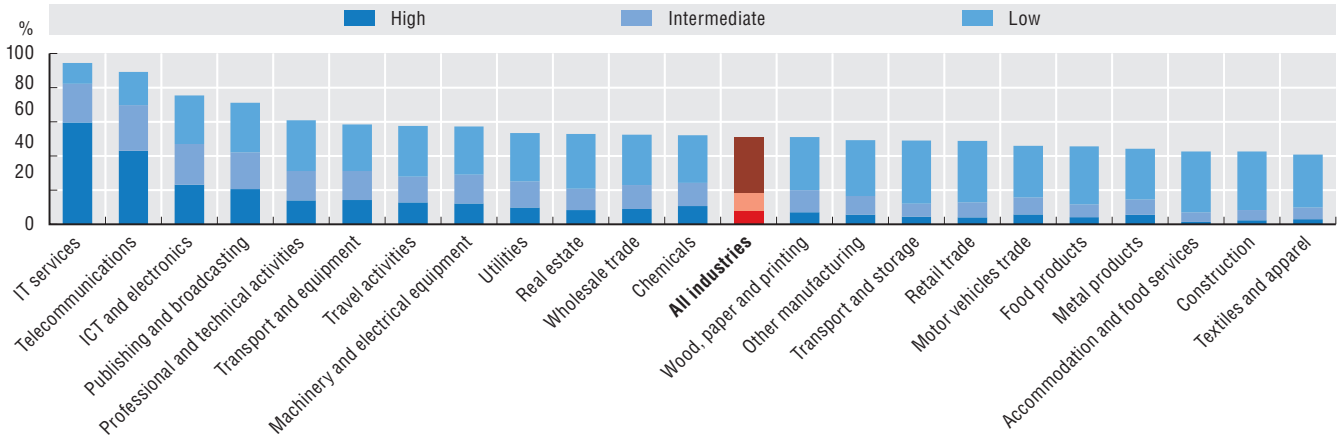
To analyse different aspects of the diffusion of digitisation in business, the OECD and Eurostat worked with participating countries to produce special tabulations of data from the 2018 European Community Survey on ICT Usage and E-commerce in Enterprises. As presented on the following page, these focus on the co-occurrence of different items along three dimensions of maturity and sophistication. *ICT capabilities*: (i) ICT training of staff, (ii) the employment of ICT specialists, and (iii) in-house performance of ICT functions (as opposed to contracting-out). *Advanced ICT functions*: (i) ICT security and data protection activities, (ii) tailoring of business management software and (iii) the development of web solutions. *Web maturity*: (i) having a website which allows for product customisation or tracks orders/visitors, and (ii) whether or not the business uses online advertising services. Enterprises were assigned a score for each based on the number of items present - from 0 (no items) to the joint occurrence of all 3 items (2 for Web maturity).

Digital maturity in industries

Businesses in Europe still have yet to exploit the full potential of the digital transformation. On average, 50% of all enterprises in the business sector, excluding financial services, have no specific *internal* ICT capabilities as measured by the availability of specific human capital. In ICT industries, such as IT services and telecommunications, 40% to 80% of enterprises possess *at least* intermediate capabilities. This compares to an overall average of 20%, while in relatively low-tech areas such as textile and apparel manufacturing and transport and storage services have rates around 10%. *ICT capabilities* tend to be associated performing of *advanced ICT functions*, but the relationship of both with *Web maturity* is weaker. Based on these benchmarks, which give only a partial view of digitalisation in firms, there are leading sectors (information and communication, travel, wholesale trade) and relative laggards (construction services and food, textile, and metal manufacturing industries). Retail trade and accommodation score high for *Web maturity*, while medium-high tech manufacturing industries, such as machinery, ICT, and electrical manufacturing, as well as professional and technical services are more oriented towards the integration of ICT applications within business processes.

21. Enterprises with internal ICT capabilities, by industry, EU countries, 2018

As a percentage of enterprises with ten or more persons employed in each industry

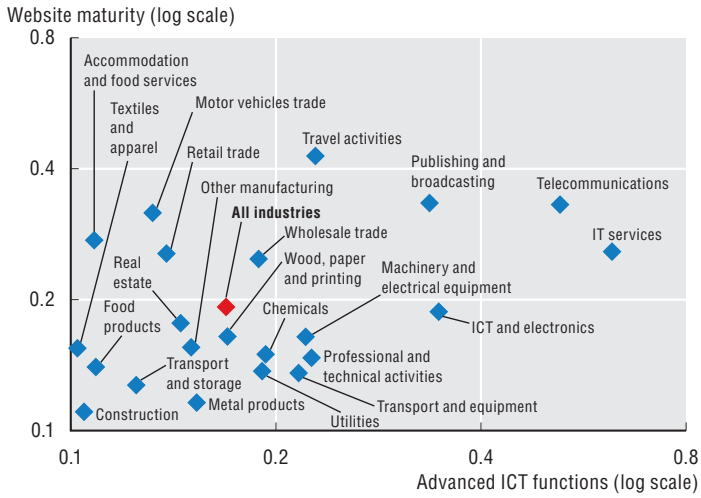


Source: OECD calculations based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928654

22. Web maturity and advanced ICT functions, by industry, EU countries, 2018

Synthetic measure of uptake in firms with ten or more persons employed



Source: OECD calculations based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes. StatLink contains more data.

StatLink https://doi.org/10.1787/888933928673

How to read these charts

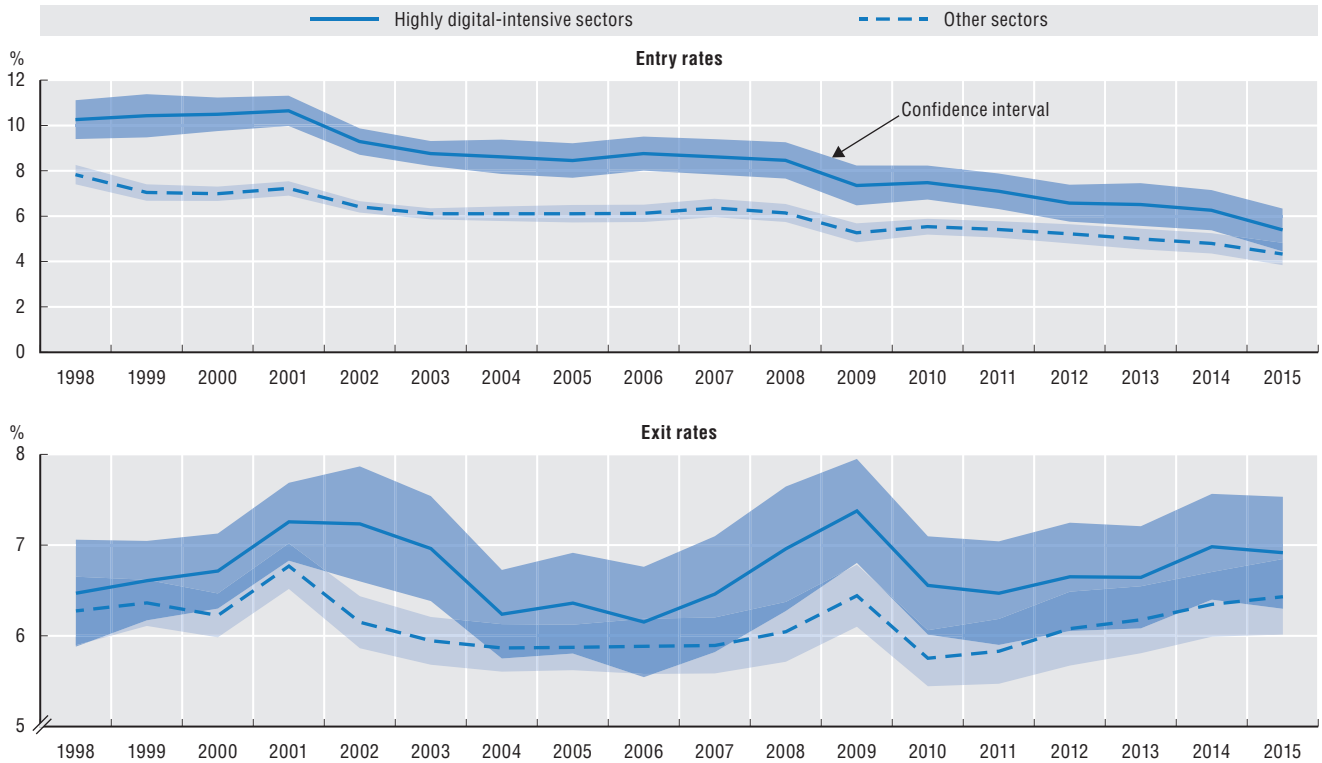
ICT capabilities are characterised as "high" when all 3 items are present, "medium" for 2 items and "low" when only 1 of the items occurs. The scatterplot presents a synthetic measure of uptake for Web maturity and Advanced ICT functions. It shows the sum of percentage shares of enterprises for each dimension divided by the theoretical maximum value (i.e. 2 or 3), to create a normalised indicator varying from 0 to 1. See "Calculating indexes of digital maturity: an experiment" on previous page.

Business dynamics and the digital transformation

Business dynamism in highly digital-intensive sectors is high but declining. While business dynamism is, on average, greater in highly digital-intensive sectors, these sectors have also experienced more significant declines in business dynamism over time – especially in terms of firm entry rates. Recent OECD work shows that highly digital-intensive sectors are more dynamic than other sectors on average – consistent with the idea that digital technologies lower entry barriers and tend to facilitate reallocation – but have experienced significant declines in dynamism since 2001, especially in terms of entry and job reallocation rates. This appears to be related, in part, to the fact that while diffusion of digital technologies continues everywhere, in highly digital-intensive sectors – where these technologies have particularly advanced application – it reaches a stage of higher technological maturity. This process is similar to past trends in other innovative sectors, and holds across countries, although there are significant differences between countries in the patterns and dynamics of highly digital-intensive sectors. In this context, institutional and policy factors, such as workers' training, the availability of venture capital, and the efficiency of business and bankruptcy regulations, play an important role in business dynamism in these sectors (Calvino and Criscuolo, 2019).

23. Changes in business dynamism, entry and exit rates, 1998-2015

Average trends within country-sector, highly digital-intensive and other sectors



Note: Sectors are classified by digital intensity (high/medium-high/medium-low/low) using a number of dimensions (ICT investment and ICT intermediates, use of robots, online sales and ICT specialists) and then grouped by quartile.
Source: OECD calculations based on the DynEmp v.2 (USA) and the DynEmp3 Databases, http://oe.cd/dynemp, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928692

OECD project on employment dynamics, young businesses and allocative efficiency (DynEmp)

The approach adopted by the DynEmp project is based on a common statistical code developed by the OECD, which is run in a decentralised manner by national experts from statistical agencies, academia, ministries or other public institutions, who have access to the national micro-level data. The micro-aggregated data generated by the centrally designed but locally executed program codes are then sent back for comparative cross-country analysis to the OECD. This distributed micro-data approach reduces confidentiality concerns as it aggregates information at a sufficiently high level, and achieves a high degree of harmonisation as the definition of the extracted information is the same, ensured by the centrally written computer routine. The experts also implement country-specific disclosure procedures in order to ensure that confidentiality requirements are respected. The figures shown are based on the second (DynEmp v.2) and third wave of data collection (DynEmp3) in the DynEmp project.

Mark-ups in the digital era

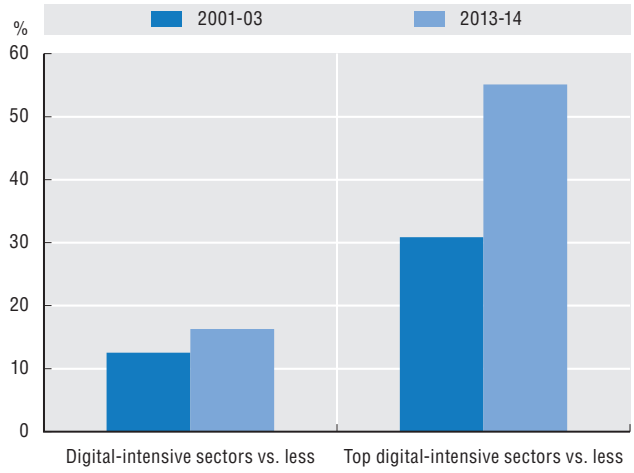
In recent years, there has been growing concern that markets around the world are becoming more concentrated and less competitive. This is sometimes attributed to the increasingly digital and globalised nature of many markets and the firms that operate within them (OECD, 2018). Digital technologies allow firms to access multiple geographical and product markets almost instantaneously, sharing ideas and exploiting increasing returns to scale, especially from intangible assets. Digital technologies are generally associated with lower costs of operations and of entry into a market, even across borders, thus potentially increasing competition among firms for the market itself. They foster the emergence of new business models, such as platforms, which further facilitate entry into other, non-digital markets, as happened in the case of Airbnb in the accommodation industry or Amazon in the retail sector.

Digital technologies can also potentially increase the market power of some firms at the expense of others. As with other general-purpose technologies, digital technologies do not diffuse instantaneously, and require complementary investments in intangible assets (e.g. in human capital and organisational capabilities) to be adopted. These knowledge-based assets are costly at the start and can take time to integrate into business models and processes. This may open a gap between leading and laggard firms. Moreover, once knowledge has been accumulated, it can be re-used without cost, allowing companies to scale up faster and more easily, and to generate increasing returns to scale. In addition, digital-intensive companies can leverage Big data analytics for targeted marketing, thus better maximising their sales. Many digital services also increase in value when the number of people using them increases (network effects), such that a potential competitor cannot extract the same level of profit until it attracts a sizeable share of the market. Over time, these characteristics may help industry leaders sustain and advance their position, and slow down the entry or growth of competitors.

According to recent OECD analysis following Calligaris et al. (2018), firms in digital-intensive sectors enjoy on average 13% to 16% higher mark-ups – 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 firms in less digital-intensive sectors (everything else held constant). Additionally, the wedge between the average mark-up of firms in the two groupings has grown over time. Lastly, the gap is significantly larger (up to 55%) and has increased more over time when comparing firms operating in highly digital-intensive sectors versus those in other sectors. The same analysis shows that the digital gap in firm mark-ups decreases in magnitude but remains significant when differences in international competition, intensity in intangible assets and firm patenting are taken in consideration.

24. The increasing wedge in mark-ups between firms in digital-intensive and less digital-intensive industries, 2001-03 and 2013-14

Average percentage differences at the beginning and at the end of the sample period



Note: 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). Mark-ups are estimated from a Cobb Douglas production function. With respect to Calligaris et al. (2018), 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 firm level. All coefficients are significant at the 1% level.
Source: OECD elaborations on Calligaris et al. (2018), based on Orbis® data, July 2018.

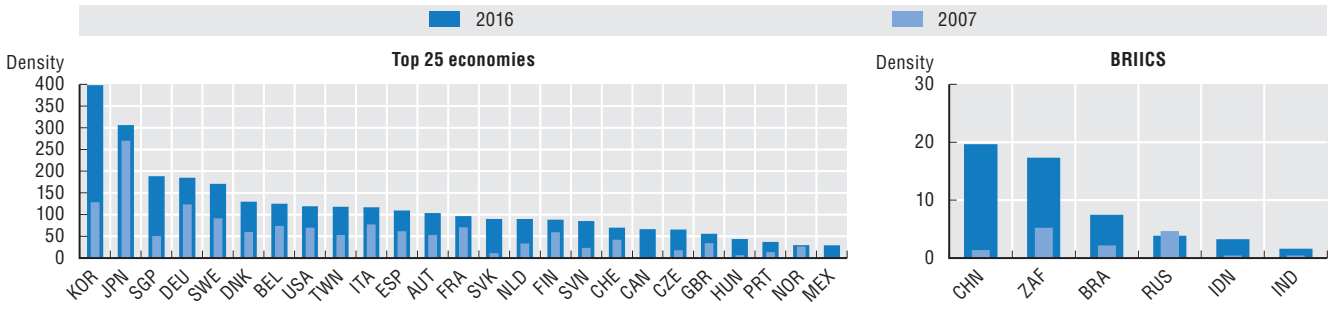
StatLink https://doi.org/10.1787/888933928711

Transforming production

Robots, including service robots, are transforming manufacturing. Advances in fields such as Big data, 3D printing, machine-to-machine communication, and robots are transforming production. Comparable and representative data on the deployment of industrial robots in 2016 show that Korea and Japan lead in terms of robot density in manufacturing (i.e. the stock of robots relative to employment). Robot density in these economies is about three times that of the average OECD country. The average density in BRIICS (Brazil, the Russian Federation, India, Indonesia, China and South Africa) is significantly lower, but has increased at twice the pace of the average of the top 25 economies between 2007 and 2016. Sales of service robots are also on the rise. In 2018, the International Federation of Robotics (IFR) identified more than 700 service robot manufacturers, both for professional and personal use (IFR, 2018). For the first time, statistics on the use of both industrial and service robots, and of 3D printing have been collected within European surveys of business ICT usage. In 2018, on average, 7% of respondent enterprises with more than ten employees were deploying robots, and 4% used 3D printing. The highest penetration rates are observed in manufacturing of metal products, chemical products and machinery.

25. Top robot-intensive economies and BRIICS, 2016

Stock of robot units per 10 000 employed persons, manufacturing sector

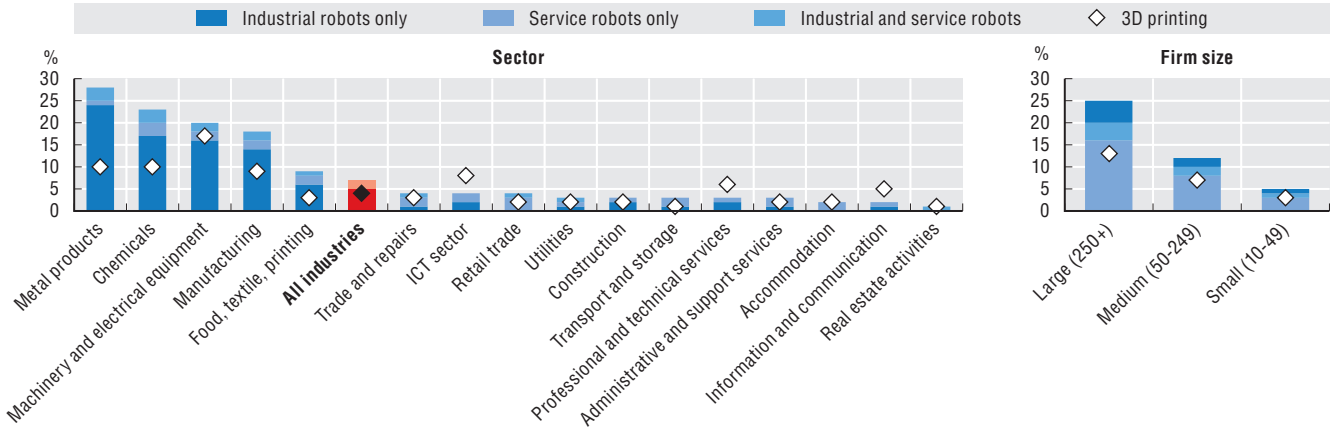


Source: OECD calculations based on International Federation of Robotics (IFR); OECD Annual National Accounts Database; OECD Structural Analysis (STAN) Database, http://oe.cd/stan; OECD Trade in Employment (TiM) Database; ILO, Labour Force Estimates and Projections (LFEP) Database and national sources, December 2018.

StatLink https://doi.org/10.1787/888933928730

26. Diffusion of robots and 3D printing in enterprises, by sector and firm size, EU28, 2018

As a percentage of enterprises in each category with ten or more persons employed



Source: OECD, based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928749

What is a robot?

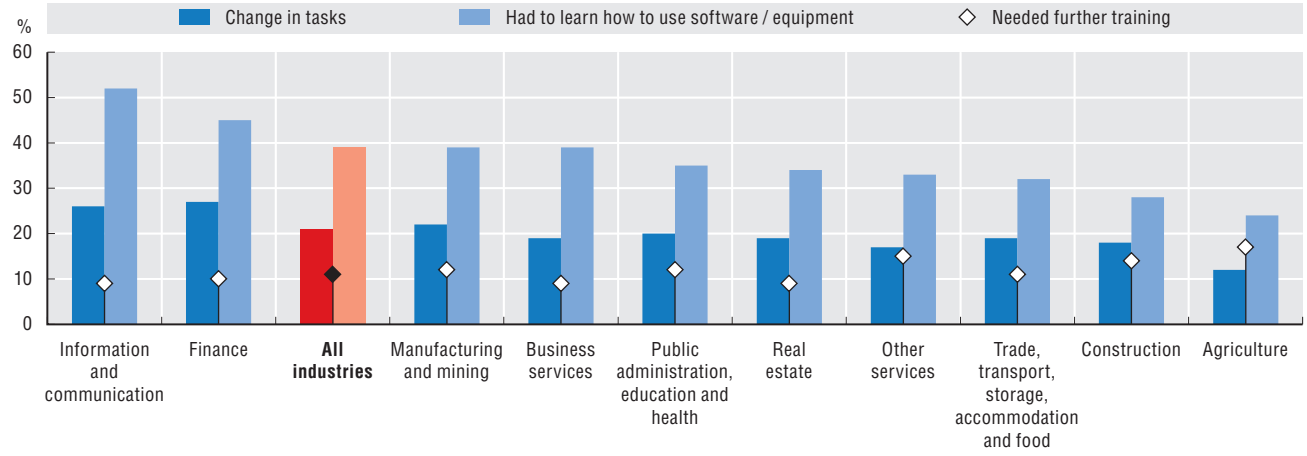
An industrial robot is defined by ISO 8373:2012 as "an automatically controlled, reprogrammable, multipurpose manipulator programmable on three or more axes, which can be either fixed in place or mobile for use in industrial automation applications". A "service robot" is a robot "that performs useful tasks for humans or equipment excluding industrial automation applications". (ISO 8373). The International Federation of Robotics collects information on shipments (counts) of industrial robots from almost all existing robot suppliers worldwide. No information on service robots is currently available. The measure of the stock of robots displayed above has been calculated by taking the first-year stock value from the IFR, adding the sales of robots for subsequent years and assuming a 10% annual depreciation. Consequently, these metrics do not capture increases in the quality of robots or their ability to perform tasks.

Transforming the world of work

Digital technologies are perceived as having diverse impacts in the workplace; in particular, their adoption is resulting in more time being spent on learning new tools and acquiring new skills. In 2018, more than half of workers in EU countries were using ICTs in their daily work. The introduction of digital tools in the workplace entails learning and adaptation and also affects workers' tasks and work organisation. In 2018, 40% of workers in the EU had to learn to use new software or ICT tools, and about one-in-ten needed specific training to be able to cope with those changes. The percentage of workers who had to learn new digital tools and the percentage who perceived changes in their work tasks were highest in ICT and finance services and in manufacturing. About 20% of workers using digital tools perceived changes in their work tasks, with the majority of them experiencing greater autonomy in organising tasks. The introduction of new digital tools, on balance, resulted in a decrease in repetitive tasks, yet 15% of workers using ICT technologies report experiencing an increase in such tasks. Workers found it easier to collaborate with colleagues but also felt their performance was more closely monitored. They often found that they needed to devote more time to acquire new skills and increased working of irregular hours was also reported. Important differences exist across countries, in particular in relation to ease of collaboration and the need to devote more time for the acquisition of skills.

27. Impacts of new software or computerised equipment at work, by industry, EU countries, 2018

As a percentage of individuals using digital tools at work

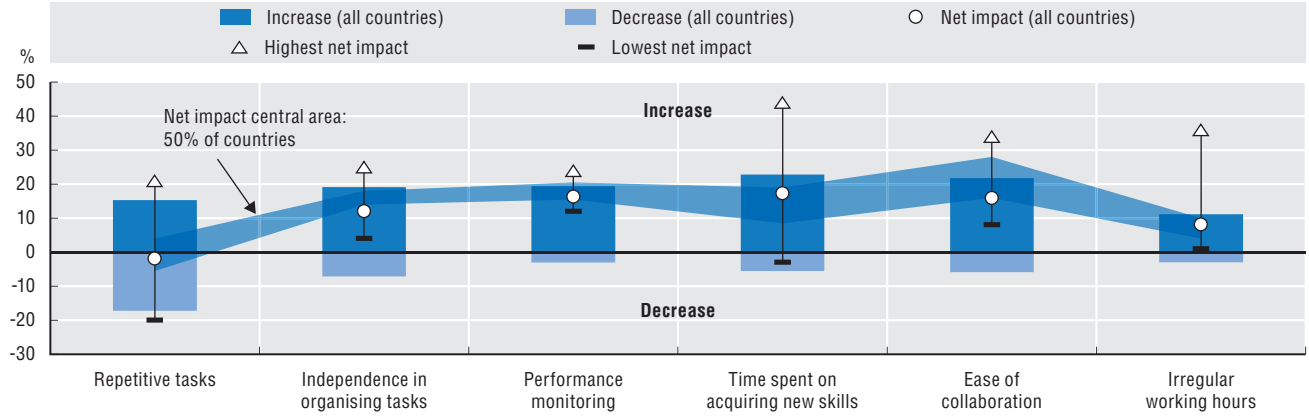


Source: OECD calculations based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928768

28. Perceived impacts of digital technologies on specific aspects of work, EU countries, 2018

As a percentage of individuals using digital tools at work



Source: OECD based on Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes.

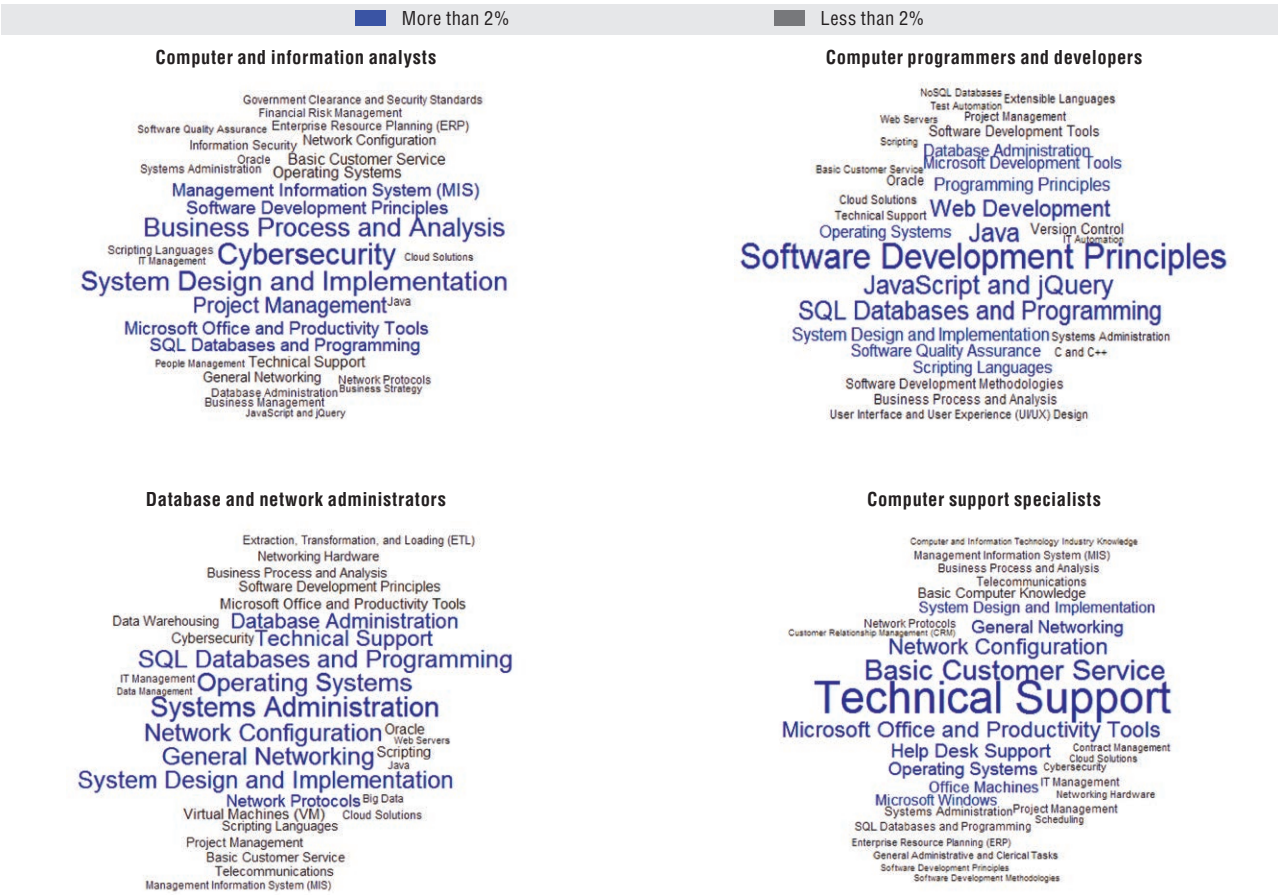
StatLink https://doi.org/10.1787/888933928787

Which skills for computer jobs?

Computer specialists are sought after, but even this narrowly defined category of jobs requires a wide array of skills – some general, some specific and many changing over time. As jobs change, so do the skills workers need to perform them. This is true for all jobs, including those in high demand, such as computer-related jobs. Burning Glass Technologies' data on online job postings shed light on the types of skills in demand and on how the skills profiles of occupations change over time. An analysis of 1.8 million job postings in the United States in 2018 for four computer-related occupations points to the types of skills in highest demand for each occupation and the types of skills for which demand has been growing fast over 2012-18. On average, one or more of up to about 500 different skills were demanded for job openings posted in these computer-related occupations, thus highlighting the heterogeneous nature of these jobs. Among the 30 skills in highest demand, some are relevant for all four occupational categories, such as knowledge of Structured Query Language (SQL) tools, system design and implementation, or software development principles. Skills related to cybersecurity are important for both computer and network specialists. The demand for some skills cuts across several of these occupations, including skills related to Java, JavaScript, and jQuery – a computer language that creates "applets" (applications designed to be transmitted over the Internet and executed by a java-compatible web browser). These skills are in high demand for computer programmers and developers, while skills related to basic customer service and help desk support are in high demand when posting vacancies for computer support specialists.

29. Top-demanded skills in computer-related jobs, United States, 2018

Top 30 skill categories demanded in online job postings



Note: The word clouds display the top 30 skills demanded in each of the occupational categories considered. The size of the words mirrors the relative frequency with which words appear. Words appearing in more than 2% of the cases in the category considered are displayed in blue.
Source: OECD calculations based on Burning Glass Technologies, www.burning-glass.com, January 2019. See chapter notes.

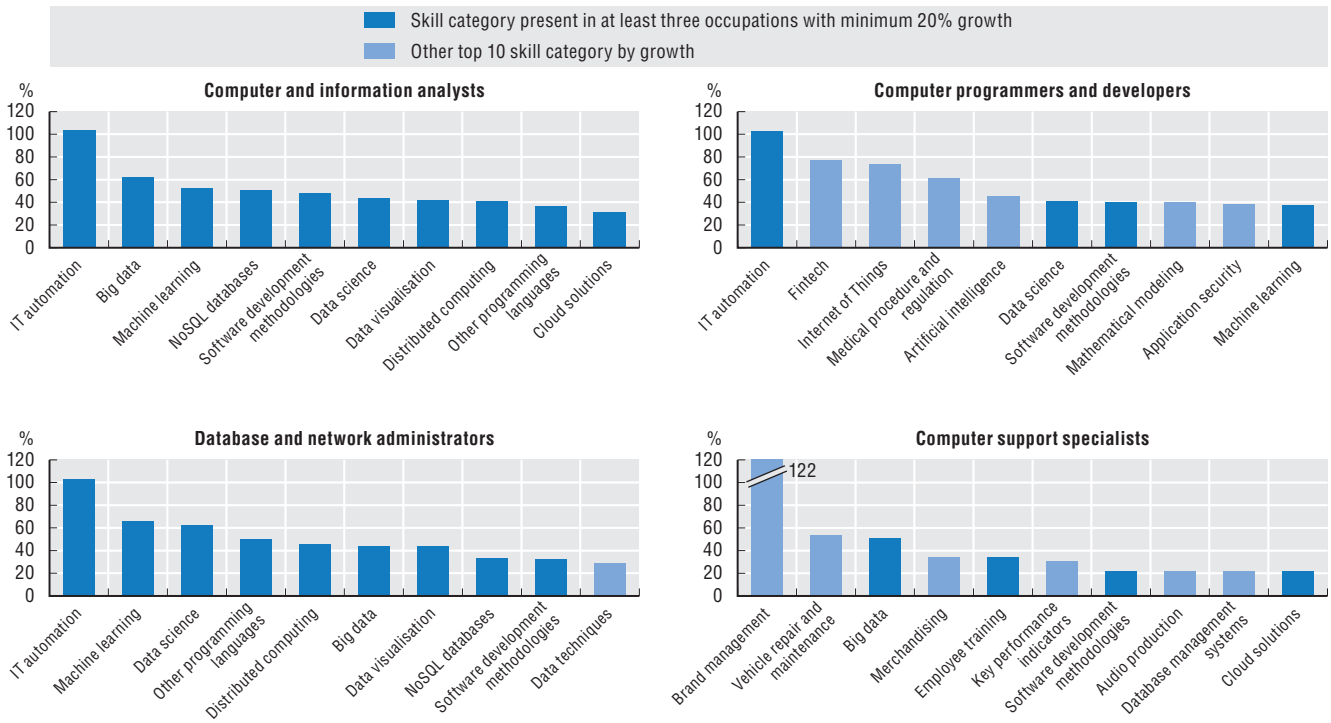
StatLink https://doi.org/10.1787/888933928806

Computer skills in growing demand

Computer-related occupations are at the heart of the development and adoption of digital technologies, but the computer-related jobs of today are likely to be different from those of tomorrow. In this rapidly changing environment, online job postings can point to fast-growing job titles or profiles in demand. For example, job postings for people working on data lakes (repositories holding vast amounts of raw data) grew rapidly in the United States between 2012 and 2018. Some of the most increasingly demanded skills are common across all computer-related occupations. Examples include "IT automation skills", "machine learning", and "Big data" or "software development methodologies". Others can be identified as fast growing across three or more of these computer occupations. The growth in demand for such technical skills is often combined with an increase in demand for complementary skills, such as the ability to train employees or industry-specific skills, such as "fintech", "medical procedure and regulation" or "brand management".

30. Top 10 skills in high demand for computer-related jobs, United States, 2012-18

Percentage increase in online job postings in each occupation over the period



Note: Only skills categories which were present in more than 2 000 vacancies in each eight-digit Standard Occupational Classification (SOC) 2010 occupation were analysed, so as to minimise the probability that a few large employers drive the resulting growth rate. Growth is calculated over the entire period.
Source: OECD calculations based on Burning Glass Technologies, www.burning-glass.com, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928825

Computer-related jobs and online job vacancies

Burning Glass Technologies scans more than 40 000 sources and tracks about 3.4 million unique, currently active job openings in the United States and a number of other countries. As the same job vacancies are often posted multiple times, duplicate postings, equivalent to close to 80% of all the postings collected, are removed using sophisticated algorithms. Skill requirements in job postings and workers' résumés can be expressed in different ways (e.g. "Microsoft Excel" vs. "MS Excel"), necessitating standardisation and categorisation. Occupational information is similarly derived from the reported job titles.

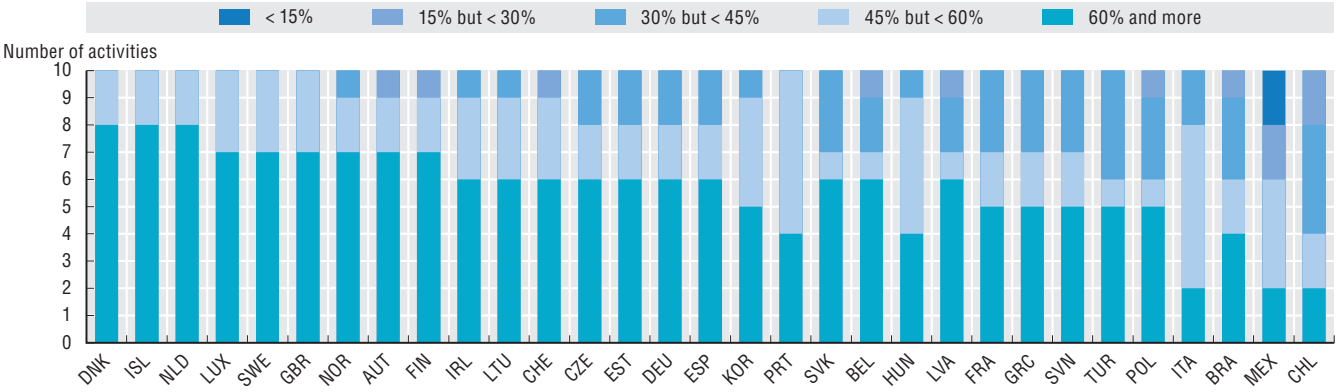
Computer and information analysts are individuals analysing science, engineering, business and other data processing problems to implement, improve, review and automate systems, computers and networks, also for security purposes. *Programmers and developers* create, modify and test the codes and scripts that allow computer applications to run; set operational specifications and formulate and analyse software requirements; analyse user needs to implement website content, graphics, performance and capacity, and may integrate websites with other computer applications. *Database and network administrators* administer, test, implement, maintain and safeguard computer databases, networks, Internet systems or segments thereof; monitor networks to ensure availability, performance and security, and may help co-ordinate network and data communications hardware and software. *Support specialists* provide technical assistance to computer users concerning the use of computer hardware and software; analyse, test, troubleshoot and evaluate existing network and Internet systems; and perform network maintenance to ensure networks operate correctly with minimal interruption.

Sophisticated adopters and uptake

Even in economies with almost universal Internet uptake, the activities many people carry out online are relatively basic and limited, pointing to a divide in digital usage. The types of activities carried out over the Internet vary widely across countries as a result of different institutional, cultural, and economic factors including age and educational attainment. Likewise, country uptake of more sophisticated activities also varies and is impacted by factors such as familiarity with online services, trust and skills. In 2017, almost 60% of Internet users carried out both online purchases and Internet banking, an almost twofold increase from around 35% in 2010. The diffusion of both these activities is strongly related to daily usage and to the overall variety of activities performed online. Controlling for Internet usage, uptake patterns differ in Germany, Switzerland, France and the United Kingdom, where individuals are relatively more likely to purchase online than to use Internet banking, while the opposite is true in the Baltic countries.

31. Sophistication of Internet use by individuals, 2018

Number of activities, out of ten, performed by shares of Internet users



Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind and Eurostat, Digital Economy and Society Statistics, January 2019. See chapter notes.

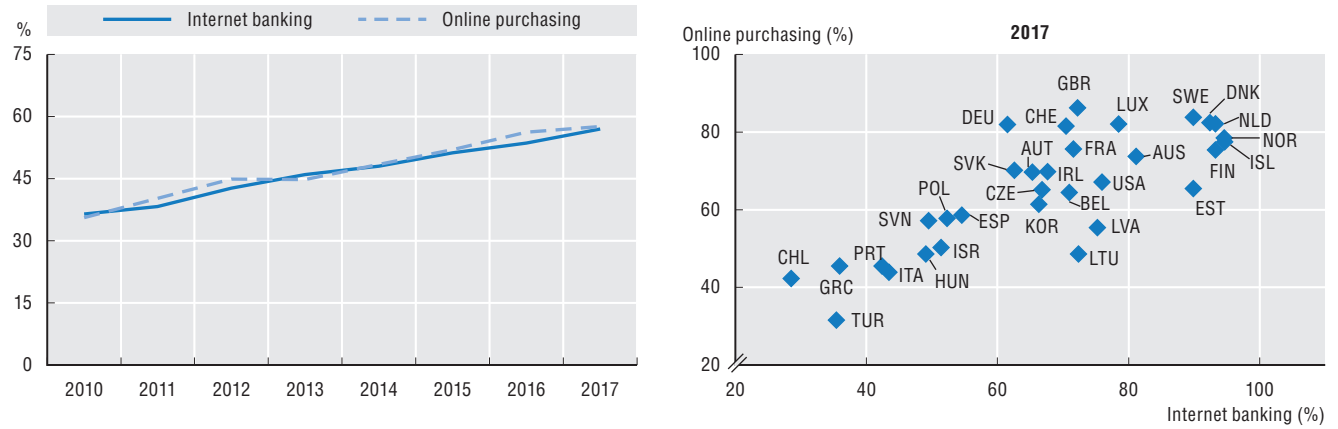
StatLink https://doi.org/10.1787/888933928844

How to read this figure

The Y axis represents the number of activities performed by a percentage share band of Internet users in a given country. For example, in Denmark, 60% or more of Internet users carry out at least 8 Internet activities, and between 45% and 60% carry out all the ten activities considered here. In Norway, instead, 60% or more of Internet users carry out at least seven activities; between 45% and 60% carry out more than 7 but fewer than 10 activities, and at least 30% but less than 45% carry out all ten activities. The ordering of the countries in the figure reflects the average number of activities weighted by the share of Internet users.

32. Diffusion of Internet banking and online purchasing, OECD, 2010-17

Percentages of individuals (left-hand panel) and Internet users (right-hand panel)



Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind, January 2019. See chapter notes.

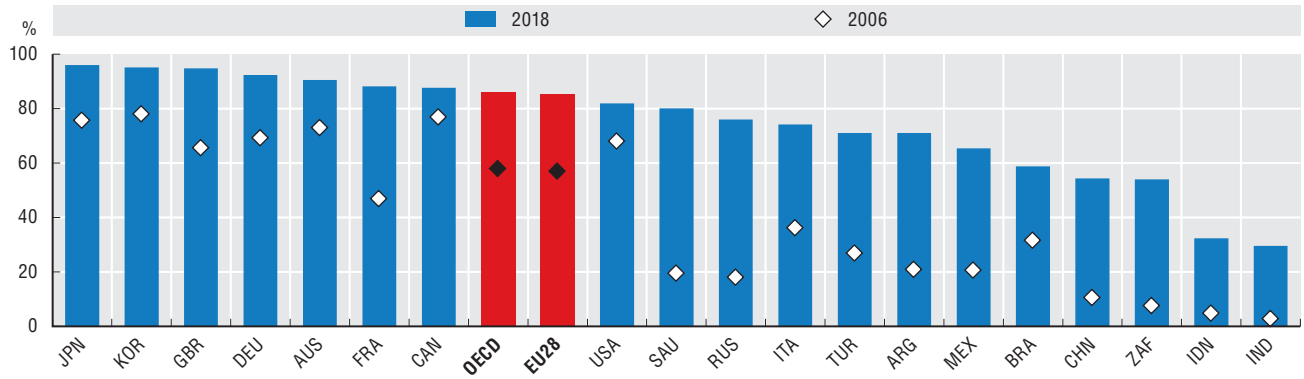
StatLink https://doi.org/10.1787/888933928863

Mind the gap

While Internet uptake is reaching saturation for the younger generation, there remains room for older generations to catch up. Today's digital economy is characterised by connectivity between users and devices, as well as the convergence of formerly distinct parts of communication ecosystems such as fixed and wireless networks, voice and data, and telecommunications and broadcasting. The Internet and connected devices have become a crucial part of everyday life for most individuals in OECD countries and emerging economies. The average share of Internet users in OECD countries grew by almost 30 percentage points between 2006 and 2018, from 56% to 85%, and more than doubled in Greece, Mexico, and Turkey. Over 50% of 16-74 year olds in Brazil, China and South Africa use the Internet nowadays, and the gap in comparison to OECD countries is narrowing. Some economies are approaching universal uptake, while there remains significant potential for catching-up in others with relatively lower income per person. There are also cross-country differences in the generational gap in usage. In the majority of OECD countries nearly all 16-24 year-olds use the Internet on a daily basis – the median value was 96% in 2018 – while for individuals in the 55-74 age bracket the median stood at 55%, with very wide differences (about 50 percentage points) between leading and lagging countries.

33. Internet users, G20 countries, 2018

As a percentage of 16-74 year-olds

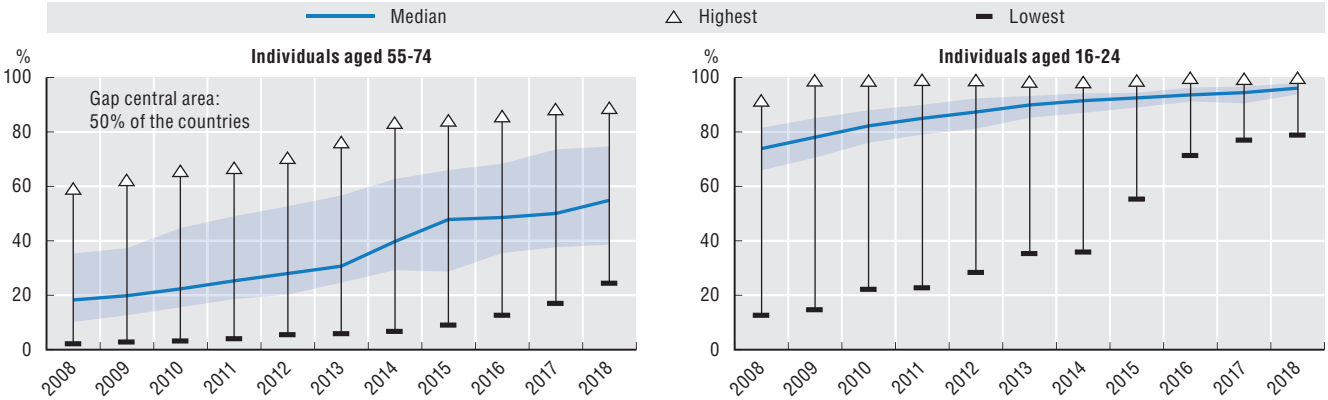


Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind; Eurostat, Digital Economy and Society Statistics; ITU, World Telecommunication/ICT indicators Database and national sources, December 2018. See chapter notes. StatLink contains more data.

StatLink https://doi.org/10.1787/888933928882

34. Generational gap in Internet diffusion, OECD, 2008-18

Percentage of daily Internet users in the each age group, 55-74 and 16-24 year-olds



Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind, January 2019. StatLink contains more data.

StatLink https://doi.org/10.1787/888933928901

How to read this figure

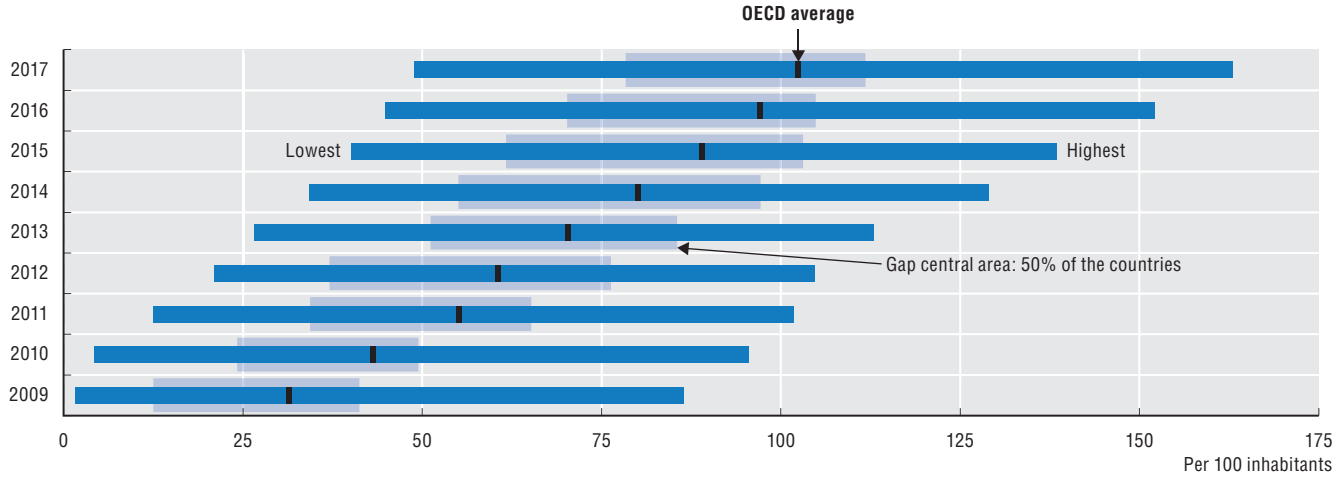
The figures show the inter-country gap of Internet use for ages 16-24 and 55-74 years respectively, between 2008 and 2018. In 2018, on average across all OECD countries, close to 95% of individuals aged 16-24 were Internet users with half of the countries ranging between the first (94%) and the third (98%) quartiles of the distribution. Internet users in the country with the lowest uptake represented 79% of the population as opposed to 100% in the country with the highest uptake.

Always-on lifestyle

Many young adults spend at least a quarter of their day online, with instant messaging and social media enabling an "always-on lifestyle". Improvements in mobile technologies have contributed substantially to the diffusion of Internet usage and broadband penetration. These advances have made online access possible for people who were previously unable to afford fixed broadband connections or found it difficult to use computers. Mobile connectivity contributes to always-on behaviour. From 2009 to 2017, the penetration of wireless subscriptions per 100 inhabitants more than tripled in the OECD area as a whole, increasing from 32 to 102. Country comparisons now range from about 50 subscriptions per 100 persons, to 160 (1.6 per person) in leading countries, with many people owning multiple independently connected mobile devices. The development of apps and increasing device sophistication favour this trend. According to ComScore (2017; 2018), mobile connections account for over half of all digital minutes in most surveyed countries, with app usage amounting to almost 90% of mobile time in 2017. Instant messaging and social networking account for the majority of time spent online. European Social Survey data reveal that the average individual aged 14 and above spent more than three hours per day on the Internet in 2016, while young people aged 14-24 spent 4.5 hours online – about 50% more. Constant connectivity is changing attitudes and behaviour in people's personal lives, with many social relations now occurring online and the distinction between work and leisure time becoming increasingly blurred. According to the Deloitte 2018 Global Mobile Consumer Survey, US consumers check their smartphones more than 50 times per day, on average, and a large majority (70%) of working adults who have work-provided mobile devices also use these outside of work.

35. Wireless broadband in OECD countries, 2009-17

Subscriptions per 100 inhabitants

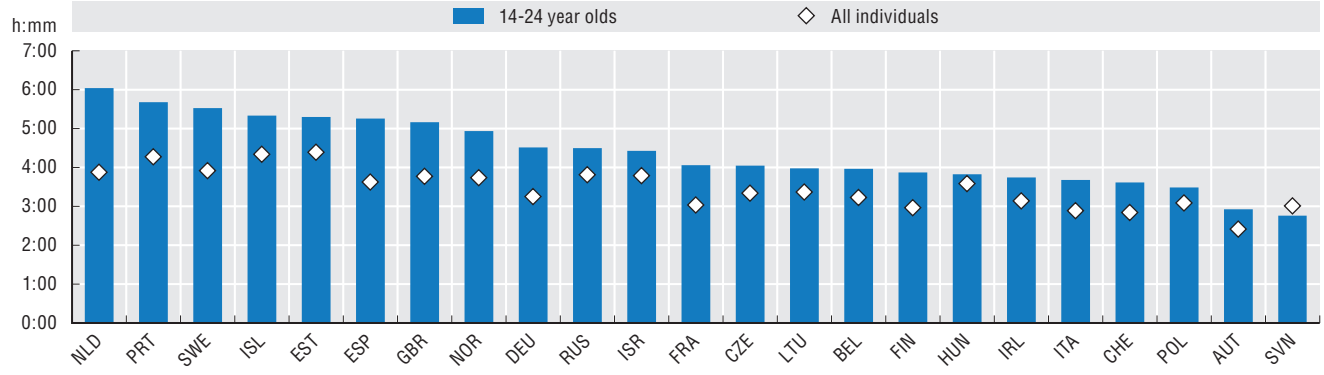


Source: OECD, Broadband Portal, http://oe.cd/broadband, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928920

36. Average time spent on the Internet daily, all individuals and 14-24 year-olds, 2016

Hours and minutes



Source: OECD calculations based on the European Social Survey micro-data (2016 edition), January 2019. StatLink contains more data.

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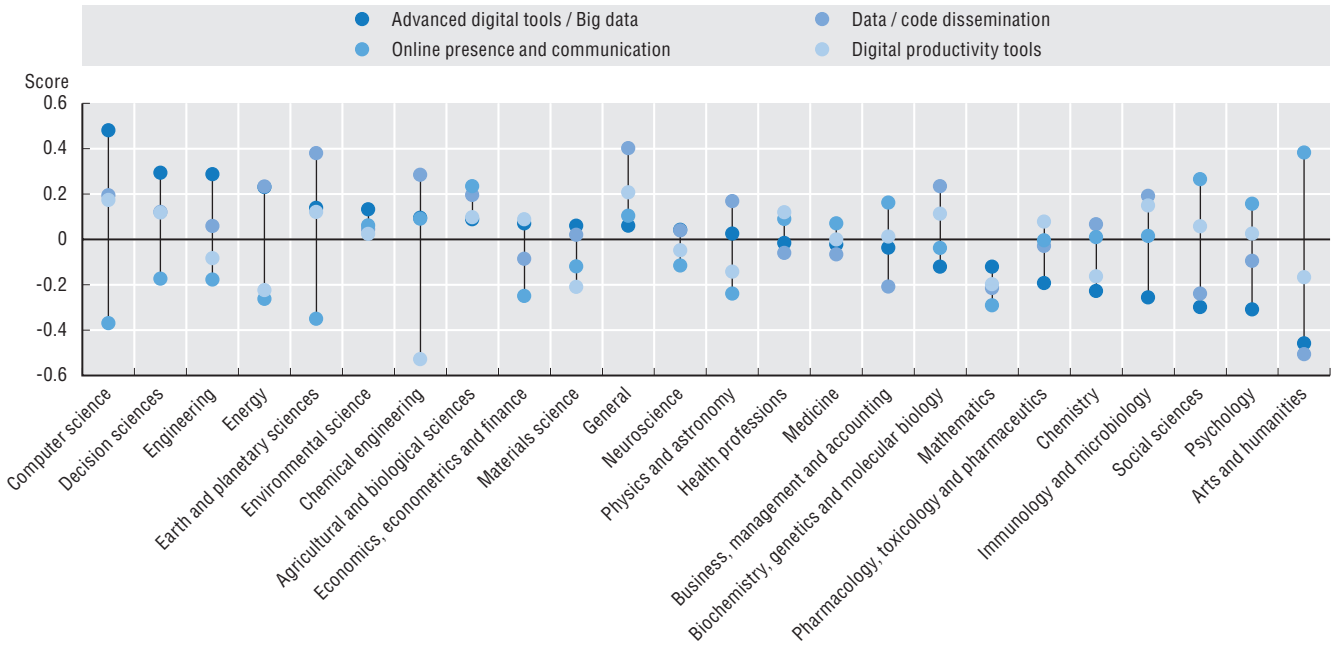
Science going digital

Digitalisation is changing the way in which research is conducted and disseminated. In order to identify emerging patterns of digitalisation in science, a new OECD survey, the International Survey of Scientific Authors (ISSA), asks scientists questions on whether digital tools make them more productive. It also includes questions on the extent to which they rely on Big data analytics, share data and source codes developed through their research, or rely on a digital identity and presence to communicate their research. Preliminary survey results reveal contrasting patterns of digitalisation by field. The use of advanced digital tools, including those associated with Big data, is more widespread in computer and decision sciences, and engineering. The life sciences (with the exception of pharmaceutical) and the physical sciences (other than engineering) report the greatest effort to make data and/or code usable by others. There are smaller systematic differences in the reported use of productivity tools, which have much higher general adoption rates. Scholars in the engineering domains report using productivity tools less frequently. Interestingly, the fields making less use of advanced digital and data/code dissemination tools – namely social sciences, arts, and humanities – are more likely to engage in activities that enhance their digital presence and external communication (e.g. the use of social media).

37. Patterns of digitalisation in science across fields, 2018

Average standardised factor scores, by field



Note: This is an experimental indicator. This figure presents the average of four distinct standardised factor scores representing latent digitalisation indicators for each scientific field. The factor analysis is based on responses by scientists to 36 questions relating to digital or digitally enabled practices, combined in four synthetic indicators. These indicators or factors have been interpreted and labelled based on how strongly they correlate with different questions.
Source: OECD, International Survey of Scientific Authors (ISSA) 2018, preliminary results, http://oe.cd/issa, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928958

The OECD International Survey of Scientific Authors (ISSA)

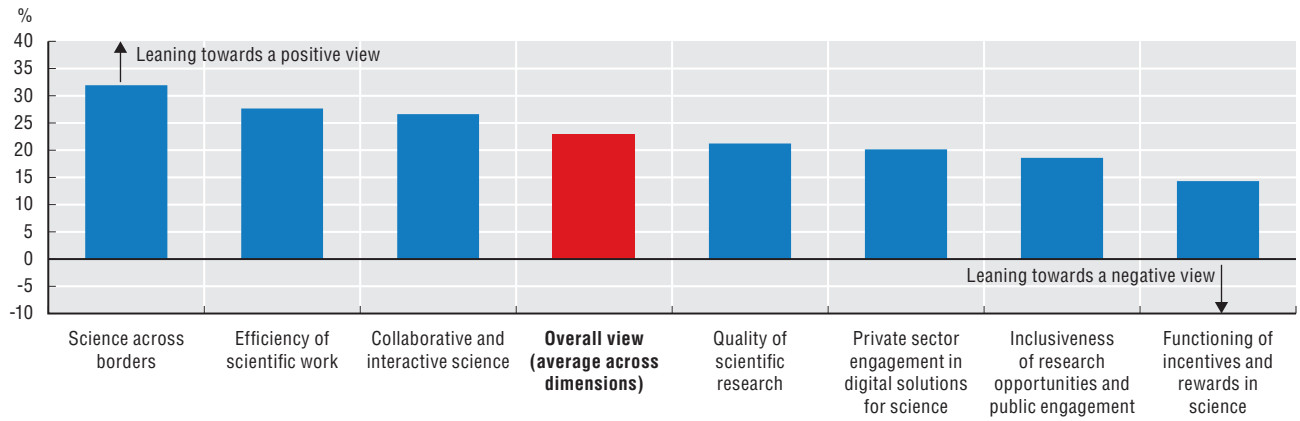
During the last quarter of 2018, the OECD contacted a large, randomly selected group of corresponding authors of scholarly documents, asking them to respond to an online survey aimed at identifying patterns of digitalisation in scientific research and exploring its drivers and potential effects. This OECD International Survey of Scientific Authors (ISSA) obtained rich information from nearly 12 000 scholars worldwide about their use of a broad range of digital tools and related practices. In order to provide an overarching and interpretable view of digitalisation patterns in science, answers to 36 questions relating to digitally enabled practices were analysed to identify four major "latent" factors. These represent how likely scientists are to: (i) make use of productivity tools to carry out regular tasks such as retrieving information and collaborating with colleagues, (ii) make data and code outputs arising from research available to others, (iii) use or develop unconventional data and computational methods, and (iv) maintain a digital identity expanding their communication with peers and the public in general. More detailed results and analysis from this study are made available on the ISSA project website (http://oe.cd/issa).

Impacts on science: scientists' views

Scientists' views regarding the impacts of digitalisation are positive overall, especially among younger authors. How do scientists themselves view the digital transformation of scientific research and its impacts? Evidence from the 2018 OECD Survey of Scientific Authors (ISSA) suggests that scientists' views are positive, on average, across several dimensions. There is strong sentiment that digitalisation has the potential to promote collaboration in general and particularly across borders, as well as to improve the efficiency of scientific research. While remaining positive, scientists appear to harbour more reservations regarding the impact that digitalisation may have on systems of incentives and rewards (e.g. the ratings of publications, citations and downloads that constitute the digital "footprint" of a scientific author). Likewise for the ability to bring together scientific communities and scientists with the public (inclusiveness), and the role of the private sector in providing digital solutions. Younger authors are more positive than their older peers, except with respect to the impacts of digitalisation on the incentive system, which may reflect concerns about their future careers. Across countries, the average sentiment towards the impacts of digitalisation seems consistent overall with results from broader population surveys on attitudes towards the impacts of science and technology (OECD, 2015). Scientists outside Europe, including those in emerging and transition economies, appear to be more positive on average regarding the impacts of digitalisation on science.

38. Scientific authors' views on the digitalisation of science and its potential impacts, 2018

Average sentiment towards "positive" digitalisation scenario, as percentage deviation from mid-viewpoint

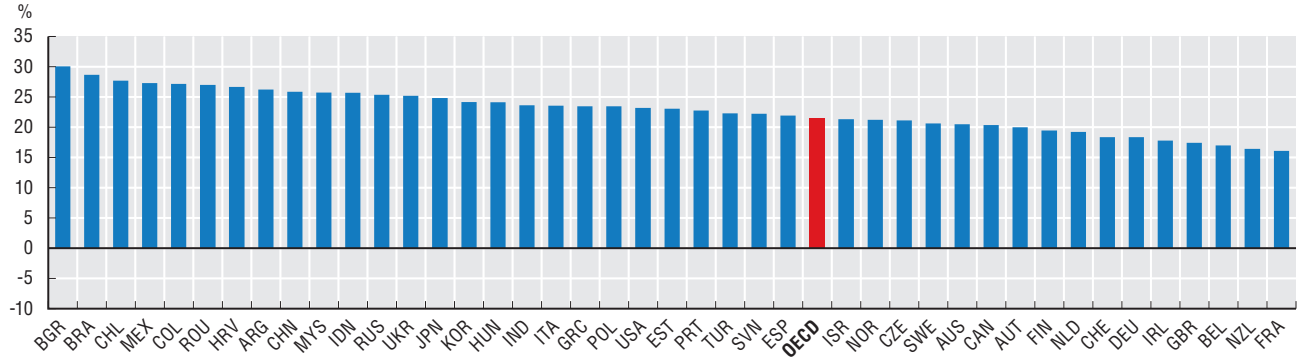


Note: This is an experimental indicator. Survey respondents were asked to rate opposing scenarios on different dimensions from (1 = fully agree with negative view) to (10 = fully agree with positive view). For interpretability, average unweighted scores on each dimension and general summary view (average across dimensions) are presented as percentage deviations from the mid-range point.
Source: OECD, International Survey of Scientific Authors (ISSA) 2018, preliminary results, http://oe.cd/issa, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928977

39. Scientific authors' views on the digitalisation of science, by country of residence, 2018

Average sentiment towards "positive" digitalisation scenario, as percentage deviation from mid-viewpoint



Note: This is an experimental indicator. Country results should be interpreted and compared with caution as the population of corresponding scientific authors is not uniformly representative of a country's scientific community. Only values for countries with at least 75 responses have been reported.
Source: OECD, International Survey of Scientific Authors (ISSA) 2018, preliminary results, http://oe.cd/issa, January 2019. See chapter notes.

StatLink https://doi.org/10.1787/888933928996

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