A ROADMAP TOWARD A COMMON FRAMEWORK FOR MEASURING THE DIGITAL ECONOMY

Report for the G20 Digital Economy Task Force

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Executive summary

This report builds upon previous G20 and other relevant work to develop *A Roadmap toward a Common Framework on Measuring the Digital Economy"*, including a proposed common agreed definition on the Digital Economy and a set of existing indicators for measuring the Jobs, Skills, and Growth in the Digital Economy. It complements previous work and proposes a clear step forward for Digital Economy measurement.

Chapter 1 provides over-arching context for the report. After providing an overview of key trends currently shaping the scale and development of the Digital Economy in G20 countries, it showcases a range of indicators, updated from the 2018 G20 Toolkit for Measuring the Digital Economy as well as complementing these with select additional indicators to give new insights and perspectives. This is one illustration of how *A roadmap toward a common framework for measuring the Digital Economy* builds on previous work by the DETF as well as initiatives by International Organisations.

Themes of *Infrastructure*, *Empowering Society,* and *Innovation and Technology Adoption* are explored through 17 key indicators. By reviewing data sources and measurement methods, as well as remaining gaps and challenges, chapter 1 lays the foundations for chapter 2, which builds upon these components to develop a G20 definition of the Digital Economy, and chapter 3, which goes a step further by setting out G20 indicators on *Jobs, Skills and Growth in the Digital Economy.* These themes are also measurement pillars within the *G20 Common Framework for Measuring the Digital Economy* set out in chapter 4; the indicators in chapter 1 give an initial indication of indicators that could be selected through future work.

Chapter 2 sets out to establish actionable definitions of the Digital Economy and useful related concepts, prerequisite for any economic measurement framework. Definitional differences can and already do result in large differences in the estimates of the size of the Digital Economy. Moreover, agreement on defining the Digital Economy as well as the tiers within it is important given the implications it has on the scope of indicators chosen to measure the Digital Economy – both those agreed to in the Roadmap, outlined in chapter 4 and those to be developed in the future.

As such, progressing towards a consensual and actionable definition of the Digital Economy is the main objective of this chapter. The following comprehensive definition of the Digital Economy is proposed:

> ***The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities.***

The Digital Economy has broader societal impacts and therefore, for policy purposes, extends beyond the activity formally recorded in economic statistics. To address this, the overarching policy definition proposed above is combined with a tiered definitional framework to not only assist with accurate measurement and comparability of the digital economy by statistical offices but to also allow for the incorporation of digitalised interactions not currently recorded as economic activity. This comprehensive definition, including the various tiers underpinning it (see below), will provide G20 members with a consistent and consensual framework to guide policymaking.

The tiers underpinning the proposed definition are the following:

- **The Core measure** of the Digital Economy only includes economic activity from producers of Digital content, ICT goods and services.
- **The Narrow measure** includes the core sector as well as economic activity derived from firms that are reliant on digital inputs.
- **The Broad measure** includes the first two measures as well as economic activity from firms significantly enhanced by the use of digital inputs.
- The final measure, **the Digital society** extends further than the Digital Economy incorporating digitalised interactions and activities excluded from the GDP production boundary, i.e. zero priced digital services.
- An additional, an alternative measure covers all **economic activity that is digitally ordered and/or digitally delivered**. It should be considered as an alternative perspective of the Digital Economy, delineating economic activity based on the nature of transactions rather than the firms' output or production methods as this measure focuses on ordering or delivery methods, regardless of the final product or how it is produced.

In order to combine flexibility and precision for measurement purposes, the comprehensive definition and its tiers find a middle way between a bottom-up approach and a top-down/trend-based approach. Most of the measures outlined in the tiers are commensurate with already existing international definitions or proposals.

As with most definitions of the Digital Economy there remains some subjectivity or "fuzziness" in the proposed delineation between firms that may be reliant on digital inputs compared to those that are significantly enhanced.

Importantly, the alternative measure, delineated by the nature of the transaction, provides not only a different perspective, but also the opportunity to split economic activity below firm level by detailing how much output and value added were ordered and/or delivered digitally rather than assigning the entire firms economic activity to a specific tier based on the production process.

The tiered structure is not the panacea for measuring the Digital Economy but it does offer greater clarity, on both a measurement and policy perspective, especially in relation to indicators for the Digital Economy – both those agreed to in this roadmap and outlined in chapter 4 as well as those developed in the future.
The digital transformation is ongoing and there are important additional phenomena on which international efforts are being focussed to improve measurement. These include:

- Measures for firms with business models based on providing free digital services, with no explicit charge to the consumer for the service provided. These firms have broken up the traditional direct transactional nature of providing good and services on an unprecedented scale.
- Appropriate valuation methods for data as well as suitable categorisation within the various macro-economic classifications. A key requirement for accurate measurement of the Digital Economy is an agreement on how to recognise and record data as a separate standalone product used in production.

Digital Economy satellite accounts begin with the completion of Digital Supply and Use tables (Digital SUTs). These tables take on additional importance, as operationalisation of the proposed tiered definitions will necessitate a statistical framework that generates outputs consistent with the different definitions; the Digital SUTs is such a framework.

Chapter 3 presents available indicators on *Jobs, Skills, and Growth in the Digital Economy*. Many of these were already set out in the *G20 Toolkit for Measuring the Digital Economy* but are complemented with additional indicators. These are set out as double pages in which key findings and links to economic theory are highlighted. Relevant definitions are set out as well as the underlying measurement approaches used.

This underpins the main purpose of the chapter - to identify a set of G20 indicators on *Jobs, Skills, and Growth in the Digital Economy* for adoption and production across G20 economies and beyond. These are presented in Table 1 below. This is undertaken in the context of the relevant measurement pillar within the *G20 Common Framework for Measuring the Digital Economy,* set out in Chapter 4.

In selecting key indicators for inclusion in the G20 set, various factors were considered. *The G20 indicators on Jobs, Skills, and Growth in the Digital Economy* aim to (1) collectively address the various key facets of this aspect of the Digital Economy and (2) reflect cross-cutting factors such as gender differences in the extent of engagement in the Digital Economy and its impacts, while also (3) using established definitions, classifications, and sources, and (4) being available with sufficient frequency and country coverage to enable benchmarking and monitoring. These indicators also seek to complement indicators used to monitor the United Nations 2030 Sustainable Development Goals (SDGs).

Finally, many of these indicators seek to operationalise the tiered G20 definition of the Digital Economy set out in chapter 2. The "Information Industries" align well with the "core" tier, while "digital intensive sectors" provide one means of operationalising the "broad" tier for measurement purposes.

Chapter 4 provides practical steps to advance *Toward a G20 Common Framework for Measuring the Digital Economy*. Key elements are the widespread use of the G20 definition of the Digital Economy (set out in chapter 2) and the regular production of key indicators on jobs, skills, and growth (presented in chapter 3) across countries. In doing so, the chapter attempts to account for countries' different capacities in terms of data infrastructure and statistical resources, while setting out clear, actionable recommendations for policy makers and national statistical offices (NSOs) to implement.

The *Roadmap Toward a Common Framework for Measuring the Digital Economy* organises the proposed steps across five areas of work: 1) Definitions 2) Indicators 3) Methodology and data collection 4) Dissemination 5) Institutional capabilities.

After presenting the Framework that is envisaged for development in the medium to long-term, the chapter proposes key implementation steps for the parts of the Framework on which the DETF has worked in 2020. These are distributed between the main actors involved: G20 countries, the DETF and IOs. Other actors such as civil society and the private actor are nonetheless included.

Preface

Widespread phenomena, including ever-increasing *digitisation* (conversion of information into digital form) and ever-greater *digitalisation* (applications of digital technologies) are serving to reinforce and expand what is commonly referred to as the "Digital Economy". Realising the opportunities and addressing the challenges of the Digital Economy requires strengthened international and multi-stakeholder dialogue on measurement. This has been explicitly recognised by the G20, which, following the creation of the Digital Economy Task Force (DETF) in 2016 and the elaboration of the 2017 Roadmap for Digitalisation: Policies for a Digital Future. In 2018, the Argentine G20 Presidency worked with International Organisations led by the OECD, to publish a *G20 Toolkit for Measuring the Digital Economy (G20, 2018*). This "*G20 Toolkit"* is designed to motivate the development of a stronger evidence base for analysis and policymaking across key dimensions including digital infrastructure, ICT-enabled innovation, and the use of digital technologies in society, as well as the role of the Digital Economy in driving jobs and growth. This provided background for a negotiated G20 Ministerial Declaration and Annex[1].

This report builds upon this and other relevant work to develop *A Roadmap toward a Common Framework on Measuring the Digital Economy"*, including a proposed common agreed definition on the Digital Economy and agreed set of existing indicators for measuring the Jobs, Skills, and Growth in the Digital Economy. As such, it complements previous work and proposes a clear step forward for Digital Economy measurement.

Chapter 1 sets out key trends shaping the ongoing development of the Digital Economy as well as updating and complementing a range of the indicators set out in the *G20 Toolkit* to provide a foundation for the discussion that follows and to illustrate the existence of definitions, methodologies, and indicators on key aspects of the Digital Economy. However, there is currently no internationally agreed definition of the Digital Economy overall, and this has been identified as one important barrier to meaningful and comparable measurement.

Chapter 2 examines definitions put forward by government, business, academic, and International Organisation sources to identify commonalities and differences. From these, an over-arching definition of the Digital Economy is proposed for discussion and agreement by the DETF. Chapter 2 also looks at the definitions available for key facets of the Digital Economy which are necessary to complement and operationalise the over-arching definition for measurement purposes. It also looks at several areas where international effort is being focussed on developing definitions and measures needed to more fully understand key elements of the Digital Economy.

Chapter 3 also seeks to advance measurement in a complementary way, by looking in detail at indicators on Jobs, Skills, and Growth in the Digital Economy and proposing a core set of indicators for discussion and agreement by the DETF with a view to their wider development and production across G20 economies. These indicators focus on key ways in which the Digital Economy is impacting economic performance and the lives of G20 citizens. Furthermore, wider adoption of these indicators will entail the broader cultivation of underlying sources, which could also provide a foundation for improving indicators in other areas, such as those set out in the *G20 Toolkit* (and Chapter 1) themes "Infrastructure", "Empowering Society", and "Innovation and Technology Adoption".

Chapter 4 then situates these within a broader measurement framework accompanied with *A roadmap toward a Common Framework for Measuring the Digital Economy.*

As an input to this publication, the Saudi Arabia G20 Presidency coordinated a short survey of DETF participating countries to investigate the existence and use of definitions and measures for the Digital Economy and other key facets thereof. We extend our thanks to all for the responses received, which are summarised in this report.

Finally, the indicators showcased in this report can and should contribute to monitoring progress towards the 2030 Sustainable Development Goals (SDGs) set out by the United Nations within G20 countries and beyond. Indicators on the accessibility of ICT network infrastructure and digital skills are particularly relevant.

This preface sets out, at a broader level, key features of the international "ecosystem" through which data on the digital transformation are gathered, compiled, and transmitted for inclusion in international databases and suites of indicators. This provides a background on the foundations underpinning many of the sources and measures discussed. It also serves to highlight key contributions and developments from the various International Organisations working to better measure and understand the Digital Economy, all of which have collaborated with the OECD in producing this report on behalf of the Saudi Arabia G20 Presidency.

1. The international "digital measurement ecosystem"

A wide range of approaches and indicators has been developed to cover various aspects of the Digital Economy. As early as 2004, a **Partnership on Measuring ICT for Development**, was launched to improve the availability

[1] http://www.g20.utoronto.ca/2018/2018-08-24-digital.html#annex3

and quality of ICT data, particularly in developing countries. The Partnership mainly established a core list of 50 ICT indicators to serve as a common basis for internationally comparable statistics. All the International Organisations mentioned below are active members of the Partnership.

Among G20-led initiatives in the field, the ***"G20 Toolkit for Measuring the Digital Economy"***, was developed and endorsed under the auspices of the Argentinian Presidency in 2018. It showcased the data available for G20 countries through 36 key indicators across the areas of Infrastructure; Empowering Society; Innovation and Technology Adoption; and Jobs and Growth. Many of these for the basis for **section 2** of this chapter.

A wide range of other products from Intergovernmental and International Organisations also showcase indicators related to the Digital Economy including:

- The **European Commission** has developed the **Digital Economy and Society Index (DESI)** (https://ec.europa.eu/digital-single-market/en/desi), which is based off a multidimensional framework that compiles and monitors indicators of digital performance across some key aspects of the European information society (Telecom sector, Broadband, Mobile, Internet usage, Internet services, eGovernment, eCommerce, eBusiness, ICT Skills, Research and Development). Countries' performances in each dimension are then summarised in a composite index of EU Member States' digital competitiveness. The International DESI (I-DESI) extends the geographical coverage, using a simplified index to assess the performance of both individual EU countries and the EU as a whole in comparison to other advanced economies (Australia, Brazil, Canada, Chile, China, Iceland, Israel, Japan, South Korea, Mexico, New Zealand, Norway, Russia, Serbia, Switzerland, Turkey and the United States). In October 2019[2], the EU and the Association of Southeast Asian Nations (ASEAN) launched a cooperation to develop the basis for an ASEAN digital benchmarking index, modelled on the DESI index and its methodology. This was mainly done through joint training sessions, workshops and experience sharing between the two institutions.

- The **ITU** ***Measuring digital development: facts and figures*** series (https://www.itu.int/en/ITU-D/Statistics/Pages/facts/default.aspx) presents a variety of indictors to give an overview of the state of digital development across its 196 member countries. ITU is currently developing a composite index that will replace the ICT Development Index (IDI). The new index will show policy makers how digital transformations impact on their ability to meet the Sustainable Development Goals (SDGs)".

- The **OECD** ***Going Digital Toolkit*** (https://www.oecd.org/going-digital-toolkit) operationalises the Going Digital integrated policy framework by providing indicators and policy information to help policymakers implement coherent policies to address the challenges of the digital transformation and fully realise its opportunities. Users can compare countries across 33 core indicators and a range of complementary indicators and explore the underlying data interactively to gain new insights. The Going Digital Toolkit covers OECD and accession countries, as well as the BRIICS economies, with plans to being additional countries on-board. This draws on a range of underlying sources and databases produced by the OECD and others.

- **UNCTAD** maintains a portal of ***Information economy indicators*** (https://unctadstat.unctad.org/wds/reportfolders/reportFolders.aspx) focussed on ICT trade and ICT use in businesses. The UNCTAD has also established a new Working Group on Measuring E-Commerce and the Digital Economy, which held its first meeting on 3 and 4 December 2019, and will aim to strengthen the work of the Partnership in terms of the development of indicators and methodologies regarding the evolving Digital Economy.

- The **UNESCO** ***ROAM-X*** **framework** assesses Internet universality through a set of 303 indicators covering four categories (Rights, Openness, Accessibility, Multi-stakeholder). Its Institute for Statistics has also developed and collected indicators on ICT access and use in education as well as prepared definitions and methodological guidelines, in particular the Guide to Measuring Information and Communication Technologies (ICT) in Education, published in 2009.

- The **World Bank Group,** in collaboration with the Institute of the Information Society, uses its ***Digital Economy Country Assessment (DECA)*** to help countries and regions assess their readiness for digital

[2] https://ec.europa.eu/digital-single-market/en/news/eu-and-asean-building-stronger-digital-economy-connectivity-cooperation

adoption**.** It is designed as a common set of indicators that can be applied to the whole country, its regions, or to specific sectors of the economy.

The indicators outlined rely on a range of data sources and measurement approaches. Survey and administrative data sources are especially important, though alternative sources such as web-scraped data are increasingly being experimented with.

Regular (usually annual) ***ICT usage surveys*** are a key pillar of the "digital measurement ecosystem", underpinning a wide range of datasets and indicators. Most G20 countries undertake some form of ICT usage survey.

- Surveys of *ICT usage in Households and by individuals* underpin measures of the number of households with computer and Internet access, the number of people using the Internet, and the activities they undertake online (among many other variables).
- *ICT adoption and usage in business* surveys offer measures of business adoption of key digital tools and business models (e.g. e-commerce).

Eurostat, the ITU, OECD, and UNCTAD routinely collate data from ICT usage surveys to produce international databases and indicators.

A wide range of other survey sources can also provide valuable insights such as Labour Force Surveys on digital-related occupations, surveys of skills and job tasks on ICT task-intensity, R&D and innovation surveys on their prevalence in ICT sectors, etc.

Another key pillar of digital measurement is ***administrative data*** on numbers of subscriptions (e.g. to fixed or mobile broadband) reported by telecommunications providers to regulators as part of their monitoring processes. These are regularly compiled by the regulators and transmitted to Eurostat, the OECD, or ITU for inclusion in international databases.

Other non-survey sources can underpin measures of Internet speed, counts of secure servers, and indicators on scientific publications, patents, trademarks, and designs related to digital technology. Indicators based on the sources highlighted and other sources are presented in **section 2** of this chapter.

The international comparability of data from all sources relies on agreed definitions, standards, and guidance.

The OECD also develops **Model surveys on ICT use by businesses and households.** These aim to improve international comparability by encouraging the use of standardised indicators for the Digital Economy and by operationalising key definitions including the internationally accepted definition of e-commerce set out in the *OECD Guide to Measuring the Information Society* (*OECD, 2011)*. The ITU *Manual for Measuring ICT Access and Use by Households and Individuals (ITU, 2014)* and *UNCTAD Manual for the production of statistics on the Information Economy (UNCTAD, 2009)* also help to encourage the adoption of ICT surveys or modules.

The EU offers a useful example of coordination across countries on statistical definitions and survey standards: EU legislation requires countries to undertake ICT usage surveys and a well-established process is followed to agree the specific modules and questions to be included on the survey form each year. This regular annual process, which balances drivers for change (technological developments, user needs, etc.) with the need to maintain core series and manage respondent burden, is especially important in driving the continual development of ICT usage surveys. National initiatives also help to drive advancements, such as the development of modules measuring the uptake of Artificial Intelligence in businesses. Further details on such initiatives are included in other sections of this report and in the *G20 Toolkit*.

With respect to measures of subscriptions, the ITU *Handbook for the Collection of Administrative Data on Telecommunications/ICT (ITU, 2011)* and *OECD Broadband Methodology (OECD, 2015)* are key references.

2. Advancing measurement of the Digital Economy

One important way in which measurement of the Digital Economy is advanced is through the proliferation across countries of surveys and indicators based on existing standards and practices. Given their unique importance, and the unique information they can gather, the continued implementation and development of well-rounded surveys of ICT usage by business, households and individuals plays an especially important role in allowing digital development to be assessed across countries. There is also a need to push forward at the frontier in order to capture key developments and phenomena. These include (among many others) the proliferation of technologies as they become mainstream, the growing importance of data in driving business models and value creation, and the ways in which digital technology use interacts with physical and mental health and well-being.

As well as presenting indicators and examining measurement approaches and methodologies, the G20 Toolkit for Measuring the Digital Economy identified the following actions for G20 members to make statistical systems more flexible and responsive to the new and rapidly evolving digital era:

i. *experiment with concepts and data gathering within existing measurement frameworks,*
ii. *exploit the potential of existing survey and administrative data,*
iii. *add questions to existing surveys,*
iv. *periodically augment existing surveys with topic-specific modules,*
v. *develop short turnaround surveys to meet specific needs,*
vi. *define policy needs and, in cooperation with other stakeholders, set priorities for internationally comparable measurement; and*
vii. *work with stakeholders, including IOs, to harness the potential of big data for developing indicators*

The G20 Toolkit also identified crucial actions that could inform the measurement agenda of G20 members in the next few years, considering the rapid pace of change in the Digital Economy:

1. *Promote a comprehensive, high-quality data infrastructure and collection tools for measuring the use and impacts of digital technologies at the individual and business level.*
2. *Work towards improving the measurement of the Digital Economy in existing macroeconomic frameworks, e.g. by developing satellite national accounts.*
3. *Foster cooperation between IOs and G20 countries to share national initiatives and disseminate international standards and best practices, improve comparability of indicators with greater emphasis on capacity enhancement in developing countries where resources, both monetary and human, are scarce.*
4. *Encourage interactions among government, business and other actors of civil society to complement official statistics and improve the design of frameworks that facilitate a better use of data in business-to-business (B2B), business-to-government (B2G) contexts, and government-to-businesses (G2B) contexts.*
5. *Enable collaboration between the public and private sector to implement business surveys on innovation and the uptake of new digital technologies, including joint efforts to anticipate the demand for skills.*
6. *Encourage development partners, in collaboration with IOs, to assist less developed countries in the collection of relevant statistics needed to enable evidence-based policy making in this area.*
7. *Promote the use of interoperable tools and data formats that facilitate access to and sharing of public and private sector data in an effort to drive innovation and make government activities more transparent.*

Various activities at national and international levels are helping to drive forward measurement of the Digital Economy. The OECD Going Digital project has produced a number of key contributions:

- ***Measuring Digital Transformation: a Roadmap for the Future (OECD, 2019),*** maps over 180 indicators across the dimensions of the Going Digital policy framework, identifies measurement challenges, and develops a roadmap for the future. Nine key actions are set out - from improving measurement of online trust to designing new and interdisciplinary data collection methods.
- The **OECD Framework for Digital Supply-Use tables** introduces new sub-categories of industry and product types within the National Accounts Supply-Use framework to make the Digital Economy more visible in economic statistics.
- The ***OECD-WTO-IMF Handbook on Measuring Digital Trade*** **(2020)** provides a conceptual framework to measure the Digital Economy component of trade by categorising trade on three dimensions: the nature of the transaction, the product type, and the partners involved.

In ***Measuring the Digital Economy (IMF, 2018)***, the IMF identifies the limitations of available concepts, definitions, price compilation and accounting techniques. In particular, the paper focuses on the “digital sector” i.e. core activities of digitalisation, ICT goods and services, online platforms, and platform-enabled activities as opposed to the broader concept of Digital Economy and suggests using indicators “beyond GDP” to understand the welfare effects of digitalisation. The IMF has also used its ***Financial Access Survey*** **(FAS),** which measures financial inclusion worldwide to collect data on digital means of financial access (e.g. mobile money accounts).

UNCTAD developed a methodology for ***Measuring Exports of ICT-enabled/digitally delivered Services*** in developing countries (UNCTAD, 2018), as part of its monitoring of the 2030 Sustainable Development Goals which include promoting access to digital technologies in developing countries**.** The study’s main purpose is to create conceptual tools to differentiate trade in ICT services from trade in ICT-enabled services (i.e. services provided over ICT network) in order to quantify the Digital Economy’s contribution to growth more accurately.

Overall, substantial work is underway to proliferate existing methodologies and tools for measuring the Digital Economy and to build upon these to help us understand key phenomena in the Digital Economy.

Chapter 1 - Measuring the Digital Economy: digitalisation in G20 economies

1. Introduction

This report sets out to establish *"A Roadmap toward a Common Framework for Measuring the Digital Economy".* It draws upon various national and international efforts to measure and understand key facets of the Digital Economy and seeks to advance measurement in G20 countries and beyond. Most directly, the report builds upon the ***G20 Toolkit for Measuring the Digital Economy*** (G20, 2018), which showcased data available for G20 countries through 36 key indicators across the themes of Infrastructure; Empowering Society; Innovation and Technology Adoption; and Jobs and Growth. The *Toolkit*, and the indicators therein, were approved and adopted by the DETF at its meeting in July 2018, with the finalised Toolkit being published later that year.

A central theme of this report is the need to address the lack of a commonly agreed definition of the Digital Economy in order to orientate the measurement and policy agenda. This is the main focus of chapter 2, which summarises and contributes to the current debate on defining the Digital Economy. Before focusing on these definitional and conceptual matters, and as a preliminary step, this first chapter aims to set out, in broad terms, "where we are" in respect of measuring key aspects of the Digital Economy and to provide motivation for what may come next.

This chapter starts by looking at indicators on several on-going trends driving the digital transformation in G20 economies and which are the context for many of the phenomena examined in this report. Overall, it can be surmised that digitalisation is continuing apace, with G20 countries playing a key role in driving the development of digital technologies, and that these technologies are serving to increase the scale of data holdings and flows. This digital transformation offers a wealth of opportunities, however there is evidence that certain groups are being left behind in terms of access to and use of digital technologies, limiting their abilities to engage with and benefit from the growing Digital Economy (see sections 2.2 and 3.2.1). These trends are helping to drive pressing policy questions, including how to best enable businesses to develop technologies while managing issues of data use and privacy and how to close gaps in access and use of digital technologies. Such challenges demand transversal thinking across the *G20 Toolkit* themes.

The chapter then goes on to review and update a selection of *G20 Toolkit* indicators to look at the latest developments under the first three themes – Infrastructure; Empowering Society; and Innovation and Technology Adoption. Selected complementary indicators are also presented to add additional perspectives and insights. For each indicator, data sources, measurement methods, and relevant challenges are set out. The fourth theme, Jobs and Growth, is the subject of a more detailed examination in chapter 3, which takes a holistic look at *Jobs, Skills, and Growth*, with the aim of proposing a core set of indicators for discussion and agreement.

In general both the demand for and supply of digital *infrastructure* are growing rapidly. However, sustained policy action is needed to ensure that infrastructure, especially that underpinning Internet connectivity, continues to enable ever greater connectedness – including between machines – and to meet business' and consumers' needs for sufficiently fast, reliable, and affordable connections. Some of the indicators showcased on the theme of *Infrastructure* can be particularly useful in supporting advancement towards the United Nations' 2030 Sustainable Development Goals (SDGs). In particular, Target 9.C[3] requires data-informed policy on the quality, accessibility and security of countries' infrastructure. Indicators presented here complement UN indicator 9.C.1 (*Proportion of population covered by a mobile network, by technology)*.

Digital technologies are *Empowering society* in a wide variety of ways including helping people connect with others, as well as to interact with governments and businesses - not least through e-commerce. However, there are divides in engagement with the Digital Economy – with men generally more represented than women and older individuals being less likely to have a life online. Augmenting digital skills is likely to be one key lever for addressing such issues. Indicators on skills are addressed in detail in chapter 3. Nevertheless, while indicators on digitalisation and society are essential to the design of inclusive and effective Digital Economy policies, there are various ways in which measurement still requires further development to leverage qualitative information and track non-monetary phenomena (*OECD, 2019a*).

Finally, businesses in G20 countries are rapidly *innovating and adopting a wide range of digital technologies* and business models. E-commerce is perhaps the most well-known, though it is still the case that fewer than half of businesses sell online in almost all G20 economies (India is the exception at 50.1%). Nevertheless, other technologies – from cloud computing services to industrial and service robots – are proliferating. This in turn impacts the skills that businesses demand and the jobs they offer, which are both examined in detail in chapter 3.

3 "Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020"

Overall, this chapter demonstrates that there are a wealth of existing measures for many key elements of the Digital Economy enabled by a variety of data sources. Complementary indicators and presentations based on existing sources can also provide important context and insights. However, indicators would benefit from broader data availability across G20 countries. To that end, chapter 3 sets out a core set of indicators in the vital area of Jobs, Skills, and Growth for discussion and agreement by the DETF. The production of an agreed set of indicators on Jobs, Skills, and Growth would rely on many of the sources underpinning the indicators presented in this chapter and could therefore also pave the way toward wider country coverage of a wider range of indicators.

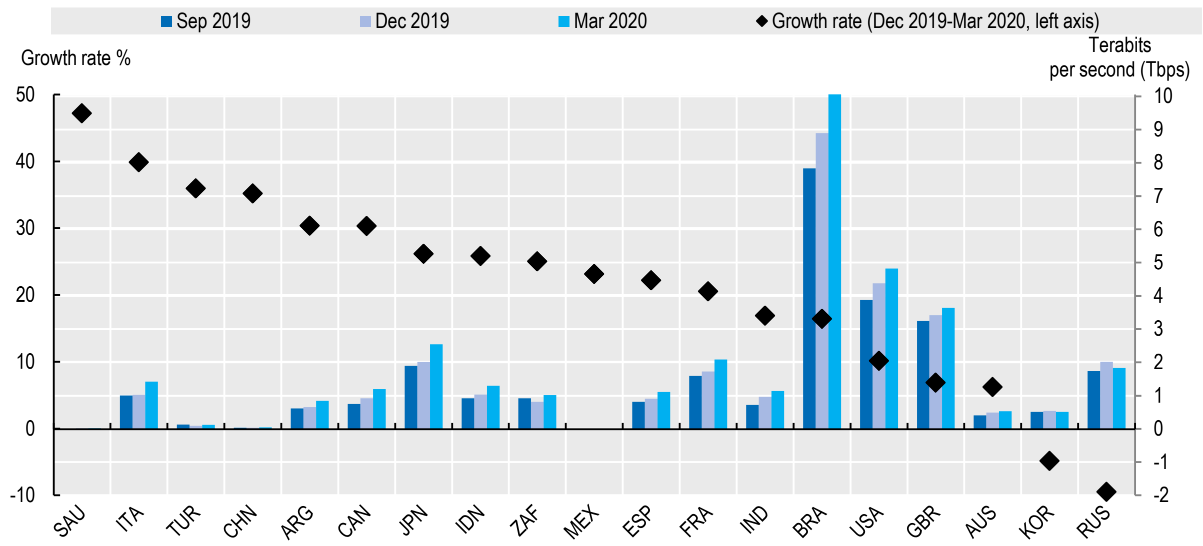
2. Major trends in the Digital Economy

2.1. The Internet is critical in times of crisis

Connectivity plays a critical role during crises. In the COVID-19 health emergency, 4.6 billion G20 citizens are faced with trying to maintain productivity while practicing social distancing. Demand for broadband communication services has soared due to confinement measures and teleworking. New record-high bandwidth has been recorded at Internet Exchange Points (IXPs) around the G20 with net increases over the period from December to March 2020 of up to 47% in total bandwidth produced by individual countries. An even more telling illustration of the crisis' effect on supply is the comparison of bandwidth production growth rates pre- and post-crisis. The European Union (27), for instance, saw the growth in IXP production double: it grew 10% in the fourth quarter of 2019 compared to 19% between December 2019 and March 2020. A similar evolution was seen in France where the growth rate was multiplied by 2.4. Italy, one of the most severely affected countries in Europe, produced 40% more bandwidth between December 2019 and March 2020, up from only 1.8% growth in the prior quarter. In other regions, statistics also show similar trends. In Japan and Indonesia, for instance, the baseline growth rates of 5.9% and 12% respectively both increased to 26%. The growth rate increased most dramatically in China, from 1% to 35%. Meanwhile, in the United Kingdom and Brazil - both important producers of Internet bandwidth - IXP production growth remained broadly in line with pre crisis levels.

Figure 2.1. Internet bandwidth produced at Internet Exchange Points (IXPs) by country

In terabits per second (Tbps)



Source: OECD based on data from Packet Clearing House (PCH, 2020).

2.2. Gaps in technology and Internet usage remain

While Internet take up is reaching saturation in some countries, gaps persist both between countries (see figure 2.2.1) and between different groups within countries – including men and women, people of different ages, people with different levels of income or educational attainment, and between those living in urban or rural areas (*OECD, 2019*). These such gaps are particularly relevant in times of crisis and, in the COVID-19 pandemic, are likely the affect how well different groups can continue to work or even remain in contact with the world outside their homes.

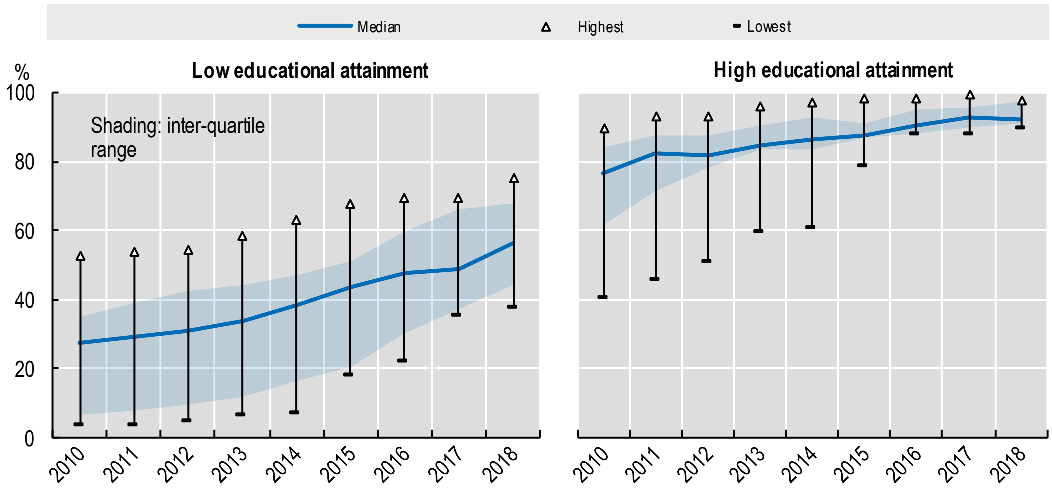
While Internet uptake is very common among the younger generation, there remains room for older generations to catch up. Today's Digital Economy is characterised by connectivity between users and devices, as well as the convergence of formerly distinct parts of communication ecosystems such as fixed and wireless networks, voice and data, and telecommunications and broadcasting.

The figures below show the inter-country gap in daily Internet use for people with low educational attainment and those with high educational attainment respectively, between 2010 and 2018. Educational attainment tends to be correlated with other factors such as personal and household income - though breakdowns by income are less-widely available for G20 countries.

In 2018, on average across all G20 countries for which data are available, close to 95% of individuals with high educational attainment used the Internet daily or almost daily, with little variation between countries. By contrast, there is much wider variation across countries in the share of people with low (or no) educational attainment who use the Internet regularly. On average across G20 countries for which data are available only 55% of individuals with low educational attainment use the Internet regularly - with the lowest uptake representing just 40% these individuals, in comparison to 75% in the country with the highest uptake.

Figure 2.2. Educational attainment gap in Internet diffusion, OECD, 2010-18

Percentage of daily Internet users in each group



Note: available data cover Brazil, France, Germany, Italy, Korea, Mexico, Turkey, and the United Kingdom
Source: OECD, based on OECD ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind, March 2020.

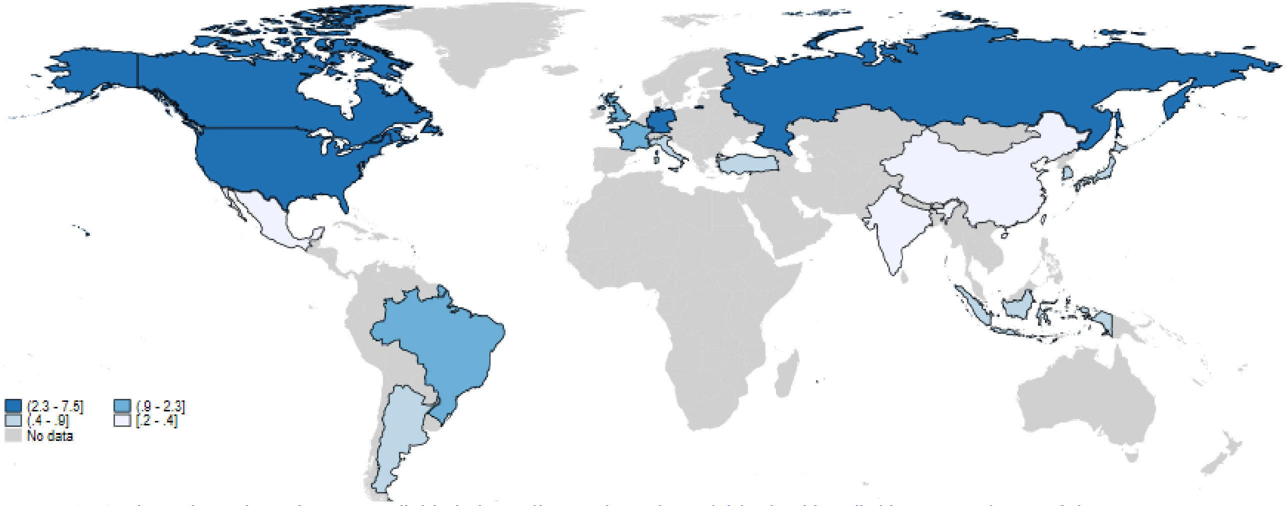
On-going technological developments, the exponential increase in the volumes of data holdings and data flows, and perpetuation of divides in access and use are among key high-level trends shaping the digital transformation on a global scale. The following sections move on to look at a variety of indicators at the level of G20 countries to consider how different countries are progressing in the digital transformation.

2.3. Managing increasing digital threats

The necessity to protect users and digital content providers against cyber-attacks, viruses and fraud has reached new levels with the global shift of economic activity online being further accelerated by the COVID-19 pandemic. Enabling individuals and businesses to have trust in online environments is a crucial foundation for this shift. While the frequency of cyber-attacks varies between countries, the stakes attached to maintaining secure networks are increasing everywhere. This is especially the case in a time of crisis where individuals' ability to work and communicate online have become a necessity for maintaining many economic activities. While different attack vectors exist, SQLi attacks (involving a code injection technique in which malicious SQL statements are inserted in order to attack data-driven applications) were the top threat when it comes to web application risks (Akamai, 2019). Looking at G20 countries over the last two years (2017-2019), Russia, the United States and Canada saw the most frequent occurrence of web application attacks being generated within their borders, while in Europe, Germany showed the highest ratio of total attacks registered per capita.

Figure 2.3a. Frequency of web application attacks, 2017-2019

Total attacks per capita registered in G20 countries

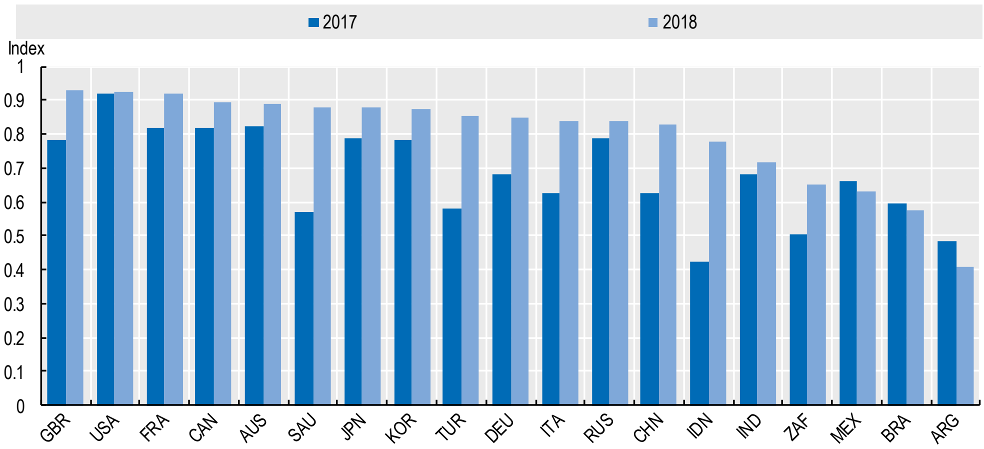


Source: OECD based on Akamai stats, available in https://www.akamai.com/uk/en/multimedia/documents/state-of-the-internet/soti-security-a-year-in-review-report-2019.pdf.

The extent to which governments recognise digital security as a central challenge is reflected in the worldwide deployment of national digital security strategies, the latter being an important dimension of national readiness in terms of digital security risk management. The ITU Global Cybersecurity Index (GCI) 2018 summarises assessments of the level of sophistication of national digital security strategies across four pillars: *legal*, *institutional*, *capacity building,* and *cooperation*. Across all countries assessed, only 58% reported having a published digital security strategy, though a further 12% had a cybersecurity strategy under development. Looking at the G20, 16 out of 19 countries increased their GCI composite score between 2017 and 2018, suggesting growing awareness and political salience. Almost half of the top-20 countries by GCI score are G20 countries.

Figure 2.3b. Global Cybersecurity Index, 2017 and 2018

Composite score (between 0 and 1)



Source: ITU (2017, 2018), Global Cybersecurity Index.

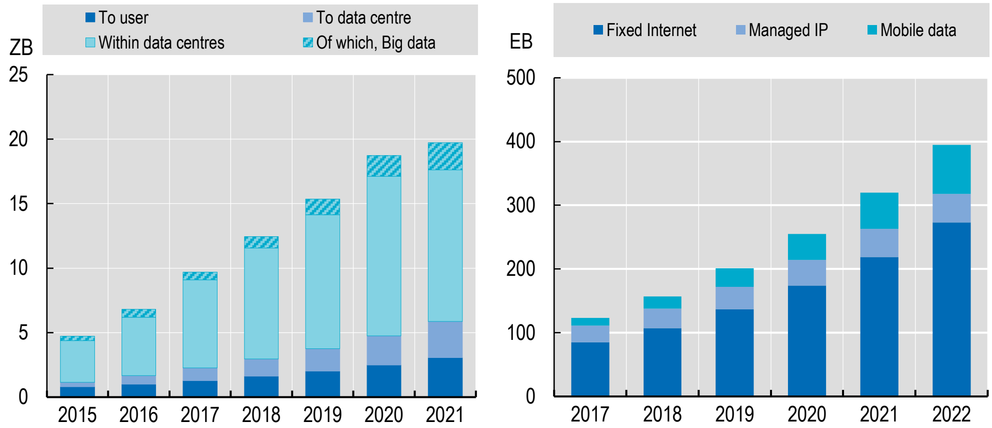
2.4. Data at the centre

Even before being further accelerated as a result of the COVID-19 pandemic, data stocks and flows have been growing in volume and importance. Capacity for data transmission is increasing everywhere, including developing economies. Cross-border data flows enable businesses to effectively co-ordinate their, supply, production, sales, after-sales, and research and development processes in global markets. In addition, data analytics is becoming an important means to monitor and model global phenomena such as climate change, while the rise of connected sensors (the Internet of Things) is offering new means of data collection. At the same time, the volume of data continues to rise (OECD, 2019a based on CISCO 2018). International bandwidth usage is increasingly shifting towards content providers such as Amazon, Google, Facebook, Microsoft, Alibaba, and Tencent, among others. Over the past few years, their share of international bandwidth usage has risen significantly, reaching 40% in 2017, on par with traditional Internet backbone providers (Mauldin, 2017).

Data centres - servers that can be used exclusively by a firm (private cloud) or rented on demand from cloud service providers - enable the storage of data, as well as remote computing via the Internet (cloud computing). The growing importance of data analytics has added to the value and growth of data centres. CISCO (2018), estimates that Global Internet Protocol (IP) traffic in 2021 will be double that of 2018, approaching 400 Exabytes/month (1 EB equals 1 billion GB) in 2022; and that global traffic from data centres in 2021 will also almost double, to more than 20 Zettabytes (1 ZB equals 1 trillion Gb). Furthermore, traffic between servers *within* the same data centre is a major component and expected to continue growing - with big data expected to represent about 3 ZB of this traffic within data centres, having increased almost five-fold since 2016 (Cisco, 2018).

Figure 2.4a. Global data centre traffic, by type and Consumer Internet Protocol (IP) traffic, by sub-segment, 2015-22

Zettabytes per year (left-hand panel) and Exabytes per month (right-hand panel)

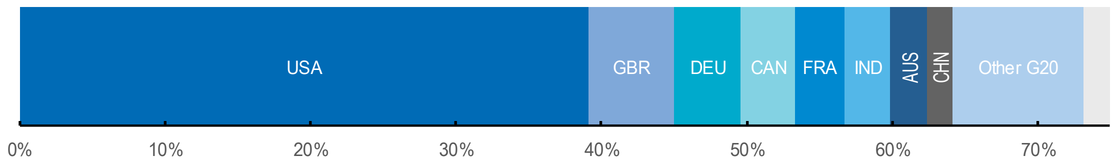


Note: "To data centre" refers to traffic flowing from one data centre to another, for example, moving data between clouds, or copying content to multiple data centres as part of a content distribution network. "To user" refers to traffic that flows from the data centre to end users through, for example, streaming video to a mobile device or PC. "Within data centres" refers to traffic that remains within a data centre, for example, moving data from a development environment to a production environment within a data centre, or writing data to a storage array.
Source: OECD calculations based on Cisco Global Cloud Index 2016-2021 and Cisco Visual Networking Index 2017-2022, January 2019.

As such the capacity for storage and processing of digital data is becoming another key aspect of infrastructure in the Digital Economy, as reflected by a growing number of colocation data centre facilities, which provide space, power, cooling and connectivity for companies' server, storage and network equipment (*UNCTAD, 2019*). While 80% of these data centres are still in developed countries (including almost 40% in the United States), more are being set up in India (3% of colocation data centres) and China (2%), for instance. In turn, this is resulting into more traffic on Internet exchange points (IXPs) – locations where telecom carriers and providers of content come together to exchange IP traffic (*UNCTAD, 2019*).

Figure 2.4b. Colocation datacentres in G20 Countries, 2020

As a percentage of colocation datacentres worldwide.



Source: OECD based on Data Center Map (https://www.datacentermap.com/datacenters.html).

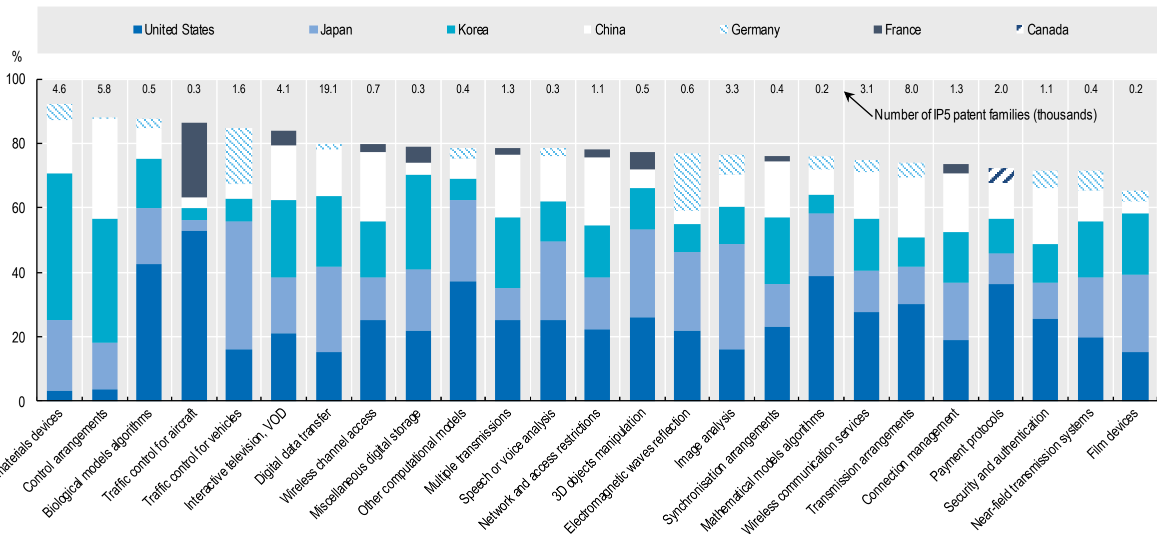
CISCO also estimates that, by 2022, mobile networks will contribute 20% of global IP traffic, more than twice their share in 2017. Correspondingly, 41% of global traffic will originate from smartphones, up from 18% in 2017. Machine-to-Machine (M2M) traffic is expected to grow from 3.8 EB to 25.4 EB per month and from 3.1% to 6.4% of global IP traffic. Internet video services function as the key driver of global traffic growth, accounting for about three-quarters of consumer IP traffic (itself more than four-fifths of global traffic). According to CISCO, this share will approach 82% in 2022, even without accounting for managed-IP traffic corresponding to video-on-demand. However, it is highly unlikely that video traffic explains the majority of value created from data flows. Indeed, many productive uses of data flows, such as the co-ordination of global value chains or cloud computing, may generate relatively little data traffic. The topic of measuring and valuing data and data flows is addressed in **chapter 2**.

2.5. Digital technology development is particularly concentrated in certain G20 countries

Rapid developments in digital technologies are a key enabler of ongoing digital transformation. Over 2013-16, G20 countries were among the top contributors of patents in each of the 25 digital technologies for which the number of new patents is growing the fastest. The top-five G20 contributors in each of these "fast-accelerating technologies" produced from 66% (film devices) to 92% (organic materials devices) of all new patents. Japan and Korea contributed to development across all fields, together accounting for 7% (traffic control for aircraft) to about 68% (organic materials devices) of all patenting activities in these digital technologies. The United States led the development of digital technologies related to aircraft traffic control (53%) and to algorithms based on biological models (43%) and mathematical models (39%). The People's Republic of China (hereafter "China") was among the top-five economies developing technologies in most fast-accelerating digital fields, and was particularly active in control arrangements (31%) and wireless channel access, as well as in network and access restriction techniques (21%). Of the European countries, Germany or France also featured among the top five G20 players in almost all of these digital technologies.

Figure 2.5. Top G20 countries in emerging digital technologies, 2013-16

Share of top five G20 country patents in top 25 technologies fast accelerating from 2010 onwards



Source: OECD, STI Micro-data Lab: Intellectual Property Database, January 2019

3. Indicators for measuring key aspects of the Digital Economy

The *G20 Toolkit for Measuring the Digital Economy* presented indicators under four "themes" addressing major aspects of the Digital Economy: Infrastructure; Empowering Society; Innovation and Technology Adoption; and Jobs and Growth. The following sections address the first three of these in turn, presenting selected indicators, highlighting important trends, examining underlying data sources, and highlighting key challenges and limitations. These indicators are mainly drawn from the 2018 G20 Toolkit for Measuring the Digital Economy. For the full selection of indicators under each theme, see the *Toolkit* publication (G20, 2018). Nevertheless, the presentation of some of these indicators has been re-formulated as well as several additional complementary indicators being presented, with the aim of providing further context, perspectives, and insights.

3.1. Infrastructure

This theme covers indicators on the development of physical, service and security infrastructures underlying the Digital Economy. It includes access to mobile and fixed networks, the development of next generation access (NGA) networks, the dynamics of household and business uptake, secure servers infrastructure, and infrastructure for the Internet of things. As a vital enabler for both households' and businesses' access and technology adoption, infrastructure developments warrant detailed measurement and monitoring across G20 countries to help ensure the necessary environment for optimal investment into both physical and intangible assets.

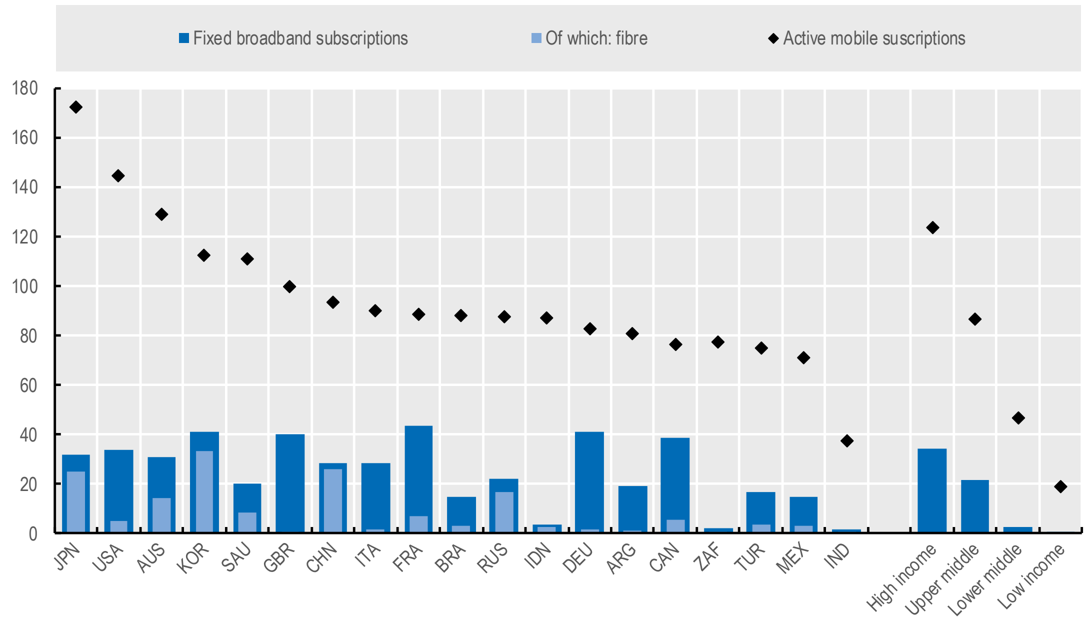
3.1.1. Increasing infrastructure capacity in fixed and mobile broadband

Broadband penetration – the number of subscriptions to fixed and mobile broadband services, relative to the country population – is a key indicator of connectivity and access. Worldwide fixed broadband subscriptions have more-than doubled in just eight years - from 527 million in 2010 to almost 1.1billion in 2018. Within the G20, France had the highest fixed broadband penetration in 2018, at 43.2%, followed by Germany and Korea both (41.2%).

Communication operators are continuing to deploy fibre optics further into their networks. Where fibre does not reach all the way to customers' premises, communication operators still rely on other "last mile" technologies, such as copper, wireless and coaxial cable, which also provide relatively high connection speeds - though inferior to fibre. As a result, the share of fibre (to the home/premises) remains low in some high-income countries. Countries without legacy telecommunications networks may be able to leapfrog directly to fibre – according to data collected by the ITU, fibre represents almost 70% of total fixed broadband subscriptions in China, for example – though these countries still tend to have lower broadband penetration overall. These countries are also pushing wireless connections, and the devices people use in their daily lives are increasingly wireless. Nevertheless, fast wireless connections are only possible if the fixed networks they feed into can meet the growing demand for backhaul capacity connecting wireless towers or end users directly; here fibre is also a key enabling technology and will become ever more important with the rollout of 5G networks.

Growth in mobile broadband subscriptions has far outstripped fixed broadband growth since 2010, with worldwide subscriptions increasing five-fold from 816 million in 2010 to 5.3 billion in 2018. In high-income countries, there is more than one mobile connection per inhabitant on average. Upper middle-income countries have adoption almost twice that of lower middle-income countries, while the lowest income countries record only 19 connections per 100 inhabitants, on average.

Figure 3.1.1a. Fixed broadband subscriptions and active mobile broadband subscriptions, per 100 inhabitants, 2018



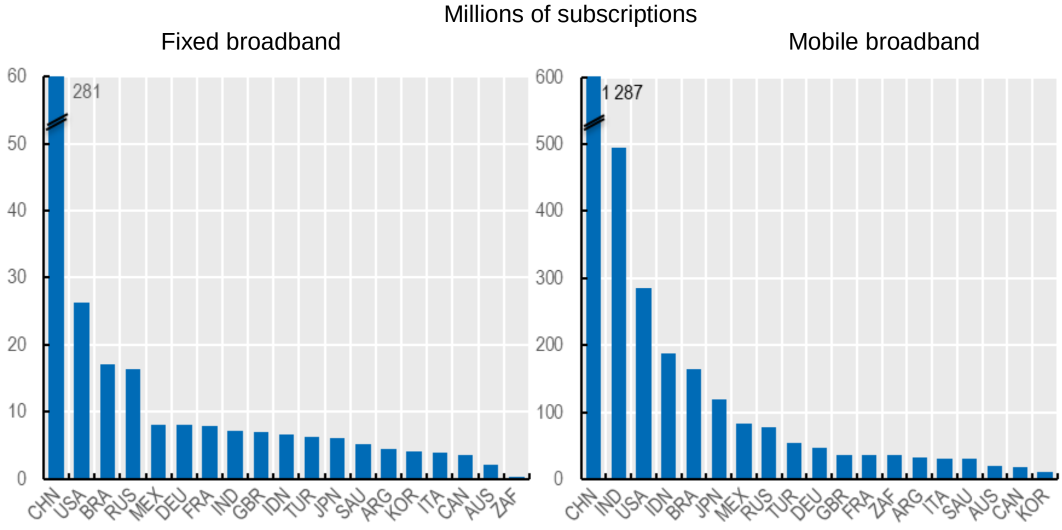
Note: includes fibre-to-the-home and fibre-to-the-building but excludes fibre-to-the-cabinet/node. United States data are estimates. Data for Germany include fibre lines provided by cable operators. Country groups are weighted averages.
Source: ITU World Telecommunication/ICT Indicators database; OECD, "Broadband database", OECD Telecommunications and Internet Statistics (database), www.oecd.org/sti/broadband/oecdbroadbandportal.htm, March 2020.

Since 2010 the number of active mobile broadband subscriptions in China has increased by 1.3 billion - almost one additional subscription per person in the Chinese population in 2017, though it should be noted both personal and business subscriptions are included as these are not delineated in the data. Argentina and Mexico both experienced 18-fold increases, while India added almost half a billion subscriptions in eight years and more than 162 million mobile broadband subscriptions in 2018 alone. Nevertheless, it should be noted that subscriptions only give a partial view on the extent of Internet access across the population. Some individuals may not have a subscription but gain Internet access through another subscription within their household or through shared services such as the community Internet kiosks available in India. Meanwhile, it is not possible to identify and adjust for cases where one person has multiple subscriptions and both business and personal subscriptions are included in the total.

The relatively limited availability and affordability of fixed broadband can be an important contributing factor to such strong mobile broadband growth. Nevertheless, fixed broadband has also continued to expand its reach in countries without legacy communication networks. Again, China has seen the greatest increase, with over 281 million fixed broadband subscriptions added from 2010 to 2018. The USA saw the second-greatest nominal increase, 26 million additional connections.

Figure 3.1.1b. Change in subscriptions, 2010 to 2018

Millions of subscriptions



Source: ITU World Telecommunication/ICT Indicators database; OECD, “Broadband database”, OECD Telecommunications and Internet Statistics (database), www.oecd.org/sti/broadband/oecdbroadbandportal.htm (June 2018).

Measuring fixed and mobile broadband penetration

Fixed broadband penetration refers to the number of subscriptions, per 100 inhabitants, to services with a 256 Kbps advertised download speed or greater, provided over DSL, cable, fibre-to-the-home (FTTH), fibre-to-the building (FTTB), satellite, terrestrial fixed wireless, or other fixed-wired technologies. *Fibre broadband* refers to subscriptions where fibre reaches the subscriber’s premises or terminates no more than 2 metres from an external wall. Fibre-to-the-node/cabinet is excluded.

Mobile broadband penetration includes subscriptions to mobile-broadband networks that provide download speeds of at least 256 Kbps (e.g. using WCDMA, HSPA, CDMA2000 1x EV-DO, WiMAX IEEE 802.16e and LTE), and excludes subscriptions using only GPRS, EDGE or CDMA 1xRTT networks. Figures relate to the number of active handset-based and computer-based (USB/dongles) mobile-broadband subscriptions to the public Internet, based on either a recurring subscription fee for data/Internet access or the subscriber having accessed the Internet in the last three months. M2M SIM cards are excluded (see section 3.1.4).

Compiling such indicators is relatively straightforward, simply requiring counts of the numbers of subscriptions that telecommunications providers have on their books. However, one important limitation is that these data do not currently distinguish between consumer and business users for which the motives for, requirements of, and benefits from broadband access are likely to be rather different.

Broadband subscription data are typically supplied to the OECD and ITU by communications regulators that collect them directly from network operators according to common definitions. It is not currently possible to delineate business and consumer subscriptions and so both are counted. Broadband subscription penetration rates do not provide information about the prices that users pay, realised connection speeds or whether there are restrictive data caps. Countries performing well in one measure may be weaker in another.

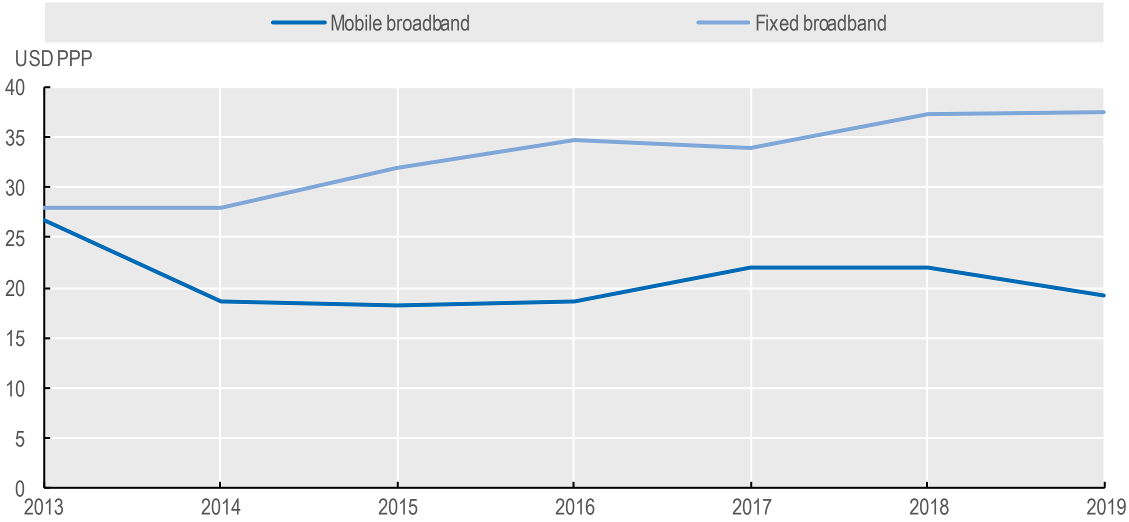
These indicators build upon pioneering academic work including The Global Information Technology Report 2001-2002 (Kirkman et. al. 2002).

3.1.2. Prices for connectivity

As the providers of vast, nationally important, physical assets, communication markets are a crucial and sensitive area of regulation and policymaking related to the Digital Economy. Prices for connectivity can be a good indicator of the level efficiency of communication markets. Between 2013 and 2019, average prices across the G20 decreased for mobile broadband access but increased for fixed broadband connections. This is drawn from a comparison over time of the averages for specific ITU price comparison baskets for telecommunication services – for 1.5 GB of mobile data over a 3G or better connection for mobile broadband and for 5GB of fixed-line broadband data respectively. The baskets are designed to provide a snapshot of prices at any given time rather than as a series. Accordingly, the lowest cost plan is selected at any point in time and may have different characteristics from earlier plans (e.g. higher speed or increased amount of data). That caveat aside, it is nonetheless worth considering an average for all G20 countries as an indicator of likely trends in the segment of the market shown (e.g. entry-level for fixed broadband). It should be noted, though, that the OECD also compiles broadband price indicators which cover different usage patterns – 20Gb and 200Gb for fixed broadband and up to 2Gb for mobile broadband; for more information see the OECD Broadband Price Baskets Methodology: https://oe.cd/2id.

Declining unit prices do not mean that all users will be paying less, as consumers can choose to pay the same amount as before for plans with higher included amounts of data, higher speeds, etc. or incur costs to switch plan. In mobile markets, increased competition has both lowered prices and increased the quality of the offers.

Figure 3.1.2. G20 trends in fixed and mobile broadband prices, 2013-19



Note: PPP = purchasing power parity; Gb = Gigabyte; Mb= Megabyte. Unweighted averages. The fixed-broadband basket is based on the cheapest fixed-broadband subscription with a minimum of a 5 GB monthly usage and an advertised download speed of at least 256 Kbit/s. Until 2017 the data allowance was 1GB only, but that does not materially affect the time series. For mobile broadband, 2018 and 2019, prices are for a data plan with a monthly allowance of at least 1.5 GB, irrespective of the device used, over a 3G or higher data transmission network or higher. Until 2017, prices are for a USB/dongle, computer-based, post-paid subscription of at least 1 GB. Broadband minimum speed is 256 kbit/s.
Source: ITU World Telecommunication/ICT Indicators database (accessed March 2020).

Different methods to measure broadband affordability
ITU price data are collected in the fourth quarter of each year. Data on mobile-broadband prices are collected by ITU directly from operators' websites, while fixed-broadband price data are collected through the ITU ICT Price Basket questionnaire sent to the administrations and statistical contacts of all 193 ITU Member States. For mobile broadband the basket is based on prepaid prices except where prepaid subscriptions make up less than 2% of the total, in which case post-paid subscriptions are used. The fixed-broadband sub-basket refers to the price of a monthly subscription to an entry-level fixed-broadband plan with a monthly data usage of 1 GB or more. Where data volume caps below 1 Gb exist, additional data cost is added. For more information see https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/pricemethodology.aspx.

OECD broadband price data are gathered directly from network operator websites. For fixed-line broadband a set of three operators with a combined market share of at least 70% is compared. All DSL, cable, and fibre offers with advertised speeds over 256kbps are included. For mobile broadband, at least the two largest network operators, with 50% or more combined market share based on subscriber numbers, are covered. Offers include 3G and 4G mobile phone services, including post-paid, prepaid, and SIM only tariffs. Data and voice offers are treated separately from data only. Handsets are not included. Offers are for month-to-month service advertised clearly on the operator's website and should be available in the country's largest city. Work is currently underway to further revise and improve this approach, For more information see the OECD Broadband Price Baskets Methodology: https://oe.cd/2id.

3.1.3. Faster broadband speed

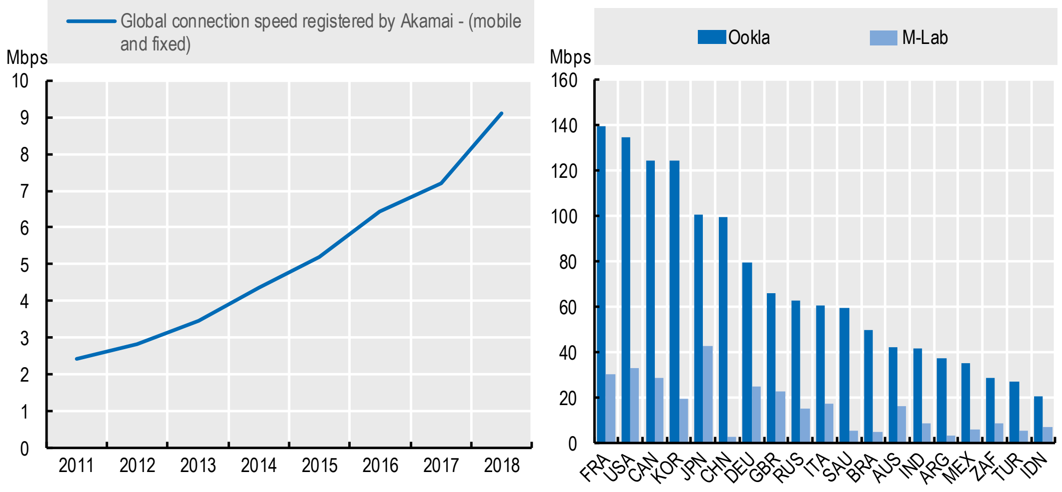
Beyond availability and affordability, connection quality factors including reliability and speed can play an important role in determining individuals' and businesses' ability to engage with and benefit from the Digital Economy. According to commercial data from Akamai, the average (fixed and mobile combined) global Internet connection speed increased from around 2 Mbps to more than 9 Mbps between 2011 and 2018. Adequate network speed is essential to fully exploit online services, especially for businesses that rely increasingly on large data flows and digital products (e.g. as a result of adopting cloud computing services or Internet of Things devices).

In terms of consumer service offers, speeds vary considerably with most fixed broadband subscriptions already marketed at over 10 Mbps in many countries. Business users, educational institutions, and the public sector can often access tailored high-speed products such as leased lines between specific locations. As of 2019, the leading advertised download speed in G20 countries was 10 Gbps, though few offers were available with such speeds.

Nevertheless, consumer offers marketed at 1 Gbps are increasingly common, particularly in countries with high population densities, such as Japan and Korea, as well as in an increasing number of cities in the United States. Residential offers at 1 Gbps are most common where there is either strong infrastructure competition between operators or between retail providers using wholesale networks.

Even in countries where connections are advertised at 1Gbps or greater, delivering these speeds to all geographical locations remains a challenge. It is also common for actual speed in use to be below (sometimes significantly below) the advertised speed. Measurements from Ookla and M-lab, which allow users to self-test their connection speeds as well as Akamai's data on download speeds, provide indications of real-world Internet speeds experienced by users but none of these fully represent the overall Internet experience in each country, offering a useful but only partial perspective on Internet speed. This is, in part, illustrated by differences between readings from the two sources. Based on Ookla data, France and the USA experienced the highest average connection speeds at over 130 Mbps. By contrast, M-lab readings are generally slower, with Japan appearing to have the highest average connection speeds, at around 40 Mbps.

Figure 3.1.3. Global connection speed, 2011-18 (mobile and fixed) & Average experienced download speed of fixed broadband connections in G20 countries in 2019



Source: OECD based on Akamai, Ookla, October 2018 and M- Lab (Worldwide broadband speed league), between June 2017 and May 2018.

Using speed test data

Internet speed relates to the amount of data passing through a network connection in a second. Speed is commonly expressed in megabits or Gigabits per second (Mbps or Gbps). 1000 Mbps = 1 Gbps.

Measurement of broadband performance is affected by the potential gap between *advertised* and *experienced* speeds delivered to customers. An alternative measure uses information collected by regulators on the *advertised* download speed of fixed line subscriptions, which can be compiled into indicators broken down by speed tiers to give a view of subscriptions' "theoretical" speed. Such indicators are available on the OECD broadband portal: http://oe.cd/broadband. However, such indicators only cover fixed line connections at this time and there can also be significant differences between the speed advertised and the average speed experienced by users in daily use.

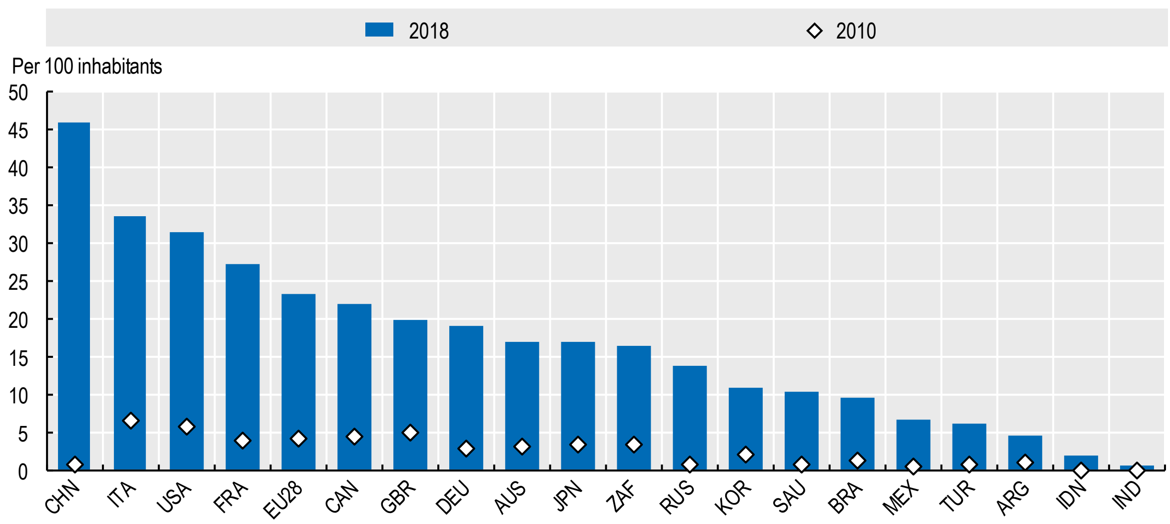
Several tools are available to measure actual download or upload speeds, together with other quality-of-service parameters. Akamai - a content delivery network (CDN) and cloud services provider serving between 15% and 30% of all web traffic – collects data on the average download speed of content transiting through its network to clients. The Ookla measure reflects wired or wireless broadband speed achievable 'on-net', while the M-Lab Network Diagnostic test is primarily for identifying Internet bottlenecks rather than computing averages of upload and download speeds from different user populations. However, none of these fully represents the overall Internet experience, providing only partial indicators.

3.1.4. The rise of the Internet of Things

The Internet of Things (IoT) refers to an ecosystem in which applications and services are driven by data collected from devices that act as sensors and interface with the physical world. Laptops, tablets and smartphones are excluded from this definition. IoT technologies are finding applications in health, education, agriculture, transportation, manufacturing, electric grids, and many more areas. IoT-powered devices could soon be a fundamental part of the everyday lives of people in OECD countries and beyond (OECD, 2019a). As such, and with the right policy environment, IoT is expected to become a central element of countries' Digital Economy infrastructure powering high-profile innovations such as telemedicine and autonomous vehicles. Indeed, such technologies could help to address high-level challenges in G20 countries such ageing populations and climate change. However, measuring the development and diffusion of IoT can be challenging and holistic perspectives are yet to be developed (OECD, 2018).

Part of the underlying infrastructure of the IoT is machine-to-machine (M2M) communication. Similar to broadband penetration, counts of subscriptions (e.g. SIM cards) enabling M2M services are currently a key indicator on the expansion of the IoT. The GSMA tracks the global number of SIM cards embedded in machines, such as automobiles or sensors, which allow communication between such devices. Among G20 economies, China had the highest penetration (number of M2M SIM cards per inhabitant) in 2018, followed by Italy and the United States. Between 2010 and 2018, the number of subscriptions increased by 1 591% in the G20. The People's Republic of China had the largest share of worldwide M2M subscriptions – 69% of the total – at 842 million in December 2018, representing six times the share of the United States.

Figure 3.1.4. M2M SIM card penetration per 100 inhabitants, G20, 2010 and 2018



Source: OECD, Science, Technology, and Industry Scoreboard 2017, OECD publishing, http://oe.cd/sti-scoreboard; OECD calculations based on GSMA Intelligence, March 2020.

Measuring the infrastructure for IoT using GSMA data

The GSMA defines M2M as "a unique SIM card registered on the mobile network at the end of the period, enabling mobile data transmission between two or more machines. It excludes computing devices in consumer electronics such as e-readers, smartphones, dongles and tablets". The GSMA collects publicly available information about mobile operators that have commercially deployed M2M services. A data model based on a set of historic M2M connections reported by mobile operators and regulators over time is then used, along with market assumptions based on a large-scale survey of M2M operators and vendors. This data is then reconciled with the GSMA definition of M2M SIM cards, normalised, and analysed to identify specific M2M adoption profiles. These adoption profiles are then applied by the GSMA to all operators that have commercially launched M2M services, but do not publicly report M2M connections to produce national figures. For more information, see www.gsmaintelligence.com. While the OECD and ITU collect data on M2M SIM cards directly from countries, the GSMA Intelligence estimates have been used here to ensure a global coverage from the same source and applied methodology. It should also be noted that mobile technologies are just a few of the more than 15 transmission technologies of IoT.

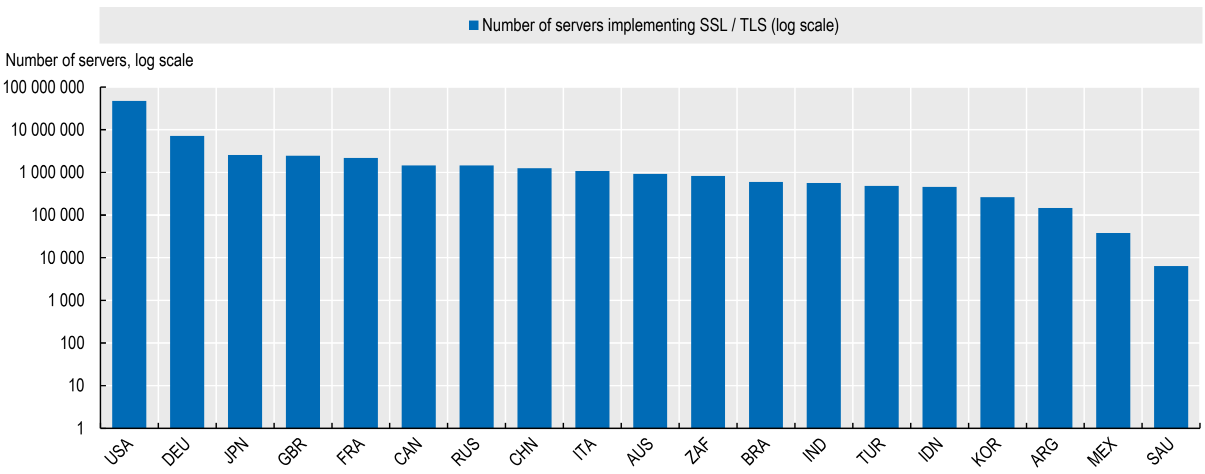
3.1.5. More secure servers

The rapid spread of digital technologies and reliance on digitised information creates new challenges for the protection of sensitive data and network communications. Servers implementing SSL/TLS digital certificate protocols can be used for the exchange of sensitive information, such as passwords and credit card numbers. As such, they are a vital infrastructure helping to underpin consumer confidence in key Digital Economy activities such as e-commerce.

According to data from the January 2020 Netcraft survey, 71 million implementing SSL/TLS digital certificate protocols - were deployed across G20 countries. This represents a marked growth from 25 million in June 2018 – when there were only 33 million such servers worldwide. Growth accelerated markedly in 2014; having risen by around 20% year-on-year previously. The United States accounted for over two-thirds of servers implementing SSL/TLS in G20 countries – (47 million). This was followed by Germany (7 million) and Japan and the United Kingdom (each almost 2.5 million). However, SSL/TLS protocols are implemented on a small fraction of the total servers hosted (OECD, 2019)a; policy action may be needed to ensure security measures such as these are adopted more widely and upgraded over time.

Figure 3.1.5. Web servers implementing digital certificates, by host country, G20, June 2020

Number of Internet hosts in each country using SSL / TLS



Source: Netcraft, www.netcraft.com, accessed March 2020.

Measuring server security

Secure servers are servers implementing Transport Layer Security (TLS) or Secure Sockets Layer (SSL) protocols. Internet browsers and web servers use these to exchange sensitive information. They rely on a certificate authority trusted third parties such as Symantec and GoDaddy), which issues a digital certificate containing a public key and information about its owner, and can confirm that a given public key belongs to a specific website.

Netcraft, carries out monthly secure server surveys covering public secure websites (excluding secure mail servers, intranet and non-public extranet sites) using electronic tools to ascertain whether public servers have TLS or SSL implemented. Statistical information on online security are typically drawn from three major sources: i) user surveys, usually conducted by national statistical offices, ii) activity reports and iii) the Internet.

Each data source has advantages and drawbacks. Besides the issues specific to each data source, there is a more fundamental challenge to the measurement of security and privacy, whether online or offline. To fill the measurement gap, the OECD is working on the collection of information on digital security risk management practices in businesses and standardised reporting of personal data breach notifications by Privacy Enforcement Authorities.

3.2. Empowering Society

Beyond its economic impact, the use of digital technologies has also improved people's lives and broader well-being in a relatively short time Digital technologies enable more people to access government services, promote civic engagement and allow more people to connect than ever before. They also increase consumer choice and convenience (*OECD, 2019b*). At the same time, as the ability to access ever more aspects of society – from government services to job opportunities – becomes intertwined with access to the Internet, there is a need to ensure no one Is left behind. As such, the societal effects of the Digital Economy's development are both essential and difficult to assess, as they are not clear-cut and still lack widely adopted indicators in some areas (e.g. digital financial inclusion).

This theme considers indicators that portray the evolving role of the Digital Economy in people's lives, how they access and use digital technologies, and their abilities to exploit fully their potential. It includes indicators on people's use of the Internet, including online interactions with government, and indicators of the gender gap in engagement in the Digital Economy. These indicators were presented under the Empowering society theme in the G20 Toolkit. However, the facets covered here interact considerably with jobs and skills, which are addressed in chapter 3.

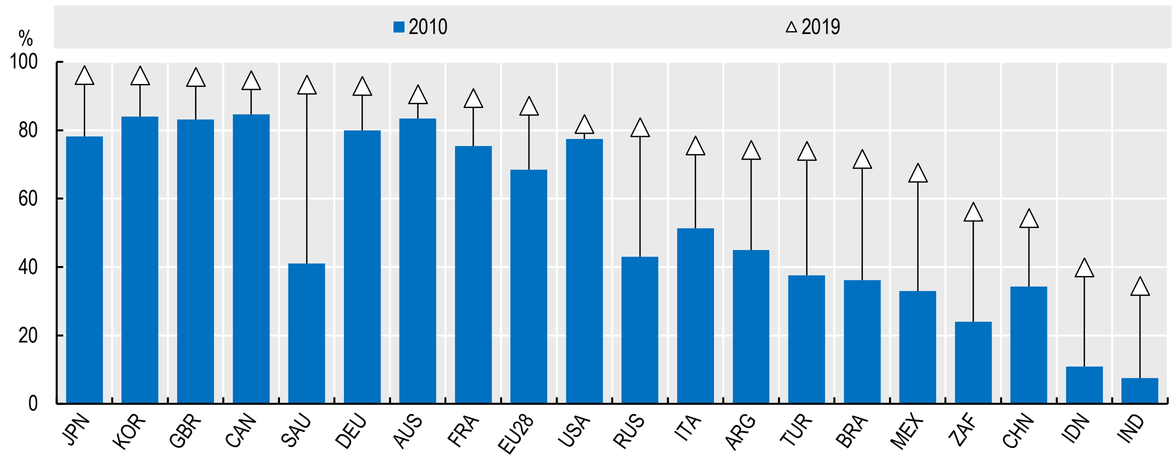
3.2.1. The digital divide

Today's Digital Economy is characterised by connectivity between users and between devices, as well as the convergence of previously 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 most individuals' everyday life in G20 economies.

The share of individuals using the Internet in G20 countries almost doubled on average between 2010 and 2019, with especially considerable increases seen in Saudi Arabia, Turkey, Brazil, Mexico, South Africa, Indonesia, and India - narrowing the gap among G20 economies. Japan, Korea, the United Kingdom, and several other G20 economies are reaching saturation (uptake by nearly 100% of individuals), while there remains significant potential for catching-up in others. In general, older generations are less connected, although the generational gap varies across countries.

Figure 3.2.1. Internet users, G20, 2010 and 2019

As a percentage of 16-74-year olds



Note: Unless otherwise stated, Internet users are defined as individuals who accessed the Internet within the 3 months prior to being surveyed. For Japan, the recall period is 12 months, likewise for Australia 2010 and Canada 2010 figures. For Argentina, India, Indonesia, the Russian Federation, Saudi Arabia and South Africa, the recall period is not specified in the ITU data file. Brazil, Canada, Indonesia, Korea, Mexico, Russian Federation, and Saudi Arabia refer to 2018 instead of 2019. Argentina, China, India, Japan, United States, and South Africa refer to 2017 instead of 2019. Australia refers to 2016 instead of 2019. Some countries use a target age-range other than 16-74.
Source: OECD, Science, Technology, and Industry Scoreboard 2017, OECD publishing, http://oe.cd/sti-scoreboard; based on OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind; ITU, World Telecommunication/ICT Indicators Database and national sources, March 2020.

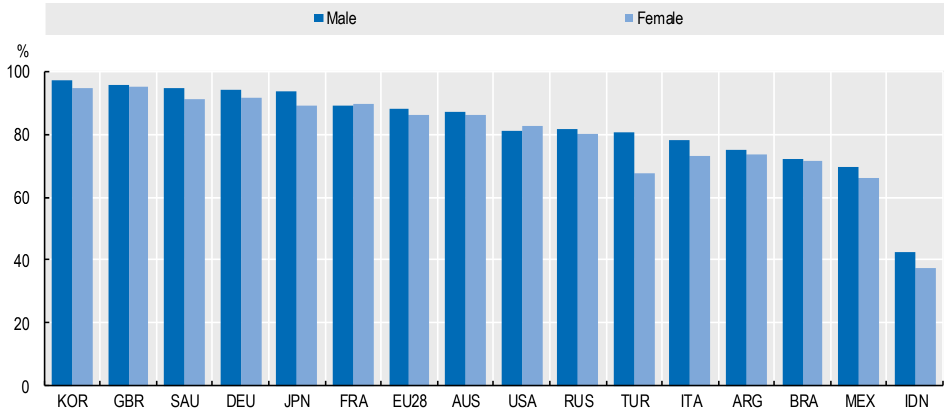
Defining Internet users
Internet users are individuals who accessed the Internet within the last three months prior to surveying. Nevertheless, some countries use longer recall periods or have no recall period at all limiting the possibility to make international comparisons.
These data are generally gathered through direct surveys of ICT use in households and by individuals or using questions on broader household surveys. Even among European countries, where indicators are fully harmonised, data collection practices differ. In some cases data are collected through Labour Force Surveys or general surveys of living conditions (e.g. in Italy).

3.2.2. The gender gap

Despite a sustained pace of increase overall, Internet take-up has been uneven across different groups in society. This has created a digital gender divide in two-thirds of countries worldwide (*OECD, 2018b*). As such, targeted policy interventions may be needed to address the causes of such disparities. That said in G20 countries for which data are available, the gender gap in Internet usage is relatively moderate, with only Turkey, Germany and Italy exhibiting gender gaps in Internet usage of greater than 5 percentage points.

Figure 3.2.2a. Individuals using the Internet, by gender, G20 economies, 2019

As a percentage of all men and women aged 16-74, respectively



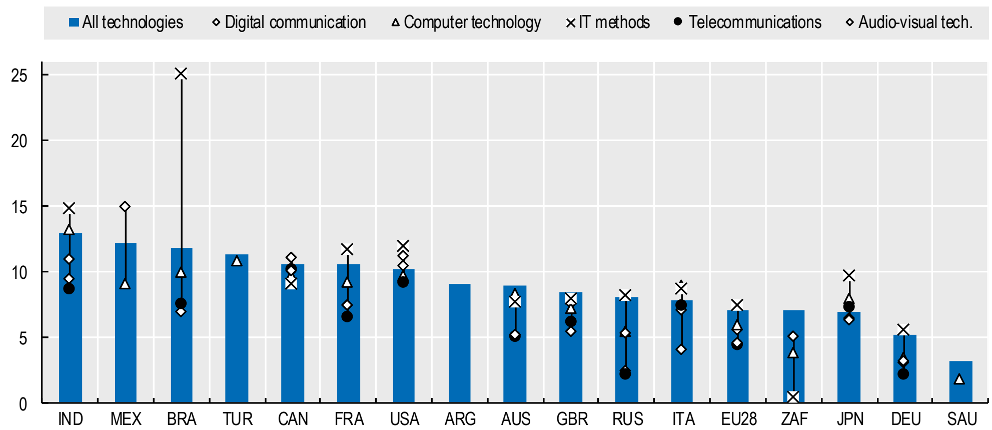
Note: Unless otherwise stated, Internet users are defined as individuals who accessed the Internet within the 3 months prior to being surveyed. For Argentina, Indonesia, Japan, and Saudi Arabia the recall period is not specified in the ITU file. For Australia, data refer to individuals “who accessed the Internet for personal use in a typical week”. For Brazil, Indonesia, Japan, Russian Federation, Mexico, and Saudi Arabia data relate to 2018 instead of 2019. For Argentina, Australia, and the United States data relate to 2017 instead of 2019.

Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind and ITU, World Telecommunication/ICT indicators Database, February 2020.

More pronounced gender imbalances are found in other areas of the Digital Economy. Among G20 economies, over 2012-15, India, Mexico and Brazil reported the highest shares of patents invented by women. High proportions of patents invented by women are also observed in Korea and in China, though these figures are not fully comparable with other countries so are not shown here (*OECD, 2018b*). In G20 economies, over the years 2012-15 female inventors appeared generally less active than men in all forms of ICT-related patents. These figures need to be considered with care, as countries differ substantially in the overall number of IP5 patent families filed and therefore, in absolute numbers, figures may (and) look different from those emerging when ratios are considered. There are many factors that may contribute to explain the figures at hand, including education and industry specific characteristics, as well as selection effects determined by culture or social norms.

Figure 3.2.2b. Patenting activity by women inventors, 2012-15

As a percentage of IP5 patent families, by technology and inventors' country



Source: OECD based on STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, June 2017.

Measurement

Patents protect technological inventions, i.e. products or processes providing new ways of doing something or new technological solutions to problems. IP5 patent families are patents within the world’s five major IP offices (IP5). *Patents in ICT* are identified using the International Patent Classification (IPC) codes (see Inaba and Squicciarini, 2017).

3.2.3. How people use the Internet

The types of activities people do online vary widely across G20 countries and are influenced by differences in institutional, cultural, and economic factors as well as characteristics including age, educational attainment, and income. Even in economies with almost universal Internet uptake, there is notable variation in the way people use the Internet in terms of the level of sophistication of their activities, with many people carrying out relatively basic and limited activities online.

Monitoring the types of activities people do online is one way for policymakers to assess the benefit of policies to extend access or improve digital skills (see chapter 3). At the G20 level, this can also act as an indicator of convergence across countries, as they experience digitalisation at different paces.

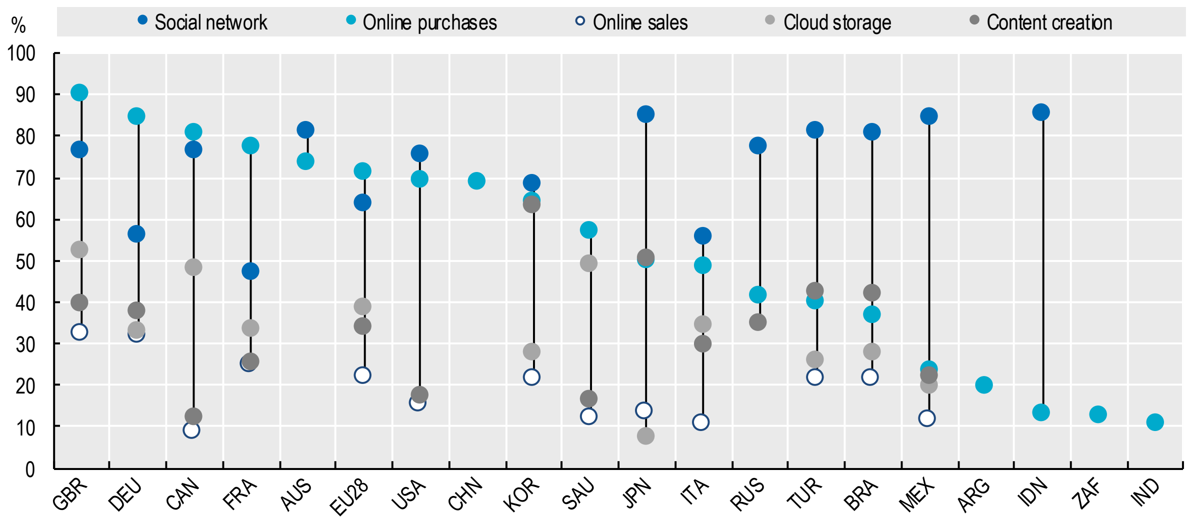
In all G20 countries, participating in social networks is a particularly popular online activity. On average across the G20 countries, 74% of Internet users use social networks, and over 85% in Indonesia and Japan.

Only in the United Kingdom, Germany, and France are social networks surpassed online shopping as the most popular online activity. In general, Internet users are considerably more likely to make purchases online (57%) than sell goods or services online (19%).

Content creation and cloud storage came third in terms of popularity, with 34% of G20 Internet users carrying out these activities – which contribute to the wide array of content available online.

Figure 3.2.3. Diffusion of selected online activities among Internet users, 2019

As a percentage of Internet users



Note: Australia and Indonesia data relate to 2016. Argentina, China, India, United States, and South Africa data refer to 2017, likewise for Japan with the exception of cloud storage which refers to 2015. Brazil, Canada, Korea, Russian Federation, and Saudi Arabia data relate to 2018. The recall period is the last 3 months for all activities except online purchases (last 12 months) and the following: for Australia, Canada and the United States, the recall period is the last 3 months for all activities; for Japan and Korea, the recall period is the last 12 months for all activities. For Mexico, the recall period for online sales is the last 12 months.

Source: OECD, ICT Access and Usage by Households and Individuals Database, http://oe.cd/hhind; European Commission (Digital Economy and Society Index -DESI- and International DESI); ITU World Telecommunication/ICT Indicators Database, and UNCTAD B2C E-commerce Index (https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d14_en.pdf), March 2020.

Measurability

Surveys of individuals' ICT usage can ask if the respondent has undertaken a wide range of online activities during the recall period. The OECD Model Survey on ICT Access and usage by Households and Individuals (OECD, 2015b) proposes various activities for investigation. Data on mobile commerce (purchase via a handheld device) are also usually collected within these surveys, as well as the types of products that are being purchased (e.g. travel, films, music, books, food, etc.). Data collection is uneven across countries, due to differences in the frequency and nature of surveys, which can impact the ability to make international comparisons. A recall period of 3 months is recommended (meaning the respondent should have undertaken the online in the 3 months prior to being surveyed). Nevertheless, some countries have higher thresholds or no recall threshold at all. Differing age limits impact comparability; for example, data for Japan and the United States refer to all individuals aged 6 and over instead of for 16-74 year olds, which might reduce overall rates.

An e-commerce transaction describes the sale or purchase of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders (*OECD, 2011*). Online purchases are usually measured with respect to a 12-month recall period, in consideration that online shopping may not be a high-frequency activity. *Cloud storage* relates to using the Internet as a storage space to save files for private purposes. *Content creation* relates to uploading self-created content on sharing websites such as YouTube, Facebook, and Spotify.

3.2.4. Digital government

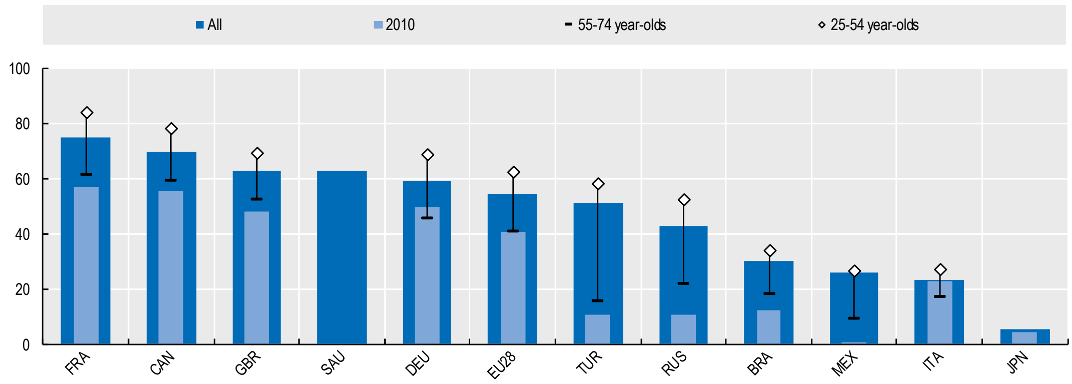
Governments can take full advantage of new technologies to deliver better services and make processes more efficient. Global trends show that e-government has been growing rapidly since 2001. The United Nations tracks the E-Government Development Index (EGDI) based on three components: the scope and quality of online services, the status of development of telecommunication infrastructure and the inherent human capital (*UN, 2018*).The digitisation and automation of processes can play a considerable role in simplifying the ways people and businesses interact with public authorities - from simple document browsing and downloading forms to completion of administrative procedures. One important example is online filing of personal and corporate tax returns, which is especially common in Brazil, Italy, Australia, Korea, and India (*OECD, 2019b*).

In G20 countries for which data are available, the share of individuals using the Internet to interact with public authorities has increased in recent years, from 30% in 2010 to 46% on average in 2019. Mexico and Russia saw particularly pronounced increases from 0.5% and 10.6% respectively in 2010 to nearly 26% and 43% in 2019. Inter-country differences remain large, however, ranging from around 70% in France and Canada to 5.3% in Japan. Across all G20 countries, older individuals are less likely to use the Internet to interact with public authorities that younger cohorts: while 51% of 16-24 year-olds report online interactions, only 34% of 55-74 year-olds do so. Inter-country differences may reflect differences in Internet usage rates, the supply of e-government services and the propensity of users to perform administrative procedures online, as well as limited data comparability.

On average, 12% of EU citizens who needed to submit a completed form to public authorities in 2019 reported being unable to submit online because the service was unavailable. The share was much higher in Slovenia (31%) and Germany (29%). Concerns about protection and security of personal data are also frequently reported as a reason for not submitting official forms online. In 2019, 20% of people in the EU chose not to submit completed forms to public authorities online and, on average, 16% among those cited privacy and security concerns as a reason for not doing so. This was also particularly the case in Hungary (38%) and Germany (33%). Another frequent reason for not submitting official forms online was lack of skills or knowledge of citizens. On average, 19% of EU citizens who had the need to submit completed forms to public authorities admitted that lack of skills or knowledge prevented them from doing it online.

Figure 3.2.4. Individuals using the Internet to interact with public authorities, G20, by age, 2019

As a percentage of population in each age group



Notes: Unless otherwise stated, data refer to the respective online activities in the last 12 months. For the Russian Federation, data refer to 2018 and 2014, and to individuals aged 15 to 72. For Brazil, Canada and Mexico, data refer to 2018. For Canada, in 2018, data refer to individuals aged 15 to 74. Internet users include individuals who used the Internet for personal use, excluding business- and school-related use, from any location during the past 12 months. In 2010, data refer to individuals aged 16 to 74. For Japan, data refer to 2017, and to individuals aged 15-69 instead of 16-74 using the Internet for sending filled forms via public authority websites in the last 12 months. For Mexico, using e-government services includes the following categories: "communicating with the government", "consulting government information", "downloading government forms", "filling out or submitting government forms", "carrying out government procedures" and "participating in government consultations". For Saudi Arabia, data refer to 2017, and to individuals interacting with general government organisations.
Sources: OECD, Science, Technology, and Industry Scoreboard 2017, OECD publishing, http://oe.cd/sti-scoreboard; based on OECD, ICT access and use database, http://oe.cd/hhind; ITU World Telecommunication/ICT Indicators database (March 2020).

Measuring people's online interactions with government
Individuals' online interactions with public authorities range from the simple collection of information on government websites to interactive procedures where completed forms are sent via the Internet – excluding manually typed e-mails (for individuals).
Public authorities refer to both public services and administration activities. These may be authorities at the local, regional, or national level. E-government can be measured by collecting information on electronic services offered by government entities (supply-side approach) or on the use of these services by businesses and individuals (demand-side approach). Currently the latter is the main approach, with use being investigated through ICT surveys. However, as the same services (e.g. transport, education, health) can be provided by government and/or by public or private sector businesses - with the precise mix varying between countries - the scope for e-government service use by individuals and firms will therefore differ between countries.

3.3. Innovation and technology adoption

This theme presents indicators that address innovation in digital technologies, digitally-enabled business models, the role of ICTs as an engine for innovation, and the adoption of ICTs and other emerging technologies by businesses. The digital transformation can have a positive impact on economic growth and on well-being through productivity improvements, as well as increased access to markets and product choice. As such, it is useful to monitor the development and uptake of disruptive and innovative technologies. This also helps to frame policymaking in complementary areas such as skill development (see chapter 3).

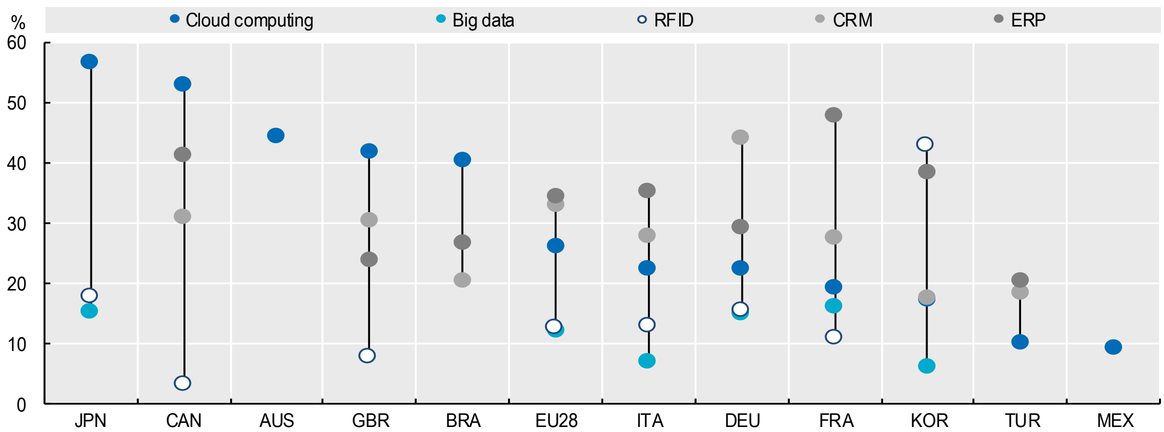
3.3.1. ICT use by businesses

Most businesses use digital tools or ICTs of some sort, though often not to their full potential. This can result from factors including the availability of relevant skills in the workforce, including among directors (see Chapter 3) and the degree of competition in the market in which a given firm operates. Monitoring business use of digital tools across different business categories is essential to identify, investigate, and close gaps between frontier firms and other businesses in terms of the adoption of technology, which remains one key hurdle to productivity gains being realised in most G20 economies today (*OECD, 2019c*). This indicator illustrates the differing extent to which selected relatively sophisticated ICT tools have been adopted by businesses in different G20 countries. These are key tools in many economies but in some cases, especially in developing countries, it would be important to consider such fundamental aspects as having a computer, having a web presence, placing orders and receiving orders over the Internet, or access to broadband.

The G20 countries for which data are available exhibit considerable variation in the take-up of ICTs by business. Japan and Canada have the greatest uptake of purchased Cloud computing services among enterprises (57% and 53% respectively). Meanwhile, their uptake of radio frequency identification (RFID) was lower than other countries. By contrast, use of RFID technology is particularly high in Korea (43%) while uptake of Customer Relationship Management (CRM) tools was relatively low (18%) - close to Turkey (18.5%).and Brazil (20%). In general, Big Data shows the lowest diffusion across enterprises in G20 countries. This is notable as data are becoming an increasingly important driver of digital transformation in many sectors.

Figure 3.3.1. Diffusion of selected ICT tools and activities among enterprises, by technology, G20, 2019

As a percentage of enterprises with 10 or more persons employed



Notes: Enterprises with ten or more employees. Data for ERP relate to 2019 for all countries except Brazil (2017), Canada (2017) and Korea (2017). Data for CRM relate to 2019 for all countries except Brazil (2017), Korea (2017), and Canada (2013). Data for RFID relate to 2017 for all countries except Canada (2013). Cloud computing: data refer to 2018 for all countries except Japan (2017), Brazil (2017), Canada (2017) and Korea (2017); for Australia, data refer to 2016 and for Mexico to 2012. Due to the underlying survey methodology, these data represent firms with 10 or more employees; smaller firms, which are not covered, vary in prevalence between countries.
Source: OECD, based on ICT Access and usage by Businesses Database, http://oe.cd/bus.

Measuring ICT use by businesses
Enterprise resource planning (ERP) systems are software-based tools for managing internal information flows. *Customer relationship management (CRM)* is a programme for managing a company's interactions with customers, employees and suppliers. *Cloud computing* refers to ICT services over the Internet to access server, storage, network components and software applications. *Big data analytics* refer to the analysis of vast amounts of data generated by activities carried out electronically and through machine-to-machine communications.
These data are gathered through direct surveys of business' ICT usage. Aside from differences in the survey vehicle, the majority of indicators correspond to generic definitions that proxy the functionalities and potential uses of ICT tools. For example, various software with different functionalities are within ERP, and there are substantial differences in the sophistication of ERP systems and their degree of implementation. Cloud computing services and big data raise similar issues and the measurement of e-commerce is equally affected by different practices in data collection and estimation (*OECD, 2019*).

3.3.2. E-commerce

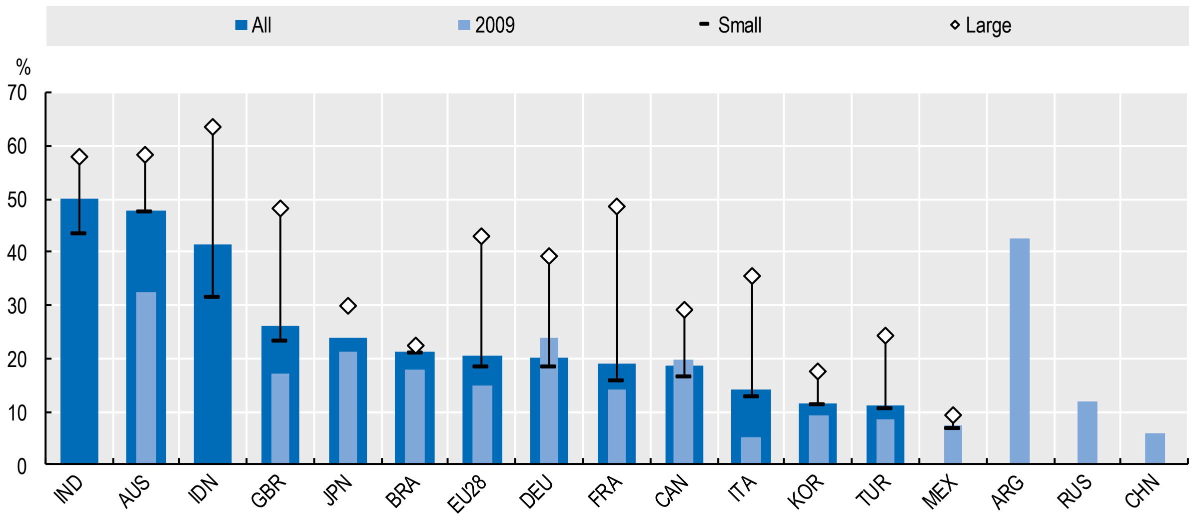
Selling online can enable firms to access new markets and a wider pool of customers to drive demand and growth. Encouraging firms to take up e-commerce may therefore be a policy priority. On average, 25% of enterprises in the G20 countries for which data are available make sales via e-commerce, representing an increase of 8 percentage points since 2009.

Differences among countries remain large. Around half of enterprises in India and Australia report making sales online, compared to fewer than 15% firms in Italy, Korea and Turkey. Non-harmonised definitions of e-sales may explain some of these differences, but a key factor appears to be differing shares of smaller firms in different economies, as small firms use significantly less e-commerce on average (22%) than large firms (37%). In France, for instance, 49% of large businesses engage in e-commerce while only 16% of small businesses do so, similar to the pattern seen in Europe as a whole with 18% of small firms using e-commerce compared to 43% of large ones. Indonesia has the highest share of large firms engaging in e-sales at 64%, followed by India and Australia with 48%.

Meanwhile, on average across G20 countries, half of all Internet users made online purchases in 2019 – ranging from 11% in India to over 90% in the United Kingdom (see indicator 2.2.3).

Figure 3.3.2. Enterprises engaged in sales via e-commerce, by size, 2019

As a percentage of enterprises in each employment size class



Note: Unless otherwise stated, only enterprises with ten or more employees are considered. Small firms have 10-49 employees, medium-sized firms have 50-249 employees and large firms have 250 or more employees.

For Argentina data refer to 2006 and manufacturing sector only. For Canada, data refer to 2013. Medium-sized enterprises have 50-299 employees and large firms have 300 or more employees. Sales online over the Internet may include EDI sales over the Internet as well as website sales, but do not include sales via manually typed e-mail or leads. For China, data relate to 2005 and includes businesses with fewer than 10 employees. For India data refer to 2013 and manufacturing sector/factories only. For Japan, data refer to 2017 and to businesses with 100 or more employees instead of ten or more. Medium-sized enterprises have 100-299 employees and large firms have 300 or more employees. For Mexico, data refer to 2012 and to businesses receiving orders via the Internet instead of over computer networks. For the Russian Federation data relate to 2008 and to legal entities except for small business entities. Data for the following remaining countries all refer to 2017 instead of 2019: Australia, Brazil, Republic of Korea. Data for Indonesia relate to 2015.
Source: OECD, ICT Access and Usage by Businesses Database, http://oe.cd/bus, December 2018 and UNCTAD enterprise use of ICT statistics (June 2018).

Measuring e-commerce sales
An e-commerce transaction describes the sale or purchase of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders (OECD, 2011). The goods and services are ordered by these methods, but the payment and ultimate delivery of the goods and services do not have to be conducted online. For enterprises, e-commerce sales include all transactions carried out over webpages, extranet or Electronic Data Interchange (EDI) systems. Measurement of e-commerce presents methodological challenges that can affect the comparability of estimates, such as the adoption of different practices for data collection and estimations, as well as the treatment of outliers and the extent of e-commerce carried out by multinationals.

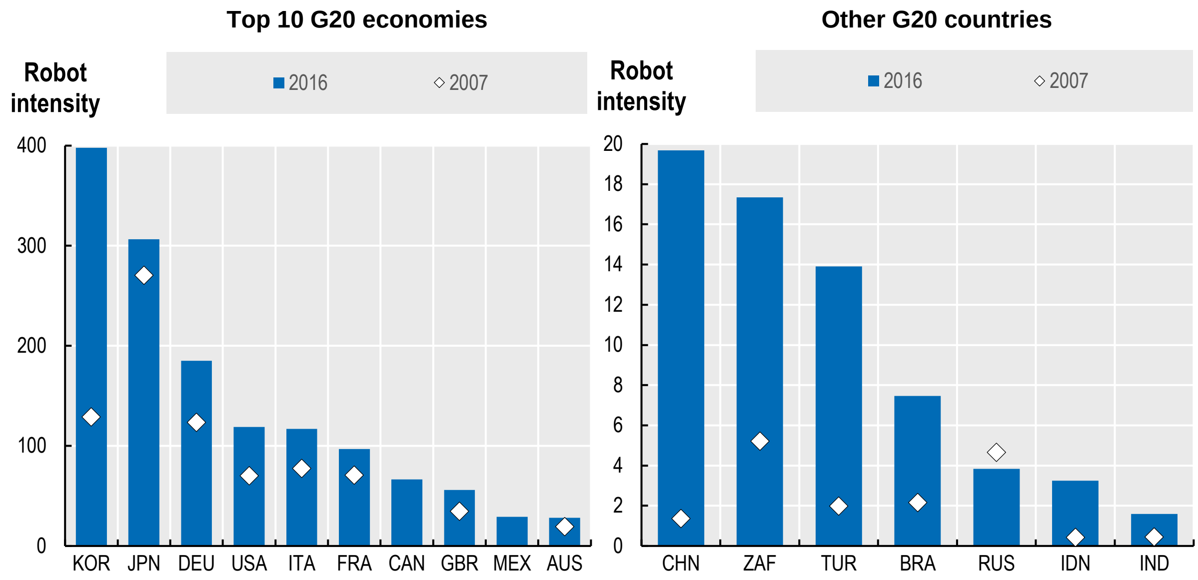
3.3.3. Robotisation in manufacturing

Advances in fields such as Big data analytics, 3D printing, machine-to-machine communication, and robots – including service robots - are transforming production. As such, the number of robots used in industrial and manufacturing settings offers one leading indicator of the degree of change and automation underway (see also chapter 3). Primarily, it is a useful reflection of whether businesses are effectively embedding digital technologies into their productive processes and have the incentive to do so, considering labour costs and other financial incentives (*OECD, 2019c*).

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, followed by Germany, the United States and Italy. While the average intensity is significantly lower in other G20 countries, it is growing faster than in the top 10 countries robot technology becomes more commonplace. In particular, robot-intensity in manufacturing has increased 20-fold in China between 2007 and 2016. However, these figures should be interpreted with caution, since the indicators are based on the quantity of robots active in an economy at a specific moment and do not capture changes in the effectiveness or quality of robots over time.

Figure 3.3.3. Robot intensity in G20 economies, 2007 and 2016

Stock of robot units per 10 000 employed persons employed, 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.

Defining robots

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". The International Federation of Robotics (IFR) collects information on shipments (counts) of industrial robots from almost all existing robot suppliers worldwide.

3.3.4. ICT-related innovations

Competing in Information and Communication Technology (ICT) markets worldwide requires innovations and technological developments to be bundled with appealing designs, while helping consumers to recognise and easily use the new and often complex products on offer. Because digital technologies show a particularly high speed of evolution (*OECD, 2019a*), the ability innovate, including through the adoption and innovative use of technologies, is likely to become a particularly important capability for firms and economies in the digital era. Over 2013-16, ICT patents accounted for about 26% of all IP5 patent families filed by G20 countries – 2 percentage points more than a decade earlier (2003-6). In particular, China increased its share by a quarter to become the IP5 patent portfolio most specialised in ICT.

Patents are not the only form of intellectual property that can be leveraged in relation to ICT products. Some countries seem to progressively move towards ICT IP bundle strategies which put less emphasis on technological innovation (patents) and leverage more on the look and feel of products (design) and on extracting value from branding (trademarks). Meanwhile, some G20 countries - notably BRIICS countries - are seemingly pursuing technological catch-up strategies, while ring-fencing their products through designs and brands.

Figure 3.3.4a. ICT-related patents, 2003-06 and 2013-16

As a percentage of total IP5 patent families owned by countries

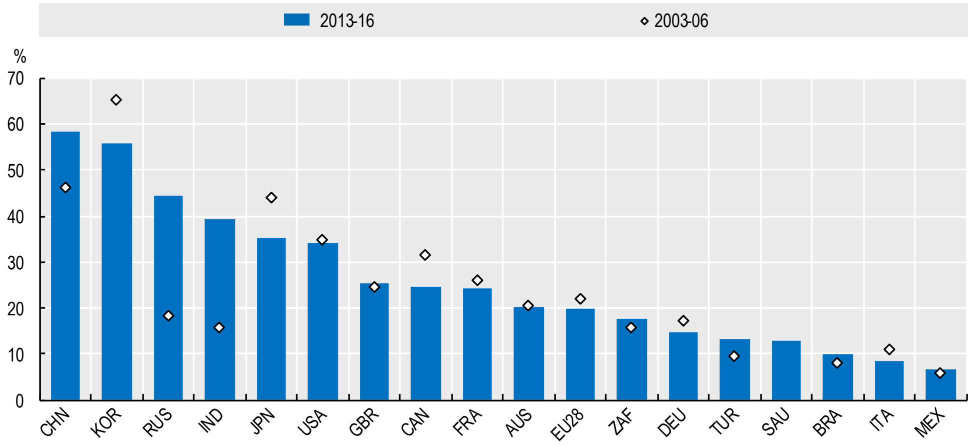
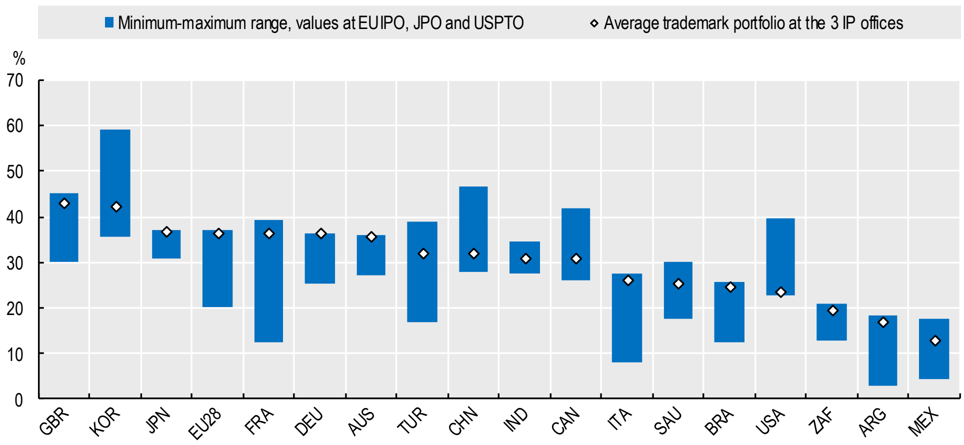


Figure 3.3.4b. ICT-related trademarks, 2012-15

As a percentage of total trademarks, EUIPO, JPO, and USPTO



Source: OECD, STI Micro-data Lab: Intellectual Property Database, http://oe.cd/ipstats, September 2018.

Measuring innovation with IP statistics

Patents protect technological inventions, i.e. products or processes providing new ways of doing something or new technological solutions to problems. IP5 patent families are patents within the world's five major IP offices (IP5). *Patents in ICT* are identified using the International Patent Classification (IPC) codes (see Inaba and Squicciarini, 2017). *Trademarks* are distinctive signs, e.g. words and symbols, used to identify the goods or services of a firm from those of its competitors. ICT-related designs and trademarks are identified following an experimental OECD approach based on Locarno and Nice Classifications, respectively, combining a normative approach with ICT-related keywords. Using information on the priority date of patents (i.e. the date of the first filing of a patent, which has subsequently been filed in other IP jurisdictions, thus extending the geographical scope of protection), allows for the reconstruction of patent families and avoids duplications when counting IP assets. The same is not possible for trademarks and designs, as information about identical registrations is seldom available.

3.3.5. AI-related science

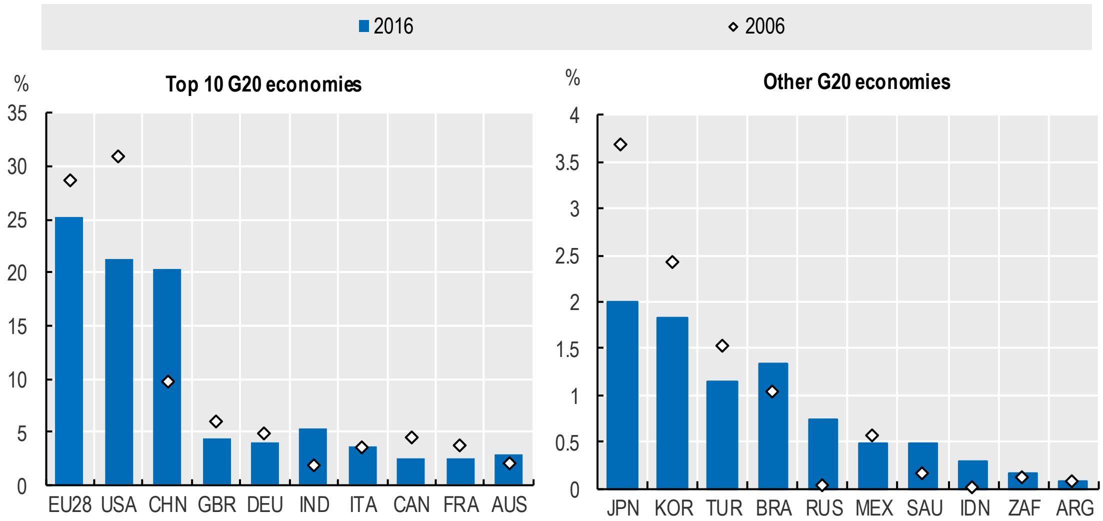
Disruptive technologies displace established ones and affect production processes, the entry of new firms, and the launch of ground-breaking products and applications. Among these, Artificial Intelligence (AI) holds the promise of contributing to tackling global challenges related to health, transport and the environment but may also lead to some jobs being significantly changed or even automated away (*Nedelkoska and Quintini, 2018*). One way to measure G20 countries' relative contribution to advancing the state of knowledge on AI is to track scientific publishing in that field.

Scientific publishing related to AI has experienced a remarkable expansion over the 2006-2016 period. Since 2006, the annual volume of AI-related publications has grown by 150%, compared to 50% for the overall body of indexed scientific publications.

The EU28 and the United States are responsible for the greatest shares of highly cited AI-related publications (i.e. those featuring among the world's top 10% most cited publications), followed by China. Their shares, however, declined between 2006 and 2016, from 29% to 25% for the EU28 and from 31% to 21% for the United States. Meanwhile China and India doubled their shares of top-cited AI publications over the past decade, while the Germany, Italy and Korea remained relatively stable.

Figure 3.3.5. Top-cited scientific publications related to AI, 2006 and 2016

Number of AI-related documents among the 10% most cited publications, fractional counts



Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 1.2018 and 2018 Scimago Journal Rank from the Scopus journal title list (accessed March 2018), January 2019.

Defining AI-related technologies

Artificial Intelligence (AI) is a term used to describe machines performing human-like cognitive functions (e.g. learning, understanding, reasoning or interacting).

Measuring the development of AI technologies is challenging as the boundaries between AI and other technologies blur and change rapidly over time. The indicators presented here make use of technology classes (i.e. the International Patent Classification, IPC, codes) listed in the patent documents to identify AI-related inventions. All inventions belonging to the "Human interface" and "Cognition and meaning understanding" categories listed in the 2017 OECD ICT taxonomy (see *Inaba and Squicciarini, 2017*), as well as those related to G06N code of the International Patent Classification (IPC) are here considered as being AI-related.

The OECD is working to refine further its operational definitions of AI technologies and scientific outputs, mining the bibliometric and patent data hosted in its Micro-data Lab infrastructure. Advanced search strategies are being implemented to identify scientific publications in AI, based on keywords in peer-reviewed articles, citations linked to pioneer studies etc. In parallel, refinements of the operational definition of AI-related inventions are being undertaken in consultation with experts and leading actors in the field. Both approaches can shed light on the emergence of AI-fields, topics and applications, and the science-technology links in AI. The indicators presented here rely on patent families (patents applied at the same time to at least two of the five largest IP offices - IP5).

4. Indicators toward a G20 common framework for measuring the Digital Economy

This chapter has updated and complemented a range of indicators on key aspects of the Digital Economy, related to Infrastructure, Empowering society, and Innovation and technology adoption, which were originally set out in the *G20 Toolkit for measuring the Digital Economy (G20, 2018)*. These existing indicators use a variety of measurement approaches and sources, hence the availability of data varies across G20 economies. It is also the case that a range of indicators exist on the 4th *Toolkit* theme of Jobs and Growth. These are addressed in detail in chapter 3. Nevertheless, there are various important areas where further development is required.

The indicators set out in this chapter are a key component of wider efforts to measure the Digital Economy. They benefit from an array of definitions and methodologies agreed and used internationally. Nevertheless, there is not yet an internationally agreed definition of the Digital Economy as a whole. Indeed, the concept has proved particularly challenging to define, with great variability depending on the policy or research questions at hand. Chapter 2 looks at this in more detail, considering the benefits that an internationally agreed definition could offer, providing an overview of the on-going debate around defining the Digital Economy, and identifying common themes and features in the frameworks, definitions, and classifications available. Based on that, a high-level definition of the Digital Economy is proposed for consideration by the DETF. Chapter 2 also looks at several areas of intensive international action seeking to establish definitions and measures for data and data flows, digital and platform-enabled services, and digital Supply-Use Tables.

In the G20 context, the adoption and enhancement of key measurement infrastructure such as ICT usage surveys with internationally comparable questions could be aided by agreement on a standard set of indicators. Chapter 3 seeks to move towards such an agreement in the key area of “Jobs, Skills, and Growth” in the Digital Economy. It considers available indicators in detail, with a view to identifying a core set of indicators for discussion and agreement by the DETF and mainstreaming of their production across G20 members. The widespread production of an agreed set of indicators on Jobs, Skills, and Growth would rely on many of the sources used for indicators presented in this chapter and could therefore also pave the way toward wider country coverage for these other useful indicators.

Chapter 1, like the *G20 Toolkit for Measuring the Digital Economy* which underpins it, provides a foundation for further discussions and developments. It offers a snapshot of key elements of current Digital Economy measurement in G20 countries and illustrates areas where measurement is not only important but also where wider adoption and improvement across G20 countries is relatively feasible due to the existence of established definitions and sources. Most importantly, it shows that G20 economies are vital players powering the ongoing development of the Digital economy. One additional way to help shape those developments is for the G20 to show further leadership in measuring the Digital Economy.

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Chapter 2 – Measuring the Digital Economy: definitions and key measurement challenges

1. Measuring the Digital Economy: toward a definition of the Digital Economy

A wide range of approaches and indicators have been developed to measure various aspects of the Digital Economy. For example, the *G20 Toolkit for Measuring the Digital Economy* (G20, 2018), developed and endorsed under the auspices of the Argentinian G20 Presidency in 2018, highlighted the data available for G20 countries through 36 key indicators across the areas of *Infrastructure*; *Empowering Society*; *Innovation and Technology Adoption*; and *Jobs and Growth*. These cover important aspects of the Digital Economy and many are presented in chapters 1 and 3 of this report.

Indicators on the availability and use of the Internet and other digital technologies by businesses, households, and individuals, form a solid evidence base for policies aiming to maximise the benefits that can be reaped from the digital transformation – including for employment and economic growth. In order to determine if these policies are having the desired effect, governments often seek to quantify the economic impact of digitalisation. For this reason a key action from the G20 toolkit was for members to *"Work towards improving the measurement of the Digital Economy in existing macroeconomic frameworks, e.g. by developing satellite national accounts."*(*G20, 2018*).

Clear and actionable definitions are a prerequisite for any economic measurement framework and the inclusion of relevant indicators. The need for a common definition of the Digital Economy was expressed by the IMF in a recent paper on *Measuring the Digital Economy* stressing that the "*lack of a generally agreed definition of the "Digital Economy" or "digital sector" and the lack of industry and product classifications for Internet platforms and associated services are hurdles to measuring the Digital Economy."* (*IMF, 2018*). As such, progressing towards a consensual and actionable definition of the Digital Economy as well as related concepts is the main objective of this chapter. In doing so, the main challenge encountered was to propose a definition able to support both broad political discussions and precise economic measurement.

Finding a definition that simultaneously satisfies these criteria is a considerable challenge and therefore discussions on definitions of the Digital Economy are complex. The wide literature setting out different ways in which the Digital Economy can be conceived, analysed and interpreted - each offering a new perspective or proposing a new definition - is evidence of this. In addition, definitional differences often owe to the nature of the research questions and the facet of the Digital Economy that is analysed. Section 2 reviews some key contributions in this literature. .

For example, an analysis of digitalisation in production will likely focus on producers' use of digital products, requiring a product-based definition of the Digital Economy to measure the intermediate use of and investments in Information and Communication Technologies (ICT) related products. Alternatively, a macro-economic analysis of value added and income generated by the Digital Economy will require a more traditional industry-based definition. On the other hand, an analysis of digital disruption in value chains may require a definition focused on the nature of transaction, i.e. whether products are digitally ordered and/or delivered or not. Meanwhile, a focus on digitally-driven disruption in households' behaviour (e.g. in terms of consumption and production) will likely include a focus on the non-monetary aspects of the Digital Economy and require, a definition that goes beyond the current national accounts production boundary. It is therefore important to design a framework that allows for different perspectives, through a sufficient degree of flexibility in the way products and actors involved in the Digital Economy are grouped.

With many possible uses for a single definition, each focusing on different aspects of the Digital Economy to serve specific policy needs or measurement purposes, it is challenging to come up with an all-encompassing definition of the Digital Economy able to support all relevant analysis. Nevertheless, there are potential benefits to establishing a definition, as set out above.

In attempting to balance these tensions, this report proposes to define the Digital Economy in a "tiered way", as an association of tiers incorporating complementary and mutually dependent elements or perspectives of digitalisation in the economy. While these tiers would exist under one "comprehensive" definition of the Digital Economy for policy purposes, these tiers would allow countries to scale up and down the extensiveness of the Digital Economy depending on the policy or measurement need.

To this end, the following comprehensive definition is put forward:

***The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities*.**

Although relatively broad, this definition will, combined with the various tiers underpinning it, provide G20 members with a consistent and consensual framework to guide policy making providing a logical standard by which to compare indicators.

While discussed further in section two, the tiers underpinning the proposed definition are the following:

1. The **Core measure** of the Digital Economy only includes economic activity from producers of ICT goods and digital services.
2. The **Narrow measure** includes the core sector as well as economic activity derived from firms that are reliant on digital inputs.
3. The **Broad measure** includes the first two measures as well as economic activity from firms significantly enhanced by the use of digital inputs.
4. The final measure of **Digital society** extends further than the Digital Economy and incorporates digitalised interactions and activities not included in the GDP production boundary, such as the use of free digital platforms (including free public digital platforms). While these interactions are not explicitly considered part of the Digital economy per se, this activity is important for effective digital policy by government.
5. An additional measure covers all **economic activity that is digitally ordered and/or digitally delivered.** It be considered as an alternative perspective of the Digital Economy, delineated based on the nature of transactions. Rather than splitting the economy based on firms' output or production methods, this measure focuses on ordering or delivery methods, regardless of the final product or how it is produced.

The ambition to propose a definition of the Digital Economy is not new; various definitions have been proposed and used in a variety of contexts. Section 2 provides an overview of the advantages and disadvantages presented by existing definitions as well as how the newly proposed G20 DETF definition finds a useful compromise between flexibility and precision, allowing G20 members to advance the Digital Economy policy agenda.

Such a definition will necessarily need to be complemented by more specific and detailed definitions for other key aspects of the Digital Economy for the latter to be measured. Many of these already exist – as set out in Section 3 – however, in several complex and evolving areas definitions and measures are still in development. Sections 4 and 5 address specific areas of the Digital Economy where measurement efforts are currently being concentrated, namely: *data and data flows*, *online intermediary platforms*, and *digital services*. Experimental work on the latter has begun to bear fruit as a variety of definitions and measurement proposals that are now generally accepted for many important components of the Digital Economy.

Section 6 discusses the progress made on *"developing a satellite national account*" in order to produce macro-economic indicators of digital activity consistent with the System of National Accounts (SNA) (*UN et al., 2009*). This section explains why it is vital to produce statistics on the Digital Economy that are not only internationally comparable but are easily interpretable, usable, and aligned with traditional macro-economic indicators such as GDP and national account indicators. Finally, it should be noted that this report has mainly tried to define the Digital Economy with the aim to develop and compile macroeconomic statistics on the latter. However, a range of other purposes, policy-related for instance, could motivate the development of definitions of the Digital Economy. While this chapter will mainly focus on appropriately defining and measuring the *economic value* of the Digital Economy and its components, the definitions put forward may well find application in policy areas such as labour markets and employment, taxation or productivity and the Digital Economy's subsequent impact on them.

2. Defining the Digital Economy

Various definitions of the Digital Economy (or similar concepts) are already used by governments, businesses and International Organisations. This section reviews these definitions, considering their commonalities and differences, and how they relate to the proposed G20 DETF definition of the Digital Economy as incorporating *"all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities."*

Overall, there are two broad approaches conventionally used to define the Digital Economy. The first type of definition follows a *bottom-up approach* characterising industries' and firms 'output or production processes to decide whether they should be included in the Digital Economy. The second type of definition, by contrast, follows a *top-down* or *trend-based* approach, first identifying the key trends driving the digital transformation and then analysing the extent to which these are reflected in the real economy. While variations of these two approaches have been proposed by various international organisations, national statistics offices, academics and the private sector, none has been able to fully capture all facets of, and perspectives on, the Digital Economy. It is for this reason that this report proposes a tiered definitional framework outlining different measures of the Digital Economy in order to address different facets and perspectives.

The first part of this section will discuss selected examples of bottom-up and top-down approaches and provide examples of why such definitions and other attempts to define the Digital Economy have not achieved broad consensus. This section then introduces a third type of definition which might be described as a *flexible approach*, breaking the Digital Economy into core and non-core components, and thereby finding a compromise between adaptability and the need to arrive at some common ground on the meaning of the term (*UNCTAD, 2019*). The proposed definition builds off this flexible approach and presents the opportunity for users to analyse the Digital Economy from whichever perspective suits their needs. Importantly it also offers a chance for the statistical community to use a structured definition that can meet both compilers' and users' demands and aligns with efforts currently undertaken to bring the Digital Economy into existing macro-economic statistics (see digital SUTs framework - Section 6).

2.1. Bottom-up definitions

Bottom-up definitions define the Digital Economy in a "traditional" way as the aggregate of a specific indicator (e.g. the sum of value added, the number of employed people) for an ensemble of industries or sectors identified as actors in the Digital Economy. The latter can be selected according to various criteria such as the nature of the products made (narrow) or the share of "digital inputs" used in their production processes (broader).

In a narrow sense, the Digital Economy is thus all industries or activities that directly participate in producing, or crucially reliant on digital inputs. This approach is usually employed in economic work trying to quantify the contribution of the Digital Economy to total economy growth. For instance, the US Bureau of Economic Analysis (BEA) defines the Digital Economy as the sum of digitally enabling infrastructure (ICT sector), e-commerce activity and digital media activities (*Barefoot et al., 2018*), a definition that has been reproduced by the Australian Bureau of Statistics (ABS) and Statistics Canada (*ABS, 2019; Statistics Canada, 2019a*). Similarly, McKinsey adds up the value of the ICT sector, of the e-commerce market - measured as online sales of goods - and of offline consumer spending on digital equipment (*McKinsey, 2018*).

However, when applied to measurement work, such definitions of the Digital Economy used by national statistical offices have tended to cover only the most fundamental of digital-related activity while failing to capture how digitalisation has influenced wider industries and products. For example the ABS (*ABS, 2019*) acknowledges that UBER (and most likely other well-known intermediary platforms) is not included in their estimates, while the BEA states that, although it is an area of future research, initially they "*did not attempt to include the digital portion of those goods and services categories that include both digital and non-digital components*" (*Barefoot et al., 2018*). The IMF uses a similar approach in *Measuring the Digital Economy* (2018), but makes it more encompassing by including "*online platforms [and], platform-enabled services"* in addition to *"suppliers of ICT goods and services"* (*IMF, 2018*). The entire subset is then described as "*comprising the producers at the core of digitalisation".*

Although they might overlook some desirable components, such *narrow bottom-up definitions* constitute the most actionable approach currently available for measurement purposes, as they draw upon existing frameworks and definitions most notably the SNA. In addition, while national accounts data can present *"conceptual challenges associated with translating the new economic activities into statistical data"* (*UNCTAD, 2019*) - around the value added of platforms delivering intermediary or zero-priced services for example - these are challenges that will need to be overcome regardless of the definitional approach chosen, in order to achieve holistic measures of the Digital Economy. Finally, national accounts use macro-economic indicators that policymakers and analysts are familiar with using and interpreting. Consequently, including indicators such as, total output, value added and compensation of employees, as was done in the work by the ABS and BEA, provides easily understandable and comparable statistics for macro-economic analysts. Any definition or framework for measurement will likely be more successful if it tries, where possible, to align with existing standards and classifications. As such, the Core measure of the Digital Economy proposed here is consistent with the widely accepted ICT sector definition included in ISIC Rev. 4.

A second, *broader subset of bottom-up definitions*, defines the Digital Economy as all industries using digital inputs as part of their production process. These inputs include digital infrastructure, equipment and software but can also include data as well as complementary skills. Such a broad perspective was applied by the DETF in its declaration at the 2016 G20 Summit where the Digital Economy was defined as; "*a broad range of economic activities using digitised information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of information and communication technology as an important driver of productivity growth and economic structural optimisation*" (G20 DETF, 2016).such bottom definitions avoid the limitation presented by narrower bottom-up definitions, which by focusing only on the nature of output, offer a partial view of the Digital Economy's development.

That said, the concern with broad bottom-up definitions is that measuring the Digital Economy beyond its core components is difficult as impacts from "*the use of digital technologies may result from spill-over effects and intangible outcomes*" (*UNCTAD, 2019*). Moreover, as observed by the IMF, if the Digital Economy encompasses all activities that use digitised data, the entire economy could soon be included in the concept, making it potentially unclear (*IMF, 2018*). Such a broad definition would risk significantly reducing the analysis possible and insights that can be gained.

2.2. Top-down definitions

Top-down definitions start from the identification of broad trends at play in the digital transformation and define the Digital Economy as the result of their combined impact, including trends enabled by the progress and adoption of digital technologies by *societies*. It thus extends beyond the economic realm, reflecting the need to bridge different policy areas to set the necessary conditions for inclusive and sustainable growth of the Digital Economy. These trends include ideas such as "platformisation" (defined by *Van Alstyne et al., 2016* as business models moving away from linear, pipeline models of interactions towards transaction forms using platforms) or the growing reliance on digital data and E-commerce or government services being increasingly provided online.

As such, top-down definitions do not merely consider a set of firms, industries, or sectors but the extent of digitalisation in all productive and societal processes, as well as the consequent changes in labour market demand and regulations. In their publication, *Digital Dividends*, the World Bank summarises this view: "*the Digital Economy transcends the ICT sector, encompassing most sectors of the economy and society. Yet many governments continue to treat the Digital Economy as a sector, with exclusive emphasis on developing ICT infrastructure and creating an information technology (IT) workforce"* (*World Bank Group, 2016*)*.* Similarly, the OECD describes "*the Digital Economy [as extending] beyond businesses and markets [as] it includes individuals, communities and societies"* (*OECD, 2019a*) while Oxford Economics finds that the Digital Economy "*encompasses businesses across all sectors of the economy, using digital technologies with ever-more intensity, to profoundly disrupt how value is created"* (*Oxford Economics, 2016*).

By nature, top-down definitions tend to be ill suited for economic measurement as they offer an open-ended concept, which seems to describe the "digitalised economy" rather than the Digital Economy. While providing information that can be useful for setting out policy debate, trend based or top-down definitions tend to lack alignment or consistency with macro-economic indicators. Additional difficulty comes with the fact that any definition built around one or a few specific trends will be limited to only providing a partial, often non-monetary, perspective on the Digital Economy, while definitions combining too many trends or too universal a trend, such as Internet use, might become too vague. As observed by the IMF, if the Digital Economy encompasses all activities that simply use digitised data, the entire economy could soon be included in the concept, making it likely unclear *(IMF, 2018).*

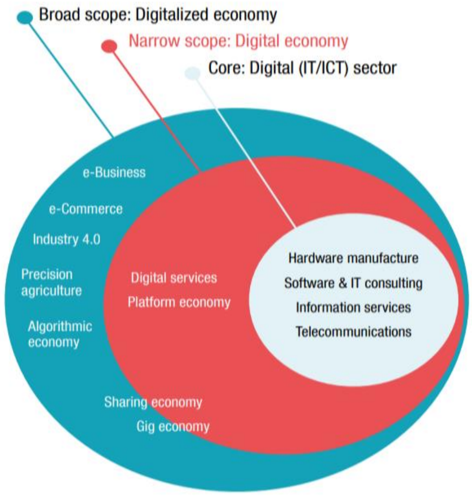
As a result, trend-based definitions require some subjective qualification such as those included in the proposed DETF definition. According to that definition, the narrow Digital Economy is "*all economic activity reliant on digital inputs*" and the broad measure "*economic activity significantly enhanced by digital inputs*". As such, while flexible, the DETF definition put forth by this report provides a clear rule to determine whether a given firm has to be included in the different measures of the Digital Economy.

That said, measurement based on a top down definition can serve measurement purposes if used to provide a summary of a country's overall digital activity based on a blended quantitative measure of a set of indicators. The European Commission's Digital Economy and Society Index (DESI) monitors the Digital Economy's development using a composite index based on a number of indicators for key trends driving countries' performance such as human capital or digital public services. In addition, the iDESI benchmarks EU economies with non-EU economies using most but not all DESI indicators due to data availability. However, while the DESI can provide one form of overview it cannot be used to answer questions such as "how much value added does the Digital Economy generate?" or "how many people work in the Digital Economy?"

2.3. Flexible definition

An example of a flexible definitional approach includes that, endorsed by UNCTAD in its *2019 Digital Report*, and based on Bukht and Heeks' findings at the Manchester Centre for Development Informatics. In their paper *Defining, Conceptualising and Measuring the Digital Economy* (2017), Bukht and Heeks distinguish between extensive and intensive use of digital technologies to set the limits of the Digital Economy (see figure 1).

Figure 1: The Digital Economy represented using a "tiered" approach



Source: The Digital Economy Report, 2019, UNCTAD – adapted from *Bukht and Heeks, 2017*

Under this definition, the Digital Economy consists of all sectors making extensive use of digital technologies (i.e. for which existence depends on digital technologies), as opposed to sectors making intensive use of digital technologies (i.e. only applying digital technology to enhance their productivity). For Bukht and Heeks, the Digital Economy is thus the share of output that *"is derived solely or primarily from digital technologies with a business model based on digital goods or services*" (*Bukht and Heeks, 2017*).

Because it defines several tiers that are connected but not necessarily embedded in the Digital Economy, this definition is flexible enough to incorporate business model innovations over time, while still excluding or separately classifying the wider array of digitalising sectors, where digital products and services are being increasingly used (e.g. a high-street retailer also selling goods online). This definition would allow various business models to be moved from the broad scope to the narrow scope once their business becomes reliant on digital inputs.

A flexible definition would also be consistent with the compilation of the digital SUTs. A detailed summary of these tables is provided in Section 6. By breaking down the supply and use of products according to the nature of the transaction, the framework can highlight how digitalisation has affected the provision of traditional products as well as digital products. The framework includes definitions for new digital industries that allow for greater clarity on the actors involved in the value chain between producer and consumer. The new digital industries are detailed extensively in Section 6 but include industries such as digital intermediary platforms, E-tailers, and data and advertising driven platforms. Similar to the Digital Economy as outlined by Bukht and Heeks, units move from the conventional ISIC industries to the newly defined digital industries based on their production of ICT goods and services or their shift from intensive to extensive use of digitalisation.

Such flexibility may equally cause challenges from a statistical point of view. The most obvious of these challenges is recording firms and industries that move across categories rather quickly. Indeed, this is where a key challenge of measuring the Digital Economy lies: while statistics usually rely on definitions that give population groups that are expected to be stable over-time, the ever-expanding nature of the Digital Economy is hard to reconcile with fixed definitions. An additional challenge for statistical offices is maintaining conceptually consistent and long time series, which are vital for proper analyses. The ever-expanding nature of the Digital Economy may contribute to breaks in series, slight conceptual differences at various points in time or difficulties in back casting. While not insurmountable, these challenges must be considered in the application of any flexible Digital Economy definition.

2.4. Summary of responses to a survey the use of definitions and measures of the Digital Economy in G20 countries

As an input to this report, DETF participating countries were surveyed on their current approach to (1) defining the Digital Economy (2) measuring and defining skills needed in the Digital Economy (3) measuring data flows / stocks of data (4) measuring digital services and the platform economy. Based on the answers provided by countries that have replied so far, the areas where most progress was made was in defining the Digital Economy, platforms and digital services. Data flows measurement was the least advanced area of measurement, followed by that of digital skills.

Among other things, countries were asked whether they use "a definition of the Digital Economy or similar concepts". While most surveyed countries did provide a **definition of the Digital Economy**, the responses revealed marked variation in countries' current approaches, as presented by in **Table 1**, which attempts to show where each country's definition belongs in terms of the previously defined categories. For instance, the United States and the United Kingdom both adopt a "bottom up" approach, where relevant sectors are identified in National Accounting and aggregate to define the Digital Economy., Meanwhile Argentina and Australia had a "top down approach" considering a wider array of trends to study and define the Digital Economy. Countries that reported using the European Commission's DESI framework (Italy and France) are also considered to be applying a top-down definition, as the DESI considers a wide array of societal and economic trends characterising the Digital Economy.

Table 1 Summary of responses given on currently used definitions of the Digital Economy of the questionnaire on Measuring the Digital Economy (February 2020)

BOTTOM UP DEFINITIONS	TOP DOWN DEFINITIONS
Brazil: "The Digital Economy is characterised by a series of digital technologies applied to production processes and organisational routines that have interoperability and interconnectivity as their main characteristic".	**Argentina**: "The concept of Digital Economy (…) contemplates *all aspects of digital penetration and transformation*, in the emergence of new technologies, which transversely affect all sectors of the economy that use ICTs as growth and profit competitiveness factors."
China: "The Digital Economy refers to a broad range of economic activities that include using digitised information and knowledge as the key factor of production, modern information networks as an important activity space, and the effective use of information and communication technology (ICT) as an	**France**: The framework used by France is the one developed by the European Commission at EU level through the Digital Economy and Society Index (DESI). (Which is considered by this categorisation to use a top down definition of the Digital Economy given the range of trends and areas considered. For

important driver of productivity growth and economic structural optimisation."	more detail, see https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2019)
Mexico: "The Digital Economy is composed by telecommunications infrastructure, ICT industries, the network of economic and social activities by Internet, cloud computing, mobile network, social networks and the remote sensors. It is an ecosystem composed of communication network, hardware, processing services and web technologies, the development level and the merge of these components define the maturity of each country."	**Italy**: The framework used by Italy is the one developed by the European Commission at EU level through the Digital Economy and Society Index (DESI). (Which is considered by this categorisation, as using a top down definition of the Digital Economy given the range of trends and areas considered. For more detail, see https://ec.europa.eu/digital-single-market/en/news/digital-economy-and-society-index-desi-2019)
United Kingdom: "The definition used in the UK was developed by the OECD using the UN Standard Industrial Classifications (SICs) and therefore has the advantage of international comparability. The SIC codes used in this definition are shown in Table 2.2 and in Table 2.4 for the sub-sectors. Therefore, the definition is in terms of coverage of economic activities based on ISIC Rev. 4 Part IV, Alternative Aggregations."	**Germany**: "'Digital economy' in the survey programme means the performing of online transactions between people and companies. Examples are the survey modules on E-Commerce, E-Government and the integrated questions on the so-called 'sharing economy' (also 'collaborative economy') which sort of overlap with other content of the E-Commerce module."
United States: "The BEA includes three major types of goods and services in its definition of the Digital Economy: The digital-enabling infrastructure needed an interconnected computer network to exist and operate; the e-commerce transactions that take place using that system and digital media, or the content that Digital Economy users create and access. BEA considers data part of the Digital Economy.	
Australia: "the ABS measured the digital activities in Australia as the production of: *Digital enabling infrastructure* (computer hardware, software, telecommunications equipment and support services that form and facilitate the use of computer networks); Digital media (digital audio, video and advertisement broadcasting services) and E-commerce."	

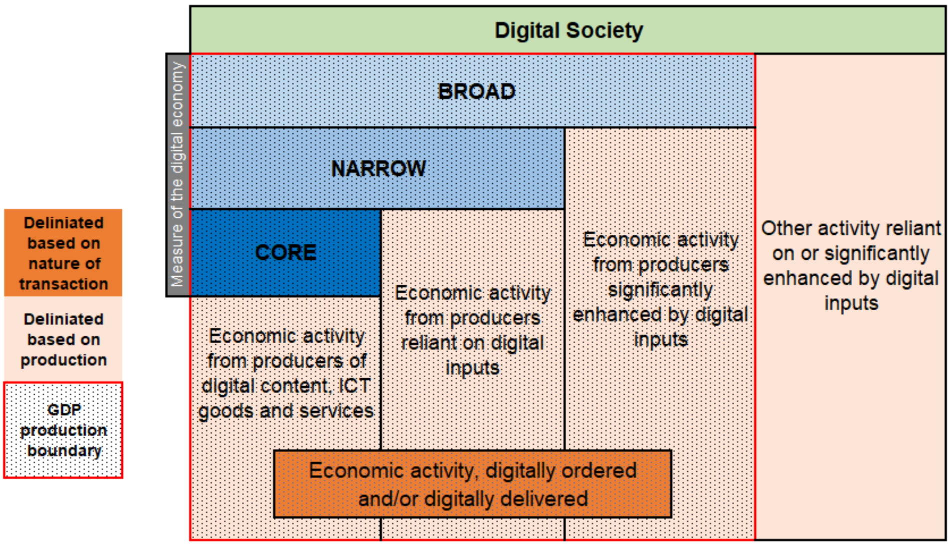
Source: G20 Digital Economy Task Force (DETF) Questionnaire on Measuring the Digital Economy; Note: only countries that responded to the questionnaire are shown.

2.5. Toward a G20 definition of the Digital Economy

With many possible users (e.g. economists, decision makers), and each of them requiring different indicators for different purposes, it is crucial that any definition of the Digital Economy provides enough flexibility. Flexible boundaries also enable the development of new indicators reflecting the ever-changing products and actors involved in the digital transformation. At the same time, a definition that is too flexible or broad would set national statistical offices an impossible task or constrain them to producing outputs that do not allow for meaningful analysis, due to a lack of detail or context. Ultimately, if a proposed definition is too impractical to enable robust measurement, it is of little use for governments' trying to assess policies' success or failure. Therefore, from a measurement perspective, any definition of the Digital Economy needs to include elements that are conceptually flexible but practically possible for NSOs to measure accurately. This practicality is important, as even if these tiers are not possible for all countries currently, they would still present NSO's with a clear target for development.

The definition of the Digital Economy proposed in this report provides some clarity for policy purposes. From a measurement perspective, the addition of the tiers underneath this definition provide the necessary clarity to allow for measurement comparability with both a top down and bottom up approach to measurement. Furthermore, it provides G20 members the opportunity to develop the definition further by delineating and measuring the specific actors, activities, products and techniques that are considered as "reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities".

Figure 2: Tiered definition of the Digital Economy



Source: OECD

2.5.1. Tiers of the Digital Economy

As displayed in the diagram, the different "tiers" in which the Digital Economy can be broken down are the following:

1. The **Core measure** of the Digital Economy only includes economic activity from producers of ICT goods and ICT and information services.
2. The **Narrow measure** includes the core sector as well as economic activity derived from firms that are reliant on digital inputs.
3. The **Broad measure** includes the first two measures as well as economic activity from firms significantly enhanced by the use of inputs.
4. The **Digital society** extends further than the Digital Economy and incorporates digitalised interactions and activities not included in the GDP production boundary, such as the use of free digital platforms (including public digital platforms). While not considered part of the Digital economy per se, this activity is important for effective digital policy by government.
5. The additional measure **economic activity, digitally ordered and/or digitally delivered** can be considered as an alternative perspective of the Digital Economy as it is delineated based on the nature of the transaction, rather than split based on firms' output or production methods. This measure focuses on the method of ordering or delivery, regardless of the final product or how it is produced.

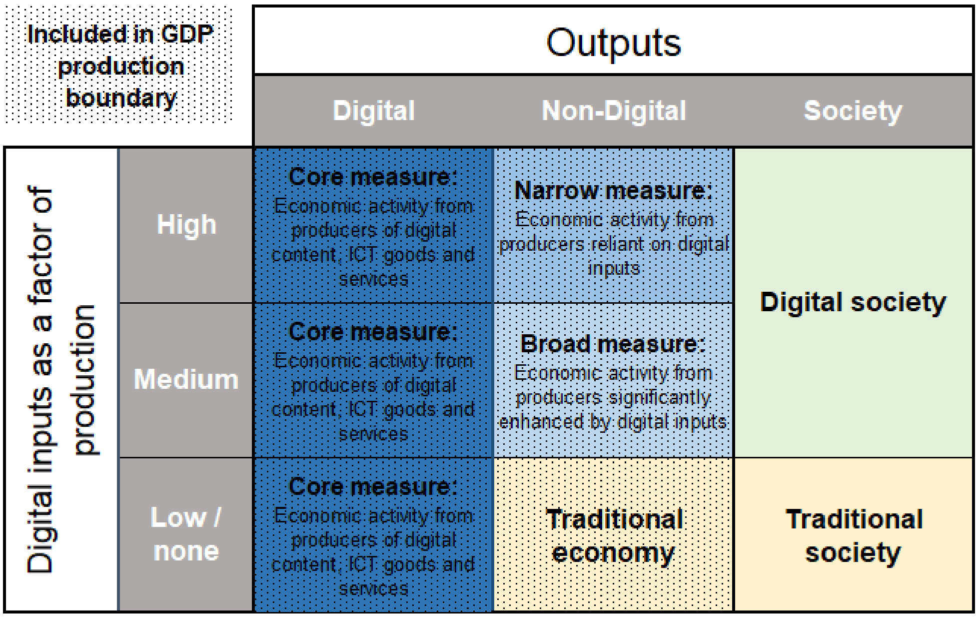
The way in which these tiers fit into the broader economy is outlined in Figure 3 below. The figure places the different tiers of the Digital Economy into a bi-dimensional matrix showing the type of production (Digital, Non-Digital, Non-Economic) and the level of digital inputs used in the production process (High, Medium, Low/None).

Looking at Figure 3, all output deemed "digital" is regarded as part of the **Core measure** of the Digital Economy, regardless of the level of digital inputs used in production. As further explained in the next section, digital output does not necessarily include all services delivered digitally: indeed, a large amount of non-digital output such as (education, gambling, government services) can be delivered digitally however this does not make it a digital service or a digital output (as viewed in this figure). Rather, the **Core measure** is restricted to economic activity generated by producers that belong to the ICT sector consistent with that included in ISIC rev 4.0

As explained in the previous definitions and showcased in Figure 3, economic activity included in the **Narrow** and **Broad measure** include output that is not digital in nature. For non-digital output that is included, the decision factor is the level of digital inputs being used in the production process. A high amount of digital inputs makes a firm qualify as "*reliant*" and as a result, included in the **Narrow measure**. A medium level of digital input makes the firm qualify as "*enhanced by digital inputs*" rather than being reliant on it. This delineation will likely be challenging in practice, however a fundamental difference can be made by paraphrasing a question put forth by Burkt and Heeks (2017), "*has this economic activity only arisen due to digital inputs*?" If the answer is yes, then the firm producing the economic activity is likely reliant on digital inputs, if the answer is no and the business model of the firm and the economic activity generated existed previously, albeit in a reduced or more inefficient form, the firm is likely just enhanced by digital inputs.

Finally, the "**Traditional" economy** is shown in the Figure, including output that is non-digital in nature and produced using a zero or a low amount of digital inputs. A low rather than zero only amount is included here as the amount of digital inputs being used by traditional firms: as explained in Section 2.2 almost all firms use some form of digitalisation in their business, this may include the use of email, an electronic machine in production (i.e. cash register) or the Internet. This also draws a distinction with the Broad measure: not that all business should be included within the **Broad measure** of the Digital Economy but rather only those that have seen significant enhancement in their production due to digitalisation.

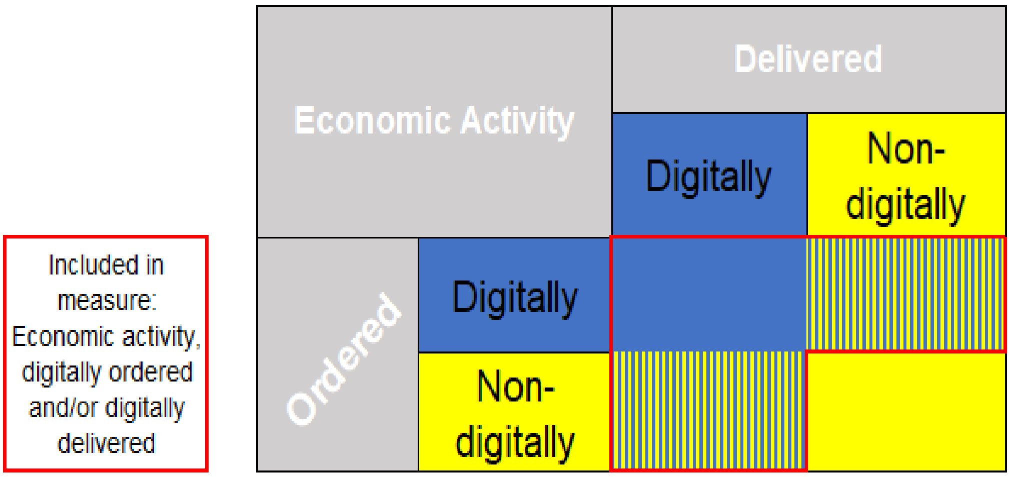
Figure 3: Measures of the Digital Economy within the traditional economy



Source: OECD

Economic activity, digitally ordered and/or digitally delivered is not included in the previous figure as it is not an additional tier but rather an alternative view of the Digital Economy, one that offers countries a more objective view by delineating economic activity based on the nature of the transactions rather than the process used to produce it. Figure 4 shows which proportion of economy activity is included in that delineation according to the way it was transacted:

Figure 4: Delineation of Digitally ordered and/or delivered



Source: OECD

While many goods and services are digitally ordered they are not necessarily digitally delivered: E-commerce transactions, airline and hotel reservations all fall into the top right quadrant despite not being digitally delivered. In addition, there are also a vast number of products that are digitally ordered and digitally delivered, including a large amount of intangible goods and services; examples include, online movie streaming, online gambling, use of cloud technologies etc. Completing the measure of **economic activity, digitally ordered and/or digitally delivered** is the small amount of transactions that fall into the bottom left quadrant of figure 4 representing a service delivered digitally but ordered non-digitally, while rare, such an example may be a telecommunications contract purchased in a store. The final quadrant represent economic activity that is neither ordered nor delivered digitally.

2.5.2. Benefits of the alternative measure of the Digital Economy

All four quadrants are equal to the GDP production boundary as outlined in the 2008 SNA and are therefore equal to the six sextants shown as belonging to the production boundary on Figure 3. When operationalising these frameworks, it is likely that a large amount of economic activity included in the digitally ordered/delivered measure will be coming from firms included in the **Core** and **Narrow** tiers. This makes sense, as many producers included in the **Core measure** have no choice but to deliver their services digitally. Likewise, many firms that are reliant on digital inputs are reliant because digitally is the only avenue for consumers to order (UBER) and/or receive (Netflix) their service. There may be less overlap with the **Broad measure:** firms included in this tier may be enhanced by digital inputs but not necessarily using digital transactions with consumers.

Conceptually, there is an important similarity between the first and last measures of the Digital Economy (the core measure and economic activity, digitally ordered and/or digitally delivered) and the other three. Indeed, the core measure and that based on the nature of the transaction are objective by nature, as inclusion of a good or service into the delineated sector is decided upon by answering a binary question i.e. "*is this good or service digital or not?",* or *"was this good or service ordered or delivered digitally or not?".*

In contrast, the other three sectors allow for more subjectivity as they use words such as "*reliant"* and "*enhanced"* These sectors are delineated based on the characteristic of the firms in the economy being measured and are thus delineated by asking questions starting by "how". This choice is deliberate as not only are countries' economies at different stages of the digitalisation process, but firms within a given economy are also likely to move between sectors based on how their business and technology continues to evolve.

An additional consideration is that for practical reasons, when classifying firms into the core, narrow or broad measures, the entire output of the firm will be included. This may result in an amount of secondary production that may not be enabled or reliant on digital inputs being included, however, this will likely be only an immaterial amount of the overall level of output. Importantly, the alternative measure delineated by the nature of the transaction provides the flexibility and opportunity to split economic activity by product, which is *below firm level* rather than assigning the entire economic activity of the firm to a tier. While this may result in a more laborious measure due to difficulties caused by data availability, it will arguable create a more detail picture of the Digital Economy.

That said, a significant advantage in delineating the economy at the firm level is that it allows statistical offices to assign all *firms* reliant on or significantly enhanced by digital inputs to one of the tiers, thereby delineating the economy into economic activity that is digital and economic activity that is not (outlined as the traditional economy square in figure 3). This ensure that all economic activity is accounted for, but importantly only accounted for once. A definition that sought to separate digitalised production from non-digital production within a single firm would open the door to potential double counting where the value added may be considered both a part of the Digital Economy and the Non-Digital Economy.

As such, the tiered definitional framework is not the panacea when it comes to measuring the Digital Economy: the definitions of its tiers, especially the Narrow and Broad measures still contain an element of ambiguity. This in itself is not unusual: as Bukht and Heeks observed, for the past 20 years, definitions of the Digital Economy have consistently contained an element of "fuzziness" around the exact definitional boundary (*Bukht and Heeks, 2017*). Just like the definition of "the economy", is often reduced to the Gross Domestic Product, Digital Economy definitions will always be subject to different interpretations once operationalised. Even now, some users still feel that the concept of GDP excludes important aspects of "the economy" that should be counted, such as unpaid household production and informal volunteer work. That said, the tiered structure presents the notable advantage of offering additional benchmarks and sub-categories that will facilitate easier interpretability and international comparability.

Reaching an agreement on a definition of the Digital Economy and its tiers within it, is a prerequisite and crucial step because it will define the scope of the framework and as a result the set of indicators for the Digital Economy – both those agreed to in the Roadmap outlined in chapter 4 and those developed in the future. A tiered definition not only increases the range of relevant indicators that can be conceived and produced but also provides clarity on how each of those relates to each tier (see Table 2 below). Furthermore, indicators linked to the various tiers make the final definition and the tiers outlined in this report not only more useful but more likely to be mainstreamed into statistical use.

For example, indicator, 4.3.1 on ICT goods, imports and exports (chapter 3), clearly relates to the Core measure of the Digital Economy. On the other hand, indicators based on digitally intensive sectors are such as indicator 2.1.1;

jobs in digitally intensive sectors, are aligned with the Broad measure of the Digital Economy. By clearly defining the different tiers of the Digital Economy, users can identify the indicators suitable for different types of analyses.

2.5.3. Defining the tiers of the Digital Economy

This following section will provide more detail on each of the definitions.

1. **Digital Economy, core measure**

“Economic activity from producers of ICT goods and digital services”.

This definition would define the Digital Economy as output produced by firms that are “*intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display*”. (*UNSD, 2008*)

In this way, the narrow definition of the Digital Economy would be consistent with existing definitions for the ICT goods and services within the established international standards, ISIC rev 4.0. This definition would be the easiest for statistical offices to produce; in fact, many are already producing this output. For practical reasons, the core measure would incorporate all output generated by these producers including secondary production rather than trying to delineate production based on the final product produced. While it does not include much of the digital activity that most users consider part of the Digital Economy, it would provide a clear indicator for the increasing importance (and proportion) of the economy that producers of ICT goods and digital services make up. The specific industries that are included in this classification are presented in section 2.3.

2. **Digital Economy, narrow measure**

Core measure + “Economic activity reliant on digital inputs”

While still aligned with the existing GDP production boundary, this definition is not focused on the final output or method of transaction. Instead, the determining factor delineating the narrow measure is whether production of the good or service is reliant on digitalisation.

Digitalisation has created many new business models that are entirely reliant on digital inputs such as digital services or data to exist but are not themselves producing ICT goods or ICT and information services as defined in the core measure. This is different to the additional firms that are incorporated in the broad measure where digital inputs only enhance production rather than enabling production.

Intermediary platforms – including public digital platforms - that facilitate transactions between producers and consumers are reliant on digital information and technologies in order for this production to take place. These businesses intensively use ICT goods and services to derive new types of value added but are not considered producers of ICT goods or ICT and information services.

3. **Digital Economy, broad measure**

Narrow measure + “Economic activity significantly enhanced by digital inputs”.

ICT goods and services have also transformed conventional firms that now leverage digitalisation to improve or extend business activity and processes. Financial services for example, is still the fundamental service of “obtaining and redistributing funds” however, in many countries, digitalisation has significantly altered the way in which financial firms produce that same service.

While the inclusion of the word “significantly” does create an element of ambiguity, it is important to generate a bar for which firms must reach to be considered part of the Digital Economy. Almost all firms use some ICT good in their business, even if a simple as a personal computer or email. However, in order to avoid a definition that incudes almost all economic activity, firms must be separated between those that are assisted by using this technology and those that are significantly enhanced by the use digital inputs.

The use of the word significantly also acknowledges that in the real world there is often no clear rigid boundary between digital and non-digital activities, not only within a single domestic industry, but also when comparing economic activity internationally. A given set of industries may be labelled as “reliant or significantly enhanced by the use of digital inputs” in some countries, but not in all. For example, in many countries the use of digital inputs has significantly enhanced the level of value added produced from both the agriculture and mining industries. If these industries were included within a set definition of the “digitally produced economy”, it may be applied to countries where agriculture and mining make up significant portions of the economy but make only limited use of digitalisation and thus significantly overestimate the resulting measure of the Digital Economy.

That said, international comparison is still possible based on this definition as it provides a consistent test of the same digital trend, i.e. the significance of ICT goods and services in production, to determine the make-up of each countries digitally enhanced economy. The aggregate could be published along with the metadata explaining which industries are and are not included. Although many of these would be very similar across countries, the inherent flexibility of that definition would leave some discretion to countries in considering a specific industry is "*reliant or significantly enhanced by the use of digital inputs including digital technologies, digital infrastructure, digital services and data*", or not, in their economy.

As pointed out in the roadmap (see chapter 4.) a future step for the DETF may be to introduce some form of additional guidelines or criteria that countries could use to assist in this delineation between tiers.

It should be noted that this definition is not proposed to attempt to measure how much additional value added is created by digitalisation but rather as a *benchmark* for statistical offices to decide if the producer or industry should be considered part of the Digital Economy.

4. The Digital Society

Broad measure + "Other activity reliant on or significantly enhanced by digital inputs".

This final definition of the Digital Economy goes beyond the production boundary outlined in the system of national accounts. It would include digital activity that is not explicitly recorded as economic production but results in additional consumer surplus, welfare and other benefits to society such as the diffusion of information and knowledge. While not strictly included in the proposed definition of the Digital Economy, it is important to include in the set of tiers to provide a reference to digital activity that government are required to make policy about. For instance, this definition could be used for policy regarding digital privacy, personal data, and digital well-being.

In the 2019 OECD publication, "Going digital, shaping policies, improving lives", it was observed, "Digital technologies and large-scale data flows fundamentally change how people live and work, interact with one another, participate in the economy, and engage with the government". Not all of these activities are included within the measurement of GDP and therefore should not be explicitly considered as part of the Digital Economy. That said, the ubiquitous nature of digitalisation results in a blurred interlinked economic/social boundary that necessitates any Digital Economy measurement framework to at least identify the non-economic impact that digitalisation has on society.

5. Economic activity, digitally ordered and/or digitally delivered

The alternative measure of the Digital Economy would include *"all goods and services that are digitally ordered and/or digitally delivered".* The definition rests on two different concepts: *digitally ordered* and *digitally delivered*, while defined below, further discussion on these two concepts is in section 2.3.

- **Digitally ordered goods and services** is equivalent to the current e-commerce definition already broadly in use, which comprises "the sale or purchase of goods or services, conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders" (*OECD, 2011*).

- **Digitally delivered services** *"all services that are delivered remotely in an electronic format, using computer networks specifically designed for the purpose". This category includes services for which a computer network is necessary for the service to be administered, as well as other intangible goods and services.*

While the vast majority of services digitally delivered are also digitally ordered and therefore would be covered by the previous definition, adding digitally delivered services to the definition rather than just the existing E-commerce definition would ensure that all digital transactions are covered.

This approach of delineating output based on the nature of the transaction has already been included in the *Handbook on Measuring Digital Trade* (2019) and the framework for compiling digital supply-use tables (DSUTs). This definition focuses on demand for and delivery of, a range of products including some that are not fundamentally digital. In this way, as illustrated in Figure 1, this measure would likely include output from all three of core, narrow and broad measures while not necessarily being entirely aligned to any of them.

As mentioned previously, this definition would allow for international comparison as countries can objectively measure whether goods and services are ordered or delivered digitally. Estimates of digital trade that is based on similar concepts have already been published. While the proportion of digital ordering would vary across countries, so would the specific products and services ordered and delivered. While some countries may have quite a mature e-commerce market for a broad range of goods and services, for other countries digital ordering and delivery might be much more concentrated.

Table 2: Summary of the different tiers making up the Digital Economy

Measure of the Digital Economy	Includes	Commensurate international concepts / proposals
Core	"Economic activity from producers of ICT goods and digital services".	ISIC rev. 4 *(UNSD, 2008)* **Information and communication technologies (ICT) sector**, defined in ISIC rev. 4 as output produced by firms that are "intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display". UNCTAD*, Digital Economy Report, 2019* **Core aspects or foundational aspects of the Digital Economy**, which comprise fundamental innovations (semiconductors, processors), core technologies (computers, telecommunication devices) and enabling infrastructures (Internet and telecoms networks) – **Digital (IT/ICT) sector** *OECD (2019a), Measuring the Digital Transformation: A Roadmap for the Future* **Information industries**, defined as the combination of the ICT sector (see above) and the OECD definition of the "content and media sector" (OECD, 2011).
Narrow	Economic activity reliant on digital inputs	*Bukht & Heeks 2017* & UNCTAD, *Digital Economy Report, 2019* **Digital Economy** "economic output derived solely or primarily from digital technologies with a business model based on digital goods or services". Sectors making extensive use of digital technology, extending the boundaries of economic activity.
Broad	Economic activity significantly enhanced by digital inputs	*Bukht & Heeks 2017* & UNCTAD, *Digital Economy Report, 2019* **Digitalised economy** - Sectors making intensive use of digital technology, improve in some way – existing economic activity G20 Digital Economy Development and Cooperation Initiative (2016) "economic activities that include using digitised information and knowledge as the key factor of production" *OECD (2019a), Measuring the Digital Transformation: A Roadmap for the Future* **Digital-intensive sectors** are sectors that rank in top two quartiles of the taxonomy of sectors by digital intensity developed by *Calvino et al. (2018)*. The taxonomy ranks industries based on indicators highlighting the extent of digital transformation in sectors by looking at firms' investments in "digital" assets, as well as by changes in the way companies approach markets and interact with clients and suppliers, by the (type of) human capital and skills needed, and the way production is organised.
Digital Society	Other activity reliant on or significantly enhanced by digital inputs	*OECD (2019) Going Digital: Shaping Policies, Improving Lives* Digital transformation refers to the economic and societal effects of digitisation and digitalisation. World Bank Group, *World Development Report (2016)* "The Digital Economy transcends the ICT sector, encompassing most sectors of the economy and society."
Economic activity, digitally ordered and/or digitally delivered	Economic activity, digitally ordered and/or digitally delivered	*OECD-WTO-IMF (2020) Handbook on Measuring Digital Trade* **Digital trade -** "trade that is digitally ordered or digitally delivered". **Digitally delivered trade -** "international transactions that are delivered remotely in an electronic format, using computer networks specifically designed for the purpose." *OECD (2011), OECD Guide to Measuring the Information Society*

		E-commerce – "the sale or purchase of goods or services conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders (OECD, 2011). *OECD (2019d), Guidelines for Supply-Use tables for the Digital Economy* "The Digital SUTs framework differentiates between digitally ordered and non-digitally ordered goods and services, and digitally delivered and non-digitally delivered goods and services."

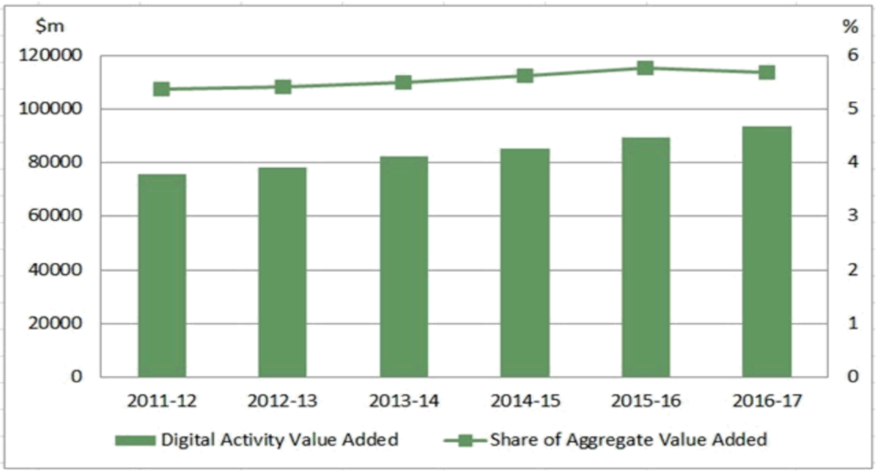
2.6. Implications of the definition variation for estimates of the size of the Digital Economy

The need for common and more formal definitions of the different components of the Digital Economy is further demonstrated by the extensive variation in the way G20 members currently measure the Digital Economy. Importantly, these definitional differences result in large differences in the estimates of the size of the Digital Economy. In 2019, China, the United States and Australia released estimates of the size of their respective digital economies as of 2017. As a percentage of GDP, the Australia and United States had similar proportions of 5.8% and 6.9% respectively (see **figures 3 and 4**). In contrast, the estimate provided by China Academy of Information and Communications Technology showed that in 2017 the Digital Economy made up 32.9% of Chinese GDP (see **figure 5**), compared with 20.3% of GDP in 2011 (*Miura, 2018*). By comparison, the 2017 estimates calculated by the USA and Australia had remained broadly stable compared to 2011 (*Barefoot et al., 2018; ABS, 2019*).These differences in the size and growth of the Digital Economy did not owe to different data sources or methodologies, but to the fact that the three countries applied different *definitions* of the Digital Economy.

Indeed, Australia and the USA defined the Digital Economy as the entire information and communications technologies (ICT) sector (defined in Section 3.1 below) as well as the digital-enabling infrastructure needed for a computer network to exist and operate, the digital transactions that take place using that system (e-commerce), and the content that Digital Economy users create and access (digital media). By contrast, a much broader definition consisting of a core sector similar to that used by the BEA and the ABS as well as a "mixed segment" consisting of *"value added and employment generated through the use of digital technology in sectors other than ICT"* was applied by China (*Miura, 2018*). All three countries used *bottom-up approaches to defining the Digital Economy*, however, China's was broader much than Australia's and the USA's. The wide discrepancy between these countries' estimates is easy to understand once the full description of each country's definition's scope is explained. However, such level of detail often lacks in reporting, which means that the resulting estimates end up being compared at face value.

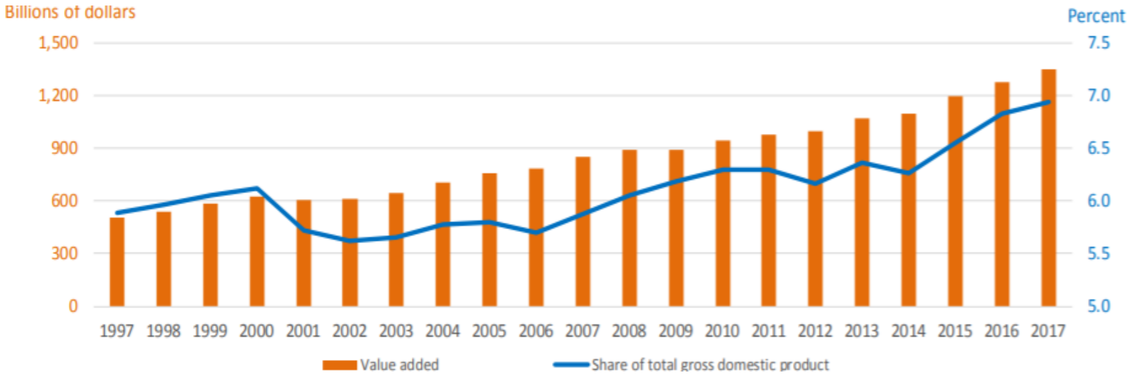
Overall, these examples showcase the importance and value of agreeing on a common definition at the G20 level to enable valid comparisons and data-informed policymaking.

Figure 5: Digital economy, Australia; 2012 – 2017



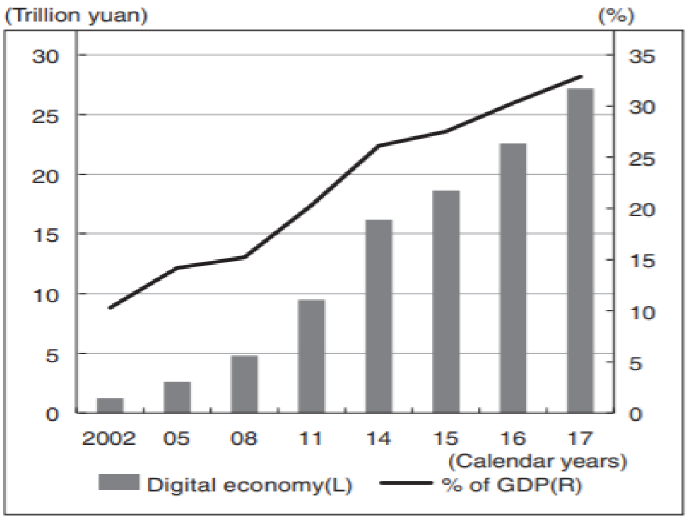
Source: Australian Bureau of Statistics

Figure 6: Digital economy, United States of America; 1997 – 2017



Source: Bureau of Economic Analysis (BEA)

Figure 7: Digital economy, China; 2002 – 2017



Source: Compiled by JRI using data from the China Academy of Information and Communications Technology**,** 2018

The proposed definition of the Digital Economy and its tiers are not brand-new concepts: most of the measures outlined in the tiers are commensurate with existing international definitions. Section 3 sets out some of these already established concepts and definitions for key parts of the Digital Economy. As these will be needed to operationalise any high-level definition. Sections 4-6 then look at particular areas where international efforts are being focussed to develop both concepts and definitions, as well as measurement approaches and indicators in order to better understand key phenomena in the Digital Economy.

3. International definitions and classifications related to the Digital Economy

Digitisation (conversion of information into digital form) and ever-wider *digitalisation* (applications of digital technologies) are not new phenomena, and as a result, certain definitions and classifications related to digital activity currently exist. Some, such as the OECD definition of e-commerce (*OECD, 2011*), are already incorporated into international standards. At the same time, the rapid pace at which these trends unfold requires further international co-ordination to continuously update common definitions for key products and industries related to the Digital Economy.

This section discusses ICT-related definitions currently derived from and included in international standards namely the Central Product Classification, (CPC 2.1) (*UNSD, 2015*), and the International Standard Industrial Classification of All Economic Activities, rev. 4 (ISIC rev. 4.) (*UNSD, 2008*). It will also explain how these definitions have subsequently refined through newer international classifications, in particular for ICT goods and services. Even with this refinement, there are still limitations to these classifications, which have resulted in international organisations and national statistical offices generating new definitions for a range of digital products, actors and transactions, examples of which are presented.

3.1.1. ICT sector, Information Industries, Digital intensive sectors, and associated products

Within the industry classification, the ICT sector is defined as a combination of manufacturing and services industries that are primarily "*intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display*" (*UNSD, 2008*), One important feature of this definition is that it breaks the traditional ISIC dichotomy between manufacturing and services activities. While the production or distribution of ICT products can be found everywhere in the economy, the identification of sectors within the ISIC rev. 4. classification that produce or distribute ICT products as a main activity constitutes a first-order approximation of the ICT sector (*UNSD, 2008*).

Information industries supplement the ICT sector to also include the content and media sector. This is defined as the group of economic activities that are primarily *"engaged in the production, publishing and/or the distribution of content (information, cultural and entertainment products), where content corresponds to an organised message intended for human beings."*(*UNSD, 2008*). The following classification of content and media activities from ISIC Rev. 4. was established by the OECD and included in the 2011 version of the *OECD Guide to Measuring the information society*. These can be associated to the *core measure* of the Digital Economy:

- ISIC 581 Publishing of books, periodicals and other publishing activities
- ISIC 591 Motion picture, video and television program activities
- ISIC 592 Sound recording and music publishing activities
- ISIC 60 Broadcasting and programming activities
- ISIC 639 Other information service activities

On the product side, a complimentary classification for ICT products was incorporated within the CPC 2.1, which is widely implemented internationally - either directly or through related frameworks such as the Statistical classification of economic activities in the European Community (*Eurostat, 2008*) and the North American Product Classification System (NAPCS). It includes products linked to the industries in the aforementioned ICT sector definition and was delineated using a similar definition: products that *"must primarily be intended to fulfil or enable the function of information processing and communication by electronic means, including transmission and display."* (UNSD, 2015) this allowed for a delineation of products considered fundamental to enablement of the Digital Economy.

A broader way to delineate sectors in relation to the Digital Economy is to consider sectors' digital intensity to define digital-intensive sectors. Based on seven different metrics, Calvino et al. (2018) propose a taxonomy of sectors by digital intensity. Various indicators such as, firms' investments in "digital" assets, the (type of) human capital and skills needed for production or the way companies approach markets and interact with clients and suppliers are used to classify industries into "high", "medium-high", "medium-low" and "low" digital intensity as seen in table 1. While this approach could be considered somewhat rudimentary, as all firms in an industry are classified regardless of their specific level of digitalisation, the approach has the benefit of being able to be compiled using currently available industry aggregates. This is evidenced by several indicators in chapter 3, which leverage categorisation.

Taxonomy of sectors by digital-intensity, overall ranking, 2013-15

ISIC Rev.4 industry denomination	Quartile intensity	ISIC Rev.4 industry denomination	Quartile intensity
Agriculture, forestry, fishing	Low	Wholesale and retail trade, repair	Medium-high
Mining and quarrying	Low	Transportation and storage	Low
Food products, beverages and tobacco	Low	Accommodation and food service activities	Low
Textiles, wearing apparel, leather	Medium-low	Publishing, audiovisual and broadcasting	Medium-high
Wood and paper products, and printing	Medium-high	Telecommunications	High
Coke and refined petroleum products	Medium-low	IT and other information services	High
Chemicals and chemical products	Medium-low	Finance and insurance	High
Pharmaceutical products	Medium-low	Real estate	Low
Rubber and plastics products	Medium-low	Legal and accounting activities, etc.	High
Basic metals and fabricated metal products	Medium-low	Scientific research and development	High
Computer, electronic, optical products	Medium-high	Advertising and other business services	High
Electrical equipment	Medium-high	Administrative and support service	High
Machinery and equipment n.e.c.	Medium-high	Public administration and defence	Medium-high
Transport equipment	High	Education	Medium-low
Furniture; other manufacturing; repairs	Medium-high	Human health activities	Medium-low
Electricity, gas, steam and air cond.	Low	Residential care and social work activities	Medium-low
Water supply; sewerage, waste	Low	Arts, entertainment and recreation	Medium-high
Construction	Low	Other service activities	High

Source: Calvino et al. (2018) based on Annual National Accounts, STAN, ICIO, PIAAC, International Federation of Robotics, World Bank, Eurostat Digital Economy and Society Statistics, national Labour Force Surveys, US CPS, INTAN-Invest and other national sources

This approach can be seen as a way of combining both top-down and bottom-up types of definitions of the Digital Economy, described in Section 2. It qualifies sectors based on trends (top-down) to then decide on the industries to be included into measures (bottom-up) based on how much they are affected by the considered trends. However, it would be necessary to repeat the analysis (or even alter the indicators used depending on their changing importance) to account for developments over time and as such the industries included in each digital intensity grouping may change (thus the definition would not be stable over time). Furthermore, this taxonomy mainly enables analysts to assess how different sectors, are positioned in terms of technology adoption in order to monitor the digital transformation, rather than to measure the size of the Digital Economy *per se* (*OECD, 2019a*).

3.1.2. ICT goods and digitally ordered goods

The above definitions for the ICT sector and the ICT products have been refined when classifying goods or services to measure international trade flows. Trade in ICT goods follows a classification based on the World Customs Organization (WCO)'s 2017 Harmonised System (HS 2017), adapted by UNCTAD and UNSD from its former HS 2010 and HS 2012 versions. The most recent list (2018) consists of 94 goods defined at the 6-digit level of HS 2017.[4]. The latter was summarised in the Handbook on Measuring Digital Trade (*OECD-WTO-IMF, 2020*) as four main categories:

- Computers and peripheral equipment
- Communication equipment
- Consumer electronic equipment
- Miscellaneous ICT components and goods

While ICT goods are occasionally referred to as digital goods due to their role as enablers of the Digital Economy, it is important to note that digital goods are different from digitally ordered goods. This difference is clearly outlined in the *Handbook on Measuring Digital Trade* and can be established using a simple example. For instance, shoes can be ordered online (a digital transaction) but are difficult to conceive as digital products. A second point of clarification regarding the definition of digital goods is that, according to the aforementioned Handbook, goods cannot be digitally delivered, whereas services can and often are (e.g. audio-visual services). As outlined in the *Handbook*, this assumption includes the delivery of goods produced via 3D printing, while the code may be delivered digitally, this code would be considered a service, even though it may ultimately end up producing a good.

3.1.3. ICT services, ICT enabled services and digitally delivered services

Unlike goods, services can be delivered remotely, making service classifications potentially more complex to define as they could encompass ICT services, which can be potentially delivered offline or online (e.g. IT system design, software development), ICT-enabled services, and also digitally delivered services (e.g. editing, management services and education services).

ICT services' definition was developed by the OECD Working Party on Indicators for the Information Society (WPIIS) and subsequently refined by the Partnership on Measuring ICT for Development (*UNCTAD, 2015*). At the core of this definition of ICT services are the service component of the ICT sector (described above in ISIC Rev. 4. and CPC 2.1.) with some important additions. It includes the following ISIC Rev. 4. industry categories:

- ISIC 5820 - Software publishing
- ISIC 61 - Telecommunications
- ISIC 60 - Programming and broadcasting activities
- ISIC 619 - Other telecommunications activities
- ISIC 6202 - Computer consultancy and computer facilities management activities
- ISIC 6201 - Computer programming activities
- ISIC 6311 - Data processing, hosting and related activities
- ISIC 9511 - Repair of computers and peripheral equipment
- ISIC 8549 - Other education.

ICT-enabled services have currently no internationally agreed definition, but were defined by the UNCTAD led Task Group on Measuring Trade in ICT Services and ICT-enabled Services (TGServ) as *"all activities that can be specified, performed, delivered, evaluated and consumed electronically that is to say, all services that "are delivered remotely over ICT networks"* (*UNCTAD, 2015*).

Digitally delivered services as defined in the Handbook on Measuring Digital Trade as *"all services that are delivered remotely in an electronic format, using computer networks specifically designed for the purpose"* (*OECD-WTO-IMF, 2020*).

While there are strong similarities between the concepts of *ICT-enabled services* and *digitally delivered services*, the main difference is that ICT-enabled services include services delivered by methods that do not necessarily require computer networks, such as human-to-human interactions via the phone (*OECD-WTO-IMF, 2020*). Moreover, both digitally delivered services and ICT-enabled services have the potential to be significantly broader

[4] See https://unctad.org/en/PublicationsLibrary/tn_unctad_ict4d10_en.pdf.

than the more basic ICT services based on the ICT sector. For example, in 2018, digitally deliverable service exports amounted to $2.9 trillion, or 50 per cent of global services exports while exports of ICT services were about $568 billion (*UNCTAD, 2019*).

3.2. Additional definitions of concepts related to the Digital Economy

The different classifications related to digital services highlight an important point concerning the original ICT sector classification: digitalisation has now spread far beyond industries and products originally classified as part of the ICT sector. This ICT sector is now considered as a *digital enabling sector* (in the Digital SUTs) or the Core Digital Economy measure in the proposed DETF definition. It provides the infrastructure and related goods and services to allow other producers to leverage digitalisation for their own benefit (*OECD, 2019d*).

While newer definitions (which will be elaborated on in Section 3) have tended to become broader in their measurement approach existing classifications can also be considered too aggregated to appropriately identify new products and actors and adequately reflect the trends at play in the Digital Economy.

Unlike the Digital Economy as a whole, work by the various IOs and statistical offices has developed definitions that, while not part of any formal international classification structure (ISIC rev. 4., CPC. 2.1.), has contributed to discussion on various elements of digitalisation. Definitions of services products such as cloud computing, digital intermediary services and of technologies such as artificial intelligence have been agreed upon at the OECD level. On an industry basis, decisions on clear definitions to better identify and aggregate groups of actors within the Digital Economy have been made. Digital Intermediary Platform (DIPs), E-tailers, artificial intelligence and cloud computing are all examples where definitions have been debated and developed independently of any formal classification update.

3.2.1. Digital Intermediary Platforms

There are currently several published definitions for digital intermediary platforms (DIPs), each focusing on different characteristics. A much more detailed discussion on the definition and measurement of digital platforms is provided in Section 5. However, a broad definition published by the OECD is that a DIP is; *"an online entity providing a digital service that facilitates interactions between two or more distinct but interdependent sets of users (whether firms or individuals) who interact through the service via the Internet*" (*OECD, 2019b*).

This definition was further refined when used for discussion within macro-economic statistics. As will be outlined further in Section 5 for the purpose of the national accounts production boundary, it is important to distinguish between those platforms that charge an explicit fee to the producer or consumer and those that do not. Therefore, as published in the handbook on measuring digital trade, which is consistent with the definition for the digital SUTs, DIPS are defined as; "*Online interfaces that facilitate, for a fee, the direct interaction between multiple buyers and multiple sellers, without the platform taking economic ownership of the goods or services that are being sold (intermediated)"* (*OECD-WTO-IMF, 2020).*

3.2.2. Cloud computing services

Cloud computing services are a key area of interest for policy makers, however one that has proven problematic for statisticians. While many conceptual challenges remain regarding their measurement, there have been some definitional developments in response to gaps in the current product classifications (i.e. CPC). To this end, the OECD has defined cloud computing as *"Computing services based on a set of computing resources that can be accessed in a flexible, elastic, on-demand way with low management effort"* (*OECD, 2014*).

This definition includes the full range of cloud computing services including those where consumers access the cloud service provider's applications over the Internet (Software as a Service, SaaS); where they develop their own applications or deploy other applications remotely onto the provider's infrastructure (Platform as a Service, PaaS); and where they pay to use the provider's underlying hardware, storage and other basic services (Infrastructure as a Service, IaaS).

Complementing this definition, a Eurostat task force is working on a classification of various cloud-computing products within the EU Classification of Products by Activity (CPA – the EU-tailored version of the CPC). This includes CPA 58.2 (Software publishing services) for SaaS; CPA 62.01 (Computer programming services) for PaaS and CPA 63.11.1 (Data processing, hosting, application services and other IT infrastructure provisioning services) for IaaS (Eurostat, 2018).

3.2.3. Labour market related definitions

As is further discussed in chapter 3, the Digital Economy is transforming labour market structures, the nature and content of jobs, as well as supply and demand for certain skills. To analyse and monitor these changes, relevant categories of jobs, tasks and workers have been defined.

ICT specialists are *"workers who have the ability to develop, operate and maintain ICT systems, and for whom ICT constitute the main part of their job"*. They are usually measured using Labour Force Survey data classified according to the 2008 International Standard Classification of Occupations; "ISCO-08" (see *Eurostat-OECD, 2015*). One key measurement challenge arises from a lack of data availability at the most detailed (4-digit) level of disaggregation. Therefore, the OECD adopts an operational definition corresponding to the following ISCO-08 occupations: 133 (Information and communications technology service managers), 215 (Electrotechnology engineers), 251 (Software and applications developers and analysts), 252 (Database and network professionals), 351 (Information and communications technology operations and user support), 352 (Telecommunications and broadcasting technicians), 742 (Electronics and Telecommunications Installers and Repairers) (*OECD, 2019a*). ICT specialists (i.e. people in ICT specialist occupations) can be employed in any economic sector but are associated with firms making medium or high use of digital inputs, as such, this concept can be considered as a component of the Broad measure of the Digital Economy.

A broader grouping of ICT task-intensive occupations has a high propensity to include ICT tasks at work ranging from simple use of the Internet, through use of word processing or spreadsheet software, to programming. Thee people can be employed in any economic sector but are mostly associated with firms making medium or high use of digital inputs. As such, this concept can be considered as a component of the Broad measure of the Digital Economy.

3.3. Definitions in the framework for Digital Supply-Use Tables and Handbook on Measuring Digital Trade

A more comprehensive example of published definitions that can be used to better measure and understand digital activity is in the area of digital SUTs and digital trade. The two frameworks (see figure 6) have been developed in unison sharing similar definitions for the digital actors and products as well as similar methods to categorise transactions according to the where (in the accounts are transactions recorded), the how (are digital transactions defined), the what (types of products are included) and the who (are the buyers and sellers).

The aforementioned *Handbook on Measuring Digital Trade* contains many definitions, including some that have already been covered earlier in the chapter. These definitions have been consolidated from various working groups and task forces working on digitalisation and are used consistent with the digital SUTs frameworks when measuring domestic production. It is this work on Digital Trade and Digital SUTs that aligns with the proposed alternative measure of the Digital Economy as economic activity that is digital ordered and/or digital delivered, put forward in the tiered definitional framework.

In addition to providing a framework, the Handbook on Measuring Digital Trade, has begun to operationalise these definitions including:

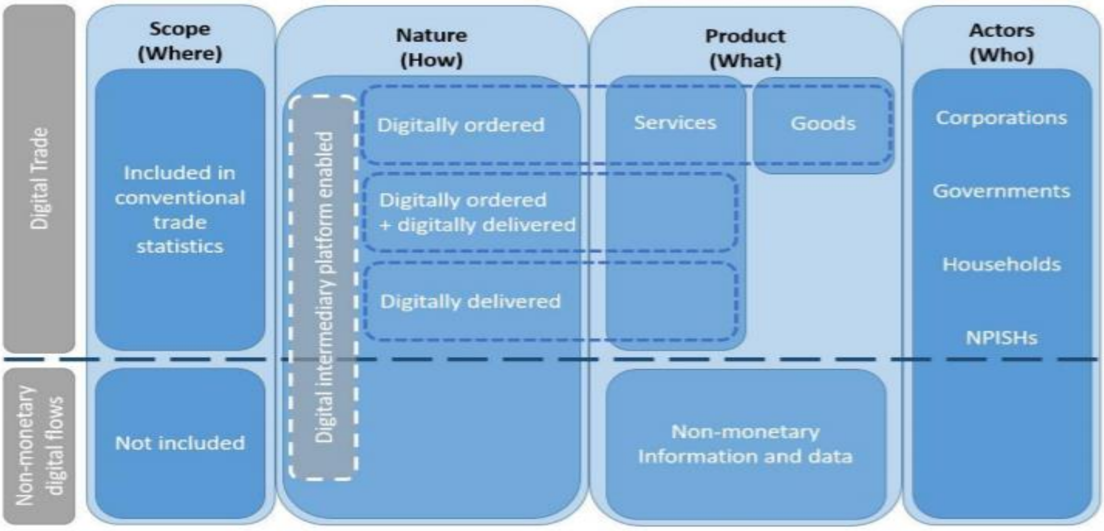
- Digital trade - defined as *"trade that is digitally ordered or digitally delivered*".
- Digitally ordered trade - refers to *"the international sale or purchase of a good or service, conducted over computer networks by methods specifically designed for the purpose of receiving or placing orders"*.
- Digitally delivered trade designates *"international transactions that are delivered remotely in an electronic format, using computer networks specifically designed for the purpose."*

For both digitally ordered and digitally delivered, transactions cover orders/deliveries made over computer networks (the web/Internet, including via mobile devices, extranet or via electronic data interchange) but should exclude any services, not provided or ordered over computer networks, including via phone, fax or manually typed email (*OECD-WTO-IMF, 2020*).

This work is a prime example of how the statistical community can provide additional guidance on definitions to assist national statistical offices to further develop measurement on specific aspects of digital activity without waiting for formal updates of standard definitions and classifications.

However, this does not mean that official standards and classifications do not need to be updated to reflect the changing nature of the economy. The technical sub-group on international standard on industrial classification of economic activity (TSG-ISIC) has commenced a review of the current ISIC in an effort to provide categories that will better reflect all actors involved in the Digital Economy such as digital intermediary platforms (*UNSD, 2019*). Any subsequent update to ISIC would be incorporated into updates to NACE and NAICS, planned for the next benchmark revisions within the EU/EFTA countries, which should improve statistical organisations' ability to analyse their impact on the economy.

Figure 8: Conceptual framework for measuring digital trade



Source: OECD-WTO-IMF Handbook on Measuring Digital Trade

Section 3 has provided an overview of various definitions in use to define and measure key aspects of the Digital Economy including those incorporated into the proposed DETF tiered definition. Nevertheless, the digital transformation is ongoing and there are still important phenomena on which international efforts are being focussed to develop the definitions and indicators needed to underpin vital Digital Economy policy decisions. These areas of ongoing work include measuring data and data flows (Section 4), measuring digital services and online platforms (Section 5), and a summary of efforts, led by the OECD, to develop and populate Digital Supply-Use Tables.

4. Measuring data and data flows

While section 3 primarily focussed on aspects of the Digital Economy where there is broad international agreement on concepts and definitions, data flows and zero-priced digital services are two areas where measurement challenges exist beyond their definition. This section and the next will discuss the substantial progress that has been made in producing indicators on these subjects, including the further work required to integrate them into existing frameworks and standards. Specifically, this section will discuss how data are currently reflected in statistical accounts and the reason that measurement challenges remain.

In recent years, both the scale of data usage and its value for many business models and processes have increased (*Nguyen and Paczos, forthcoming*). In 2019, more than 53% of the World's population, or 4 billion people, were Internet users. On average, these users made nearly 4.5 million google searches every minute in the same year (*Domo, 2019*). This is just one example of the ever-growing amount of data being created by users that can potentially be used in the process of producing goods and services. More recently, the rapid growth of publicly available data, led the Economist to compare data with sunlight *"because soon, like solar rays, they will be everywhere and underlie everything"* like a public good (*Economist, 2020*).

A recent Statistics Canada paper defined data as *"observations that have been converted into a digital form that can be stored, transmitted or processed and from which knowledge can be drawn"* (*Statistics Canada, 2019c*). It is this knowledge that contains the economic value that the international statistical community is attempting to measure. However, as will be outlined in this section, the unique characteristics of data and the context dependent nature of its use makes its valuation particularly challenging.

4.1. The measurement challenge

This rapid increase in the production and availability of data has resulted in firms operating business models that "*would not exist without access to large amounts of data and advanced data analytics*" (*Nguyen and Paczos, forthcoming*). Even traditional businesses are leveraging data when they can - referred to as "*data-enhanced business*" by Nguyen and Pazcos. This results in a situation where, as pointed out by the IMF, almost all businesses use data "*to improve products and processes to enhance productivity, improve performance, and increase profitability*". (*IMF, 2018*)

With the omnipresence of data comes the danger that various economic statistics could become less meaningful. While evidence has shown that up until now, declining rates of productivity growth cannot be explained solely by the mismeasurement of output in the digital age (*Ahmad et al, 2017; Ahmad and Schreyer, 2016*), there is a risk that future estimates of output and multifactor productivity could be flawed if the inputs used do not reflect the use of asset-like data products. Additionally, because transactions related to data are only recognised in the SNA when a monetary exchange occurs, there is a possibility that balance sheet estimates of corporations that have acquired data will be distorted compared to those that have developed data and databases in house. Alternatively, due to the absence of an explicit data product, purchased data may not even make it to the balance sheet if currently consumed in a broader "business service" product.

This recognition of a transaction only when a monetary transaction occurs is only one challenge to the measurement of data due to the current conceptual treatment outlined in the SNA. According to 2008 SNA para. 10.113: "*The creation of a database will generally have to be estimated by a sum-of-costs approach*." Importantly it adds, "*the cost of preparing data in the appropriate format is included in the cost of the database but not the cost of acquiring or producing the data*." The "*Report on Intellectual Property Products*" of the Joint Eurostat – OECD Task Force on Land and other non-financial assets (*Eurostat-OECD, 2020*) provides a more detailed explanation of the challenges associated with this, highlighting that it will likely be difficult to delineate those costs that should be included from those that should be excluded. The current treatment - applying a narrow scope for the costs to be included - is likely to lead to National Accounts figures providing a restricted estimate of the overall value of databases and of the data they contain (*Ker et al., forthcoming*)

While it is argued that the stock of data has the potential to be under-reflected in National Accounts, "the contribution of data to production is (implicitly) always captured. (*Ahmad and van de Ven 2018*). However this treatment results in data being represented as a non-produced input, a treatment that has become more and more detached from the way data are generated, transacted and used in the real world. An additional measurement challenge regarding data is that, as some of the expenditure on improving products or production processes will likely already be recorded as research and development expenditure/investment, any definition for a new standalone data product would need to carefully delineate between these two products to avoid double counting.

Therefore, while there is still much discussion regarding appropriate valuation methods for data as well as suitable categorisation within the various macro-economic classifications, a key requirement is to recognise data as a separate standalone product used in production, which differs from the current conceptual treatment and measurement practices.

4.2. Factors influencing the classification and valuation of data

The significant challenges of measuring the economic value of data and their contribution to production are often linked to their uniqueness. Indeed, the characteristics of data differentiate it from other inputs in production: this includes the way data comes into existence, their varied use in the production process and the unknown value that can be derived therefrom. These unknown variables are due to both the uniqueness of each dataset and the varieties of business models using it. Another challenging and distinctive feature of data is their non-rivalrous nature (*Nguyen and Paczos, 2019; Kahin, 2019*). Unlike all tangible fixed assets and many non-tangible assets, the use of data by one producer does not necessarily reduce the availability and usefulness of the relevant data for another.

The fact that data are not subject to the standard wear and tear of tangible assets means, theoretically, that they can be used multiple times without inherently losing value (*Nguyen and Paczos, 2019*). That said, the value of data can be reduced by obsolescence, and information on certain subjects is more useful (and therefore valuable) if delivered in a timely manner. As the gap between the time of the actual event and the processing of information grows, the value of the information is likely declining.

These different modes of "economic discovery" of data along with the unique characteristics of data highlight the difficulty in placing data into the various micro-economic classifications that currently exist, let alone assign them to a single classification. Due to this, it is likely that when fully embedded into economic statistics, a range of data classifications will be required.

The uniqueness of data does not just owe to its intrinsic characteristics, but also to the way in which it is generated. Using the recent Statistics Canada paper, which defined data as *"observations that have been converted into a digital form that can be stored, transmitted or processed and from which knowledge can be drawn"* (Statistics Canada, 2019c) one can consider the variety of observations from which data can be extracted and more importantly all the different ways that these observations are created and subsequently collected. The most usual types of observations are:

- Exchanged observations (generated and collected by a business in exchange for providing services for below market or zero cost.;
- Auxiliary observations (generated and collected by a business as part of the existing primary production process); and
- Free, third party observations (collected by a business from already existing publicly available dataset) (*Ahmad and van de Ven, 2018*).

The methods described above consider only digital observations, but for completeness, any all-encompassing measurement framework -such as those used for economic measurement - would have to include observations that are generated non-digitally, as these could also be used in a production process and therefore possess some inherent value.

4.3. Factors influencing the valuation of data

Leaving aside the conceptual concerns that arise when developing taxonomies for data, national statistical offices are also faced with the practical difficulties of determining a value (and theoretically a price index) in order to produce volume estimates of any data produced. The overriding difficulty in creating this valuation is the context dependency on which data are used. That is, information valuable to one firm is quite likely to be of less use (and therefore less value) to another. For example, a person's desire to go on vacation, as identified based on their Internet search history is likely to be of limited use to the supermarket where they do their shopping but of quite some value to the search engine that can provide targeted advertising services to online travel agent companies.

This difficulty in assigning an appropriate value to different types of data is also due to the different characteristics of each dataset. For example, Nguyen and Paczos (2019) suggest that data are most likely to provide a basis for monetisation and value-creation, if they are:

- linkable – data can be merged with the other datasets;
- accessible – data are easily retrieved and/or integrated into business processes;
- disaggregated – is the data available at the desired (dis)aggregation level;
- timely – data are updated with sufficient frequency to meet business requirements, e.g. annually, daily or in real time;
- trustworthy - data are deemed credible by those using it; data are unbiased and impartial, and do not depend on the judgment, interpretation, or evaluation of individuals;
- representative - records do not contain missing fields, data are representative enough to meet business requirements;
- scarce - data are proprietary or secret, difficult to come by (*Nguyen and Paczos, 2019*).

Of note is the recurring point that many of these characteristics are subjective or dependent on the context for which the data may be used. Two different firms who acquire the same data may take very different views on whether the data are accurate or considered trustworthy. Even something that might be considered more objective like timeliness of the data would still need to be viewed in the context of their ultimate use.

Furthermore, individual pieces of data are usually of little or no value. Value emerges once individuals, businesses, governments and other organisations compile data in large quantities in order to provide information and enable data-driven decisions. Thus, an important determinant of the value of data is the capacity of these actors to generate the characteristics mentioned earlier (linkable, accessible, representative, etc.) in the data in order to ensure they are able to aggregate, process, transmit, store, analyse and make sense of data, and generate value (*UNCTAD, 2019*).

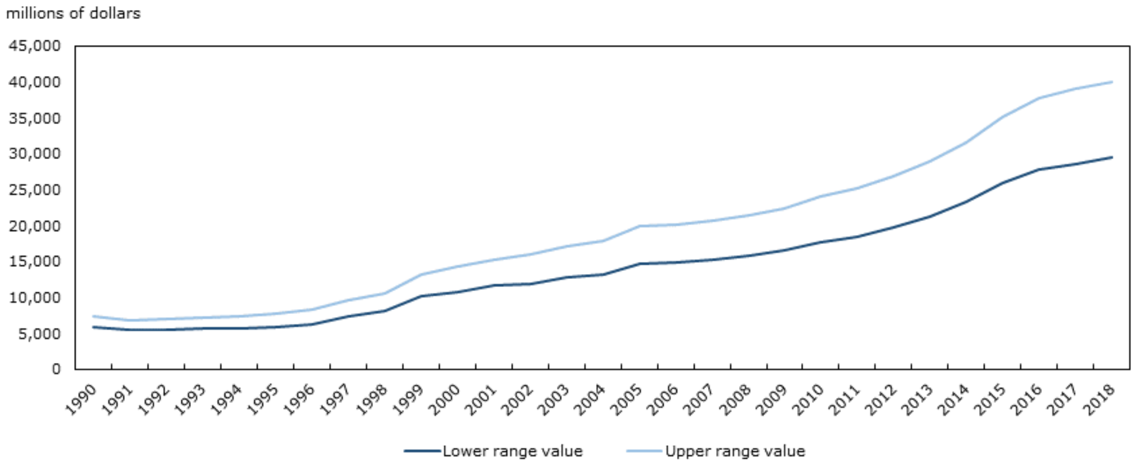
Due to these challenges, there is, as of yet, no consensus regarding the best practice for valuing data. Current attempts to estimate the value of data have largely focused on three methods:

- Market-based: value is determined based on the market price of comparable products on the market.
- Cost-based: value is determined by the cost of producing the information/know-how derived from data.
- Income-based: value is determined by estimating the future cash flows that can be derived from the data.

Statistics Canada and the BEA have both produced experimental estimates of the value of data in their respective economies. Both used variations of the cost-based approach by calculating the costs involved in producing own account data and databases that are being used in production.

Specifically, Statistic Canada estimated the value of data with reference to the labour costs incurred in their production plus associated non-direct labour and other costs, such as the costs of the associated human resource management and financial control, electricity, building maintenance and telecommunications services. Due to the level of modelling required, they calculated both an upper and lower range (Figure 7) and found that, on average, total investment growth in data-related assets averaged 5.5% between 2005 and 2018 compared to overall average annual investment growth of 1.25% (*Statistics Canada, 2019b*).

Figure 9: Range of investment in data products, Canada; 1990 - 2018



Source: Statistics Canada

The BEA used a similar method based on labour costs for calculating estimates of the own-account production of data but also went a step further and included estimates of expenditure from the 2012 Economic Census on certain products deemed data related (e.g. Market research, Internet directories and data management). This allowed estimation of data that were produced on own account and purchased. They found that from 2012 to 2017, average annual growth over the period was around 6.8% for own–account data and 5.7% for purchased data (*BEA, 2019*).

Future work in measurement of Data

Further progress toward an internationally agreed treatment of data and data flows in a National Accounts context is occurring through a variety of channels, including through the Inter-Secretariat Working Group on National Accounts (ISWGNA) subgroup on digitalisation (*Strassner and Soelistyowati, 2019).* This subgroup, which includes members from International Organisations, national statistical offices and experts in the field, is tasked with developing guidance notes on a range of issues related to digitalisation, including the measurement of data and data flows.[5] The work is conducted in view of the eventual update of SNA 2008.

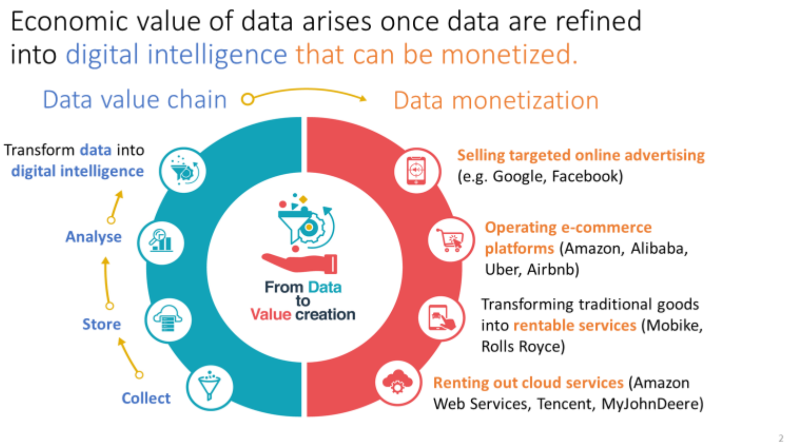
Although discussions are still ongoing, several proposals have suggested a conceptual treatment that would *include* expenditure associated with the collection of data while *excluding* the observation component, identified as the initial starting point of the information value chain as these do not fit the existing SNA definition of a produced asset (*Statistics Canada, 2019c; Ahmad and van de Ven, 2018*).

Including a data product – unnamed as of now - as a separately defined asset used in the production of goods and services would allow for a more appropriate allocation of output (and value) to the assets used in producing it, rather than the current treatment where minimal (if any) expenditure associated with data are capitalised.
Discussions are still occurring however, regarding exactly when, along the information value chain, or the data value chain (see figure 8) production of the previously mentioned unnamed data product actually commences as well as a consistent nomenclature.

The inclusion of data as an asset in the same way as machinery and equipment needs to take into consideration that data is only valuable if there is an ability to monetise it. This transition from observations to data science, and by extension value creation, is represented in the data value chain and is far from automatic, requiring a large amount of resources and network.

[5] This subgroup is just one of many international working group, examples of these include, (followed by the organisation acting as secretariat) Working Party on Measurement and Analysis Digital Economy (WPMADE) – OECD, Expert Groups on Household and Telecommunication Indicators (EGH/EGTI) – ITU, Working Group on Measuring E-Commerce and the Digital Economy – UNCTAD, UNCEBTS Task team on globalisation and digitalisation – UNSD, Informal advisory group on measuring GDP in a Digitalised Economy-OECD and the ISWGNA subgroup on digitalisation – Eurostat.

Figure 10: Data Value Chain



Source: UNCTAD

A final consideration concerns the various countries that have begun to enact legislation in response to the increased prevalence of data and data flows. Due to this, consideration for any new classification and method of data collection and valuation by statistical offices and international organisations will also have to reflect the legislative climate in regards to data ownership as. The General Data Protection Regulation (GDPR) within the EU, for example creates provisions and guidelines regarding the collection, ownership and handling of personal data. While economic statistics are often more concerned with the economic owner than the legal owner, there is a possibility that this delineation may not be as clear-cut for data products as it is for other assets. Guidelines such as the GDPR have the potential to limit what, or how, business are able to report the data they use, in turn limiting the ability to measure it.

4.4. Summary of responses to a survey on the use of definitions and measures of the Digital Economy in G20 countries – data flows

Based on survey responses, only three countries reported having an operational measurement framework for data flows. Australia has "recently completed a Metrics Review [investigating] current measures of intangible capital which includes the volume and value of flows and stocks of data"; Statistics Canada has "released a conceptual framework on how to measure the value of data, databases and data science in July 2019". China has developed a national "standard Data Management Capability Maturity Assessment Model" to encourage better data management by firms. Measurement work was still in progress in The United Kingdom and United States of America, respectively working on a "set of measures for benchmarking and tracking digital engagement" and "the valuation of data as an asset". Brazil is planning a dedicated collaboration between its National Statistical Institute (IBGE) and its Centre of Studies for the Development of the Information Society (CETIC) on the matter. Finally, Spain measures the production related to the "data economy" as part of its broader measurement of "the turnover of Spanish companies in the main ICT goods and services". That said, most countries acknowledged that measuring and valuing data and data flows is a priority.

Overall, while there is a consensus on the growing importance and omnipresence of data in the economy, there is none on the best way to measure and value different types of data and data inputs in the production process to reflect them in national statistics. In turn, this also affects the feasibility of measuring other phenomena and their contribution to economic growth such as the emergence of platforms providing digital services, given that data collection and usage often underpins their business models.

5. Measuring digital services and platforms

There are many different types of digital platforms, providing a variety of different services. While some platforms and the services they provide are digital in nature, such as free video games, online maps or social media, others just have a digital component that facilitates the delivery of a non-digital service, such as booking accommodation or having food delivered to your house. While some platforms explicitly charge users for the service provided, many provide zero-priced services. In these cases, platforms are generating revenue in other ways, either by monetising the data that they are gaining access to (see Figure 9) and/or by providing advertising space. Firms operating with these business models, with no explicit charge to the consumer for the service provided, have made measurement of production difficult by breaking up the traditional direct transactional nature of providing good and services. Additionally, with so many digital services being "consumed" without a market price, as well as the emergence of public digital platforms in fields such as health or digital payments, one might ask how best to value these services, as well as where to include them in relation to existing macro-economic statistics. Indeed, while there is no global reference model available on public digital platforms at this stage, public digital platforms based upon open Application Programming Interfaces (API), interoperability and leveraging public data for open innovation models have resulted in a novel approach to solving certain socio-economic issues. Based on four core principles (paperless, presence-less, cashless and consent-based), public digital platforms have created multiple opportunities for small and medium enterprises to create low-cost and high-impact innovative solutions.

This section presents information on how different types of digital platforms are currently recorded in the national accounts both those that charge and explicit fee and those that do not. The section finished with a discussion on how transaction that are not currently included in the production boundary of the national accounts, could be included in a Digital Economy Satellite Account.

5.1. Free or paid for: why are certain digital services explicitly recorded in national accounts and others are not?

An interesting observation from reviewing the many different platforms currently in use is that all types of genres contain both platforms that charge an explicit fee to consumers and those that generate revenue in other ways. While this may not be an issue in some statistical settings, the presence or absence of explicit monetary transactions between end users and the platform has fundamental implications when considering how to measure the digital platforms' economic activities. In short, monetary transactions can be directly measured, while the value of non-monetary transactions must be inferred.

In the SNA context, only when a good or service is provided in exchange for money has a clear transaction occurred and the output and value added associated with the transaction is recorded within the national accounts. While the national accounts do include transactions based on bartering and while it has been well established that the units providing free digital services are receiving data that can be monetised, this does not (and should not – see section 2.5.5) automatically qualify the specific transaction for inclusion within the accounts. Other transactions, most notably unpaid household production have been excluded from the production boundary of the national accounts in the interest of maintaining the robustness of the GDP measure and its connection with other macro-economic indicators (*UN et al., 2009*).

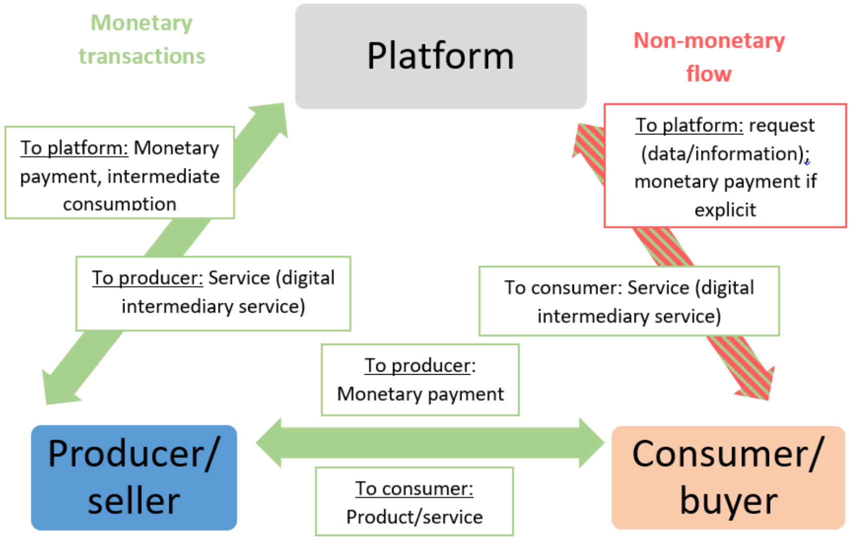
With this in mind, it is important to distinguish and label those platforms deriving revenue by explicitly charging a fee, referred to as "digital intermediary platforms (DIPs) charging a fee" from those generating revenue (and adding value) through other means, most likely advertising or selling information generated from collected data - referred to as "data and advertising-driven digital platforms". While both are generating value added in the SNA sense they are producing output of a very different nature and should be separated as such as is done in the digital SUTs (See section 2.6).

Within the proposed DETF definition, output from both types of platforms would be considered as "e*conomic activity reliant on digital inputs".* These types of platforms are clear examples of the new types of business that while not providing fundamental ICT infrastructure or services, are only able to exist due to the ability to connect with a large amount of consumers that digital technology provides, as opposed to existing business who are leveraging of digital technologies to enhance their business.

5.2. Classifying the monetary flows of online platforms

The accepted treatment of monetary transactions involving digital platforms is that the payment from the end consumer shall be recorded as paid to the producer rather than to the platform (see figure 9). In most cases this payment will be imputed as the actual monetary transaction usually occurs between the consumer and the platform and then between the producer and the platform. This amount paid by the consumer usually includes the cost of the product as well as an amount that is kept by the platform for facilitating the transaction (the digital intermediary service payment). While this amount is explicit between the producer and the platform, it is usually not explicitly charged to the consumer. This will mean that for Digital Intermediary Platforms (not taking ownership of the products they intermediate), estimates of turnover (sales) that are digitally ordered should reflect only revenues related to the intermediation services they provide and not include the value of the products intermediated.(*OECD-WTO-IMF, 2020*)

Figure 11: The recording of flows involving digital intermediary platforms charging an explicit fee



Source: OECD

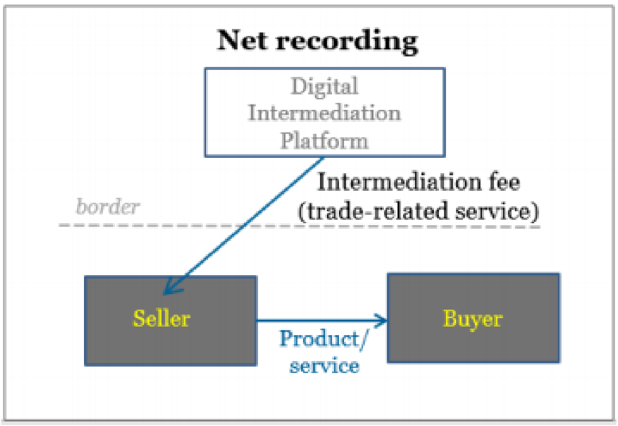
An additional consideration regarding these flows is the rise of non-resident units into transactions that traditionally only involved resident units. Goods or services purchased by a resident and provided by a resident producer/seller are now often facilitated by a non-resident digital intermediation platform. This provides an additional reason for reporting of the monetary flows on a "net" basis, which is direct between consumer and producer.

Under a "gross recording" approach - that is the intermediary platform taking ownership of the good or service - the end-consumer would have imported the full value of the good or service being intermediated. This would include any intermediation fees paid to the DIP, whilst the (resident) producer would have exported the full value of the product being intermediated and imported the intermediation service. Such a treatment would greatly inflate trade estimates, despite the underlying good or service having never crossed a border. Due to the consideration that platforms do not actually own the product, a "net recording" approach has been considered more accurate and is the recommended approach in both the *Handbook on Measuring Digital Trade* and the framework for digital SUTs.

As the example **figure 10** illustrates, when the "net recording" approach is applied, only the value of the intermediation services is included as international trade, with the transaction between buyer and seller recorded as a purely domestic transaction. Where the intermediation fees are implicit rather than separately itemised in a transaction, the current guidance recommends attributing the flows of intermediation services to the buyer only, as presented in the example. However, where the flows are explicit, the recommended recording is for the explicit flows to be recorded for both the seller and the buyer with the DIP for intermediation services (*OECD-WTO-IMF, 2020*).

To improve the accuracy of these flows' measurement, more information will be required about the specific business practices of the intermediary platforms. In this regard, Eurostat has recently undertaken a project that aims to improve the ability to collect data and payment information directly from the platforms involved with accommodation services, as this information is difficult to source from households directly. Initial tests have shown positive results and the first experimental results based on the full datasets will be released before the end of 2020.

Figure 12: "Net" recording of non-resident Digital Intermediary Platforms



Source: Handbook on Measuring Digital Trade (OECD-WTO-IMF, 2020)

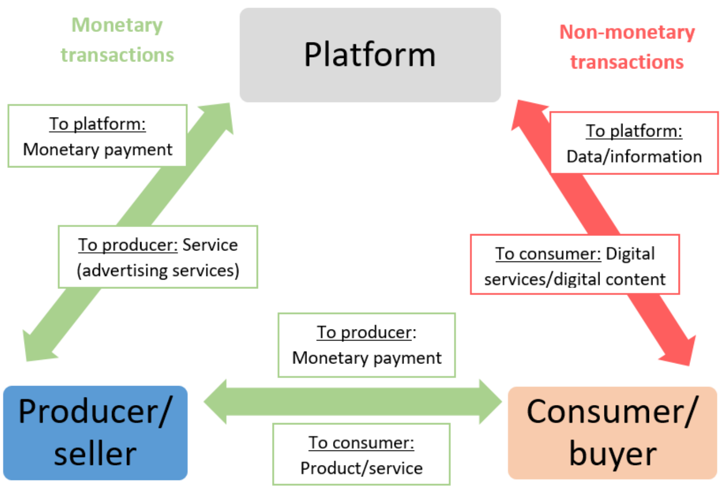
5.3. Online platforms providing zero-priced digital services

This section will cover discussion on the measurement of digital services that are provided to consumers at a price of zero. Specifically, it will explain where expenditure from platforms with this business model currently recorded in the national accounts? Moreover, how might they be reflected in a digital satellite account in the future?

5.3.1. Zero-priced digital services currently recorded in national accounts

While understanding the monetary flows is relatively simple when the services are directly exchanged for payment, matters are more complicated when a service is provided for zero-price. In this instance, as Figure 11 illustrates, a monetary payment occurs in exchange for advertising services flows between the producer and the platform, as well as a monetary payment between the producer and the consumer when the product is subsequently purchased. The transaction between the platform and the consumer is non-monetary, consisting of digital services exchanged for data which can ultimately be monetised by the platform as higher quality advertising services.

Figure 13: The recording of flows involving online platforms providing zero-priced digital services



Source: OECD

Business models that do not charge an explicit fee rely on having a desirable and heavily used platform through which they can collect and generate a large amount of data that can be transformed into digital intelligence that in turn can be monetised, for example, by selling advertising space online in order to better target viewers. In this way, the money spent providing the zero-priced platform is used to produce a higher quality final product that can be sold for a higher price reflecting a better advertising service, i.e. one that is relatively more effective in generating clicks and sales. Due to this, the expenditure on the platform and the subsequent quality change is also reflected in the various price indexes used to deflate the final output, another example of how zero-priced digital services are affecting the national accounts.

5.3.2. Zero-priced digital services in a Digital Economy Satellite Account

It is relatively easy to measure zero-priced digital services in a non-pecuniary manner, i.e. the quantity of tweets, the number of active users, even the amount of gigabytes transferred. Assigning an economic value to this activity within the framework of the national accounts is much more challenging. There have been many different efforts not just to try to account for this expenditure by firms but more importantly to place a value on its productive worth. The various methods have included valuations from both the firms' side and the household side.

While some of the methods proposed are theoretically consistent with the current national accounts, incorporating the additional flows associated with these non-monetary transactions would result in significant, but likely stable, increases to existing flows, thereby reducing the analytical usefulness of the resulting macro-economic statistics. As pointed out by the SNA itself in reference to the inclusion of unpaid household work; *"the inclusion of large non-monetary flows of this kind in the accounts together with monetary flows can obscure what is happening on markets and reduce the analytic usefulness of the data"*. (*UN et al., 2009*) Inclusion of these transactions would also have potential flow-on effects to e.g. primary income and disposable income of households, and to estimates of productivity. Furthermore, the source data required for the methods proposed are both conceptually difficult and practically expensive to gather. As such, the IMF suggested, *"a change in the conceptual framework of GDP to directly include free digital services in consumption would not be warranted"* (*IMF, 2018*).

The IMF and the OECD also concluded, *"indicators of welfare from free digital products can, and should, be developed in the context of measurement of nonmarket production outside the boundary of GDP"* (*IMF, 2018; OECD, 2019d*). This idea of estimates of consumption of free services being included in a satellite account has gained support from both international organisations and national statistical offices. As a result, zero-price digital services are included in the digital SUTs framework (see Section 6), aiming for countries to generate these estimates in the future. Digital satellite accounts are well suited for the inclusion of transactions that, despite being outside of the core production boundary of the SNA, are subject to growing political and economy interest and in many respects, remain fundamental to formulate a complete definition of the Digital Economy. It is for this reason that the tired structure of the proposed 2020 DETF definition of the Digital Economy incorporates a definition for the Digital society to incorporate digital activity of interest to policy makers that resides outside the GDP production boundary.

5.4. Summary of responses to a survey on the use of definitions and measures of the Digital Economy in G20 countries – digital services and platforms

Most (three quarters) of countries that returned the survey said they were developing or had developed dedicated measures related to digital services and platforms. Of the nine countries that responded positively, four had developed measurement tools aimed primarily at quantifying the size of the sharing economy. These were Canada (through a module of its Internet Use Survey), Germany (using the German structural business surveys and as part of a European Task Force to measure the Digital Collaborative Economy), Saudi Arabia (as part of its measurement of value added by the Digital Economy) and the United States (currently "*exploring measurement of cloud computing services and online platforms*"). Other countries reported having survey or monitoring tools that include qualitative indicators, exploring a more diverse range of issues related to platforms and digital services such as consumer protection and competition (Australia), job creation and protection (Switzerland) and "the healthy development of platforms" (China). Brazil's ICT Enterprises Survey and Spain's ONTSI Sector, Media and Audio-visual report had a mixed range of indicators, both qualitative and quantitative.

6. The Digital Economy and the system of national accounts

6.1. The need to reflect the digital transformation in economic statistics

In the various roadmaps and toolkits that have been developed to promote measurement of the digital transformation, a key aspect has been the necessity to improve the link between the digital activity and the established set of macro-economic statistics used by the international statistical community.

In 2018 under the auspice of the Argentinian G20 presidency, the G20 Digital Economy Task Force (DETF) released a *Toolkit for Measuring the Digital Economy*; the tool kit identified key actions for G20 members to make statistical systems more flexible and responsive to the new and rapidly evolving digital era. A key recommended action was to *"Work towards improving the measurement of the Digital Economy in existing macroeconomic frameworks, e.g. by developing satellite national accounts"* (*G20 DETF, 2018*).

A similar recommendation was made in *Measuring the Digital Transformation*; *A Roadmap for the Future* (2019) by the OECD. The publication identified gaps in the current measurement framework; assessed progress made towards filling these gaps and set out a forward-looking measurement roadmap. Of the nine proposed actions, the first two reflected the importance of having an economic perspective of digitalisation, by appropriately recording digital activity in the established economic statistics:

- *Make the digital transformation visible in economic statistics*
- *Understand the economic impacts of digital transformation (OECD, 2019a*).

The Digital SUTs take on additional importance in light of the proposed DETF tiered definitions. The operationalisation of the different definitions will necessitate a statistical framework that generates outputs consistent with the different definitions; the Digital SUTs is such a framework. As discussed later in the section, the proposed core measure of the Digital Economy is consistent with the digitally enabling industry outlined in the framework. The seven new “digital Industries” provide a clear delineation between firms that are reliant on digital inputs compared to those that are enhanced by it. Finally, with the framework based around the nature of the transaction, outputs related to digital ordering and delivery are produced, generating the alternative view of the Digital Economy based on economic activity, digital ordered and/or digitally delivered.

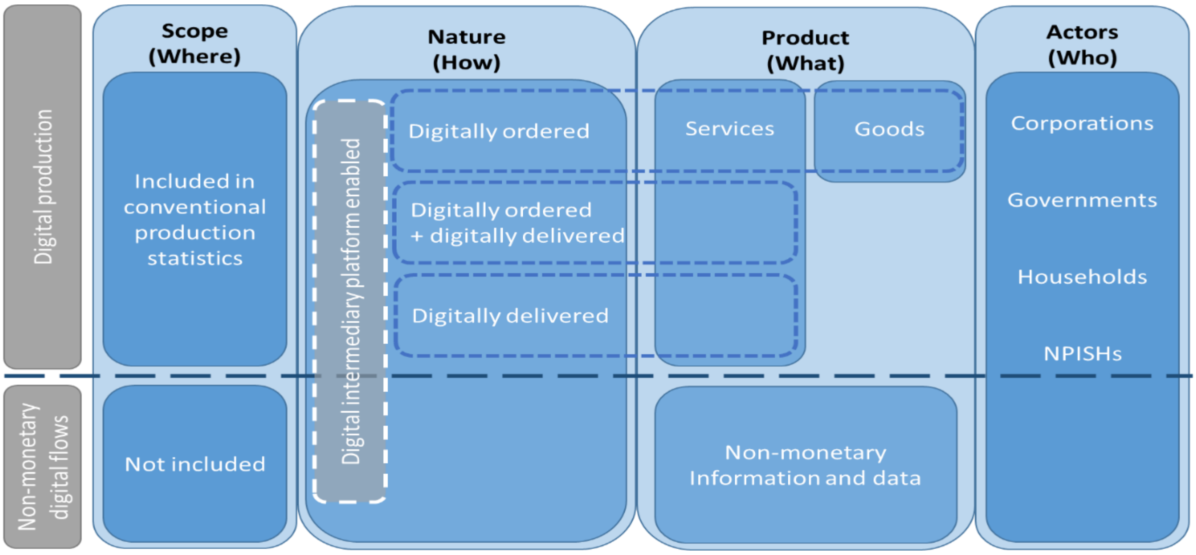
This section will detail explicitly the framework for digital SUTs, including definitions for newly proposed digital industries. The section will explain the importance of linking measurement of digital activity with the SNA and the benefits of doing so. Finally, it will present the initial high priority indicators that countries are encourage to provide, in doing so it will not only improve policy makers understanding of the role of certain actors in the Digital Economy but will also provide an opportunity for international comparison.

6.2. Digital Supply and Use Tables

The G20 Toolkit for Measuring the Digital Economy (G20, 2018), recommended that G20 member should “Work towards improving the measurement of the Digital Economy in existing macroeconomic frameworks, e.g. by developing satellite national accounts.”(*G20, DETF 2018*). In response to this, the OECD has continued to develop a framework for digital SUTs. These tables produce indicators on digital activity in the economy that are aligned with the SNA. Developed under the auspices of the OECDs Informal Advisory Group on Measuring GDP in a Digitalised Economy (the Advisory Group), the framework builds on and expands the conventional supply and use framework; a standard tool in the compilation of national accounts.

At the heart of this framework (see Figure 15) is the breakdown of transactions in a number of directions associated with key aspects of digitalisation; in particular the framework differentiates between digitally ordered and non-digitally ordered goods and services, and digitally delivered and non-digitally delivered goods and services. By breaking down the supply and use of these products by the nature of their transaction, the framework can highlight how digitalisation has affected the provision of traditional products as well as digital products.

Figure 14: Conceptual framework for the Digital Economy proposed for Digital Supply-Use tables



Source: OECD

In addition, the framework defines groupings of firms and products around digital industries and digital products. In doing so, it produces easily interpretable statistics on digital activities that are consistent with the concepts and terminology already used in the national accounts.

Furthermore, in response to the fact that many transactions related to the Digital Economy are not included in measures of GDP for being ‘free’, the framework also covers and motivates the measurement of new digital phenomena, in particular social media, open source software, the use of data, and other zero-priced digital services. While discussions are still ongoing regarding the appropriate measurement and valuation methods of these phenomena (see Sections 4 and 5), their inclusion, despite being outside the core production boundary of the 2008 SNA reflects the key interest for these items.

A central idea of the framework, as discussed earlier in the chapter, is that given the pervasiveness of digitalisation, different perspectives require different measures, specific to relevant aspects of the Digital Economy. Once the digital SUTs are populated, an array of indicators can be derived from these tables. These indicators on digital activities can assist the development of appropriate policy as well as facilitate international comparison between countries. Additionally, it provides insight in how specific elements of the Digital Economy, which may have been considered to be missing or underrepresented within the national account aggregates, are accounted for. Finally, when fully populated, the Digital SUTs have the potential to distinguish the economic activity that is "*reliant or significantly enhanced due to the use of digital inputs*", i.e. that should be included in the Digital Economy, as defined by this report.

6.3. Summary of responses to a survey on the use of definitions and measures of the Digital Economy in G20 countries – digitalisation in economic statistics

Of the nine countries that filled the questionnaire and are currently undertaking "work on measures in the context of economic statistics frameworks", six reported working on the development of Digital Supply-use tables or of a Digital Satellite account, based on OECD work or the methodology used by the Bureau of Economic Analysis in the United States, in the case of Canada. Among countries that did not mention such work, Mexico highlighted its reporting of aggregate gross e-commerce value and Argentina reported that its National Institute of Statistics and Census (INDEC) estimates the importation of digital services in the balance of payments.

6.4. Make-up of the Digital Supply-Use Tables

To create digital SUTs, the standard OECD supply-use tables (*UN et al. 2009*) have been modified in order to produce additional information on the Digital Economy. The modifications include:

- Five additional rows under each product (and aggregates of products), representing the nature of the transaction.
- Seven additional industry columns, representing the new digital industries.
- Four additional rows, representing digital product categories that fall within the SNA production boundary.
- Three additional rows, representing data and digital services currently outside the SNA production boundary.
- Additional columns, allowing for the separate recording of digitally delivered consumption, imports and exports.

While many of the products and transactions included in the digital SUTs have been defined earlier in Section 3, definitions of the various digital industries included in the digital SUTs have not yet been covered. These industry classifications have been developed in order to quantify specific aspects of digital activity currently unidentifiable within the existing industry allocation of supply use tables. Some businesses may meet the definitions of one or more of the new digital industries. In these circumstances, similar to current practice with classifying units, units should be broken down if possible to reflect its main business practices or alternatively t should be placed in the digital industry with a more specialised purpose. These include Digital intermediary platforms charging a fee, Data and advertising driven digital platforms, Firms dependent on intermediary platforms, E-Tailers, and Digital only firms providing financial and insurance services.

The digital industries proposed within the Digital SUTs framework broadly align with the tiers outlined earlier in the chapter. For example, the *Core* measure is consistent with the "Digitally enabling industries" while the remaining industries listed would include firms that are classified within the *Narrow* measure as they are reliant on digital inputs. The *Broad* measure of the Digital Economy could be observed in the Digital SUTs based on indicators such as the level of digital ordering and/or delivery taking place or the amount of digital goods and services used as an input into production, both of which are outputs of the digital SUTs.

A key driver behind the development of this identification of digital industries within the Digital SUTs is international comparability. If statistical agencies have the data available and deem the work relevant for their country, they are obviously free to break down any specific new digital industries into additional subsets suitable for their policy needs.

6.4.1. Digitally enabling industries

Simple definition: Digitally enabling industries includes businesses engaging in production that enables the function of information processing and communication by electronic means including transmission and display; explicitly it is those industries defined in the ICT sector list in ISIC Rev. 4.

It includes; Internet service providers, telecommunications companies, providers and developers of software, Computer manufacturers, and website developers. While excluding free and priced digital media providers, social media providers, digital platforms directly or intermediately providing goods and services not included in the defined ICT sector list for ISIC Rev.4.

Examples: Amazon Web Services, BSNL, Dell, Indosat, Ooredoo, Orange, Verizon.

6.4.2. Digital intermediary platforms charging a fee

Simple definition: Business that operate online interfaces that facilitate, for a fee, the direct interaction between multiple buyers and multiple sellers, without the platform taking economic ownership of the goods or services that are being sold (intermediated).

It includes; food delivery companies, travel booking portals, platforms facilitating online auctions or marketplaces that assume no ownership of stock. While excluding; digital platforms that sell their own goods or services, platforms that do not receive an explicit monetary fee from either the producer or consumer.

Examples: Airbnb, Booking.com, Deliveroo, Didi, Mercado Libre, OLA, Trivago, Uber.

6.4.3. Data and advertising driven digital platforms

Simple definition: Businesses that are operating exclusively online that predominately generate revenue via selling data or advertising space.

It includes; search engines, social media platforms, developers of zero-priced phone applications and information sharing platforms. While excluding; business that sell goods or service (excluding data or advertising space) for a monetary price, subscription based services providers, priced phone applications and information sharing platforms.

Examples: Citymapper, Facebook, Google, Tik Tok, Twitch, Youku

6.4.4. Firms dependent on intermediary platforms

Simple definition: Businesses that always or a significant majority of the time transact with consumers via an independently owner third party digital platform.

It includes; independent service providers who source work from digital platforms, business who sell via a third party digital platform. While excluding; business who sell predominately digitally but do so via their own website/digital platform.

Examples: Bicycle couriers, Ghost kitchens, Uber drivers

6.4.5. E-tailers

Simple definition: Retail and wholesale businesses engaged in purchasing and reselling goods or services who receive a majority of their orders digitally.

It includes; businesses receiving orders digitally that sell their own inventory and/or have set contracts with producers and suppliers. While excluding; businesses that carry no ownership of the purchased good or service, businesses who contribute no additional value added to the consumed good or service.

Examples: ISOS, JD.com, Sarenza, Yesstyle, Zalando.

6.4.6. Digital only firms providing financial and insurance services

Simple definition: Businesses providing financial and insurance services that are operating exclusively digitally, with no interaction with consumers physically.

It includes; online only banks and other financial service providers, online only payment system providers. While excluding; banks and other financial service providers that include consumer-facing locations, platforms solely acting as intermediaries between lender and borrower (i.e. crowd funding websites).

Examples: Ally financial, Directline, Fidor bank, Open bank, Paypal, Seven bank, Transferwise.

6.4.7. Other producers only operating digitally

Simple definition: Businesses that produce their own services for sale but operate exclusively digitally.

It includes; priced digital media providers, subscription based service providers (assuming the service is delivered digitally) While excluding; business who do not deliver their good or service digitally regardless of how they receive orders.

Examples: Bet365, The Independent newspaper, Netflix, Showmax, Spotify, Starz Play.

6.5. Advantages of the Digital Supply-Use Tables

The great advantage of measuring the Digital Economy using the established boundaries of the SNA is that the vast majority of countries are already producing the initial data. The SNA is an established international statistical standard with a long history of being used for cross-country comparisons. While countries may initially have trouble generating the additional splits requested by the Digital SUTs due to an absence of source data, the data used as a starting point is uniformly available. This allows initial estimates to be generated more easily, with others to follow as additional data sources are created. Furthermore, by starting with the overall estimate of GDP, which incorporate the entire economy, both digital and non-digital, the Digital SUTs provides additional context of how the Digital Economy is placed within the overall economy, as outlined in Figure 3.

The same advantage exists for policymakers and economists. Rightly or wrongly, GDP is arguably the most well-known and oft-referred macro-economic indicator. Users and policy makers have quite rightly looked for a derivative of this well-known indicator to use as a metric for the size and growth of the Digital Economy. An estimate of compensation of employees, total output or value added of digital industries, such as digital intermediary platforms or E-tailors are examples of indicators from the digital SUTs that already come with a high level of interpretability and understanding. The continual reference to a sector or product as "a proportion of GDP" is testament to the widespread usage of the GDP and the need to have an indicator of digital activity aligned to it.

While the digital SUTs have the capacity to generate a single definition of the Digital Economy they are not constructed to do so. Similar to the SUTs used for measuring the conventional economy, the value added of all the digital industries could be defined as an estimate of the Digital Economy; in this case, it would be consistent with the narrow measure of the Digital Economy, including economic activity that was reliant on digital inputs. As outlined in the tiered definition such a definition is considered only one perspective of the Digital Economy.

The significant benefit of the Digital SUTs is that in addition to the perspective mentioned previously, the framework also allows for the generation of additional outputs consistent with the proposed definitional tiers. This includes goods and services that are digital ordered and/or delivered encompassing digital transactions of traditional goods and services. Alternatively, the broad measure of the Digital Economy that includes firms being significantly enhanced by digital inputs could be addressed by identifying the amount of economic activity from conventional industries who are creating a large amount of digital transactions or utilising a large amount of ICT goods and digital services in their production. In this way, the Digital SUTs are able to produce indicators that align with the proposed comprehensive definition that the Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities.

6.6. Outputs of the Digital Supply-Use Tables

Instead, the digital SUTs produce a suite of indicators that are able to answer a variety of questions posed by policy makers. This includes the following

- GVA by digital industry.
- Amount of e-commerce consumed.
- Amount of ICT goods and services consumed.
- Digital trade in line with the definition used in the handbook on measuring digital trade.
- Expenditure on specific digital products and services, this includes investment and both final consumption by household and intermediate consumption by businesses.

While no indicator is able to directly measure a trend or "top down" definition, (see Section 2), the final indicators listed can be used to provide an indicator of the degree of digitalisation of more conventional industries. For example, as an industry (such as transport or accommodation services) digitalises you would expect that a greater proportion of their intermediate consumption used in production would consist of ICT goods and services. Once completed, this delineation can be observed in the digital SUTs. This split between digital and non-digital inputs would allow a comparison to be made regarding which industries or production of specific products has become more digitalised than others.

The informal advisory group on measuring GDP in a digitalised economy has been developing aspects of this framework since 2017. The framework has been shared across international organisations and national statistical offices and is now moving from a conceptual phase to a practical implementation phase as countries begin to generate estimates of outputs from the digital SUTs. Countries have already been requested to supply any available estimates that will be shared and discussed at the next meeting of the advisory group in mid-2020.

6.7. High Priority Indicators

Generating outputs for the entire digital SUTs is an extremely ambitious task. Combined with the various levels of data sources and resources available, this will likely result in countries progressing quite slowly in their initial effort to compile the digital SUTs. As a result, the advisory group selected a set of high priority indicators that countries would initially be encouraged to produce. This list of indicators not only offers a road map for countries to focus developmental resources in the most impactful way in the short term, but also provides assistance to coordinate the initial results provided by countries (*OECD, 2019c*).

The proposed list of high priority indicators includes the following:

1. Output, Gross Value Added (GVA) and its components, of digital industries.
2. Intermediate consumption of Digital Intermediary Services (DIS), Cloud Computing services (CCS) and total ICT goods and digital services.
3. Expenditures split by nature of the transaction.

These specific indicators were selected as high priority for both the value proposition they bring as interpretable, informative, aggregate indicators of digital activity but also due to the balance they strike between what is desired by policy makers and what might be possible for statistical compilers. Specifically these indicators would provide information currently unidentifiable in established economic outputs. This includes the overall output of a defined collection of units that are fundamental to the digitalisation of the economy, an indicator reflecting how digitalisation has affected the interaction between producers and consumers as well as a measure of the digitalisation of more conventional industries based on the uptake in digital goods and services being used in production.

While these indicators are the immediate priority, countries are encouraged to work towards a more complete population of the digital SUTs. Agreeing on a number of high priority indicators will help however in co-ordinating the initial results that can be derived from the digital SUTs, thereby maximising its use as an internationally comparable framework. The digital SUTs as such remain a roadmap for further internationally co-ordinated development in the future.

6.8. A Digital Economy Satellite Account

It is important that any framework used to compile estimates of the Digital Economy can display estimates of digital goods and services that currently lie outside of the current production boundary. While goods and services such as data and data-based information may well be introduced into the production boundary at a later date (see Section 4), there is already an expectation amongst users that some form of valuation or production estimate can be assigned to the transaction.

Due to this the digital SUTs explicitly includes rows that provide for estimates related to data, zero-priced digital services provided by enterprises and zero-priced digital services provided by communities. The framework is not descriptive in regards to the manner that these estimates might be calculated, however, it is descriptive in that the rows should be included in any broader estimate of digital activity that might be incorporated into a Digital Economy Satellite Account.

These rows request information on capital and labour inputs that may later form the basis for a satellite account similar to those often produced for transport, culture or tourism. A Digital Economy Satellite Account is the ultimate long-term output of the digital SUTs.

As outlined in the SNA, a satellite account is created in different ways to serve different purposes. Initially a satellite account can involve some rearrangement of the central classification and the possible introduction of complementary element; in this case, this would be the re-arrangement and aggregation of digital products and industries from many different conventional classifications. By contrast, a satellite account may include an account based on alternative concepts to those of the SNA. In this case, this would involve the inclusion of non-monetary transactions.

6.9. Ongoing compilation challenges and future work for digital Supply-Use Tables

Despite the broad support for the project, there are still considerable hurdles for national statistical offices even as the overall project moves from being faced with conceptual challenges to more practical compilation challenges. The most obvious of these are the limited availability of data sources, and the fact that current compilation methods use business surveys or tax data that do not necessarily lend themselves to also providing additional information on the nature of the transaction. Furthermore, statistical business registers often lack the required level of detail to delineate units that are fundamentally involved in the Digital Economy, such as intermediate platforms, from the broader industries that they are currently classified within. That said it is important to recognise that none of these challenges are conceptually unsolvable, and that the majority of national statistical offices would be able to overcome these concerns if equipped with the additional resources.

In anticipation of this, it is important to note that the digital SUTs were constructed in such a way that countries can complete them as additional data becomes available. There is no minimum amount of compilation required; rather countries are encouraged to complete what they can as soon as they can, with the idea of eventually sharing compilation best practice to ensure that other countries can catch up with those first able to complete key parts of the tables.

A large amount of conceptual work has been done on the framework over the past two years, so much so that the OECD has already requested countries to provide initial experimental estimates of the high priority indicators. It is envisioned that preliminary aggregates of the high priority indicators across a handful of countries could be analysed at some point during 2020. Supporting this initial request is the decision by Eurostat in early 2020 to call for proposals for grants to support the development of Digital Economy supply and use tables in EU/EFTA countries. This call is based on, and compatible with, the digital SUTs methodology discussed in this section.

6.10. Measuring the Digital Economy and the Digital Supply-Use Tables

The digital SUTs constitute a unique platform for international collaboration on measurement of the Digital Economy. By working with National Statistical Offices to develop estimates, the digital SUTs framework can ensure consistency across countries and with existing statistical standards and classifications. While outputs of the Digital SUTs may be limited to begin with, the quantity of estimates and the number of countries providing estimates should grow as this work becomes more mainstream. As more countries begin to generate estimates for the digital SUTs, there will be greater opportunity to develop and share best practice techniques across the international statistical community, including beyond G20 members, thereby generating momentum for future pr ogress.

International fora such as the G20 provide an opportunity to recognise the merits of this work and encourage further participation in particular in the cohesion that exists between the outputs of the digital SUTs and the proposed tiered definition. Policy makers from the G20 members can accelerate the development of the digital SUTs by advocating for and prioritising resources towards this work.

By incorporating digital activity into the existing internationally comparable statistics makes it easier for policy makers and researchers to study the similarities and differences across countries in the production and use of digital technologies. Importantly, this makes it possible to evaluate, from an economic perspective, the effectiveness of programs and polices across countries as they relate to digital technologies, allowing countries to compare experiences and potentially learn from one another.

Feedback from National Statistical Offices in regards to this work has identified that an absence of resources is the most common obstacle prohibiting them from generating outputs in line with the digital SUTs framework. Ultimately, the member countries policy makers stand to benefit the most from this work, as better measurement will enable the implementation of better data-driven policies concerning the Digital Economy.

7. Concluding remarks

The need for sound measurement of the Digital Economy has been widely acknowledged by the G20 and the broader statistical community. As the Digital Economy impacts a wide range of policy areas, this need has only intensified over the past decade. In this respect, the lack of a clear, commonly agreed definition of the Digital Economy itself has been identified as a hurdle. In considering the lack of an established definition for the Digital Economy, this chapter has examined three questions:

Firstly, what definitions are currently employed to set the boundaries and describe the concept of the Digital Economy and why has none of these found consensus?

Secondly, which of the key concepts that make up the Digital Economy have been defined and how?

Lastly, which complementary concepts are still presenting challenges for definition and measurement, and what is being been done to address these measurement needs?

In attempting to answer the first question, Section 2 categorised existing definitions of the Digital Economy into two broad types. The first, groups definitions that aggregate activities presented in existing statistics (e.g. in the form of industry classifications) to define the Digital Economy (*bottom-up definitions*). The second encompasses definitions that describe the Digital Economy as the result of a set of trends that are more or less pronounced in the different economies or sectors considered (*top down definitions*). Each of these offers benefits and challenges. It is therefore proposed that a tiered structure, based on the flexible approach put forward by UNCTAD using the work of Buhkt and Heeks (2017) and utilising concepts taken from existing work within the international statistical community might be most useful to both policy makers and economists. <u>As such, this report comprehensively defines the Digital Economy:</u>

> ***The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities.***

Importantly, the definition is complemented by a tiered definitional framework incorporating clear definitions for **Core, Narrow** and **Broad** measures of the Digital Economy along with an alternative view based **economic**

activity, digitally ordered and/or digitally delivered. Finally, a final tier was introduced to define **the Digital Society**, incorporating the broader digital transformation occurring**.**

Section 3 provided an overview of those in existence including definitions for ICT goods and services, digitally enabled services, digital trade, digital intermediary platforms and cloud computing as well as terms designating the workforce employed by the Digital Economy's core actors. Indeed, these notions have been the object of substantial definitional work by the OECD, the UNCTAD, the IMF-OECD-WTO *Handbook on Measuring Digital Trade* (2020) as well as Eurostat and national statistical offices. Many of these underpin both the different tiers included in the proposed definition as well as indicators presented in chapter 3.

Additionally, there are various key phenomena within the Digital Economy for which considerable measurement challenges remain. Sections 4 and 5 present the challenges and approaches being developed define and measure data and data flows, digital services and the activities of digital intermediary platforms. As reflected in the survey G20 countries answered on *Measuring the Digital Economy*, data and data flows are simultaneously seen as a measurement priority but also a particularly complex measurement challenge. Indeed, the economic importance of firms using data as a fundamental element of their business model and the political salience of consumer data protection and monetisation are widely acknowledged. At the same time, measurement is made difficult by the context-dependent nature of data's value, its non-exclusive and fluid nature, as well as the wide range of uses and sources that characterises data as an input of production.

Concerning digital intermediary platforms (DIPs), the quantification of their output poses relatively fewer conceptual issues. However, the diversification of DIP types (in particular between DIPs that charge an explicit fee to consumers and DIPs that generate revenue in other ways) and across industries have led to questions and challenges around industry classification. In addition, classifying and measuring their monetary flows remains a challenge given the rise of non-resident units into these transactions.

Finally, Section 6 reiterates the importance of linking the measurement of digital activity with the system of national accounts (SNA) which underpins major economic statistics al while maintaining a consistency with the proposed definition and tiers. This is achieved by distinguishing key categories of actors and products within the supply-use framework. Nevertheless, such delineations require a variety of compilation issues to be overcome, most notably around the availability of sufficiently detailed data. While recognising existing compilation issues, this section also proposes a list of high priority indicators that countries would initially be encouraged to produce when starting to develop digital supply-use tables.

Overall, this chapter sets out and supplements the definitions and concepts needed to conceptualise and measure the Digital Economy. Chapter 3 presents a number of these already in use for the practical measurement of Jobs, Skills, and Growth in the Digital Economy across the G20.

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Chapter 3 - Measuring the Digital Economy: Jobs, Skills, and Growth

1. Introduction

This chapter presents selected empirical findings on *Jobs, Skills, and Growth* in the Digital economy – examining each of these in turn. As well as setting out the debate on measurement in each of these areas it presents a range of indicators based on established, internationally agreed definitions and on methods and data sources that are already replicated in most G20 countries – including many set out in the *G20 Toolkit for Measuring the Digital Economy (G20 DETF, 2018)*. From these, a selected range of available indicators that paint a reasonably broad and nuanced, picture of jobs, skills, and growth in the Digital Economy is proposed for discussion and agreement by the Digital Economy Task-Force with a view of their adoption for benchmarking and monitoring across the G20.

For this purpose, the selected indicators need to collectively address each of the key facets identified in this chapter as well as key cross-cutting factors such as age or gender differences in the extent of engagement in and impact of the Digital Economy. Particular emphasis is put on gender parity, as the digital transformation provides "*new avenues for the economic empowerment of women and can thereby contribute to greater gender equality"* (OECD, 2018) which need to be understood and monitored by policy makers. Various indicators showcased in this chapter thus include a gender dimension. In order to include indicators for which a gender breakdown is most informative, this report has tried to align with the recommendations made by the Digital Inclusion Focus Group (W20), whose contribution is outlined in more detail in section 5 of this chapter. To aid their identification, indicators presenting a gender breakdown are marked by the symbol throughout the chapter. Nevertheless, the W20 identified a number of additional indicators which should be developed. In further developing data sources and indicators it is recommended that gender and other key personal characteristics are considered and, in particular, that data collections are designed to deliver published breakdowns along these lines.

In addition, the indicators presented throughout this report can support the monitoring and implementation of the United Nations' 2030 Sustainable Development Goals (SDGs). For instance, indicator 3.1.1 is based on ITU data on individuals with ICT skills that underpins UN SDG indicator 4.4.1, relating to SDG 4 Target 4.4: "*By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship*.". Similarly, working towards the 9th SDG "*Build resilient infrastructure, promote inclusive and sustainable industrialisation and foster innovation*", can be served by the monitoring several key indicators in this report. In particular, target 9.C: "*Significantly increase access to information and communications technology and strive to provide universal and affordable access to the Internet in least developed countries by 2020*" will need to build on informed policies for digital skills provision (see Section 3 of this chapter) as well as quality infrastructure (see chapter 1 section 2).

Furthermore, the indicators selected should as far as possible, reflect the amorphous nature of the Digital Economy. As a frame for analysis, chapter 2 of this report proposed an over-arching definition with which the indicators presented are also compatible.

The Digital Economy incorporates all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities. In support of the progress made by G20 countries, through the DETF, in adopting a common tiered definition for the Digital Economy (see chapter 2), many of these indicators directly speak to the tiered approach. For example, the "Information Industries" align with the "core" definition of the Digital Economy by covering firms classified to industries that produce ICT goods and services as well as digital content. Additionally, the "digitally intensive sectors" presented in several figures provide one existing means of operationalising the "broad" definition of the Digital Economy. These also align with several indicators in the *G20 2018 Toolkit for measuring the Digital Economy* and thus allow for continuity. Table 2 in Chapter 2 summarises the links between tiers of the proposed definition and the indicators set forth in this chapter. Nevertheless, with the tiered definition now in-hand, further efforts will be necessary to establish new, improved, and agreed means of operationalising each of the tiers in the definitional framework to deliver aligned indicators.

The indicators chosen also need to offer reasonable country coverage or at least the feasible prospect of extending coverage across G20 economies. To that end, being based on generally adopted data sources with internationally agreed methods and frames aids adoption across countries. The indicators chosen should also be available with sufficient frequency to allow evolutions to be monitored.

In addition, several less-widely adopted indicators are presented. These show how other facets of jobs, skills, and growth in the Digital Economy can be measured by leveraging existing data sources – such as through the addition of new questions or modules to ICT usage surveys. Though not currently suitable for inclusion in a G20 suite of benchmarking indicators, these show how, with coordinated international effort and uptake, key additional indicators could be developed. Table 1 indexes the indicators presented in this chapter.

Table 1: Indicators on Jobs, Skills, and Growth in the Digital Economy

Section	Indicator name	Data source(s)	Underpinning data source
Jobs	**2.1.1** Jobs in digital-intensive sectors and Information Industries	OECD Structural Analysis (STAN) Database based on National Labour Force Surveys	National Accounts sources / Labour force surveys
	2.1.2 Contributions to changes in total employment by digital-intensive sectors	OECD STAN Database ; National Accounts Statistics ; National sources and Inter-Country Input-Output Database	LFS
	2.1.3 Individuals who have offered services on a platform	Flash Eurobarometer, European Commission	Eurobarometer survey
	2.2.1 Jobs in ICT task-intensive and ICT-specialist occupations	European Labour Surveys and other sources	LFS
	2.2.2 ICT professionals and technicians by gender	International Labour Organization (ILO) based on national Labour Force Surveys	LFS
	2.2.3 Enterprises that reported hard-to-fill vacancies for ICT specialists	OECD, ICT Access and Usage by Businesses Database	Business ICT usage surveys
	2.3.1 Jobs in Information Industries and digital-intensive sectors sustained by foreign final demand	OECD Trade in Employment Database	LFS
	2.3.2 Business dynamism (average post-entry employment growth)	OECD DynEmp3 Database	LFS
	2.3.3 Likelihood of automation or significant change to jobs	Survey Programme for the International Assessment of Adult Competencies (PIAAC) database	PIAAC skills survey module
Further indicators for development	**2.5.1** Individuals teleworking from home in the last 12 months	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
	2.5.2 Perceived impacts of digital technologies on specific aspects of work	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
Skills	**3.1.1** Selected ICT skills by gender	ITU World Telecommunication/ICT Indicators database and OECD ICT Access and Usage by individuals database	Household and Individuals ICT usage surveys / modules in LFS
	3.1.2 Eurostat Digital Skills Indicator	Eurostat Digital Skills Indicator	Household and Individuals ICT usage surveys / modules in LFS
	3.1.3 Proficiency in problem solving in technology-rich environments	PIAAC database	PIAAC skills survey module
	3.2.1 ICT task intensity of jobs by gender	PIAAC database	PIAAC skills survey module
	3.2.2 Computer-based tasks performed by individuals at work	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
	3.2.3a Impacts of new software and computerised equipment at work	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
	3.2.3b Digital skills mismatch at work	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
	3.3.1 ICT usage in school	OECD Programme for International Student Assessment (PISA) Database	PISA assessments
	3.3.2 Students' reported ICT capabilities, by gender	OECD PISA Database	PISA assessments
	3.3.3 Individuals who completed training to improve their digital skills	Eurostat, Digital Economy and Society Statistics	Household and Individuals ICT usage surveys / modules in LFS
	3.4.1 Tertiary graduates in natural sciences, engineering, ICTs, and creative and content fields of education	OECD Education Database	Administrative registers and/or survey sources
	3.4.2 Tertiary graduates in NSE & ICT, by gender	OECD Education Database	Administrative registers and/or survey sources
	3.4.3 Employment rate of NSE ICT graduates compared to the overall the tertiary-educated population	OECD Education Database	Administrative registers and/or survey sources
Further indicators for development	Top 10 skills in high demand for computer-related jobs	Burning Glass Technologies (www.burning-glass.com)	Web-scraped data
	4.1.1 Value added by information industries	OECD STAN Database	National Accounts sources
	4.1.2 Information industry-related domestic value added	OECD Inter-Country Input-Output (ICIO) Database and Trade in Value Added (TiVA) Database	National Accounts sources

Growth	**4.1.3** Value added by digitally intensive sectors	OECD STAN Database and OECD ICIO Database	National Accounts sources
	4.2.1 ICT investment by asset	OECD, Annual National Accounts Database and national sources	National Accounts sources
	4.2.2 ICT contribution to labour productivity growth	OECD Productivity Statistics Database	National Accounts sources, LFS
	4.2.3 Labour productivity in Information Industries	OECD STAN Database	National Accounts sources, LFS
	4.3.1 ICT goods exports and imports	UNCTAD Information Economy database	Merchandise trade data
	4.3.2 ICT services exports and imports	UNCTAD Information Economy database	Trade in services data
	4.3.3 Digitally-deliverable services exports and imports	UNCTAD Information Economy database	Trade in services data
Further indicators for development	Output, Gross Value Added and its components in digital industries	National accounts using Digital Supply Use tables (SUTs)	National Accounts sources
	Expenditures split by nature of the transaction	National accounts using Digital Supply Use tables (SUTs)	National Accounts sources
	Intermediate consumption of Digital Intermediary Services, Cloud Computing services (CCS) and total ICT goods and digital services	National accounts using Digital Supply Use tables (SUTs)	National Accounts sources

2. Jobs in the Digital economy

The Digital Economy has many facets and involves a range of technologies that simultaneously affect employment in several key ways including job creation, job destruction, and job changes (*Degryse, 2016*). As such, there is currently no consensus on the net impact of digital technologies diffusion on total job quantity and quality (*OECD, 2016b*). Indeed, while there is a clear direct labour substitution channel, the productivity gains induced by technology adoption may simultaneously increase firms' propensity to recruit or engage in new activities, thereby creating new jobs. Similarly, in the case of "platforms" it is not clear at this stage whether they are simply replacing traditional intermediaries in the labour market with digital ones or will lead to large expansions of non-standard forms of work, (*OECD, 2019d*). Therefore, rather than the overall impact on the number of jobs, the major measurement challenge will be to estimate the effects of digitalisation on the redistribution of employment between sectors and workers.

There has already been a decline in the labour share of national income across certain G20 economies. This has been partly attributed to technological change, as increasing market shares are being captured by digital-intensive, platform-based "superstar" firms benefiting from strong network effects that employ relatively little labour in their production process (*Van Reenen, J., Autor, D., Dorn, D., Katz, L., & Patterson, C., 2017*). If left unaddressed, these changes tend to result in anxiety about the future for workers, reinforcing the "*growth of inequalities*" and "*distortions in cross-border competition*" associated with the emergence of new players in the Digital Economy (*OECD, 2019c*).

The rise of the platform economy has raised important questions about the balance between flexibility and precarity of work and leads to crucial policy considerations of online workers' social protection and rights. The emergence of platform-intermediated work has led to the reorganisation of a wide range of markets, labour relations and contracts, and ultimately of value creation. Platforms enable individuals to choose to supply services online, perhaps finding work they would not have had otherwise, or complementing their main income. However, platform work simultaneously increases the share of non-standard work[6] in total employment, which is more likely to go along with wage penalties, lower chances to receive employer-sponsored training, and a higher risk for workers to transition into unemployment (*OECD, 2016b).* Moreover, "*by breaking down jobs into "tasks", platforms facilitate new ways of commodifying labour, and selling it "on demand" to businesses looking to outsource some aspects of their workload at a lower cost*" (ILO, 2018). One of the most high-profile challenges when considering measures of the number of jobs in the Digital Economy relates to tasks transacted through online platforms ("platform work"). The first difficulty when quantifying platforms' contribution to employment is the growing diversity of their business models: indeed, platforms ""*include both web-based platforms, where work is outsourced through an open call to a geographically dispersed crowd ("crowdwork"), and location-based applications (apps) which allocate work to individuals in a specific geographical area*" (*ILO, 2018*). This is particularly important as the extent of the challenges outlined above is in large part a function of how common platform work is. Although, there are currently limited indicators on platforms, results from experimental questions could be developed and mainstreamed into surveys.

The Digital Economy extends far beyond a relatively small number of large platforms and "superstars", impacting the way many firms do business and the nature of the jobs they offer. Looking beyond the narrow definition of ICT specialists reveals that jobs in ICT task-intensive occupations are widely permeated throughout the economy. Meanwhile, indicators on the extent to which firms find vacancies for such occupations hard to fill can give an indication of the balance between supply and demand. However, although measures for these rely on widely implemented survey vehicles – labour force surveys and surveys of ICT usage in business – the necessary information are not available for some G20 economies, pointing towards a need to further encourage the collection and publication of relevant data series.

There is evidence that existing jobs are being changed or even displaced by digital technologies. Nedelkoska and Quintini (2018) estimate that, on average across G20 economies, 14% of existing jobs could disappear as a result of automation over the coming 15-20 years. A further 32% are likely to change significantly as certain tasks are automated. Advances in Artificial Intelligence (AI) robots, and other technologies may encroach upon many more tasks previously performed by humans. Examples of activities with a high likelihood of automation keyboard operators, medical and pharmaceutical technicians as well as metal processing (*OECD, 2019a* based on *Frey and Osborne, 2017*). Older workers may also face displacement from their jobs because of skills obsolescence resulting

[6] *Non-standard work arrangements* are defined by what they are not: full-time dependent employment with a contract of indefinite duration, or what is generally considered the "standard" work arrangement. This implies that self-employed own-account workers and all part-time workers fall under "non-standard workers" (*OECD, 2016b*)

from the fast evolution of digital technologies (OECD, 2019c). While assessments of the likelihood of automation vary, as do estimates of the number of jobs that may be impacted, policies are needed that prepare workers for technology-driven changes. Several indicators presented in this chapter provide insights into how technological change is impacting various aspects of work.

Nevertheless, there are also various channels through which digitalisation may actually boost employment. Firstly the digital sector has been a strong contributor to overall employment growth across the G20, with the high digital-intensive sectors representing 20% of employment on average across G20 economies in 2016. Secondly, digitalisation also drives job creation outside the digital sector, as new business models and modes of production emerge. New jobs may be created to complement machine capabilities within existing occupational categories (e.g. new types of teachers who blend in-class and computer-based learning) or in entirely new fields (e.g. social media managers, Internet of things architects, AI experts, etc.). In particular, the development of platform-based business models enabled new types of entrepreneurial activity as workers in SMEs or self-employed occupations are able to develop activities in addition to their main job (*OECD, 2019d*). By increasing productivity and reducing prices, digital technologies can also have a positive impact on employment in industries other than the ones where they are deployed. At the firm level, productivity gains from technology adoption can boost recruitment and wages, for both low- and high-skilled workers (*Aghion, P., Bergeaud, A., Blundell, R. 2017*). That said, overall labour productivity growth has decreased markedly across the G20 (*OECD, 2019f*).

More than any change in the quantity of jobs, a key challenge stems from the uneven distribution of the effects of digitalisation – negative and positive alike – across workers, industries and regions, as well as across personal characteristics such as gender and age, and business characteristics such as size. This is resulting in substantial polarisation of labour markets. While middle-skilled jobs have been particularly exposed to digitalisation so far, in the long term, low-skilled workers are most likely to bear the cost of digital transformation (*OECD, 2019d*). Low skilled workers will likely be faced by increased competition for jobs from middle-skilled workers (previously displaced) while also least likely to be able to adapt to new technologies and working practices, and to benefit from the new opportunities that arise as a result of digital transformation. Moreover, while the likelihood of an overall drop in employment could be limited at the aggregate level, certain industries and regions may see net declines in the number of jobs available. As a result, policies must focus on facilitating labour mobility and responding to regional disparities (*OECD, 2019c*).

This creates a clear need to develop more granular indicators able to reflect variations in the impacts of digitalisation across different constituencies. Nevertheless, a more immediate prerequisite to that is the wider adoption and publication of existing indicators across countries for benchmarking and monitoring. The data that are available show that the path of digital transformation varies across G20 economies. The wider availability of key indicators will reinforce the foundation available for evidence-based policy, allowing policymakers to shape the future of work in the digital era for the better. The following sections present key available indicators offering complementary perspectives on jobs in the Digital Economy. The indicators have been selected to provide multiple complementary measures of the direct and indirect impacts of digitalisation on jobs. Moreover, they present data on the information industries (often described as “the core” of the Digital Economy”), as well as other perspectives on the Digital Economy more widely.

2.1. Indicators on the number of jobs in the Digital Economy

One approach to considering jobs in the Digital Economy looks at employment in the industries most implicated in the digital transformation. On average, Information Industries accounted for 2.8% of total employment in G20 countries in 2017, roughly the same as in 2010 (2.7%). IT and other information services has become the largest information industry in employment terms in two thirds of G20 countries, while in Korea, Russia, Mexico, China and Indonesia, Computer electronics and optical products manufacturing remains first (*G20, 2018*). Overall, the employment share of Information Industries was largely stable or slightly increasing between 2010 and 2017 in a majority of countries.

Looking at *digital-intensive sectors*, a much more expansive picture emerges. High and medium-high digital-intensive sectors account for 44% of jobs in G20 countries on average, and over half of jobs in the United States, Germany, the United Kingdom, France, and Canada. By contrast, the share is lower in China and India at around 25%, although both have experienced marked growth since 2010 alongside Mexico and Indonesia. In general, medium-high digital intensive sectors contribute the greater portion of these jobs.

Digital transformation has contributed to job creation across the G20. Between 2006 and 2016, total employment in the G20 grew by 13%, a net gain of almost 127 million jobs. While digital transformation may have contributed to the destruction of some jobs (*OECD, 2019b*), highly digital-intensive sectors contributed 43% or 55 million of these net job gains. This finding is in line with the theory that, in addition to direct job creation, investment in or use of ICTs should result in indirect job creation by contributing to rising productivity, lower prices and new products that lead to higher final demand and in turn employment (*OECD, 2016a*). In contrast to job creation in more digital-intensive sectors, job losses that took place over the same period in some countries tended to occur in sectors of low or medium digital-intensity.

Increased use of digital platforms has generated new forms of work that has emerged from the innovations in business models and work organisation enabled by technological developments. Among the fastest growing online platforms in recent years are markets in which individuals sell accommodation and transportation as homes and cars are among the most valuable and underused assets they owned.

It is likely that, participation in platform markets has grown significantly over the past decade (*OECD, 2016b*). Nevertheless, data sources are still under development in this area. In the European Union, 6% of individuals offered services on a platform at least once in 2018, with France reaching as many as 11% - though that is a decrease from 16% in 2016, following regulatory changes. Over the same period, the total share of people offering services over platforms increased in Italy and the United Kingdom. If upake were to accelerate, a large oversupply of jobseekers on online platforms may lead to a race to the bottom in terms of compensation and other working conditions (*Graham et al., 2017*).

Did you know?
Around one-in-four jobs in the G20 are in digital-intensive sectors and these sectors contributed 43% of new jobs between 2006 and 2017.

Definitions
Information industries combines the OECD definitions of the "ICT sector" and the "content and media sector" (*OECD, 2011*). While this definition includes detailed (three- and four-digit) ISIC Rev.4 industrial activities (United Nations, 2008), in this analysis it is approximated by the following ISIC Rev.4 (two-digit) Divisions, due to limited data availability: "Computer, electronic and optical products" (Division 26), "Publishing, audiovisual, and broadcasting activities" (58 to 60), "Telecommunications" (61), and "IT and other information services" (62 to 63).

Sectors were 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 (*Calvino et al., 2018*). Examples of high digital-intensity sectors include transport equipment, ICT services, finance and insurance, legal and accounting, R&D, advertising and marketing. Examples of medium-high digital-intensity sectors include ICT equipment and machinery, wholesale and retail, publishing, audiovisual. See **Appendix A** for more information.

Platform work encompasses a broad range of activities that use online platforms to connect the demand and supply of particular services. Services offered through digital labour platforms can be broadly distinguished as being performed digitally (i.e. clerical and data entry, translation or design services, etc.) or performed on location (i.e. transport, delivery, housekeeping, etc). (OECD, 2020).

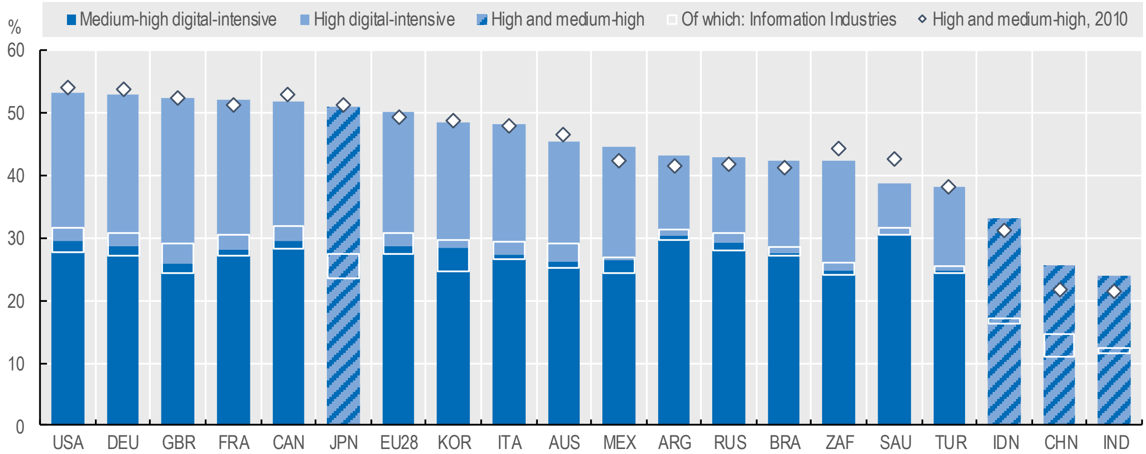
Measurement
Employment by occupation data are usually collected through Labour Force Surveys; these ask respondents to identify their occupation from a standardised list. Census data may also be of use. Data for the United States are based on the Current Population Survey.

Changes in employment levels can be "normalised" to highlight the relative contributions of sectors of different digital-intensities to employment gains / losses. The aggregate increase or decrease in employment in sectors of each digital-intensity is shown as a percentage of the total absolute change in employment in each country. Using a finer activity breakdown (e.g. two-digit Divisions) would produce different estimates for total gains and losses, though total net changes would remain the same.

Although comparable statistics are scarce, the statistical agencies of various countries have begun to ask questions on platform work in labour force surveys and ICT usage surveys. This chart presents data on the *Use of collaborative platforms* from the European Commission Flash Eurobarometer. Nevertheless, estimates vary widely, across countries and surveys. Tailored data collection methods should also be investigated.

2.1.1 Jobs in digital-intensive sectors and Information Industries, 2017

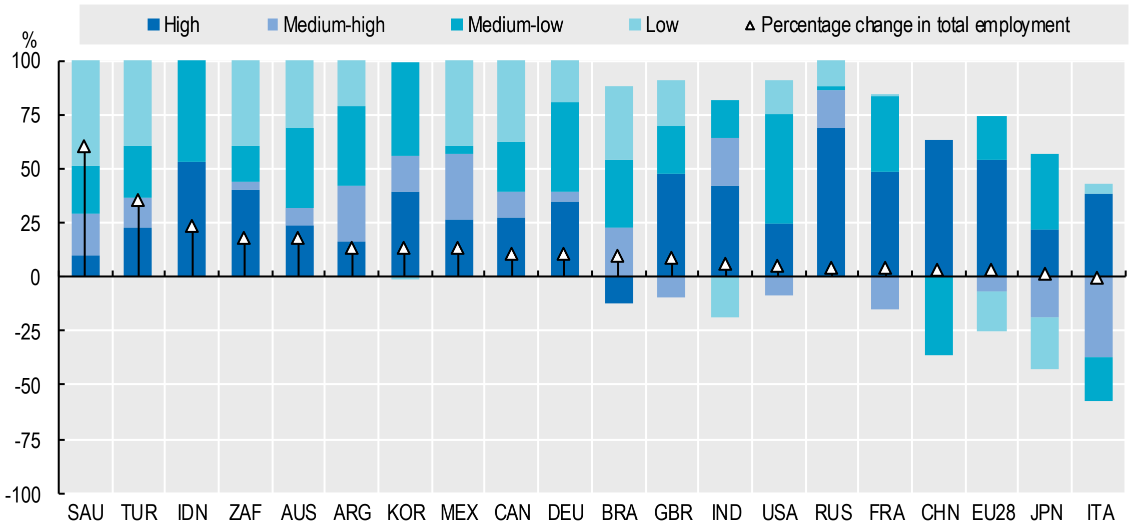
As a percentage of total employment



Source: OECD, STAN Database, http://oe.cd/stan, National Accounts Statistics and national sources, March 2020.

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

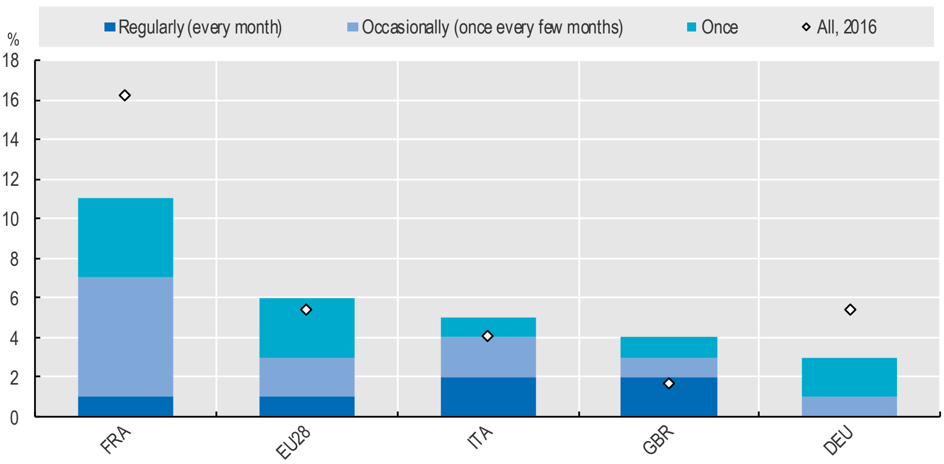
As a percentage of total absolute changes in employment



Source: OECD calculations based on STAN Database, http://oe.cd/stan, National Accounts Statistics, national sources and Inter-Country Input-Output Database, http://oe.cd/icio, March 2020.

2.1.3 Individuals who have offered services on a platform, 2018

As percentage of all individuals



Source: European Commission (2018), The use of collaborative platforms, Flash Eurobarometer, No. 467

2.2. Indicators on ICT-intensive jobs

Another perspective on jobs in the Digital Economy concerns the extent to which they increasingly involve ICT tasks. Several perspectives on this can be gained from Labour Force Survey data broken down according to the International Standard Classification of Occupations 2008 (ISCO-08).

ICT specialist occupations are among the most ICT task-intensive and have experienced buoyant supply and demand in recent years. In 2017, on average across G20 countries for which data were available, ICT specialists accounted for 3.5% of total employment.

While ICT specialists are most likely to work in the Information Industries (*OECD, 2019a*), broader ICT task-intensive occupations are pervasive across sectors. These jobs comprised 11.8% of total employment, in 2017, on average across the G20 countries for which data are available - up 1 percentage point since 2011. The United States and United Kingdom show particularly high shares of over 17%. The majority of these, over two-thirds on average, are non-ICT-specialist roles, providing one illustration of the wider digitalisation of jobs.

There are large differences between the numbers of men and women in these occupations. Examining the gender breakdown for the two main categories of ICT specialists - ICT professionals and ICT technicians, who comprise around 70% of ICT specialists on average (*G20 DETF, 2018*) - shows that while 2.8% of male workers in G20 countries are ICT professionals and technicians on average, this proportion is just 0.7% for women workers in 2018. Across all G20 countries for which data are available, the share of ICT professional and technician jobs in employment for women is less than half that of men. The greatest gender disparities in are seen in Germany and Brazil, where men are around five times more likely to be ICT professionals or technicians than are women. The Gender disparity in ICT specialist jobs is intrinsically linked to relative underrepresentation of women in the fields of study most likely to be relevant to such jobs (see indicator 3.4.2).

There has been some concern over potential imbalance between the demand for and the supply of ICT specialists in the labour market (*OECD, 2017*). According to data available for European countries, over half of firms in the EU that tried to recruit ICT specialists in 2018 reported difficulties doing so. Of those G20 countries for which data are available, this share reaches almost 70% in Germany, suggesting a considerable shortage of supply. In all cases the share of enterprises with difficulty recruiting ICT specialists has increased since 2012. Furthermore, these data cannot account for the number of ICT specialist vacancies offered by businesses, so offer only a partial view of recruitment challenges faced by firms.

Despite certain limitations, questions on hard to fill vacancies for ICT specialists have been well-tested in Europe and provide a model ready for adoption in other G20 countries. Such wider adoption would enable inclusion in a G20 set of indicators in the future.

Did you know?
In the USA and United Kingdom, almost one-in-five jobs are in ICT-intensive occupations.

Definitions
ICT specialists are individuals employed in tasks related to developing, maintaining and operating ICT systems and considered, where ICTs are the main part of their job. The operational definition applied here due to limitations in the degree of data detail available, corresponds to the following ISCO-08 occupations: Information and communications technology service managers (133), Electro technology engineers (215, Software and applications developers and analysts (251), Database and network professionals (252), Information and communications technology operations and user support (351), Telecommunications and broadcasting technicians (352), and Electronics and Telecommunications Installers and Repairers (742). See OECD and Eurostat (2015).

ICT task-intensive occupations have a high propensity to include a significant degree of ICT tasks at work ranging from simple use of the Internet, through use of word processing or spreadsheet software, to programming. They comprise, *in addition to the above*: Business services and administration managers (ISCO-08 occupation 121); Sales, Marketing and development managers (122); Professional services managers (134); Physical and earth science professionals (211); Architects, Planners, surveyors and designers (216); university and Higher education teachers (231); finance professionals (241); Administration professionals (242); Sales, marketing and public relations professionals (243); See Grundke et al., forthcoming.

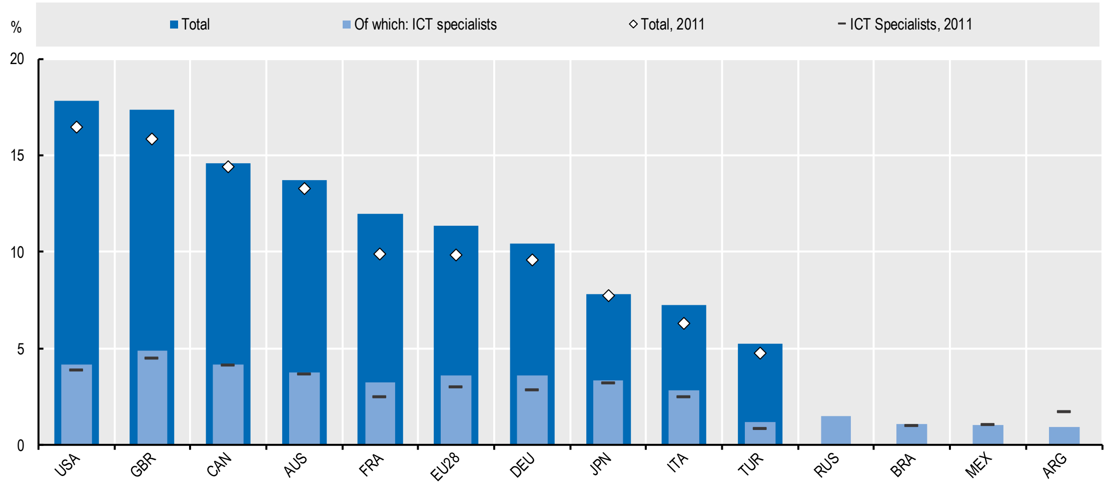
Measurement
Employment by occupation data are usually collected through Labour Force Surveys asking respondents to identify their occupation from a standardised list. Data for the United States are based on the Current Population Survey.

In this report, ICT specialists are estimated based on ISCO-O8 classes 25 (Information and Communications Technology Professionals) and 35 (Information and Communications Technicians) only as this simplification allows greater country coverage compared to taking all ICT Specialist occupations.

The ICT task intensity of jobs is assessed using exploratory factor analysis of responses to 11 items on the OECD Programme for International Assessment of Adult Competencies (PIAAC) survey, which relates to the performance of ICT tasks at work. See Grundke et al., 2017 for the detailed methodology.

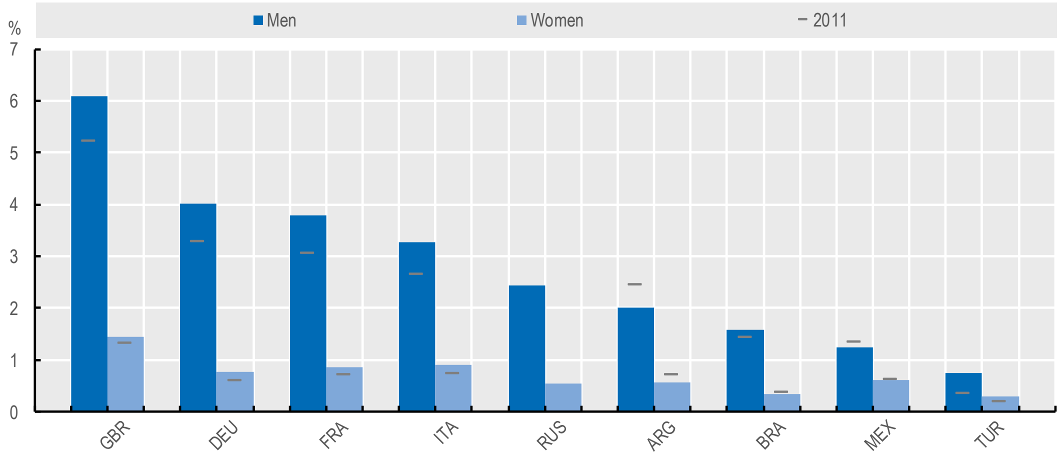
ICT usage in business surveys are used to ask responding firms if they recruited or tried to recruit one or more ICT specialists in the reporting year and, if so, whether the vacancies(s) were “difficult to fill”. There can be many reasons for difficulty to fill ICT specialist vacancies, only one of which is under-supply of people with such skills.

2.2.1 Jobs in ICT task-intensive and ICT-specialist occupations, 2017
As a percentage of total employment



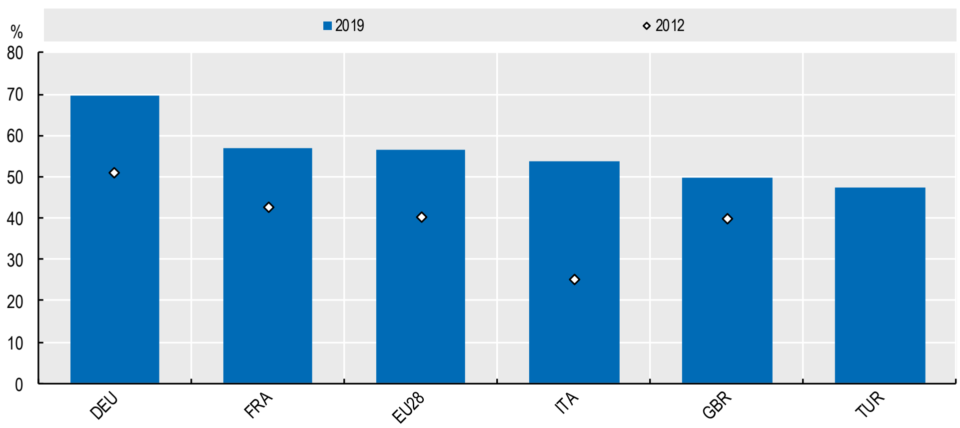
Note: ISCO 3-digit level data needed to calculate ICT Task-Intensive occupations unavailable for Argentina, Brazil, Mexico, and Russian Federation. For Japan the latest data refer to 2015, Canada to 2016, and Mexico to 2017. The 2011 data refer to 2012 for Brazil and 2013 for Mexico.
Source: European Labour Force Surveys, national labour force surveys and other national sources, March 2020

2.2.2 ICT professionals and technicians by gender, 2018
As a percentage of all male and female workers



Source: International Labour Organization (ILO) estimates based on Australian, European, Korean and South African labour force surveys, Census of Japan 2015, the United States Current Population Survey, alongside ILO data.

2.2.3 Enterprises that reported hard-to-fill vacancies for ICT specialists, 2019
As a percentage of enterprises advertising for ICT specialists



Note: For Germany, 2012 marker relates to 2014
Source: OECD, ICT Access and Usage by Businesses Database, http://oe.cd/bus, March 2020.

2.3. Indicators on the dynamics of job creation related to the Digital Economy

Greater integration in global value chains enabled by the "digital trade revolution" implies that foreign demand sustains an increasing share of domestic employment (*López González, J. and M. Jouanjean, 2017*). In 2015, just under a quarter of G20 countries jobs in Information Industries were sustained by foreign demand, a slight decrease (2.4 percentage points) from 2005. The role of foreign demand exceeded 60% in Mexico and 40% in India as well as Korea, which has a strong specialisation in the information sector. By contrast, comparatively low rates of foreign demand underpinned domestic employment in Canada, the United States, Saudi Arabia, and Brazil. Relatively similar patterns occur for the broader digital-intensive sectors, though there are large divergences in those more specialised in ICT manufacture and services (Mexico, India, Korea, China).

Digitalisation and the diffusion of information and communication technologies (ICTs) have also revolutionised the way in which firms and markets operate, with differences in business dynamism between digital-intensive and other sectors of the economy. Higher levels of business dynamism are associated with higher productivity. Examination of the average post-entry employment growth of new firms five years after entry shows that surviving entrants in highly digital-intensive sectors grow faster, on average, than those in other sectors of the economy. Although this is true for most countries, the magnitude of the difference varies. In Canada and Italy post-entry employment growth in highly digital-intensive sectors is 15% and 18% higher than other sectors.

The implications of digitalisation for jobs, are a key concern for workers, employers and governments. Digitalisation will create new jobs and forms of work, materially change others, and in some cases replace entire tasks and jobs. Identifying the tasks that are most likely to be substituted by technology – those involving basic exchange of information, buying and selling, and simple manual dexterity – and the workers performing them can help to design active and passive labour market policies. The OECD Survey of Adult Skills (PIAAC) collects detailed information on the tasks workers perform on the job and the skills needed. Using this, along with expert assessments (*Frey and Osborne, 2013*), each worker in the dataset can be assigned a probability of being impacted by digital technologies. Based on this approach, it is estimated that 14% of jobs in G20 countries with available data are likely to be automated in the coming 15-20 years. A further 34% of jobs are estimated to have a 50% to 70% probability of facing significant change as they perform several automatable tasks alongside tasks that are not currently automatable. Nevertheless, identifying and measuring the most relevant job tasks and skills is fraught with challenges and data gaps persist (US Bureau for Labour Statistics 2020).

The estimated likelihood of automation varies across G20 countries. Turkey (43%) and Japan (39%) have the greatest share of jobs exposed to significant change, in-line with the finding that industrial and manufacturing sectors are most affected by digital technologies (*Nedelkoska and Quintini, 2018*). The share of jobs with high likelihood of automation varies between 10% (United States and Korea) and 18% (Germany).

Did you know?
In the G20, over one-in-five of jobs in digital-intensive sectors are sustained by foreign, rather than domestic, demand.

Definitions
Employment in Information Industries sustained by foreign demand estimates the share of employment that is used in production by these industries to meet foreign final demand. This indicator can reveal the extent to which a country's workforce depends on its integration into the global economy.

Information industries combines the OECD definitions of the "ICT sector" and the "content and media sector" (*OECD, 2011*). While this definition includes detailed (three- and four-digit) ISIC Rev.4 industrial activities (United Nations, 2008), in this analysis it is approximated by the following ISIC Rev.4 (two-digit) Divisions, due to limited data availability: "Computer, electronic and optical products" (Division 26), "Publishing, audiovisual, and broadcasting activities" (58 to 60), "Telecommunications" (61), and "IT and other information services" (62 to 63).*Business dynamism* was proxied using post-entry employment growth or the ratio between total employment at t+5 over total employment at time t (the period at which the market is entered) of surviving entrants.

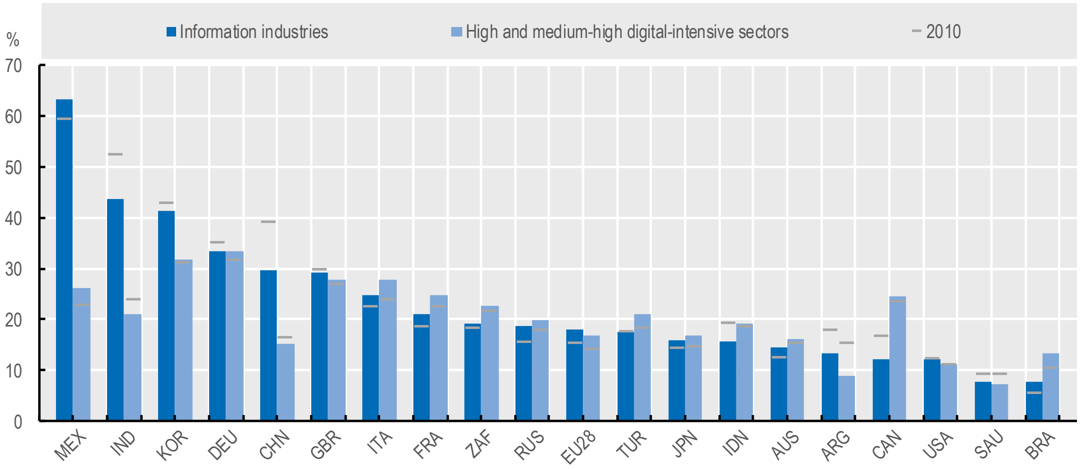
Highly digital-intensive sectors are those in the upper ("high") quartile of the distribution by digital intensity. They consist of Computer and electronics; Machinery and equipment; Transport equipment; Telecommunications; IT; Legal and accounting; Scientific R&D; Marketing and other business services; and Administrative and support services. See Calvino et al. (2018), Table 3.

Measurement
Business dynamism was calculated using data collected for the OECD DynEmp project, which uses common statistical code developed by the OECD, and is run in a decentralised manner by national experts from statistical agencies, academia, ministries or other public institutions, who have access to national micro-level data.

The figure reports unweighted average post-entry employment growth across sectors and available years for the period 1998-2015 in the "Highly digital-intensive" and "All sectors" groups using "transition matrices" or yearly flow data from the OECD DynEmp3 database. The "transition matrices" summarise growth trajectories of cohorts of units from year t to year t + j. The analysis focuses on cohorts of entrants followed for five years (with t = 1998, 2001, 2004, 2007, 2010 and j = 5). Figures are based on manufacturing and non-financial market services, with the exception of Japan where only manufacturing data are available. Self-employment and the Coke and Real estate sectors are excluded from the analysis. A detailed coverage table is available in Calvino and Criscuolo (2019).

2.3.1 Jobs in Information Industries and digital-intensive sectors sustained by foreign final demand, 2015

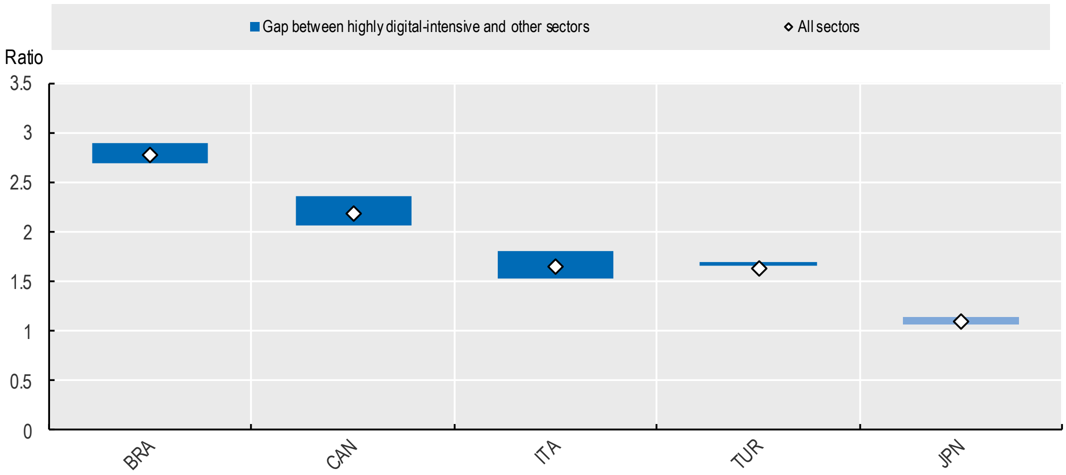
As a percentage of employment in Information Industries or digital-intensive sectors



Note: EU28 reflects demand coming from *outside* the EU (i.e. the EU is treated as a single market).
Source: OECD, Trade in Employment Database, http://oe.cd/io-emp, March 2020.

2.3.2 Business dynamism, average post-entry employment growth, 1998-2015

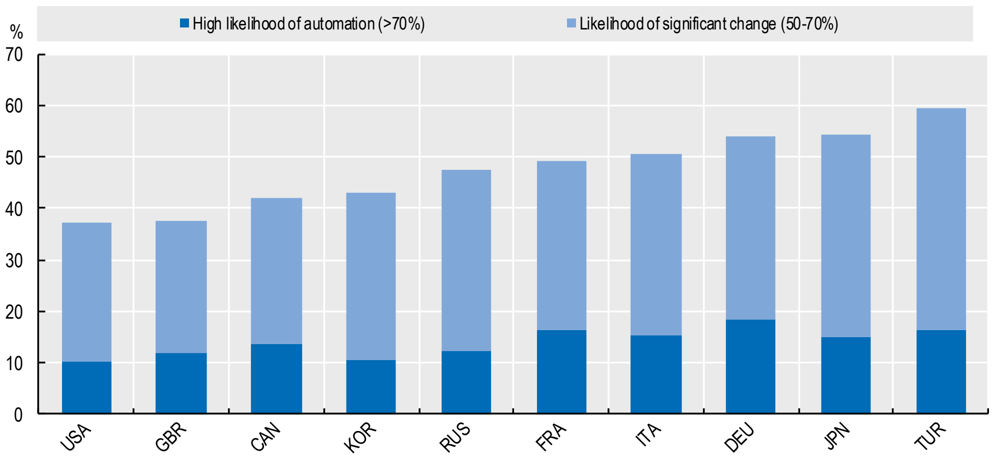
Highly digital-intensive and all sectors



Source: OECD calculations based on DynEmp3 Database, http://oe.cd/dynemp, January 2019.
Notes : Data for Japan are for manufacturing only.

2.3.3 Likelihood of automation or significant change to jobs, 2012 or 2015

As a percentage of all jobs



Source: Nedelkoska, L. and G. Quintini (2018), "Automation, Skill Use and Training", OECD Social, Employment and Migration Working Papers, No. 202, OECD Publishing, OECD Publishing, Paris, https://doi.org/10.1787/2e2f4eea-en.

2.4. Proposed indicators for monitoring purposes

Sections 2.1-3 have presented a variety of indicators offering complementary perspectives on jobs in the Digital Economy. However, their coverage of G20 countries varies due to the availability of underlying data and several that offer useful insights are clearly not yet ready for inclusion in a suite of benchmarking indicators (see **Section 2.5**).

With a view to balancing the considerations set out in section 1, the following indicators are proposed for adoption by the DETF:

2.1.1 Jobs in digital-intensive industries and Information Industries, as a percentage of total employment
2.2.1 Jobs in ICT task-intensive and ICT-specialist occupations, as a percentage of total employment
2.2.2 ICT professionals and technicians by gender, as a percentage of all male and female workers

These indicators help policymakers understand where jobs related to the Digital Economy sit within the broader economy and to identify relevant policy interventions (e.g. to support industries' digitalisation or to identify which sectors' skills needs should be prioritised. Where possible, these could be disaggregated by gender and age group to better inform policy analysis.

In general, these offer good coverage of G20 countries, although this is less true for 2.2.1 and 2.2.2. However, the occupation-based data that these present come from Labour Force Surveys. Such surveys are implemented in almost all G20 countries so the main barrier to greater coverage is less one of data collection and more about the availability of the necessary aggregations. In particular, the public availability of data mapped to 3-digit ISCO (international standard classification of occupations) classes could considerably extend the coverage of indicator 2.2.1.

2.5. Further key areas for development

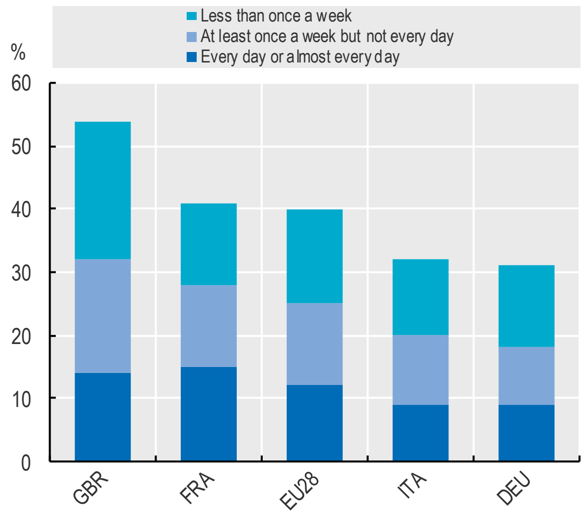
In several of the key areas for development highlighted – namely individuals offering services on online platforms and enterprises with hard-to-fill ICT specialist vacancies – previous efforts undertaken in some G20 countries provide a model for wider adoption and development. Existing survey vehicles, including Labour Force Surveys and surveys of ICT usage in households and businesses can be used creatively to examine important developments in the Digital Economy.

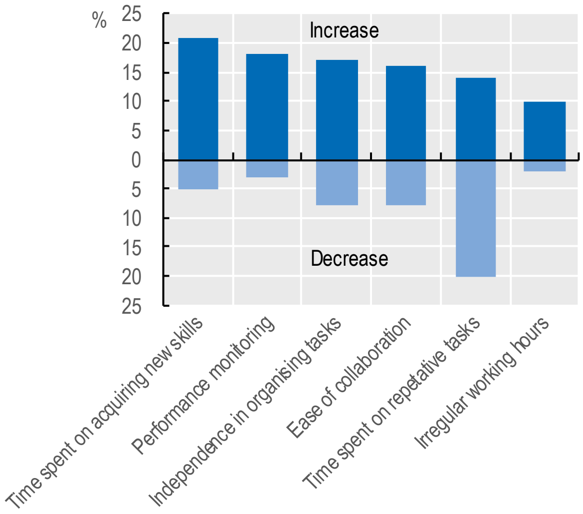
Figures 2.6.1 and 2.6.2 provide further illustration of the creative use of household and individuals' ICT usage surveys to better understand how digital technologies are impacting specific aspects of work. G20 countries are encouraged to pursue coordinated efforts to develop indicators in these areas for eventual inclusion into the G20 suite of indicators for benchmarking and monitoring the Digital Economy. These indicators are available from specific localised implementations of ICT usage surveys. The development of guidelines and specifications for general application of these surveys is one practical step that would aid wider adoption across countries.

2.5.1 Individuals teleworking from home in the last 12 months

2.5.2 Perceived impacts of digital technologies on specific aspects of work, Germany

Percentage of individuals who, at work, use any type of computers, portable devices, computerised equipment or machinery, 2018





Source: OCED based on Eurostat, Digital Economy and Society Statistics, March 2020.

3. Skills in the Digital Economy

The digital transformation creates two major challenges for national skills development systems. First, despite growing awareness that the skills profile of citizens and workers in the future will be very different from that of the past, identifying essential skills with certainty is difficult due to rapid technological change (OECD, 2019a and c). As boundaries between disciplines fade away, the task content of occupations changes and the skills bundles required by new tasks are transformed. This is still under-reflected by current skills statistics. Once essential skills for the digital future have been identified, the second challenge is to ensure that skills development systems adjust sufficiently fast to match the demand for new skills (*OECD, 2019a*). As such, the development of common indicators for skills in the digital era is key to addressing both challenges and designing policies that enable workers to develop skills to both adapt to changes within occupations and navigate between occupations.

Digital transformation is creating demand for new skills along two main lines. Firstly, the production of ICT products such as software, webpages, e-commerce, cloud-based computing, and big data analytics requires ICT specialist skills to program, develop applications and manage networks. Second, workers across a wide-range of occupations need to acquire generic ICT skills to be able to use such technologies in their daily work (e.g. access information online, use software, etc.). Excess demand for ICT-skills is starting to be reflected in wages: all things being equal (including education and other workers' skills), the higher the ICT task intensity of a job, the higher the hourly wage earned (*OECD, 2019a*). This statement should however be nuanced by the fact that the Digital Economy has simultaneously led to the emergence of new categories of relatively low-skilled jobs such as those undertaking data cleaning and labelling that do not require specialist or generic ICT skills.

These skills tend to be insufficiently supplied in most G20 economies. The share of businesses overall having difficulties with filling ICT specialist roles has increased in G20 economies while 11% of workers in the European Union report needing further training to cope with the ICT-related demands of their job. In this respect, getting a clear picture of skills needs and employee skill gaps is crucial. Current skills statistics, however, do not seem sufficient to address the scope and pace of such changes. The majority are based on educational attainments acquired in formal education, vocational training with standardised content, or occupational classifications with codified and predictable tasks (*OECD, 2019a*). This issue is partly addressed by the *OECD's Programme for the International Assessment of Adult Competencies* (PIAAC), which measures adults' proficiency in several key information-processing skills of literacy, numeracy and problem solving in technology-rich environments. In similar manner, Eurostat's *Digital Skills Indicator* (DSI) provides a measure of individuals' levels of digital skills (no skills, low, basic, above basic skills), based on a large number of activities related to the Internet, computer or mobile device use, and software-related activities. The DSI[7] is thus a composite indicator (shown for the G20 in Figure 2.1.2), broken down into information skills, communication skills, problem solving and software skills for content editing, reflecting four competence areas of DigComp 2.0 (The Digital Competence Framework for Citizens[8]).

Beyond ICT-related skills, digitalisation also increases the need for complementary cognitive skills in response to jobs' task-content evolving. There are large complementarities between technology and workers' general skillsets. The first is that digital technology diffusion in work environments reduces the time spent on "routine tasks" for which ICT can increasingly substitute workers, leading to a heightened use of management and communication skills, accountancy and selling skills and advanced numerical skills. As a result, workers need stronger general cognitive skills (*OECD, 2019d*). A second is that, by facilitating the execution of tasks like reading and writing emails or using a computer for numeracy tasks, technology can accelerate workers' skill development in these areas (*OECD, 2019d).* Finally, adapting to and gaining from workplace digitalisation requires an ability to learn new things, as workers perform more diverse tasks and ICT are particularly subject to obsolescence due to rapid changes both in hardware (smartphones, tablets) and software. "Readiness to learn" is thus becoming crucial aptitude in digital work environments (*OECD, 2019b*). To provide holistic insights, measures of skills for the digital age therefore need to address a broad set of complementary skills and attributes – such as interpersonal skills and general cognitive abilities – alongside more straightforward measures of ICT skills.

[7] Note that The DSI methodology is currently undergoing a revision and its implementation is planned for the survey year 2021 (with data available at the end of 2021). The improved DSI will additionally include the fifth dimension of the DigComp 2.0 – safety skills, which has not been included in the DSI until now. The revision of the DSI includes also an overall improvement of questions aimed at better and more complete reflecting the DigComp 2.0. The coming revision of the DSI will more closely reflect the DigComp 2.0, but will cause a break in time series, compared to the current methodology. The current methodology has been used since 2015, with data available for 2015-2017 and 2019. From 2021 onwards, the revised DSI will be available on annual or biennial basis.

[8] https://ec.europa.eu/jrc/en/digcomp/digital-competence-framework

However, workers who are most exposed to displacement by technologies also receive less training, on average. Indeed, despite high returns on training the low-skilled, firms tend to provide more training to high-skilled workers (*OECD, 2019b*). This calls for targeted labour market programmes to support displaced workers and design effective income support schemes to provide income security without undermining work incentives. In addition to targeted measures for the groups most at risk (older workers, specific industry workers), universal schemes should be envisaged to ensure that workers whose employers do not have sufficient incentive or capacity to provide them with training, benefit from the necessary skill development opportunities. This is one respect in which, online platforms require particular attention. While they may give workers opportunities to find jobs they would otherwise not have had, they also tend to provide less employer-sponsored training (*OECD, 2017*). As such, platform workers' mobility and ability to navigate the labour market is particularly important to avoid transition into unemployment, and policies should ensure that they benefit from equal training opportunities (*OECD, 2019d*). To facilitate policy development, measures on the availability of, and access to, forms of non-employer based training such as online courses and materials would be beneficial.

Even outside the workplace, skills determine the well-being that individuals are able to derive from the use of digital technologies. Firstly, individuals who would benefit greatly from online networks (e.g. the elderly with reduced mobility) are also less likely to have the skills needed to access and use them. Second, lacking basic literacy and numeracy skills is a barrier to performing activities online while the absence of basic problem-solving skills can prevent individuals from engaging in diversified and complex activities (*OECD, 2019d*). More generally, the digitalisation of economies requires people to be well-rounded, or relatively proficient in many cognitive, social and emotional skills, which have to be adequately provided and monitored by governments.

As a result, skills play a key role in the emergence and evolution of digital divides. Digital divides are evolving from a divide in Internet access to a divide in how individuals use the Internet and benefit from their online activities (*OECD, 2019d*). Indeed, when compared with all other reasons reported by households to explain why they have no Internet connection (including access and equipment costs, privacy concerns, access elsewhere), lack of skills has experienced the most sizeable rise since 2010 on average across European countries (*European Commission, 2018*). Inclusive and long-term growth relies on ensuring that key groups such as women, lower-income households, and the youth are also positioned to benefit from the ongoing development of the Digital Economy. Developing sources and indicators that deliver insights on these is therefore a key foundation for policy design.

Adult learning systems that allow adults to maintain and upgrade their skills throughout their career are essential to harness the benefits of digital transformation. Most of the occupations at high risk of automation have a majority of workers with at most a post-secondary non-tertiary degree. However, raising educational attainment and enrolling more people in tertiary education would be costly and not necessarily a good solution as having a tertiary degree does not guarantee having the required skills (*OECD, 2019d*). Therefore, targeted and accessible life-long training opportunities will be needed to facilitate labour mobility. To remain efficient, adult learning provision will also have to diversify away from the traditional model of employer-provided training, to leverage the development of flexible education and training programmes, the use of open education and massive open online courses (MOOCs), and the adoption of working organisation practices that favour co-operation. With regard to measurement, this implies a strong need for indicators that go beyond school and academic qualifications to track the development of digital and complementary skills throughout peoples' careers. Governments can also play a central role in helping workers and employers to adapt to changes driven by digitalisation. In 2017, G20 governments spent almost 0.3% of GDP[9] on active labour market policies, on average. In addition, primary and secondary education is increasingly seen as a key vector for diffusing relevant skills as the use of technology in the classroom can help develop digital and complementary skills people will need in the digitalised economy (*OECD, 2019a*). Closing the skill gap is also a prerequisite for other elements of the digital policy agenda to succeed. In particular, if governments are to leverage digital technologies to deliver efficient, user-centred services, the technologies they rely on will have to be accessible to all citizens (*OECD, 2019b*).

Overall, individuals' capacity to make the most of digital technologies in their everyday lives and at work is likely to be shaped by a range of skills that cannot be measured with existing methods (*OECD, 2019d)*. At the same time, assessing skill shortages and needs is prerequisite to estimating the cost of meeting training needs. Consequently, measures that help us understand the many facets of skills barriers will be a vital foundation for policy action in various areas. In particular, establishing common categories and standardised levels for digital skills across G20 countries is a priority for improving measurement and monitoring.

[9] Using data from the *OECD Employment and Labour Market Statistics Database*, for the following G20 countries: Australia, Canada, France, Germany, Italy, Japan, Korea, Mexico, United Kingdom, United States of America.

3.1. Indicators on individuals' ICT and complementary skills

ICT skills are a key determinant of the ability to make effective use of digital technologies and progressively reduce the digital divide in usage. Directly measuring ICT-specific skills is challenging and hence researchers and policymakers must often rely on proxy indicators that look at the tasks people report performing to infer skills and capabilities. Individuals with ICT skills is one relevant indicator, also used to monitor SDG Target 4.4[10]. Indicator 3.1.1 presents selected ICT tasks from the ITU database. These range from the relatively basic task of copying or moving files or folders, through more demanding tasks of finding, downloading, installing and configuring software and the use of presentation software, through to writing a computer program using a specialised programming language – generally regarded as the most advanced task routinely covered by ICT usage surveys.

Programming skills are becoming a key competence for prospering in the Digital Economy. In 2018, on average 6% of respondents in the G20 countries available had used programming skills. The gender gap is stark; with nearly twice as many men than women typically using programming skills in G20 countries. Women also tend to report relatively lower performance than men of other ICT tasks across all G20 countries, including less advanced tasks. Such skills differentials limit the ability of some groups to engage with and shape the development of digital technologies. This can risk biases being coded into technologies such as artificial intelligence.

The Eurostat Digital Skills Indicator (DSI) takes these and a wide range of additional skills-revealing ICT tasks as well as complementary skills (e.g. problem-solving) and classifies them into levels in order to identify the share of people with different degrees of digital skills. One finding from this is that, in all G20 countries for which the DSI is available, the share of individuals with higher than basic digital skills is smaller than the average across the EU28.

With digital technologies supporting workers on varied tasks, complementary cognitive skills are also important. The PIAAC assessment of problem solving in technology rich environments refers to specific types of problems that individuals deal with when using ICTs at work. It contains three levels, of which 2 and 3 represent the most sophisticated tasks. Across all G20 countries for which data are available, only 29% of 16-65 year olds performed to these levels in the skills assessment, with the majority at level two, rather than at level three (which indicates the highest degree of proficiency). The data also indicate a significant age gap in problem solving aptitudes in technology rich environments: while on average 42% of 16-25 years olds achieve level two or three in the assessment, only 11% aged 55-65 do so on average. This age gap is particularly strong in Korea, Japan, Germany, and the Russian Federation. As such, lifelong training is one crucial way to up-skill individuals to meet their digital skills needs.

Did you know?

Fewer than one-in-ten adults have advanced digital skills such as computer programming in G20 countries.

Definitions

Problem solving in technology-rich environments refers to the ability to use digital technologies, communication tools and networks to acquire and evaluate information, communicate with others and perform practical tasks. The assessment focuses on the abilities needed to solve problems for personal, work and civic purposes by setting appropriate goals and plans, as well as accessing and making use of information through computers and computer networks.

Measurement

The indicator on individuals' ICT skills is collected through household ICT surveys, where individuals are asked whether they have undertaken various computer-related activities in the recall period (usually the last three months). These activities include using copy and paste tools, sending messages (e.g. e-mail, SMS) with attached files as well as more complex tasks such as programming.

The Eurostat Digital Skills Indicator (DSI) analyses information collected through the Community Survey on ICT usage in households and by individuals on tasks performed during the three months prior to survey by Internet users. These cover four main "domains" of digital skills: information, communication, problem solving, and software skills for content manipulation. For each domain, a set of activities is selected to reflect the competences covered by the domain, with the purpose of discriminating between people having, or missing, basic or above basic skills. For instance, activities testing user competence in the "information" domain include "copying or moving files or folders" and "saving files on Internet storage space", while activities testing user competence in the "problem solving" domain include "transferring files between computers / other devices", "installing software and applications (apps)" or "Internet banking".

Based on the number of activities performed by each individual, three levels of skills ("none", "basic" and "above basic") are computed for each domain. Based on the levels of skills in each domain an overall composite indicator with four levels of digital skills ("none", "low", "basic" and "above basic") is computed for each individual.

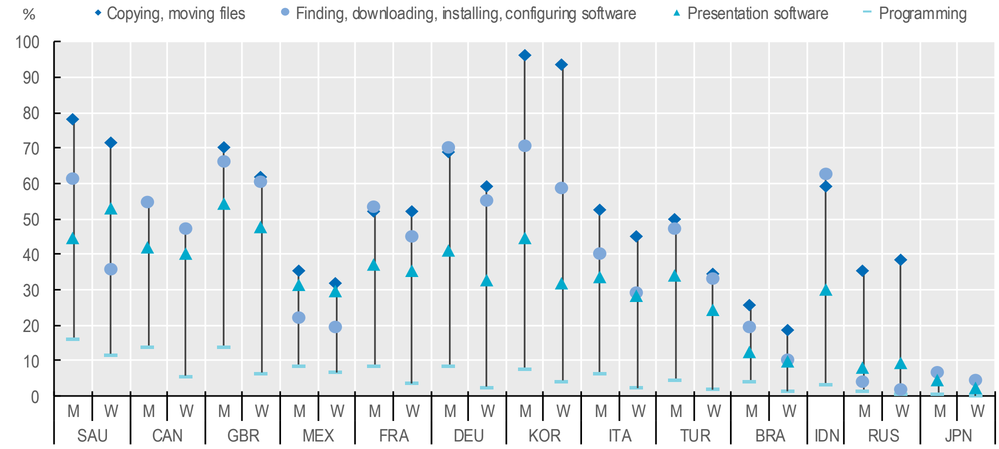
Problem solving in technology-rich environments is based on a subset of PIAAC countries, as France, Italy and Spain did not participate in the relevant assessment tests.

While these indicators provide a good basis for measuring skills relevant in the Digital Economy, DETF participants have stressed the necessity to define, agree on, and adopt standardised skill levels and categories to draw clear comparisons across the G20.

[10] By 2030, substantially increase the number of youth and adults who have relevant skills, including technical and vocational skills, for employment, decent jobs and entrepreneurship.

3.1.1 Selected ICT skills, by gender, 2018

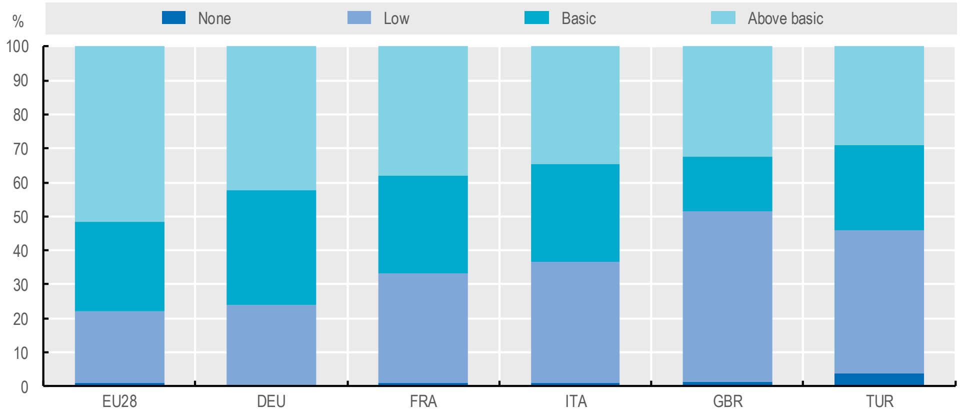
As a percentage of individuals; M = men, W = women



Notes: Germany and Turkey relate to 2019 rather than 2018. France, Indonesia, and United Kingdom to 2017, Italy to 2016. For France, the gender breakdown for copying and moving files is unavailable so the overall share is used and other series are sourced from the OECD database which may use slightly different definitions. Data for Canada, as well as Turkey software downloads also from OECD. Population in scope varies by country: age 5+ for Indonesia; 6+ for Italy, Japan and Mexico; age 10+ for Brazil and Germany; 10-74 years for Saudi Arabia; 15-72 years for Russian Federation and 16-74 years for France, Korea, Turkey and United Kingdom.
Source: ITU World Telecommunication/ICT Indicators database and OECD ICT Access and Usage by individuals database, March 2020

3.1.2 Eurostat Digital Skills Indicator, 2019

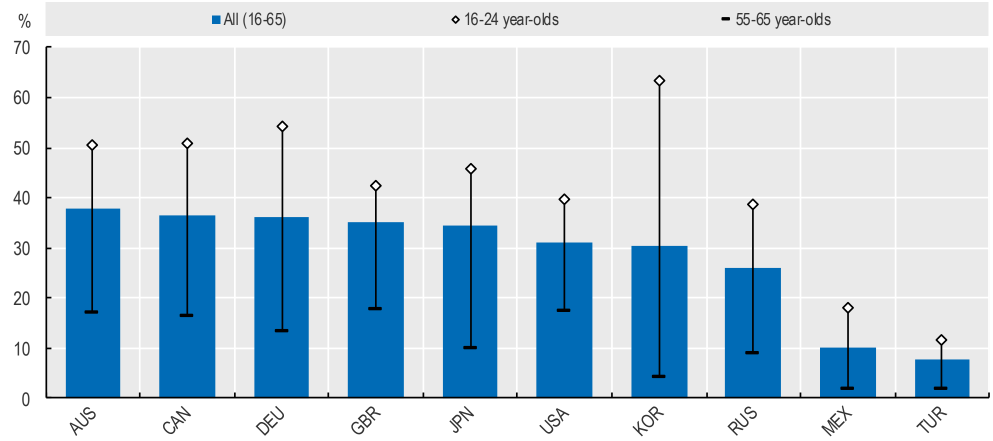
As a percentage of all individuals



Source: OECD based on Eurostat Digital Skills Indicator

3.1.3 Proficiency in problem solving in technology-rich environments, by age, 2012/2015/2017

Percentage scoring at levels 2 and 3 in each age group



Note: Data year varies depending on which round of PIAAC each country participated in. Data relate to the following years: 2017 – United States. 2012 - Australia, Canada, Germany, Italy, Japan, Korea, the Russian Federation (excluding Moscow), the United Kingdom (England and Northern Ireland). Data for other countries refer to 2015.
Source: OECD calculations based on Survey of Adult Skills (PIAAC) Database, September 2018

3.2. Indicators on digital technologies at work

Information and communication technologies (ICTs) are changing jobs and the workforce. Roles differ in their ICT task intensity – the frequency with which ICT tasks are undertaken – with jobs in occupations such as software, finance, sales and marketing generally more ICT task intensive, while those in areas such as accommodation and food, and health and social work tend to have relatively lower ICT task intensity.

On average, women tend to have more ICT-intensive jobs (50%) than men (48.5%) in the G20 countries for which data are available. Only in Japan and Korea do men have more ICT-intensive tasks on average. The average ICT task intensity of jobs held by women ranges from around 40% in Turkey and the Russian Federation to nearly 60% in Australia. A possible explanation for this result is that, while men make up the majority of ICT professionals and technicians with ICT-specific skills, women tend to be more represented in services jobs such as administrative functions, marketing or communication, all requiring extensive usage of ICT.

In terms of computer-based tasks performed at work, "exchanging e-mails or entering data into databases" is the most common" activity - undertaken at least once a week by over 80% of people who use computers or computerised equipment at work in the G20 countries for which data are available. Creating or editing electronic documents is also commonplace, with over 60% of workers typically performing these tasks. Development or maintenance of IT systems or software - a task relevant to relatively fewer jobs - was most performed in the UK (16%) and least in France (9%).

On average, 29% of workers in the available G20 countries used online applications to receive tasks or instructions for work, at least once a week. This includes those finding work through online platforms, as well as a wide range of situations such as workers in e-commerce fulfilment centres or hospital staff who receive instructions via apps on smart devices (e.g. the location of a product in a warehouse or of a patient in a hospital).

Self-assessments can offer one perspective on the extent to which workers' skills match the ICT-related tasks needed for their work, and their training needs. In 2018, about 63% of workers using computers or computerised equipment at work in the available G20 countries reported that their skills corresponded well to ICT-related aspects of their work duties. Meanwhile, 13% reported needing further training to cope with the ICT-related demands of their job, with the greatest needs registered in France and Italy (17%). This is lower than the share whose ICT skills may be under-utilised: on average 25% declared that their digital skills exceed the requirements of their jobs, raising questions on the optimal use of skills.

In the same year, 40% of workers in the available G20 countries reported having to learn to use new software or equipment at work, of which 12% needed training. As such, the proliferation digital technologies in the workplace is resulting in more time being spent on learning new tools and acquiring new skills.

Did you know?
Jobs held by women are generally more ICT task-intensive than those of men in G20 economies.

Definitions
The ICT task intensity of a person's job describes the frequency with which they undertake ICT tasks at work. The ICT tasks considered relate to the frequency of: using word processing and spreadsheet software; using programming language; making transactions via the Internet (banking, selling/buying); using e-mails and the Internet; using ICT for real-time discussions; reading and composing letters, emails and, memos; and use of computers on the job. See Grundke et al., (2017).

Computers and computerised equipment include computers, laptops, smartphones, tablets, other portable devices, and other computerised equipment or machinery such as those used in production lines, transportation or other services.

Digital skills (mis)match at work is based on self-declarations regarding individuals' skills relating to the use of computers, software or applications at work. Responses relate to the main paid job in cases of multiple employment.

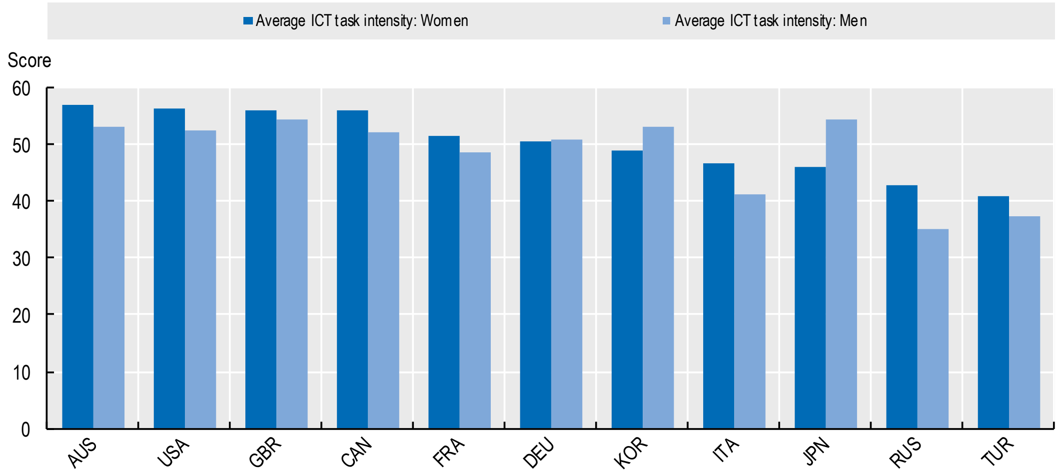
Measurement
The ICT task intensity of jobs is assessed using exploratory factor analysis of responses to 11 items on the OECD Programme for International Assessment of Adult Competencies (PIAAC) survey relating to the performance of ICT tasks at work. The detailed methodology can be found in Grundke et al. (2017). Compared to earlier studies, this approach helps to distinguish between the tasks that workers perform on the job and the skills with which they are endowed.

The 2018 European Community survey on ICT usage in households and by individuals contained a special module of questions on ICT usage at work. This provides information on various dimensions related to the use of ICTs for working activities including the types of ICT-related activities undertaken regularly and some elements on digital skills including a question on how well respondents' skills relating to the use of computers, software, or applications at work match their duties (digital skills (mis)match).

It is important to develop separate indicators on both workers' digital skills and digital skills in the population at large. While the former relate to productivity trends and labour market dynamics, the latter should inform broader social and education policy to ensure an inclusive Digital Economy.

3.2.1 ICT task intensity of jobs, by gender, 2012 or 2015

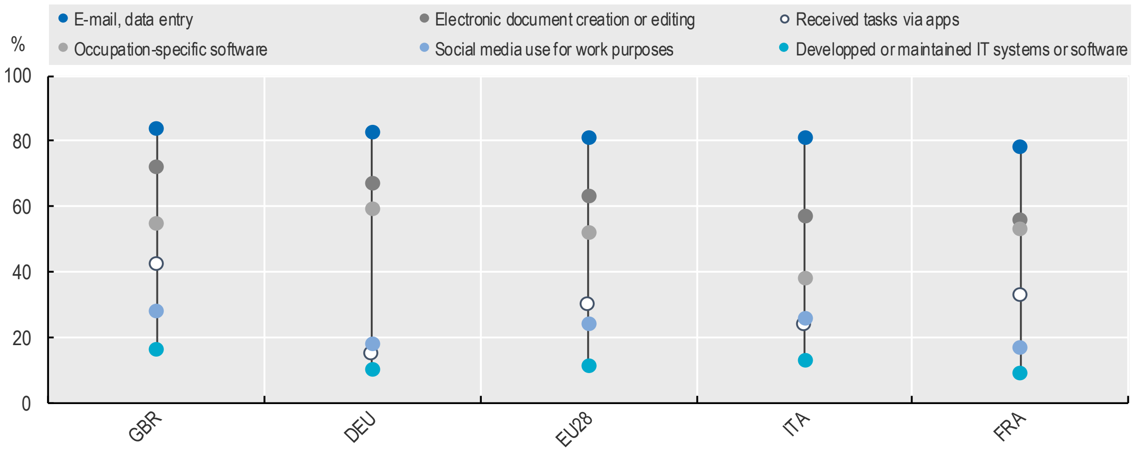
Average scores



Notes: Data relate to the following years: 2012 - Australia, ,Canada, France, Germany, Ireland, Italy, Japan, Korea, the Russian Federation (excluding Moscow), the United Kingdom (England and Northern Ireland) and the United States ; 2015 - Turkey.
Source: OECD calculations based on the OECD Survey of Adult Skills (PIAAC) Database, October 2018.

3.2.2 Computer-based tasks performed by individuals at work at least once per week, 2018

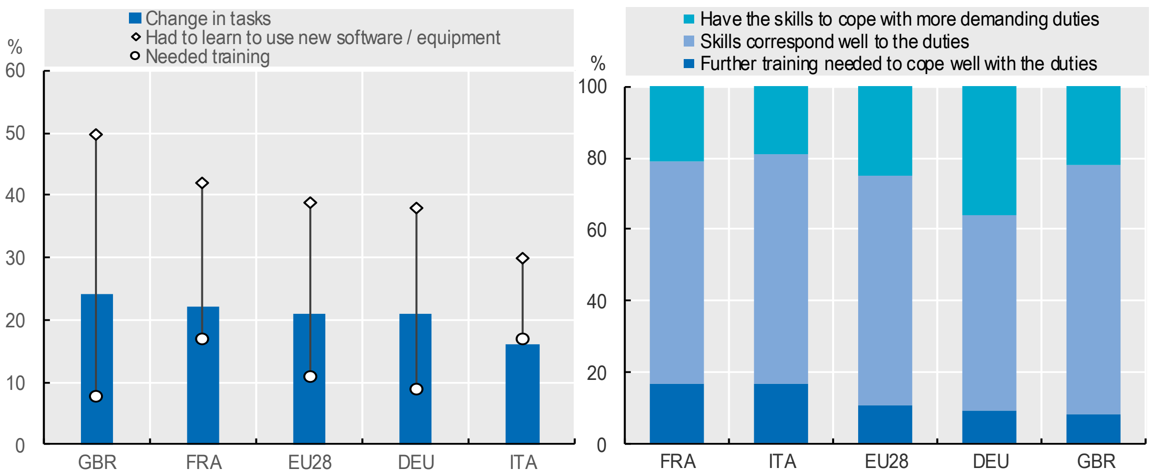
As a percentage of individuals who use computers or computerised equipment at work



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

3.2.3 Impacts of new software and computerised equipment at work, 2018 (left panel) and digital skills mismatch at work, 2018 (right panel)

As a percentage of individuals who use computers or computerised equipment at work



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

3.3. Indicators on the digital skills pipeline

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 use of digital technologies appear to depend on whether digital tools are used as substitutes or complements to traditional education. At school, computer-assisted instruction appears to have more positive effects on students' educational outcomes when supplemented with additional instruction and with investment in teacher skills (*OECD, 2019b*).

Students access to and usage of computers and digital technology has increased markedly between 2012 and 2018 in many G20 countries – especially in Russia, Korea, Italy, Japan, Mexico and Turkey. The use of tablet computers, as an alternative or complement to desktops and laptops, is much less common but has increased especially strongly over the period.

Other data available from the OECD PISA show that, overall, more students use digital technologies in the home than in school. However, this is partly driven by widespread use of mobile phones, which are less practical for advanced activities such as programming or using design software. As such, the growing use of computers in the learning environment, suggests that students are increasingly likely to be acquiring digital skills through systematic learning.

The PISA also asks students to provide a self-assessment of ICT capabilities such as choosing and installing software, problem solving, and ability to use unfamiliar devices. In most countries, more than half of students agree or strongly agree that they have these skills. In general, the greatest share of students choose their own applications but a lower share install their own software.- a skill that tends to be among the lowest reported, alongside comfort with using unfamiliar devices. On the whole, female students tend to report lower capabilities than do male students, with the most marked overal gender differences seen in Germany and the United Kingdom. Meanwhile, in Japan especially low shares of female students report being able to fix problems with their devices or comfort with using unfamiliar devices.

Beyond school, lifelong learning is one crucial way to up-skill individuals to meet their personal and professional digital skills needs. ICT usage surveys can investigate the incidence of skills-augmenting activities such as home or work-based training. With the widespread use of digital technologies, alternative training channels such as massive open online courses (MOOCs) have become popular, especially among younger people. On average, in 2018 11% of Internet users in the EU undertook free online training courses or self-studied to improve their skills related to the use of computers, software or applications. The most common channel is on-the-job learning (13%) while employers also often pay for or provide more formal training 9%.

Did you know?
Schools are an important place for the development of digital skills. Student use of computers and the Internet in school varies markedly in G20 countries, from around 50% in Brazil and Turkey to 90% in Australia, the United Kingdom, and the United States.

Definitions
Computer use in school comprises students who reported using one or more of: desktop, laptop, Internet connected school computer.
Tablet use in school comprises students who reported using tablet computers such as iPad® or BlackBerry® PlayBook™ in school.
Internet connection use in school comprises students who reported using either or both of: Internet connected school computers, Internet connection via wireless network.

On-the-job training comprises informal learning activities undertaken at work, often with input from other individuals such as co-workers or supervisors.

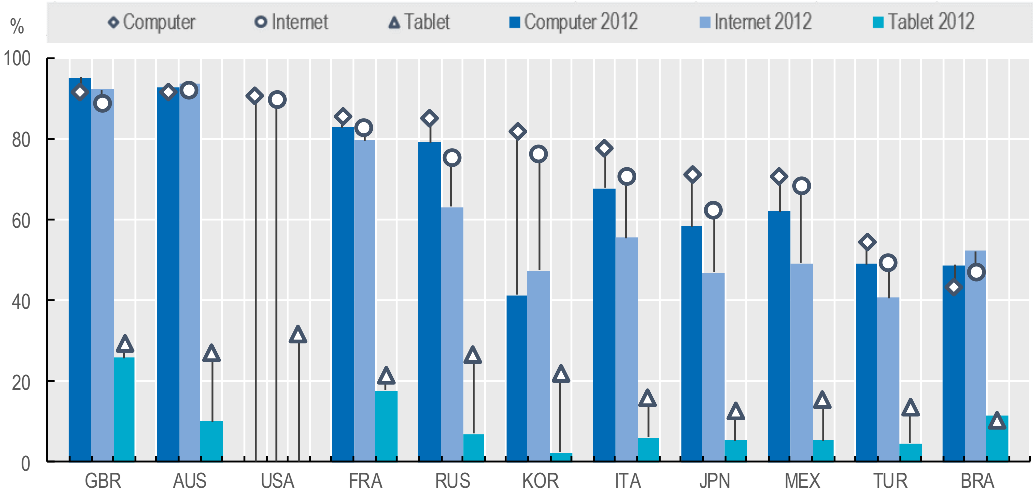
Measurement
Students' ICT and Internet access at school and home as well as reported ICT capabilities are based on the OECD Programme for International Student Assessment (PISA) *ICT familiarity module*. Every three years, the PISA assesses the skills of students aged 15-16 years in 72 economies – including a majority of G20 countries – although not all field the ICT familiarity questions. Over half a million students between the ages of 15 years, 3 months and 16 years, 2 months, representing 28 million 15-year-olds globally, took the internationally agreed 2-hour test for the 2018 PISA. All participants must be enrolled in school and have completed at least six years of formal schooling, regardless of the type of institution, programme followed, or whether the education is full-time or part-time. All G20 countries except India, Saudi Arabia and South Africa participated in PISA 2018. Four provinces of China participate: Beijing, Shanghai, Jiangsu, and Guangdong.

The optional *ICT familiarity module* inquires on the availability of ICTs at home and school, the frequency of use of different devices and technologies, students' ability to carry out computer tasks and their attitudes towards computer use. In 2018, 10 out of 16 G20 economies participating in PISA ran this specific module. Data from multiple PISA waves allow student use of ICTs both at school and outside school to be explored over time, as well as investigation of the impact on school performance - a key policy concern (*G20, 2018*).

These data on training are gathered through the European Community Survey on ICT use in households and by individuals. Respondents are asked to indicate if they have carried out any of these forms of learning activities "to improve skills relating to the use of computers, software or applications" in the 12 months prior to being surveyed.

3.3.1 ICT usage in school, 2018

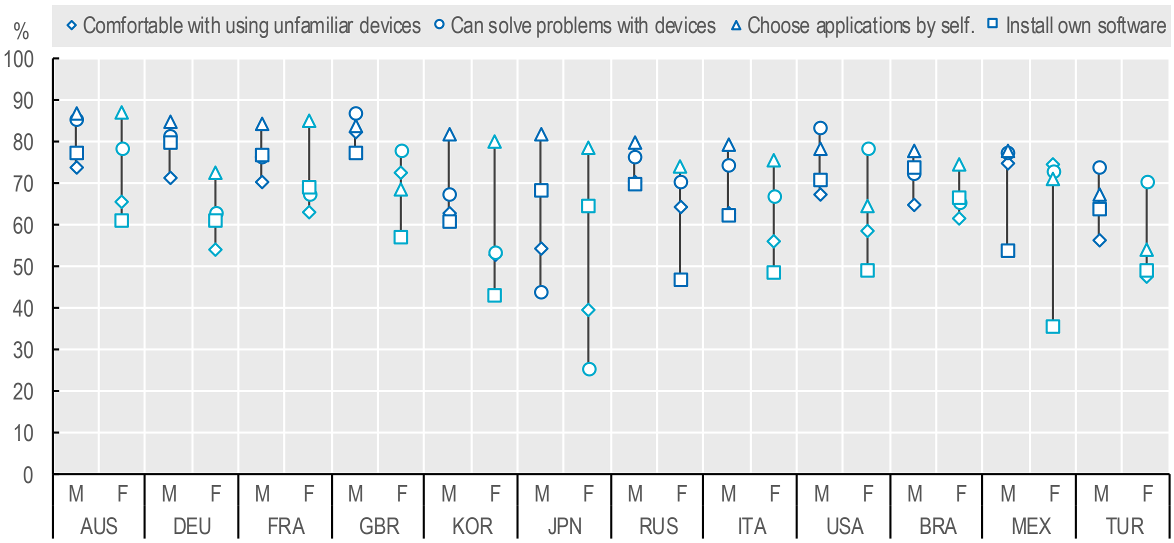
Percentage of school students aged 15-16 years



Note: for Brazil, France, and the United Kingdom, 2012 figures relate to 2015.
Source: OECD calculations based on OECD PISA 2018 database, March 2020.

3.3.2 Students' reported ICT capabilities, by gender, 2018

As a percentage of school students aged 15-16 years of each gender; M = Male, F = Female



Source: OECD calculations based on OECD PISA 2018 database, March 2020.

3.3.3 Individuals who completed training to improve their digital skills, by type, 2018

As a percentage of Internet users

Source: OECD, based on Eurostat, Digital Economy and Society Statistics, Comprehensive Database, March 2020.

3.4. Indicators on NSE and ICT graduates

Tertiary education has expanded worldwide to support the supply of highly educated individuals and to meet rising demand for skills, especially cognitive skills (*OECD, 2019a*). Policymakers are particularly focused on the supply of scientists, engineers and ICT experts, because of their direct involvement in technical change and the ongoing digital transformation.

When it comes to tertiary graduates in fields of study that are key in the digital age, important differences emerge among countries. In 2017, on average, 23% of students graduating at tertiary level in G20 countries did so with a degree in the natural sciences, engineering, and information and communication technologies (NSE & ICTs, which includes qualifications in mathematics and statistics). NSE and ICT graduates accounted for over one-third of all tertiary graduates in Germany and just under a third in India (32%) and Russia (30%). In most G20 countries, graduates in Engineering, manufacturing and construction are the greatest contributor.

It should be noted, though, that modern degree programmes in other fields can also endow students with relevant ICT skills. For example, graduates in the arts, graphic design, journalism and information, are increasingly involved in activities related to production and management of digital content. Tertiary graduates in creative and content fields of education accounted for 5% of tertiary graduates on average in G20 countries with avalable data. In the United Kingdom and Korea, they comprise around 10% of total graduates.

However, there is a large mismatch between the numbers of male and female graduates in such subjects. In G20 countries, only one third of 2017 graduates in NSE & ICT fields were women. Shares range from 16% in Japan and 25% in Korea to 48% in Argentina and 43% in India. As work environments become increasingly digitalised, this could have an impact on gender pay equality. Indeed, workers in digital-intensive industries with high science, technology, engineering and mathematics skills and high levels of self-organisation or management and communication skills tend to earn a wage premium relative to those in non-digital intensive industries (*OECD, 2019b* based on *Grundke et al., 2017*).

As well as numbers of students newly graduating, it is also relevant to consider the share of these subjects in the total population of tertiary-educated adults. In G20 countries, NSE & ICT graduates typically represent 20-30% of all tertiary-educated adults. Furthermore, high shares of these graduates are in work – 85% on average, ranging from 77% in Turkey to over 90% in Germany. In comparison, the average employment rate in the countries presented was 67% (76% in Germany and 52% in Turkey). As such, NSE & ICT graduates appear to be in strong demand. Accordingly, their relative earnings can be between 10% and 50% higher than tertiary graduates overall (*OECD, 2019e*)

Did you know?
In India there are almost 600 000 new tertiary graduates in ICT each year, about five times as many as in the United States.

Definitions
Tertiary level graduates are individuals that have obtained a degree at ISCED-2011 Levels 5 to 8 in the given year (2016).

The natural sciences, engineering and ICT fields of study correspond to the following fields in the International Standard Classification of Education (ISCED) 2013 classification: 05 Natural sciences, mathematics and statistics; 06 Information and Communication Technologies; and 07 Engineering, manufacturing and construction.

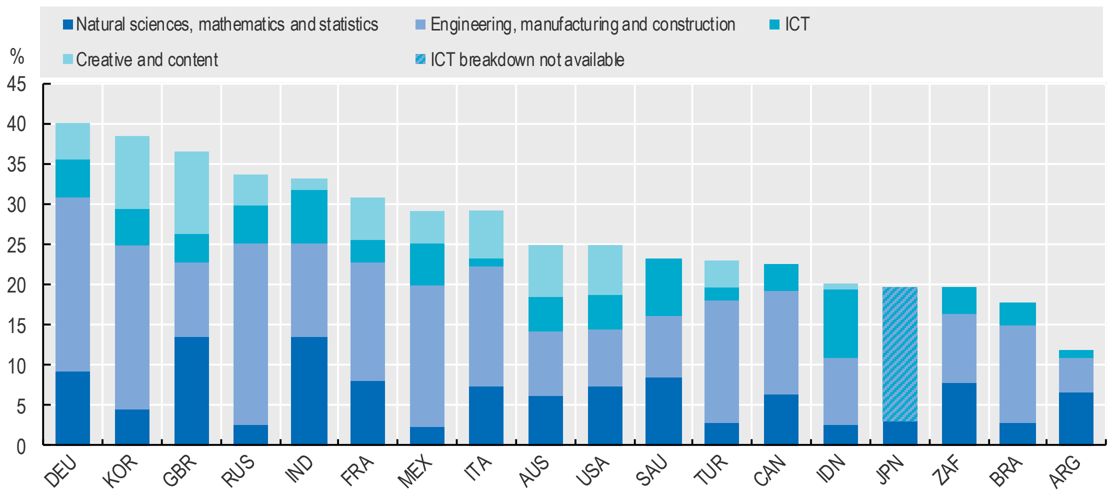
Employment rates are defined as a measure of the extent to which available labour resources (people available to work) are being used. They are calculated as the ratio of the employed to the working age population.

Measurement
Indicators on graduates by field of education are computed on the basis of annual data jointly collected by the UNESCO Institute for Statistics, the OECD and Eurostat. The data collection aims to provide internationally comparable information on key aspects of education systems in more than 60 countries worldwide. See http://www.oecd.org/education/database.htm. Countries provide data from administrative records or survey sources in accordance with commonly agreed definitions.

The educational attainment profiles for most countries are based on the percentage of the population that has completed a specific level of education. The 2011 International Standard Classification of Education (ISCED 2011) is used to define the levels of education and is applied to data gathered through national labour force surveys. Specific reliability and confidentiality thresholds are applied by compiling countries.

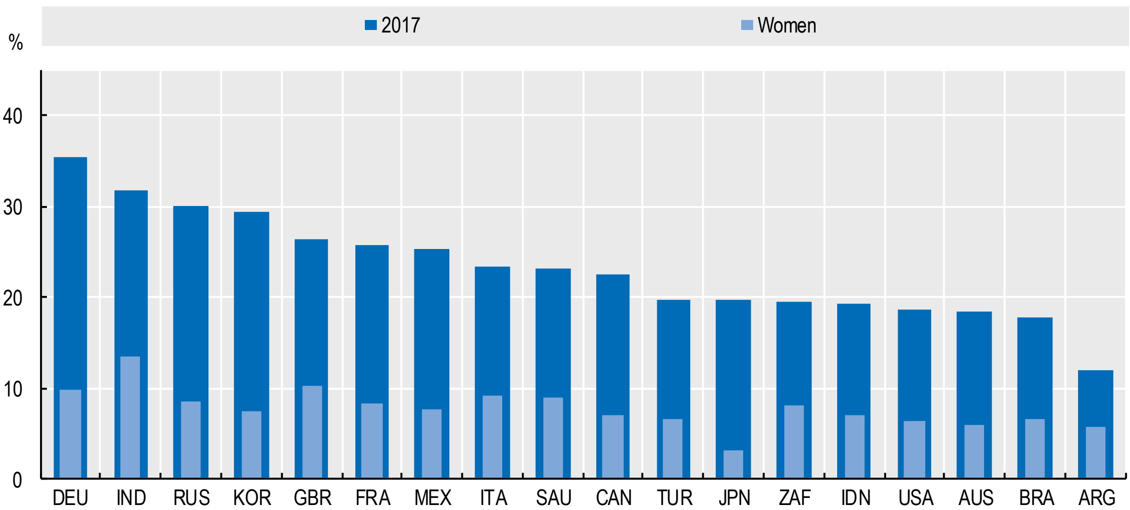
For more information see: https://www.oecd-ilibrary.org/education/education-at-a-glance-2019_d138983d-en.

3.4.1 Tertiary graduates in natural sciences, engineering, ICTs, and creative and content fields of education, 2017
As a percentage of individuals graduating at the tertiary level



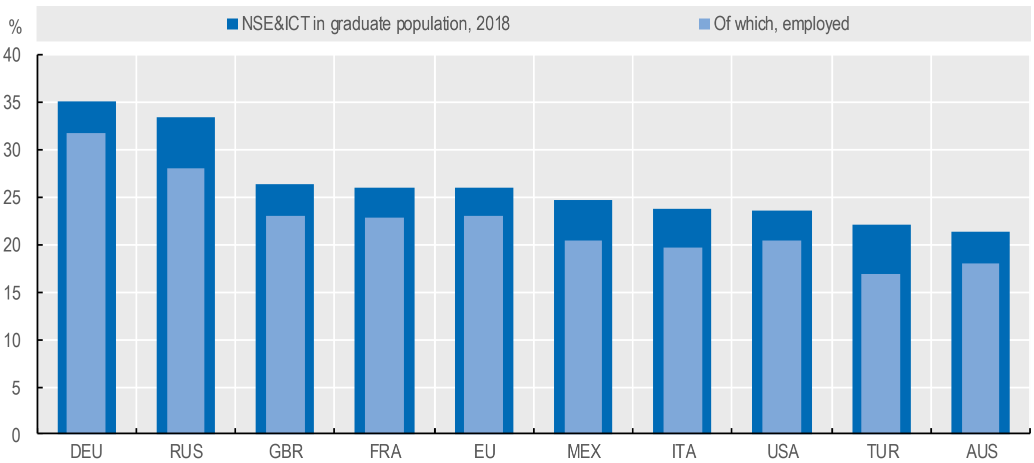
Source: OECD calculations based on OECD Education Database, March 2020.

3.4.2 Tertiary graduates in NSE & ICT, by gender, 2017
As a percentage of individuals graduating at the tertiary level



Source: OECD calculations based on OECD Education database, March 2020.

3.4.3 NSE & ICT graduates in the tertiary-educated population, 2018
Percentage of adults with tertiary education



Source: OECD calculations based on OECD Education at a glance 2019.

3.5. Proposed indicators for monitoring purposes

Sections 3.1-4 have presented a variety of indicators offering complementary perspectives on skills in the Digital Economy. However, their coverage of G20 economies varies due to the availability of underlying data and several that offer useful insights are clearly not yet ready for inclusion in a suite of benchmarking indicators (see also Section 3.6).

With a view to balancing the considerations set out in section 1, the following indicators are proposed for adoption by the DETF:

- **3.1.1 Selected ICT skills by gender**
- **3.2.1. ICT task intensity of jobs, by gender**
- **3.3.1 ICT usage in school**, percentage of school students aged 15-16 years
- **3.3.2 Students' reported ICT capabilities, by gender**
- **3.4.1 Tertiary graduates in natural sciences, engineering, ICTs, and creative and content fields of educatio**n, as a percentage of individuals graduating at the tertiary level
- **3.4.2 Tertiary graduates in NSE & ICT, by gender**, as a share of individuals graduating at the tertiary level

Indicators on tertiary graduates offer good coverage of G20 countries (18 in total). In addition, Indonesia conducts a Labour Force Survey that could potentially be used to provide the requisite data for their inclusion in this indicator. A broader recommendation is, therefore the wider availability of statistics on tertiary graduates by all ISCED 2 digit fields of education, which are a prerequisite both for the indicator proposed and for a holistic view on graduates in G20 economies.

Meanwhile, the ICT skills and ICT usage in school indicators offer coverage of over half of G20 countries included. Furthermore, the latter is based on the OECD PISA assessment. All G20 countries except India, Saudi Arabia and South Africa participated in PISA 2018. All G20 countries are encouraged to consider participation in future rounds of assessment – the next of which will take place in 2021. Within PISA participation, wider administration of the *ICT familiarity questionnaire* would concretely help to improve the country coverage of indicators on students' experiences with ICT in both school and the home.

Where possible, additional breakdowns by age and gender characteristics should be made available to provide greater insights and facilitate policies targeted at marginalised groups.

3.6. Further key indicators for development

Amongst the indicators set out, there are various examples of how surveys of ICT usage in households and by individuals can be used creatively to gain insights on digital skills. From use of programming skills (3.1.2) and details on computer-based tasks in the workplace (3.2.2), to the implications for training needs (3.2.3-4) and actions taken to address those training needs (3.3.3). Once again, these efforts, implemented in a small number of G20 countries, can provide a model for wider development and implementation.

In addition to better exploiting existing survey vehicles, indicators are being developed based on alternative sources – such as data scraped from the web or provided by certain websites.

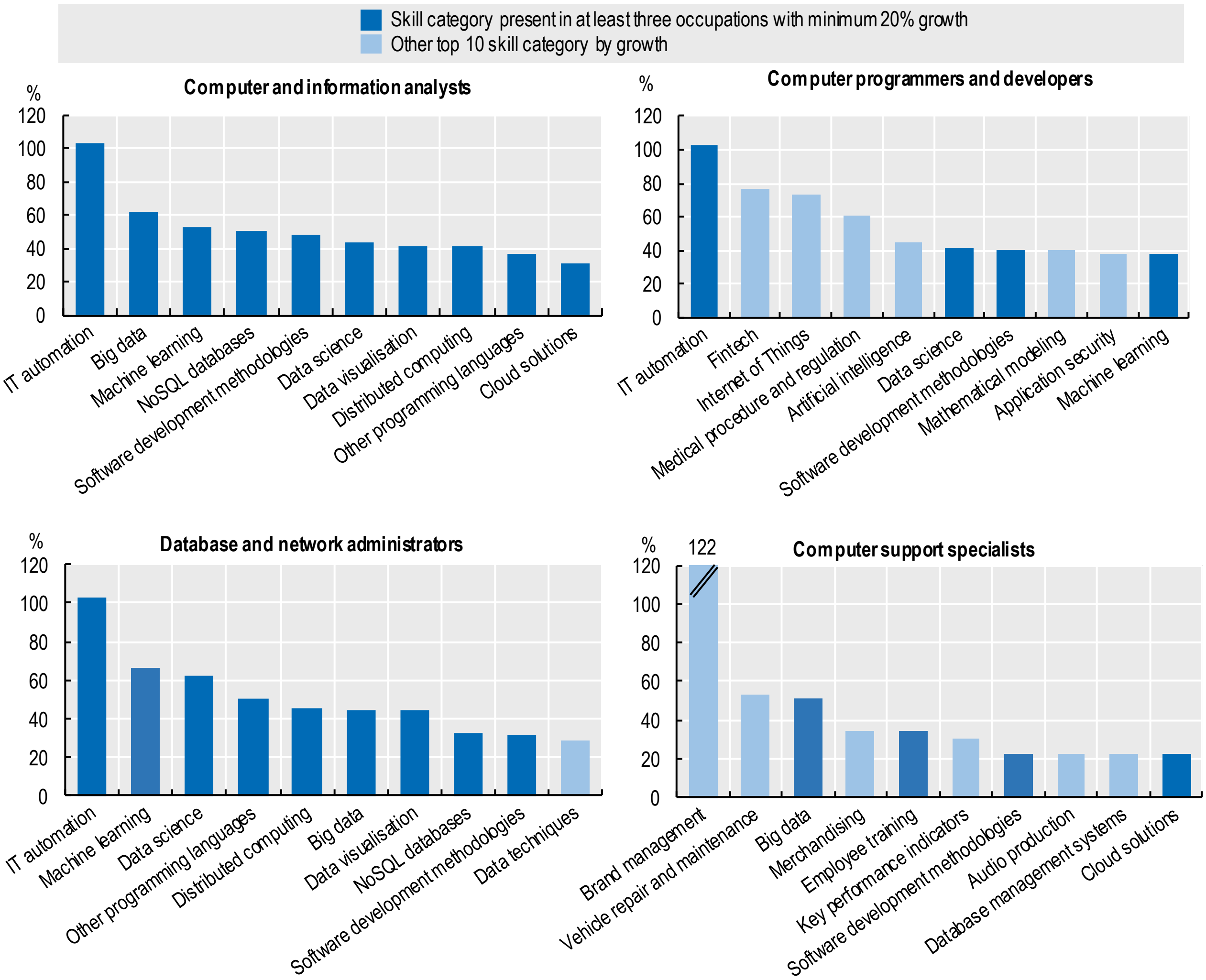
For instance, figure 3.6.1 shows the most demanded skills in the United States between 2012 and 2018, based on the analysis of content scraped from online job postings over the period. In the rapidly changing environment driven by the digital transformation, online job postings can point to fast-growing job titles or profiles in demand. Indeed, 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, which requires constant updating. 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".

The methodology used for the analysis presented in 3.6.1 could be applied to other countries and indicators: it is based on data provided by labour market analytics company Burning Glass Technologies, which 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") are standardised and categorised and occupational information is similarly derived from the reported job titles.

While such methodologies create challenges in ensuring representativeness and comparability across countries, they can also offer advantages. Most importantly, they are likely to be more timely than survey-based indicators (potentially being near real-time). Furthermore, such approaches can circumvent some issues that arise when using classifications such as the International Standard Classification of Occupations (ISCO-08), which take time to modify in order to appropriately reflect rapidly emerging occupations and fields such as those associated with key parts of the Digital Economy.

3.6.1 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



Source: OECD (2019) *"Measuring the Digital Transformation: a roadmap for the future"*; calculations based on Burning Glass Technologies, www.burning-glass.com, January 2019.

4. Growth and the Digital Economy

The "size" of the Digital Economy in terms of production, as well as the extent to which it contributes to overall economic growth has long been a question for analysts and policymakers alike. More recently, several G20 countries have developed experimental measures (*Bureau of Economic Analysis, 2017*), (*Statistics Canada, 2019*), (*Australian Bureau of Statistics, 2019).*

Notwithstanding the questions around defining the Digital Economy, as set out in chapter 2, it is currently possible to derive several complementary perspectives on its economic contribution in G20 economies based on industry data. Nevertheless, developments in the Digital Economy, and the ongoing digital transformation, raise important theoretical and practical questions both at the level of measurement and of policy.

Developments in the Digital Economy affect industry-level and firm-level labour productivity in two main ways. Firstly, although it varies according to countries' roles in global value chains, labour productivity in Information Industries was higher than in other industries in the non-agricultural business sector in almost all OECD countries in 2016, thus contributing positively to average productivity growth. Secondly, there is ample evidence that the usage of ICT in firms increases productivity - key channels for this being automation of routine tasks and complementarity with workers' abilities on non-routine tasks. As such, productivity benefits from digital adoption appear greater in manufacturing industries where the share of automatable tasks is greater (*Sorbe, S., et al., 2019*). More broadly, Brynjolfsson and Steffenson (2017) find that substantially more data-intensive decision-making is associated with a statistically significant increase of 3% in productivity, on average.

A key driver of digital technology use in firms is their investment in ICTs (*OECD, 2019a*). This encompasses investment in both physical assets (ICT equipment, hardware) and intangible assets (software, databases). The latter have grown quickly and now match or exceed the value of traditional capital in a number of developed economies (*Corrado, Haskel, Jona-Lasinio, Iommi, 2016*). The advantages of scale, scope and speed enabled by digitisation and digitalisation of products, processes and organisations continue to create incentives for firms to invest in intangible assets and new sources of value. Even so, measures of ICT hardware, software and databases are not yet available across all G20 economies.

In spite of the ongoing diffusion and development of digital technologies, aggregate productivity growth, as measured in existing statistics, has slowed over the past decade in advanced economies, motivating substantial debate on how digital technologies can actually boost productivity ever since Robert Solow first identified the so-called "productivity paradox" in 1987. Several explanations have been put forth.

Some analysts find that uneven uptake and diffusion of digital technologies throughout the economy is an important driver of the productivity slowdown (*Andrews, Criscuolo and Gal, 2016*). Indeed, there is extensive variation in the pace of digital transformation across sectors (*Calvino et al, 2018*) as well as within sectors as large firms are more likely to adopt technology than small and medium sized enterprises (SMEs) (*Sorbe, S., et al., 2019*).

According to others, investment in ICTs is a necessary but not sufficient condition for the diffusion of digital tools; a second essential condition is investment in complementary assets, knowledge-based capital (KBC) in particular, including research and development (R&D), data, design, new organisational processes, and firm-specific skills (*OECD 2019b*). Consequently, skill shortages in an industry, for example of managerial or digital-related technical skills, tend to reduce the productivity benefits from digital adoption. This also reinforces the unevenness of digital technology uptake as non-frontier firms such as small and medium-sized enterprises in less digital-intensive sectors are more likely to lack the management and financial resources needed for these investments.

Moreover, productivity gains can take time to materialise (*Sorbe, S., et al., 2019*).

Additionally, underestimation of the Digital Economy's contribution to labour productivity growth has been presented as a potential explanation for the productivity slowdown – for instance, due to "*insufficient adjustment for quality change in the deflators for digital products" and "gaps in measuring online platforms' activities*" (*IMF, 2018*). However, as stressed by the IMF (2018), the effect of that under-measurement is too small to explain the overall phenomenon.

It should also be noted that the productivity paradox may be more of a feature in those countries – mostly developed countries – that are close to the digital technology frontier. Therefore, for most developing countries, the scope for productivity gains from an increasing use of digital technologies is still significant (*UNCTAD, 2019*).

This calls for regulatory frameworks that reduce barriers to investment, promote open financial markets and accessible training opportunities. Well-functioning product, labour and capital markets and bankruptcy laws that do not overly penalise failure can raise the expected returns to investing in KBC for non-frontier firms (*OECD 2019b*). In complementary manner, policies promoting ICT-related investment through financial schemes providing monetary support or incentives for the purchase of ICT equipment or through non-financial support provided via targeted training can support diffusion and use of digital technologies.

Further to this, questions have also been raised about the ability of existing statistical measures and approaches to capture the expected developments as they materialise (e.g. Bean, 2016). Meeting the challenges that arise is likely to require new and innovative approaches. For example, as digitalised activities are increasingly internalised in other sectors, measuring Information Industries' contribution to overall value added requires extended measures (*OECD, 2019a*). Digital technologies affect other sectors' value generation by transforming the way firms produce, scale up and compete. The latter can now access multiple geographical and product markets almost instantaneously, and exploit increasing returns to scale from intangible assets. As such, considering the value added generated by the Information Industries requires combining the value added generated by domestic Information Industries with the value added of other domestic industries embodied in global demand for information sector products. For that purpose, the OECD measures the "extended information footprint", *(OECD, 2019a*). The further example of Digital Supply-Use Tables has been outlined in chapter 2.

The digital transformation also affects the distribution of value added between labour and capital. Thanks to a fall in ICT costs and transport costs, increased access to consumer data, as well as a reduction in tariffs, firms have been increasingly able to access global markets and leverage network effects. This has increased enormously the potential for economies of scale (*OECD, 2019b*). The result is that the most productive firms in the economy (defined as "superstar" firms by David Autor, 2017) are "*now significantly larger than the most productive firms were decades ago*", as they benefit from winner-takes-most dynamics (*OECD, 2019c*). This is one of the factors behind the reduction in the h labour value added share as fixed labour overhead costs decline and their mark-up increases.

Digitalisation also contributes to economic growth by increasing the scale, scope and speed of trade (*López González, J. and J. Ferencz, 2018*). After a first stage of international trade growth characterised by the separation of production and consumption across national borders and a second stage enabled by the fragmentation of supply chains, "the age of digitally enabled trade" can be seen as the third stage (*López González, J. and M. Jouanjean, 2017*). On one hand, digitalisation is enabling more trade at <u>constant scope</u> through further reductions in transport and coordination costs, coupled with a considerable fall in the costs of sharing ideas through the transfer of data, or information and reduced informational asymmetries and search frictions helping firms, particularly SMEs, upscale production and bear the costs associated with exporting.

On the other hand, it is <u>enlarging the scope of tradable products</u>. Digitalisation is both giving rise to new 'Information Industries' delivering 'big data' analytics, cybersecurity solutions or at-a-distance quantum computing services across borders and changing the tradability of established service industries. For instance, some transport services, such as taxis, have traditionally not been tradable across borders and have required domestic presence, but digitalisation is changing the nature and delivery of such services (*López González, J. and M. Jouanjean, 2017*) even though the transport services themselves remain inherently localised.

As such, digital trade is a broader concept than trade in ICT goods and services: it is also about digital sales and purchases across a wide range of industries. Evidence suggests that the number of firms selling across borders using online tools is growing across nearly all sectors. In the European Union, for example, nearly 60% of enterprises providing accommodation services sell online, and more than half of these sell across borders (*López González, J. and M. Jouanjean, 2017*). In OECD countries, digitally deliverable services make up about a quarter of total services trade. However, current indicators on digital trade remain incomplete and geographically concentrated. It is therefore difficult to get a sense of the magnitude, or scale, of digital trade. As in traditional trade, digital trade might be expected to bring productivity benefits by enhancing specialisation and competition (*Sorbe, S., et al., 2019*). However additional trade policy considerations are also emerging, related to data flow regulation and digital connectivity to ensure that the gains from digital trade are inclusive, within and across countries. Meanwhile growing reliance on digital services and technologies at all stages of production, increases the number of cross-border interactions, making market openness increasingly important.

It should be stressed that the potential benefits from the evolving Digital Economy and digital trade are far from automatic, and there are challenges, costs and risks involved. High levels of concentration of resources, skills and capacities needed to leverage digital transformations are heightening the risk that further digitalisation and data-driven development will lead to widening digital divides and income inequalities, instead of contributing towards more inclusive and sustainable development. This calls for greater efforts to build the capacities needed to help more people and businesses in developing countries to become developers, producers and sellers in the Digital Economy. There is a need to revisit national and international policies that can affect the creation and distribution of wealth (UNCTAD, 2019).

Overall, measuring the extent and ways that the Digital Economy contributes to overall economic growth requires a holistic approach, considering the different channels through which it affects value added generation, productivity, and trade. The following sections present key available indicators.

4.1. Indicators on value added in the Digital Economy

As highlighted in section 2.1, industry-based measurement approaches can provide several complementary perspectives on the Digital Economy. Demand for information and communication products has increased continuously since 2010 (*OECD, 2019a*). In most G20 economies, however, the share of value added by Information Industries broadly remained the same– with the average increasing only slightly to 5.3% of GDP in 2017 (from 5.2%). Computer and electronics manufacturing and, to a lesser extent, telecommunication services saw their weight in total value added diminish in advanced economies as production shifted to emerging economies, and unit prices fell as a result of productivity growth and increased competition (*OECD. 2019a*). On average, the share of ICT manufacturing activities in G20 countries was 1.2% of total value added in 2017 and the share of telecommunication services was 1.5%.

Measuring the value added generated by Information Industries only provides a partial view of their weight in each economy. In addition to final products, the output from domestic Information Industries is embodied, via intermediate products, in a wide range of goods and services meeting final demand (business capital investment, household and government consumption), both domestically and abroad. Consequently, it can be informative to consider an "*extended information footprint*" combining the value added generated by domestic Information Industries with that of other domestic industries embodied in global demand for information sector products.

The importance of this "extended information footprint" can be illustrated by considering *Information Industries related domestic value added* as a share of total value added. Using this extended measure, it can be seen that the *Information Industry-related* share of total value added, at 14%, is 4 percentage points more than Information Industries alone in Korea. Similar differences between indicators 4.2.1 and 4.2.2 can be observed for other countries. As such, neglecting the value added generated in other sectors of the economy in meeting global demand for information products can result in under-estimation of the economic importance of these sectors and their products.

Another comparator is the share of broader digital-intensive sectors (of which the Information Industries are a subset) in total value added. These offer a wider perspective of the Digital Economy through industries that are, on average, these are expected to show higher productivity from the extensive usage of ICT and high contribution to value added (*Calvino et. al. 2018*). Indeed, in the available G20 economies, high and medium-high digital intensive sectors accounted for 46% of total value added on average, and as much as 54% in Germany and the United States. In many G20 countries these shares are similar to 2010 but Argentina, Mexico, China, India, Turkey, and Saudi Arabia have experienced marked increases over the period.

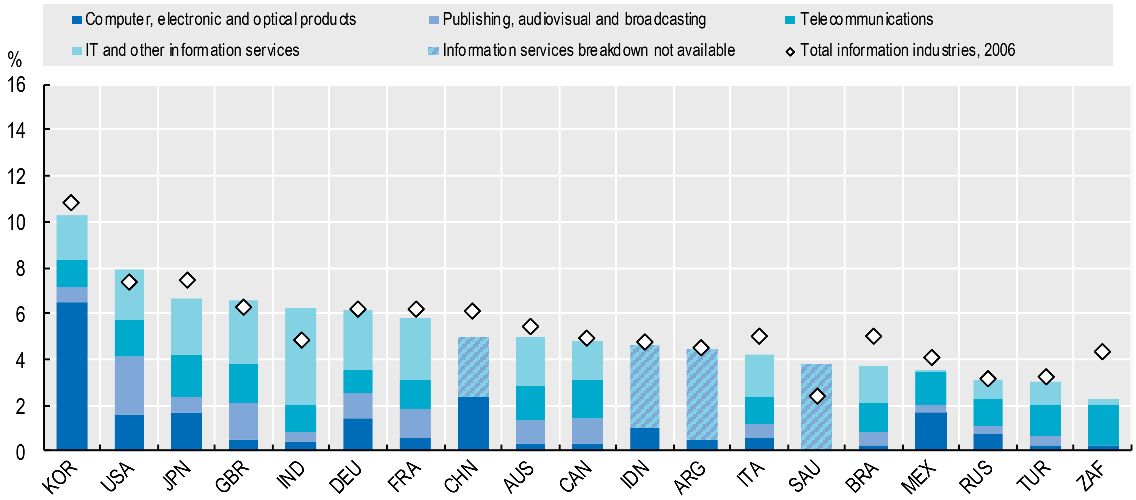
Did you know?
Digital-intensive sectors generate almost half of value added in G20 economies.

Definitions
Information industries-related value added is the corresponding measure in the domestic economy, presented as a share of total value added (GDP).

Value added consists of the value of production net of the costs of intermediate inputs. In practice, it includes both gross profits and wages, and at the country level is equivalent to GDP. The OECD defines the information economy sector (see the OECD Guide to Measuring the Information Society 2011) as the aggregate combining ICT and digital media and content industries in the current version of the International Standard Industry Classification (ISIC Rev.4).

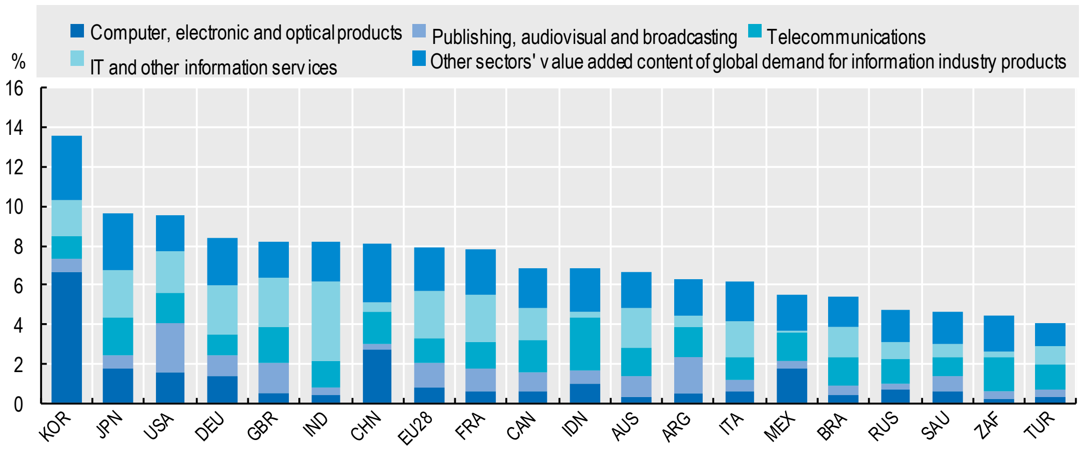
Measurement
Industry value added is generally available from national accounts statistics. However, tracking the country and industry origins of value added embodied in final goods and services requires the use of Trade in Value Added (TiVA) indicators, such as the "origin of value added in final demand", based on the OECD Inter-Country InputOutput database. This provides estimates of inter-country, inter-industry flows of intermediate and final goods and services that allow for the development of indicators on countries' participation in the global economy. The recent introduction of the ISIC Rev.4-based industry classification in the OECD ICIO database improved the measurement of extended information footprints via better identification of information services (such as telecommunications).

4.1.1 Value added by information industries, 2017
As a percentage of total value added



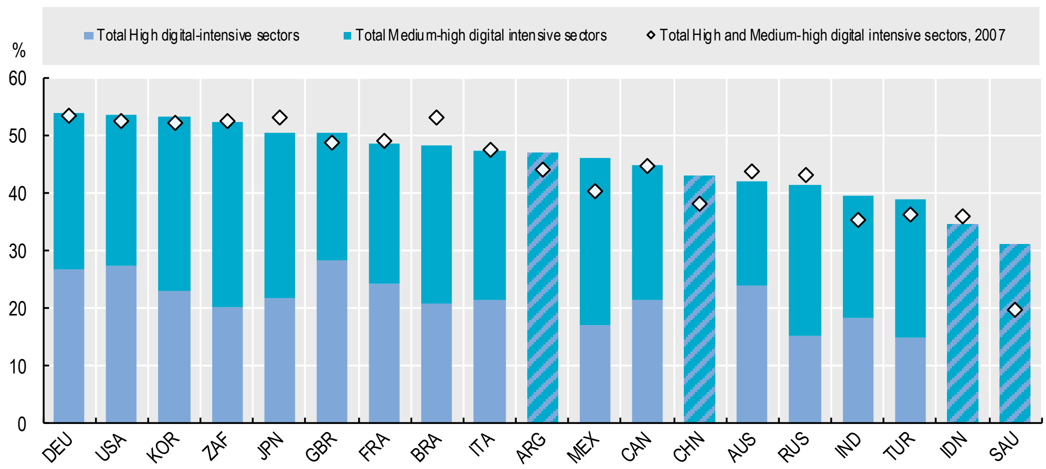
Source: OECD, STAN Database, http://oe.cd/stan, National Accounts Statistics, Inter-Country Input-Output Database, http://oe.cd/icio and national sources, December 2018.

4.1.2 Information industry-related domestic value added, 2015
As a percentage of total value added



Source: OECD, Inter-Country Input-Output (ICIO) Database, http://oe.cd/icio and Trade in Value Added (TiVA) Database, http://oe.cd/tiva, December 2018.

4.1.3 Value added by digitally-intensive sectors, 2017
As a percentage of total value added



Source: OECD, STAN Database, http://oe.cd/stan, National Accounts Statistics, Inter-Country Input-Output Database, http://oe.cd/icio and national sources, March 2020.

4.2. Indicators on investment and productivity in the Digital Economy

Investment in knowledge-based capital as recorded in National Accounts (KBC), which includes Software and databases alongside R&D and other intellectual property products, is an important element of the knowledge base. Computer software and databases (the valuation of which excludes the value of any data therein) constitute the main component of ICT investment in most G20 countries, ranging from just over half of total ICT investment in Germany to almost 90% in France. Comparing 2018 to 2010, G20 countries' investment in ICT assets remained stable on average at 2.3% of GDP but decreased in Japan, Australia, and the United Kingdom while increasing markedly in France as well as in Italy. General stability, at a time of on-going digital transformation, might be explained in part by decreasing prices of ICT products and by substitution between capital investment and purchases of cloud computing and other ICT services, which allow users to access software, storage, processing power and other systems through the Internet without buying ICT assets outright.

By complementing workers on non-routine tasks or substituting workers on routine tasks, digital technologies can increase the level of output for every hour worked, resulting in labour productivity growth (*OECD, 2019d*). This can be achieved if more capital per labour unit is used in production (capital deepening), or by improving the overall efficiency with which labour and capital are used together (higher Multi-Factor Productivity, "MFP"). ICT capital deepening has been a positive contributor to growth in all G20 countries for which data are available over 2010-2018 - albeit less than MFP gains. MFP's contribution was especially high in Korea (1.7 percentage points), Germany and Japan (1.1 percentage points) which experienced labour productivity growth of 2.9%, 1.2% and 1.1%, respectively over the period.

In 2016, labour productivity in Information Industries was higher than in other industries in the non-agricultural business sector in almost all G20 economies. This reflects the relatively higher investment by Information Industries in machinery and equipment, as well as knowledge-based capital such as software and Research and Development. The labour productivity of Information Industries varies among countries for reasons including the roles different countries play in global value chains and variations in the weight of the different components of Information Industries (e.g. ICT manufacturing and services). Large differences in productivity relative to the rest of the economy contribute to very high ratios of labour productivity in Information Industries compared to other industries in India (nearly 5 to 1), and Turkey (over 2.5 to 1). In contrast, the high ratio in the United States (over 2 to 1) reflects a focus on relatively higher value-added activities, while in Korea (2 to 1) it is indicative of the strength of ICT manufacturing.

Did you know?

Computer software and databases are the main component of ICT investment in G20 economies.

Definitions

ICT investment refers to gross fixed capital formation (GFCF) of "information and communication equipment" and "computer software and databases". The value of data within databases is not included.

Labour productivity is the amount of output (value added) produced per unit of labour input (number of persons employed or, when data allow, the number of hours worked). Industry values are computed relative to the whole economy (i.e. to GDP per person employed in each country), adjusting the indicator for differences in productivity levels across countries.

Capital deepening is defined as changes in the ratio of the total volume of capital services to total hours worked. Its contribution to labour productivity growth is calculated by weighting it with the share of capital costs in total costs. *Multi Factor Productivity* (MFP) designates the overall efficiency with which labour and capital are used together.

Information Industries comprise ICT manufacturing and information services i.e. ISIC Rev.4 Divisions 26 and 58 to 63. *The non-agricultural business sector* excluding Information Industries refers to ISIC Rev.4 Divisions 05 to 25, 27 to 56, 64 to 66 and 69 to 82.

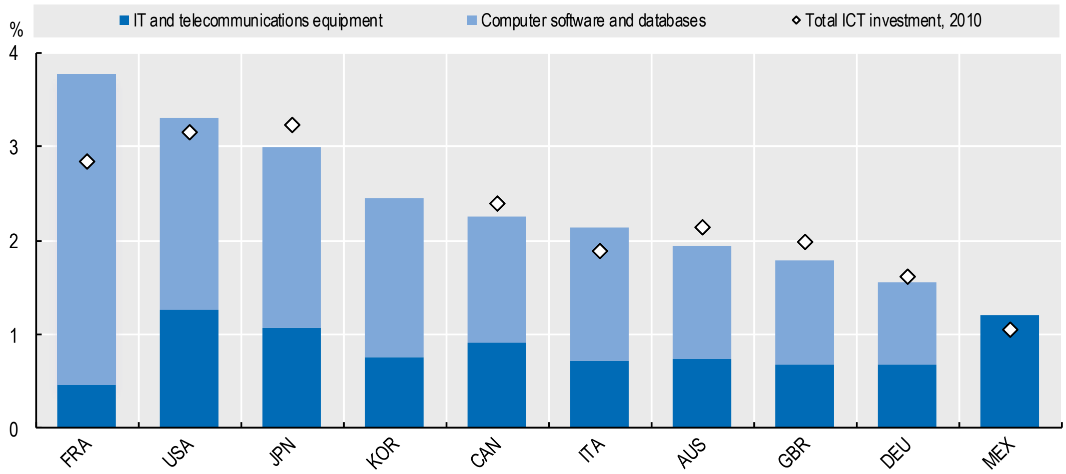
Measurement

The value of ICT investment comes from National Accounts and is based on underlying sources such as Structural Business Surveys. However, data availability varies. In particular, some economies do not isolate all ICT items, resulting in under-estimation.

Differences in labour productivity growth across sectors may relate to the intensity with which sectors use capital (including knowledge-based capital) and skilled labour in their production, the scope for product and process innovation, the degree of product standardisation, the scope for economies of scale and their involvement in global value chains. By re-formulating the growth accounting framework, labour productivity growth can be decomposed into the contribution of capital deepening and multi-factor productivity.

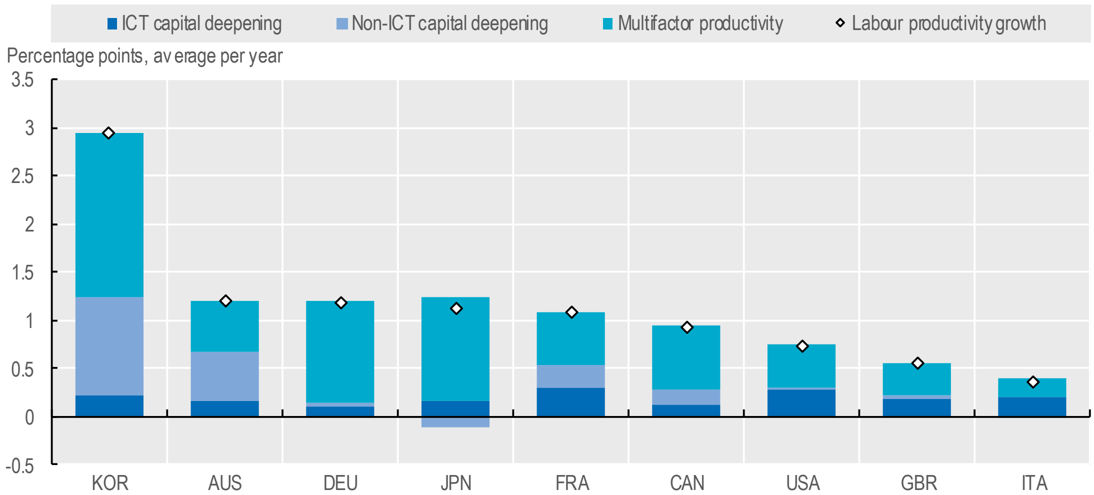
Challenges in measuring real value added affect the comparability of productivity growth estimates across industries and countries. For example, most countries assume no change in labour productivity for public administration activities so this sector is not included here. Real estate services are also excluded, as its output includes large imputations for dwelling services provided and consumed by home owners. In addition, sectors such as construction and several services (for example, hotels and restaurants) are characterised by a high degree of part-time work and self-employment, which can affect the quality of estimates of actual hours worked. See OECD (2019a) for more extensive discussion of measurement issues related to productivity growth.

4.2.1 ICT investment by asset, 2018
As a percentage of GDP



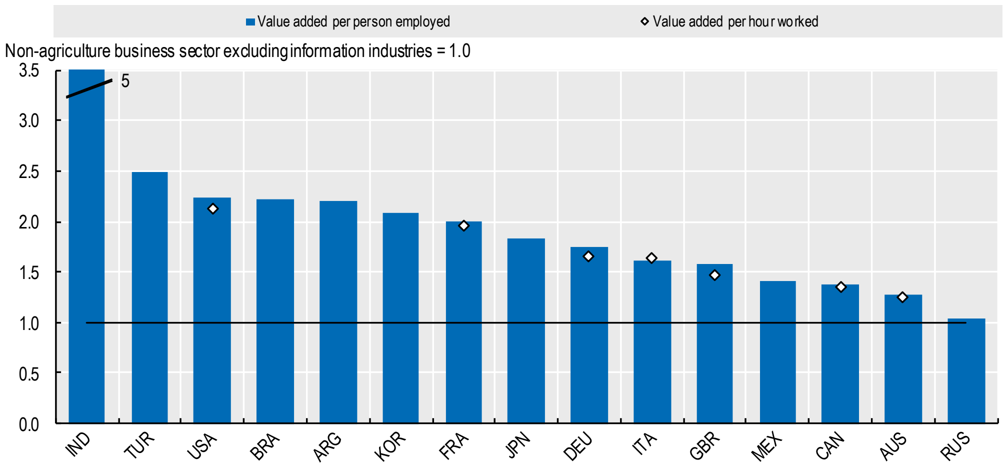
Note: Data for Australia, Germany, Italy, Japan, Korea, United Kingdom, and the United States relate to 2017.
Source: OECD, Annual National Accounts Database and national sources, March 2020

4.2.2 ICT contribution to labour productivity growth over 2010-18
Total economy, annual percentage point contribution to labour productivity growth



Note: For Japan, data relate to 2010-2017.
Source: OECD Productivity Statistics Database, March 2020.

4.2.3 Labour productivity in Information Industries, 2016
Relative to labour productivity of other industries in the non-agriculture business sector



Source: OECD, STAN Database, http://oe.cd/stan, National Accounts Statistics and national sources, September 2018.

4.3. Indicators on international trade related to the Digital Economy

The manufacture of ICT goods is one of the most globally integrated industries. Finished ICT products are the result of numerous stages of production spread across many countries.

A comparison of exports and imports of ICT goods by G20 countries reveals that China accounted for 27% of global gross exports in 2017, down from 29% in 2010. Mexico (16%) also experienced a similar decline in export share over the same period while Korea (25%) increased its share by 4 percentage points. In ten G20 countries, ICT goods represent less than 3% of merchandise exports, illustrating the relative specialisation of certain other members in ICT manufacture.

Most G20 countries import a high proportion of the ICT goods they use – including those used as intermediate inputs to ICT goods manufactured. ICT goods exceed 10% of merchandise imports in six G20 countries but are as low as 5-6% in Italy and Turkey. ICT goods represent the largest shares of imports in China, Korea and Mexico, - countries strong in ICT manufacture and integrated into global supply chains. Between 2010 and 2017 India has seen the largest increase in the share of ICT goods in imports, from 6% to 10%.

Trade in ICT services has grown in recent years and reached USD 530 billion in 2017, representing 10% of total global trade in services. As with trade in ICT goods, a few economies account for the majority of global ICT services exports. Within this, global exports of computer and information services have surged relative to telecommunication services (*OECD, 2019a*). Among G20 countries, in 2018, India was the main exporter of ICT services, which comprised 28% of total services exports. Nevertheless, this was down 6 percentage points from 2010. ICT services exports are also especially key for China (18%) and Argentina (13%) and Germany (12%), which each grew their share of ICT in services exports. Along with Canada, these five economies account for around half of worldwide exports of ICT services.

Digitalisation has not only intensified trade in ICT services (eg. software development) but also enabled trade over ICT networks for a range of other, already installed services, ranging from education to marketing and health services (*López González, J. and M. Jouanjean, 2017*). Such digitally deliverable services" (*UNCTAD, 2015*) comprise a large share of services exports and imports in many G20 countries. In particular, they account for over half of all services exported from the United Kingdom (71%), India (65%), Brazil (61%), Germany (58%), Canada (58%) and the United States of America (56%). Meanwhile, digitally deliverable services are a greater component of imports than of exports in countries including Japan, Mexico, Turkey, and Saudi Arabia.

These indicators provide useful and complementary perspectives on the importance of digital-economy products in G20 trade.

Did you know?
Digitally deliverable services exports are of critical importance for many G20 countries and comprise over two-thirds of services exports from Brazil, India, and the United Kingdom.

Definitions
ICT goods exports and imports cover the sale and purchase from abroad of goods that are the main product of the ICT sector. Five broad categories of ICT goods are covered: (a) computers and peripheral equipment, (b) communication equipment, (c) consumer electronic equipment, (d) electronic components and (e) other ICT goods. These all represent important inputs to the Digital Economy.

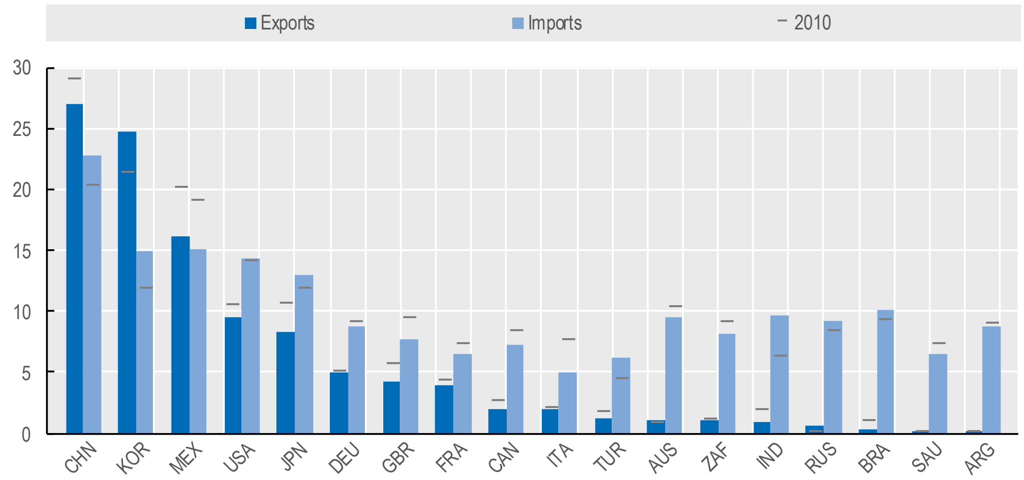
The *ICT goods* classification adopted by the Partnership on Measuring ICT for Development was developed by the OECD through its Working Party on Indicators for the Information Society (WPIIS). When the definition was first released in 2003 it was based on a list of 6-digit items according to the HS classification, the HS 1996 and HS 2002 editions. Since then the definition of ICT goods has been revised in 2008 and the transition from HS 2002 to HS 2007 resulted in a break in time series. The definition was updated again when transitioning from HS 2007 to HS 2012 and then to HS 2017 (*UNCTAD, 2018*).
The ICT *services* definition was developed by the OECD Working Party on Indicators for the Information Society (WPIIS) and subsequently refined by the Partnership on Measuring ICT for Development. At the core of this definition of ICT services is the service component of the ICT sector (*UNCTAD, n.d*.). The statistics presented correspond to the concepts and definitions of the IMF Balance of Payments and International Investment Position Manual, Sixth Edition (*BPM6, 2009*). – namely computer and telecommunications services.

Digitally-deliverable services are defined by the UNCTAD as an aggregation of insurance and pension services, financial services, charges for the use of intellectual property, telecommunications, computer and information services, other business services and audio visual and related services. The digitally-deliverable services series is based on the concept of *potentially ICT-enabled services* defined as "services that can be delivered remotely [and] includes ICT services, sales and marketing, management, administration, and back office services, engineering, R&D, education". This concept was developed by UNCTAD in a technical note in 2015.

Measurement
All G20 economies compile and report to UNCOMTRADE detailed merchandise trade data at the 6-digit level of the HS classification, various revisions. Data availability on exports and imports of ICT goods is generally very good for both developed and developing countries, albeit with a time lag. Based on UNCOMTRADE, UNCTAD publishes tables on the share of ICT goods as a percentage of total merchandise trade, on bilateral trade flows by ICT goods categories, and on trade in digitally-deliverable services as a percentage of total trade in services.

4.3.1 ICT goods exports and imports, 2017

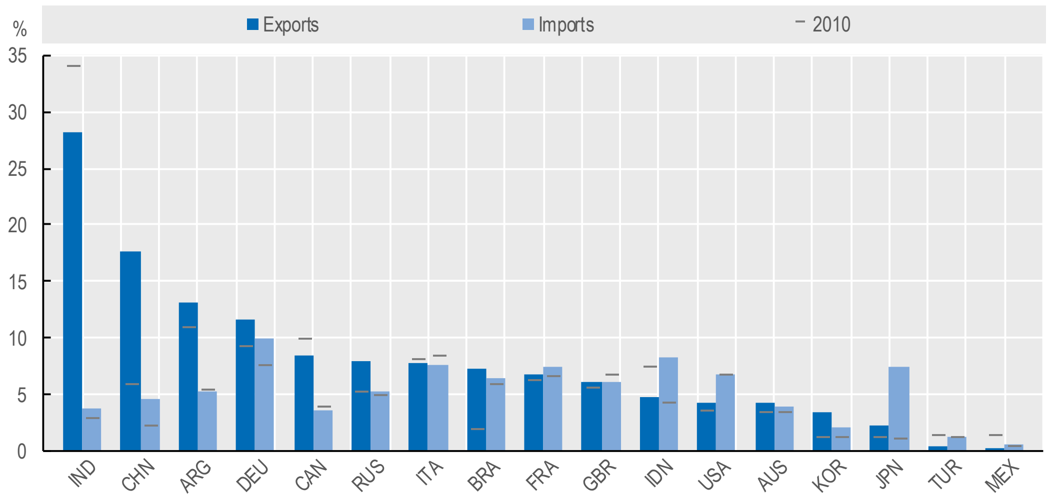
As a percentage of merchandise trade



Source: OECD based on UNCTAD Information Economy database, March 2020.

4.3.2 ICT services exports and imports, 2018

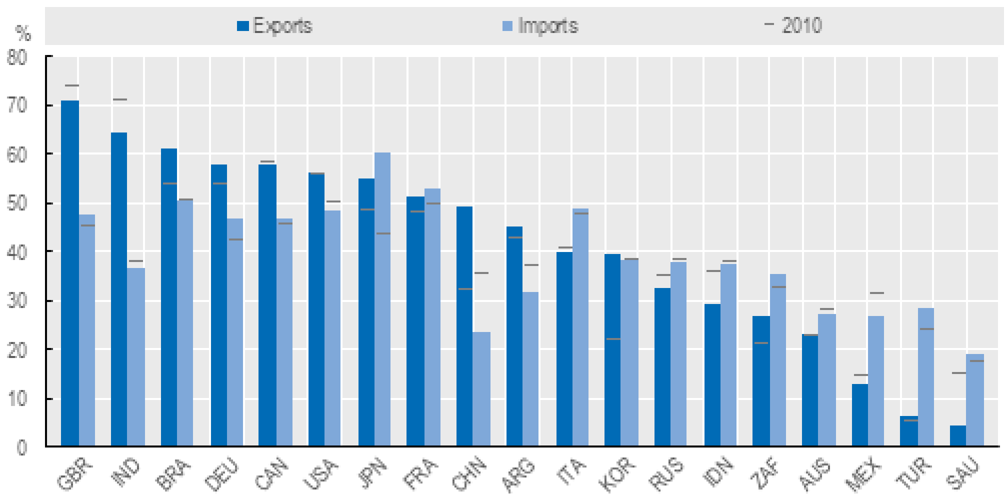
As a percentage of total trade in services



Source: OECD based on UNCTAD Information Economy database, March 2020.

4.3.3 Digitally-deliverable services exports and imports, 2018

As a percentage of total trade in services



Source: OECD based on UNCTAD Information Economy database, March 2020.

4.4. Proposed indicators for monitoring purposes

Sections 4.1-3 have presented a variety of indicators offering complementary perspectives on growth in the Digital Economy. While most offer complete or very good coverage of G20 economies, some more complex indicators, such as ICT investment by asset and labour productivity suffer from poorer availability of underlying data despite being based on routine outputs form the compilation of National Accounts in accordance with the 2008 System of National Accounts (*UNSD, 2008*).

With a view to balancing the considerations set out in chapter 1, the following indicators based on established methods and data sources already replicated in most G20 countries are proposed for adoption by the DETF:

4.1.1 Value added by information industries, as a percentage of total value added
4.1.2. Information industry-related domestic value added, as a percentage of total value added
4.1.3 Value added by digitally intensive sectors, as a percentage of total value added
4.2.1 ICT investment by asset, as a percentage of GDP
4.2.2. ICT contribution to labour productivity growth, total economy, annual percentage point contribution to labour productivity growth
4.3.1 ICT goods exports and imports, as a percentage of merchandise trade
4.3.3 Digitally-deliverable services exports and imports, as a percentage of total trade in services

Indicators based on value added perhaps come closest to providing an answer to the question "what is the (monetary) size of the Digital Economy?". They also benefit from near-perfect coverage of G20 countries and furthermore, as they are based on data from the National Accounts routinely compiled by G20 countries it should be possible to expand coverage to all. As figure 4.1.1 and 4.1.3 show it is possible to manage unavailability of some more detailed components of the breakdown. However, these rely on deciding what activity should be included in the estimates; a focus on Information Industries or the wider digital-intensive sectors provide two complementary means of delineation currently used in practice though others could be conceived. Furthermore, classifications based on relative digital-intensity need updating over time to reflect the on-going development of the Digital Economy.

Data on ICT investment by asset (4.2.1) is less widely available across G20 countries. However, these figures should also be routinely compiled as part of National Accounts so the main challenge is likely to be one of public availability of the data (e.g. by transmission into international statistical collections). In cases where a lack of availability is due to issues of statistical robustness of the series, ICT investment could be prioritised for improvements.

Similarly, G20 country coverage is good for indicators on trade in Digital Economy products, with these being a part of routinely produced trade statistics.

4.5. Further key indicators for development

A key area of further development would be for G20 economies to develop comparable indicators that not only highlight, in greater detail, the actors and transactions occurring in the Digital Economy but are constructed in accordance within the established definitions, classifications and guidelines of the System of National Accounts. Production of such indicators (such as the high priority indicators within the digital supply-use tables, discussed in chapter 2) would enable countries to easily incorporate and compare indicators of digital activity in the economy with the broader macro-economic indicators currently produced. The initial indicators outlined include:

1. Output, Gross Value Added (GVA) and its components of the digital industries as defined in the digital SUTs.
2. Intermediate consumption of Digital Intermediary Services (DIS), Cloud Computing services (CCS) and total ICT goods and digital services.
3. Expenditures split by nature of the transaction.

Production of these high priority indicators would provide:

1. A measure of the contribution to overall economic growth from a defined collection of units that are fundamentally benefiting from, contributing to or reliant on, the digitalisation of the economy.
2. A measure of the digitisation of the more conventional industries based on the uptake in digital goods and services being used in production including information on two key digital services, fundamental to the Digital Economy, and currently unidentifiable in established economic outputs.
3. A clear indicator regarding how digitalisation has affected the final delivery process with consumers.

5. Survey of definitions and measures of the Digital Economy in G20 countries

As an input to this report, the Saudi Arabia G20 Presidency coordinated a survey on G20 countries' measurement efforts related to the Digital Economy. Of the thirteen G20 countries that returned the survey, seven declared having "*measures for jobs in the Digital Economy*". **Argentina**'s Employment and Business Dynamics Observatory (Ministry of Labour, Employment and Social Security) registers employment data in private sector companies providing software and computer services, telecommunications services and audiovisual services. In addition, the National Institute of Statistics and Censuses Permanent Household Survey provides information on employment "*linked to software production and productive technological development*", including a breakdown by gender and sectors. **Brazil** reported collecting data on jobs in the Digital Economy through the Household and Innovation Surveys, compiled by the National Statistical Office (IBGE). Using Labour Force Survey data, **Canada** breaks down employment data by National Occupation Codes (NOCs) in order to "*fit to the identified definition of the Digital Economy*" using the Digital Economy Satellite Account. **France and Italy** did not provide specific detail on their methods, simply stating that they apply the EU framework developed by the European Commission through the Digital Economy and Society Index (DESI) framework, while **Germany** has developed a special module on "ICT at work" comprising questions related to the usage of ICT at work. The **United Kingdom** records employment in the "Digital, Culture, Media & Sport" sector. In the **United States**, the Bureau of Economic Analysis (BEA) publishes estimates of employment and compensation for the Digital Economy within the supply-use framework, while its *2019 Annual Business Survey* is collecting data on the impact on employment and skills of certain advanced technologies among U.S. firms, including "robotics, cloud computing, artificial intelligence, specialised software and equipment". **Australia** reported having no specific measures of jobs in the Digital Economy as it considers that the latter "is not separate from the economy" but tracks to technology-related employment in sectors like ICT, telecommunications services; Internet service providers, among others.

Regarding skills measurement in the Digital Economy, countries were asked whether they had "*undertaken work to identify skills that matter in the Digital Economy*" and "*developed any measures*" in relation to those. Five G20 countries answered positively to the first question, while eight reported having developed specific measures related to skills.

In *Digital Education Competencies report* (2017)**,** the **Argentinian** Ministry of Education identified six core skills for individuals to prosper in the Digital Economy: creativity and innovation, communication and collaboration, information and representation, responsible and supportive participation, critical thinking and autonomous use of ICT. In addition, it launched a *Digital Transformation Skills Program* for state employees providing training in digital skills as well as *Argentina's Digital Agenda*, as part of which a survey characterising businesses' skills needs identified skills such as Web development and Programming among the most demanded.

As part of the project ***Australia****'s Tech Future,* the importance and the nature of skills in the digital era were assessed. Concerning measurement, the Department for Education, Skills and Employment keeps enrolment and graduation data on a number of fields, including ICT, which reveals "*increased demand for digital skills across all industries*". To analyse the need for skills in the digital era, **Brazil** has included indicators on computer and Internet-related skills in the ICT in Households Survey, for individuals aged ten or more. **Canada's** Internet Use Survey collects information on a variety of tasks conducted using a computer or the Internet and "*that can be used as a proxy for skills required for the Digital Economy*". As part of the Labour Force Survey, **Germany** included a module on E-Skills, tracking indicators similar to those used by ITU (see page 3.1) and "*providing significant input to the European DESI indicator*". More broadly, Germany is actively participating in the European Task Force supporting the development of the European E-Skills module together with Eurostat and the related EU DGs. **Turkey** collects data on individuals' skills related to the use of computers and the Internet through the ICT Usage in Households Survey (based on Eurostat's model questionnaire) on a biannual basis. In the **United Kingdom**, the Office for National Statistics gathers data on skills through the Internet Access, Opinions and Lifestyle Survey while the Department for Culture Media and Sports has a specific *Digital skills and inclusion policy*, seeking to assess skill needs in the digital era. In a policy paper on *Digital skills for the UK economy* (2016), it notes that "*the definition of digital skills has 'broadened' over time. The first definitions of computer or ICT literacy focused on technical, operational and procedural knowledge about computer use, while later definitions covered cognitive, attitudinal, social and emotional skills*". **China** reported having formulated relevant policies for "*improving digital literacy of rural residents*".

Finally, seven G20 countries reported producing "*measures related to economic growth, value added, and/or productivity in the Digital Economy".* **Argentina** National Institute of Statistics and Censuses (INDEC) measures of gross value-added data includes but does not yet discriminate digital activities. The National Statistics Offices in **Brazil** and **Canada** both reported producing related statistics, with Canada first compiling a Digital Economy Satellite Account in 2019. The **United Kingdom** also compiles figures on employment and growth in the Digital Economy. While **China** did not mention specific measurement policies, it has developed a Big Data Strategy, Broadband China Strategy, Network Speed-up and Fee Reduction Plan, Information Consumption, Industrial Internet Plan, all supporting the growth of the Digital Economy. As mentioned previously, the **United States** BEA assesses the "*diffusion and employment effects of recent advanced technologies used by U.S. firms*", however the Annual Business Surveys for 2018 and 2019 do not estimate aggregate growth, value-added, or productivity in the

Digital Economy. **The United Kingdom** indicated tracking gross value added and employment figures. The **Australian** Bureau of Statistics (ABS) has been measuring the contribution of digital activities applying the BEA's approach to estimate digital activity in Australia using selected separately identifiable digital products from the ABS supply-use tables. **Turkey** is currently investigating potential data sources and methods for measuring the Digital Economy's contribution to growth and productivity, with the compilation of digital SUTs planned for the next revision.

In addition, inputs from the Digital Inclusion Focus Group (W20) have been taken into account in selecting indicators for adoption (see Table 2 below). In particular, they encouraged the presentation of gender details as widely as possible and helped to identify indicators in which a gender breakdown is most informative and impactful. Overall, women's ability to engage with new entrepreneurial opportunities offered by the Digital Economy as well as digital literacy and skills were highlighted as areas requiring the most urgent attention. As such, the chosen set reflects skills by gender among the total population (3.1.1) as well as school students (3.3.2), and women's presence among NSE & ICT graduates (3.4.2), the latter being most likely to find work within the "core Digital Economy" (see chapter 2) or in ICT specialist roles. It is worthy of note that women are more likely than men to be in occupations that are ICT task-intensive (*OECD, 2019a)*. As such, monitoring the extent to which the necessary *conditions* for women's equal participation in the Digital Economy are realised, the resulting *outcome* in labour markets is also measured. The share of female ICT professionals (2.2.2) was thus selected for adoption, in line with W20 recommendations. Looking ahead, key indicators proposed by the W20 could be developed for adoption across the G20 and beyond, including the share of women-led technology-driven enterprises or patenting activity by women inventors in ICT related fields (see section 2.2.2 of chapter 1).

6. G20 indicators on jobs, skills, and growth in the Digital Economy

This chapter presented existing indicators drawn from a wide range of areas, covering jobs, skills and growth. By so doing, it identified gaps in the current measurement framework and assessed progress made by several initiatives towards filling these gaps. The overarching objective of the chapter is to advance the measurement agenda by building on these achievements and a wide body of ongoing work in national and other international organisations, as already identified in the G20 Toolkit for Measuring the Digital Economy (*G20 DETF, 2018*).

This is a challenge. Existing metrics and measurement tools struggle to keep up with the rapid pace of the digital transformation. The range of questions that can be asked about its impacts is daunting. How can digital transformations be measured and tracked in all sectors of the economy? How to measure disruption to existing business models and the emergence of new ones, their impact on the economy, the reorganisation of work, or the size of the sharing economy? What are the economic activities, jobs and skills of the future?

Much of the information required to respond to these questions already exists or is being developed, but not all. There is a recognition that statistical information systems need to adapt, and in some cases expand, to capitalise on their ability to provide more granular insights. There is also a need for new, complementary, data infrastructures capable of tracking the emergence of new activities and monitoring their substitution for traditional ones, on a timely basis wherever these occur.

Such information systems must also adapt to newly emerging digital footprints (i.e. the enormous flows of information generated by digital technologies and digitally enabled activities, such as e-commerce, cloud services and the Internet of Things) that are now being generated and that offer new opportunities for measurement.

In the short term, the challenge is to improve the international comparability of current indicators and make statistical systems more flexible and responsive to the introduction of new and rapidly evolving concepts driven by the digital transformation. As noted in the *G20 Toolkit*: "Even in areas where international standards to guide statistical collection exist, countries may lack the capabilities and resources to implement them systematically, disseminate the resulting information openly or make efforts to ensure that data are comparable. There is a clear lack of coverage in developing countries compared to developed countries due to differences in statistical capacity among countries, or user needs and priorities for statistical collection".

Even among developed countries, ensuring the international comparability of indicators used to monitor the Digital Economy can present challenges. Only a limited number of indicators can be compiled for monitoring across countries, and these are usually fairly standard and not sufficiently granular to capture the changing dynamics of the digital transformation. Efforts to exploit official statistics at the micro level (e.g. enterprise/establishment/organisation, worker or household/individual) in an internationally co-ordinated fashion, including the use of administrative data and the exchange of micro-data among national statistical offices (NSOs), should be supported, especially with respect to data-linking opportunities. This will mean continuing to encourage the development of tools and mechanisms to access micro-data while ensuring data confidentiality.

A number of options exist and have begun to be explored and developed to increase the flexibility of current statistical frameworks. These include developing and populating satellite accounts, exploiting the potential of existing microdata, adding questions to existing surveys, periodically augmenting existing surveys with topic-specific modules and developing high-frequency surveys to meet specific needs. Remaining gaps could be addressed through new and experimental approaches developed to meet the specific priorities and resources of countries (*OECD, 2014*).

In the longer term, the main challenge for the statistical community will be to design new and interdisciplinary approaches to data collection and to leverage the information captured by digital systems. As the digital transformation spreads across every sector and affects every aspect of society, measuring its distinct features and dynamics will become increasingly challenging. New approaches will be needed – and the digital tools and footprints created by digital activities can form part of the solution. The digital transformation is also being felt across all dimensions of data production and use. For example, qualitative information is increasingly becoming a source of quantitative evidence. Text-mining tools (e.g. natural language processing) underscore the potential to alleviate some of the common challenges facing statistical collection (e.g. survey fatigue and classification systems that are applied differently by human coders) and offer opportunities for generating adaptable indicators. In this context, policies promoting (open) access to data collected for administrative purposes by the public and private sectors represent an important means to facilitate new forms of analysis.

The next generation of data infrastructure for policy making in the digital era needs to build partnerships with the private sector and engage with stakeholders to bring publicly available, reliable data into the policy-making process. The proposed measurement roadmap will have to be discussed and implemented gradually through close co-operation between the statistical community and other stakeholders. Policy makers will need to define user needs, while researchers contribute insights essential for the development of appropriate metrics and data infrastructures. Engagement with organisations, businesses, universities and the public sector will be indispensable, as the statistical system can only collect data that can feasibly be measured inside such organisations. In particular, private source data can open new opportunities for monitoring the digital transformation and its impacts. They can help track data flows and uses on a continuous basis across actors, sectors and locations. For example, these data can provide insights into job vacancies and the emergence of new jobs profiles or the new services and business models enabled by online platforms. However, the use of private source data for measurement and analysis raises new challenges that need to be overcome by working together both on statistical quality frameworks and viable economic models of data sharing.

International organisations contributing to the digital measurement agenda will need to continue to improve co-ordination, in order to avoid fragmented efforts and initiatives and ensure that the international community takes up the challenge to further build the evidence base for more robust policies for growth and well-being in the digital era.

With respect to the shorter-term challenge of improving the availability and comparability of key indicators across G20 countries an agreement on which indicators and underlying sources to prioritise can be a useful guide for G20 efforts. This chapter has presented a wide range of indicators on jobs, skills, and growth in the Digital Economy (see Table 2) that are currently available based on established, internationally agreed definitions and on methods and data sources that are already replicated in most G20 countries – including many set out in the G20 Toolkit for Measuring the Digital Economy (*G20 DETF, 2018*).

Based on an assessment considering important factors including G20 country coverage, data frequency, the need to compare among groups – especially different genders and ages, and the need to reflect the amorphous nature of the Digital Economy a range of available indicators have been selected. The following table sets out these indicators and notes the underlying data sources uses.

The indicators are intended to that paint a reasonably broad and nuanced (given the current state of measurement), picture of jobs, skills, and growth in the Digital Economy and are selected for adoption by the Digital Economy Task-Force with a view to monitor their evolution across the G20.

Table 2: G20 indicators on Jobs, Skills, and Growth in the Digital Economy proposed for joint monitoring

Section	Indicator name	Data source(s)	Underpinning data source
	2.1.1 Jobs in digital-intensive sectors and Information Industries	OECD Structural Analysis (STAN) Database based on National Labour Force Surveys	National Accounts sources / Labour force surveys
Jobs	**2.2.1** Jobs in ICT task-intensive and ICT-specialist occupations	European Labour Surveys and other sources	LFS
	2.2.2 ICT professionals and technicians by gender	International Labour Organization (ILO) based on national Labour Force Surveys	LFS
	3.1.1 Selected ICT skills by gender	ITU World Telecommunication/ICT Indicators database and OECD ICT Access and Usage by individuals database	Household and Individuals ICT usage surveys / modules in LFS
	3.2.1 ICT task intensity of jobs by gender	PIAAC database	PIAAC skills survey module
Skills	**3.3.1** ICT usage in school	OECD Programme for International Student Assessment (PISA) Database	PISA assessments
	3.3.2 Students' reported ICT capabilities, by gender	OECD PISA Database	PISA assessments
	3.4.1 Tertiary graduates in natural sciences, engineering, ICTs, and creative and content fields of education	OECD Education Database	Administrative registers and/or survey sources
	3.4.2 Tertiary graduates in NSE & ICT, by gender	OECD Education Database	Administrative registers and/or survey sources
	4.1.1 Value added by information industries	OECD STAN Database	National Accounts sources
	4.1.2 Information industry-related domestic value added	OECD Inter-Country Input-Output (ICIO) Database and Trade in Value Added (TiVA) Database	National Accounts sources
	4.1.3 Value added by digitally intensive sectors	OECD STAN Database and OECD ICIO Database	National Accounts sources
Growth	**4.2.1** ICT investment by asset	OECD, Annual National Accounts Database	National Accounts sources
	4.2.2 ICT contribution to labour productivity growth	OECD Productivity Statistics Database	National Accounts sources
	4.3.1 ICT goods exports and imports	UNCTAD Information Economy database	Merchandise trade data
	4.3.3 Digitally-deliverable services exports and imports	UNCTAD Information Economy database	Trade in services data

In addition, several less-widely adopted indicators have been presented. These show how other facets of jobs, skills, and growth in the Digital Economy can be measured by leveraging existing data sources – such as through the addition of new questions or modules to ICT usage surveys. Though not currently suitable for inclusion in a G20 suite of benchmarking indicators, these show how, with coordinated international effort and uptake, key additional indicators could be developed. A key message arising from these is that the creative use of survey sources – especially ICT usage surveys – is a key way in which measurement of the Digital Economy develops over time. Approaches tried out in several G20 countries could be more widely adopted in order to gain new and detailed insights into how the jobs, skills, and growth are being impacted by digitalisation and to better identify, design, implement, and monitor policies aimed at maximising the benefits and the mitigating risks associated with on-going developments in the Digital Economy.

6.1. Implementation steps

G20 countries, along with collaborating International Organisations (IOs), discussed the proposed indicators on jobs, skills and growth presented above at a workshop held on 4th May 2020. Following this, the indicators set was discussed by the DETF. Nevertheless, there is a need to capitalise upon this to deliver implementation of the indicators and their regular production across the G20 and beyond. Key steps suggested for implementation of the indicators are:

1. Countries should put in place the necessary **infrastructure** to compile relevant data in the area of Jobs, Skills and Growth. Given the sources underpinning the selected indicators, this includes:

    a. Conducting regular **Labour Force Surveys**, according to ILO guidelines[11], that gather sufficient detail on relevant occupations (defined according to ISOC08) as well as personal characteristics needed for breakdowns – at a minimum gender, age, educational attainment, household income.

    b. Ensuring that relevant **data and aggregates are compiled as part of routine National Accounts production** according to international standards (System of National Accounts, 2008). This includes data on ICT investment, broken down by asset, and value added and employment series with sufficient industry detail to allow Digital Economy-related aggregates to be compiled (including totals for Information Industries and sectors by digital intensity.

    c. Regularly conducting **surveys of ICT usage in households and by individuals**[12], according to international guidelines (OECD, 2015b UNCTAD, 2009), including questions to assess various ICT tasks and skills, including in work settings. These surveys should gather sufficient data to produce breakdowns of personal characteristics – at a minimum gender, age, educational attainment, household income. Surveys of ICT usage in business are also encouraged and can be used to assess the demand for and use of ICT skills by businesses.

    d. (Continuing to) take part in the OECD **Programme for International Student Assessment (PISA)**, including the ICT familiarity to assess young peoples' access to digital technology at home and school, and their capabilities around digital technologies. PISA rounds occur every three years and the 2024 round is currently welcoming participants (https://www.oecd.org/pisa/).

    e. (Continuing to) take part in the OECD **Programme for International Assessment of Adult Competencies (PIAAC)** which is not only used to measure a wide range of digital and complementary skills but also underpins analyses of the ICT task-intensity of jobs. The PIAAC is conducted in rounds every 10 years. The second round is currently underway (https://www.oecd.org/skills/piaac/).

    f. Ensuring **administrative registers** or other suitable sources can be used to deliver **statistics on new graduates** in relevant fields of education (namely natural sciences, engineering, ICTs, and creative and content fields).

    g. Collecting and compiling **international trade data relevant to the Digital Economy** according to international standards (UNCTAD, 2009; OECD-WTO-IMF, 2020) and with sufficient product detail to produce figures for imports and exports of ICT goods, ICT services, and digitally-deliverable services.

    In general, a key foundation for these is ensuring that National Statistics Offices or other relevant bodies are mandated and sufficiently resourced – both financially and in terms of skills and capabilities - to undertake these activities.

2. The resulting data could then be used to **produce the G20 indicators on Jobs, Skills, and Growth in the Digital Economy**:

    a. **Regularly**, with annual production being the aim for most indicators – although frequency might be adjusted according to countries' needs, collectively defined. In addition, regular production allows emerging trends to be monitored and compared across countries (including by calculating incremental changes in indicators from period-to-period).

    b. In a **timely** manner that keeps lags to a minimum and thereby maximises the benefit that can be gained from these indicators.

    c. With sufficient **disaggregation** to allow differences in the engagement of key groups within G20 societies, its differing impacts on those groups to be understood. These include: workers, women, youth, low income households, and individuals with low educational attainment.

3. **Disseminate the indicators and data** at national and international levels:

    a. Indicators should be made **publicly available**, including online in accessible formats.

    b. Data should be fed into relevant **international collections and databases** hosted by International Organisations:

        i. ILO annual ILOSTAT questionnaire (occupation data)

[11] https://ilostat.ilo.org/resources/lfs-resources/

[12] These are most often conducted as stand-alone surveys but sometimes modules in other surveys, such as LFS, are used.

   ii. ITU and OECD collections of data on ICT usage in households and by individuals (data on skills and ICT tasks)

   iii. OECD STAN/ICIO/TiVA databases (data for indicators related to value added, value chains, employment by industry)

   iv. UNESCO-OECD-EUROSTAT joint collection of education statistics (graduates data)

   v. UNCTAD Information Society Information and Communication Technology Database (data for international trade indicators)

c. It could also be considered to establish a central database for the G20 indicators (including sets for other measurement pillars, to be agreed in future). This would optimise dissemination and facilitate monitoring implementation. However, it would be necessary to establish related governance arrangements and to secure the necessary financial and human resources on an ongoing basis.

4. Supporting and monitoring implementation

a. **Experience-sharing** will be important in encouraging adoption of the indicators across the G20 and beyond.

   i. The DETF could consider providing time for experience sharing and monitoring implementation, this could be achieved, for example, through an annual workshop on Digital Economy indicators (see the Roadmap in chapter 4).

   ii. Committees, Working Parties, and conferences hosted by International Organisations can also provide valuable opportunities for experience sharing and showcasing the G20 indicators to promote wider uptake.

   iii. Bi-lateral experience sharing between countries can also be valuable and is encouraged

b. A more intensive process of **capacity enhancement** may also be helpful to some countries. International Organisations are mandated to help countries build capacity in data collection and processing. Countries are encouraged to take up this support as needed to deliver the G20 indicators on Jobs, Skills, and Growth in the Digital Economy.

5. Reviewing and developing

a. The DETF could consider establishing a **multi-stakeholder approach for reviewing** the G20 indicators in terms of:

   i. The extent to which they meet user needs and help to guide policy

   ii. Availability and comparability across countries

   iii. Developments in data, tools, measurement approaches, guidelines, etc. that could inform improvements including the potential addition of new G20 indicators offering additional insights. This includes, for example, common definitions for digital skills levels.

   iv. Links with SDG indicators to leverage potential complementarities and avoid duplication.

b. Various initiatives are already underway that can lay the foundations for future improvements. G20 countries are encouraged to **support, actively engage in, and help to shape efforts to better conceptualise and measure aspects related to Jobs, Skills, and Growth the Digital Economy** including:

   i. ILO efforts to develop agreed definitions of digital skills levels.

   ii. Implementing the OECD-WTO-IMF Handbook on Measuring Digital Trade (OECD-WTO-IMF, 2020) to improve measures of digital trade.

   iii. Efforts to populate the OECD Framework for Digital Supply-Use Tables (OECD, 2019g) to gain improved insights on the contributions various sectors make to the Digital Economy.

   iv. Eurostat/ILO/OECD efforts to measure economic activity facilitated by online platforms and platform work.

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Appendix A

Taxonomy of sectors by digital-intensity, overall ranking, 2013-15

ISIC Rev.4 industry denomination	Quartile intensity	ISIC Rev.4 industry denomination	Quartile intensity
Agriculture, forestry, fishing	Low	Wholesale and retail trade, repair	Medium-high
Mining and quarrying	Low	Transportation and storage	Low
Food products, beverages and tobacco	Low	Accommodation and food service activities	Low
Textiles, wearing apparel, leather	Medium-low	Publishing, audiovisual and broadcasting	Medium-high
Wood and paper products, and printing	Medium-high	Telecommunications	High
Coke and refined petroleum products	Medium-low	IT and other information services	High
Chemicals and chemical products	Medium-low	Finance and insurance	High
Pharmaceutical products	Medium-low	Real estate	Low
Rubber and plastics products	Medium-low	Legal and accounting activities, etc.	High
Basic metals and fabricated metal products	Medium-low	Scientific research and development	High
Computer, electronic, optical products	Medium-high	Advertising and other business services	High
Electrical equipment	Medium-high	Administrative and support service	High
Machinery and equipment n.e.c.	Medium-high	Public administration and defence	Medium-high
Transport equipment	High	Education	Medium-low
Furniture; other manufacturing; repairs	Medium-high	Human health activities	Medium-low
Electricity, gas, steam and air cond.	Low	Residential care and social work activities	Medium-low
Water supply; sewerage, waste	Low	Arts, entertainment and recreation	Medium-high
Construction	Low	Other service activities	High

Source: Calvino et al. (2018) based on Annual National Accounts, STAN, ICIO, PIAAC, International Federation of Robotics, World Bank, Eurostat Digital Economy and Society Statistics, national Labour Force Surveys, US CPS, INTAN-Invest and other national sources.

These are generalised findings across the countries for which the necessary data are available:

> Argentina, Australia, Austria, Belgium, Bulgaria, Brazil, Canada, Chile, Colombia, Costa Rica, Cyprus, Czech, Republic, Germany, Denmark, Estonia, Finland, France, Greece, Croatia, Hungary, Indonesia, Ireland, Iceland, Israel, Italy, Japan, Korea, Latvia, Lithuania, Luxembourg, Malta, Mexico, Netherlands, Norway, New Zealand, the People's Republic of China, Poland, Portugal, Romania, Russian Federation, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom, United States.

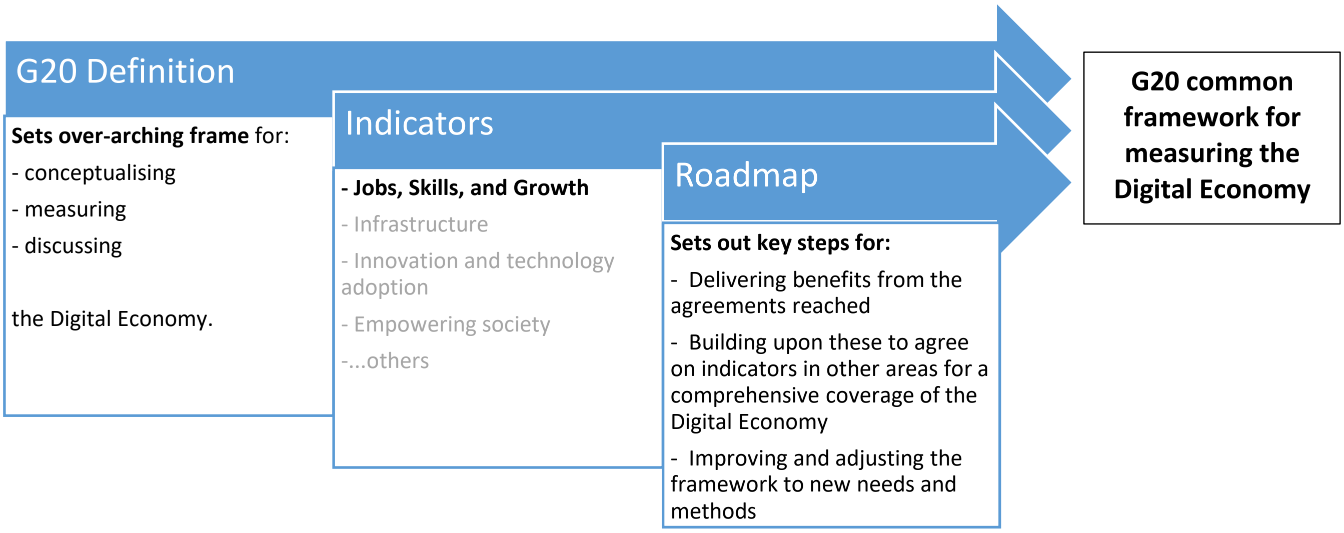
Nevertheless, countries will vary in the degree of digital transformation attained overall, both in general and in individual sectors.

Chapter 4 - Roadmap toward a common framework for measuring the Digital Economy

This chapter provides practical steps to advance *Toward A G20 Common Framework for Measuring the Digital Economy*. Key elements are the widespread use of the G20 definition of the Digital Economy (set out in chapter 2) and the regular production of key indicators on jobs, skills, and growth (presented in chapter 3) across countries. In doing so, the chapter attempts to account for countries' different capacities in terms of data infrastructure and statistical resources, while setting out clear, actionable recommendations for policy makers and national statistical offices (NSOs) to implement.

Together, the G20 definition and agreed indicators on jobs, skills, and growth represent key foundations for and contributions to a G20 common framework for measuring the Digital Economy. Nevertheless, in order to realise value from this effort, the G20 definition must become widely used within the G20 and beyond. In addition, the agreed indicators on jobs, skills, and growth must be routinely produced and published across G20 countries. Furthermore, G20 countries should work to develop and agree additional indicators offering new insights both in the area of jobs, skills, and growth, as highlighted in chapter 3, and in complementary areas including the other themes set out in the G20 Toolkit for Measuring the Digital Economy (*G20 DETF, 2018*), as well as data flows measurement, digital services and platforms, or Digital Government. Beyond the definitional aspects and the choice of indicators, together with the methodologies and tools to produce them, countries should work for institutional and capacity building and enhancement activities for implementation to be effective and sustainable. Such sustained and ongoing effort will achieve a comprehensive and useful G20 framework for measuring the Digital Economy that is both robust on paper and insightful in practice. **Figure 1** summarises this process.

Figure 1. Toward a G20 common framework for measuring the Digital Economy



Source: OECD

1. Introduction

The G20 has been actively promoting efforts to improve measurement of the Digital Economy at the international level. In 2016 in Hangzou, G20 leaders committed to "collectively leverage the opportunities and address the challenges of an increasingly digital world" by creating the G20 Digital Economy Development and Cooperation Initiative and the Digital Economy Task-Force (DETF). The following year, the 2017 Dusseldorf Ministerial Declaration encouraged countries to reflect the measurement of the Digital Economy in national statistics in a comprehensive way and to review existing statistical frameworks. Under the Argentinian G20 presidency, the 2018 G20 Toolkit for Measuring the Digital Economy was published to highlight methodological approaches and indicators used to monitor the Digital Economy as well as key gaps and challenges regarding Digital Economy measurement for further study. In 2019, under the Japanese presidency, Digital Ministers agreed that the "*Digital divide should be addressed with a commitment to evidence-based policy approaches together with the efforts to improve the measurement of the Digital Economy that enable the widest possible adoption and use of innovative technology*."

Nevertheless, there is still room for further progress *toward a G20 Common Framework for measuring the Digital Economy.* The value of such a common framework, comprising basic agreements regarding how the Digital Economy is conceptualised and measured would be twofold. Firstly, describing trends and understanding where G20 economies stand with respect to the ongoing digital transformation requires comparable statistics and indicators based on common definitions and inclusion criteria. Secondly, agreeing on key definitions also enables policy makers to frame the policy agenda and identify the key actors involved, facilitating dialogue and enabling policy to shape the Digital Economy at national and international levels.

This report makes several further steps, *toward a G20 Common Framework for Measuring the Digital* Economy:

1. **Establishing a common definition of the Digital Economy** for adoption across the G20 and beyond. This step was prioritised to a single frame for policy debates and to guide the harmonisation of measures related to the Digital Economy across the G20.

2. **A suite of key indicators for monitoring developments related to Jobs Skills, Growth in the Digital Economy**. This area was chosen amongst the themes set out in the *G20 Toolkit* for *Measuring the Digital Economy* due to the profound impacts that the Digital Economy is driving in labour markets and national economies, bearing important consequences on the availability and nature of employment, the rate of productivity growth as well as having material impacts on people's lives and social issues such as gender parity.

This progress builds upon existing frameworks, definitions, and indicators and is the result of close collaboration between Intergovernmental and International Organisations (IOs) - OECD, the European Commission, ILO, IMF, ITU, UNSD, and UNCTAD, under the guidance of the G20 Digital Economy Task Force. It also draws upon a survey of Digital Economy definitions and measurement initiatives in G20 countries conducted in the context of this report. Findings from this were outlined in chapters 2 and 3.

However, these steps alone do not achieve a holistic framework for measuring the Digital Economy. It is necessary to turn concepts and agreements into implementation, which includes building the necessary structures and capacity. Furthermore, a comprehensive measurement framework needs to move beyond the discussed measures for jobs, skills and growth to address all areas covered by the agreed definition of the Digital Economy. This chapter aims to set out a roadmap for both of these areas of work, defining clear objectives and actions, which contribute to committing all relevant stakeholders to action as well as defining their roles, and enabling countries and International Organisations to establish immediate priorities. It therefore also provides a frame for assessing progress moving forward.

The Saudi Arabia Presidency of the G20 provided directions for the overall outline for this roadmap, identifying key actions to be included. The roadmap was then developed in drafting by the OECD and with input from other collaborating International organisations with the DETF providing input and guidance at a workshop convened in May 2020. Given the expansive and continuously changing nature of the Digital Economy, it is necessary to take immediate actions to understand its evolution and impacts and to maintain an active role in updating and adapting Digital Economy measurement frameworks. It is therefore critical that countries in the G20 and beyond, with help and support from International Organisations, rise to the challenges of measuring and understanding the Digital Economy and are thereby able to optimise policies allowing everyone to prosper in an ever-expanding Digital Economy.

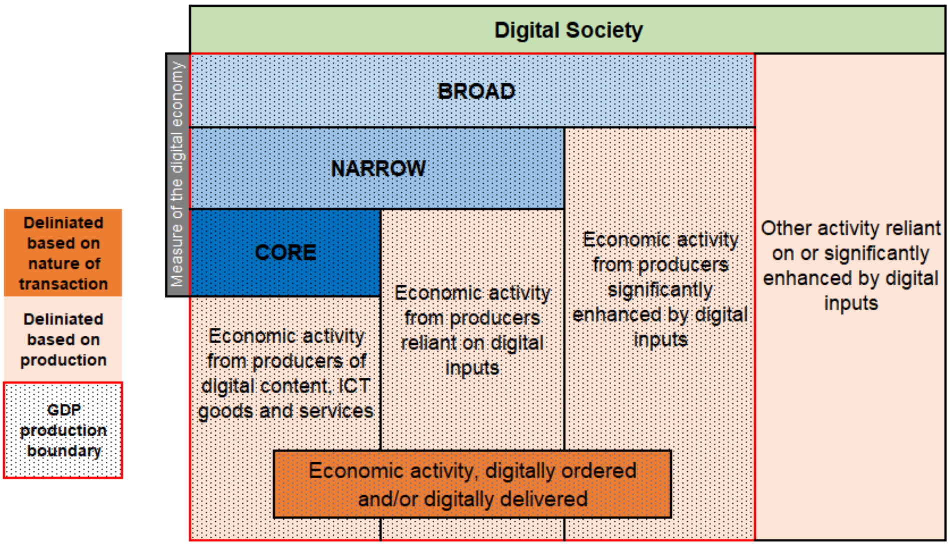
2. Conceptual framework

Before outlining a *Roadmap toward a Common Framework for Measuring the Digital Economy*, it is necessary to consider what that framework might look like in terms of components and mechanisms. From this, key **areas of work** for DETF attention and effort by countries can be identified. To develop the framework, a series of fundamental questions can be considered.

The first overarching questions that need answering to build a framework for both Digital Economy measurement and policy, are "*what is actually understood by the concept of the Digital Economy?"* and *"which other key concepts contribute to or make up the Digital Economy*?". Despite abundant literature on the matter, a key limiting factor, thus far, has been a lack of agreement around the object of discussion and analysis. For this reason, any measurement framework will need be founded upon **a common *definition* of the Digital Economy** as well as other key related concepts that complement and operationalise it.

This report contributes to moving forward by defining the Digital Economy as *incorporating "all economic activity reliant on, or significantly enhanced by the use of digital inputs, including digital technologies, digital infrastructure, digital services and data. It refers to all producers and consumers, including government, that are utilising these digital inputs in their economic activities".* This is further conceptualised and operationalised through a tiered approach that allows flexibility and scalability in setting the boundaries used when considering different policy and measurement issues (Figure 2). Following an extensive review of available literature, as well as considering advantages and limitations of different limitations (see chapter 2), this sets out a flexible and inclusive way of describing the Digital Economy as a collection of "tiers" each being necessary but none sufficient in isolation to describe the Digital Economy. In doing so, it reflects the evolving nature of the concept and the need for a definition that can be used for economic measurement as well as framing broad political discussions.

Figure 2. G20 tiered definition of the Digital Economy



Source: OECD

With a common definition in hand, essential questions that follow include "*which are the fundamental factors affecting the evolution and development of Digital Economy?"* and "*what are the relationships between them?*". Such questions are the subject of intense ongoing research and debate. Nevertheless, it is possible to identify various ***measurement pillars*** -comprising key enablers, dynamics, and areas profoundly impacted by digital transformation - in which indicators need to be developed, agreed, and monitored in order to paint a comprehensive picture of the Digital Economy and its evolution. The first four measurement pillars identified for inclusion in the G20 common framework follow the themes set out in the *G20 Toolkit for measuring the Digital Economy (G20, 2018)*: Infrastructure; Technology adoption and innovation; Empowering society; Jobs, Skills, and Growth. These could also be complemented by others as necessary and as developments in data and methodologies allow. Chapter 2 of this report has pointed to several potential areas which, following ongoing development efforts, could eventually be considered for inclusion in the framework (i.e. data and data flows; online platforms). DETF delegates also strongly highlighted interest in developing indicators on Digital Government as well as Cybersecurity, Data Privacy and Child online security. This could be achieved within the theme *Empowering Society,* which covers a wide array of aspects of how the digital transformation is impacting society. It could also be developed as a standalone measurement pillar with a dedicated set of indicators. Similarly, while the suggested pillar of *Technology adoption and Innovation* currently includes Cloud Computing and E-commerce, these themes could be treated as separate, standalone pillars.

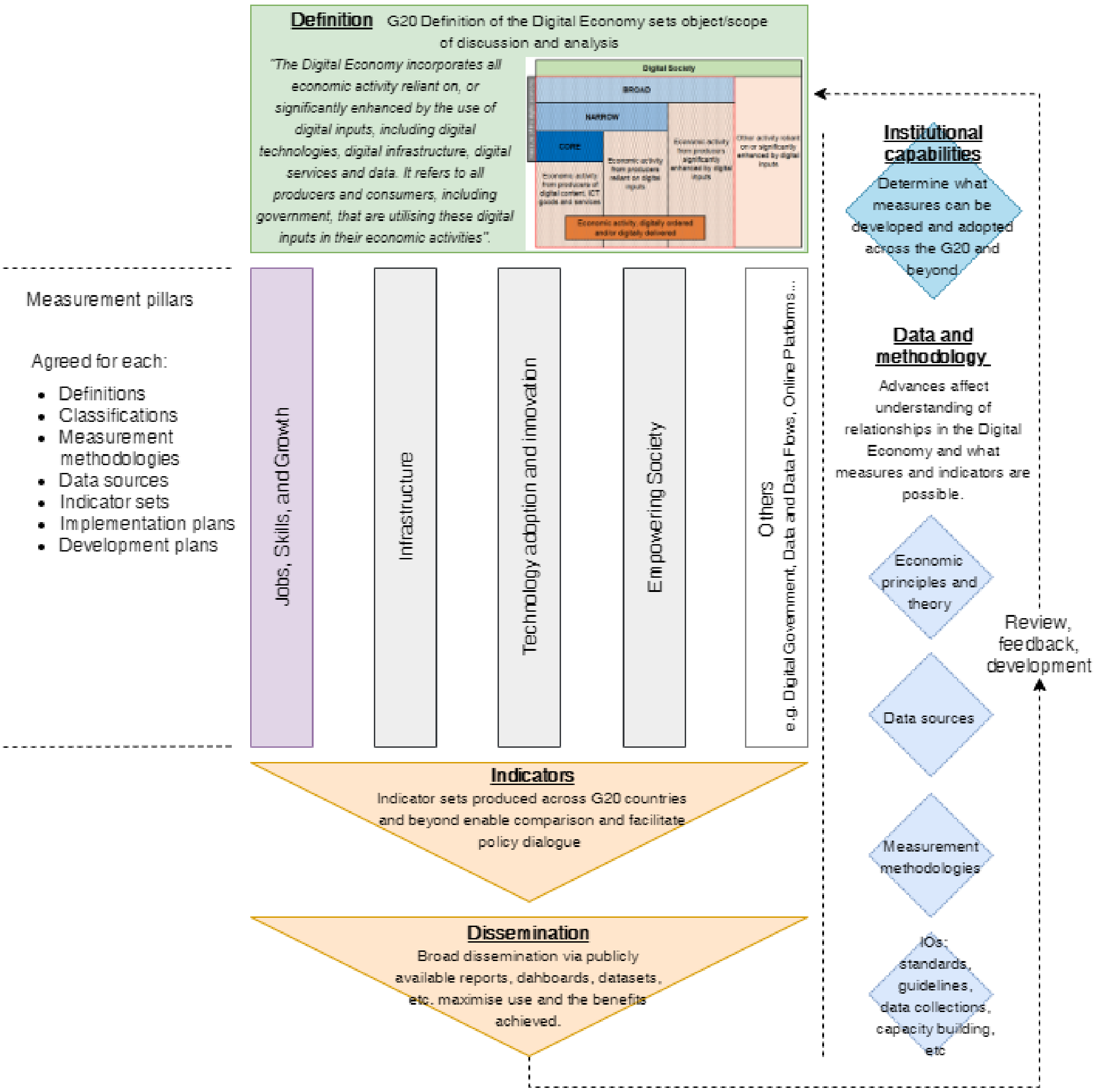
Within each of these measurement pillars, a key question is "*which indicators best capture these factors and relationships to provide understanding and insights?*". With the aim being to establish sets of **agreed *indicators*** that can paint a reasonably meaningful and nuanced picture of the Digital Economy that also reflects priority issues and considerations such as gender parity and other aspects of inequality.

The answer depends primarily on what indicators available ***data sources and measurement methodologies*** can deliver, as indicators are only useful for benchmarking and comparison if they are available for a sufficient body of countries. In this respect, it must also ensure that the ***institutional capabilities*** exist to apply these methodologies across G20 countries and beyond to deliver indicators regularly. Action in these work areas will therefore be key to further developing additional useful indicators across all measurement pillars. International Organisations' contributions such as standards, guidance, frameworks, coordinated data collections, and capacity building efforts play a vital role in helping to drive progress. These underpin a process of ***review, feedback, and development*** leading to continuous improvement of the framework and across all measurement pillars (e.g. through the inclusion of additional indicators).

A final vital element is ***dissemination*** of the resulting indicators so that they can be used for analysis and policymaking in both national and international contexts. This includes feeding into the international data collections coordinated by International Organisations. It is a vital principle that indicators, as well as associated datasets, should be made available online, in open formats in order to enable broad use and maximise the insights gained.

Figure 3 brings these elements together to form a G20 Common Framework for Measuring the Digital Economy.

Figure 3: G20 comprehensive framework for measuring the Digital Economy



Source: OECD

Chapter 3 starts to "build out" this framework. Focussing on the Jobs, Skills, and Growth measurement pillar, it looks at the indicators available across various sub-topics, considering the underlying measurement methodologies, definitions and data sources. From these, a common set of indicators is identified that aims to give a meaningful and sufficiently broad view while also offering good coverage across G20 economies. The detailed reasoning for these choices, as well as links to economic principles and theory are presented in chapter 3.

Going forward, a key question will be "*what new or alternative data sources, measurement methodologies and indicators can be developed to further and refine the current understanding of the Digital Economy and its various impacts on society*?". Ongoing developments in data sources and accompanying measurement methodologies as well as the tools available for handling, analysing, and presenting data will allow useful new indicators to be developed and considered for inclusion in the set of indicators. To support this with regards to Jobs, Skills, and Growth, chapter 3 highlights various useful indicators and approaches which, through coordinated effort, could be further developed and mainstreamed across G20 countries and beyond.

The breadth and diversity of indicators presented in the *G20 Toolkit for Measuring the Digital Economy* (G20, 2018), as well as in chapter 1 of this report, demonstrates that jobs, skills, and growth is undoubtedly only one part of the framework needed to comprehensively measure and monitor the Digital Economy. It is also a telling illustration of the relevance of a tiered definition for the Digital Economy as the concept extends beyond purely economic variables, and its impact on growth and welfare can only be properly assessed through a multifaceted framework. As such, there is a clear need for to continue to "build out" the framework. The work on Jobs, Skills, and Growth, set out in chapter 3, provides a template for further such efforts.

On this basis, five complementary work areas for DETF and country effort can be identified:

1. **Definition**: build agreement around what we understand by the Digital Economy (sectors, activities, tasks) and the policy questions that motivate its analysis.
2. **Indicators**: reach consensus about which are fundamental indicators that can describe the Digital Economy and inform related policies, consistent with (1). The G20 has already advanced on at least four sets of basic indicators through the 2018 G20 Toolkit: Jobs, Skills, Infrastructure, Technology adoption and innovation, and Empowering Society.
3. **Data and methodology**: share best practices and experience regarding sources of data, methodologies, and tools to produce agreed indicators.
4. **Dissemination of indicators**: share best practices and recommendations regarding frequency and modes of publishing data and indicators, and how to facilitate data pooling for international comparability by international organisations.
5. **Institutional arrangements and capabilities**: share recommendations and best practices regarding which institutional capacities are needed (e.g. skilled staff in government offices, digital infrastructure); how to best engage with IOs and relevant stakeholders to enhance measurement efforts; management and institutional capabilities to promote international cooperation and collaboration. These actions can help ensure that (1)-(4) are undertaken on an on-going basis so that the measurement framework evolves and improves over time by adjusting to emerging policy needs and leveraging new data sources and experience.

3. A Roadmap toward a common framework for measuring the Digital Economy

With a view to concretise the discussions in this year's areas of work and to establish potential horizons to advance on other areas of work, the following Roadmap sets out practical steps to advance towards achieving a comprehensive G20 Common Framework for Measuring the Digital Economy.

Consistent with the constituting elements of the measurement framework shown in Figure 3, the proposed steps are organised across the five areas of work previously identified and allocated between the main actors involved: G20 countries, the DETF and Intergovernmental and International Organisations (IOs). Other actors such as civil society and the private sector are nonetheless included.

Given progress made in the DETF in 2020, actions and next steps in each of the five areas of work are as follows.

3.1. Definitions and concepts

G20 countries are encouraged to consider:

a. Using the definition proposed in this report as a starting point in their work on the Digital Economy going forward
b. Identifying further elements needed to operationalise the definition which require further research and discussion. Items to be prioritised include:
   i. Defining common categories and standardised levels for digital skills across G20 countries might be needed to improve measurement. For instance, recent work by the ILO identifies two types of measurement of digital skills: supply side (through employees surveys or direct skills testing) and demand side (vacancies and scraped online job postings) which could be further investigated, as well as the ILO Guidelines on measuring digital skills mis-match.
   ii. Additional concepts such as "ICT-task intensive jobs" or the "digital intensive sectors", currently defined and operationalised by the OECD, might require further definition and official agreement at the DETF level.

iii. Developing further guidelines and working practices necessary to operationalise the definition. A key example relates to delineating digitally reliant and digitally enhanced activities to operationalise the "narrow" and "broad" tiers of the Digital Economy definition.
iv. In operationalising the definition of the Digital Economy, strong coordination between IOs and countries will be needed, starting with ensuring the indicators are gathered and used in international collections.

c. Sharing experiences in operationalising the definition through the DETF and other fora, including IOs.

The DETF can support and further these efforts by considering:

a. Reporting on the use of the definition of the Digital Economy for measurement purposes in G20 countries and beyond.
b. Guiding further measurement efforts by suggesting policy priorities.

Finally, IOs are encouraged to help facilitate mainstreaming the definition by using it in their analysis and frameworks.

3.2. Indicators

G20 countries are encouraged to consider:

a. Working towards the production of the full suite of indicators on Jobs, Skills and Growth.
b. Taking steps to improve indicators, including coordinated creative use of ICT surveys and other sources, taking advantage of measurement guidance being developed by IOs, e.g. efforts to implement the measures set out in the OECD-WTO-IMF Handbook on Measuring Digital Trade and the OECD Framework for Digital Supply-Use Tables or other relevant measurement initiatives, for instance the European Commission's iDESI framework, the UNESCO's Roam-X indicators or the UNCTAD's *Information economy indicators*.

The DETF can support and further that effort by considering:

a. Undertaking work to discuss indicator sets for other measurement pillars presented in the in the 2018 G20 Toolkit for Measuring the Digital Economy: Infrastructure, Empowering society, Technology adoption and innovation.
b. Identifying further measurement pillars for development where necessary. These could cover, for example, key topics identified by DETF participants such as Digital Government; Digital Security; Data and data flows; and Online platforms.
c. Incorporating indicators in DETF reporting and analysis, reviewing discussed indicator sets and adjusting them according to relevant developments.

Finally, IOs are encouraged to continue to collaborate and contribute toward such further developments. Inclusion of other stakeholders involved in Digital Economy measurement work, such as national administrations, academia, the private sector and civil society, is also important to ensure that the chosen indicators reflect and adapt to society's needs, as recommended in section 4.

3.3. Data and methodology

G20 countries are encouraged to consider:

a. Making sure they have or putting in place foundational infrastructures for collecting relevant data, following internationally accepted standards and practices. Various international guidelines help to set definitions, standards and guide countries in developing and harmonising statistical systems for measuring a range of aspects jobs, skills, and growth in the Digital Economy. These include:
    i. ILO Labour Force Survey resources
    ii. ITU Manual for Measuring ICT Access and Use by Households and Individuals (*ITU, 2014*)
    iii. OECD Guidelines for Supply-Use Tables for the Digital Economy (*OECD, 2020*)
    iv. OECD Model Survey on ICT Usage by Businesses (*OECD, 2015b*)
    v. OECD Model Survey on ICT Access and Usage by Households and Individuals (*OECD, 2015a)*
    vi. OECD Programme for International Student Assessment (https://www.oecd.org/pisa/test/)
    vii. OECD-WTO-IMF Handbook on Measuring Digital Trade (*OECD-WTO-IMF, 2020*)
    viii. UNCTAD Manual for the Production of Statistics on the Information Economy (UNCTAD, 2009)
    ix. System of National Accounts 2008 (*EC, IMF, OECD, UN*, and *WBG, 2008*)

b. Producing all indicators through data collection approaches (e.g. surveys) that accord with internationally accepted practice, standards, and classifications.
c. Collecting data and leveraging existing data to support (e.g. through sufficient sample sizes) key breakdowns on relevant characteristics that are sufficiently robust to be published. Particular focuses include gender and youth, which have been recognised by the DETF as key priorities to foster inclusive growth of the Digital Economy. As such, collections should at least support breakdowns by gender, sex, age group, educational attainment, and household income for individuals; and employment size-band and industry for firms. In addition, monitoring trends for each indicator is an overarching goal and as such, where the chosen indicators show absolute values (e.g. the employment share of ICT professionals in a given year), countries should ensure that data enable incremental changes in the indicators to be analysed as well.
d. Establishing and improving input-output tables.
e. For some aspects of the Digital Economy, collecting data at the national level can be challenging and coordinated international collection mechanisms might be more optimal. This is particularly the case for platform services measurement: given the increasing number of platforms operating internationally, leaving data collection to the national level could hinder coherence and exhaustiveness. An international approach is already being developed by Eurostat, which in 2019 reached an agreement with major accommodation platforms to provide data for aggregation into descriptive statistics (*European Commission, 2020).*

3.4. Dissemination of indicators

G20 countries are encouraged to consider:

a. Producing indicators regularly, as permitted by national circumstances (at least every 3 years but greater frequency is strongly encouraged),
b. Making the resulting indicators and datasets publicly available and fed into international statistical collections facilitated by IOs.
c. Ensuring that key outputs, including reports, indicators, and datasets available online in accessible formats. This includes by feeding into international data collections coordinated by International Organisations.

The **DETF can support** and further these efforts by considering reporting on the production of these indicators across G20 countries and beyond, taking into account the links between the indicators adopted and the SDGs to make sure they align.

3.5. Institutional arrangements and capabilities

G20 countries are encouraged to consider:

a. Developing, including through the provision of training, the necessary digital skills that will enable public officials, especially those in National Statistical Offices, to engage in the new activities that this Roadmap entails. In particular, best practice exchanges between NSOs, as well as with IOs, are encouraged. This includes on the processing and handling of large volumes of data, the use of complementary non-survey data sources and techniques (e.g. web-scraped data), etc.
b. Investing in digital infrastructure for statistics, including but not limited to data storage and processing infrastructure and complementary data analysis software, within reasonable budget constraints.
c. Seeking complementary management knowledge and capabilities to engage with relevant stakeholders and explore partnerships that could enhance measurement efforts, including collaborating with the private sector to explore alternative sources of data and measurement techniques.
d. Supporting a multi stakeholder approach, enabling dialogue between businesses, government, and other actors from civil society to strengthen the evidence base for measurement of the Digital Economy.
e. Engaging in multilateral fora, including but not limited to those facilitated through International Organisations leading measurement discussions, and strengthen multilateral collaboration and cooperation to share best practices and experiences and facilitate knowledge transfer.

4. Recommendations

Overall, this chapter presents a high-level *Roadmap toward a Common Framework for Measuring the Digital Economy*. It identifies the key areas of work that the G20 Common Framework should include. It combines short-term and long-term view in identifying actions that can be taken today to lay the foundations for future improvements including new indicators offering beneficial insights according to policy priorities. It then sets out steps needed to concretise the key outcomes of the report -namely, adopting the definition of the digital Economy and the set of indicators on Jobs, Skills and Growth. This provides a basis for an ongoing work process under the DETF.

This final section sets out a set of key recommendations regarding how to capitalise upon and continue the work set out in the roadmap:

1. The broad uptake of agreed definitions, measurement approaches and proposed data collection methods will require **experience and best practice sharing between G20 countries** (e.g. between National Statistical Organisations) and capacity building and enhancement from IOs. This will ensure greater harmonisation of measurement methods and the comparability of the data collected across G20 countries and beyond. In particular, it is recommended to establish an annual workshop, in the context of the G20 DETF, to monitor uptake, share experiences, and identify best practices in operationalising the G20 definition of the Digital Economy and implementing the G20 indicators on Jobs, Skills, and Growth in the Digital Economy. Furthermore, this would provide a forum for identifying and further developing the identified areas of work including additional measurement pillars.

2. **Countries should fully utilise and work to improve existing statistical infrastructures.** A fundamental enabler for this is the provision of sufficient financial resources as well as necessary skills and expertise to put in place statistical infrastructures that can meet measurement needs now and in the future. Specific examples are populating digital supply-use tables (DSUTs), measuring transactions in line with the *Handbook on Measuring Digital Trade* (2020), and ICT usage surveys to look in detail at the impacts of digital transformation at work, on well-being, and on key groups within society.

3. **Developing alternative (non-survey) sources of data, including private sector data sources, and data gathered from the Internet might become necessary to measure certain indicators describing more qualitative phenomena** – including on skills, inclusiveness, and business activities (*OECD, 2019a*). Web-reading techniques may enable the search for and retrieval of information online that may not otherwise be available with comparable levels of timeliness, detail and exhaustiveness (*Bean, 2016*). The ILO is preparing a publication on the feasibility of using big data for skills anticipation and matching that could provide useful input in that area. Nevertheless, primary level survey sources and other authenticated sources may often be privileged for quality reasons.

4. In doing so, **a multi stakeholder approach, enabling dialogue between businesses, government and other actors from civil society** will serve to strengthen the evidence base and complement current statistics to develop new interdisciplinary approaches to data collection. **The G20 should support and contribute to relevant initiatives by other actors**. For example, the work led by private non-for-profit international consortia to consolidate online registers of organisations, curating administrative data sources published by governments and public bodies, and rendering them accessible and usable online (*OECD, 2019a*). Coordination with the ITU could also further align future G20 indicators with those currently use to monitor progress toward the SDGs.

5. In particular, **public-private partnerships should be further developed**. Progress on measuring data flows will require further study of the role and nature of data in business models and private sector data can usefully complement traditional sources (i.e. surveys) with new insights (e.g. on skills demand by employers displayed in online job postings). G20 countries should develop a **fruitful dialogue with the owners of Internet-based platforms** that are facilitating growing shares of online activity and have access to the associated digital footprint (OECD, 2019a).

6. Countries must therefore **recognise and act upon the "*need to support statistical operations and capacity building in G20 members, [and also] in developing countries*"** (*G20 Digital Economy Ministerial Declaration, 2018*). Progress will depend not only definitional and conceptual developments, but also the budgetary and physical resources that governments will be able to allocate to enhance NSO's capacity to engage with new work streams. At all times, data should be gathered and stored in accordance with best practice with respect to governance and security to maintain personal and corporate confidentiality. The example of EU-ASEAN cooperation on the development of an ASEAN digital index based on the Digital Economy and Society Index (DESI) methodology offers an example of cooperative capacity building and the value of experience sharing.

7. **The resulting indicators, and where possible datasets, should be made publicly available,** including through international statistical collections coordinated by IOs. International Organisations are also encouraged to ensure these indicators are gathered and used in their work. This would allow G20 indicators to contribute to monitoring progress against relevant Sustainable Development Goals (SDGs). As such, the indicators are also of relevance to non-G20 countries, these should be encouraged to progressively take up the G20 suite of indicators (e.g. as part of capacity-building missions by IOs).

8. **Regular reassessment and updating of the indicators and methods in use** should be a key feature of countries' approach to measuring the Digital Economy. NSOs should promote innovation and flexibility with the "*progressive inclusion of new relevant indicators that reflect the Digital Economy's growth and its empowering impact on individuals and businesses*", by making statistical systems more responsive to the new aspects of the Digital Economy (*G20 DETF, 2018*).

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