CONNECTING OFFICIAL DEVELOPMENT ASSISTANCE AND SCIENCE, TECHNOLOGY AND INNOVATION FOR INCLUSIVE DEVELOPMENT: MEASUREMENT CHALLENGES FROM A DEVELOPMENT ASSISTANCE COMMITTEE PERSPECTIVE

Fredrik Ericsson and Sam Mealy

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Comments on the present Working Paper are welcomed and may be sent to sam.mealy@oecd.org — the Development Co-operation Directorate, OECD, 2 rue André-Pascal, 75775 Paris Cedex 16, France.

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Abbreviations and acronyms

AAAA	Addis Ababa Action Agenda
AI	Artificial intelligence
CRS	Creditor Reporting System
DAC	Development Assistance Committee
EDGE	Enhanced Data rates for GSM Evolution
GDP	Gross domestic product
GERD	Gross domestic expenditure on research and development
GPRS	General Packet Radio Service
IATT	United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs
IOT	Internet of Things
IP	Intellectual property
IXP	Internet exchange point
LDC	Least developed countries
LMIC	Lower middle-income countries
LTE	Long-term evolution
NCD	Non-communicable disease.
NGO	Non-governmental organisation.
NLP	Natural language processing
ODA	Official development assistance
ODF	Official development finance
OOF	Other official flows
Other LIC	Low-income countries that are not LDCs
PPP	Private public partnerships
R&D	Research and (experimental) development
SDG	Sustainable Development Goals
SME	Small and medium enterprises
STI	Science, technology and innovation
TFM	Technology facilitation mechanism
TOSSD	Total official support for sustainable development
UMIC	Upper middle-income countries.
USF	Universal Service Fund

Executive summary

Advancements in science and technology are important drivers of economic growth and have the potential to transform economies and societies. Investments in the search for new knowledge and the development of new technologies and innovations are central to any economy for greater utilisation of resources and to strengthen its competitiveness vis-à-vis other economies. The rapid expansion of information and communication technologies (ICTs) are resulting in an increasingly connected world, where developing countries have the opportunity to leapfrog development stages by directly adopting new and cleaner technologies.

Greater investments are needed to strengthen countries' research capacity and exploit the benefits of modern technologies. Despite the rapid development in access to ICTs, many countries still lack skills, resources and strategies for further investments in digital infrastructure and for progressing in the transition towards digital societies. While investments in infrastructure are often driven by the private sector, public spending and development co-operation fill important gaps where the private sector lacks incentives to intervene. The 2030 Agenda for Sustainable Development acknowledged the importance of Science, Technology and Innovation (STI) for development and established new international mechanisms to help strengthen developing countries' STI capacity towards the achievements of the Sustainable Development Goals (SDGs), such the creation of the Multi-stakeholder Forum on Science Technology and Innovation for the SDGs that convenes once a year under the auspices of the President of ECOSOC (see Resolution 70/1 of the United Nations General Assembly).

Measuring countries' efforts in promoting STI and ODA have both long histories, but still use different definitions and standards. The first edition of the OECD Frascati Manual, the international standard on collecting resources devoted to research and development (R&D), was released in 1963. The same year, the first Development Assistance Committee (DAC) Recommendation on Financial Terms and Conditions was agreed, setting out initial conditions for what later would become official development assistance (ODA). The definitions, statistical standards, and reporting directives of these concepts have since evolved through discussions and agreements within their own policy communities. As a result, the definitions and standards used and the granularity of tracking of financial resources are not consistent between the two policy communities.[1] It will be important that the STI and development communities deepen their collaboration and reach consensus on tracking STI-related development finance and develop together new policy recommendations and best practices on international co-operation for STI development.

This paper tests a methodology to assess STI-related development finance starting from development finance data reported to the OECD. Using this experimental methodology, it estimates that total development finance to STI have averaged USD

[1] This paper approaches development financing to STI using DAC standards, definitions and tools. As such, it could not align with core OECD definitions on R&D and innovation set out in the OECD Frascati Manual and the guidelines for collecting, reporting and using data on innovation in the Oslo Manual. A key conclusion of the paper is the need for better alignment of definitions across communities so each can satisfy its need for data-driven policy analysis without creating potential conflicts of interpretation.

14 billion between 2010 and 2016. The majority of these resources, USD 10 billion, are provided as concessional finance from DAC members and multilateral agencies. The largest share of concessional finance supports research activities relating to challenges of developing countries. While most research is grant-based, investments relating to ICTs and other technologies are often financed through concessional and non-concessional loans, in particular by multilateral development banks. Private philanthropy has grown to be a significant contributor towards research, in particular for research activities in the health sector.

Based on this experimental methodology some tentative policy implications are offered on financing STI in a development context. More resources in soft infrastructure can result in faster economic growth and progression towards a digital economy**.** While the development of digital infrastructure are often led by private investors, development providers can support the digital transformation by focusing on education and strengthening citizens' digital skills, provide capacity building to governments and businesses, and support the development of innovation-friendly policies and strategies. Development providers can also examine how digital tools and other technologies can improve their planning and implementation of development projects for improved results and better monitoring and evaluation.

ODA-eligible research activities needs to be further examined. While additional funding towards research aimed to tackle challenges in developing countries is encouraged, there is a risk of dilution of resources aimed for development projects and programmes in favour of research, which is often conducted by universities and research institutions in donor countries. Increasingly global challenges and a greater share of ODA supporting national interests, e.g. research conducted in donor countries, necessitates further assessments on how the new knowledge gained from those activities benefit developing countries. Further enhancements of the DAC statistical systems, in close collaboration with the OECD body responsible for STI statistics, namely the OECD Working Party of National Experts on Science and Technology Indicators (NESTI) within the Committee for Scientific and Technological Policy (CSTP) and the OECD Working Party on Measurement and Analyses of the Digital Economy (MADE) within the Committee on Digital Economy Policy (DEP), can contribute to more granular assessments of ODA-eligible research funding, and to explore the share of resources, which are aimed to strengthen the capacities of universities and other institutions in developing countries.

1. Introduction

The creation and diffusion of new knowledge and technologies are important drivers of economic growth and sustainable development. Investments in STI are widely recognised as crucial means towards the development of a stronger economy and upgrading towards more sophisticated and environmentally sustainable economic activities. Investments in research and infrastructure for ICTs are resulting in an increasingly connected world, where information and "know-how" flow faster than ever before.

Developing countries have the potential to leapfrog development by directly adopting new and cleaner technologies. These economies can benefit from peer learning to avoid mistakes previously made by other countries while setting their own development trajectories. While most countries have adopted broadband policies or strategies, more infrastructure investments are necessary to ensure reliable connections and universal access to ICTs. However, access to ICTs is not enough. Additional efforts are needed to strengthen domestic capacity, especially in digital literacy, higher education and other research institutions, to better exploit the full benefits of ICTs and set sustainable growth paths for the future.

The adoption of the 2030 Agenda at the United Nations Sustainable Development Summit 2015 recognised the importance and cross-cutting nature of STI towards the Sustainable Development Goals (SDGs). Access to new knowledge, innovation, and new technologies can catalyse efforts and contribute to faster achievement of many of the SDGs. To accelerate this process, new technology mechanisms to support knowledge-transfers and strengthen countries' STI capacities were launched at the 2015 Summit and through the Addis Ababa Action Agenda (AAAA), which was agreed at the Third International Conference on Financing for Development in July 2015.

These efforts are driven by the major differences within and across countries in access to science and technology. While some developing countries are on track to catch up, or even surpass, many advanced economies in research spending and the adoption of new technologies, other countries are still struggling with basic social and infrastructure needs, such as basic education and access to electricity. If these basic needs are not addressed, there is a risk that the technology gap will widen across countries in the coming years. Similarly, large digital divides persist within countries. Women, the elderly and people with lower education or living in rural areas have disproportionately less access to ICTs.

In the divided digital world, official development assistance (ODA) and other development finance play crucial roles. If countries are to have the opportunity to leapfrog development stages, then it is not only important for ODA to continue to assist countries to overcome basic development challenges, but also to support countries to improve productivity through better use of new technologies and to help build capacity and incentives for further innovation. ODA resources can also contribute towards research and to find solutions to the "grand challenges", such as climate change and infectious diseases, which disproportionally affect less developed countries.

The aim of this paper is to examine STI-related official development finance (ODF) from a development perspective. It forms part of DAC Secretariat's well-established work to analyse the distribution of ODA by sectors.[2] It builds upon previous work and the report *Official Development Finance in the SDG era: a sectoral overview*. The paper seeks to complement analyses made by the United Nations Inter-agency Task Team on Science, Technology and Innovation in mapping existing STI initiatives, mechanisms and programmes by for the first time analysing development finance data at activity level using the DAC Creditor Reporting System (CRS). It is intended to highlight the possibilities and challenges in using the CRS as a source for tracking international government support to STI in an international development assistance context.

The paper examines development finance for the three components of STI: science, technology and innovation. The analysis on technology is somewhat biased towards international support for ICT development; however, efforts have been made to also include technology transfers in other sectors, in particular relating to green technologies and renewable energy. While support for ICT development does not necessarily result in new knowledge, ICTs are fundamental towards the development of a knowledge economy. Investments in ICTs provide the necessary infrastructure for facilitating knowledge transfers, both directly through the Internet, but also indirectly as it contributes to building domestic capacity in developing, maintaining and using ICTs. It is also necessary for building a digital economy, which can bring wide benefits for social and economic development. This paper addresses the importance of innovation and aims to identify ODA activities supporting innovation or using innovative approaches. However, the current CRS structure does not lend itself to robust identification of activities supporting entrepreneurship or innovation policy. For these reasons, support to innovation may be underestimated.

The structure of this paper is as follows. The first section of this paper presents an introduction to the concept of STI and addresses the cross-cutting nature of STI in support of the SDGs. It presents key definitions and concepts and displays some of the main STI trends, in particular relating to research and (experimental) development (R&D) spending and ICT development. It highlights efforts made to increase access to STI in developing countries and explains the transformational effect of ICTs on the economy. It also highlights common barriers faced by many developing counties in fully utilising new technologies. The third section presents the approach to identify STI-related activities in the CRS, and discusses opportunities and limitations with the data. The fourth section of this paper presents the main trends in ODF in support of STI for the SDGs, including by development providers, financial instruments, key sectors and receiving countries and regions. This section also presents new data on how private foundations support STI activities, and showcases additional initiatives from the private sector to support countries' efforts to further expand ICT access, use and digital skills. The last section of the paper provides policy recommendations and highlight areas of further work. The full methodology of identifying activities in the CRS are presented in Annex A.

[2] For more information relating to DAC Secretariat's work in analysing ODA to sectors, please see http://www.oecd.org/dac/financing-sustainable-development/development-finance-topics/

2. The importance of science, technology and innovation for inclusive development

Advancements in science and technology have the potential to transform economies and create new economic opportunities. Investments in STI are a fundamental pillar of any economy in its path to development. While science, technology and innovation can be thought of as three separate concepts, they all represent investments towards new knowledge and practical applications to improve the current state of knowledge. The interlinkages between science, technology and innovation also makes these terms difficult to dissect. Modern research is often dependent on access and use of modern technologies. Similarly, the development of new technologies and other innovations are often products of research conducted in public institutions, such as universities, and private corporations or other entities.

2.1. The cross-cutting nature of sciences, technology and innovation and international efforts

The adoption of the 2030 Agenda for Sustainable Development in 2015 recognised the crucial importance of STI as key enablers to reaching several of the 17 goals. While agricultural research and technological development can support increasing the productive capacity in developing countries and contribute to food security (Goal 2), access to technologies can promote women's empowerment (Goal 5) and ensure youth and adults develop the right competencies required for employment and the jobs of the future (Goal 4). Investments in research and new technologies are also central to making progress in areas such as health (Goal 3), energy (Goal 7), protecting the environment (Goal 14), build resilient infrastructure and foster innovation (Goal 9), and strive for inclusive and sustainable economic growth and consumption patterns (Goal 8 and 12).

Due to the cross-cutting nature of STI, research and new technologies and innovations are more considered as enablers for the SDGs rather than a goal in itself. Most SDGs have specific STI-related targets, such as increase investments in research, facilitate capacity building and technology transfers to developing countries, and to promote policies that support entrepreneurship and innovation. Out of the 232 indicators in the Global indicator framework for the SDGs, there are at least 16 indicators, which directly relate to STI (See Annex C). However, indirectly, progress across several other SDGs and targets depend on the development and implementation of new knowledge and technologies. Therefore, the list of SDG goals and targets, which mention or benefit from enhancements in STI is significantly longer.

The AAAA recognised the need for additional international support in building domestic capacity to harness new technologies and incentivise innovation and new research towards the attainment of the SDGs. The AAAA acknowledged the great need for capacity building and developing national policies and strategies that create an enabling environment and incentivise research and innovation in developing countries. The creation of domestic STI strategies and their integration into national sustainable development strategies are key for countries to increase national research capacity and skillsets, and to take advantage of ICTs and other modern technologies for countries' future development. Development providers committed to support these efforts and enhance their international support, including ODA, "*for effective and targeted capacity-building in developing* *countries*" and transfer "*economically sound technologies to developing countries on favourable terms*" (United Nations, 2015[1]).

The commitment to establish a new, multi-stakeholder Technology Facilitation Mechanism (TFM) was central to the AAAA's efforts to scale up and strengthen international co-operation on STI. The key outcome of the TFM is an online platform for information sharing on STI initiatives, mechanisms and programs to support the attainment of the SDGs (see Box 2.1). It also established a collaborative multi-stakeholder Forum on Science, Technology and Innovation for the SDGs (STI Forum), which meets once a year to discuss STI co-operation for the implementation of the SDGs. The United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs (IATT) leads the implementation of these initiatives. The IATT consists of 35 international organisations and is supported by a multi-stakeholder group consisting of ten experts from civil society, the scientific community and the private sector.

Box 2.1. The Technology Facilitation Mechanism online platform

The main purpose for establishing an online platform is to facilitate knowledge sharing on STI initiatives, mechanisms and programs. More precisely, the TFM online platform will:

- Contain a mapping and serve as a gateway for STI initiatives, mechanisms and programmes.
- Provide access to information on best practices and lessons learned on STI facilitation initiatives and policies.
- Disseminate open access scientific publications.

The online platform is expected to go beyond development providers and multilateral agencies and contain business and technology requests and offers by private actors, as well as information about events and trainings.

A demo version of the online platform was launched in May 2018 and can be accessed at http://ec2-18-208-31-215.compute-1.amazonaws.com. The demo version also allows disaggregation of all initiatives and opportunities by SDG and country.

Source: UN dedicated website for the Technology Facilitation Mechanism at: (UNDESA, 2019[2]).

Current efforts aim to harmonise the international support to STI. One of the key topics of the first STI forums has been to enhance the support to countries to develop STI roadmaps. While many of the international organisations participating in the IATT already support countries' STI efforts through capacity building and analytical work, these efforts are often fragmented and not necessarily have a focus on the SDGs. One of the first tasks of the IATT was therefore to assess different STI initiatives conducted by IATT members. The mapping included 1600 activities across 20 different UN agencies with a total budget of around USD 1 billion. The mapping revealed that the primary objectives of more than half of the initiatives were related to technology, one-third science-related, and roughly 10-20% related to innovation (IATT-STI, 2017[3]).

The mandate of agencies determines their area of focus. The mapping also showed differences in priorities across agencies. For example, UNIDO focus mainly on industrial innovation and technology transfer at local level, FAO and UNESCO mainly support science through global partnerships, and the focus of ITU and UN Environment are largely related to norm-setting and technical assistance in the area of technology. Other agencies, such as WIPO and the World Bank have a more diverse focus. Several agencies supported countries developing STI policy frameworks, including UNCTAD, UNESCO, UNIDO, UNECE, UNESCAP and the World Bank (IATT-STI, 2017[3]).

Strong commitments to strengthen developing countries' STI capacities were already made in 2011. The declaration made at the Fourth United Nations Conference on the Least Developed Countries (LDCs) in Istanbul in 2011 welcomed the establishment of a technology bank dedicated to LDCs. The Istanbul Programme of Action for The Least Developed Countries for the Decade 2011–2020 included the establishment of a "*Technology Bank and Science, Technology and Information supporting mechanism, dedicated to least developed countries which would help improve least developed countries' scientific research and innovation base, promote networking among researchers and research institutions, help least developed countries access and utilise critical technologies, and draw together bilateral initiatives and support by multilateral institutions and the private sector, building on the existing international initiatives.*" The AAAA and the 2030 Agenda for Sustainable Development reaffirmed the importance of this mechanism and requested, through SDG target 17.8, for it to be "*fully operationalised by 2017*".

A new UN institution supporting STI is taking shape. United Nations General Assembly officially established the Technology Bank as a new UN institution in 2016; however, it took until June 2018 to inaugurate the Technology Bank's headquarters in Gebze, Turkey. In 2018, the Technology Bank are planning to conduct STI reviews and technology-need assessments in five LDCs and improve access for scientists and researchers to data, publications and STI initiatives in another twelve.

The importance of STI for development and the attainment of the SDGs is growing in importance. The digitalisation of societies and economies have the potential to serve as a catalyst in making progress towards many of the SDGs. Several international declarations have recognised the growing importance and cross-cutting nature of STI. Countries and organisations have agreed on ambitious commitments, which have already resulted in new international entities and an increasing awareness of the importance to further support the development of national STI policies, and integrate new knowledge and technologies in development co-operation delivery.

2.2. The growing importance of research & development

Investments in science are often measured through the resources dedicated to R&D. Science relates to the study of natural and social phenomena using certain formal methods (systematic, empirical, replicable) (UNESCO, 2017[4]) R&D is a sub-set of science on which there is generally international consensus as to how it is measure. The OECD Frascati Manual is the international standard on collecting and using statistics on the financial and human resources devoted to R&D. The Frascati Manual defines R&D as the "*the creative and systematic work undertaken in order to increase the stock of knowledge – including knowledge of humankind, culture and society – and to devise new applications of available knowledge*". (OECD, 2015[5]) There are five core criteria that needs to be satisfied for an activity to count as R&D. Box 2.2 presents the basic principles for activities to be considered as R&D.

R&D is classified into three types: basic research, applied research and experimental development. Basic research represents "*experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.*" Basic research is usually performed in higher education or in public institutions where the researcher has some freedom and may not have any predefined views of the potential applications of the findings. Applied research is directed "*primarily towards a specific, practical aim or objective.*" It often uses findings from basic research, but aims to find applications of the knowledge. Experimental development is "*systematic work, drawing on knowledge gained from research and practical experience and producing additional knowledge, which is directed to producing new products or processes or to improving existing products or processes.*" However, this categorisation of R&D is not meant to be interpreted as linear as it is possible that findings from experimental development can adapt or change basic knowledge. The key criteria determining the type of R&D is the expected use of the results, in particular how far in the future and in what field the knowledge can lead to any application.

Box 2.2. The principles for Research and Development (R&D)

The OECD Frascati Manual was first developed in 1963 and set the international standard for R&D statistics. While the objectives of an R&D activity can differ, the fundamental principle of R&D is that the aim of the activity should always be to generate new knowledge. There are five fundamental criteria, which all must be satisfied for an activity to be considered R&D:

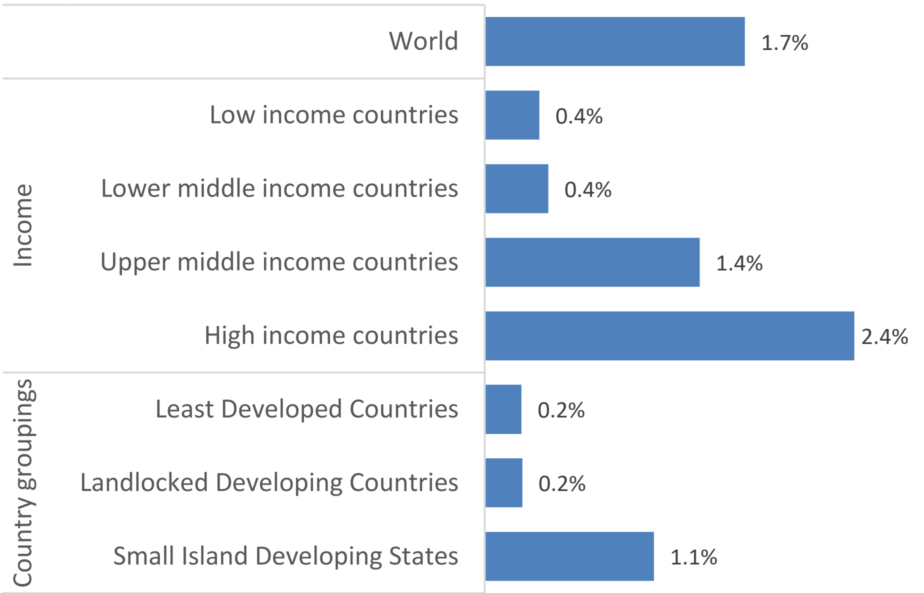
- Novel: the aim of the activity must result in new findings. Activities that simply aim to replicate a previous activity are not considered novel and should not count as R&D.
- Creative: the activity must add knowledge by incorporating new concept or ideas. Changes in existing processes can only be considered R&D if new methods are applied to improve current processes.
- Uncertain: The final outcome, the time and the cost required are often not known from the start of the activity. This uncertainty is a key criterion for activities to be classified as R&D.
- Systematic: The treatment of the activity must be done in a systematic way, meaning the purpose and source of funding as well as the records of the process and outcome should be prepared and made available.
- Transferable and/or reproducible: The new knowledge should have the potential to be transferred and the results should be able to be reproduced.

Source: Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development. (OECD, 2015[5]). http://dx.doi.org/10.1787/9789264239012-en

The inclusion of R&D investments in the calculation of gross domestic product (GDP) has spurred further demand for R&D data. While always being closely linked to the System of National Accounts (SNA), the 2008 revision of the SNA adopted the Frascati definitions and derived data to change the treatment of R&D from being intermediate consumption to investments. This change had implications on the calculation of GDP as R&D would be considered production. The re-classification resulted in an increase in GDP by on average 2.2 percentage points in OECD countries. (OECD, 2015[6]) By changing the status of R&D to become part of GDP, the 2008 revision of the SNA resulted in an increase in the demand for disaggregation of R&D activities.

In 2015, countries spent on average 1.7% of their GDP on research and development; however, with large variations across countries. While high-income countries spent 2.4% of GDP on R&D, low-income and lower middle-income countries only spent 0.4% of their GDP on research. Transforming these percentages into monetary terms reveal even greater discrepancies. In 2015, high-income countries spent approximately 615 times more on R&D than low-income countries. While upper-middle income countries are rapidly increasing research spending, driven largely by the increase efforts by the People's Republic of China, R&D as a share of GDP is static in low- and lower middle-income countries. The absence of STI strategies and policies hinders many countries from taking advantage of the possibilities of STI for development. Elaborating policies that create a friendly business climate and which incentivises research and development can bring additional investments for economic growth. Figure 2.1 shows R&D spending as a share of GDP for various country groups in 2015.

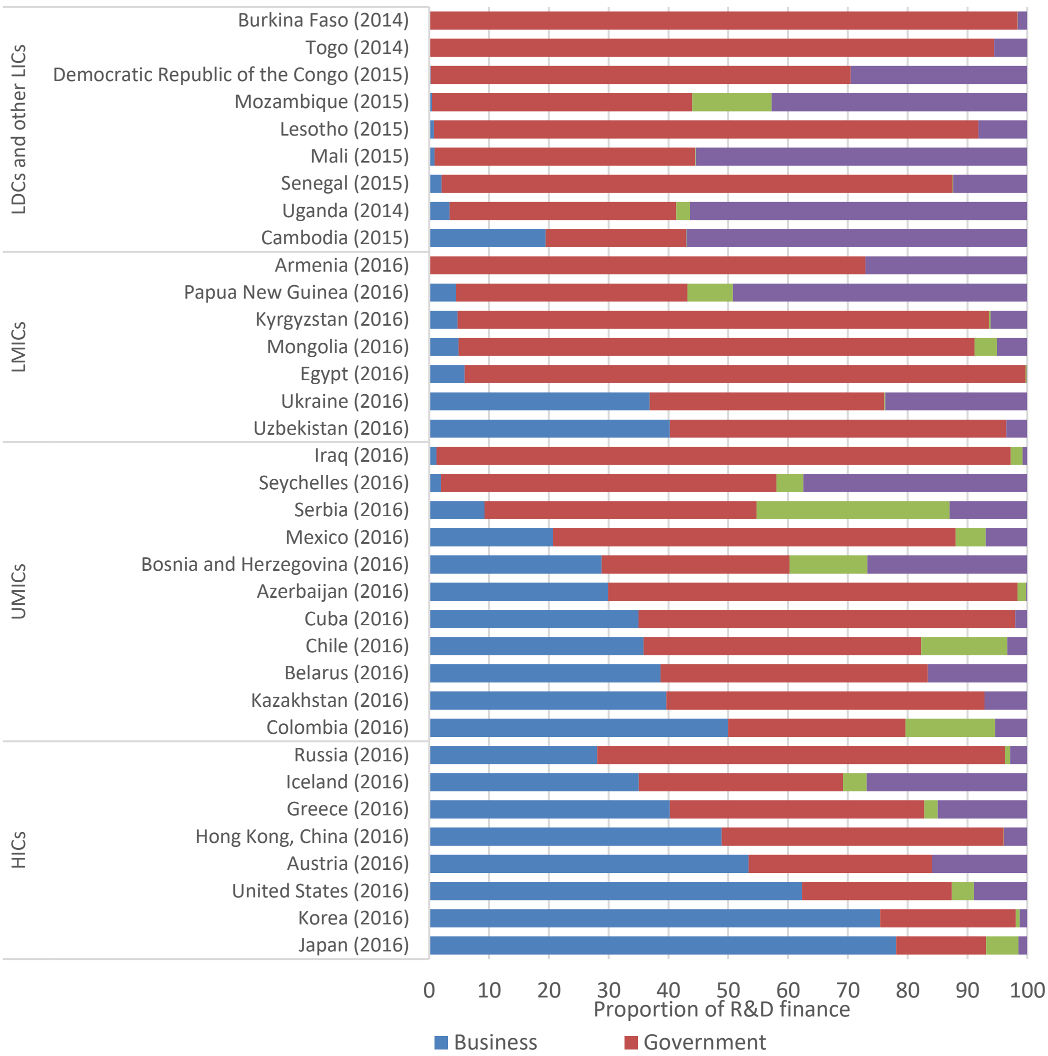
Figure 2.1. Gross domestic expenditure on R&D as percentage of GDP (2015)



Source: (UNESCO, 2018[7]) Institute for Statistics (UIS). http://uis.unesco.org/

As countries become richer, the private sector tends to replace the government as the main vehicle for R&D. In low and lower-middle income countries, nearly all funding for R&D is provided by the government or, in some cases, from other countries and international organisations. Only a minor share of R&D resources is coming from the private sector. In upper middle-income countries, the government is still the main funder of R&D; however, a significant share of R&D resources come from businesses. In many high-income countries, businesses are the main contributors towards R&D; however, with some variations across countries. In Japan, for example, nearly 80% of all R&D funding stem from businesses, while the government and R&D funding from abroad still represent the majority in countries in Eastern Europe. Figure 2.2 shows the funding source of R&D spent for selected countries across the different income groups.

Figure 2.2. Gross domestic expenditure on R&D by finance (%; selected countries between 2014 and 2016)



Note: The category "Other" encompass finance by the following categories: "private non-profit", "rest of the world (abroad)" and "not specified source". The category "rest of the world (abroad)" refers to:
a) all institutions and individuals without a location, place of production or premises within the economic territory on which or from which the unit engages and intends to continue engaging, either indefinitely or over a finite but long period of time, in economic activities and transactions on a significant scale; and
b) all international organisations and supranational entities including facilities and operations within the country's borders.
Source: (UNESCO, 2018[7]) Institute for Statistics (UIS) http://uis.unesco.org/

2.2.1. ODA criteria for R&D spending has evolved over time

The definition of ODA is constantly evolving; however, the original concepts of supporting countries´ economic development through concessional resources remains key principles. ODA has a long history with the first DAC Recommendation on Financial Terms and Conditions agreed in 1963. However, the eligible expenditures to be counted as ODA has evolved since with decisions to include administrative costs, imputed student costs and refugee costs during the 1970s and 1980s. (Hynes and Scott, 2013[8]). Similarly, the statistical reporting of ODA has evolved through the decades, moving from aggregates to activity-based reporting through the Creditor Reporting System.

Government funding for R&D spending can be considered as ODA under certain conditions. For an activity to qualify as ODA, there are four main criteria that needs to be fulfilled:

- The activity must have the economic development and welfare of developing countries as its main objective.
- The activity must support countries and territories on the DAC List of ODA Recipients.
- The financing must be provided by official agencies, including state and local governments, or by their executive agencies
- The financing has to be concessional in nature, e.g. provided as grants or soft loans.

If a research activity fulfils these four criteria it can be counted as ODA. There are no specific conditions as to the specific location of the research in the DAC directives. Research conducted in universities or in other public institutions in donor countries can therefore be considered as ODA as long as the research is financed by the public sector and aimed to address challenges of developing countries.

Increasingly global challenges make ODA eligible research harder to determine. The directives and rules on ODA eligibility are rather vague in their definition of research and which research costs can be counted as ODA. For example, while there are several diseases which mainly affect developing countries, e.g. malaria, and for which the argument for ODA eligibility is rather strong, non-communicable diseases (NCDs) often pose a greater threat to the welfare of developing countries. The World Health Organization (WHO) estimates that over 85% of all deaths caused by NCDs occur in low and middle-income countries. Any advancement in the prevention or treatment of these diseases will no doubt have a positive effect on the economic development and welfare of developing countries. For the moment, only activities focused on the prevention of communicable diseases anywhere and research and activities focused on NCDs conducted in developing countries are classified as ODA.

The new measure of total official support for sustainable development (TOSSD) can contribute to better tracking on research for global challenges. According to the definition, only research spending which has the economic development and welfare of developing countries as its main objective can be counted as ODA. Consequently, research spending relating to global challenges, which does not qualify as ODA, is often not reported to the DAC statistical systems. However, these resources are still very important contributions to improve the well-being of people in both developed and developing countries. The answer may lie in a new, broader measure on development finance, which is currently being developed by the international community. This new measure, referred to as TOSSD (see box 2.3), aim to improve the tracking of all officially-support resources supporting global public goods, including also research for global challenges. TOSSD reporting instructions are expected to be finalised in 2019, and will include the modalities of eligibility for research activities.

These is a distinction between conducting research projects and strengthening the institutional research capacity in developing countries. Institutions in developed countries with collaborators in developing countries often manage research projects and programmes. One of the main aims of such partnership is to benefit from the, often, greater research capacity in developed countries and the local, contextual knowledge in developing countries. However, it is difficult to assess to what extent the knowledge generated from these projects contributes to strengthening the institutional research capacity of developing countries. It is also not possible in DAC statistics to precisely determine the shares of research spending allocated to the in-donor country institutions and the partners' institutions in developing countries. Therefore, it is not possible to precisely distinguish between ODA funding aimed to strengthen countries' domestic STI capacity and funding for more specific research activities, which often are conducted in donor countries. The distinction is, however, very important for developing countries' prospects in strengthening its research capacities at universities and other institutions.

There is a need for further work to better assess and determine the boundaries of ODA-eligible research. The current ODA definition of research is vague and may need further clarification, especially considering the introduction of TOSSD and increasingly global challenges. It will also be important to improve the DAC statistical systems to better distinguish between research funding and international collaboration focused on strengthening domestic STI capacity in developing countries and other research activities conducted by universities and research institutions in donor countries.

2.3. Innovation is an important driver of development

Innovation is key to increase productivity and output for any firm or economy. As a term, it is broader than R&D and includes all steps towards the implementation of innovations. The Oslo Manual is the international source for the collection, reporting and use of data on innovation activities. While most previous efforts have aimed to measure innovation in the business sector, the 2018 edition of the Oslo Manual provides a general definition of innovation that is applicable to all sectors in the economy. The Oslo Manual defines an innovation as "*a new or improved product or process (or combination thereof) that differs significantly from the unit's previous products or processes and that has been made available to potential users (product) or brought into use by the unit (process)*" (OECD/Eurostat, 2018[9]).

Innovation can be considered both an outcome and an activity. While the former implies innovations that change specific products, the latter implies changes to business processes. The Oslo Manual defines a business innovation as "*a new or improved product or business process (or combination thereof) that differs significantly from the firm's previous products or business processes and that has been introduced on the market or brought into use by the firm.*" The product can be either a good or a service. Innovation activities "*include all developmental, financial and commercial activities undertaken by a firm that are intended to result in an innovation for the firm*". Based on its definition, it is not a requirement that an innovation activity or outcome is successful. It is also not a requirement that an innovation has a positive effect on society or the financial results of a firm.

Box 2.3. Total official support for sustainable development

The international community is developing a new international statistical measure on development finance. This new measure, total official support for sustainable development (TOSSD), aims to track all resources invested to achieve the SDGs, and will – for the first time – allow transparency of the full array of officially supported bilateral and multilateral financial flows to developing countries as well as South-South co-operation for sustainable development.

TOSSD will cover all officially supported resources regardless of the channel and financial instrument used. It will enable the international community to monitor all resources supporting the SDGs beyond ODA, including private resources that are mobilised through official means. It will also track international support for development enablers and global challenges – currently lacking in global development finance statistics.

Originating from work at the OECD-DAC to align its statistical system with today's development finance landscape, an international, multi-stakeholder Task Force was established in July 2017 to further develop the new measure of TOSSD. The Task Force was a response to the commitment made in AAAA to "hold open, inclusive and transparent discussions on the modernization of the ODA measurement and on the proposed measure of total official support for sustainable development".

The TOSSD Task Force is made up of statistical and development policy experts from provider countries, developing countries, emerging providers and multilateral institutions. The Task Force will prepare a first set of reporting instructions with the overall aim to seek an international agreement on TOSSD in 2019 and the integration of TOSSD in the SDG monitoring framework in 2020.

Source: (OECD, 2019[10]), What is total official support for sustainable development (TOSSD)? https://www.oecd.org/dac/financing-sustainable-development/tossd.htm

Innovation includes, but also goes beyond, R&D. An innovative activity can include R&D activities, but also includes efforts to strengthen organisational capacity to develop new products, processes, or marketing or other methods to increase the firm's performance. This can include purchasing knowledge, technology, machinery, or provide trainings for individuals to learn about new products or adapt to new processes or methods. Trainings and capacity building exercises can therefore be considered innovation if they lead to a new way of working.

Patent data can provide additional insights in measuring innovation and technological performance. The AAAA recognised the importance of creating enabling environments which incentivise innovation, including having "*adequate, balanced and effective protection of intellectual property rights*" and "*voluntary patent pooling and other business models, which can enhance access to technology and foster innovation*". The World Intellectual Property Organization (WIPO) is the United Nations specialised agency leading the development of a balanced and effective international intellectual property (IP) system, which enables innovation and creativity. Intellectual property is protected in law through patents, copyright and trademarks to ensure inventors earn recognition or financial benefit from their inventions. Patent data is a unique source of information as it can contribute to assess innovation and the technological performance across countries.

Measuring amounts spent in support of innovation is challenging. Data on firms' innovation activities are collected through innovation surveys. These surveys can capture firms' motives, obstacles and types of innovation in which they are engaged. However, it is difficult to accurately calculate innovation expenditures since these types of costs are not specified in firms' financial accounts. Moreover, countries do not collect systematic information on the sources of funding for innovation expenditures. The DAC statistical system on development activities is also not designed to capture innovation expenditures. While many development activities can include innovative approaches, including the use of innovative financing mechanisms, it does not necessarily mean that the activities supports innovation, but rather represent innovation in the delivery of development assistance.[3] It is also difficult to determine the outcomes from capacity-building exercises, in particular whether the training leads to innovation in products, processes or methods. The approach used in this paper to assess official development finance towards innovation generally excludes capacity-building exercises.

The Development Assistance Committee (DAC) is intensifying its efforts to support innovation. The DAC High Level Meeting in 2017 recognised the need for the DAC to step up its focus on innovation for development: *"Innovation is an essential enabler for both improved development co-operation practices and quick and effective responses to development co-operation challenges. We intend to gather evidence, facilitate and encourage the sharing of good practices and experiences, foster platforms on innovative policies, tools and practices so that DAC members can increase their knowledge and implement innovative programming that delivers humanitarian and development impact in ways that are better than existing approaches."* The DAC are also discussing ways to improve knowledge sharing, promote learning, and incentivise innovation in development co-operation policies and practices.

DAC members are discussing new ways to measure innovation for development. In 2018, the Working Party on Development Finance Statistics (WP-STAT) discussed a proposal to create a new policy marker in the CRS to better track innovative development activities (DAC WP-STAT, 2018[11]). While the details of such marker are not yet defined, the proposal to add a new marker on innovation signals DAC members' increasing ambition towards greater innovation in how development co-operation is planned and implemented.

2.4. The transformational effect of information, communication technologies in society and the economy

Technology is the application of scientific knowledge for practical purposes. While there are many technological developments across many fields, most references in STI policy are linked to the digital transformation and the access and use of modern information, communication technologies (ICTs). However, ICTs are more than just access and use of the Internet and the development of a digital economy. It also relates to the use of ICTs to create more efficient systems for effective and reliable service delivery and to improve productivity in a large number of sectors. For example. ICTs contribute to improve energy efficiency and low-carbon energy production, enhance agricultural and industry

[3] Innovative financing for development refers to initiatives that aim to raise new funds for development, or optimise the use of traditional funding sources. For more information about innovative financing, see http://www.oecd.org/dac/stats/beyond-oda-innovative-financing-for-development.htm.

productivity, support trade facilitation, and improving the delivery of humanitarian aid and other social services. However, while technological improvements are made across many sectors, technological convergence often includes elements of communication networks and fast processing of data. For these reasons, this section will focus on the digital development and the current opportunities and challenges in access and use of ICTs in developing countries.

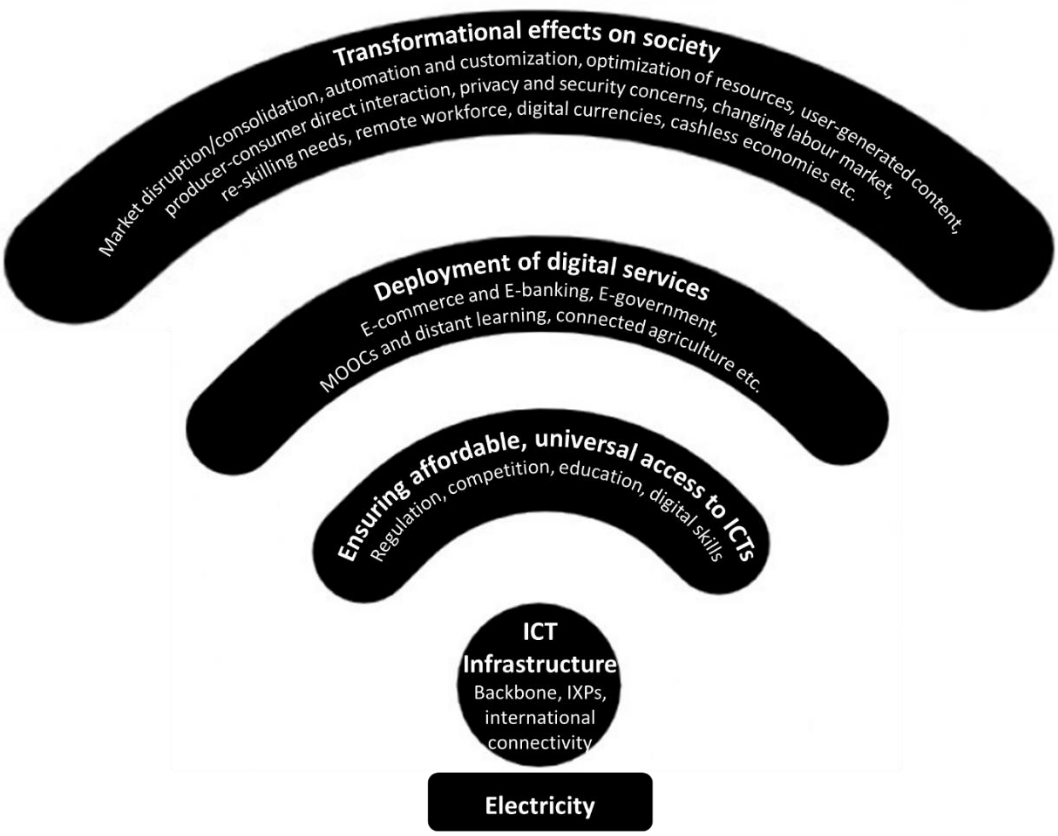
The World Economic Forum identifies four levels of Internet maturity among users. The aim is to "*provide a common vocabulary for the extent to which the internet is incorporated into individuals' lives, and facilitates discussion between the public, private and civic spheres*".

- Level one consists of users with basic Internet skills, and limit their use to web browsing and communication through emails and use of social media. These activities can often be performed even with limited connectivity.
- Level two users refer to greater incorporation and dependence of the Internet, such as using apps, streaming videos and shopping online. These activities typically requires reliable and relatively fast connectivity.
- Level three users are more reliant on the Internet for personal and professional reasons, often owning multiple devices and using cloud storage. This type of usage require fast and widespread mobile connectivity.
- Level four maturity refers to the reliance on ICTs for more advanced use, including connectivity between devices, Internet of Things (IoT) and the use of artificial intelligence (AI) and machine learning technologies for quick processing of data. This maturity level often requires fixed connections with very high speed.

The World Economic Forum also anticipates a fifth level with needs for even greater demands in speeds and service quality, e.g. relating to self-driven cars, holographic video conferencing and internet-enabled medical implants. The levels of Internet maturity can be useful to define a framework of ICT skills, adjust education policies, and to plan for future ICT infrastructure to ensure networks has the "*sufficient capacity, quality and speed to support more advanced usage."* (World Economic Forum, 2018[12])

The transformational effect of ICTs on the economy can catalyse development for faster progress towards the attainment of the SDGs. Overall, connecting people and devices through ICT technologies can have widespread benefits throughout society and on the economy. The future possibilities of IoT and AI bring yet another dimension to how the use of ICTs can contribute to lowering transaction costs, improving system efficiency and transform production and delivery chains. However, while developing countries have the opportunity to leapfrog the digital development by directly deploying more advanced technologies, the digital transformation of society requires investments across many sectors. The digital transformation is also an iterative process with incremental progress in supply and demand; however, some fundamentals are necessary. Figure 2.3 illustrates the steps of creating a digital society and some of the effects the digital transformation has on societies.

Figure 2.3. Digital transformation in society



Note: This figure is intended to be indicative and does not represent an exhaustive illustration of all the complexities of the digital transformation.
Source: Author's illustration.

2.4.1. Investments in infrastructure

A pre-condition for the development of a digital society is adequate and reliable infrastructure. In 2016, there were 44 countries, many of which LDCs, in which less than half the population had access to electricity.[4] The lack of reliable energy sources hampers the digital development and countries run the risk of further falling behind, amplifying the digital divide across countries rather than diminishing it. Even if countries have access to electricity, frequent power cuts cause problems for any technical system to run smoothly and can disincentives the use of digital solutions. The cost of electricity can also be a major factor in many countries as high costs to power networks are transmitted to consumers, raising the price they have to pay for Internet access. (ITU, 2018[13]) Investments in reliable and affordable energy is therefore a crucial pre-condition for countries to be able to further develop their ICT sector and participate in the growing digital economy.

National backbones and international connectivity are the foundations for the creation of a digital economy. A national backbone network provide powerful links to connect different areas of the country. International connectivity is crucial to ensure reliable

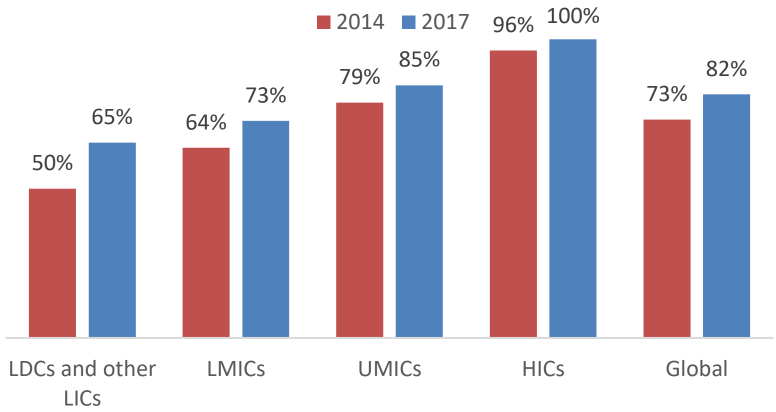
[4] Data on access to electricity (% of population) were extracted from World Bank's World Development Indicators database in September 2018.

and fast data transfers across countries and regions. The number of submarine cables have increased in recent years, allowing faster and cheaper connectivity, thus incentivising greater Internet use. Still, there are many countries and areas with low connectivity, especially landlocked countries, which are dependent on their neighbours for international connectivity. The backbone network also deliver traffic to and from Internet Exchange Points (IXPs), which is a network access point that helps facilitating local Internet traffic exchanges between operators and helps reduce the cost and latency of data traffic. There are hundreds of IXPs around the world and new IXPs are established every year. However, IXPs are still scarce in many parts of the world. In 2017, less half of LDCs had an IXP (ITU, 2018[13]). Developing a national backbone network is capital intensive and often financed by the private sector or through public-private partnerships.

National broadband strategies guide the development of ICT infrastructure. In May 2010, the UN Broadband Commission was established by ITU and UNESCO in response to UN Secretary-General's call to step-up efforts to meet the Millennium Development Goals (MDGs). The Broadband Commission has the aim to promote access to broadband infrastructure as a mean towards sustainable and inclusive development, and set up international targets for incentivising further investments in broadband development (see Box 2.4). The Commission, which was rebranded as the Broadband Commission for Sustainable Development following the 2015 UN summit, brings together industry leaders, senior officials, academia and international organisations, and advocates for universal access to the Internet. A key component has been to encourage the development of national broadband plans or strategies. Since its foundation in 2010, the number of countries with a broadband plan has rapidly increased. By 2017, 82% of countries have adopted a broadband plan, an increase from 73% only three years earlier. While, LDCs and other LICs are still lagging behind, these countries show the greatest progress with almost two-thirds of counties having adopted a broadband plan by 2017.

Few national broadband strategies include financial strategies. The development of ICT infrastructure is capital intensive, yet the majority of strategies do not address investment needs. As assessment of national digital strategies made by UNCTAD in 2017 revealed that only half of the assessed strategies that included digital infrastructure objectives addressed investment needs. While most plans acknowledged various sources of finance, including public and private, only a few strategies included an assessment of the amount required (UNCTAD, 2017[14]).

Figure 2.4. Proportion of countries with a broadband plan (2014 and 2017)



Source: (ITU, 2018[15]) Broadband Commission for Sustainable Development, The State of Broadband: Broadband catalyzing sustainable development, https://www.itu.int/dms_pub/itu-s/opb/pol/S-POL-BROADBAND.19-2018-PDF-E.pdf

Box 2.4. Broadband Commission for Sustainable Development targets

In 2011, the Broadband Commission set up targets for broadband development and Internet access to be achieved by 2015. In January 2018, the Broadband Commission extended and updated this list with more ambitious targets for 2025. The targets are:

1. By 2025, all countries should have a funded national broadband plan or strategy, or include broadband in their universal access and services definition.

2. By 2025, entry-level broadband services should be made affordable in developing countries, at less than 2% of monthly gross national income per capita.

3. By 2025 broadband-Internet user penetration should reach:

   a) 75% worldwide

   b) 65% in developing countries

   c) 35% in least developed countries

4. By 2025, 60% of youth and adults should have achieved at least a minimum level of proficiency in sustainable digital skills.

5. By 2025, 40% of the world's population should be using digital financial services.

6. By 2025, un-connectedness of micro-, small- and medium-sized enterprises should be reduced by 50%, by sector.

7. By 2025, gender equality should be achieved across all targets.

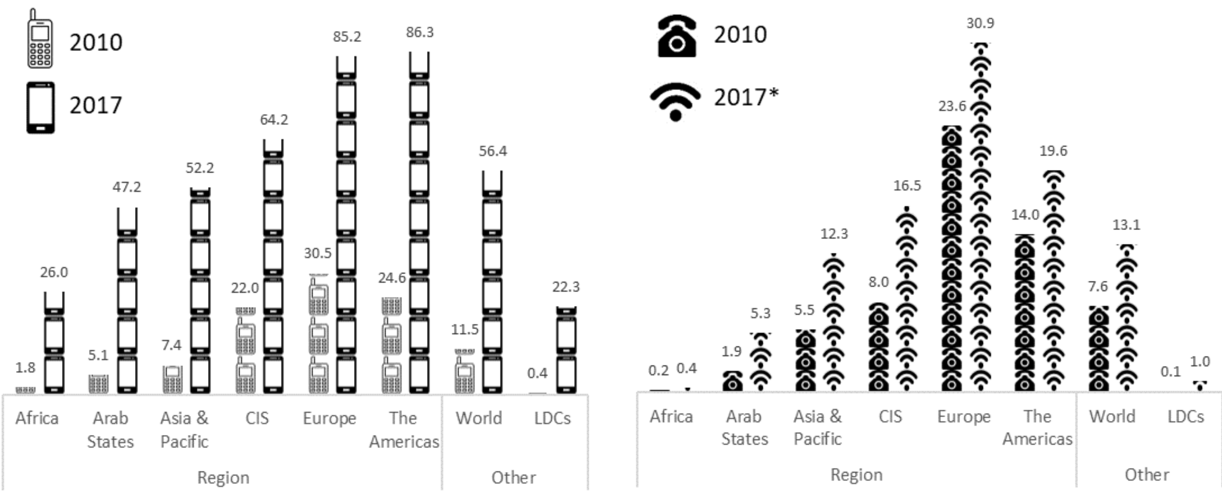
Source: (ITU, 2018[16]), 2025 Targets: "Connecting the Other Half" https://broadbandcommission.org/Documents/publications/wef2018.pdf

The fast evolution of mobile broadband technologies have significantly changed our economies, our societies and our lives. The deployment of the first commercial 3G network in Japan in 2001 marked a historical shift in the telecommunication sector. While

2G technologies such as EDGE and GPRS had allowed people to access the Internet and browse websites, the possible uses were limited due to low speeds. However, the introduction of 3G networks increased speeds nearly ten times from earlier technologies, allowing much faster to the internet and made video streaming possible. Only eight years later, in December 2009, the first LTE network (commonly referred to as 4G) was launched in Sweden and Oslo, with a ten-fold increase in speeds over 3G networks. By 2016, both 3G and LTE networks had been deployed in most countries, and more than 80% of the world´s population had access to 3G networks and two-thirds had access to LTE networks. (ITU, 2017[17])

Figure 2.5. Mobile (left) and fixed (right) broadband subscriptions per 100 inhabitants

Mobile broadband subscriptions per 100 inhab. **Fixed broadband subscriptions per 100 inhab.**



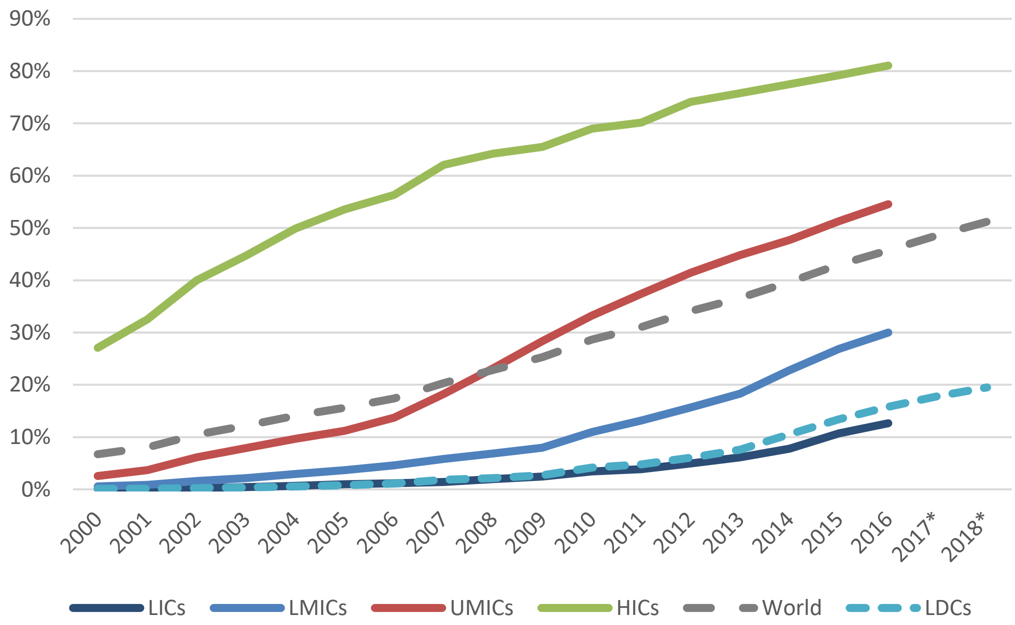
Note: The regions in this figure are ITU regional classification. For more information, see https://www.itu.int/en/ITU-D/Statistics/Pages/definitions/regions.aspx.
Source: (Broadband Commission for Sustainable Development, 2018[18]), The State of Broadband: Broadband catalyzing sustainable development

While mobile broadband Internet access is a giant leap towards universal Internet access, it is not yet sufficient for the use of advanced Internet services. Many developing countries rely almost exclusively on mobile broadband technologies. While this gives individuals and businesses the access to key tools for the development of a digital economy, replying exclusively on mobile broadband has several limitations. First, the current speed of mobile broadband is inferior to fixed technologies, which limits the development of advanced technologies requiring high speed Internet to function properly. Second, spectrum is a limited resource and telecommunication operators compete with other actors in the use of spectrum. As such, the capacity of mobile broadband is limited and more traffic can affect speed and quality of service (ITU, 2018[13]). Therefore, it is imperative for developing countries' long-term development to also invest in fixed infrastructure and offload traffic through mobile networks.

2.4.2. Ensure affordable and universal access to the Internet

The spread of mobile broadband provide opportunities for developing countries to participate in the growing global digital economy. By 2018, half of the world's population is using the Internet. While developing countries still lag behind more advanced countries in the use of ICTs, remarkable growth is happening in all regions of the world, especially in low and lower-middle income countries. Infrastructure investments and efforts to reduce prices have tripled the number of Internet users in LDCs in only five years from 6 % of the population in 2012 to nearly 18 % in 2017 (ITU, 2017[17]). While LDCs are still far behind more advanced countries, the rapid pace of the digital development signal positive signs for the future. Figure 2.6 shows the evolution of Internet users by income group.

Figure 2.6. Proportion of individuals using the Internet (2000-2018)



Note: 2017 and 2018 are ITU estimates. No estimates are available by income group beyond 2016.
Source: (ITU, 2018[19]), Measuring the Information Society Report 2018, https://www.itu.int/en/ITU-D/Statistics/Pages/publications/misr2018.aspx

Major digital divides still exists within countries. In 2017, the estimated share of women using the Internet was 12% lower than the share of men. This gender digital divide is highest in Africa where 25% of men and only 19% of women were using the Internet in 2017. (ITU, 2017[20]) However, there are also significant digital divides between individuals of different ages, with the elderly being the latest adopters of new technologies, between individuals living in urban and rural areas and between individuals of different socio-economic status (ITU, 2016[21]). ITU estimates that to bridge the digital divide and to connect the next 1.5 billion people will require new or upgraded ICT infrastructure to the cost of USD 450 billion. However, closing these digital divides require more than infrastructure investments (Broadband Commission for Sustainable Development, 2018[18]).

Increasing competition and regulation are key for universal and affordable access to ICTs. While the number of Internet users are rapidly increasing across the world, high costs for devices and ICT services and concerns about the quality of networks and services remain key barriers for many people to enter the digital world. ICT regulatory authorities have a responsibility to level the playing field among competitive actors and strive towards improving coverage and affordability of ICT services. Many countries have in recent years awarded new spectrum licences and opened up competition in the telecommunication industry, resulting in lower prices for consumers. Several countries have also set up Universal Service Funds (USF), financed through mandatory contributions from telecommunication operators, and aimed to bring ICT infrastructure to remote areas. These efforts have contributed to reducing prices of ICTs services, especially in LDCs where the average price for entry-level mobile broadband subscription has decreased by two-thirds between 2013 and 2016 (ITU, 2018[22]).

2.4.3. Digital services raise demand for education and digital skills

Digitalisation brings new opportunities for transforming societies and economies. One of the strongest evidence of the digital transformation is the rapid growth of global E-commerce. The emergence of online retailers and platforms, such as E Bay, Amazon and Alibaba, have transformed the retail industry and changed consumers' behaviours. E-commerce platforms has the potential to reduce transaction costs and create direct links between producers and consumers, providing small and medium enterprises (SMEs) with access to new markets. Mobile and digital technologies also have the potential to reduce the costs of financial transactions, e.g. on remittances, and open up banking services to new groups of people.

The digital transformation bring new opportunities to accelerate development. Deployment of digital services can improve government effectiveness and service delivery in areas from the collection of taxes, to provision of health care and welfare services. Another area, which can greatly benefit from digitalisation, is agriculture. Mobile applications can support identifying and prevent pests and diseases which affects crops, provide real-time weather forecasts, and connecting producers and traders. An emerging field is the use of drones for service delivery. In 2018, the company Zipline together with the Government of Rwanda launched a delivery system using drones to transport blood and other medical supplies to doctors in rural Rwanda. The doctors order the supplies by text message and the drones can travel up to 80 mph before dropping the supplies at their destination. However, for all of these digital services to flourish, more investments are needed in ICTs and other infrastructure to ensure secure and reliable payment systems and the delivery of goods or services, and a digitally skilled population, which can develop and support the systems and drive demand.

The level of educational attainment is a strong indication of how Internet is used. Digital literacy is crucial for individuals to be able to participate in the digital society. However, in order to benefit from digitalisation, Internet access and basic digital skills are not enough. Developing digital skills is a continuous learning process and what a person does online is strongly linked to his or her level of traditional education. In many developing countries, and among individuals with lower educational attainment in advanced countries, the Internet is still mainly used for communication and entertainment. People with tertiary educational attainment are much more likely to take advantage of E-commerce and E-banking than people with secondary educational attainment (ITU, 2016[21]).

Investments in traditional education are central to climb the digital ladder. The 2012 OECD Programme for International Student Assessment (PISA) showed that students in the highest-performing countries in digital reading were "*not more exposed to the Internet at school than are students in other OECD countries*". The assessment further suggested that "*many of the evaluation and task-management skills that are essential for online navigation may also be taught and learned with conventional, analogue pedagogies and tools*" (OECD, 2015[23]). Further investments in high quality education are essential for building a strong ICT sector and preparing young people for the jobs of the future.

Online education can accelerate digital skills. The increasing popularity of Massive Open Online Courses (MOOCs) provided by many universities and other companies and institutions have the potential to transform consumers of digital content into entrepreneurs. Many of these courses are free and strengthen individuals' skills, in particular technical skills, for future employment. Both private and public stakeholders are engaged in using online education for improving digital skills in developing countries. Google's Digital Skills for Africa project aims to train Africans in digital skills and online marketing through its online portal. After reaching its initial target of educating 1 million people in March 2017, the company announced it would aim to train 10 million more in the coming five years, including 100 000 software developers in Nigeria, Kenya and South Africa. Several other companies and industry organisations, such as Mozilla and GSM Association (GSMA), has developed online toolkits for smartphone usage.

Several countries have developed digital skills strategies or launched ambitious programmes to strengthen citizen's digital skills. For example, in partnership with the World Economic Forum's Internet for All initiative and the Canadian charitable organisation Digital Opportunity Trust (DOT), the Rwandan government launched the Digital Ambassadors Program (DAP), a programme in which 5 000 young individuals will train 5 million Rwandans in basic digital skills. The International Telecommunication Union (ITU) recently also developed a toolkit for governments guiding them in developing a digital skills strategy (ITU, 2018[24]).

2.4.4. International co-operation is key when the digital world disrupts the "real" world

The increasing use of digital services creates market disruptions and transforms industries. The widespread use of digital services and platforms have resulted in many legal challenges, for example relating to intellectual property rights, privacy and security of personal information and even the meaning and definition of the services, e.g. the company Uber being a digital or transport platform. There is also a growing convergence between the telecommunication and broadcasting industries market, often resulting in consolidation of market players, e.g. the merger between the U.S. telecommunication giant AT&T and the broadcasting company Time Warner, and the Swedish telecommunication operator Telia's announced purchase of Bonnier Broadcasting.

Increasing connectivity also changes the labour market. While automation and AI technologies can result in the elimination of jobs across sectors and markets, the digital transformation also creates new jobs; however, often requiring a different skillset. These new demands require adapting national education policies and developing new systems for adult re-skilling. Adaptation to labour market disruption is influenced by the quality of education, cost and quality of ICT connectivity, prevalence of jobs with digital exposure, and opportunities for lifelong learning (World Economic Forum, 2017[25]). The increasing use of digital technologies at work and the extensive coverage of reliable ICT networks reduces the need for office space as working remotely becomes a more acceptable, and often cost-effective, option.

Digitalisation bring new products and increasing customisation based on consumers' individual needs. The growing online community resulted in the creation of virtual currencies, with the creation of Bitcoin in 2009 as the most known example. However, virtual currencies existed long before Bitcoin, e.g. E-gold and Linden dollars used in the virtual world called Second Life. Other technologies, such as 3D printing, which allows the creation of physical objects from digital images, has large potential for manufacturing as it allows customizable products at low prices. However, concerns have been raised about the possibilities of using 3D printing technologies for malicious purposes, e.g. the creation of weapons, or unintended consequences, e.g. health issues relating to printing process or the plastic used.

The increasing privacy and security concerns are associated with increasing digital presence. The popularity of social media and the large amount of data generated from individuals' digital presence has elevated the need for regulation of the use and protection of user-generated data. New laws and policies are currently being developed to increase online security and to strengthen the protection of personal data. National security concerns have also been raised about the misuse of such data and the consequences of the digital transformation on national security.

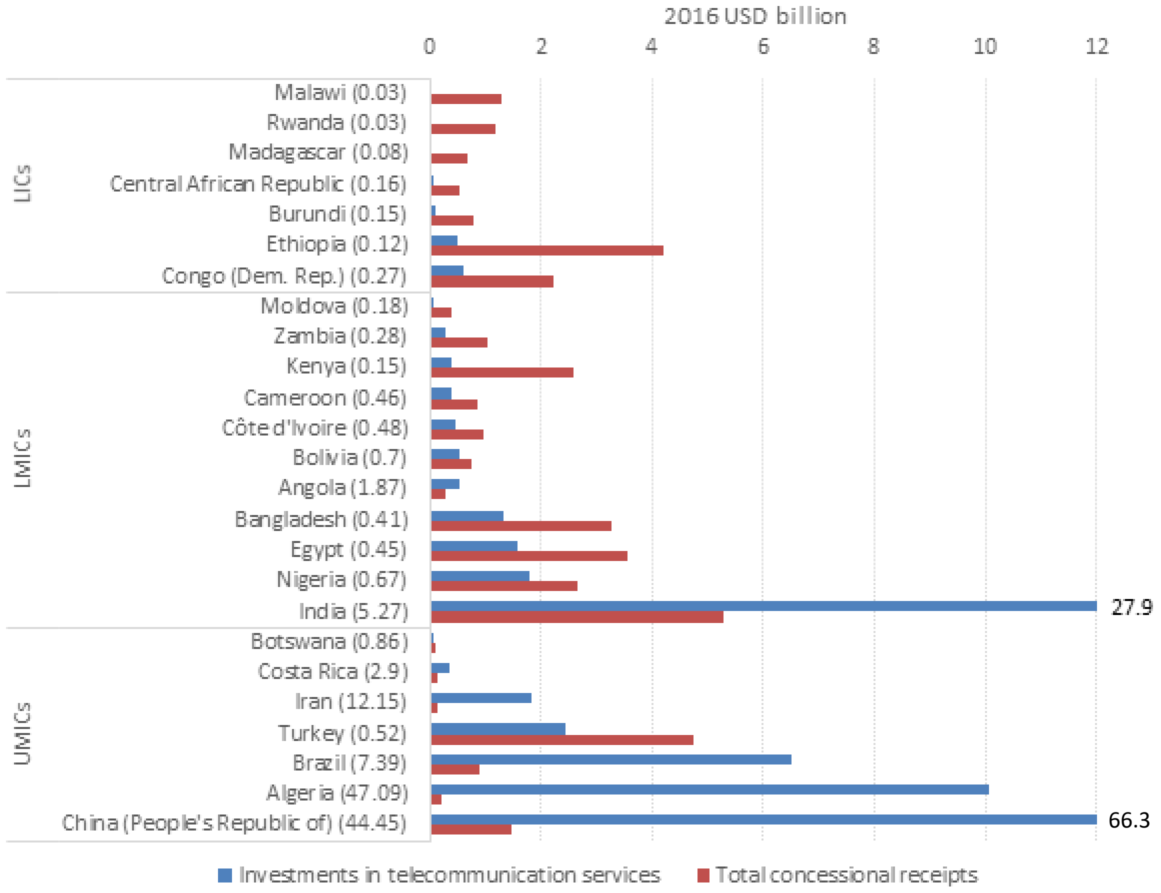
There is a need for greater international co-operation and new policies in response to the digital transformation. Governments need to apply a whole-of-government response to form coherent policies to seize the opportunities and tackle the evolving challenges of the digital transformation. In 2017, the OECD launched a horizontal project titled *Going Digital: Making the Transformation Work for Growth and Well-being*. This project aims to help policy makers better understand the digital transformation and create a policy environment that enables their economies and societies to prosper in an increasingly digital and data-driven world.[5]

2.4.5. The role of official development finance for the digital transformation

International co-operation can support many aspects of the digital transformation. Already in 2005, a review of DAC members' policies to finance ICT for development revealed that most donors had "*abandoned supporting ICT infrastructure, leaving the job to the private sector*" (OECD, 2005[26]). While investments by telecommunication operators in ICT infrastructure and other telecommunication services continue to be driven by private sector actors or government entities or corporations, investments in many low-income countries are still very limited. Despite infrastructure being capital intensive, total investments in telecommunication services in several countries in Africa represent less than one-sixth of total concessional finance received by the same countries (see Figure 2.7). Official development finance can contribute towards strengthening the business environment to drive further investments, support key infrastructure projects with concessional or non-concessional financing, and use blended finance to mobilise additional resources from the private sector.

[5] For more information about the OECD Going Digital project, see http://www.oecd.org/going-digital.

Figure 2.7. Comparison between investments in telecommunication and total concessional receipts (2016; selected countries)



Notes: (1) The figure after each country represent the ratio of investments in telecommunication services and total concessional receipts provided by DAC and non-DAC members and multilateral agencies.
(2) Annual investment in telecommunication services refers to the investment during the financial year made by entities providing telecommunication networks and/or services (including fixed; mobile and Internet services; as well as the transmission of TV signals); for acquiring or upgrading fixed assets (usually referred to as CAPEX); less disinvestment owing to disposals of fixed assets. Fixed assets should include tangible assets such as buildings and networks, and non-tangible assets, such as computer software and intellectual property. The definition closely corresponds to the concept of gross fixed capital formation, as defined in the System of National Accounts 2008. The indicator is a measure of investment made by entities providing telecommunication networks and/or services in the country; and includes expenditure on initial installations and additions to existing installations where the usage is expected to be over an extended period of time. It excludes expenditure on fees for operating licences and the use of radio spectrum.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1; (ITU, 2019[28]), World Telecommunication/ICT Indicators database , https://www.itu.int/en/ITU-D/Statistics/Pages/publications/wtid.aspx

Concessional finance, e.g. grants, may be more suited to support "soft" infrastructure. To benefit from ICT technologies, basic education and digital skills are key. Concessional finance can support greater incorporation of digital trainings and ICT solutions in the education system. It can also be useful to support the digitalisation of government systems, including tax and health systems, for improved service delivery (Dahlman, Mealy and Wermelinger, 2016[29]). New technical solutions adapted to the local environment, e.g. mobile banking and peer-to-peer lending platforms, can also help businesses and social enterprises raise additional funds for investments and facilitate cheaper and safer remittances from foreign workers to individuals (UNCTAD, 2017[14]). Other important areas for the use of concessional finance include: support policies and implementation of initiatives for universal Internet access and the eradication of the digital divides, supporting local business and start-ups, and greater use of technological solutions to boost agricultural productivity, improve access to financial services, and strengthening systems for disaster risk reduction.

Greater incorporation of ICT tools in the delivery of development co-operation can strengthen the effectiveness of development co-operation. Technological innovation in how development co-operation is planned and delivered can not only improve results in developing countries, but it can also strengthen international efforts in expanding data collection and improve timeliness of reporting on development activities. With increasing coverage of 3G and LTE mobile networks in most countries, the costs in utilising ICTs are fast decreasing. New applications and tailored ICT tools can be developed to improve communication, enhance data collection on results and geographic location of development projects, and strengthen monitoring and evaluation for better analyses and more effective development co-operation. The OECD-WTO aid for trade monitoring exercise found that ICT is already prioritised in the development strategies of two-thirds of donors and that nearly all developing countries (90%) anticipate the need for future assistance in this area. Aid commitments to ICT project stood at USD 1 billion in 2017, mostly in the form of technical assistance for regulatory form (OECD/WTO, 2017[30]).

3. Measuring development finance to science, technology and innovation

The international commitments made in the AAAA highlights the growing importance of STI to address global challenges and to bridge the technological divide through additional investments in capacity building and knowledge sharing. Governments committed to develop and adopt STI strategies and policies "*that incentivise the creation of new technologies, that incentivise research and that support innovation in developing countries*". (United Nations, 2015[31]) However, three years after the conference in Addis Ababa, the 2018 monitoring report from the Inter-agency Task Force on Financing for Development highlighted the lack of information on countries that have adopted policy frameworks for national STI strategies and how these fit into their broader development strategies. The report also underscored the importance of measuring international support towards the development of STI policy frameworks and requested further work to measure the percentage of ODA to support STI (Inter-Agency Task Force on Financing for Development, 2018[32]).

The G20 also acknowledges that effective engagement of various stakeholders, including government, academia, research institutions, civil society, private sector and international organisations, is essential in unleashing the potential for STI. Through the G20 Development Working Group (DWG), Japan has advanced Guiding Principles for the Development of STI for SDGs Roadmaps. STI for SDGs roadmaps function as policy action plans, aligned to national development strategies and take a holistic approach to the SDGs. The OECD is supporting this process through this paper and its broader work linking ODA and STI for inclusive development.

The approach taken in this paper aims to serve as a first attempt to calculate the share of ODA and other development finance towards STI. The findings are expected to complement other analysis made by the Interagency Task Team on Science, Technology and Innovation, the G20 and other actors.

3.1. Methodological challenges and analytical limitations

There are two approaches to assess the portion of ODA in support of STI: examining government budgets and assessing individual development activities. These two approaches, which can be considered as "top-down" or bottom-up", have different benefits and limitations. The available data of both approaches come from different sources designed for different purposes. They also come with challenges as to the definitions used and purpose and scope of the analysis, for which there are differences between the development and STI communities. The approach taken in this paper is to assess STI financing based on individual development activities using the CRS as the main data source.

Development activities can provide significant insights on STI-related ODA, but definitions in the CRS are not consistent with standard STI guidelines and definitions. The approach in this paper takes information on development activities as its basis. As such, the analysis conforms by the available information on the purpose and implementation of development activities and the structure and definitions of the CRS. However, the CRS is neither designed nor tailored to identify development activities according to official STI definitions, such as the definitions of R&D and innovation as described in section 2. Its classifications are also not consistent with other international classifications, such as the International Standard Industrial Classification (ISIC) or the Classification of the Functions of Government (COFOG).

Descriptions of development activities add value but are not sufficient to ensure STI definitions are followed. The description field in the CRS provide valuable information about the specificities of development activities. However, while often at length, the descriptions of development activities do not provide the necessary details to assess whether the activities are in line with the definitions of R&D and innovation. While an improvement in the quality of the descriptions provided and greater use of machine learning techniques can further enhance the value of descriptions of development activities as a source of information, it is unlikely to be sufficient to ensure conformity with STI definitions.

Capturing financing to STI through government budgets may conform to STI definitions but will have limitations on the comparability with other ODA spending. The alternative option, which is not explored in this paper, is to capture ODA financing to STI directly through government budgets. However, while this approach may allow for a better alignment of some ODA-related finance according to STI definitions, it may not necessarily be comparable to other cross-cutting themes. ODA is a **post-measure** of the expenditures of ODA-eligible activities for a given year, and while the budgets set the framework for development spending, it is not certain that all ODA-eligible spending for STI are captured in the development budgets. The amount identified may result in an under-estimation of total support to STI as individual projects or programmes not captured in detail in the budget, may include STI-related components. In addition, a budget view of STI-related ODA would not necessarily allow for disaggregation of activities by recipient country or type of aid, thus making ODA to STI not comparable to other cross-cutting themes and measures. It may also be difficult to properly assess the amount of ODA that supports STI from a developing country perspective. In other terms, the development community has no other alternative but to use the CRS database. The question then becomes: should it renounce to mapping ODA to STI or other sectors in the absence of alignment of definitions?

To overcome these challenges, the development and STI communities need to engage each other and discuss possible ways forward. The measurement of R&D and ODA are similar in the way that they both have long histories and detailed and internationally agreed definitions. However, with the focus on the attainment of the SDGs, their paths have crossed. The development community is increasingly interested in research, innovation, and the use of new technologies to improve development results. And vice versa, the STI community is increasingly interested in assessing their impact on development and the SDGs. Measuring progress in these areas are crucial and of great policy relevance; however, any new measure should be the result of a consolidated effort by both policy communities to understand the rationale for each system, including their benefits and limitations, and build upon their combined strengths. The limitations highlighted by this paper call for a reinvigorated dialogue of the two communities, in the UN Forum on STI and beyond. The OECD DAC and STI committees could play a key role towards that end.

In an attempt to bridge this gap, the approach developed in this paper makes several assumptions as to the scope of what constitutes STI, and stresses their distance from other agreed definitions. Considering that the available information on development activities does not follow standard STI definitions and classifications, several assumptions had to be made as to the assessment of which activities to consider as support to STI. Based on the current classifications and structure of CRS, there are several "grey areas" which are difficult to dissect. For example, activities for developmental purposes conducted by universities often include both research activities and trainings or other capacity building exercises. Ideally, the assessment would only consider research activities as support to STI. However, as it is often not possible to distinct between the research and training component of these activities, the assessment in this paper considered all development activities implemented by universities as support to STI.

3.2. Identification of STI-related activities in the CRS

The wealth of information in the OECD Creditor Reporting System (CRS) provides the basis for most analyses on official finance to developing countries. The CRS contains data on ODA and other official flows (OOF) for DAC members, non-DAC members and concessional and non-concessional financing from the largest multilateral agencies and several private entities.

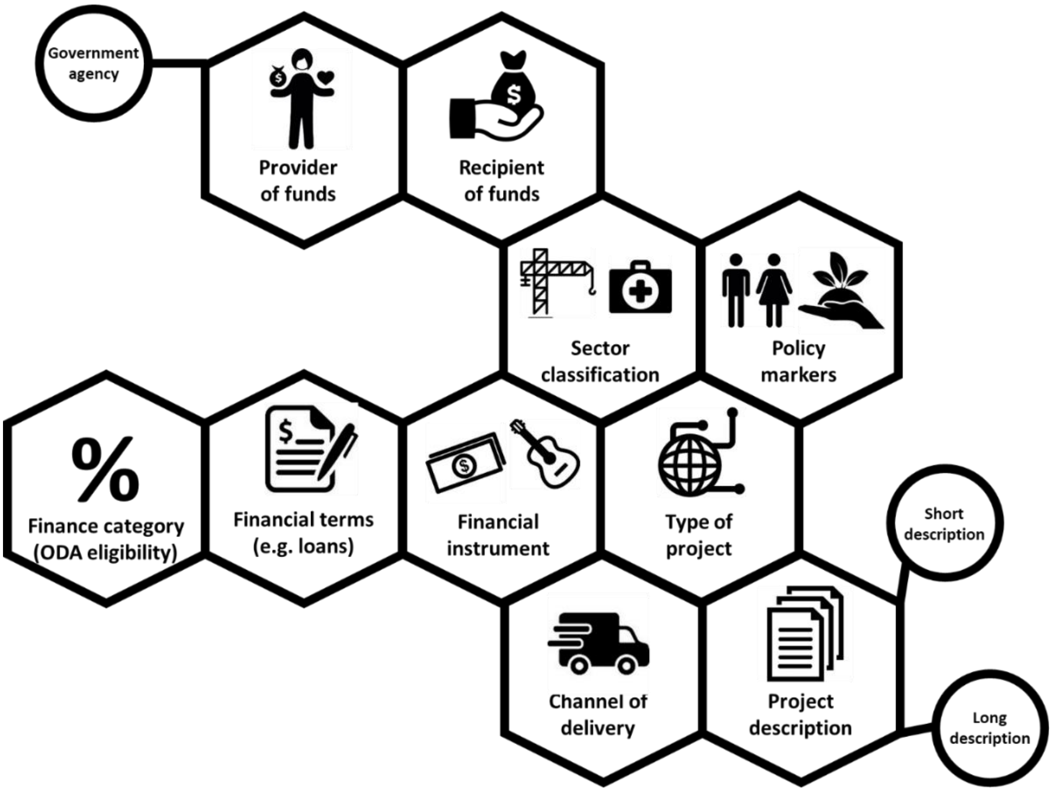
The CRS is rapidly increasing in popularity. The number of countries and organisations reporting detailed information about their development activities to the CRS has increased by over 60% since 2010, from 52 reporting entities in 2010 to 85 in 2016. Each year, roughly 250 000 records (each containing up to 50 fields of information) on development activities from countries, multilateral agencies and private actors are submitted and stored in the CRS. This makes the CRS a goldmine for assessing development activities targeting different themes and sector.

The structure of the CRS does not allow for a simple examination of STI-related activities. The CRS includes several classificatory variables, including provider and receiver of the funds, channel of delivery (entity implementing the activity), sectors (main sectors the activity is targeting), financial instruments (e.g. grants, loans etc.) and type of project. However, none of these variables is sufficient to clearly identify aid activities with an STI focus, which are cross-sectoral in nature. The CRS also includes description fields, in which the reporting entity can enter project summaries or descriptions of the main objectives of the activity. These fields are free text fields without much restrictions on structure, and can assist in the validation process of the data, e.g. to ensure accuracy of coding. These fields are also aimed to support studies where the topic of interest cannot be separately identified through other classificatory variables. Figure 3.1 shows the main classificatory variables included in the CRS.

Cross-sectoral policy areas are generally addressed through the CRS marker system. In response to the need to address other important cross-cutting policy areas, such as gender and environment, the Working Party on Development Finance Statistics (WP-STAT) have over the past decade agreed to the creation of dedicated markers, which facilitates monitoring and comparison of activities that addresses a certain policy area, but which may cut across different sectors. For example, it is possible that activities supporting either education or health can also support gender equality. The markers distinguish between activities where the policy objective is the principal (primary) objective of the activity and activities supporting the policy objective, but where the objective was not the prime motivation for undertaking the activity. While these policy markers are useful to address cross-cutting policy areas, they create additional burden on reporting entities and enlarges the structure of the CRS. This increase in the volume of information run the risk of lower quality and less possibilities for rigor validation processes by both reporting entities and the DAC Secretariat. The larger structure of the CRS may also discourage new entities to report to the CRS.

Starting from 2019, data reporters will have the possibility to report the SDG target (or goal) of the development co-operation activities, alongside the other CRS fields. This information could also help in identifying STI related activities in the future.

Figure 3.1. Classificatory variables in the CRS



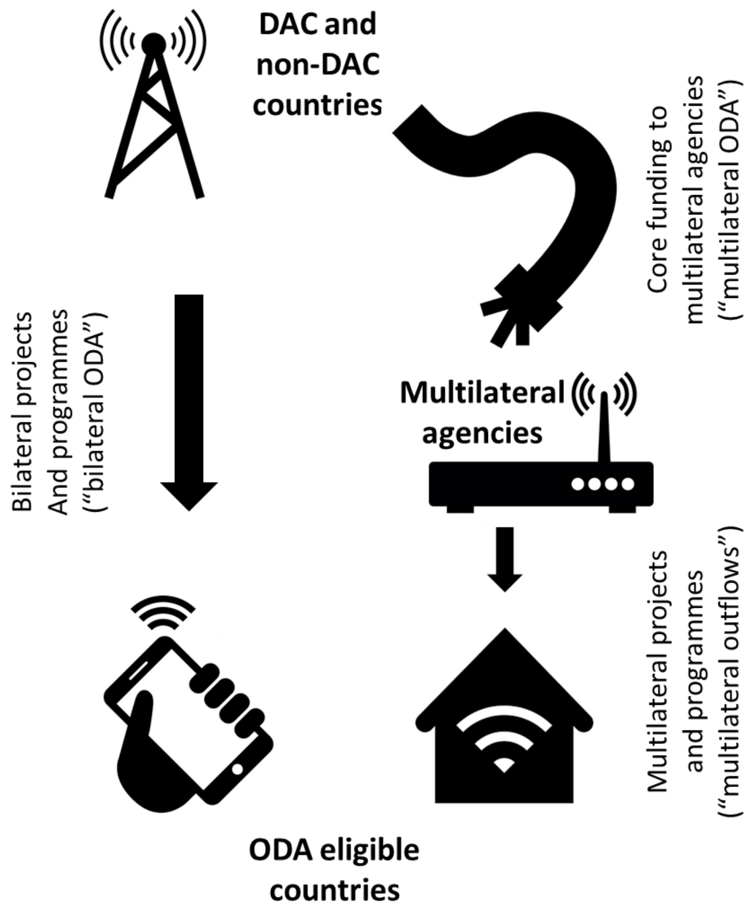
Source: Author's illustration

3.2.1. Methodological considerations using the CRS as the data source

Science, Technology and Innovation (STI) is a broad term, encompassing both research activities, the development of new technologies, and other forms of innovation to increase efficiency and knowledge. As such, STI is often not considered as a sector in itself as STI activities cuts across all sectors. New science, methods and technologies can improve productivity and result in better outcomes in almost all sectors. The lack of a policy marker on STI activities in the CRS makes identification of STI-related ODA activities challenging.

Identifying STI-related ODA and other external finance in the CRS can be performed in two ways: assessing ODA expenditures from provider countries or examining the inflows of development finance into developing countries. The difference between these two approaches is whether to examine STI-related development finance from a donor or recipient angle. The donor angle will include core funding to multilateral agencies (also referred to as "multilateral ODA"), while the recipient angle will include the outflows from multilateral agencies (see Figure 3.2).

Figure 3.2. Development finance expenditures



Note: ODA technically consists of *bilateral* and *multilateral ODA*. *Bilateral ODA* consists of ODA-eligible projects and programmes to countries and territories on the DAC List of ODA Recipients. This is illustrated in this figure as the provision of mobile broadband (left side) in which the signal goes directly from a radio tower to a smartphone. *Multilateral ODA* are official contributions to multilateral agencies, whether negotiated, assessed or voluntary, for which the governing boards have the unqualified right to allocate as they see fit within the organisation's charter. However, DAC statistical system also tracks flows from multilateral organisations to countries, or *multilateral outflows*. The use of multilateral agencies as an intermediary is illustrated in this figure as the provision of fixed broadband (right side) in which a router transforms the signals coming from cables and creates a Wi-Fi network. The analysis in this paper is based on *bilateral ODA* and *multilateral outflows*.
Source: Author's illustration

The general approach taken in this paper is to focus on the total inflows of concessional financing into developing countries. Taking the developing country angle makes more sense to assess the amount of resources available to countries towards the attainment of the SDGs. Instead of counting core funding to multilateral agencies, the analysis includes research activities performed by multilateral agencies based on the same criteria as for bilateral donors. By 2018, there were 39 multilateral agencies, which report their outflows to the CRS, and whose activities are included in the analysis. These represents the bulk of all official development finance going through the multilateral system. However, in a few exceptional cases, it is necessary to include core funding to multilateral agencies. These are cases where the agency does not report their outflows to the CRS, but has a core mandate to conduct or support research, encourage innovation, or support ICT development or facilitate technology-transfers to developing countries. For these agencies, it is assumed that all their activities support STI. In total, the analysis includes developing activities from 77 providers. The full list of all providers is presented in Annex B.

Not all core funding to a multilateral agency supports STI activities. While core funding to a multilateral agency may indirectly support STI-related activities performed within that agency, it difficult to determine the share of core funding dedicated to these activities from support to other programmes within the same agency. Counting all core funding to multilateral agencies that perform some research would severely over-estimated the amount of STI-related ODA. This relates in particular to many UN agencies, the World Bank, IMF and regional development banks whose core mandate may not necessarily be research or financing STI activities in developing countries, but for which these types of activities are part of their agreed work programme.

While specific sector codes exists to identify activities supporting research and ICTs, the strict use of these codes would neglect activities with a research or ICT-component classified in any other sector. For example, an activity supporting the development of ICT skills among children may be classified in the CRS as *education* rather than *ICTs*. Similarly, medical research relating to infectious diseases are often classified according to the category *STD control including HIV/AIDS* rather than *medical research*. Technological support towards disaster risk reduction may also be classified as *humanitarian aid*. In addition, support to research institutions may be classified as *unallocated by sector* or *multi-sector* as the research conducted may encompass many different sectors. However, these activities are clearly supporting STI. For these reasons, the analysis in this paper goes beyond the sector classification and take into consideration all development finance except for resources considered as in-donor costs.

Most in-donor costs are excluded from the analysis. In-donor costs are ODA eligible resources spent in donor countries and includes the administrative costs of donor agencies, the cost of hosting refugees in donor countries and imputed student costs. The imputed student costs refer to the indirect cost of tuition for students in secondary and tertiary education from developing countries studying in donor countries. It is only applied to "*non-fee charging educational systems, or where fees do not cover the cost of tuition, and if the presence of students reflects the implementation of a conscious policy of development co-operation by the host country*" (OECD, 2018[33]). While imputed student costs can be considered as support to increasing research capacity in academia, it is excluded from this analysis on the basis that secondary education cannot be distinguished from tertiary education. However, resources for scholarships are included in the analysis on the basis that scholarships are provided for students "*registered for systematic instruction in private or public institutions of higher education to follow full-time studies or training courses in the donor country*".

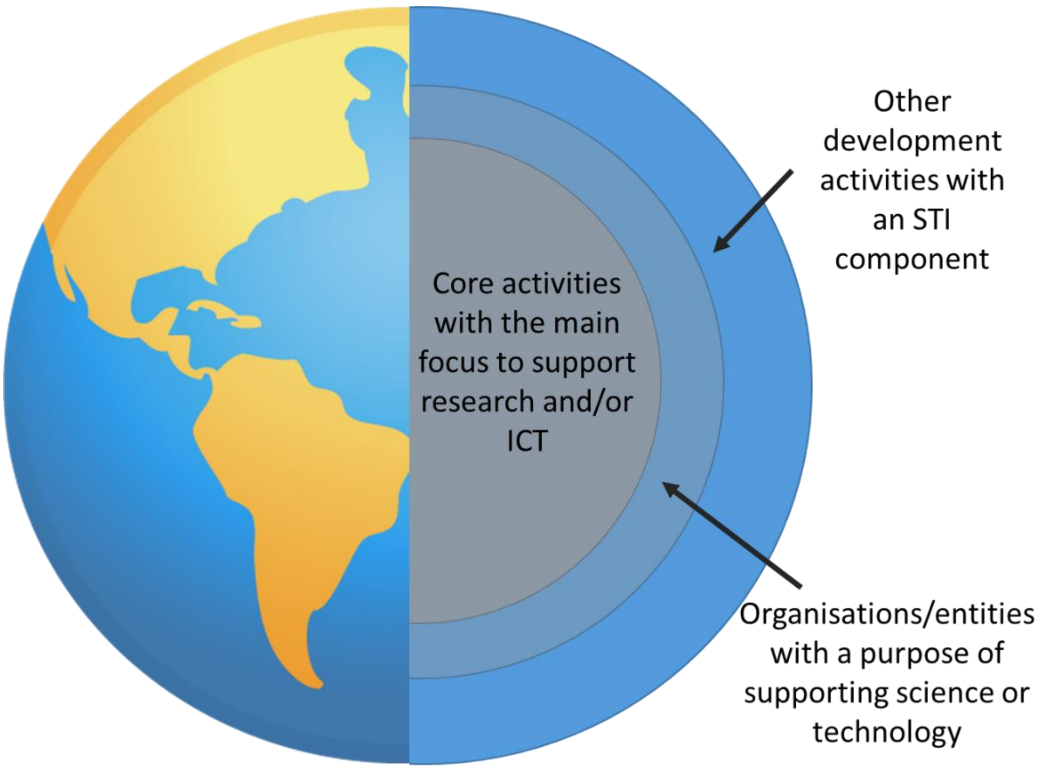
The current limitations of the CRS makes identifying activities supporting innovation and technology beyond ICTs complex. Classificatory variables exist in the CRS to identify development activities that support research programmes or scientific networks and partnership for improved knowledge-transfer between developed and developing countries. It is also possible using the existing structure of the CRS to identity projects and other activities aimed to support countries' efforts to expand ICT infrastructure and strengthen their digital economies. However, the CRS currently lacks any classificatory variables, which can support the identification of technology-oriented activities, e.g.

technology transfers, or activities supporting innovation and innovation policy. The methodology used in this paper aims to capture support to innovation and technology beyond ICTs by exploring the description fields in the CRS (see next section).

3.2.2. The three-tiered approach for identifying STI-related ODA

For the purpose of this analysis, a three-tier approach was developed to identify STI-related activities. The reason for the three-tier approach was to use the available classificatory variables to the maximum extent, but complement these with additional activities identified using text mining techniques. The three-tiered process was a response to the lack of convenient structure in the CRS for identification of activities supporting STI. By using complementary information across variables, a broader view on STI-related development finance can be presented. Figure 3.3 illustrates the three-tiered methodological approach used in this analysis.

Figure 3.3. Three-tiered approach to identify STI activities



Source: Author's illustration.

First stage: Identifying STI "core" activities

The first stage includes identifying core activities, which are those activities that can be easily identified to supporting research and ICT development through the CRS sector codes (see Annex A for more information on these sector codes). These activities are often core support to universities or other research institutions or financing for other larger research programmes, e.g. the such as Canada's Development Innovation Fund for Global Health Research and the Norwegian Programme for Global Health and Vaccination Research, which support research towards improving the health for people living in low-and lower-middle income countries. The activities identified through the sector codes also includes support for telecommunication and other ICT infrastructure developments in countries and regions as well as other initiatives to strengthen digital skills or bridging the digital divide.

The number of CRS sector codes have increased rapidly in recent years to accommodate the growing demand of better tracking of development finance activities. The CRS sector classification aims to responds to the question "*which specific area of the recipient's economic or social structure is the transfer intended to foster*". Traditionally, only the primary sector of the activity was reported. However, it is possible that one activity can support multiple sectors. In 2016, members at the Working Party on Development Finance Statistics (WP-STAT) agreed to introduce a new system allowing multiple purpose code reporting to better track activities benefitting several sectors. The introduction of this new system will facilitate more granular reporting as activities will be able to be split upon several sectors rather than only one sector, and is expected to increase the quality of the data and provide better estimates of the aid volume targeting different sectors. In addition, the WP-STAT also agreed to add new sector codes to improve the alignment of aid information with partner country budget classifications. The expansion of the CRS sector code list and the introduction of the new system of multiple purpose codes can contribute to better tracking of activities supporting STI in the future.

Second stage: Identifying support to entities with an STI focus

The second stage identifies STI activities implemented by entities that are on the DAC list on channels of delivery. The channel of delivery is defined as the first implementing partner, e.g. it is the "entity that has implementing responsibility over the funds and is normally linked to the extending agency by a contract or other binding agreement, and is directly accountable to it". Similar to the DAC list of sector codes, the DAC list on channels of delivery is frequently updated and expanded with additional entities. There are currently 355 entities on the list. It includes NGOs, PPPs and networks, multilateral organisations, universities, college or other teaching institution, research institute or other think-thanks. The list also includes broad categories of public and private sector institutions.

The entities identified in this paper has STI as their focus. The entities are either conducting research, supporting access and use of ICTs, or financing projects relating to technology transfer, e.g. projects supporting renewable energy. In total, 65 entities have been identified to support STI, of which 27 are classified as universities or other research institutes (See Annex Table A.3). While some activities implemented by these entities may already have been identified in the first stage, it is imperative to also include additional development activities, which may have been classified according to a different sector code. The list is also not exhaustive as it is solely based on the 355 entities on the DAC list of channels of delivery. It is likely that there are additional entities that receive financing from official sources and support STI in developing countries. While some of these resources may be captured in stages 1 or 3, it is likely that not all funding is captured in this analysis.

The list of identified entities includes support to organisations and initiatives focused on a specific theme. For example, the list includes the International AIDS Vaccine Initiative (IAVI), which aims to develop vaccines and other innovations for HIV prevention, and research for agricultural development and food security conducted as part of the CGIAR network. It also includes support to entities aimed to strengthen the ICT capacity in developing countries, such as the Development Gateway, which build digital technology tools and processes, the Global e-Schools and Communities Initiative, which support greater use of ICTs in education, and Commonwealth of Learning, whose mandate to promote open and distance learning using technology-based approaches. While there are other entities on the list, which also conduct research as part of their work programme, e.g. multilateral organisations, research is often not their main activity. Contributions to or through these entities are therefore not included in this analysis as it cannot be determined that all funding supports STI.

Core funding to a few multilateral organisations are included in the analysis providing that they do not report their expenditures to the CRS. This includes organisations in which research and support to innovation, ICT development or other technology-transfers are fundamental to the organisation´s existence (see Tables A3 and B1 in the annexes). The second criteria for inclusion is that these entities do not report the expenditures of their activities to the CRS, as it would otherwise lead to double counting.[6] This includes core funding to multilateral agencies, such as UNESCO, with a specific mandate for science, and the International Telecommunication Union (ITU), the UN's specialized agency for ICTs, whose core mandate is focused on developing technical standards relating to ICTs, allocate radio spectrum and satellite orbits, and promote ICT development across the world. It also includes core funding to the World Intellectual Property Organisation (WIPO), whose mission is to enable innovation and creativity through the development of a balanced and effective international intellectual property (IP) system.

For the purpose of this paper, all official development finance (both concessional and non-concessional) channelled through universities or other research institutions are considered as support to STI. Most of these funding refer to research activities conducted by universities; however, in many cases these activities also include elements of capacity building. These capacity building trainings and workshops are often aimed at faculty, students, and other researchers and public servants in developing countries. For the purpose of this analysis, it is assumed that these trainings contribute towards enhancing countries' STI capacity. However, it is likely that the inclusion of all development finance channelled through universities over-estimates the amount of development finance supporting STI. The full list of entities included in this analysis is found in Annex A.

Third stage: Text mining to find activities with an STI component

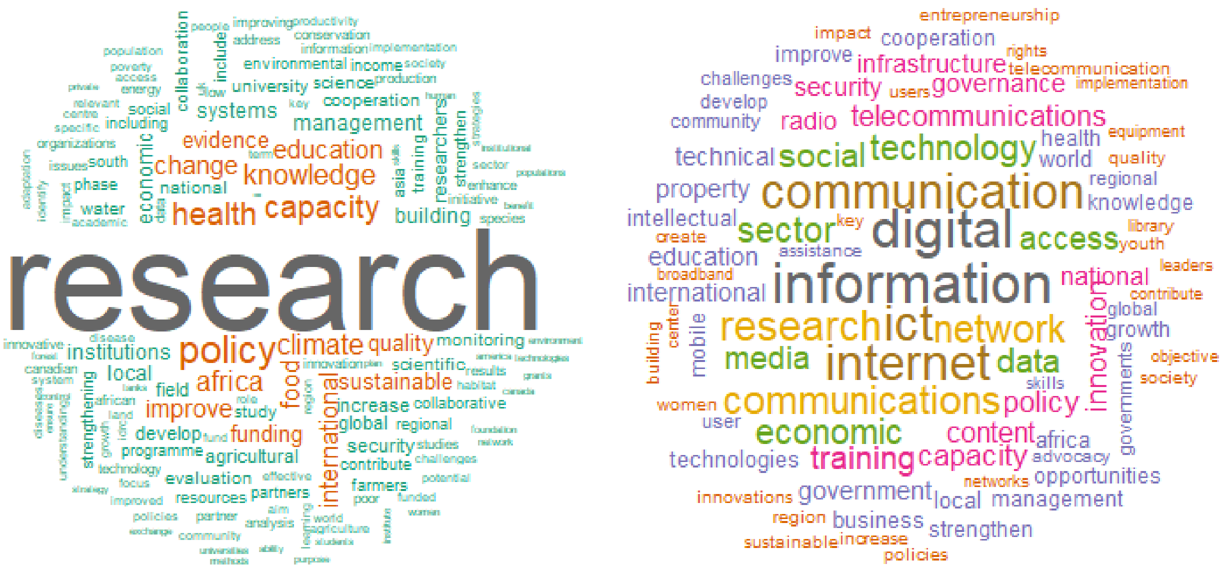
The last third stage identifies development activities using text-mining methods applied to the providers' descriptions of activities in the CRS. Providers are required to include text descriptions of the activities when reporting to the CRS; however, in practice this information has been difficult to use for analytical purposes because of the differences in quality of the descriptions. While some providers include nearly half a page of information for one single activity, other providers may restrict the amount of information to a few words. Nearly all descriptions are in English; however, other languages are also used, which further adds challenges to synthesising the information. Considering that the CRS contains approximately 250 000 activities per year, it has previously been challenging to process the amount of information captured in these description.

The frequency of words used in the description of development activities were analysed to identify the most appropriate keywords. Natural Language Processing

[6] A trade-off must be made between counting the inflows to multilateral organisations, i.e. the core funding provided by government entities, or the outflows from multilateral organisations, i.e. their own expenditures of development activities.

(NLP) algorithms were used to identify the most prominent keywords in the description of activities supporting research and ICT development identified using the sector codes in the first stage. Approximately 22 000 activities supporting research and 12 000 activities supporting ICT development for the years 2013-2016 were assessed. Common ‘filler words’ such as “the”, “is” and “are” were excluded from the analysis The most prominent keywords translated into English are shown in figures 3.1 and 3.2. The larger the text, the more descriptions included the particular word.

Figure 3.4. Most frequently used words in the description of activities supporting research (left) and ICT development (right)



Source: Author’s illustration.

The most prominent keywords were used to identify additional development activities with an STI-component and which had not already been identified in the first of second stages. Several checks were performed to assess the results, including manual checks of the development activities identified. If a specific keyword did not seem to capture activities with an STI element, e.g. if the keyword “research” referred to “market research”, the keyword was removed or modified.

A robustness test was made to assess the relative importance of the specific keywords used to identify research and ICT activities. The prevalence of the most frequent words identified in the “core” STI activities identified through the sector codes was compared against the prevalence for the same words across the description of all other activities in the CRS. The results indicated that the keywords used for the analysis were strongly linked to activities supporting research or ICT development. For example, keywords such as “ICT” and “digital” were more than 50 times more frequent in the description of core ICT activities than in other activities. Other words such as “Internet”, “broadband” and “cyberspace” were more than 100 times as frequent. Similarly, words such as “scientific” and “research” were more than 10 times more frequent in “core” research activities than in other development activities. This analysis indicates that these keywords are appropriate to identify additional development activities supporting STI, which had not already have been identified in the first or second stages.

Concluding remarks about the methodology

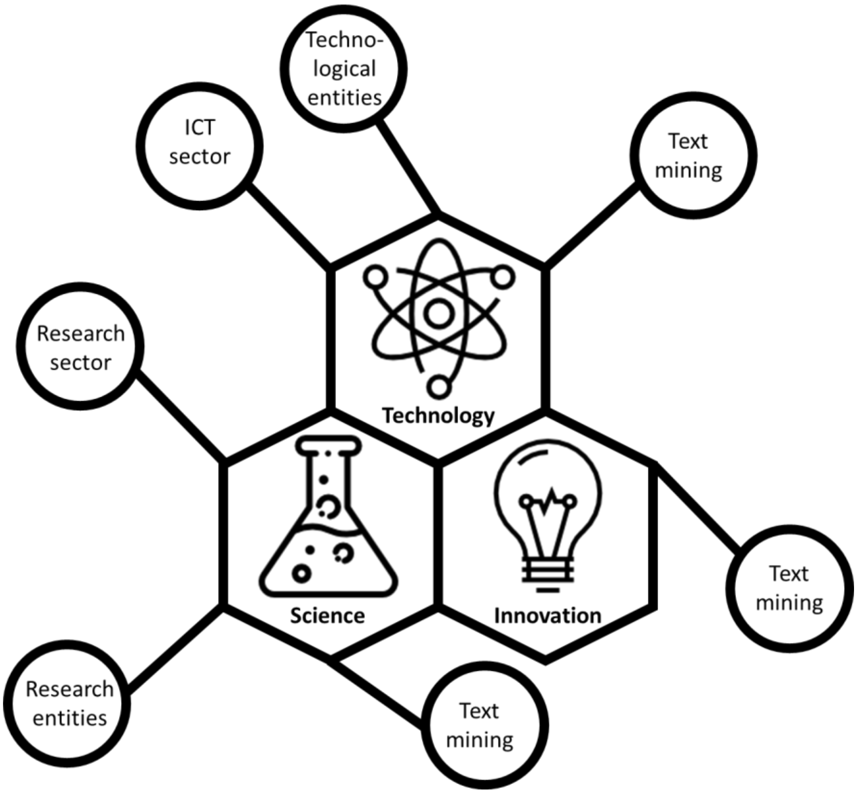
The combination of these three methods capture a broader range of STI activities than simply relying on CRS sector codes. This approach also captures development finance providers’ various preferences to support STI. For example, some providers may prefer to support research for which there is no sector code, e.g. infectious diseases. Other providers may prefer core funding to certain institutions, which have core STI mandates, but which may or may not be present on the DAC list of channels of delivery.

The classification of activities by science, technology and innovation is based on the available variables and criteria to identify the activities. Development finance towards science includes spending on activities classified as research through CRS sector codes (stage 1), core funding or earmarked funding through research entities (stage 2), and additional finance of activities with a research component that have been identified using text mining (stage 3). The identification of development finance towards ICTs and other technologies follow a similar approach; however, the accuracy in identifying activities with a technological component may be less than for research, considering the limited number of technology-specific sector codes (stage 1) and the larger heterogeneity in technology-oriented keywords. The approach used in this paper to identify technology-oriented activities is biased towards ICT-oriented activities. As also described in section 3.2.1, the identification of activities supporting innovation is based solely on text mining.

Improved classification in the CRS can strengthen the methodology to assess contributions from development providers towards STI-related projects. Further developments in the CRS, e.g. new sector codes, policy markers, channels of delivery and reporting on the SDG target, may be necessary to improve the identification of STI-related development finance, while the development of TOSSD could provide a better picture of the development finance, including mobilised private finance and the finance devoted to development enablers and global challenges. In addition, future work may consider other sector codes as support to STI, e.g. sector codes relating to renewable energy or energy efficiency. Figure 3.3 shows the different approaches used to identify activities in the areas of science, technology and innovation.

Further analyses using machine-learning techniques can improve the robustness of the text mining analysis. The text mining analysis used to identify additional activities with STI-related components in stage three are based on development providers´ current reporting of their activities to the CRS. The records used for the analysis are based on current CRS classifications and descriptions of development activities, and not official STI documents. This makes the identified keywords vulnerable to the quality of development providers´ reporting, which can vary on a yearly basis and across providers, and to the specific development activities conducted in those years. For example, if a provider conducts a large research study of ecosystems in the rainforest and includes detailed descriptions of these activities in its yearly reporting, then the machine learning algorithms will have greater likelihood to pick up keywords not only relating to the research conducted but also to specific terms relating to the flora and fauna of the rainforest. As such, the NLP algorithms rely on the source of information rather than the most appropriate terms and concepts. While several manual checks were performed to examine the activities identified by the keywords, the algorithms used in this paper could be improved by examining official STI documents, identifying core keywords distinctively from the CRS.

Figure 3.5. Methods to identify STI-related activities in the CRS, by type of STI.



Source: Author's illustration.

4. Official development finance supporting science, technology and innovation development

The bulk of support for STI in developing countries is provided by domestic government entities and the private sector. Financing R&D and the application of new technologies in society or for enhanced production is often beyond the role of most development agencies. For example, the development of basic ICT infrastructure requires significant capital investments, far beyond those that can be mobilised through ODA. These investments are long-term investments and mainly financed by the government, by private or public telecommunication operators or jointly through Private Public Partnerships (PPPs). Furthermore, one feature that distinguishes the telecommunication and ICT sector from other infrastructure sectors is the high-paced technological evolution, which require a constant and sustained flow of investments. (ITU, 2012[34]). Similarly, as countries' economies develop, finance to R&D grows (Figure 2.1) and a larger share is financed by businesses (Figure 2.2).

However, public spending and development co-operation on STI fills an important gap where the private sector lacks incentives to intervene. For R&D, market failure relate to the production and dissemination of knowledge. For example, if a private firm cannot fully capitalise on their discoveries, either in terms of turning the knowledge into a profit-making product or in terms of protecting competitors from benefitting from the discovery, then there is less incentive for it to invest in R&D. The uncertainty in R&D generating results can also be a barrier for private actors to invest in research, e.g. relating to basic research. In terms of ICTs development, there is less incentive to invest in broadband development in rural areas, simply because of the high costs in connecting villages over larger distance with low population density. In these cases, governments need to step in with regulation, legislation, or direct or indirect financing, e.g. through tax incentives, subsidies or directly funding projects.

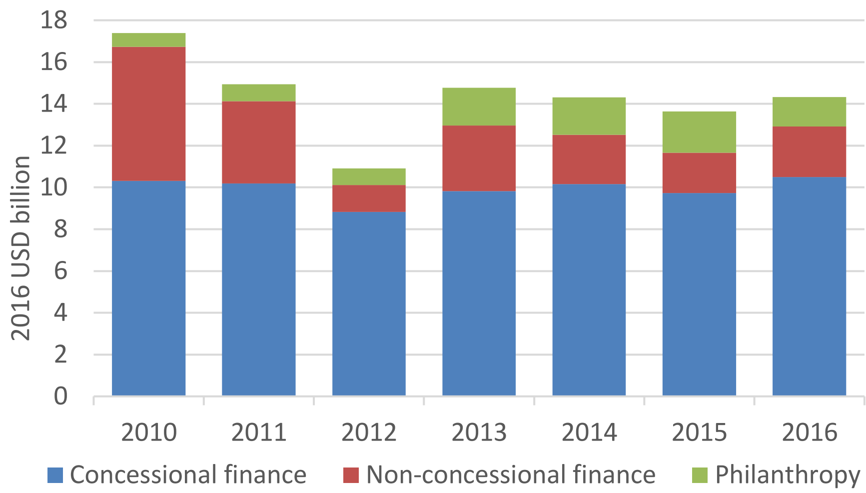
4.1. Most official development finance is concessional

Total development finance to STI have been fluctuating between USD 11 and 17 billion in the past years. The fluctuations are due to the volatility of non-concessional finance. Concessional finance to STI amounts to USD 10.5 billion per year, representing 5.9 % of total concessional finance by DAC members, multilateral organisations and other countries. The largest share of concessional finance supports research related to development challenges. Non-concessional finance represent a minor share of total development finance; however, it still represents nearly USD 3 billion per year, not counting export credits.[7] Non-concessional finance mainly consist loans from multilateral development banks towards technology-related infrastructure projects, e.g. relating to ICTs and renewable energy, and investments in raising countries' technological and innovative capacity. Private foundations' contributions towards STI, mainly targeted towards research in the health sector, represents a growing share of total development finance to STI.

[7] Export credits are not included in this analysis because of lack of data.

Figure 4.1. Official development finance to science, technology and innovation (STI)

Disbursements in 2016 prices

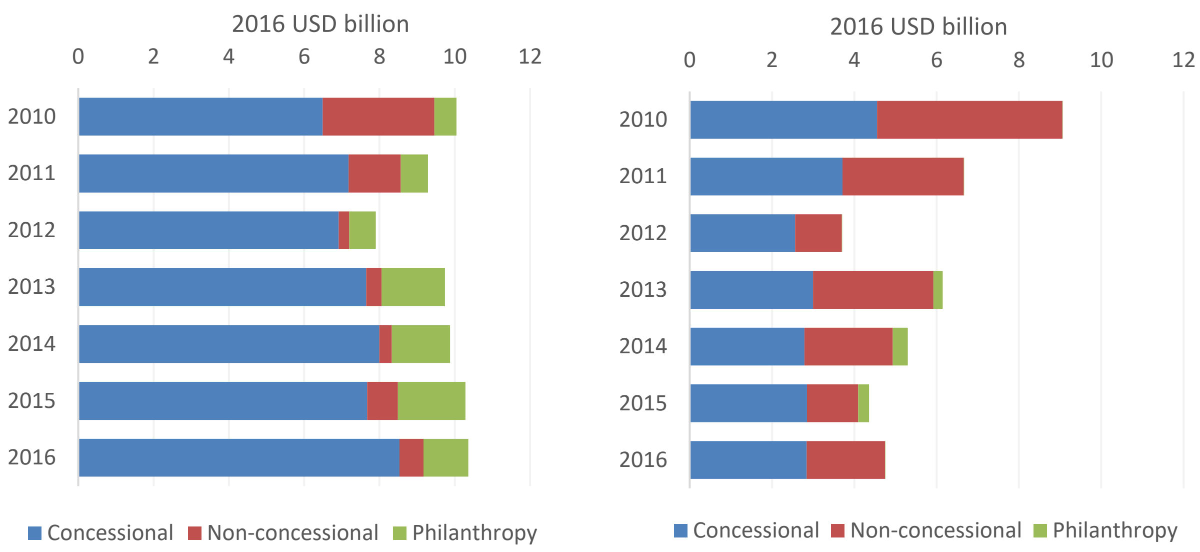


Note: 2010-2012 only includes Bill and Melinda Gates Foundation. 2013-2015 data come from the OECD Philanthropy Survey covering 143 foundations (OECD, 2018[35]). The philanthropy data for 2016 only include Bill and Melinda Gates Foundation, Dutch Postcode Lottery and MetLife Foundation.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1; (OECD, 2018[35]), Private Philanthropy for Development, http://dx.doi.org/10.1787/9789264085190-en

There are clear distinctions in the allocation of development finance across science, technology and innovation. Concessional finance is mainly used to support research and innovation, including also the implementation of development activities with a specific innovative approach. Financing support to NGOs, universities and other entities conducting research or supporting STI development are also concessional in nature. Support towards technology, and especially for ICT development, is to a large degree financed through non-concessional finance extended through loans by DAC members and multilateral development banks. Non-concessional finance supporting science and innovation are mainly loans extended by multilateral development banks to recipient government for various research projects. Philanthropy financing to STI is nearly entirely focused on supporting science and innovation, either directly or through universities or other research institutions.

Figure 4.2. Official development finance to science and innovation (left) and technology (right)

Disbursements in 2016 prices

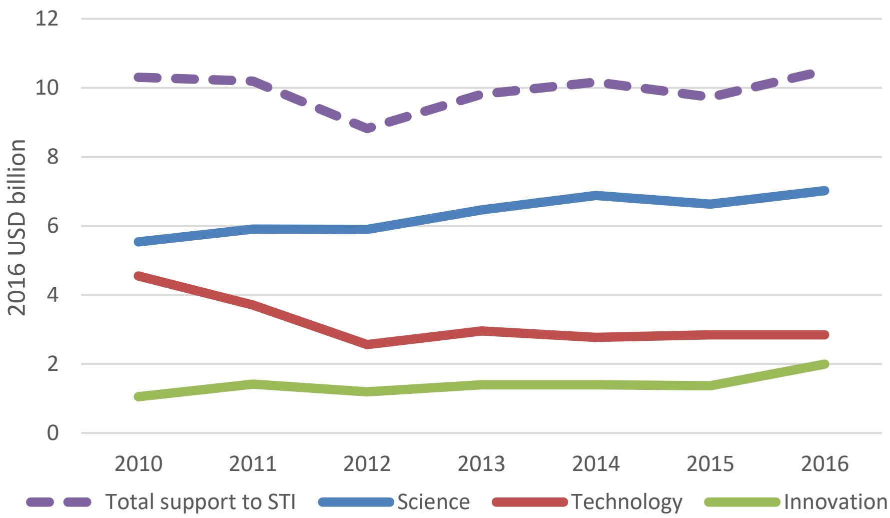


Note: * 2010-2012 only includes Bill and Melinda Gates Foundation. 2013-2015 data come from the OECD Philanthropy Survey covering 143 foundations. The philanthropy data for 2016 only include Bill and Melinda Gates Foundation, Dutch Postcode Lottery and MetLife Foundation.
Source: (OECD, 2018[35]), Private Philanthropy for Development, http://dx.doi.org/10.1787/9789264085190-en

While total concessional finance to STI has remained rather static since 2010, concessional finance to science is on the rise. Official support to research activities has grown steadily during the past years from USD 5.5 billion in 2010 to USD 7.0 billion in 2016. While research spending is increasing, concessional finance used for ICTs and technology transfers has been static following a decline between 2010 and 2012. Support towards innovation increased sharply in 2016 because of additional funding to innovative projects across sectors by several DAC members, including Canada, EU institutions, Germany, Sweden and the United States. There are significant overlaps across the STI spectrum as development activities can have both a scientific angle and a more technical angle. Figure 4.4 illustrates the overlap across science, technology and innovation.

Figure 4.3. Concessional finance towards science, technology and innovation (STI)

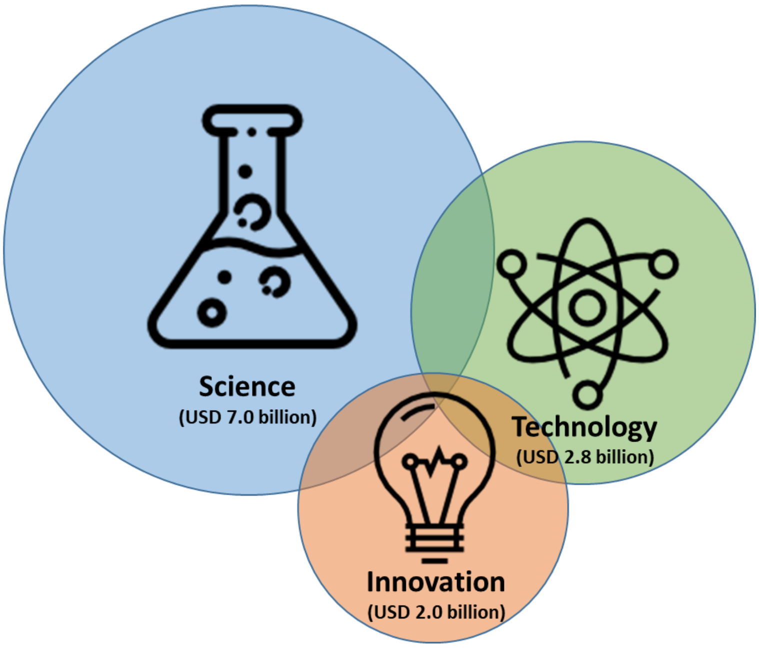
Disbursements in 2016 prices



Note: The sum of the three categories in this chart will exceed total support to STI because of activities contributing to several categories.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

Figure 4.4. Overlap in allocation by type of STI (2016)

Disbursements in 2016 prices



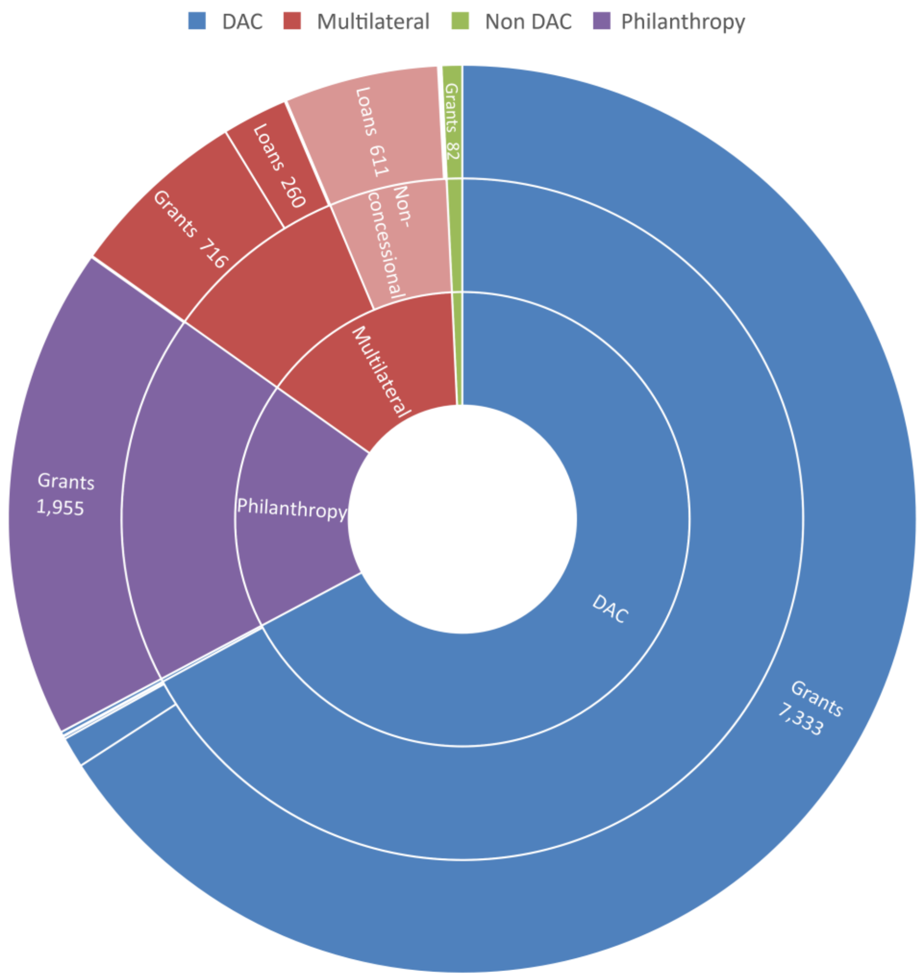
Source: Author's illustration.

4.2. Financial modalities differ between science and technology

Nearly all support to science is financed by grants. More than 90% of total ODF towards science and innovation is financed from grants. Bilateral funding represents the vast majority of grants; however, private philanthropy is a key contributor for universities and other research institutions. Multilateral agencies' contribution is split between grants and loans. Both concessional and non-concessional loans are mainly provided to the recipient government with the aim of strengthening higher education. Other type of finance besides grants and loans, e.g. equity, is scarce. Figure 4.5 shows total ODF towards science by development provider and type of finance.

Figure 4.5. Official development finance to science and innovation by provider and type of finance (2016)

Disbursements in USD million in 2016 prices

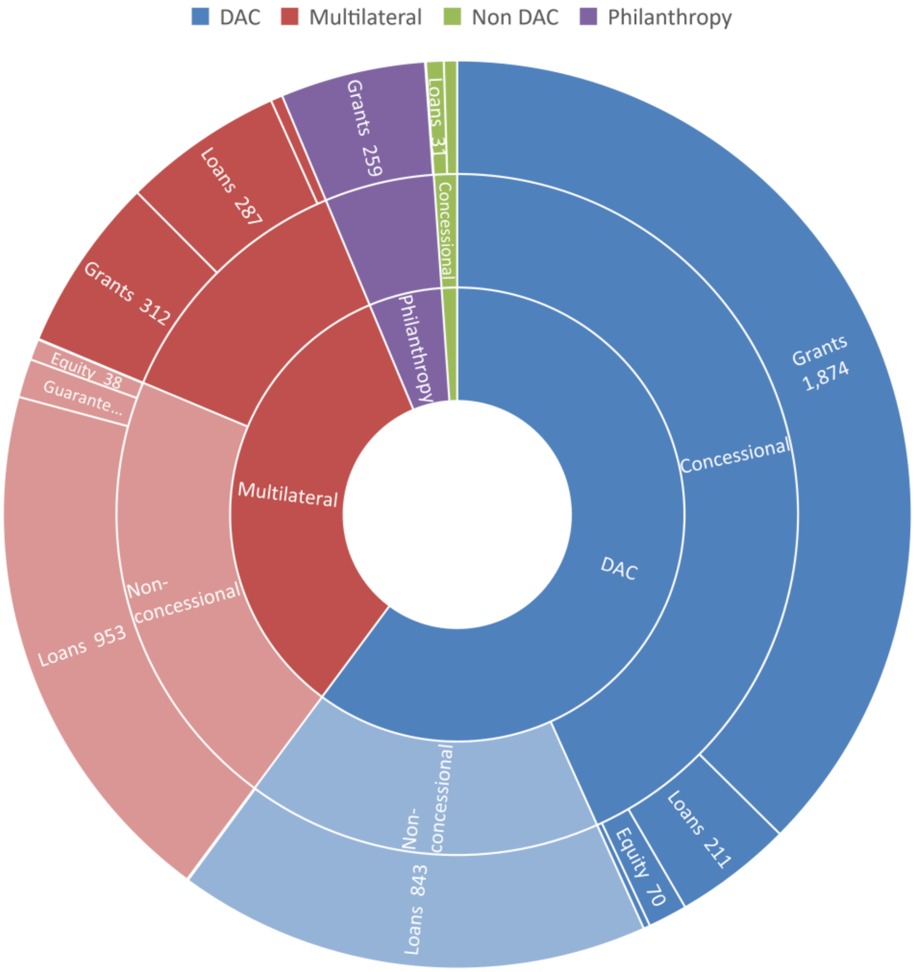


Note: Data for philanthropy represents 2015.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1; (OECD, 2018[35]).

There are greater variety in the type of finance used to support ICTs and other technologies. Concessional and non-concessional loans represents half of all ODF towards technology, with greater participation of multilateral agencies. The majority of all finance form multilateral agencies are extended in the form of loans. Support from private philanthropy represents a minor share of total support of technology-oriented development finance.

Figure 4.6. Official development finance to technology by type of finance (2016)

Disbursements in USD million in 2016 prices



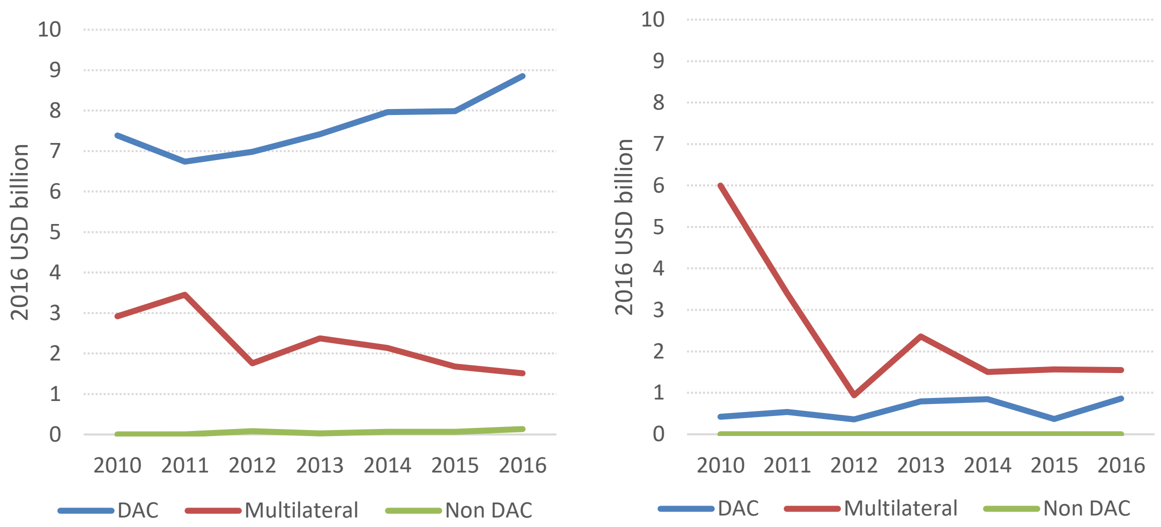
Note: Data for Philanthropy represents 2015.
Guarantees are not a flow, but risk-sharing agreements under which the guarantor agrees to pay part or the entire amount to the lender/investor in the event of non-payment by the borrower or loss of value.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1; (OECD, 2018[35]), Private Philanthropy for Development, http://dx.doi.org/10.1787/9789264085190-en

4.3. Providers have different science, technology and innovation priorities

Bilateral and multilateral providers prefer different modalities in support of STI. While multilateral agencies use both concessional and non-concessional finance to support STI, bilateral providers are relying almost exclusively on concessional finance. The increase in support to STI can also be attributed to DAC members, which have scaled up its support towards science. In contrast, multilateral development finance is declining, mainly driven by a decrease in concessional and non-concessional loans from the World Bank. Non-DAC providers' support to STI is minor, yet slowly increasing, representing the growing number and granularity of non-DAC providers' reporting of development finance flows to the CRS.

Figure 4.7. Concessional (left) and non-concessional finance (right) to STI by provider

Disbursements in 2016 prices



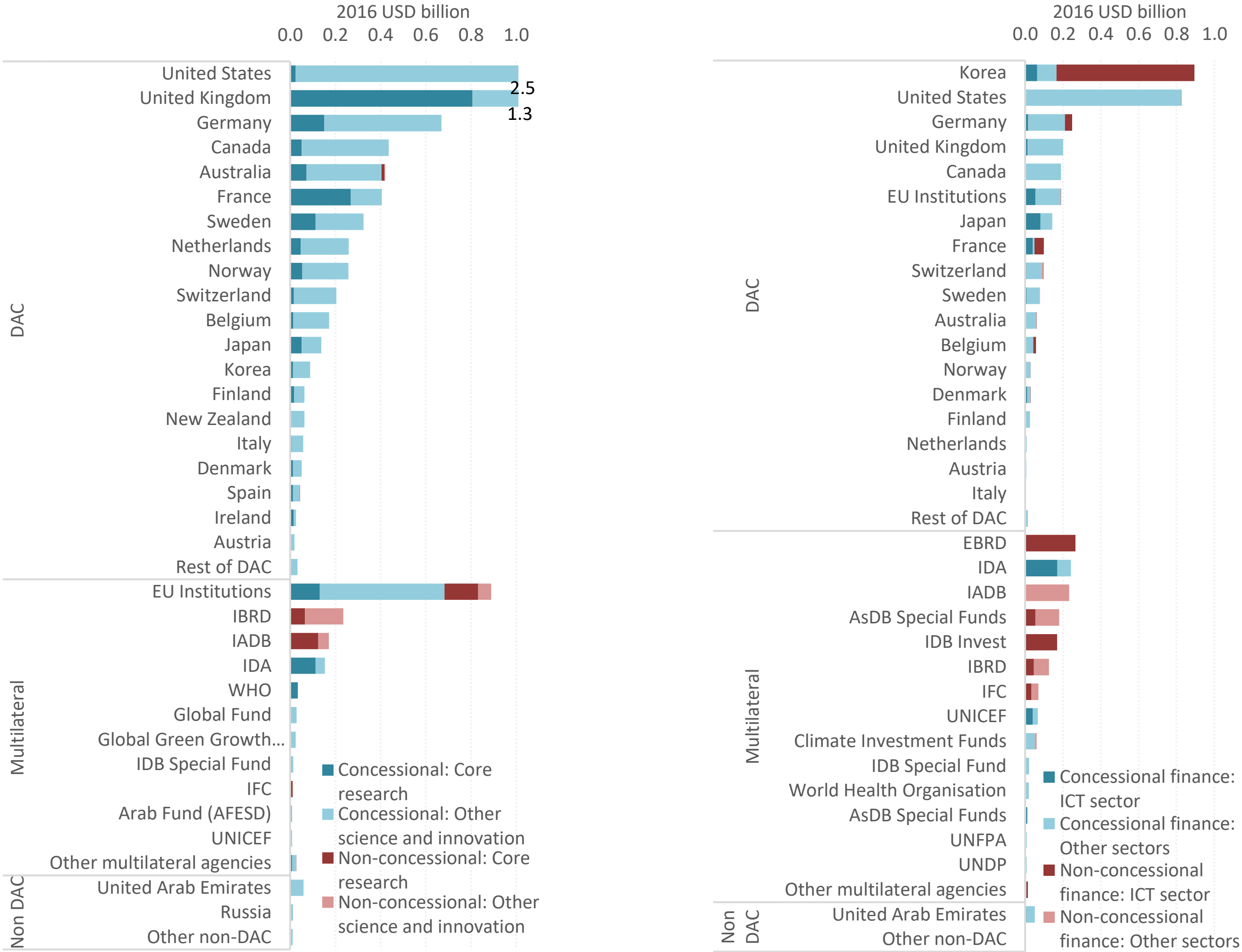
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

Concessional finance from DAC members in support of science, technology and innovation amounted to USD 8.9 billion in 2016, an increase from USD 7.4 billion in 2010. An additional USD 1.5 billion is provided by multilateral agencies and USD 0.1 billion is spent on STI by non-DAC members reporting to the CRS. The largest provider of concessional financing to STI is the United States, with a strong commitment to support research and innovation in the health sector, and the United Kingdom, which has recently scaled up its effort to support research for global challenges. Together, these two countries provides half of the DAC members' total support to STI. However, other countries, such as Australia, Canada and New Zealand, provide a greater share of their total bilateral ODA as support to STI.

The type of STI supported varies across countries. Some countries are dedicated towards one sector or theme. For example, the United States is committed to the global fight against infectious and other diseases, and many of its programmes include STI-related components. France's focus is on agricultural and environmental research, while Japan and Korea's main support is directed towards the ICT sector and other technologies. In contrast, more than half of the ODA financing to STI from the United Kingdom are provided to universities or scientific institutions conducting ODA-eligible research serving multiple purposes. Many of these are located in the United Kingdom. Similarly, a large share of Australia's support to STI comes in the form of scholarships to citizens from developing countries to pursue undergraduate or postgraduate studies at universities and other institutions in Australia. While these resources are ODA-eligible, it can be debatable whether scholarships for higher education or research conducted in donor countries contributes to raising domestic STI capacity in developing countries.

Figure 4.8. Top development providers supporting science and innovation (left) and technology (right) (2016)

Disbursement in 2016 prices



Note: The sum of the two charts will exceed total support to STI because of activities contributing to both science/innovation and technology. Core research refers to research activities classified according to one of the nine research sector codes in the CRS. ICT sector refers to activities that have been reported against the four sector codes for communication in the CRS. Commitments were used as proxy for disbursements for the Caribbean Dev. Bank, Global Environment Facility, IDB Invest, IFAD, IFC, and the Islamic Dev. Bank.

Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

The United States is the largest provider of concessional finance to STI, with a large share of its funding directed towards research, capacity building and innovative approaches to fight the spread of infectious and tropical diseases and prevent maternal and child deaths. The USAID Global Health Research and Development Strategy 2017-2022 aims to strengthen the capability of researchers, improve the evidence-base on health and development interventions, and accelerate the development use of health technologies and approaches to address critical unmet needs and emerging challenges. (USAID, 2017[36]) Many of its programmes, such as the U.S. President's Emergency Plan for AIDS Relief (PEPFAR), include significant research and innovative components, either directly through its activities or in partnerships with academia or research institutions.

The United Kingdom is heavily scaling up support to research. In 2013, the United Kingdom Government announced its pledge to provide 0.7% of its gross national income (GNI) as ODA. The following three years, new research funds were set up to support research activities tackling challenges faced by developing countries (see box 4.1). A second aim of the research funds were also to benefit from the high quality standard of research conducted in the United Kingdom. While the Department for International Development (DFID) has committed to invest 3% of its budget in research, additional funding is expected to be provided through the new funds. ODA support from the United Kingdom towards research activities increased more than four times between 2010 and 2016, from USD 181 million in 2010 to USD 807 million in 2016 and is expected to further increase in coming years.

Sweden's research co-operation programme focus on both strengthening the research capacity of developing countries and financing research projects. It is grounded in the government's Strategy for research co-operation and research in development co-operation 2015-2021. The aim of the strategy is "to contribute to strengthened research of high quality and of relevance to poverty reduction and sustainable development, with a primary focus on low-income countries and regions." While support to research co-operation has represented a minor share of Sweden ODA (roughly 2 %), the Swedish Development Agency (Sida) is aiming to scale up its research programme following strong country demands.

Most of Japan's ODA-STI related activities are focused on large infrastructure technology projects in Asia. These are largely financed by loans and public-private partnerships (PPPs). It has comparative advantages in: private sector development, through high-level talks at the G20 and through the Japanese International Cooperation Agency and World Bank Presidents on firm capabilities and technology absorption (kaizen); and disaster prevention and relief by shaping the global agenda through multilaterals based on its technology advantages and building soft and hard infrastructure (policy research, PoC, early warning systems). Japan is interested in building on its existing international leadership in development co-operation and scaling up these and other activities, such as on quality infrastructure, universal health coverage and disaster risk management.

Agricultural development and research is a priority for many development providers. As part of its One World – no hunger initiative, Germany has established green innovation centres in 14 partner countries. The Centres promote the introduction and spread of innovations throughout the agricultural sector. They train and educate small farmers in business and cultivation methods and help the farmers to organise themselves to set up start-ups, co-operatives and create partnerships with the private sector. Several development providers also supports the CGIAR partnership, a global research partnership, which aims to increase food security, improve nutrition, and ensuring sustainable use of natural resources. The CGIAR partnership includes 15 Research Centres across the world hosting more than 8 000 scientists, researchers, technicians, and other staff.

DAC members are increasingly supporting research activities. Several DAC members are scaling up its support towards research and innovation. However, while part of these funding are aimed to strengthen the research capacity of developing countries, a large share is directed towards research projects at universities and research institutions in donor countries. In the United Kingdom, several universities have developed manuals for researchers of how they can apply for ODA-eligible funding. The manuals include the definitions and criteria of ODA and guide researchers through the process of developing a research proposal, for which the funding would qualify as ODA.

Further analysis could assess the additionality of ODA-eligible research spending. While additional funding for research benefitting developing countries would be welcomed by the development community, it is unclear whether the funds are additional or simply re-reallocated from other projects. For example, one university manual in the United Kingdom states that "*while the UK ODA spend remains 0.7% of GNI, the establishment of GCRF will see diversion of funding from other development activities to research, potentially diverting support away from the world's poorest. As such, some peer reviewers may feel that applicants have a moral responsibility to undertake research under the Newton Fund and the GCRF which is not only excellent but which is also ethical, genuinely beneficial, and impactful*" (University College London, 2017[37]). While research spending in both donor and recipient countries can be classified as ODA, it can be debated whether potentially reallocating funds from development projects and programmes in developing countries towards research spent primarily in donor countries is justifiable. To provide more evidence on the purpose and location of research spending, it is necessary to strengthen the CRS and distinguish between research spent in donor countries and strengthening the research capacity of developing countries.

Digitalisation brings new opportunities for more effective development co-operation. Several DAC members have recently adopted digital strategies or other solutions to increase the use of modern technologies in the delivery of development programmes. For example, Norway's 2018 *Digital strategy for Development Policy* aims to integrate digital solutions into its main developmental policy priority areas, especially education and health, and greater use of ICTs in the management of development assistance. DFID's Digital *Strategy 2018 to 2020: Doing Development in a Digital World* aims to improve the use of digital technologies to "improve the speed, value for money, reach and impact of its programmes". It also aims to design and implement digital tools based on users' needs.

The US Global Development Lab is a vehicle for innovation in development. Founded in 2014 by USAID, the US Global Development Lab serves as an innovation hub to test new ideas and solutions and harness the power of science, technology and new innovative tools and approaches that accelerate development impact. It funds researchers and partners with universities to address global development challenges, promotes and mobilises additional funds through private-public partnership for digital inclusion and digital finance, and develops new applications and solutions to improve the use of digital technologies and data in development programmes.

Box 4.1. The new research funds of the United Kingdom

In 2014, the United Kingdom launched the Newton Fund, a fund aimed to support developing countries' economic development and social welfare through research and capacity building programmes. Originally aimed to disburse 75 million pounds per year up to 2019, the 2015 United Kingdom research review agreed to extend the programme up to 2021 while also doubling the investment to 150 million pounds per year by 2021.

In 2015, the United Kingdom government set up the Ross Fund, a 1 billion pound fund, aimed to support the challenge against infectious diseases in developing countries. The Ross fund, named after Sir Ronald Ross who proved in 1897 that malaria is transmitted through mosquitoes, will invest in research and the development of new products and prevention and response to future disease outbreaks.

The following year, in 2016, yet another fund was established. The Global Challenges Research Fund (GCRF). The aim of the Global Challenges Research Fund is to address challenges faced by developing countries, whilst benefitting from the research capacity in the United Kingdom. It is expected that new partnerships will be formed between researchers in the United Kingdom and in developing countries, forging greater knowledge exchange and strengthening the capacity for research and innovation in both the United Kingdom and in other countries. The budget for the GCRF is 1.5 billion pounds over 2016-2021

Source:, (United Kingdom Government, 2019[38]), Global Challenges Research Fund, https://www.ukri.org/research/global-challenges-research-fund/

Germany's Digital Africa Initiative launched in 2015 and BMZ's Digital Agenda aims to take greater advantage of digital solutions for development co-operation. The Digital Africa Initiative has a budget of around EUR 50 million per year. Out of a total of 22 projects implemented between 2015 and 2017, 41% were focused on improving digital skills. The remaining projects focused on working with the youth to encourage local entrepreneurship (22 %), expanding access to internet and phone networks (11 %), providing new ICT solutions for greater government transparency, participation and efficiency (19 %), and developing new digital solutions in the health sector (7 %).

New digital opportunities in developing countries bring greater needs for international support. While investments in the ICT sector have previously been linked to the development of infrastructure, new needs for international support emerges as part of countries' digital transition. For example, greater investments in education and digital skills are crucial for countries to exploit the benefits of ICTs. Digital skills are not only required to develop and operate networks and systems, but also to use and benefit from digital tools and services. Other examples include: supporting governments in using ICTs for more effective and efficient systems (e.g. tax systems) and developing user-friendly digital products and services, support the development and implementation of STI policies, support initiatives in innovation and entrepreneurship, and enhancing the planning and delivery of development co-operation through greater use of digital tools. DAC members' new digital strategies and initiatives are encouraging steps as these suggest a greater development focus on ICTs and innovation in the future.

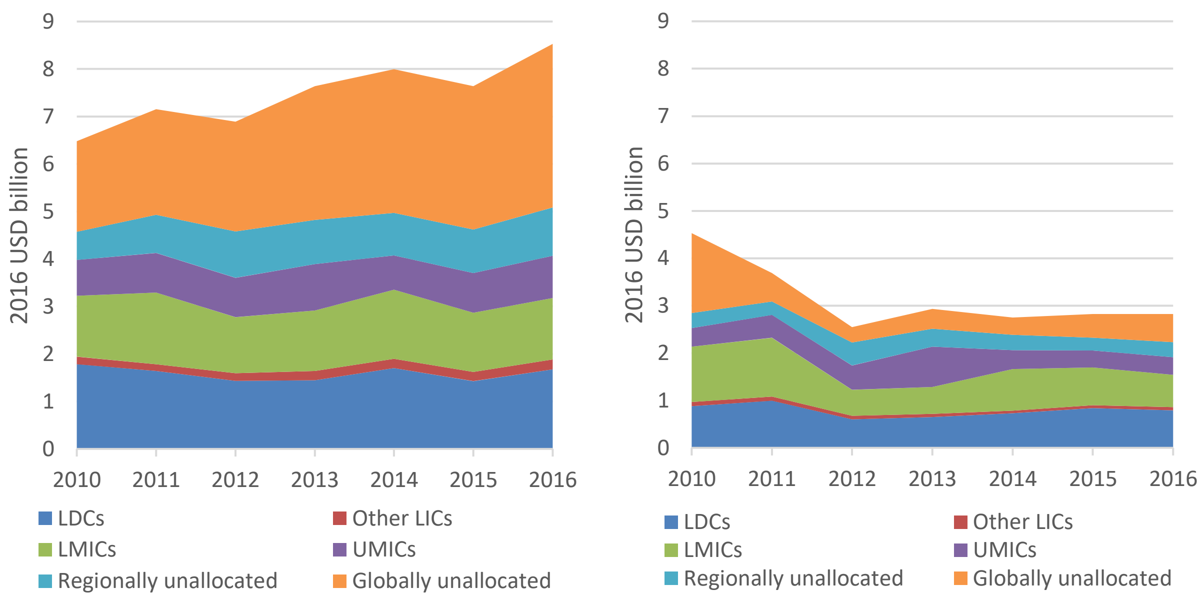
4.4. Funding science, technology and innovation is often not country-allocable

Half of all STI-funding is not allocated to countries. More than one-third of all concessional finance to STI is reported as "globally unallocated". Concessional finance which is not country-allocable are often support towards research at universities and research institutions in donor countries or core support to NGOs or other entities with a global or regional mandate. A greater share of technology-oriented development finance is allocated to countries compared to support to research.

Globally unallocated financing to STI is rising. Most of the increase in concessional finance to STI can be attributed to support to research institutions, which tend to have a global focus. Support to countries have remained rather stable since 2010 with most research spending aimed to benefit LDCs and LMICs. In contrast, concessional finance towards technology is stable following a decline between 2010 and 2012. Still, technology-oriented concessional finance is scarce, representing only one-third of the amount spent on research and innovation and less than 2 % of total concessional finance. While non-concessional and private finance represents a large share of total support towards ICTs and other technologies, greater international efforts using concessional finance could further support people's access to ICTs and improving digital skills.

Figure 4.9. Concessional finance to science and innovation (left) and technology (right) by income (2010-2016)

Disbursements in 2016 prices

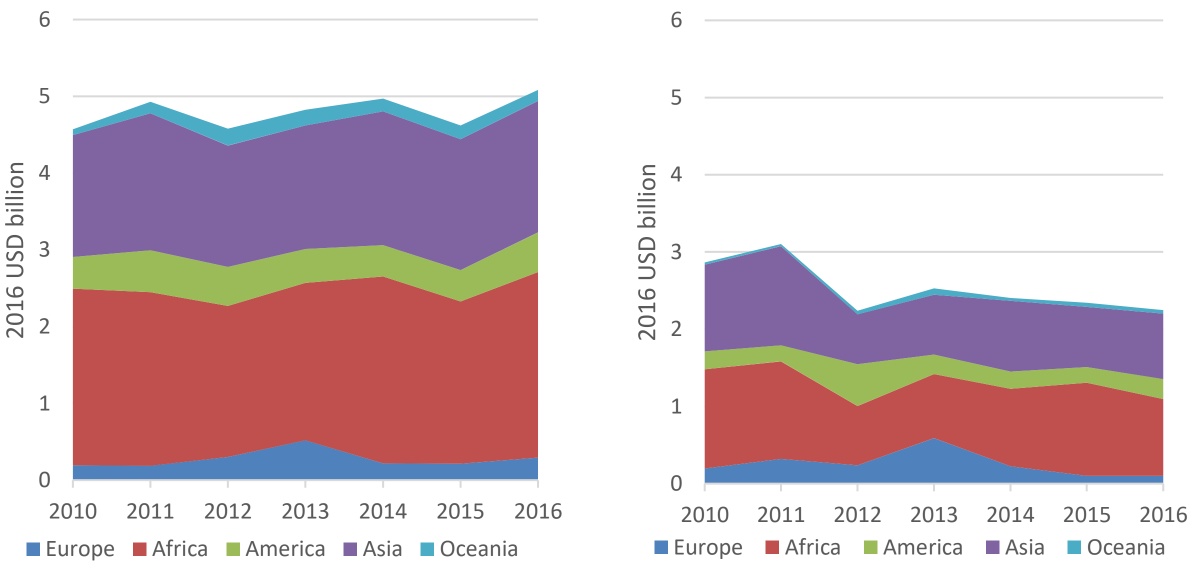


Note: The sum of the two charts will exceed total support to STI because of activities contributing to both science/innovation and technology.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

Concessional finance is mainly allocated to countries in Africa and Asia. The top recipient countries of STI-related concessional finance are English-speaking countries in East Africa, such as Tanzania, Kenya, and Ethiopia, or countries in Asia, including Afghanistan, Indonesia, India and Pakistan. Most STI towards these countries are going through universities or projects which includes a research or technological component, representing on average 5% of the concessional finance received. However, there are wide discrepancies across countries with core research activities representing one-quarter or more of total STI resources in Ethiopia and India, but less than 5% in Indonesia and Pakistan. In Ethiopia, Kenya, and Pakistan support towards ICTs represents less than 1% of total support to STI, while more than 10% of STI resources are targeting ICT development in Indonesia and Tanzania.

Figure 4.10. Concessional finance to science and innovation (left) and technology (right) by region (2010-2016)

Disbursements in 2016 prices.

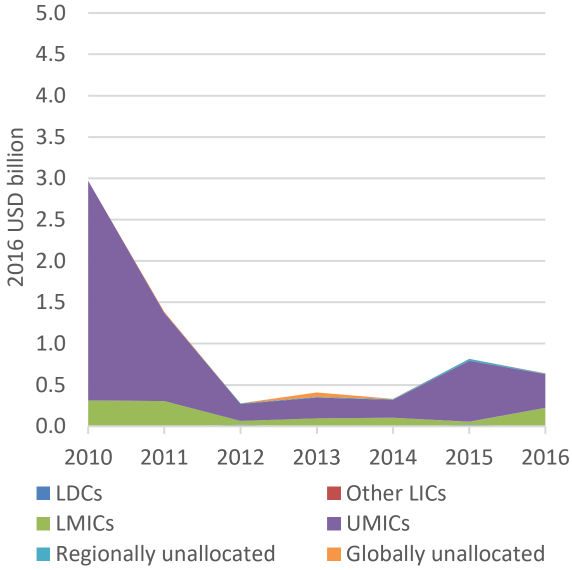


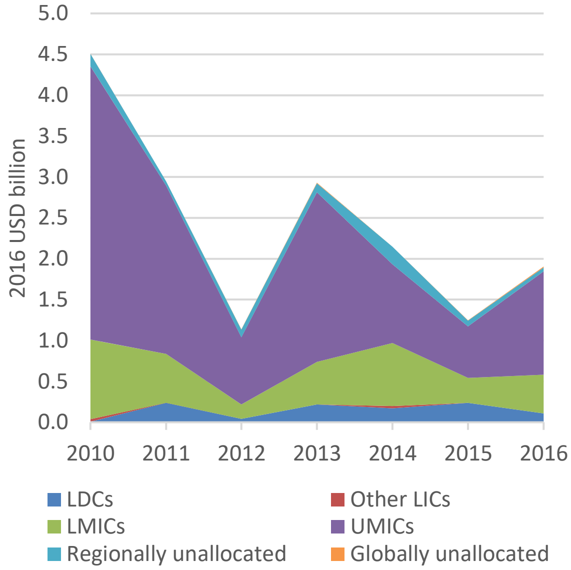
Note: The chart showing concessional finance to STI by region excludes finance that is reported as globally unallocated. The sum of the two charts will exceed total support to STI because of activities contributing to both science/innovation and technology.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

Non-concessional finance is volatile and mainly supporting upper-middle income countries. Considering that non-concessional finance mainly consists of development loans that do not qualify as ODA, the recipients of non-concessional finance are mainly countries with acceptable credit rating and borrowing capacity. Most non-concessional finance to STI are allocated to upper-middle income countries in the Americas and in Asia, in particular Argentina. Brazil, People's Republic of China, India, and Mexico. The largest providers of non-concessional finance to STI are the Asian Development Bank, EU institutions (incl. EBRD), Inter-American Development Bank, Korea, and the World Bank (IBRD and IFC).

Figure 4.11. Non-concessional finance to science and innovation (left) and technology (right) by income (2010-2016)

Disbursements in 2016 prices

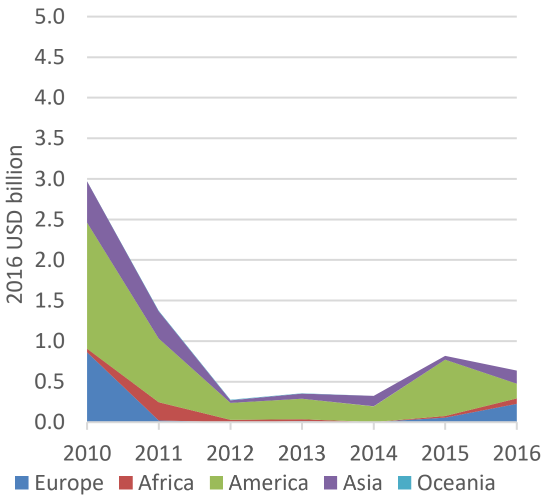


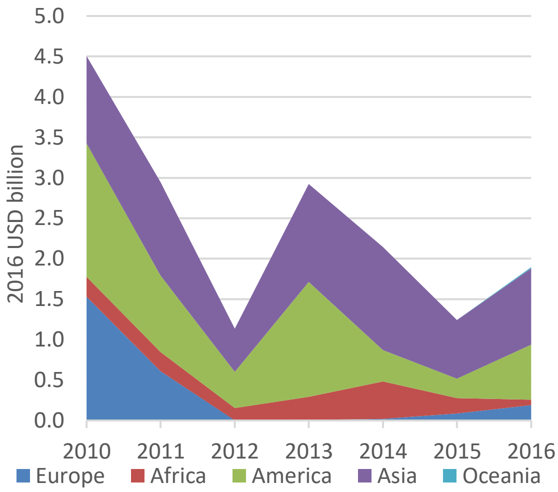


Note: The sum of the two charts will exceed total support to STI because of activities contributing to both science/innovation and technology.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

Figure 4.12. Non-concessional finance to science and innovation (left) and technology (right) by region (2010-2016)

Disbursements in 2016 prices





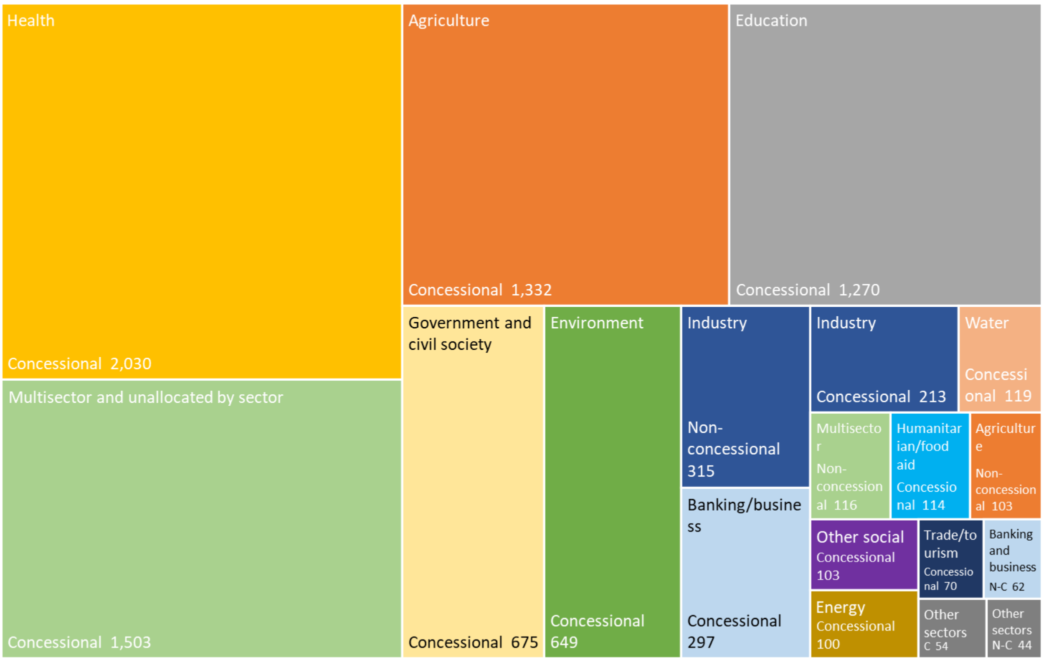
Note: The sum of the two charts will exceed total support to STI because of activities contributing to both science/innovation and technology.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

4.5. Agriculture, communications and health are the primary science, technology and innovation sectors

Improving the health of individuals is a key research area. Despite no increase in funding since 2010, the health sector is still the largest receiving sector of ODF support to science and innovation. The focus areas in the health sector are infectious and STD-related disease control, including HIV/AIDS, and reproductive health. Other priority sectors are the agriculture and education sectors. Concessional support to agricultural research and development has increased by 22 % since 2010, with significant funding provided by the United States and other DAC members to the CGIAR network. There are also increasing support to research and innovation in the environment sector, especially relating to environmental policy, and towards SMEs and other actors in the business and financial sector. However, the largest increases are observed in activities classified as multisector, which is mainly support to research and scientific institutions. Additional funding from the United Kingdom towards development research mainly drives this.

Figure 4.13. Official development finance to science and innovation by sector (2016)

Disbursements in 2016 prices

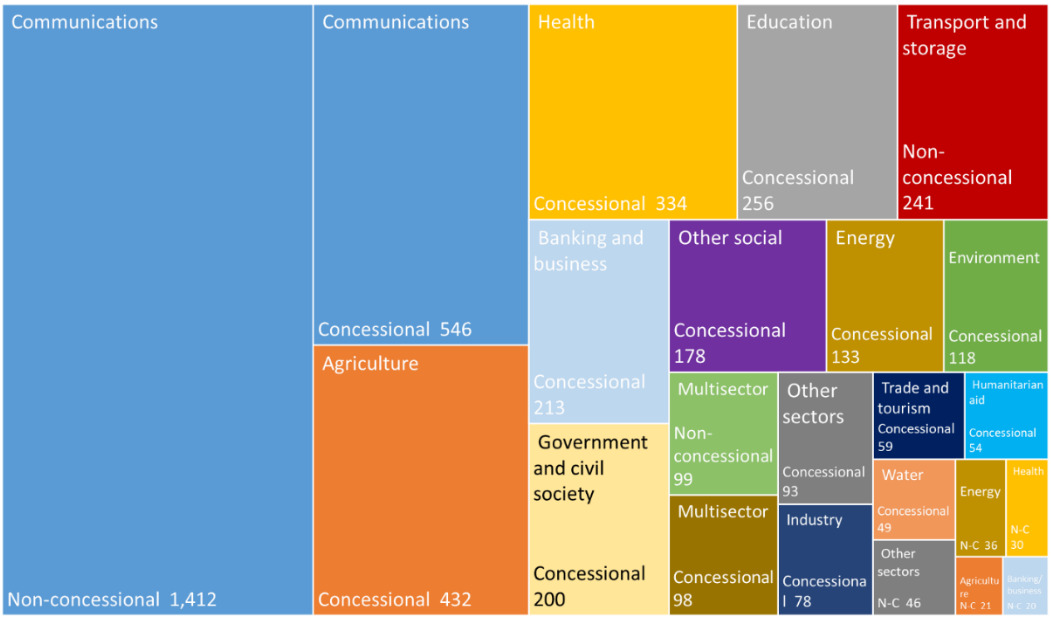


Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

The communication sector is the primary target of technology-oriented ODF. The ICT and telecommunication sectors are large receivers of non-concessional loans, mainly provided by multilateral development banks. Other sectors with ICT and technology focus are agriculture, health and the education sector. Overall, financing towards ICTs and technology represent a minor share of total development finance; however, the rapid pace of digitalisation and the increasing focus to use modern technologies and innovative approaches in development co-operation could change this shortly.

Figure 4.14. Official development finance to technology by sector (2016)

Disbursements 2016 prices



Note: The colours represents the different sectors. C is short for concessional and N-C is short for non-concessional financing.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1.

5. The private sector is a key driver for supporting science, technology and innovation in a development context

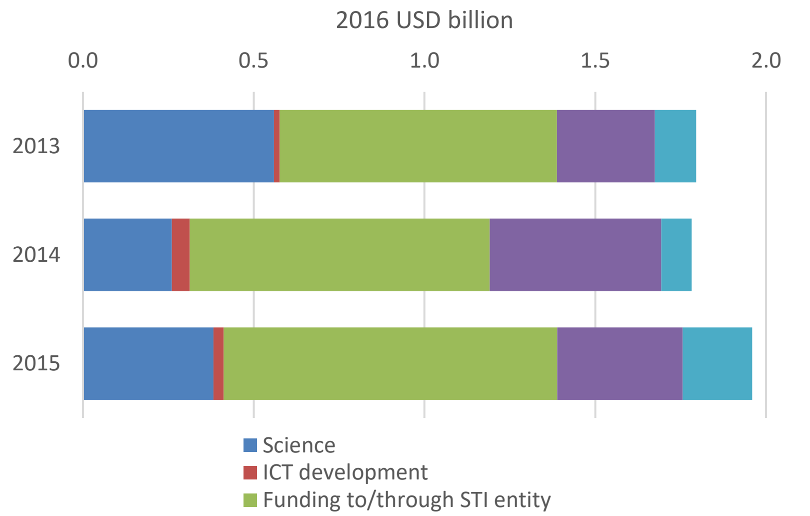
The private sector is driving a lot of technological development. There are strong incentives for businesses to invest in STI, and private investments in ICT infrastructure and R&D are often many times higher than public spending. However, the private sector are also actively supporting the well-being and welfare of developing countries and their citizens through philanthropy, corporate social projects, and through partnerships with international organisations and other development providers. As such, the private sector is becoming a key partner in development co-operation.

A large share of private philanthropy supports STI. A recent OECD report estimated that total private philanthropy for development amounted to USD 8 billion per year. While these resources are still modest compared to official development finance, foundations are becoming key partners in specific sectors, in particularly the health sector. Based on the resources spent by 143 foundations over the years 2013-2015, foundations' support was the third-largest source of financing in the health and reproductive health sectors (OECD, 2018[35]). Nearly one-quarter of total support provided by foundations targets STI activities and initiatives (Figure 5.1).

Private foundations are important contributors towards research. More than 80 % of all foundations included in the OECD Philanthropy Survey provided financial support to STI projects and initiatives, most of which supported research activities. Nearly three-quarters of all support towards STI are directly supporting research activities or funding institutions conducting research. The largest foundation, Bill and Melinda Gates Foundation, provides more than half of all support from foundations targeting STI. Only a small share of all financing from foundations is aimed towards ICT development, of which a large share is support to increase access to ICTs at public libraries.

Figure 5.1. Private philanthropy to STI (2013-2015)

Disbursements in 2016 prices



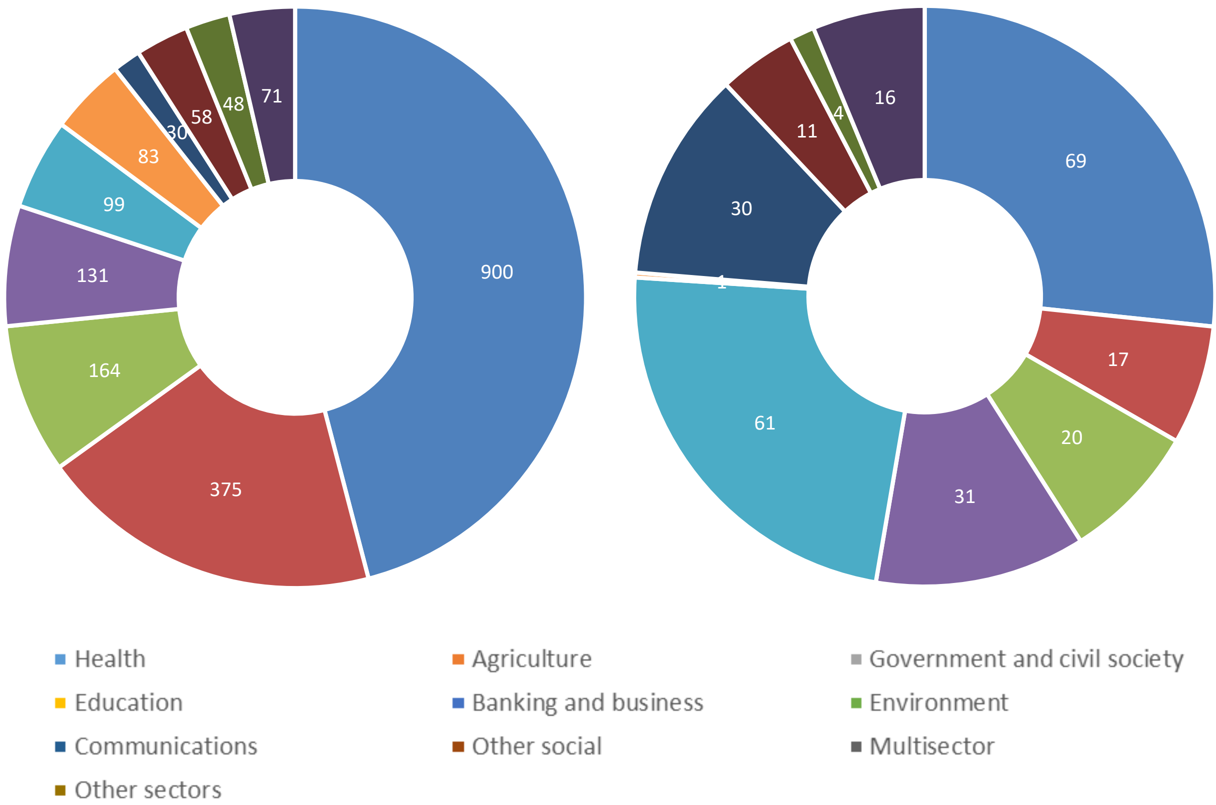
Note: This chart only shows data for the years 2013-2015

Source: (OECD, 2018[35]), Private Philanthropy for Development, http://dx.doi.org/10.1787/9789264085190-en

Foundations' key sectors and recipients follow the patterns of official development providers. Foundations sectoral priorities show similar patterns as official development providers. In 2015, the health sector received 47% of foundations' research spending and 27% of all support relating to ICTs and other technologies, with significant investments in vaccine development and Infectious disease control. Foundations' second research priority is the agricultural sector, with significant support provided by Bill and Melinda Gates Foundation. Similar to official development providers, half of the resources provided by foundations are not country-allocable, with one-third considered globally unallocated and the rest mainly targeting Asia and Africa. The top receiving countries of support from foundations towards STI were in 2015: India, Mexico, South Africa, Ethiopia and People's Republic of China.

Figure 5.2. Private philanthropy to science and innovation (left) and technology (right) by sector (2015)

Disbursements in 2016 prices, millions



Source: (OECD, 2018[35]), Private Philanthropy for Development, http://dx.doi.org/10.1787/9789264085190-en

Besides foundations, the private sector is engaged in its own projects to support ICT development. While it lies in the business interests of technology firms to connect more people to the Internet, their efforts contribute to national and international priorities improving access and use of ICTs. For example, technology companies are key players in connecting the unconnected. In an effort to combine business prospects and providing social goods, both Google and Facebook have launched their own initiatives to bring

Internet access to remote areas. While Facebook's Aquila project, which aimed to use solar-powered drones as satellites, was recently abandoned, Google's Loon project was spun off into its own company in July 2018. Starting as a research project, Loon uses a network of high-flying balloons to deliver Internet access to people in rural and unserved areas. In 2014, the first LTE connection was made with a local school in Brazil. In 2017, Loon's balloons helped deliver basic connectivity to thousands of inhabitants in Peru affected by flooding and 200 000 people in Puerto Rico following the hurricane Maria.

New partnerships between international organisations and tech companies are emerging. The private sector is also increasingly partnering with development providers to improve the use of technological solutions in development co-operation. For example, in September 2018, the Famine Action Mechanism (FAM) was launched as a coalition between the World Bank, the UN, International Committee of the Red Cross, Microsoft, Google and Amazon. The aim of the FAM is to use new technologies and predictable analytics, e.g. AI and machine learning, to improve early warning system to be able to identify areas where there are increasing risks of famines. Prearranged funding mechanisms and actions plans will be developed to allow for earlier and more efficient interventions.

6. Conclusions and ways forward

STI and development are increasingly connected. STI is an important cross-cutting theme for the SDGs, with implications for practically all SDGs. However, it is dispersed across many goals and targets and its total contribution to the achievement of the SDGs is hard to measure. Still, strong commitments and significant efforts have been made in recent years to support developing countries harness the power of new technologies and incentivise innovation. Additional resources are also being mobilised for research relating to global challenges. While many fruits of these efforts are yet to materialise, the increasing awareness placed on the importance of STI within development raises the need for adequate monitoring of the financial resources supporting these efforts. This paper makes an effort to estimate the financial resources spent on STI-related development activities by combining information across different CRS fields. However, based on the criteria used, the analysis can be considered to both under and over-estimate the available amount of resources. The quantitative data here presented is indicative (or best effort), due to the lack of precise identification of STI in the underlying statistical classification.

A policy dialogue between the STI and the development communities is required to determine how to best monitor development flows supporting STI activities. While lots of detailed information exists on development activities through the CRS, the lack of adequate classifications that conforms to official STI definitions and standards pose a challenge in assessing the portion of development finance targeting STI. Alternatively, assessing government budgets may be sufficient to provide an estimate of the total amount of ODA to be spent on STI-related government priorities, but the timing and lack of detail of these estimates may create challenges relating to the accuracy when compared to official ODA and other development finance. Budget estimates are also unlikely to adequately determine the financial resources spent on supporting STI development in individual countries, information that will be important for the monitoring of the SDG. A key conclusion of the paper is the need for better alignment of definitions across the STI and development communities so each can satisfy its need for data-driven policy analysis without creating potential conflicts of interpretation.

Enhancing the CRS is the most likely solution; however, it would be hard to ensure definitions are adhered to accurately. In response to the need to address other important cross-cutting policy areas, such as gender and environment, the Working Party on Development Finance Statistics have over the past decade agreed to the creation of dedicated markers, which facilitates monitoring and comparison of activities that addresses a certain policy area. However, the creation of additional policy markers is not necessarily a sustainable solution since they create additional burden on reporting entities and enlarges the structure of the CRS, possibly resulting in lower coverage or quality of the data provided. In close discussion with the STI community, additional efforts should be placed on investigating alternative solutions, including enhancing the CRS sector code system or use machine learning or other statistical methods to find proxies for the resources targeting STI.

Development partners and international organisations can assist developing countries on STI by facilitating peer learning, exchanging information, enhancing and aligning donor contributions, in addition to helping mobilise additional concessional financing. Additional concessional resources should be used for “soft” ICT infrastructure. While concessional finance is mainly used to finance research activities, non-concessional finance is used to finance ICTs and other technology-intensive sectors. However, this distinction misses opportunities as the deployment of new technologies creates needs besides capital-intensive infrastructure. For example, more concessional resources in "soft" infrastructure, such as strengthening education and digital skills, can result in faster growth and progression in the digital economy. In addition, the spread of new technologies and the growing importance of the ICT ecosystem necessitates further breakdown of ICT sector codes in the CRS.

The digitalisation of the development industry can be accelerated. Many development providers are exploring new ways of how to better integrate ICTs in the planning and implementation of development activities. However, more consolidated efforts through the DAC and other forums can improve knowledge sharing and set new standard and requirements across the development planning and implementation cycle. With greater access to the Internet through 3G and LTE mobile networks in developing countries, tailored ICT tools have the potential to improve measuring results and strengthen monitoring and evaluation of development projects.

The ODA eligibility of research activities need to be further examined to ensure the research contributes to the economic development and welfare of developing countries. There is ambiguity in the definition of research spending that can be classified as ODA. It is not clear as to which evidence is needed to ensure results from ODA-eligible research contributes to the economic development and welfare of developing countries. It is important to assess how donor-conducted research is transmitted to researchers and policy makers in developing countries. A separate discussion is also needed to clarify the ODA rules on research spending relating to the new concept of TOSSD. Without clarifying the ODA rules for research activities, there is a risk of inflation of ODA-eligible research as development providers may use ODA funding as a means to subsidise research in their own countries. While additional funding towards research aimed to tackle challenges in developing countries is encouraged, there is a risk that spending towards research activities may result in a reallocation of resources which would otherwise be spend on projects in developing countries.

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Glossary

The following terms and concepts are commonly used in this report.

Abbreviation/term	Definition
Bilateral ODA	ODA flows provided directly by a donor country to an aid recipient country.
Concessional finance	Official development finance extended by bilateral or multilateral providers at concessional financial terms to developing countries. For bilateral providers it is the same as bilateral ODA.
Core research	Activities which have been reported against the nine research sector codes in the CRS (see annex A).
Core ICT	Activities which have been reported against the four sector codes for communication in the CRS (see Annex A).
CRS	**Creditor Reporting System**; the DAC database on individual aid activities.
DAC	**Development Assistance Committee**, the committee of the OECD, which deals with development co-operation, matters.
EDGE	**Enhanced Data rates for GSM Evolution**, a pre-3G digital mobile phone technology that allows improved data transmission rates.
Frascati Manual	**The OECD Frascati Manual** is the international standard on collecting and using statistics on the financial and human resources devoted to R&D.
GPRS	**General Packet Radio Service**, a packet-oriented mobile data standard on 2G and 3G cellular communication network's global system for mobile communications.
IATT	**The United Nations Interagency Task Team on Science, Technology and Innovation for the SDGs,** one component of the Technology Facilitation Mechanism.
IXP	**Internet exchange point**, a physical location through which Internet service operators exchange Internet traffic.
LTE	**Long-Term Evolution**, a standard for high-speed wireless communication for mobile devices and data terminals.
Multilateral ODA	Official contributions from donor countries to multilateral agencies, whether negotiated, assessed or voluntary. They are resources that the governing boards of multilateral organisations have the unqualified right to allocate as they see fit within the organisation’s charter.
NLP	**Natural Language Processing**, a subfield of artificial intelligence that helps computers understand, interpret and manipulate human language.
Non-concessional finance	Official Development Finance extended by bilateral or multilateral providers to developing countries under conditions that would not qualify as ODA. For bilateral providers it is the same as OOF.
ODA	**Official Development Assistance.** Grants or loans extended by bilateral providers to countries and territories on the DAC List of ODA Recipients (developing countries) and to multilateral agencies. These need to be: (a) undertaken by the official sector; (b) with promotion of economic development and welfare as the main objective; (c) at concessional financial terms.
ODF	**Official Development Finance.** ODF includes (a) bilateral ODA, (b) grants and concessional and non-concessional development lending by multilateral financial institutions, and (c) Other Official Flows for development purposes that have too low a grant element to qualify as ODA.
OOF	**Other Official Flows.** Transactions by the official sector with countries on the DAC List of ODA Recipients, which do not meet the conditions for eligibility as Official Development Assistance.
Oslo Manual	**The OECD/Eurostat Oslo Manual** is the international standard for the collection, reporting and use of data on innovation.

Abbreviation/term	Definition
TFM	**Technology Facilitation Mechanism,** a mechanism set up to support the implementation of the Sustainable Development Goals (SDGs).
TOSSD	**Total official support for sustainable development,** a measure of cross-border finance currently under development, covering all officially supported resource flows regardless of financial instrument used or level of concessionality, or whether they are delivered through bilateral or multilateral channels.
USF	**Universal Service Fund,** funds financed through contributions from telecommunication operators, and aimed to ensure that telecommunication services are accessible to all people (and communities) at affordable prices.

Annex A. Methodology for identification of STI-related activities in the Creditor Reporting System (CRS)

The following section describes the process to identify research-related activities and activities supporting ICT development in greater detail.

Stage 1: Identification of core science, technology and innovation activities

The first stage was to examine the CRS sectoral classification through the five-digit CRS purpose codes. The purpose codes are also commonly referred to as sector codes as they provide a classification of the sector of the activity. In total, there are 261 purpose codes with 207 mandatory and 54 new voluntary codes, which have recently been added to the CRS to more easily link development activities to developing country budgets.

There are eight purpose codes responding to activities supporting research across different sectors and one purpose code responding to activities supporting research institutions. These activities are considered core STI activities as their ultimate aim are clearly focused on obtaining new knowledge through scientific studies in their respective sectors. The description of these codes are presented in table A.1.

Table A.1. Research sector codes in the CRS

CRS CODE	DESCRIPTION	CLARIFICATIONS
11182	Educational research	Research and studies on education effectiveness, relevance and quality; systematic evaluation and monitoring.
12182	Medical research	General medical research (excluding basic health research).
23182	Energy research	Including general inventories, surveys.
31182	Agricultural research	Plant breeding, physiology, genetic resources, ecology, taxonomy, disease control, agricultural bio-technology; including livestock research (animal health, breeding and genetics, nutrition, physiology).
31282	Forestry research	Including artificial regeneration, genetic improvement, production methods, fertiliser, harvesting.
31382	Fishery research	Pilot fish culture; marine/freshwater biological research.
32182	Technological research and development	Including industrial standards; quality management; metrology; testing; accreditation; certification.
41082	Environmental research	Including establishment of databases, inventories/accounts of physical and natural resources; environmental profiles and impact studies if not sector specific.
43082	Research/scientific institutions	When sector cannot be identified.

Source: (OECD, 2018[33]), *Converged statistical reporting directives for the Creditor Reporting System (CRS) and the annual DAC questionnaire*, https://one.oecd.org/document/DCD/DAC/STAT(2018)9/FINAL/en/pdf.

There are four purpose codes for activities supporting the development of communication networks, which includes ICTs. All activities reported under these codes are considered as core support to the ICT sector. The description of these codes are presented in table A.2.

Table A.2. Communication sector codes in the CRS

CRS CODE	DESCRIPTION	CLARIFICATIONS
22010	Communications policy and administrative management	Communications sector policy, planning and programmes; institution capacity building and advice; including postal services development; unspecified communications activities.
22020	Telecommunications	Telephone networks, telecommunication satellites, earth stations.
22030	Radio/television/print media	Radio and TV links, equipment; newspapers; printing and publishing.
22040	Information and communication technology (ICT)	Computer hardware and software; internet access; IT training. When sector cannot be specified.

Source: (OECD, 2018[33]), *Converged statistical reporting directives for the Creditor Reporting System (CRS) and the annual DAC questionnaire*, https://one.oecd.org/document/DCD/DAC/STAT(2018)9/FINAL/en/pdf.

Stage 2: Identification using channels of delivery

The second stage included an examination of all entities on the DAC list of channels of delivery. The DAC list of channels of delivery permits the identification of the first implementing partner of the activity. It is the entity that has implementing responsibility over the funds and is normally linked to the extending agency by a contract or other binding agreement, and is directly accountable to it.[8] The channel of delivery includes public sector institutions, non-governmental organisations, private-public partnerships, multilateral organisations, universities and other research institutions, and private sector institutions. Government agencies and private sector institutions are included as categories, rather than as specific entities and organisations, e.g. distinguishing between central government entities and local government entities or between banks and pension funds. In 2018, the DAC list of channels of delivery contained 355 channels, of which 318 were specific entities and organisations.[9]

All entities, whose core purpose or main work was considered STI-related, e.g. conducting research, support to innovation, or focused on ICTs or other technologies, were included in the analysis. Official development finance provided as core funding to these entities or activities implemented by these entities were considered to support STI.

In total, the assessments identified 64 individual entities on the CRS channel list and the broad category titled “university, college or other teaching institution, research institute or think-tank”. Most of these agencies are research institutions, or NGOs or other networks focused on science in a particular field. The list also includes entities focusing on standard setting or monitoring of the ICT landscape and entities providing technical assistance or supporting technology transfers in the field of ICTs or green technologies. These entities are presented in table A.3.

While many other entities on the list, including many multilateral organisations, are also engaged in research activities and support ICTs and technology transfers, these activities are not necessarily the core purpose of the agency. For example, many entities also have a

[8] The extending agency is the government entity (central, state or local government agency or department) financing the activity from its own budget. It is the budget holder, controlling the activity on its own account.

[9] More information on the DAC classifications and the list of channels of delivery can be found at: http://www.oecd.org/dac/financing-sustainable-development/development-finance-standards/dacandcrscodelists.htm.

core purpose of facilitating networks and partnerships, focusing on advocacy or capacity building in a wide variety of areas, or implementing development projects not related to STI. Concessional finance to or through these entities were not included in this analysis as it would be difficult to determine the "STI-proportion" of the total finance received by these entities.

Table A.3. Creditor Reporting System channels of delivery with a focus on supporting science or technology

Type of entity	Channel code	Entity
International NGO	21045	African Medical and Research Foundation
Donor country-based NGO	21006	Development Gateway Foundation
	21049	European Centre for Development Policy Management
	21014	Human Rights Information and Documentation Systems
	21025	International Seismological Centre
Developing country-based NGO	21048	Association of African Universities
	21003	Latin American Council for Social Sciences
	21030	Pan African Institute for Development
Public-Private Partnership (PPP)	31006	Coalition for Epidemic Preparedness Innovations
	30007	Global Alliance for ICT and Development
	30012	Global Climate Partnership Fund
	47043	Global Crop Diversity Trust
	30015	Global Energy Efficiency and Renewable Energy Fund
	30003	Global e-Schools and Communities Initiative
	30005	International AIDS Vaccine Initiative
	30006	International Partnership on Microbicides
Network	31001	Global Development Network
	31002	Global Knowledge Partnership
	21017	International Centre for Trade and Sustainable Development
United Nations agency, fund or commission (UN)	41303	International Telecommunications Union
	41320	Technology Bank for Least Developed Countries
	41304	United Nations Educational, Scientific and Cultural Organisation
	41125	United Nations Institute for Training and Research
	41129	United Nations Research Institute for Social Development
	41134	United Nations University (including Endowment Fund)
	41308	World Intellectual Property Organisation
	41309	World Meteorological Organisation
Other multilateral institution	47009	African and Malagasy Council for Higher Education
	47002	Asian Productivity Organisation
	47012	Caribbean Epidemiology Centre
	47015	CGIAR Fund
	47025	Commonwealth of Learning
	47065	Intergovernmental Oceanographic Commission
	47067	Intergovernmental Panel on Climate Change
	30010	International drug purchase facility
	47074	International Vaccine Institute
	47084	Pan-American Institute of Geography and History
	47092	South East Asian Fisheries Development Centre

Type of entity	Channel code	Entity
University, college or other teaching institution, research institute or think-tank	47101	Africa Rice Centre
	47069	Bioversity International
	47018	Centre for International Forestry Research
	21004	Council for the Development of Economic and Social Research in Africa
	21009	Forum for Agricultural Research in Africa
	47047	International African Institute
	47051	International Centre for Agricultural Research in Dry Areas
	47053	International Centre for Diarrhoeal Disease Research, Bangladesh
	47017	International Centre for Tropical Agriculture
	47054	International Centre of Insect Physiology and Ecology
	47057	International Crop Research for Semi-Arid Tropics
	51001	International Food Policy Research Institute
	21021	International Institute for Environment and Development
	21039	International Institute for Sustainable Development
	47062	International Institute of Tropical Agriculture
	47063	International Livestock Research Institute
	47020	International Maize and Wheat Improvement Centre
	47021	International Potato Centre
	47070	International Rice Research Institute
	47071	International Seed Testing Association
	47075	International Water Management Institute
	47099	University of the South Pacific
	51000	University, college or other teaching institution, research institute or think-tank
	47056	World AgroForestry Centre
	47103	World Maritime University
	47008	World Vegetable Centre
	47104	WorldFish Centre

Source: (OECD, 2018[33]), *Converged statistical reporting directives for the Creditor Reporting System (CRS) and the annual DAC questionnaire*, https://one.oecd.org/document/DCD/DAC/STAT(2018)9/FINAL/en/pdf.

Stage 3: Identification using text mining analysis

The third stage included the identification of STI activities using text-mining methods. The most prominent keywords used in the description of the activities identified in stages 1 and 2 were identified using Natural Language Processing algorithms.

The algorithms extracted each word in the description field of the roughly 22 000 research activities and 12 000 ICT activities, covering the years 2013-2016. Common English words such as “the”, “is”, and “are” were removed from the analysis. Similar procedures were implemented to remove common words also in French, German, Portuguese and in Spanish. In addition, words such as “project/s”, “development/s” and “country/ies” were excluded as these words tend to be typical in the description of development activities, but do not provide any relevance of the particular sector of the activity.

The keywords referring to research activities, such as “’research”, “knowledge” and “university”, were used in the initial screening of the CRS for identifying additional STI-related activities. The translation of some of these words into other languages were also used as the base for the analysis. Manual checks and examination on larger projects and programmes were implemented to examine whether the additional activities identified could be considered STI-related.

The inclusion of activities with a research component identified using keywords doubled the total number of activities in the analysis. However, these activities include support to research programmes not classified under the research purpose codes, e.g. research on specific diseases or activities classified as "multisector aid", and contributions in building greater capacity for conducting research in higher education and other research institutions. While not being specifically classified in the CRS as research activities, it can be argued that these activities support STI development, and therefore should be included in the analysis of external support towards STI.

The additional activities identified using the keywords nearly tripled the total number of technology-related activities for the analysis. This included activities supporting the understanding and use of ICTs and broader projects such as the *FHI 360 Mobile Solutions Technical Assistance and Research* (mSTAR), a technical assistance and research program, which aims to fostering rapid adoption and scale-up of digital finance, digital inclusion and mobile data in developing countries. Many of these additional activities have an ICT or technology component, but are classified in the CRS according to a different sector, e.g. the mSTAR project is classified as "Business support services and institutions". However, considering the significant technical components of many of these activities, it is important to include them in the analysis.

Annex B. Development providers included in the analysis

Table B.1. Development providers included in the analysis

DAC members	Non-DAC countries	Multilateral organisations and funds
Australia	Azerbaijan	Adaptation Fund
Austria	Bulgaria	African Development Bank
Belgium	Estonia	African Development Fund
Canada	Israel	Arab Bank for Economic Development in Africa
Czech Republic	Kazakhstan	Arab Fund (AFESD)
Denmark	Kuwait	AsDB Special Funds
EU Institutions	Latvia	Asian Development Bank
Finland	Lithuania	Caribbean Development Bank
France	Romania	Climate Investment Funds
Germany	Russia	European Bank for Reconstruction and Development
Greece	Thailand	Global Alliance for Vaccines and Immunization
Hungary	Turkey	Global Environment Facility
Iceland	United Arab Emirates	Global Fund
Ireland		Global Green Growth Institute
Italy		IDB Invest
Japan		IDB Special Fund
Korea		IFAD
Luxembourg		Inter-American Development Bank
Netherlands		International Bank for Reconstruction and Development
New Zealand		International Development Association
Norway		International Finance Corporation
Poland		International Labour Organisation
Portugal		Islamic Development Bank
Slovak Republic		Nordic Development Fund
Slovenia		OPEC Fund for International Development
Spain		OSCE
Sweden		UN Peacebuilding Fund
Switzerland		UNAIDS
United Kingdom		UNDP
United States		UNECE
		UNFPA
		UNICEF
		World Health Organisation
		World Tourism Organisation

Note: The analysis was based on disbursements on development activities for all providers except for the Caribbean Development Bank, Global Environment Facility, IDB Invest, IFAD, International Finance Corporation, and the Islamic Development Bank. For these providers, no disbursements were available. Therefore, commitments were used as a proxy for disbursements.
Source: (OECD, 2019[27]), Creditor Reporting System (Database), https://stats.oecd.org/index.aspx?DataSetCode=CRS1;

Annex C. STI-related indicators in the SDG Global Indicator Framework

Table C.1. STI-related indicators in the SDG Global Indicator Framework

SDG	Target	Indicator
Goal 3. Ensure healthy lives and promote well-being for all at all ages	3.b Support the research and development of vaccines and medicines for the communicable and non-communicable diseases that primarily affect developing countries, provide access to affordable essential medicines and vaccines, in accordance with the Doha Declaration on the TRIPS Agreement and Public Health, which affirms the right of developing countries to use to the full the provisions in the Agreement on Trade-Related Aspects of Intellectual Property Rights regarding flexibilities to protect public health, and, in particular, provide access to medicines for all	3.b.2 Total net official development assistance to medical research and basic health sectors
Goal 4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all	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	4.4.1 Proportion of youth and adults with information and communications technology (ICT) skills, by type of skill
	4.a Build and upgrade education facilities that are child, disability and gender sensitive and provide safe, non-violent, inclusive and effective learning environments for all	4.a.1 Proportion of schools with access to (a) electricity; (b) the Internet for pedagogical purposes; (c) computers for pedagogical purposes; (d) adapted infrastructure and materials for students with disabilities; (e) basic drinking water; (f) single-sex basic sanitation facilities; and (g) basic handwashing facilities (as per the WASH indicator definitions)
Goal 5. Achieve gender equality and empower all women and girls	5.b Enhance the use of enabling technology, in particular information and communications technology, to promote the empowerment of women	5.b.1 Proportion of individuals who own a mobile telephone, by sex
Goal 7. Ensure access to affordable, reliable, sustainable and modern energy for all	7.a By 2030, enhance international co-operation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology	7.a.1 International financial flows to developing countries in support of clean energy research and development and renewable energy production, including in hybrid systems
	7.b By 2030, expand infrastructure and upgrade technology for supplying modern and sustainable energy services for all in developing countries, in particular least developed countries, small island developing States and landlocked developing countries, in accordance with their respective programmes of support	7.b.1 Investments in energy efficiency as a proportion of GDP and the amount of foreign direct investment in financial transfer for infrastructure and technology to sustainable development services

SDG	Target	Indicator
Goal 9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation	9.5 Enhance scientific research, upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries, including, by 2030, encouraging innovation and substantially increasing the number of research and development workers per 1 million people and public and private research and development spending	9.5.1 Research and development expenditure as a proportion of GDP
		9.5.2 Researchers (in full-time equivalent) per million inhabitants
	9.b Support domestic technology development, research and innovation in developing countries, including by ensuring a conducive policy environment for, inter alia, industrial diversification and value addition to commodities	9.b.1 Proportion of medium and high-tech industry value added in total value added
	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	9.c.1 Proportion of population covered by a mobile network, by technology
Goal 12. Ensure sustainable consumption and production patterns	12.a Support developing countries to strengthen their scientific and technological capacity to move towards more sustainable patterns of consumption and production	12.a.1 Amount of support to developing countries on research and development for sustainable consumption and production and environmentally sound technologies
Goal 14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development	14.a Increase scientific knowledge, develop research capacity and transfer marine technology, taking into account the Intergovernmental Oceanographic Commission Criteria and Guidelines on the Transfer of Marine Technology, in order to improve ocean health and to enhance the contribution of marine biodiversity to the development of developing countries, in particular small island developing states and least developed countries	14.a.1 Proportion of total research budget allocated to research in the field of marine technology
Goal 17. Strengthen the means of implementation and revitalise the Global Partnership for Sustainable Development Finance	17.6 Enhance North-South, South-South and triangular regional and international co-operation on and access to science, technology and innovation and enhance knowledge-sharing on mutually agreed terms, including through improved co-ordination among existing mechanisms, in particular at the United Nations level, and through a global technology facilitation mechanism	17.6.1 Number of science and/or technology co-operation agreements and programmes between countries, by type of co-operation
		17.6.2 Fixed Internet broadband subscriptions per 100 inhabitants, by speed
	17.7 Promote the development, transfer, dissemination and diffusion of environmentally sound technologies to developing countries on favourable terms, including on concessional and preferential terms, as mutually agreed	17.7.1 Total amount of approved funding for developing countries to promote the development, transfer, dissemination and diffusion of environmentally sound technologies
	17.8 Fully operationalise the technology bank and science, technology and innovation capacity-building mechanism for least developed countries by 2017 and enhance the use of enabling technology, in particular information and communications technology	17.8.1 Proportion of individuals using the Internet

Note: Other SDGs and targets may have STI-components; however, these may be monitored using other proxy indicators.
Source: (United Nations, 2019[39]), *Global Indicator Framework for the SDGs*, https://unstats.un.org/sdgs/indicators/Global%20Indicator%20Framework%20after%202019%20refinement_Eng.pdf.

BETTER POLICIES FOR BETTER LIVES