Shared challenges, transformative actions

OECD Science and Technology Policy Ministerial

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Issues Notes

OECD

BETTER POLICIES FOR BETTER LIVES

Plenary 1 - International co-operation and competition

24 April 2024, 17:00-18:30 Paris time, OECD Conference Centre, Room CC15

Chaired by: Ms. Sylvie Retailleau, Minister for Higher Education and Research of France

Key issues

- Patterns of international collaboration in science, technology and innovation (STI) are changing. Recent decades witnessed a significant increase in international collaboration in science, as evidenced by the rising trend in international co-authorship of scientific publications (Figure 1). However, this decades-long pattern of increasing collaboration now shows signs of weakening. While collaboration continues, the networks and partnerships that compose it are changing. Specific strategic research areas have seen a deceleration in collaboration, particularly between the United States and China, reflecting growing geopolitical tensions and related security concerns in technology and some scientific domains.
- Product shortages during the COVID-19 pandemic exacerbated concerns around supply chain vulnerabilities and strategic dependencies, as has the threat that geopolitical tensions could pose to the supply of certain materials (such as rare minerals) and components critical to some key technologies (e.g., semiconductors). Furthermore, many emerging technologies and areas of science are central to future competitiveness and national security, which has ushered in a new era of intensified strategic competition, particularly in critical technologies.
- These conditions have led to new policy measures to enhance resilience and aspects of self-sufficiency. Concepts of "technology sovereignty" and "strategic autonomy" have emerged as frameworks for STI policy. Many countries have recently introduced initiatives to strengthen domestic STI capabilities, including policies that (i) limit foreign access to some technologies, (ii) invest in ambitious industrial policies, and (iii) strengthen international technology alliances and/or promote the international mobility of scientists and engineers with key partners.
- Ministries with responsibilities for research and innovation, as well as funding agencies, have played a role in this re-orientation, although it has most often been led by ministries in other policy domains such as trade, foreign affairs, defence, and industry. The risk exists that an increasingly inward turn jeopardises some of the gains from specialisation, economies of scale, and the diffusion of information and know-how. It could also undermine future co-operation on global challenges. A major test for multilateralism will be to reconcile growing strategic competition with the need to collectively address global challenges, like climate change.

Source: OECD (2023) Science, Technology and Innovation Outlook

Agenda

Intervention	Duration
Opening remarks by Chair	5’
Scheduled interventions by Heads of Delegation following the French alphabetical order – speaking priority given to Ministers	2’ per Delegation
Open floor for further 2-3non-scheduled interventions or responses by raising of flag (speaking priority given to Ministers)	1’ per Delegation
Closing remarks from the Chair	3’

Key directions for policy

The OECD has drawn attention to the importance of several policy measures in this domain. These include actions that:

- Foster greater international co-ordination and collaboration on global challenges, especially as regards funding of relevant STI activities.
- Promote open knowledge sharing to address complex global challenges while ensuring research integrity and security.
- Use international agreements, standards, and other tools to fortify and increase commitments to solving global challenges.
- Strengthen capacities in STI in low- and middle-income countries to improve their ability to address country-specific societal challenges and to engage as international partners.

Key questions for discussion

- How can OECD Members and partner countries work together to ensure the benefits of science and technology are enjoyed widely and the risks well managed? Should different approaches be taken to international collaboration in either science, technology, or innovation, and can a clear distinction be made?
- To what extent may new barriers to knowledge and technology access weaken international networks in science and technology? What risks and potential costs are involved?
- How can ambitious domestic industrial policies that aim to strengthen the ability to innovate be used to help meet global challenges like climate change and biodiversity loss?
- How can international science and technology alliances provide opportunities for OECD countries to advance international collaboration for sustainability and responsible research and innovation, and support the strengthening of capabilities in STI in low- and middle-income countries?

Background

Scientific discovery and technological innovation occur in and, to some extent, are dependent on an interconnected global ecosystem that draws upon collective knowledge, talent, resources and infrastructure. Academic researchers routinely co-operate and exchange across borders to advance shared scientific interests, while innovative firms trade and invest internationally in the production of high-technology products and services. International STI linkages can be led by states but are also often built from the bottom-up, via individual researchers, research organisations and business firms. They are also wide-ranging, covering, for example:

- *International research collaboration*: around one-fifth of scientific journal articles are co-authored by researchers from more than one country, signalling the significance of international research collaboration. Many of these linkages are organised 'bottom-up' by researchers or research performing institutes themselves, who embark on research collaboration to pool knowledge resources and leverage leading international expertise. Given the benefits, public policy often enables and even incentivises international research collaboration, for example, by funding collaborative research projects, offering international mobility grants, and investing in international research infrastructures.
- *International trade and investment by innovative firms*: opportunities afforded by trade and investment, such as access to new markets or supply chains and increased domestic competition, are essential to innovation. Imports of technology-intensive capital goods and services play essential roles in technological upgrading of economies. Investments by foreign innovative firms can also contribute to technological upgrading of local supplier and buyer firms through backward and forward linkages, respectively.
- *International technical standards*: these ensure that products, processes, and systems meet specific established technical criteria or specifications. They are essential for the diffusion and interoperability of emerging technologies and the creation of markets for technology products and services. In the race to net zero, for example, international standards can effectively complement emission pricing and incentive-based policies to create demand for low-carbon innovations, induce the phase-out of obsolete technologies, and ultimately drive decarbonisation.
- *International mobility of human resources in science and technology*: the movement of researchers and engineers across national borders for the purpose of employment enables the exchange of ideas and knowledge, fosters international collaboration, and promotes technology transfer. Public policy can promote international mobility through a range of measures, e.g. by relaxing restrictions on hiring foreign researchers, simplifying the process for obtaining work visas, and improving international pension portability.
- *International research infrastructures (RIs)*: these are an effective mechanism to advance basic scientific understanding and to address global challenges. RIs can be very complex and expensive undertakings, sometimes in the billion or even tens of billion Euros range, that require international co-funding, and/or need to be distributed over multiple locations around the globe to collect the necessary data or observations. Those requirements have expanded the international dimension of individual RIs and fostered the establishment of international collaborative research infrastructure networks.

- *International research and technology assistance to low- and middle-income countries (LMICs)*: research and innovation can help LMICs address societal challenges, such as poverty, limited access to basic services and infrastructure, and environmental degradation. OECD governments offer various kinds of support for research and innovation in LMICs, some of which might be channelled through their official development assistance (ODA). For example, they may fund research and innovation projects focusing on health, education, clean energy, and sustainable agriculture needs in LMICs. They may also promote international technology transfer partnerships between domestic firms or research institutes and those in LMICs. The overarching aim is to strengthen the research and innovation capabilities of LMICs to enable them to address local and global challenges more effectively.
- *International governance and policy co-ordination in science and technology*: International organisations, such as UNESCO and the World Health Organisation (WHO), are active in co-ordinating research responses to grand challenges. The OECD is also a major global standard setter in STI policy, having 45 legal instruments in force, covering various areas such as digitalisation, broadband communication, neurotechnology, and health science. These are at the core of the OECD's mission to promote shared values, good policies and practices in both domestic and international settings. More broadly, transnational STI activities offer valuable opportunities for diplomacy and the reinforcement of shared norms and values through co-operation, collaboration and knowledge sharing.

Societal challenges, such as climate change, food security, and global health issues, are increasingly targeted in international STI co-operation, which can accelerate understanding and innovation, enhance economies of scale, strengthen incentives for investment and foster a level playing field. Sharing experiences between countries and industries can reduce individual risks, unlock synergies and efficiencies, and accelerate progress, for example, towards viable low-carbon solutions as part of sustainability transitions.

However, differing national contexts and competing interests often frustrate attempts at global collective action. With most public R&D funding allocated within national boundaries, international alignment between national strategies and programmes is notoriously difficult to achieve. National interests like domestic growth can be in tension with transnational priorities, such as protecting global common pool resources. In addition, rising geopolitical tensions and the convergence of economic and security policy agendas could undercut opportunities for cross-border knowledge exchange and technology transfer.

The remainder of this note is structured as follows:

- It begins by outlining the current state of STI co-operation, focusing on international research collaboration and mobility, as well as trade in high R&D-intensive goods. Data show that deep and extensive global linkages have developed in recent decades, particularly between China and OECD countries. However, the COVID-19 pandemic and growing geopolitical tensions have called these linkages into question and there are already early signs of decline in research collaboration between China and the United States, for instance.
- The COVID-19 experience of international co-operation was mixed, marked by vaccine 'nationalism' and 'diplomacy'. Together with the war in Ukraine, it also exposed international supply chain vulnerabilities, which have contributed to a growing 'securitisation' of STI policy. Along these lines, concepts such as 'strategic autonomy' and 'technology sovereignty' have strongly emerged as frames for STI policy, placing greater emphasis on resilience and security. This includes renewed interest in industrial policies, many of which target global challenges, such as climate change, through investments in low-carbon technologies. However, they form part of a

reconfigured techno-nationalist STI policy mix that may be ill-equipped to contribute to the provision of global public goods, such as clean air, biodiversity and global health. Securitisation extends to science, with raised concerns over unauthorised information transfer and foreign interference in public research.

- Despite these challenges to international STI co-operation, it needs to be further strengthened to help tackle global challenges like climate change. For example, while LMICs are playing increasingly important roles in international STI co-operation, they would benefit from greater support from OECD countries to strengthen their STI capabilities. Researchers will need to diversify their international linkages, drawing on support from research-funding agencies, which could still do more to deepen their contacts with a wider range of partner organisations globally. The note argues that the main policy challenge remains to reconcile growing strategic competition with the need to collectively address global challenges through international STI co-operation.

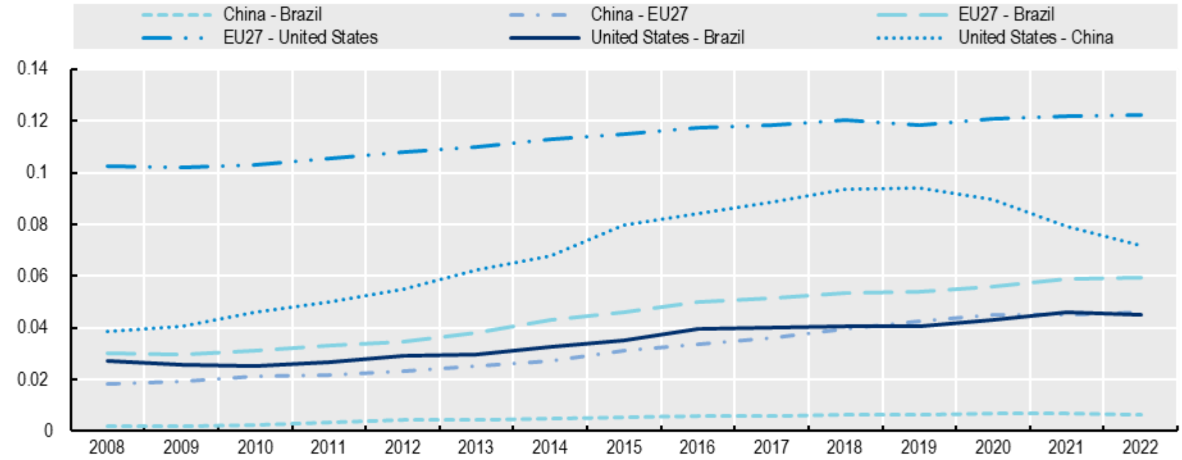
International co-operation in research and innovation has grown sharply in recent decades

Growth of international collaboration and mobility in science

For some time, increasing international co-authorship in scientific publications has been at the core of a more interconnected global research community. The growing research capabilities of middle-income countries, particularly China, have transformed the geography of international scientific collaboration over the last couple of decades. China's spending on R&D is now second only to the United States and it has the largest number of researchers globally. It is at the forefront in many areas of science and technology, with high levels of international researcher mobility and research collaboration vis-à-vis OECD countries.

Exploring specific bilateral science collaborations – as evidenced in cross-country research authorship – growing international collaboration is evident between the United States and the European Union (EU), as well as between Brazil and both the EU and the United States (Figure 1). Collaboration between Brazil and China has also grown, albeit at a slower pace, and there is a notable, though slowing, increase in collaboration between the EU and China. The intensity of Brazil's scientific partnerships with the United States and the EU has doubled since 2006, far outpacing growth in collaboration intensity between Brazil and China. However, while collaboration between China and the United States had grown rapidly in recent decades, it has declined in recent years after peaking in 2019. This has been attributed to several factors, including pandemic-related travel restrictions, visa denials affecting Chinese students and scholars, and growing geopolitical tensions and security concerns in technology and some domains of science (Wagner, 2022[1]). Most of the decline is in engineering and fields of the natural sciences, which together account for the bulk of bilateral research collaboration between China and the United States (Figure 2).

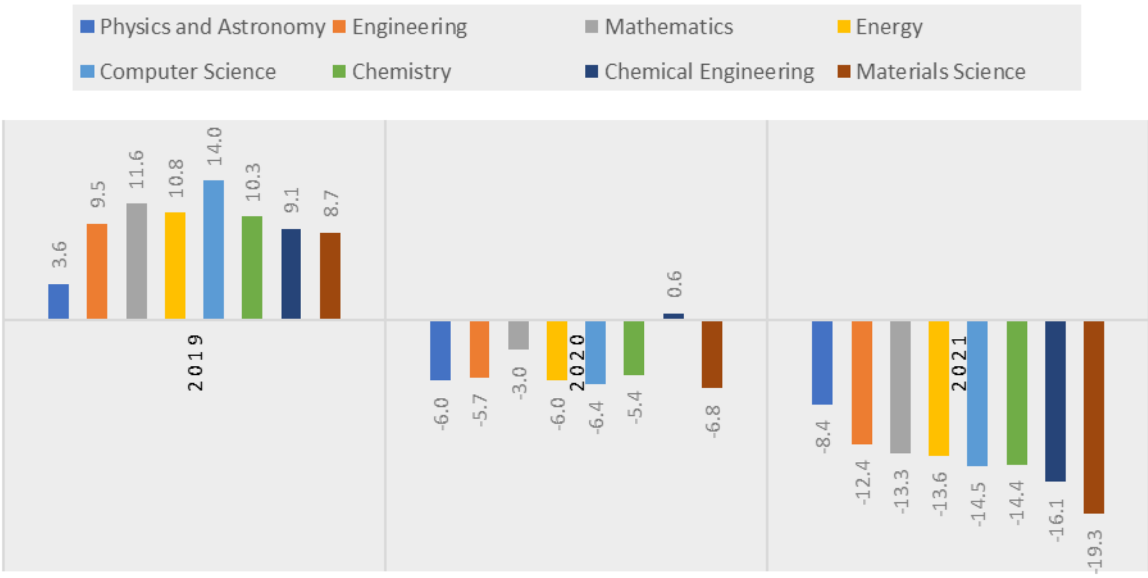
Figure 1. Trends in the intensity of bilateral collaboration in scientific publications, 2008-2022



Note: The indicator of bilateral collaboration intensity between two countries is calculated by dividing the number of scientific publications by authors with affiliations in both economies (whole counts) by the square root of the product of the publications for each of the two economies (whole counts). This indicator is therefore normalised for publication output. Publications refer to all citable publications, namely, articles, reviews, and conference proceedings.
Source: OECD calculations based on Scopus Custom Data, Elsevier, Version 1.2024, April 2024.

Figure 2. Declining collaboration between China and the United-States in selected fields 2018-2021

Percentage change in collaboration on the preceding year, fields among the top 15 fields of collaboration



Note: Collaboration between China and the United States is defined by the number of co-authored publications between both countries (whole counts). Publications refer to all citable publications, that is articles, reviews and conference proceedings. Panel A is 2018 collaborations, in absolute terms. Panel B shows the changes in collaborations for each year versus the previous year, as a percentage of 2018 collaborations.
Source : OECD (2023a) based on OECD calculations using Scopus Custom Data, Elsevier, Version 6.2022, February 2023

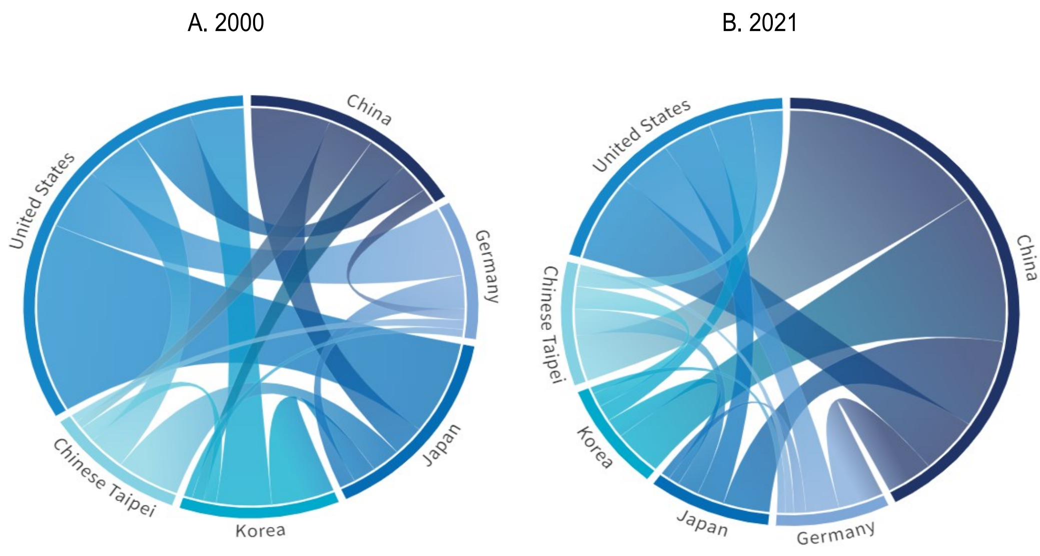
Beyond collaboration, international mobility has also grown in recent decades and the research workforce of several major research performers in OECD countries is heavily dependent on foreign-born PhDs and postdocs. In the United States, for example, the science, technology, engineering and mathematics (STEM) workforce has seen a rise in the proportion of foreign-born workers from 17% in 2010 to 19% in 2019. Some 45% of workers in science and engineering occupations at the doctorate level are foreign-born, with the highest shares among computer and mathematical scientists. Around half of foreign-born workers in the United States whose highest degree is in a science and engineering field are from Asia, with India (22%) and China (11%) as the leading birthplaces (National Science Board, 2022[2]).

Growth of global value chains in high R&D-intensive sectors

China's growth and integration into the world economy has seen manufacturing firms in OECD countries use China increasingly as a source of high-tech inputs and a platform for final assembly. This has caused growing technological interdependency between China and OECD economies. For example, over recent decades, the landscape of major importers of intermediate products for high and medium-high R&D-intensive activities has changed significantly, reflecting increased interconnectedness in global value chains. In 2000, the United States was the largest importer of these intermediates, mainly from Japan. However, twenty years into the 21st century, China had overtaken the United States as the largest importer and exporter, serving neighboring economies like Japan, Korea, and Chinese Taipei, as well as becoming the second-largest supplier to the United States after Mexico (Figure 3) (OECD, 2023[3]). At the heart of this evolution is China's emergence as a key player in science and technology worldwide, with significant roles in manufacturing critical technologies and investments in advanced R&D areas like 5G and robotics (Nolan, 2021[4]).

Figure 3. Flows of intermediate products in high and medium-high R&D-intensive economic activities, selected countries

Import flows, in USD current prices



Note: Intermediate products in high and medium-high R&D-intensive economic activities are defined in https://www.oecd-ilibrary.org/science-and-technology/oecd-taxonomy-of-economic-activities-based-on-r-d-intensity_5jlv73sqqp8r-en. They include products from the following industrial International Standard Industrial Classification of All Economic Activities, Fourth version (ISIC 4) sectors: D20 Chemicals and chemical products; D21 Basic pharmaceutical products and pharmaceutical preparations; D26 Computer, electronic and optical products; D252 Weapons and ammunition; D27 Electrical equipment; D28 Machinery and equipment n.e.c.; D29 Motor vehicles, trailers and semi-trailers; D302A9 Railroad equipment and transport equipment n.e.c.; D303 Air and spacecraft and related machinery; D304 Military fighting vehicles; D325 Medical and dental instruments and supplies. Panel B: 2021 data for Korea corresponds to 2020. This selection of imports flows represented 20 % of the World imports of intermediate products in high and medium-high R&D-intensive economic activities in 2021. *Source*: (OECD, 2023[3])

These developments are indicative of the rapid pace of product and financial market integration at the global level seen in recent decades. Combined with the relentless pursuit of efficiency gains through global supply chains, they have brought economic benefits but also exposed vulnerabilities to disruption, as shown during the COVID-19 pandemic. Increasing complexity has introduced logistical fragility into global supply chains, raising questions about the resilience of a global production model grounded on international fragmentation and just-in-time logistics. At the same time, mounting geopolitical tensions have raised concerns about supply-chain vulnerabilities in critical technologies (e.g. in semiconductors) and raised the risk of coercion to extract gains from partner countries elsewhere in the chain. A shift in the balance between the security of supply on the one hand and efficiency considerations on the other could lead to a reconfiguration of supply chains and the use of suppliers at less distant locations. This reconfiguration could affect the sourcing of high-tech products and components, particularly where there are vulnerabilities from key suppliers based in countries with different geopolitical priorities (OECD, 2022[5]).

What lessons can be drawn from the international STI response to COVID-19?

The COVID-19 pandemic was truly global in nature, and it was clear from the outset that no single country would be safe until all countries were safe. The COVID-19 global response experience was mixed, however, demonstrating what could be done rapidly through international co-operation but also its limits (OECD, 2023[3]).

Intergovernmental bodies, most notably the World Health Organisation (WHO), and related international scientific networks, such as GLOPID-R, tried hard to co-ordinate the global research effort. International research infrastructures (RIs), networks and collaborations that existed prior to COVID-19 were mobilised to support pandemic monitoring, identify research needs, and establish global research priorities and agendas. The WHO research agenda for COVID-19 was established early in the pandemic, following consultation with leading experts (WHO, 020[6]), and undoubtedly influenced many national research agendas (OECD, 2023[3]).

While researchers from all over the world collaborated with each other regardless of their countries' geopolitical and ideological differences, the strategic global co-ordination of research was not immune to such differences. Co-ordinated action to implement the global agenda was lacking, with governments often competing rather than co-operating. It became a matter of national pride for the largest economies to have the best data sets and epidemiological models, produce their own vaccines, or lead their own clinical trials. Vaccine competition among governments was, at times, influenced by geopolitical tensions, resulting in a patchwork of vaccine approvals. By mid-2022, for example, China had approved eight vaccines, almost all domestically developed. Russia followed a similar pattern, while countries like France, Japan, and the United States had not approved any vaccines developed in China, India, or Russia (OECD, 2023[3]).

The lack of political will to adopt a more global and inclusive approach to managing the pandemic was accentuated by a dearth of mechanisms allowing national research funders to truly co-operate and collaborate. While scientists do collaborate internationally, public research funding rarely crosses borders. There exist very few global RIs and, although international co-operation around data management and access is common in some scientific domains, it is not the norm in many fields (OECD, 2023[3]).

In the meantime, LMICs – which wanted to co-operate but struggled to compete – were largely left behind. The uneven distribution of RI capacities at the global level prevented equitable access to resources and data in many parts of the world, contributing to a disconnect between needs and resources. Moreover, the study of COVID-19 variants was largely concentrated in high-income and upper-middle-income countries, even though several dominant variants first arose in low- and middle-income countries. The pandemic illustrated an important need to strengthen research capacity in LMICs as part of global health preparedness and resilience (OECD, 2023[3]).

Countries reacted with policies to enhance self-sufficiency and strategic autonomy

The COVID-19 pandemic and war in Ukraine have brought risk, uncertainty and resilience to the fore as conditions and concerns for STI policy. They have contributed to a growing "securitisation" of STI policies, whose definition is broadly defined to cover a range of issues beyond traditional defence concerns to include systemic risks (e.g. food security, energy security, health security and cybersecurity), risks associated with technological change (e.g. synthetic biology and artificial intelligence), and vulnerabilities from trade dependencies in high-tech and other strategic goods (OECD, 2023[3]).

The disruption caused by the COVID-19 pandemic prompted a renewed focus on the concept of "technology sovereignty", which refers to a polity's capacity to act strategically and autonomously in an era of intensifying global technology-based strategic competition (Edler, 2021[7]). A related concept, "strategic autonomy", is broader and refers to a polity's capacity to act independently in strategically important policy areas. This idea has become more prominent as countries reassess their global research and technology networks, especially in dual-use areas that have both civilian and military applications (OECD, 2023[3]).

Countries are pursuing three main types of policy intervention to strengthen their strategic autonomy (OECD, 2023a):

- *Protection*: restricting technology flows and reducing dependency risks, e.g. through regulatory policies like export controls, supply-chain diversification measures, etc.
- *Promotion*: enhancing domestic innovation capabilities and performance, e.g. through holistic innovation policies, mission-oriented innovation policies, national industrial strategies, etc.
- *Projection*: extending and deepening international STI linkages, e.g. through international technology alliances, active participation in international standards setting bodies, etc.

Protection: Restricting knowledge flows and reducing risks from interdependency

Over the last decade, attention to the security implications of foreign investment has reached an unprecedented level, with many governments introducing new or adjusting existing policies in response to disruptions triggered by the COVID-19 pandemic and Russia's war of aggression against Ukraine. The COVID-19 pandemic, in particular, highlighted the fragility of global supply chains, exposing vulnerabilities that could pose substantial risks to economic stability and even national security. This is especially evident in the supply of critical materials like rare minerals and semiconductor components, crucial for key technologies. These dynamics have accelerated a move towards greater control of commercial flows of some technologies, with governments introducing market access barriers and more stringent controls on foreign direct investments. Well-known export controls include those imposed by the United States on China with regards to semiconductors. Lesser-known examples include China's export ban on research monkeys, which has adversely affected biomedical research in several OECD countries (Box 1). OECD economies are also looking at options to diversify supply chains, making them more resilient and less vulnerable to disruptions and shocks. Whether these new arrangements will finish up being as efficient as current ones is an open question, but they could see distinct and decoupled technology ecosystems emerge. The risk is that the global economy splits into rival blocs that significantly reduce science and technology linkages compared to those that exist today (OECD, 2023[3]).

Box 1. Shortages also affect research, the example of monkeys in pharmaceutical research

The global shortage of research monkeys, a crisis deepened by the COVID-19 pandemic, illustrates the challenges of international interdependency in science. Non-human primates (NHPs), essential for safety studies in drug development due to their genetic and physiological similarities to humans, with each treatment requiring 50 to 100 monkeys for testing. However, the supply of NHPs has fallen dramatically.

China, which bred between 60 to 80 percent of the world's supply of NHP, has seen its internal demand skyrocket, with the number of clinical trial applications increasing from 484 in 2017 to 1,159 in 2021. This strained local primate breeding operations. The crisis was further intensified in the first half of 2020 when China adopted a ban on exports of NHPs. The ban exposed significant challenges for drug developers, especially emerging biopharma companies and public research institutions, which now face supply shortages and competition with larger pharmaceutical companies to acquire the limited number of available monkeys.

Prices for research monkeys have skyrocketed as a result. The tension and scarcity in the market have led to increased illegal trade and smuggling activities. This has had implications for the biodiversity of the species, as well as raising ethical concerns around the treatment of the animals.

Sources : (The Economist, 2023[20]), (Morin, 2024[21]), (Grimm, 2023[22])

Promotion: Enhancing industrial performance through STI investments

While the industrial and innovation policy mix in most OECD economies remains largely focused on R&D, tax incentives and earlier-stage investment support, there has been a resurgence in targeted interventions that are rationalised by geopolitical tensions, supply-chain concerns and various “green” targets (DiPippo, 2022[8]). Such promotion measures, in the shape of technology-fuelled industrial policies (Box 2), look more positive for science and innovation activities at first glance. For instance, more resources could be available, especially given the large investments proposed, although what sorts of research and innovation will be funded is less clear. New EU and US industrial policies have taken care to signal the importance of developing international linkages with like-minded countries, which could spur new opportunities for international co-operation in science and innovation. However, while these measures often target challenges like climate change, they are chiefly about improving the competitiveness of national firms to compete in new emerging markets for products and services. They also increasingly have an overt national security dimension. The techno-nationalist intent of these policies can put them at odds with the provision of global public goods. At the same time, there is a danger that these large public investments descend into a “subsidy race”, with countries competing more for private investments than co-operating on shared-interest technology developments (OECD, 2023[3]).

Box 2. Examples of new industrial policies

China's indigenous innovation drive

China has adopted a multi-pronged approach to escaping the middle-income trap and to catching up with advanced industrialised countries. Its "indigenous innovation" initiative aims to create a comprehensive system of policies for R&D investment, tax incentives, and education, among others. Initiatives, like "Made in China 2025" and the "Dual Circulation Strategy", aim to bring China to a position of global leadership in STI, especially in fields such as 5G, AI, and electric vehicles. The objective is to attain higher degrees of self-sufficiency and reduce reliance on foreign technologies. These policies are backed by substantial government funding.

The European Union's open strategic autonomy

The EU has promoted the concept of "open strategic autonomy" to enhance Europe's competitiveness and reduce strategic dependencies. The approach takes the form of initiatives targeting specific sectors and horizontal measures to foster innovation-friendly policy and institutional environments. The EU's "NextGenerationEU" fund and the "Recovery and Resilience Facility" illustrate this approach, prioritising investments in the green and digital sectors, alongside STI policy reforms. The EU's industrial strategy includes Important Projects of Common European Interest (IPCEIs) focusing on critical sectors like microelectronics and hydrogen technologies.

United States' modern industrial strategy

In the United States, recent pieces of legislation such as the "CHIPS and Science Act", "Inflation Reduction Act", and "Infrastructure Investment and Jobs Act" collectively reflect a strategic shift towards a "modern American industrial strategy" (The White House, 2022[23]). This strategy aims to bolster scientific research, manufacturing, and clean energy sectors, with an emphasis on reducing supply chain vulnerabilities and enhancing technological leadership. There is a strong focus on domestic manufacturing, considered crucial for job creation, economic resilience, and technological advancement.

Source: (OECD, 2023[3])

Projection: Strengthening international STI alliances

The confluence of issues related to trade, technology and democracy has broadened perspectives on the role of technology in shaping and driving new international alignment and alliance patterns (Soare, 2021[9]). At one level, these alliances are forged between like-minded democracies, such as OECD countries, which can gain (for example) from regulatory co-operation to jointly set global technology standards based on shared values (Bauer, 2020[10]). At another level, they aim to project competing norms and values globally through technology investments and assistance, particularly in LMICs. Examples of related policies include the G7 Partnership for Global Infrastructure and Investment initiative, as well as China's Belt and Road Initiative (OECD, 2023[3]).

In some respects, these efforts at alliance-building represent a "recoupling" with like-minded and trustworthy allies – sometimes referred to as "friend-shoring". Countries can amplify their domestic innovation strengths through well-chosen strategic alliances, while at the same time enhancing their own national security by supporting the technological capabilities of others. Projection measures could also spur much-needed investments in research and innovation capacity-building in LMICs, both aiding their development objectives and contributing to solutions to global problems (OECD, 2023[3]). However, as highlighted above, these moves are driven by national interest, and there is the risk they contribute little to the provision of global public goods.

The growing securitisation agenda also extends to science

The concept of "research security" has also strongly emerged in recent years, to counter unauthorised information transfer and foreign interference in public research. The background is that some governments and non-state actors are making increasingly forceful efforts to unfairly exploit and skew the open research environment towards their own interests. Such efforts have become more apparent as geopolitical tensions have mounted, and many countries now consider unauthorised information transfer and foreign interference in public research as serious national and economic security risks (OECD, 2022[11]). Furthermore, a lack of shared and respected international regulations and norms can lead not only to a misappropriation of research, but also to certain types of research being selectively conducted in countries that do not impose legal or ethical restraints (OECD, 2022[11]).

Governments are implementing measures to improve research security while at the same time emphasising the norms and principles that constitute good scientific practice – such as academic freedom, openness, honesty and accountability – and that regulate international research collaboration – including reciprocity, equity and non-discrimination. For instance, many OECD governments have developed guidelines and checklists to increase awareness of risks to research security and integrity, frequently accompanied by policies and measures to mitigate these risks. It is important these are proportionate and based on sound risk identification and assessments, as not every research institution or research project will face the same level or type of risk. These guidelines should also be regularly revisited and revised, as necessary. Some national policies identify specific "sensitive" countries they consider liable to foreign interference, but many take country-agnostic approaches (OECD, 2022[11]).

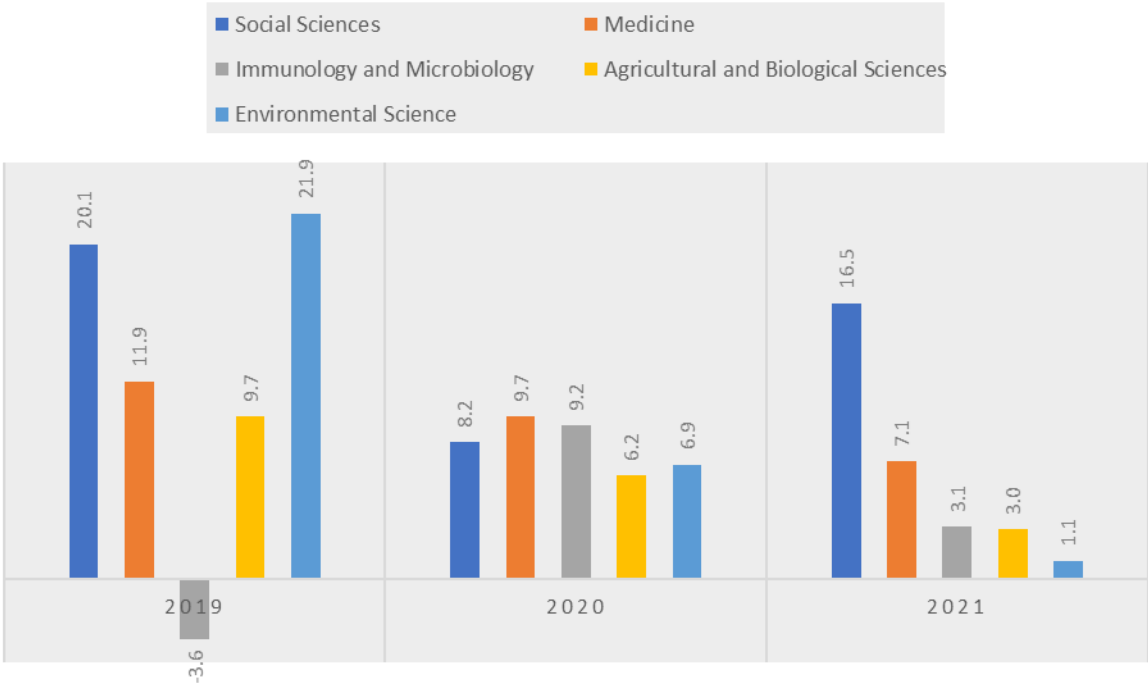
Maintaining the balance between open and trust-based scientific collaboration, and protective but potentially restrictive regulations, is considered to be a major a major challenge in many countries. Over-regulation or excessive intervention can potentially undermine the freedom of scientific enquiry and exchange. While national governments have routinely defined research on chemical, biological, radiological, nuclear and explosive technologies as dual-use, and used conventional export control systems to prevent knowledge transfer, it is less easy to control the transfer of data, information and know-how from scientific research carried out without a specific practical aim. This means that basic research has traditionally been exempt from export controls. At the same time, knowledge from many areas of fundamental research can arguably be considered as potentially dual use. For instance, AI or quantum computing have the potential for both civilian and military use, in addition to being the focus of intense economic competition between companies, countries and regions (OECD, 2023[3]).

International scientific co-operation remains essential for tackling global challenges

Despite a decline in overall scientific collaboration between China and the United States (Figure 1), joint efforts in areas critical to global challenges are on the rise. The impressive growth in China's scientific capabilities over the last two decades make it an attractive partner for many researchers in OECD countries, and vice versa. For instance, co-authored publications between China and the United States in environmental science, medicine, and immunology have increased, highlighting a continuation of co-operation in fields imperative to addressing global challenges like climate change and some health crises (Figure 4) (OECD, 2023[3]).

Figure 4. Growing collaboration in selected fields between China and the United-States, 2018-2021

Percentage change in collaboration on the preceding year, fields among the top 15 fields of collaboration



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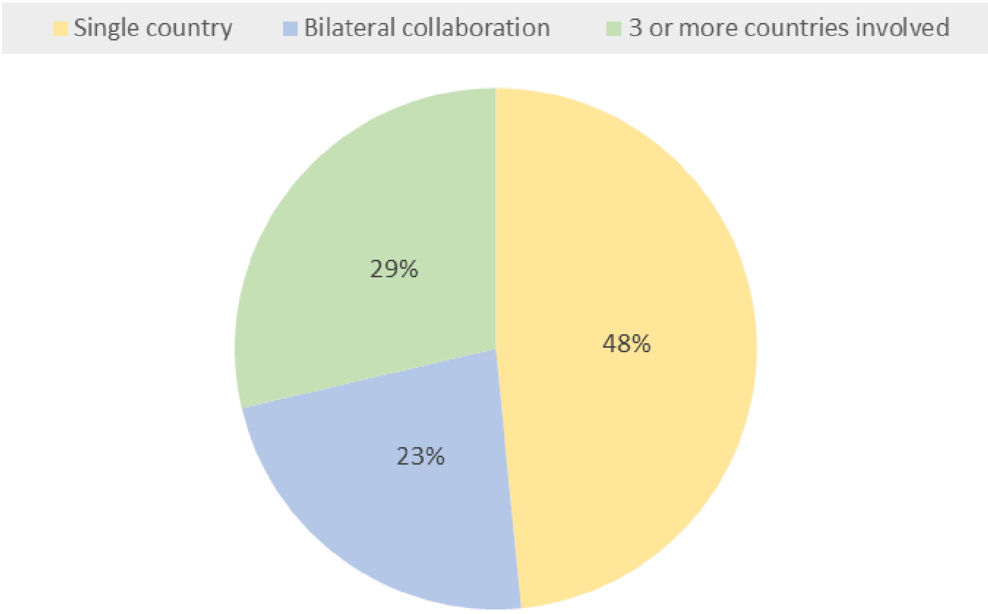
Source : OECD (2023a) based on OECD calculations using Scopus Custom Data, Elsevier, Version 6.2022, February 2023

The role of international scientific cooperation in tackling global challenges is further exemplified by the publications referenced in the Working Group I, II and III (WGI, WGII, WGIII) contributions to the Sixth Assessment Report (AR6) of the Intergovernmental Panel on Climate Change (IPCC, 2022[12]). This report assesses the physical sciences underpinning the analysis of climate change, providing an updated understanding of the current state of the climate, including how it is changing and the role of human influence, as well as the state of knowledge about possible future climates and climate-related risks. A majority (52%) of publications cited in this report were the result of international collaboration (Figure 5), reflecting the fact that collective expertise is essential in informing climate action and policy.

Figure 5. International collaboration in critical climate science

Share of all articles referenced in the IPPC WG1, WG2 and WG3 of the AR6 report that involved international collaboration



*

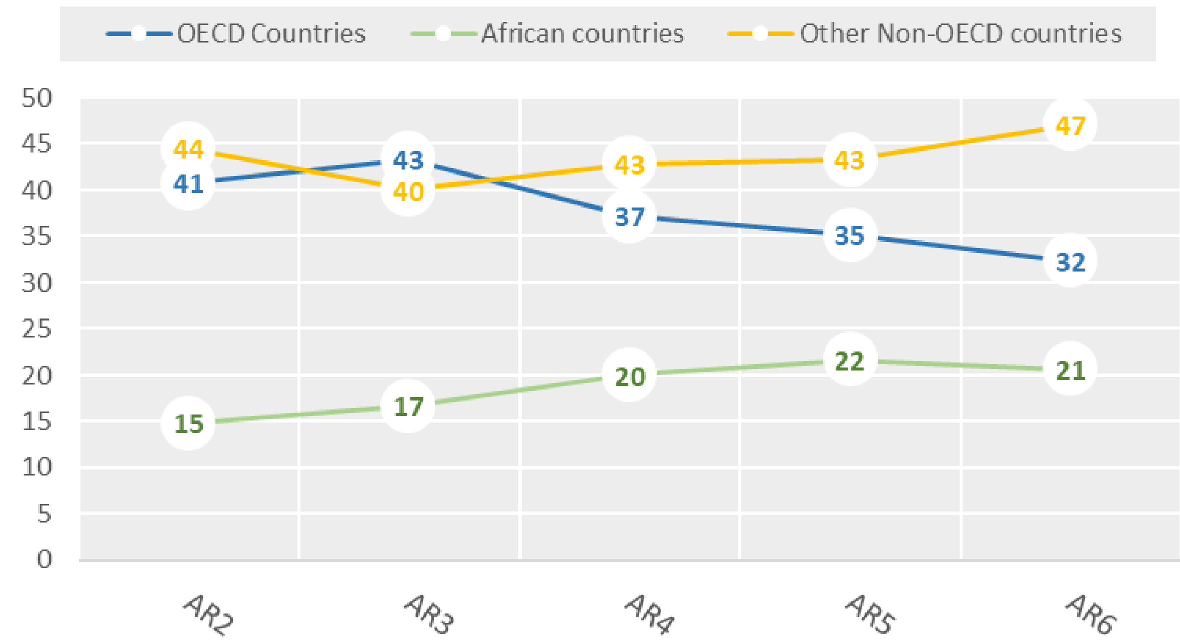
Note: The bibliographic information of the AR6 report is automatically parsed to extract DOIs then searched in the OpenAlex Database for returning Author's country affiliation. 84% of bibliographic entries returned a valid response amounting to a total of 42112 unique references. Inspired by (Chavelli, 2023[13])

Source : OECD calculation based on IPCC references information for AR6, www.ipcc.ch

There is growing need to strengthen the capabilities of LMICs to engage as equal partners in global collaboration and decision-making

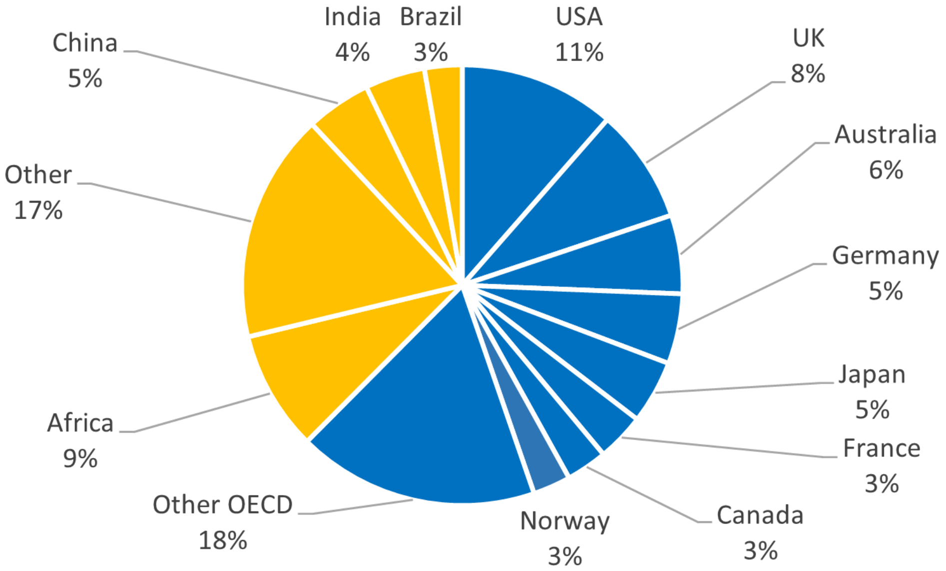
Engaging LMICs in international STI collaboration is crucial for equitable scientific progress and innovation.[1] LMICs are expected to account for the vast majority of growth in global carbon emissions until 2050. It will be important for the global community to support multilateral and club-based STI collaborations that include or are driven by representatives of the Global South. In this regard, the growing involvement of LMICs in the IPCC's assessment reports, as indicated by the increased number of bureau members from Africa, is an encouraging sign of broader engagement in multilateral STI organisations (Figure 6). On the other hand, there is still a predominance of authors from OECD countries, signaling an ongoing imbalance in global scientific dialogue (Figure 7). A concerted effort is needed to bolster the research and innovation capacities of developing countries and their participation in this dialogue.

Figure 6. Percentage of Bureau members by country for each Assessment Report 1995-2021



Source : OECD calculation based on IPCC information, www.ipcc.ch

Figure 7. Percentage of Authors of the Sixth Assessment report by country of affiliation



Source : OECD calculation based on IPCC information, www.ipcc.ch

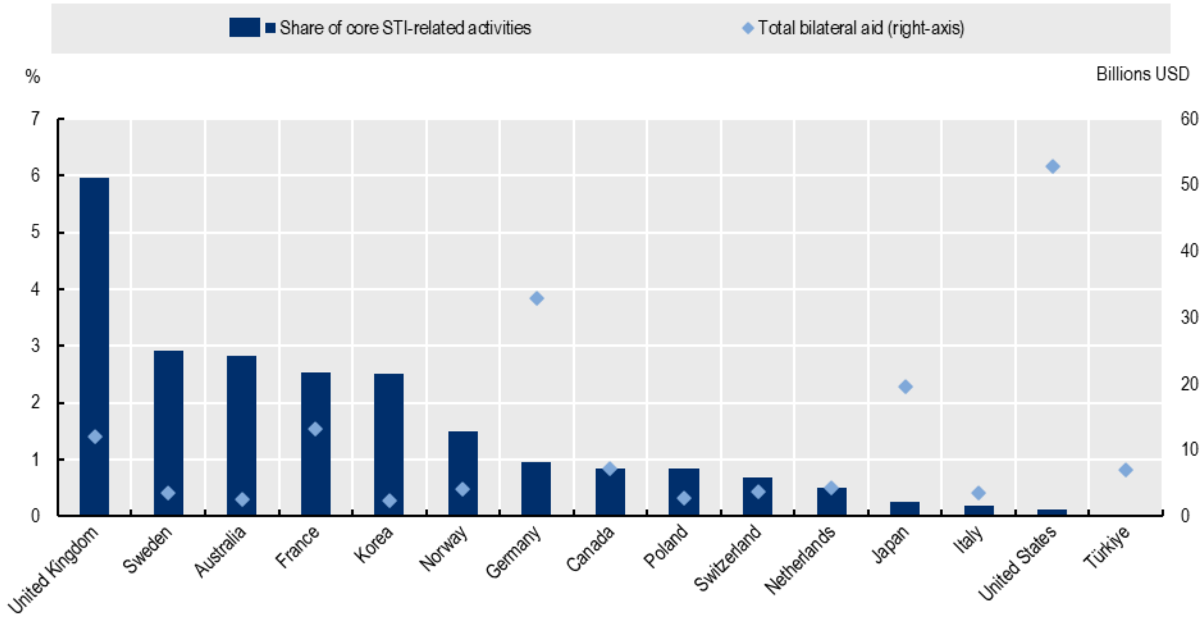
International technology diffusion is essential for meeting global challenges but needs greater policy support

A key determinant of international diffusion is the domestic level of technological development, or technological capabilities, in recipient countries. The latest IPCC report (IPCC, 2022[12]) discusses the main challenges and possible solutions at some length, and highlights emerging ideas for international co-operation on innovation. These include promoting LMICs participation in technology programmes, climate-related innovation system builders and the creation of universities in developing countries that play the role of central hubs for capacity-building, as well as encouraging sectoral agreements and international emission standards. The United Nations Framework Convention on Climate Change (UNFCCC) set up the Technology Mechanism in 2010 to facilitate support to developing countries on climate technology development and transfer. This includes financial mechanisms and capacity-building, and technical support to help countries implement their Nationally Deteremined Contributions (NDCs). The UNFCCC recently published guidance on stimulating the uptake of technologies in support of NDC implementation (UNFCCC, 2021[14]) and its new work programme until 2027 for accelerating climate action through technology development and transfer (UNFCCC, 2022[15]). However, it remains grossly underfunded in view of its ambitious mandate (Cervantes, 2023[16]).

Existing international scientific networks and global connections through trade and official development assistance (ODA) present opportunities to accelerate transitions and transfer STI-based solutions and know-how to developing countries. The allocation of funds to STI from ODA remains relatively low, however. In 2022, for instance, OECD Development Assistance Committee members contributed USD 204 billion in aid, but the proportion directed towards STI has hovered around 1.2% over the past two decades. Notably, there was a decrease in funds allocated to research and scientific institutions, even in light of the increased focus on medical research during the COVID-19 pandemic. However, there are exceptions, such as the World Bank, which has invested predominantly in ICT, constituting a significant portion of its STI-related assistance (UNCTAD, 2024[17]), and some countries, notably the United Kingdom, have dedicated a significant share of their commitment in developing countries to supporting STI activities (Figure 8).

Figure 8. Enhancing Official Development Aid for STI: Research and ICT Support in Bilateral Disbursements by Top OECD Donors, 2022

Share of core Official Development Aid activities with the main focus to support research and/or ICT among total bilateral aid, top 15 OECD donors, 2022



Note : The indicator of "STI-related" ODA is based on the sectoral tagging system used by OECD Credit Report System (CRS) database for ODA data, which does not exactly match other formal OECD definitions in the area of science, technology and innovation. The indicator captures the following CRS codes: educational research (11182), medical research (12182), energy research (23182), agricultural research (31182), forestry research (31282), fishery research (31382), technological research and development (32182), environmental research (41082) , research/scientific institutions (43082) and Information and communication technology (ICT) (22040).

Source : OECD QWIDS, https://stats.oecd.org/qwids/#?, accessed on 16 April 2024

The future of international STI co-operation?

There are high levels of international interdependency in STI, and data shows that relations have extended and deepened over the last few decades. But growing geopolitical tensions are challenging current research and innovation relationships. This is most evident in technology, with growing restrictions on international technology flows, together with larger investments in industrial policies to strengthen domestic technological capabilities as part of wider strategic autonomy agendas. Science too, faces growing concerns around research security and reciprocity, which may have contributed to recent falls in collaboration between US- and China-based researchers.

It is likely that global research and technology networks have yet to internalise fully the implications of growing technological sovereignty, particularly in research areas with dual-use potential. Excessively risk-averse policies could trigger a more abrupt and extensive intellectual decoupling and disengagement. Yet global challenges like climate change and other complex socio-economic issues cannot be tackled without international STI collaboration. If anything, STI co-operation needs to intensify, since global challenges call for global responses, including the active involvement of LMICs. Researchers will need to diversify their international linkages, drawing on support from research-funding agencies, which could still do more to deepen their contacts with a wider range of partner organisations globally (OECD, 2023[3]). Cross-country information sharing, greater harmonisation of research priorities and joint funding calls among national funding agencies, private foundations and others could help address global challenges in a more cohesive, global manner. Such measures could help reduce duplication, enhance synergies and resilience, and maximise the impact of funding and scientific advancements. More broadly, there is strong need to establish international funding mechanisms, trusted relationships and scientific networks that can respond to existing and future crises. It is important to build on what already exists, avoiding excessive duplication, while recognising that a degree of redundancy can increase the overall resilience of a global system (OECD, 2024[18]).

International STI cooperation also needs to be directed, at least in part, towards the provision of global public goods, such as biodiversity, clean air and oceans, and global health. While achieving greater technological autonomy has become a key element in the STI policy frameworks of major economies, this orientation also runs the risk of fostering a more fragmented global research and innovation landscape that is ill-equipped to tackle global challenges. The vaccine “nationalism” and “diplomacy” that some countries pursued during the COVID-19 crisis raises serious concerns about strategic competition in other technology areas and the prospects for future STI co-operation on global challenges (OECD, 2023[3]). Such international co-operation-competition dynamics are likely to shape the ways in which research and innovation can contribute to global crisis responses in the future. Adoption of broader shared values in STI policy, on the other hand – as proposed, for instance, by the OECD’s Agenda for Transformative STI Policies (OECD, 2024[18]) and Framework for Anticipatory Governance of Emerging Technologies (OECD, 2024[19]) – is aligned with meeting global challenges, placing emphasis, for example, on greater engagement of LMICs and promoting sustainability transitions. The policy challenge remains to reconcile growing strategic competition with the need to collectively address global challenges through international STI co-operation.

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[1] There is a significant element of justice to the inclusion of LMICs in multilateral initiatives and decision-making. Many of the countries that are now most vulnerable to the consequences of climate change have contributed the least to the current situation and, to keep with international commitments, will require support to pursue alternative, less carbon intensive, routes to development (Chandy, 2023).