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Science, Technology and Innovation Policy Instruments

for the Sustainable Development Goals

A Global Outlook

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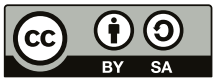

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SHORT SUMMARY

Towards effective implementation of science, technology and innovation policy instruments for sustainable development

One of the most striking differences between a developing science system and a sophisticated one is the volume of policy instruments. Effective policies often employ multiple instruments to achieve their goals. For instance, to empower the private sector, one policy instrument could provide companies with a tax rebate for their research spending, while another might aim to boost firms' innovation management capabilities.

This publication explores the design, implementation and impact of science, technology and innovation (STI) policy instruments across regions, revealing diverse policy priorities and support strategies. Data from the UNESCO Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN) platform shows that STI policy instruments are closely linked to the SDGs, particularly with SDG 9 (industry, innovation and infrastructure), SDG 8 (decent work and economic growth) and SDG 4 (quality education). Over three-quarters of these policy instruments target these goals.

This publication advocates for the use of evidence in designing policies and policy instruments and underscores the importance of continuous monitoring of their implementation. Additionally, it recommends diversifying funding sources, enhancing program management, fostering communication with stakeholders, and applying policy instruments to promote transformative learning.

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"Since wars begin in the minds of men and women, it is in the minds of men and women that the defences of peace must be constructed"

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Foreword

Lidia Arthur Brito © UNESCO

Science, technology and innovation for the Sustainable Development Goals: A global outlook for related policy instruments

Science, technology and innovation are crucial drivers of The *2030 Agenda for Sustainable Development*. They offer tools and pathways for addressing the globally interconnected challenges of our time- climate change, food security, ecosystem degradation, polluted water sources, among others.

Without policy instruments to ensure that they are effectively implemented, science, technology and innovation policies stand the risk of remaining little more than a wish list. Policy instruments are vital at national level but also at regional level, for they have the power to leverage transformation across countries and regions. For instance, innovative financing mechanisms can drive progress, be it by fostering greater access to education, stimulating quality research, promoting green jobs or by advancing solutions for clean water and renewable energy. During the Covid-19 pandemic, policy instruments played a key role in accelerating vaccine development, thereby showcasing their agility and adaptability.

Since policy instruments are interconnected by nature, our efforts should be coordinated for maximum efficiency. With the world not on track to reach its Sustainable Development Goals to 2030, having a coordinated approach has never been more vital.

As this publication underscores, through informed choices and collaborative action, we can steer science, technology and innovation towards a more sustainable and prosperous future.

Lidia Arthur Brito
Assistant Director-General for Natural Sciences, UNESCO

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1. Introduction: Science, technology and innovation (STI) policy instruments as drivers for Sustainable Development Goals

The role of STI in the Sustainable Development Goals

The 2030 Agenda for Sustainable Development and its 17 Sustainable Development Goals (SDGs), adopted by all United Nations (UN) Member States in 2015, provide a shared blueprint for peace and prosperity for people and the planet. Achieving these goals necessitates not only technological advancements but also innovative policies, partnerships and practices that can catalyse and sustain progress. The SDGs, thus, represent a pledge by countries to create and implement policies aimed at reaching these goals and to set up mechanisms to monitor and evaluate their progress (United Nations, 2015).

Many of the challenges associated with sustainable development, such as climate change, food security and access to clean water, are complex and multifaceted. Science, technology and innovation (STI) provide tools and methodologies to understand, analyze and address these challenges in an integrated manner. These tools build on the three domains of STI: *science* is devoted to the pursuit of knowledge using the systematic study of the physical, natural and social world; *technology* involves the application of knowledge for a given purpose; and *innovation* encompasses new ways of producing, delivering or using goods and services based on novel technologies, emerging business models, or new forms of economic or social organization (UNIDO and IATT, 2022).

These dimensions are interconnected and influence each other in non-linear ways with the participation of multiple actors ranging from researchers, engineers, innovators and entrepreneurs to society at large. The development of the steam engine exemplifies this non-linear relationship. While this technological invention was in widespread use from the mid-to-late eighteenth century, the laws of thermodynamics were not formulated until the nineteenth century. Therefore, the development and refinement of the laws of thermodynamics by the scientific community were, in many ways, a response to the practical challenges and observations of efforts from inventors and engineers in the steam engine era.

STI policy instruments and the 2030 Agenda

The previous example underscores the complex interactions of STI, where advancements in one area can stimulate progress or necessitate adaptations in another. Consequently, STI is a system, not a 'black box' that generates innovations in a mechanical or automatic manner. The system involves various activities and actors that are partly self-organized. This coordination is facilitated in part by the self-organization of markets, but also through policy and politics (Borrás and Edquist, 2019). While there is agreement on the importance of a well-coordinated set of policies, the literature often falls short in providing insights into the practical challenges of implementing these policies (Flanagan, Uyarra and Laranja, 2011). Further efforts are needed to challenge the traditional view of the implementation process which assumes the existence of hierarchical relations between policy-making and implementation. Instead, it is crucial to treat implementation as an integral and continuous part of the policy process rather than an administrative follow-up. This approach needs to include the discussion of mechanisms of implementation at the outset of the policy formulation processes, involving negotiation and compromises between those seeking to put policy into effect and those with responsibility for its implementation (Barrett, 2004).

The contribution of STI policy instruments to achieving the SDGs therefore merits greater attention, since they represent the main operational tools for promoting transformation within the scope of the 2030 Agenda. In advancing the SDGs, STI policy instruments operate in various capacities depending on the specific goals and the context. As a means to enhance Quality Education (SDG 4), for example, countries such as Kuwait have put in place mechanisms encouraging youth to pursue science. A partnership with the Kuwait Institute for Scientific Research (KISR) enables students to enrich their education through practical science summer programmes with the Institute's researchers and scientists.[1] To help achieve Affordable and Clean Energy (SDG 7), credit facilities similar to the Namibian Solar Revolving Fund[2] could enable access to innovative renewable energy technologies. Where industry, innovation and infrastructure (SDG 9) are concerned, STI policy instruments can be used to strengthen and modernize scientific research laboratories through competitive funding. One such example is the Peruvian National Fund for Scientific Development, Technology and Technological Innovation (FONDECYT).[3] Moreover, during the

1 KISR, *Student Programs*, www.kisr.edu.kw/en/careers-training/student-programs (accessed 30 August 2023)

2 Ministry of Mines and Energy of Namibia, *Ministry of Mines and Energy – Solar Revolving Fund*, https://mme.gov.na/directorates/efund/srf (accessed 30 August 2023)

3 Government of Peru, *Concytec lanza concurso para promover el fortalecimiento y modernización de laboratorios regionales*, www.gob.pe/institucion/concytec/noticias/343986-concytec-lanza-concurso-para-promover-el-fortalecimiento-y-modernizacion-de-laboratorios-regionales (accessed 30 August 2023)

COVID-19 crisis, STI policy instruments were instrumental in accelerating vaccine development, for example by guiding resource allocation and creating the necessary research and innovation conditions through data and knowledge sharing, access to research infrastructures and science-industry collaborations (OECD, 2023b).

The reach of STI policy instruments also extends beyond the national level. Horizon Europe, the key funding programme of the European Union (EU) for research and innovation, with a budget of €95.5 billion, tackles climate change, helps to achieve the UN's Sustainable Development Goals, and boosts the EU's competitiveness and growth.[4] Other examples include the Global Environment Facility (GEF), which made available grants of approximately US$3.9 billion between 2018 and 2023, and mobilized US$30.7 billion in funding for projects around the world; and the Global Climate Fund (GCF), which combines a variety of instruments and science-based solutions for climate action in developing countries. These funds are dedicated to confronting biodiversity loss, climate change, pollution and other stressors on land and ocean health.[5]

The UN system also plays a pivotal role in supporting the implementation of STI policies at the global level through its own instruments and initiatives. The United Nations Educational, Scientific and Cultural Organization (UNESCO) assists countries in enhancing their scientific capacity through specific programmes related to water security, the sustainable management of natural resources, disaster reduction and climate change action, among others, and also supports countries in evaluating their STI systems and understanding the STI landscape, while providing technical counsel for the development, review and implementation of policies. The Organization also formulates standard-setting instruments in the form of UNESCO Recommendations, examples of which include the Recommendations adopted in 2021 on Open Science and on the Ethics of Artificial Intelligence.

To accelerate progress towards *The 2030 Agenda for Sustainable Development*, the United Nations Development Programme (UNDP) established UNDP Accelerator Labs with the support of Germany and Qatar. This initiative is designed to test new working practices to address social and environmental challenges, thus creating a new platform for decision-makers to explore, experiment and cultivate a range of mutually reinforcing solutions to tackle these issues.[6] Another STI initiative is the United Nations Inter-Agency Task Team on Science, Technology and Innovation for the SDGs (IATT), which promotes coordination, coherence and cooperation within the UN System on STI-related matters. An important field of action of the IATT is capacity-building, specifically the design and delivery of training courses and workshops on STI policy for the SDGs, with a particularly focus on developing countries.[7]

The World Bank, the Inter-American Development Bank and other international financing institutions (IFIs) are also significant players in this domain, providing financial and technical assistance to countries for projects that integrate STI into development strategies with a view to boosting economic growth, reducing inequalities and ensuring environmental sustainability.

Regional bodies such as the African Union and ASEAN (Association of Southeast Asian Nations), among others, have their own STI initiatives and programmes. These regional efforts focus on addressing challenges specific to their member countries, leveraging local expertise and promoting regional collaboration. Examples such as the research and development (R&D) programme of the Organisation of African, Caribbean and Pacific States (OACPS), and its Policy Support Facility and ACP Innovation Fund, have significantly enhanced the quality and efficiency of STI policy systems as well as the innovation capacity in African, Caribbean and Pacific (ACP) member countries.[8] The Science Granting Councils Initiative is another instrument that has since 2015 strengthened the capacities of African councils to support research and evidence-based policies as key drivers for economic and social development.[9]

4 European Commission, *Horizon Europe*, https://research-and-innovation.ec.europa.eu/funding/funding-opportunities/funding-programmes-and-open-calls/horizon-2020_en (accessed 17 July 2023)

5 Global Environment Facility (GEF), Projects, www.thegef.org/projects-operations/database (accessed 30 August 2023)

6 United Nations Development Programme (UNDP), *About Us*, www.undp.org/acceleratorlabs/aboutus (accessed 30 August 2023)

7 UN Interagency Task Team on STI for the SDGs (IATT), https://sdgs.un.org/tfm/interagency-task-team (accessed 30 August 2023)

8 Organisation of African, Caribbean and Pacific States (OACPS), *ACP*, https://oacps-ri.eu/en (accessed 1 December 2023)

9 Science Granting Councils Initiative (SCGI), *SGCI in Sub-Saharan Africa*, https://sgciafrica.org (accessed 1 December 2023)

In conclusion, the landscape of STI policy instruments is extensive and diverse, encompassing a range of actors operating at various levels, from local to global. Coordinated and harmonious efforts are therefore essential to address the challenges highlighted by the UN Secretary-General in the lead-up to 2030. In his report, the UN Secretary-General observed that many of the SDGs are 'moderately to severely off track' (United Nations, 2023). The same report emphasizes the need to 'revolutionise science, technology, and innovation capacities and exchanges' (ibid.) and further advocates for equipping governments with 'the capacities and strategies to continually reassess and refine policy implementation' (ibid.).

Countries striving to achieve the SDGs must strengthen their capacities to design and implement STI policies in alignment with national and global objectives. This publication aims to assist in this task by examining present practices and emerging trends in STI policy instruments by region, showcasing valuable resources such as policy databases as well as notable practices.

A resource for STI policy implementation towards Sustainable Development Goals

This publication also seeks to address a widespread knowledge gap by collating the existing literature and data on STI policy instruments for sustainable development and providing a clear and reliable resource for decision-makers, researchers and practitioners in STI policy design and implementation. By delivering relevant insights and good practices, this publication enables stakeholders to make well-informed choices, propelling STI initiatives towards achievement of the SDGs.

While intended for national and local governments, agencies and institutions to support them in the design and management of policy instruments as effective tools to harness STI, this publication also serves as an instrument for individuals and organizations aiming to harness STI for sustainable development.

2. Designing and implementing effective STI policy instruments

All discussions about STI policy, in particular those related to policy implementation, benefit from the conceptual definition of policy and policy instruments. While the boundaries are often not clear-cut, this publication provides the following definitions for policy and policy instruments:

Policy **is an institutional statement of a strategic nature that identifies high-level issues and proposes a logical link between causes, solutions and results. Essentially, policy is the macro view of the solution, requiring a broader vision focused on long-term impact. This is why policies are solutions whose maturation demands continuity, since they are associated with a central macro-problem overcoming the demands of which requires a significant investment of time (Lassance, 2020).**

Policy instruments **are programmes of a technical and operational nature required to solve the issues identified by a policy. They represent the micro view detailing solutions with greater refinement that focus on a public target, estimate resources, select indicators and set short, medium and long-term goals, respectively, for delivering products, results and impacts (Lassance, 2020; UNESCO, 2015).**

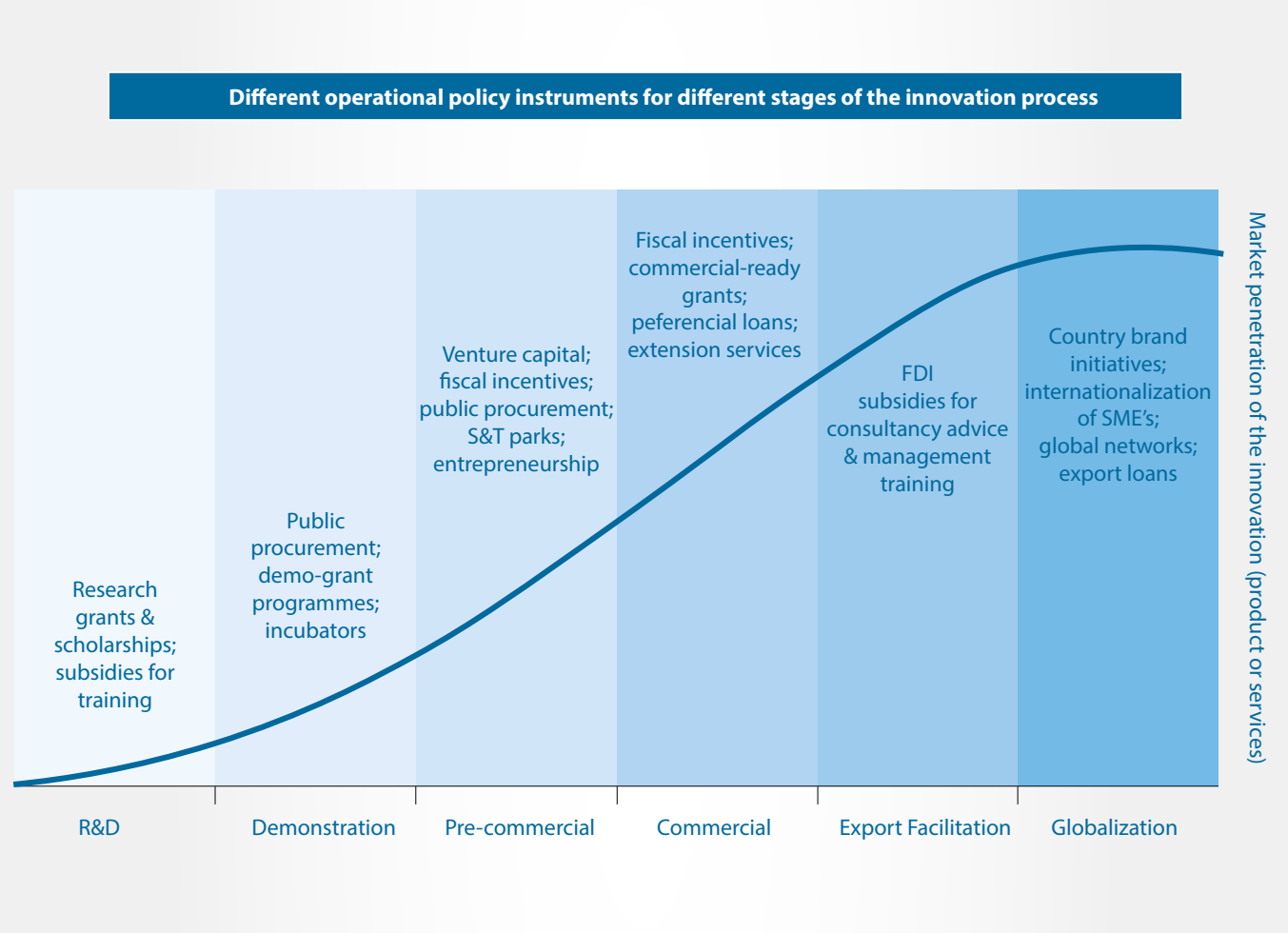
In accordance to these definitions, it can be inferred that a single policy is typically implemented through multiple policy instruments, given the complexity and multifaceted nature of most policy issues. Policies cannot exist without policy instruments and vice versa. Understanding how various policy instruments relate to the same central issue is crucial to the design of integrated policy mixes, in order to ensure that such combinations mutually enhance the intended effects rather than undermining them.

Towards adequate mix of policy instruments

A challenge faced by STI policy-makers is the often limited information available regarding the suitability of policy instruments for different problems and policy contexts (Cirera et al., 2020; Crespi et al., 2011). This challenge can be addressed analytically through two interconnected frameworks. The first of these analyzes instruments based on the different stages of the innovation process; the second does so according to the capabilities of the STI system.

Figure 2.1 illustrates a variety of policy instruments at different stages of the innovation process for products and services. For example, during the R&D stage, research grants are essential to offset the inherent risks associated with basic research. Concurrently, scholarships play a pivotal role in developing a critical mass of scientists, thereby ensuring the viability of R&D endeavours. As the innovation journey progresses, venture capital becomes crucial to bridge the 'valley of death', a phase many entrepreneurs grapple with during the pre-commercialization stage. Lastly, to effectively integrate into the global value chain, technical extension services are vital for the internationalization of small and medium-sized enterprises (SMEs). Additionally, export loans are indispensable to bolster their global market presence.

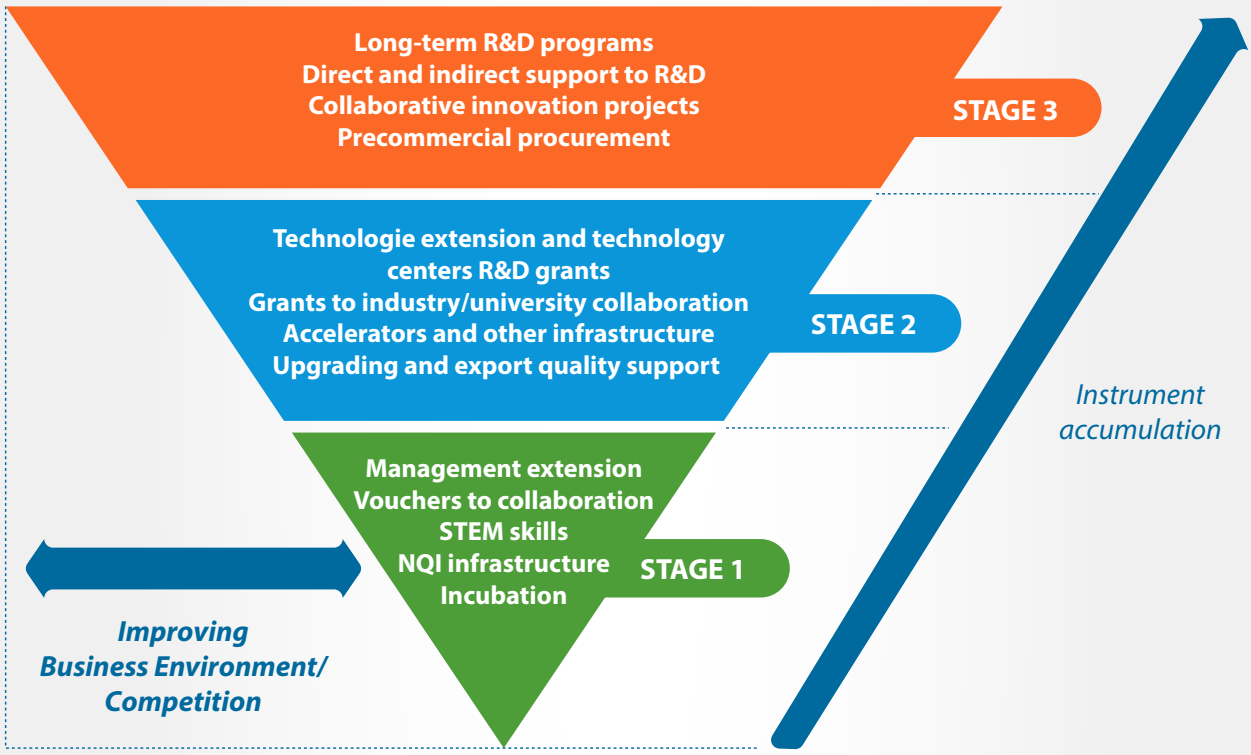
Figure 2.1. Policy instruments for different stages of the innovation process and level of market penetration



Source: UNESCO GO-SPIN platform

It is crucial to also take into account the capabilities available in STI systems to devise an adequate mix of policy instruments. Figure 2.2 divides the accumulation of these capabilities into three stages. In Stage 1, innovation happens through ad hoc activities with limited formal R&D. Under these circumstances, policy instruments are necessary to ensure technology is accessible and to fortify a firm's capacity to assimilate technology from advanced countries. In Stage 2, the intensity of R&D in STI systems increases, and the forms of innovation tend to be more sophisticated and improve in quality to accommodate escalating internal demand and the standards required for involvement in export markets. In this context, instruments supporting business R&D projects, and in some cases, fostering collaboration between researchers and the industry, become more pertinent. STI systems at Stage 3 arrive at the scientific and technological frontier. In these systems, the focus is on instruments that generate scientific discoveries, new technologies and support increasingly complicated innovative projects, while persistently enhancing the absorptive capacity within trailing SMEs (Cirera and Maloney, 2017).

Figure 2.2. Policy instruments according to the capabilities of the STI system



Note: NQI = national quality infrastructure; R&D = research and development; STEM = science, technology, engineering, and mathematics.

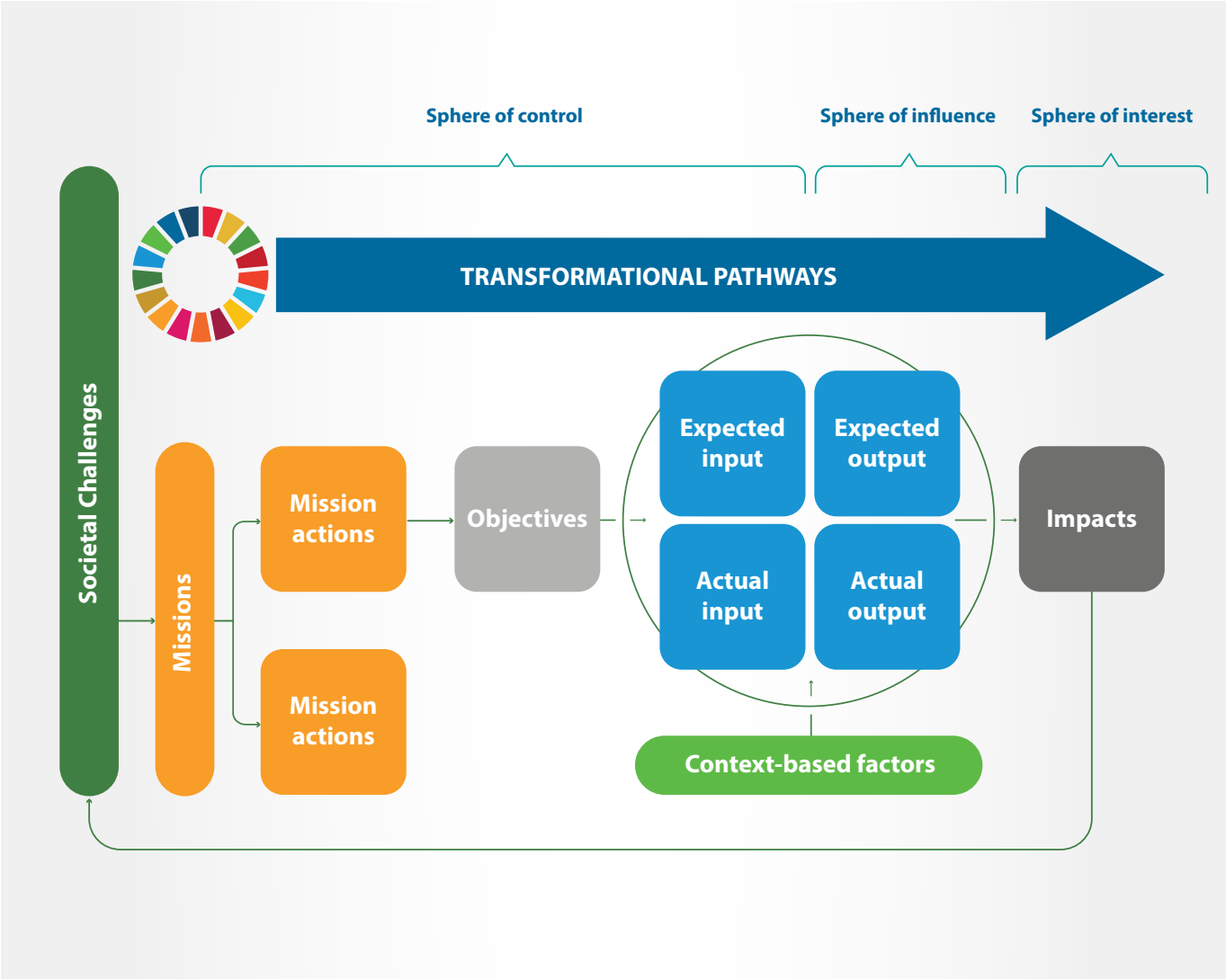
Source: Cirera and Maloney (2017)

Neither the analysis provided by the innovation process perspective nor the STI system capabilities approach provide a viable one-size-fits-all solution for policy instruments, given that different industries co-exist at various stages of the innovation process and at different points of the STI system capabilities spectrum. The key takeaway is that the policy mix of instruments is cumulative (Cirera and Maloney, 2017). While they evolve over time from basic to more sophisticated instruments, these instruments can be present simultaneously, reflecting the progression of activities within the innovation process and the capabilities of the STI system.

The directionality of the innovation process is also a crucial aspect to consider when designing and implementing policy instruments. Additional frameworks, such as the Sustainable Development Goals (SDGs), provide a targeted approach to guarantee that the innovation process aligns with broader societal goals. Incorporating the SDGs into the innovation policy framework ensures that the trajectory of technological advancements contributes positively to sustainable development. Policy-makers can integrate SDG-oriented objectives at each stage of the innovation process, from ideation to market implementation, by prioritizing ideas with the potential to provide solutions to SDG-related issues, supporting sustainable business practices and fostering global partnerships geared towards the achievement of these goals. By doing so, the innovation process not only advances scientific and technological frontiers, but also promotes the well-being of society and the planet, ensuring that the fruits of innovation are equitably shared and sustainable over the long term.

This approach is exemplified in Figure 2.3, which illustrates a standard programme intervention logic integrating mission-oriented concepts and the SDGs. It is presented as part of the European Union's initiative to adopt a mission-oriented approach within smart specialization strategies (S3) to tackle societal challenges and accomplish the SDGs.

Figure 2.3. Intervention logic for mission-oriented approaches



Source: Reid, Steward and Miedzinski (2023)

There are numerous instruments open to governments when planning the implementation of policy goals. Each instrument has its strengths, drawback and risks that need to inform design and decision making. Table 2.1 aims to inform policy-makers about these characteristics of STI policy instruments relevant for developing countries, and therefore to help start the policy instrument design with a narrowed down mechanism.

Table 2.1. Examples of STI policy instruments and their characteristics

Type of instrument	Definition	Objective	Strengths	Drawbacks and risks
Grants and matching grants	Grants are a direct provision of funding from public agencies to other public or private organizations to finance all or part of an STI project.	These instruments can address capability, appropriation and coordination issues leading to limited knowledge production, collaboration or investment.	Grants can target specific topics, regions or types of firms where intervention is needed. Grants are flexible and can be designed to apply to different stages and types of innovation. Grants are relatively easy to implement as most agencies already have knowledge of using grants. The process of evaluating grants can also serve the purpose of assessing firms' capabilities.	Potentially high management and bureaucratic costs. Need to be adequately funded with budget stability to ensure continuity. Risks of interference with the selection process when poorly designed. Risk of crowding out private funding and capture by repeated applicants.
Scholarships and human capital development	Scholarships consist of a grant or payment to individuals to support their education and hence promote skill development. Scholarships will involve some level of coursework or vocational training in a particular area of study that will result in a degree, certification or recognized award.	These instruments contribute to addressing the need to enhance human resource capacity. More specifically, they enhance the national knowledge base in the fields and disciplines seen as most closely connected with economic development, improve interpersonal and international linkages, and address social inequities.	When a scholarship involves study abroad, the country or institution implementing the programme draws on the resources of other countries to fill gaps in local capacity for human capital formation. Scholarships can inject a demand-side stimulus to enhance the system of higher or vocational education supply according to national needs. A scholarship can stimulate productivity improvement by further opening up the country's society to international best practices, internationalizing the workforce and connecting the next generation of leaders to international networks.	If the instrument is not designed properly, the maintenance costs in terms of time and personnel may be high. When scholarships involve study abroad, the risk exists that the beneficiaries will not return to their country, hence limiting the benefits for national socio-economic development. Without sufficient alignment between the fields of study of the graduates, the country may fail to obtain the human capital it needs in important economic sectors and a large number of graduates may encounter difficulty in finding gainful employment.

Type of instrument	Definition	Objective	Strengths	Drawbacks and risks
Business advisory services and technology extension services	Business advisory services and technology extension services focus directly on equipping firms with the capabilities to use and/or generate technologies.	These instruments contribute to helping organizations identify their constraints and how to overcome them. Likewise, they can assist with organizing the STI system so that service providers and users can interact.	They provide a clear and centralized suite of services. They can offer tailored services based on diagnosis of the target audience. They tend to strengthen the capabilities of beneficiaries. They can help address the skills gaps for some technologies.	They present a risk of overcrowding the market. There is a lack of willingness to pay among users. There is a risk that services will be wrongly prioritized.
Incubators and accelerators	Incubators and accelerators target innovative companies and sectors and have links with public research organizations to support the commercialization of knowledge.	These instruments help solve capability issues where early-stage enterprises lack the capabilities to develop and scale-up their ideas. Likewise, they contribute to overcoming network and infrastructure failures limiting start-up growth.	Incubators and accelerators promote network effects, technology transfer and spillover effects. They offer economies of scale in fixed costs and service provision. Dedicated advisory assistance is available. Incubators and accelerators enable high-risk investment in the early stages of development. Accelerators can help identify and filter out poor business models resulting in more efficient firm development. Accelerators allow for group interaction and learning among entrepreneurs.	The cost of running programmes is high and outreach capabilities are limited. A clear policy on selection criteria is lacking. Programmes have proliferated in the absence of effective screening mechanisms. There is a risk of not achieving financial self-sustainability. When there is insufficient coordination between different acceleration programmes, some ventures might end up being accelerated multiple times as a result of duplicate investment.
Prizes, competitions, crowdsourcing and hackathons	These activities encourage external parties to develop innovative solutions.	These instruments have the potential to address institutional challenges limiting knowledge production in particular areas. Likewise, they may produce positive externalities by addressing challenges hindering societal development that cannot be addressed by pure market mechanisms.	Their openness can attract innovative solutions from unconventional areas. The risks are distributed among participants and they allow for leveraging of public spending. The accompanying publicity can lead to public enthusiasm, venture capital investment and contracts for innovators.	Due to the ad hoc nature of technological requirements and the resulting target group, this is not a stable tool to support the build-up of deep knowledge over time. There is a danger of disconnection of results from a viable social solution if the prize is defined solely by the policy-maker. Prizes can generate too much effort and risk-taking by those developing innovative solutions, given that most teams will not reap the reward of the innovative solution produced.

Type of instrument	Definition	Objective	Strengths	Drawbacks and risks
Quality infrastructure, standards, metrology and testing	The national quality infrastructure (NQI) is part of a country's innovation system. It helps determine whether a product, process or service meets a defined set of requirements.	These instruments contribute to addressing the lack of quality standards and testing infrastructure that limits the value-adding capabilities of the economic activity and, consequently, access to foreign markets.	Quality, infrastructure, standards, metrology and testing encourage positive network effects. They are essential for ensuring product quality and consistency, which are building blocks for more sophisticated innovation. They support the internationalization of innovation processes. They improve innovation efficiency. Standards that reduce variability promote economies of scale and learning, with suppliers saving costs. They serve as a building block of innovation capability. The introduction of standards at the firm level can be an important step in building the capability for more complex innovation.	Potential conflict of interests and weak governance structures can pose a risk. They can result in the imposition of obstructive requirements and technology lock-in. There may be significant compliance and conformity costs. The risk exists of private capture and constrained competition.
Equity finance for innovative enterprises	Equity finance instruments involve the government providing capital used to invest in the equity of small and young high-risk innovation-intensive companies, to support their growth. There are various equity finance mechanisms, which include co-investment with angel investor groups, government-run funds, etc.	These instruments contribute to assessing coordination issues where investors have high costs for project appraisal, and the entrepreneur suffers from high costs while looking for investment.	Both investors and entrepreneurs are equally motivated to succeed, resulting in alignment of interests. The risks are shared through the participation of private investors. Equity finance leverages expertise and investment from the private sector. There positive spillovers to the entrepreneurship ecosystem. Incentives such as tax concessions for investors can attract experienced investors to this market segment, bringing both capital and knowledge. Business angel networks represent a direct channel of communication between entrepreneurs and investors.	The complexity of programmes demands scarce policy skills and ecosystem infrastructure. There is a risk of government failure, such as lack of competence in running a fund, inappropriate decision criteria and crowding out private investment. Early-stage equity can crowd out private sector resources. If interventions are not limited to covering the equity gap, there is a risk that public support of innovative start-ups and SMEs can crowd out private sector resources. Investments have long time frames. These interventions do not typically provide quick impacts or results.

Source: Based on Cirera et al. (2020)

2.1 Policy design

Even when an STI policy issue has been accurately identified and its causes recognized, the effectiveness of any intervention will be determined by the final design of the instrument. A crucial issue, therefore, is how to manage complexity and possible dangers when policy instrument design capabilities are limited. Some good practices for the design of policy instruments are as follows:[10]

- ***Objectives of the STI policy related to the instrument.*** Good practice dictates that the policy instrument should be rooted in a documented, evidence-based diagnosis that addresses the specific issue outlined by the STI policy. It is essential to acknowledge the political dimension inherent in the process of selecting policy goals to enhance its legitimacy. As such, the objectives of the instrument must be in sync with the identified issue. If the policy is an updated version of a prior one, the insights gained from the previous iteration should inform the diagnosis for the new instrument.

- ***Justification.*** It is imperative to establish a clear connection between the selected goals and the means chosen to tackle the problem. Ideally, this connection should be documented explicitly.

- ***Relation to the policy mix.*** The principles of coherence and rationality necessitate a focus on implicit policies. This means considering potential interactions – both synergistic and counteractive – across all instruments. Designing a policy requires an analysis of these interactions that produce implicit effects. This can be achieved either by pinpointing policies that complement the one in question or by refining the instrument to emphasize features or results that do not conflict with other policies. Typically, interactions and interdependencies in the policy mix lead to questions about coordination across various policies and governmental levels.

- ***Alternative policy instruments.*** Often, the diagnosis of the problem which drives the policy can limit the range of viable instruments even before the decision-making phases. This limitation can arise from existing conditions or a lack of knowledge about available instruments. Good practice suggests considering alternative instruments based on comparative criteria such as efficiency, effectiveness, cost-benefit ratios and context appropriateness. Tools like GO-SPIN[11] or STIP Compass[12] can be useful in identifying available alternatives.

- ***Objectives.*** Objectives should be crafted to minimize ambiguity and discord. This means that goals should be explicit, achievable, observable and quantifiable, rather than vague and generic. Not only should objectives align with STI policy goals; they should also resonate with international frameworks, such as Agenda 2030.

- ***Logic model for the use of the instrument.*** The instrument's logic model must be clearly delineated. This model outlines the instrument's intended functioning by detailing the policy's underlying theory of change and the assumptions about how inputs, activities and outputs lead to desired outcomes and impacts. It also considers the effects on specific stakeholders and audiences. A well-defined logic model aids in the ex-ante evaluation of the instrument based on anticipated outcomes and impacts.

- ***Target audience and conditions to apply for the instrument.*** The design of the policy instrument should clearly delineate the target audience that is most likely to achieve the policy's intended effects. Moreover, the instrument should unambiguously convey all conditions that potential applicants must meet. Every potential participant should have an equal opportunity to enter the selection process.

10 Policy design good practices adapted from *Cirera* et al. (2020), Lemarchand (2021), and UNIDO and IATT (2022)

11 Global Observatory of Science, Technology and Innovation Policy Instrument (GO-SPIN) https://gospin.unesco.org/frontend/home/index.php

12 Science, Technology and Innovation Policy (STIP) Compass https://stip.oecd.org/stip/

- ***Criteria for selecting participants.*** The design of the policy instrument should clearly set criteria that align with policy goals and are effective in reaching the intended audience. Moreover, these criteria should be transparent and accessible to all potential beneficiaries. All applicants should receive clear feedback regarding the feasibility of their application.

- ***Eligible costs and modes of disbursement.*** The design of the policy instrument should explicitly list all eligible costs covered by the instrument. For non-financial instruments, the support modality should be defined without ambiguity. Similarly, the methods of disbursement or service delivery should be established before the instrument's implementation to prevent administrative or financial hold-ups.

- ***Monitoring and evaluation (M&E) methods.*** An effective M&E framework, complete with relevant indicators, should be in place. This framework will enable the practical use of evaluation results for continuous learning and refining of future policy designs. The success of future iterations of the instrument relies heavily on incorporating an M&E framework during the design stages. Evaluating embedded impacts during the design phase yields valuable insights, especially for instruments initiated as pilots.

2.2 Policy implementation

In the domain of public policy implementation, many challenges are not exclusive to science, technology and innovation (STI) policies, but rather are intrinsic to public sector administration. Some of the main aspects of policy implementation in this context are as follows:

- *Implementation processes* focus on the planning, coordination and execution phases, ensuring that instruments are rolled out effectively.
- *Management quality* relates to management practices as well as the competencies and capabilities of those overseeing the implementation, ensuring optimal resource utilization and achievement of desired outcomes.
- *Monitoring and evaluation* underscore the importance of regular assessments of policy progress and impact, allowing policy-makers to gauge success and make necessary adjustments.
- *Learning* emphasizes the capacity of policy implementers to adapt and evolve based on new information, experiences and feedback, ensuring continuous refinement of policy outcomes.

Some good practices to promote robust implementation processes so that programmes run efficiently, meet government and beneficiary expectations, and produce positive and measurable benefits are as follows:[13]

Implementation processes

- ***Communication***. Provide and disseminate clear information about eligibility criteria, benefits and terms.
- ***Call for proposals and project management.*** Ensure calls for proposals are transparent, detailing the nature of projects to be funded or supported, funding levels, participant eligibility criteria, and the application and selection processes.
- ***Target audience support.*** Determine the most effective channels to reach the target audience and the mechanisms to address their needs. Identify which external stakeholders might support the program and how. Decide how feedback will be collected and used for program operations.
- ***Beneficiary selection practices***. Ensure that instruments have transparent and clear scoring systems. It is also important to implement an appeal system and disclose award recipient names.
- ***Application procedures.*** Ensure the availability of user-friendly application processes preferably online with minimal documentation requirements. Implementing agencies should leverage existing applicant information. Mechanisms should be in place to re-invite or redirect unsuccessful applicants to other suitable initiatives.
- ***Delivery mechanisms.*** The appropriate delivery mechanism and implementing agency will vary depending on the programme's nature. Some might be best delivered centrally, while others should be delivered through regional channels

13 Policy implementation good practices adapted from *Cirera* et al. (2020), Aridi et al. (2019), and Rogers (2017)

or third parties. Minimize agency numbers for a single instrument to reduce coordination challenges. If funding is involved, balance reporting requirements to maintain programme integrity without overburdening beneficiaries.

- ***Funding distribution.*** If funding is being provided, the instrument should balance the reporting requirements necessary for programme integrity, in order to avoid imposing administrative burdens on beneficiaries, which often take the form of organizations with strained human resources and financial capabilities.
- ***Capacity-building and specialized skills.*** Assess the capacity needed for instrument implementation, especially if it is new or requires specific knowledge. Develop capacity-building and skill acquisition plans if necessary. If delivery is being outsourced, evaluate the skills needed for effective management and delivery.
- ***Stakeholder engagement.*** Involve stakeholders during both the instrument design and implementation phases. Structures should ensure that stakeholder feedback is considered.
- ***Programme information management.*** An integrated digital information system is crucial for managing applications and determining whether firms benefit from other instruments. Ideally, this system should be integrated with financial management and M&E modules.
- ***Finalization of participation in the programme.*** Clearly define the end of support criteria and necessary closure documents. Implement systems to collect follow-up information, especially for innovation projects with medium to long-term impacts.

Management quality

- ***Budget and resources.*** Make sure that adequate budgeting is available for the instrument, including management, outreach and monitoring activities. Align disbursements with programme objectives and ensure rigorous financial control mechanisms are in place.
- ***Organization management.*** Implement high-quality organizational management practices. If design and implementation teams differ, they should collaborate closely.
- ***Role definition and autonomy.*** Design the system so as to prevent undue external interference. Clearly define authority lines and decision-making procedures.
- ***Human resources and training.*** Address role definitions, task autonomy, skills investment and strategic alignment, and implement merit-based reward systems.
- ***Incentives management.*** Offer proper incentives for continuous job performance improvement, including by linking pay and benefits to individual performance and providing career advancement opportunities.
- ***Process monitoring.*** Implement process monitoring with quality indicators and reporting for potential internal process improvements.

Monitoring and evaluation

- ***Programme monitoring and evaluation.*** Both external and internal evaluations are crucial for accountability and learning. Evaluation results should inform future instrument design and improvements. Establish clear evaluation guidelines and plans in advance.

Learning

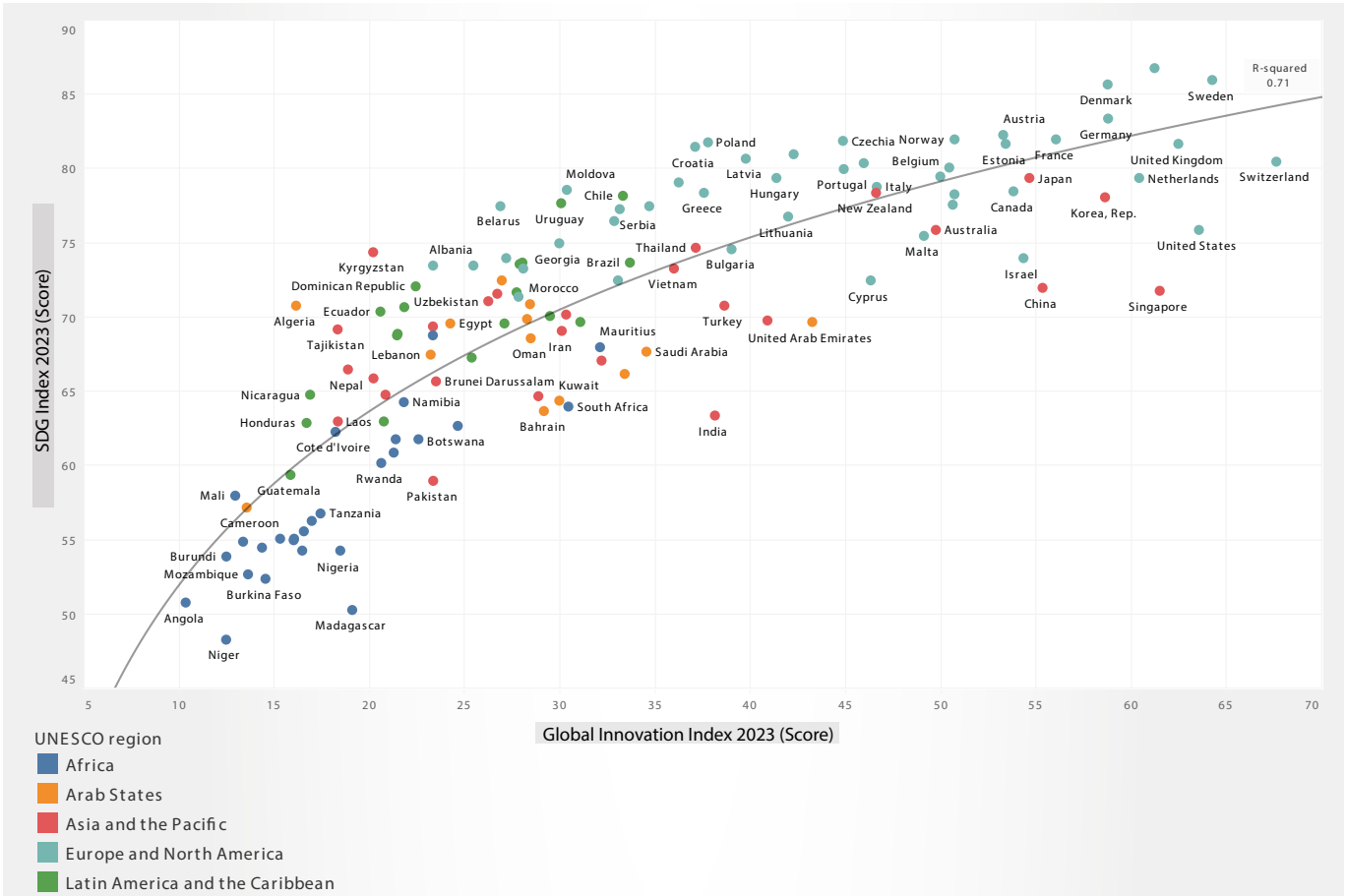
- ***Knowledge management.*** When implementing policy instruments, consider processes for learning in order to improve performance. This involves the documentation of experiences and decisions to adapt to new circumstances, the determination of implementation challenges not identified in the original design, documentation of the specific solutions adopted and remaining problems, and relevant data showing performance improvement. Policy-makers are also encouraged to connect with peers from other regions and countries to exchange knowledge and experiences

3. Overview of regional advancements in STI

Gaining a comprehensive understanding of science, technology and innovation (STI) indicators is essential when designing STI policy instruments. Indicators such as research and development (R&D), innovation and human capital, among others, offer empirical evidence to policy-makers ensuring that policies are rooted in tangible data rather than assumptions or anecdotal evidence. Furthermore, once STI policy instruments are implemented, it is essential to track their effectiveness, and STI indicators serve as benchmarks against which progress can be measured over time.

An important starting point to understand the contribution of STI towards the Sustainable Development Goals (SDGs) and, at the same time compare a country's performance with their peers, is analyzing the relationship between the Global Innovation Index (GII) and SDG Index. Analyzing both indexes offers a general but holistic perspective on a country's STI and developmental status. Figure 3.1 illustrates a positive non-linear relationship.[14] At the outset, minor improvements in a country's STI capacity can lead to significant advancements in the SDGs. However, as a nation becomes more innovative, additional efforts might yield diminishing returns. This suggests that investments in STI are particularly impactful in countries with young STI systems. Conversely, nations with well-established STI infrastructures and matured systems should strategically channel their resources and efforts to ensure optimal outcomes.

Figure 3.1. Positive relationship between STI performance and sustainable development



Source: Author's elaboration based on data from WIPO (2023) and Sachs et al. (2023)

Building upon the understanding of the interplay between STI capacity and the SDGs, it is useful to explore further the ecosystem that supports this dynamic. This chapter offers a succinct overview of key STI performance indicators across UNESCO regions: R&D intensity, R&D human capital and research output. These indicators serve as barometers to measure the effectiveness and impact of STI policy instruments.

The subsequent sections explore the STI dynamics in more depth, presenting a detailed regional analysis of STI performance. By examining each region's distinctive

14 Figure 3.1 illustrates a logarithmic model that yields an R^2 value of 0.71, suggesting that the model explains 71 per cent of the variance in the dependent variable

characteristics, strengths and challenges, this chapter aims to provide a granular understanding of the global STI landscape. This regional approach not only underscores the diversity and uniqueness of each area but also highlights common trends and shared challenges. The analysis seeks to offer a comprehensive picture ranging from the vibrant innovation hubs of Asia and the Pacific to the emerging potential of Africa, the established powerhouses of Europe, and the dynamic landscapes of Latin America and the Caribbean. Through this lens, policy-makers and stakeholders can draw meaningful comparisons and tailor strategies to their regional contexts, ensuring that STI efforts align with both local realities and global sustainability goals.

3.1 Africa

The *Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) (African Union, 2014)* adopted in 2015, recommends that countries allocate at least 1 per cent of their Gross Domestic Product (GDP) towards R&D. However, government efforts have fallen short of this target (see Table 3.1). Furthermore, while *STISA-2024 (African Union, 2014)* underscores the importance of monitoring and evaluating the implementation of policies, data are only infrequently available and are often outdated, limiting the available evidence from countries to permit an understanding of local R&D dynamics and to formulate a response. A salient feature of African STI systems is the significant support from external sources to R&D and human capacity-building. For instance, it is estimated that approximately 73 per cent of gross expenditure on R&D (GERD) in Uganda, 60 per cent in Kenya, and 50 per cent in Tanzania and Burundi is provided by external sources (AAS, 2018). In addition, the *UNESCO Science Report (UNESCO, 2021)* states that 39.9 per cent of R&D expenditure in Mozambique, 33.0 per cent in Seychelles and 33.5 per cent in Eswatini is sourced from abroad (UNESCO, 2021).

Table 3.1. GERD as a percentage of GDP in Africa (2010–2021)
In descending order based on the most recent value

Country	Most recent value	Year
Rwanda	0.76%	2019
Kenya	0.69%	2010
South Africa	0.61%	2019
Senegal	0.58%	2015
Botswana	0.56%	2013
United Republic of Tanzania	0.51%	2013
Democratic Republic of the Congo	0.41%	2015
Ghana	0.38%	2010
Mauritius	0.37%	2021
Namibia	0.35%	2014
Mozambique	0.31%	2015
Chad	0.30%	2016
Ethiopia	0.27%	2017
Eswatini	0.27%	2015
Togo	0.27%	2014
Burkina Faso	0.25%	2021
Burundi	0.21%	2018

Seychelles	0.21%	2016
Mali	0.18%	2021
Uganda	0.14%	2014
Cabo Verde	0.07%	2011
Côte d'Ivoire	0.07%	2016
Gambia	0.07%	2018
Lesotho	0.05%	2015
Angola	0.03%	2016
Madagascar	0.01%	2017

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: UNESCO Institute for Statistics

The availability of human resources for research is an area where Africa faces some challenges. According to Table 3.2, the majority of countries across the continent have fewer than 100 researchers per million inhabitants, with only a handful nearing gender parity. Africa is thus a vast region with immense unexplored potential in the realms of research and innovation. To put this into perspective, as of 2018, while sub-Saharan Africa accounted for 14 per cent of the global population, it only represented 0.7 per cent of the worldwide research community.[15] Among the countries progressing in the right direction are Mauritius, Senegal and South Africa. Each of these nations have over 480 researchers per million inhabitants, almost halfway towards the critical benchmark of 1,000 researchers per million, a figure often recognized as the threshold for a mature industrialized economy (Lemarchand and Tash, 2015). Meanwhile, based on the most recent available data, Cabo Verde, Eswatini, Mauritius and South Africa are on the verge of achieving gender parity in research roles.

Table 3.2. Researchers per million inhabitants and share of women researchers in Africa (2010–2021)
In alphabetical order based on the names of the countries

Country	Researchers per million inhabitants	Share of female researchers	Year
Angola	18.80	28.91%	2016
Botswana	185.20	30.63%	2013
Burkina Faso	47.60	21.61%	2010
Burundi	23.40	14.32%	2018
Cabo Verde	123.50	46.88%	2014
Chad	57.90	5.06%	2016
Democratic Republic of the Congo	10.60	10.06%	2015
Eswatini	142.30	44.90%	2015
Ethiopia	90.50	12.29%	2017
Gambia	52.90	28.11%	2018
Ghana	89.10	21.12%	2015
Kenya	221.40	20.00%	2010

15 UNESCO, *Researchers per Million Inhabitants by Country, 1996–2018 (in Full-Time Equivalents)* www.unesco.org/reports/science/2021/en/dataviz/researchers-million-habitants (accessed 5 May 2021)

Lesotho	24.10	40.18%	2015
Madagascar	34.00	34.12%	2018
Malawi	50.40	18.55%	2010
Mali	30.30	12.55%	2021
Mauritius	568.00	48.07%	2021
Mozambique	43.00	28.92%	2015
Namibia	149.50	38.82%	2014
Niger	26.50	22.32%	2013
Rwanda	58.80	37.74%	2019
Senegal	564.30	30.22%	2015
South Africa	484.30	45.45%	2019
Togo	45.20	11.32%	2021
Uganda	27.80	28.13%	2014
United Republic of Tanzania	19.20	24.52%	2013
Zimbabwe	99.50	25.45%	2012

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

As illustrated in Table 3.3, the volume of scientific publication has increased across all African countries, but to varying degrees. Some countries, such as Angola, Burundi, the Central African Republic, Chad, the Democratic Republic of Congo, Guinea, Niger, Somalia and South Sudan, report fewer than ten publications per million inhabitants. This limited output can arguably be attributed to the detrimental effects of conflicts, such as population displacement, loss of life and infrastructure damage. In contrast, South Africa continues to lead the region in absolute scientific production, with 21,062 publications in 2019 (UNESCO, 2021). Moreover, the country ranks second in publications per million inhabitants with 359 in 2019, trailing only Seychelles, which has 532. Botswana, Cabo Verde, Eswatini, Ghana, Mauritius and Namibia have also experienced significant growth. Scientific output has more than doubled in each of these nations, surpassing the African average of 64.6 publications per million inhabitants.

A distinctive feature of African scientific production is the high share of publications with international co-authors, a trend which has contributed to the positive progression described above. Between 2017 and 2019, 60 per cent of sub-Sahara African publications had international co-authors, the highest share worldwide (ibid.). Another feature is the significant proportion of the region's publications focusing on the health sciences (32 per cent) over the same period (ibid).

Table 3.3. Publications per million inhabitants in Africa

In descending order based on the value in 2019

Country	2011	2015	2019	Trend
Seychelles	380.9	621.2	532	
South Africa	205.2	265.5	359.7	
Mauritius	75.1	141.3	342.6	
Botswana	130.5	141.5	272.2	
Namibia	59.8	111.9	152.7	
Eswatini	43.8	49.8	101	
Ghana	27.2	46.2	86.1	
Gabon	90.2	90.9	85.6	
Cabo Verde	8	59.1	80	
Gambia	49.8	76.7	76.7	
Cameroon	35.8	45.9	64.3	
Kenya	36.5	42.4	57.9	
Zimbabwe	22.5	33.2	51.9	
Sao Tome & Principe	0	15	51.2	
Congo	27.1	39.3	47.6	
Benin	28.8	37	47.1	
Senegal	39.4	45.6	46	
Nigeria	27.4	25.8	45.7	
Uganda	26	32	39.1	
Malawi	21.4	26.7	38.3	
Rwanda	12.4	24	35.3	
Ethiopia	9.5	16.3	34.7	
Zambia	18.8	25.4	32.1	
Guinea-Bissau	18.6	20.1	31.8	
Tanzania	17.8	22.8	29.9	
Lesotho	13.5	16.5	28.2	
Burkina Faso	21.8	28.3	27.5	
Togo	14.6	19.7	24.4	
Comoros	15.6	10.3	22.3	
Côte d'Ivoire	14.3	14.9	20.8	
Djibouti	18.7	17.5	20.5	
Sierra Leone	4.6	13.7	18	
Liberia	3.7	10.1	17.8	

Mali	12.6	13.8	15.4	
Mozambique	7.9	10.9	15.1	
Eritrea	7.5	7.8	13.2	
Madagascar	10.6	12	12.6	
Equatorial Guinea	7.1	13.7	10.3	
Central African Rep.	7.5	8.2	9.9	
Guinea	3.4	8.6	9.2	
Niger	6	8	7.6	
Burundi	2.9	4.6	6.1	
Democratic Republic of the Congo	2.2	3.9	4.7	
Chad	1.9	2.1	3.8	
Somalia	0.4	1.1	3.8	
Angola	2.1	3	3.6	
South Sudan	0.5	1.1	2.4	

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO (2021)

3.2 Arab States

In aggregate, R&D investment in the Arab States is low compared to overall GDP (UNESCWA, 2017a). Some experts argue that this low level of investment is due to the high revenues generated from the dominant hydrocarbon sector, which allow for sufficient investment of capital in science, technology and innovation (STI), despite the smaller percentage share (UNESCO, 2021). However, some countries in the region have recognized the potential contribution of STI towards addressing challenges such as water and food security or economic diversification, and are reversing this trend. The United Arab Emirates (UAE) leads this trend dedicating 1.5 per cent of GDP to R&D (Table 3.4), in line with the country's Centennial Plan 2071, launched in 2021, which includes as one of its pillars 'excellent education, with a focus on science and technology, space science and engineering'. Egypt has also experienced growth in R&D expenditure, although levels have remained relatively constant since 2020 at 0.96 per cent of GDP.

An important feature of expenditure on R&D in the Arab States is the concentration within government and higher education sectors. Only in the UAE is private sector involvement in R&D comparable with that seen in developed countries, although the private sector plays a significant, but less active role in both Oman and Tunisia (UNESCWA, 2017b). Some countries have pledged to raise their R&D expenditure, with Sudan and Morocco expecting to reach 2 per cent and 1.5 per cent of GDP by 2030, respectively. However, efforts to monitor progress towards these goals remain difficult due to limited data availability, although Egypt, Jordan and Sudan, among others countries, are taking measures to address this deficiency though the establishment of STI observatories.

Table 3.4. GERD as a percentage of GDP in Arab States (2010–2021)
In descending order based on the most recent value

Country	Most recent value	Year
United Arab Emirates	1.50%	2021
Egypt	0.96%	2021
Tunisia	0.75%	2019
Morocco	0.72%	2010
Jordan	0.70%	2016
Qatar	0.68%	2021
Malta	0.67%	2020
Algeria	0.53%	2017
Saudi Arabia	0.46%	2021
Palestine	0.45%	2013
Oman	0.29%	2021
Kuwait	0.19%	2020
Bahrain	0.10%	2014
Iraq	0.04%	2021
Syrian Arab Republic	0.02%	2015
Mauritania	0.01%	2018

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: UNESCO Institute for Statistics

The density of researchers in the Arab States is growing with several countries on the path to reaching or surpassing the benchmark of 1,000 researchers per million inhabitants (see Table 3.5). To enhance growth in this area, countries such as Qatar, Saudi Arabia and the UAE, have recruited top foreign scientists for their universities and research institutes. The UAE has aided these efforts by granting scholars, scientists and PhDs permanent residence (UNESCO, 2021). Many Arab States are also training more researchers than before. For instance, since 2015, enrolment of PhD students has increased in Morocco from 1.369 per thousand of the population aged 25–65 to 2.61 per thousand in 2021. For comparison, Malta experienced growth from 0.47 to 0.97 PhD students in the same age group over the same period.[16] The Arab States are also making progress towards achieving gender parity among researchers, aligning themselves with the accomplishments of Tunisia. Kuwait has led efforts in this field, achieving parity of 50 per cent in 2017. Nonetheless, within the Gulf region, the most esteemed positions in science and engineering continue to be held predominantly by men (UNESCO, 2021).

16 UNESCO Institute for Statistics

Table 3.5. Researchers per million inhabitants and share of women researchers in Arab States (2010–2021)
In alphabetical order based on the names of the countries

Country	Researchers per million inhabitants	Share of female researchers	Year
Algeria	819	46.71%	2017
Bahrain	369	41.58%	2014
Egypt	854	42.18%	2021
Iraq	170	43.07%	2021
Jordan	596	21.09%	2017
Kuwait	174	48.45%	2020
Malta	2296	31.84%	2020
Morocco	1074	36.64%	2016
Oman	284	32.68%	2021
Palestine	575	-	2013
Qatar	903	31.71%	2021
Saudi Arabia	701	40.67%	2021
Syrian Arab Republic	91	35.13%	2015
Tunisia	1622	54.94%	2021
United Arab Emirates	2489	24.19%	2021

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

Of the approximately 96,000 scientific publications produced by the Arab world in 2019, about 50 per cent were the work of authors based in Egypt or Saudi Arabia, in similar proportions. However, when adjusted for population size, the scientific productivity of countries such as Qatar, the UAE, Saudi Arabia and Tunisia significantly surpasses that of Egypt (Table 3.6). Of nearly 6,100 highly cited researchers globally in 2018, around 90 were affiliated with universities in the Arab world, most of which are located in Saudi Arabia (Clarivate, 2019). As noted in the *UNESCO Science Report (UNESCO, 2021)*, the performance of countries like Saudi Arabia against such metrics can be attributed primarily to the hiring of foreign world-class researchers in recent years (UNESCO, 2021). Additionally, patterns of international collaboration exercise a notable influence on the publication behaviour of the region, with international co-authors represented in some 54 per cent of publications. In the case of Saudi Arabia and the UAE, this ratio climbs to 75.7 per cent and 70.9 per cent, respectively (ibid.).

Table 3.6. Publications per million inhabitants in the Arab States

In descending order based on the value in 2019

Country	2011	2015	2019	Trend
Qatar	394	1059	1320	
United Arab Emirates	242	414	737	
Saudi Arabia	299	557	736	
Tunisia	442	583	610	
Lebanon	255	315	483	
Kuwait	344	332	467	
Jordan	248	222	432	
Bahrain	219	227	416	
Oman	279	298	383	
Iraq	28	51	291	
Egypt	119	159	231	
Morocco	81	113	197	
Algeria	89	134	176	
Palestine	82	92	163	
Libya	39	63	70	
Syrian Arab Republic	21	22	30	
Sudan	14	15	21	
Yemen	10	11	21	
Mauritania	9	9	16	

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO (2021)

3.3 Asia and the Pacific

Table 3.7 illustrates the diversity of R&D intensity in the region. Both Central Asian and South Asian nations consistently demonstrate low expenditure on research. Certain countries, such as Kazakhstan, failed to achieve their set goal of 1 per cent of GDP by 2015, and it is unclear whether Mongolia will meet its target of 1 per cent by 2030, having not reached 0.6 per cent by 2020. A comparable situation is seen in South Asian countries, where Nepal set a 0.62 per cent GDP target by 2019 that it has been unable to reach (UNESCO, 2021). The contrast with countries such as China, Korea and Japan is notable, all of whom have historically demonstrated high expenditure in research at levels comparable to those of leading nations worldwide. Southeast Asian and Oceanic nations have also illustrated a consistent commitment to leveraging STI for their developmental agenda, with the data showing a convergence towards increasingly higher levels of expenditure in research from countries like Australia, Malaysia, New Zealand, Singapore and Thailand.

Table 3.7. GERD as percentage of GDP in Asia and the Pacific (2010–2021)

In descending order based on the most recent value

Country	Most recent value	Year
Republic of Korea	4.80%	2020
Japan	3.28%	2020
China	2.41%	2020
Singapore	1.89%	2019
Australia	1.83%	2019
New Zealand	1.40%	2019
Thailand	1.33%	2020
Turkey	1.09%	2020
Malaysia	0.95%	2020
Iran (Islamic Republic of)	0.79%	2019
India	0.66%	2018
Puerto Rico	0.43%	2015
Viet Nam	0.42%	2019
Philippines	0.32%	2018
Nepal	0.30%	2010
Indonesia	0.28%	2020
Brunei Darussalam	0.28%	2018
Pakistan	0.16%	2021
Myanmar	0.15%	2021
Mongolia	0.13%	2020
Uzbekistan	0.13%	2021
Kazakhstan	0.13%	2021
Sri Lanka	0.12%	2018
Cambodia	0.12%	2015
Tajikistan	0.09%	2020
Kyrgyzstan	0.09%	2020
Papua New Guinea	0.03%	2016

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: UNESCO Institute for Statistics

The distribution of researchers across countries in Asia and the Pacific is characterized by marked variation. The region, taken as a whole, has seen an upturn in this metric, with the number of researchers per million inhabitants growing from about 618 in 2010 to 912 in 2020.[17] As portrayed in Table 3.8, this growth can be attributed largely to the performance of East Asia, led by countries such as China, Japan and Korea. Southeast Asia and Oceania also contribute to the region's improvement, with Malaysia, New Zealand, Singapore and Thailand playing significant roles. However, the positive trend is not universally present across the region, with notable disparities still evident in Southeast Asia. For instance, Myanmar reported a paltry 19 researchers per million inhabitants in 2021, and according to the most recent data from 2015, Cambodia had only 30. South Asia presents its own unique set of challenges. Given the region's comparatively modest R&D expenditure, the pool of researchers is limited. Nonetheless, the situation in countries like Nepal has shown improvement, as the number of students enrolled in PhD programmes quadrupled from 2010 to 2021, reaching 1,613.[18] Similarly, Sri Lanka has seen growth more than double during the same period, reaching 4,754 PhD enrolments in 2021.[19]

A pressing issue for South Asia is the evident brain drain, which appears to be worsening. For example, a staggering 80 per cent or more of emigrants from Sri Lanka hold postgraduate qualifications. Likewise, Nepal saw a 68 per cent increase in outbound student mobility between 2012 and 2017 (UNESCO, 2021). Meanwhile, the broader context of gender parity in research roles presents significant variation across the region (Table 3.8). Mongolia leads the way with 73.45 per cent of researchers being women, while China has a meagre 16.6 per cent women researchers. Kazakhstan and Malaysia have achieved a near gender balance in research, with women researcher percentages at 50.18 per cent and 50.36 per cent, respectively. Given India's vast and diverse population, its representation of women researchers at 43.06 per cent is commendably strong.

Table 3.8. Researchers per million inhabitants and share of women researchers in Asia and the Pacific (2010–2021)
Presented in alphabetical order based on the names of the countries

Country	Researchers per million inhabitants	Share of female researchers	Year
Australia	4532	26.82%	2010
Cambodia	30	-	2015
China	1585	16.60%	2020
India	253	43.06%	2018
Indonesia	396	31.43%	2020
Iran (Islamic Republic of)	1659	-	2019
Japan	5455	-	2020
Kazakhstan	630	50.18%	2021
Malaysia	741	50.36%	2020
Mongolia	331	73.45%	2020
Myanmar	19	-	2021
New Zealand	5854	41.50%	2019
Pakistan	423	28.80%	2021
Papua New Guinea	35	52.99%	2016
Philippines	174	-	2018
Republic of Korea	8714	-	2020
Singapore	7287	42.28%	2019

17 UNESCO Institute for Statistics

18 Ibid.

19 Ibid.

Sri Lanka	106	42.54%	2018
Thailand	2070	32.38%	2020
Turkey	1775	39.80%	2020
Uzbekistan	523	44.45%	2021
Viet Nam	757	-	2019

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

Scientific publications in the region have increased steadily since 2003 (Qureshi et al., 2021). Countries such as China, Korea and Japan have historically demonstrated high levels of scientific production, comparable to those of leading nations worldwide. However, although these countries lead in absolute numbers, a different picture emerges when accounting for population size. According to Table 3.9, since 2011, Singapore has spearheaded scientific production, commencing with 2,637 publications per million inhabitants in 2011 and reaching 3,349 in 2019. In the Pacific region, Australia and New Zealand have consistently produced positive results. Australia's publication figures climbed from 2,525 in 2011 to 3,459 in 2019, while New Zealand saw an increase from 2,261 in 2011 to 2,791 in 2019. Indonesia, another South East Asian nation, exhibited remarkable growth in its publications, growing from 12 publications per million inhabitants in 2011 to 139 in 2019. Central Asia, meanwhile, is dominated by Kazakhstan's scientific output, which accounts for 65 per cent of the region's production. Although countries in this region have adopted policies to promote scientific publication, only Turkmenistan, which does not have a policy requiring scientists to publish in international journals, has experienced a downturn in productivity (UNESCO, 2021). Despite low levels of research investment, the volume of scientific publications in all countries has grown by more than 160 per cent between 2015 and 2019.

Table 3.9. Publications per million inhabitants in Asia and the Pacific
In descending order based on the value in 2019

Country	2011	2015	2019	Trend
Australia	2525	2996	3459	
Singapore	2637	3058	3349	
New Zealand	2261	2386	2791	
Niue	0	0	1859	
Korea, Rep.	1242	1411	1588	
Palau	394	962	1500	
Brunei Darussalam	300	793	1041	
Malaysia	576	740	944	
Japan	977	914	941	
Iran (Islamic Republic of)	469	526	730	
Cook Islands	440	398	513	
China	248	307	450	
Fiji	144	222	340	
Thailand	138	164	247	
Kazakhstan	31	92	202	

Tuvalu	0	90	172	
Mongolia	85	98	169	
Samoa	101	114	162	
Bhutan	66	100	156	
Tonga	97	109	144	
Indonesia	12	24	139	
Marshall Islands	88	87	136	
Kiribati	0	54	128	
India	64	84	118	
Viet Nam	24	44	113	
Vanuatu	95	125	107	
Micronesia	77	138	105	
Pakistan	44	57	100	
Sri Lanka	41	57	100	
Nauru	298	193	93	
Solomon Islands	41	73	70	
Maldives	42	51	68	
Nepal	26	35	58	
Kyrgyzstan	16	20	49	
Lao PDR	22	31	42	
Bangladesh	15	21	39	
Philippines	13	20	38	
Uzbekistan	19	14	34	
Timor-Leste	5	18	32	
Papua New Guinea	15	19	29	
Cambodia	12	19	27	
Tajikistan	9	12	21	
Myanmar	3	4	12	
Korea, DPR	1	3	9	
Afghanistan	2	2	7	
Turkmenistan	6	4	2	

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO (2021)

3.4 Europe and North America

The Europe and North America region includes a number of countries with a robust history of scientific research, such as such as France, Germany, Israel and the United States, all of which play host to some of the world's most acclaimed research institutions and universities. These nations all have substantial levels of R&D spending (Table 3.10), with the private sector playing a pivotal role. The national innovation system in the United States accounts for the greatest proportion of R&D; however, according to the *UNESCO Science Report (UNESCO, 2021)*, the country's share of global research expenditure has reduced in contrast to countries in other regions such as China, the Republic of Korea and India (UNESCO, 2021). The European Union, between 2011 and 2021, increased its research intensity from 2.02 per cent to 2.31 per cent (OECD, 2023a), improvements explained by the economic structure of its component countries as well as regional policy on STI. Horizon 2020, the former EU framework programme for research and innovation, made funding of nearly €80 billion available over the seven years leading up to 2020.[20] The current Horizon Europe programme has a budget of €95.5 billion running until 2027.[21] In spite of this positive regional performance, R&D expenditure is lower in some regional countries outside the European Union. For example, Bosnia and Herzegovina, North Macedonia and Serbia all set a target of allocating 1 per cent of GDP to R&D by 2015–2016 (UNESCO, 2021), but only Serbia came close to achieving this goal.

Table 3.10. GERD as a percentage of GDP in Europe and North America (2010–2021)
In descending order based on the most recent value

Country	Most recent value	Year
Israel	5.36%	2020
Sweden	3.49%	2020
Belgium	3.46%	2020
United States of America	3.42%	2020
Switzerland	3.19%	2019
Austria	3.19%	2020
Germany	3.11%	2020
Denmark	2.97%	2020
Finland	2.91%	2020
Iceland	2.47%	2020
France	2.35%	2020
Netherlands	2.31%	2020
Norway	2.28%	2020
Slovenia	2.14%	2020
Czechia	1.99%	2020
Estonia	1.75%	2020
United Kingdom of Great Britain and Northern Ireland	1.72%	2019
Canada	1.70%	2020
Portugal	1.61%	2020
Hungary	1.59%	2020
Italy	1.53%	2020

Greece	1.50%	2020
Spain	1.41%	2020
Poland	1.39%	2020
Croatia	1.24%	2020
Ireland	1.23%	2020
Lithuania	1.15%	2020
Luxembourg	1.12%	2020
Russian Federation	1.09%	2020
Serbia	0.99%	2021
Slovakia	0.90%	2020
Bulgaria	0.85%	2020
Cyprus	0.81%	2020
Latvia	0.69%	2020
Belarus	0.47%	2021
Romania	0.47%	2020
North Macedonia	0.38%	2021
Montenegro	0.36%	2019
Ukraine	0.29%	2021
Georgia	0.25%	2021
Republic of Moldova	0.23%	2021
Azerbaijan	0.21%	2021
Armenia	0.21%	2021
Bosnia and Herzegovina	0.19%	2021

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

Europe and North America continue to play a crucial role as global hotspots for researchers. According to the number of full-time equivalent researchers, the United States is the largest contributing country, with approximately 1.4 million researchers in 2019.[22] However, when considering the density of researchers in relation to population size (Table3.11), nations such as Denmark, Finland and Iceland have taken the lead in this area. Other countries in Europe, like the Netherlands and Poland, have experienced significant growth. The Netherlands has consistently displayed an upward trend in researchers per million inhabitants, starting with 3,219 in 2010 and escalating to 5,912 by 2020. Similarly, Poland began 2010 with 1,683 researchers per million inhabitants and experienced consistent growth, concluding 2020 with 3,288 researchers. While, traditionally, countries in south-eastern Europe have lagged behind those in the European Union, the continual growth trajectory of Serbia, peaking at 2,167 in 2021, highlights its developing role in the regional research ecosystem.

Table 3.11 also demonstrates the varying representation of women researchers across the region. North Macedonia stands out with a share of 58.12 per cent, the highest among the listed

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nations, followed closely by Azerbaijan at 56.85 per cent. In contrast, the situation in some EU countries is less promising. Germany, with only 22.73 per cent of women researchers, offers one of the most concerning statistics. This is closely mirrored by Austria and Czechia, with 23.84 per cent and 24.13 per cent, respectively, indicating a pronounced gender disparity in these nations. Meanwhile, countries such as Bosnia and Herzegovina, Montenegro and the Republic of Moldova hover around the halfway mark, suggesting a more balanced gender representation.

Table 3.11. Researchers per million inhabitants and share of women researchers in Europe and North America (2010–2021)

Presented in alphabetical order based on the names of the countries

Country	Researchers per million inhabitants	Share of female researchers	Year
Austria	5751	23.84%	2020
Azerbaijan	1741	56.85%	2021
Belarus	1418	39.43%	2021
Belgium	5750	31.73%	2020
Bosnia and Herzegovina	447	50.02%	2021
Bulgaria	2402	44.98%	2020
Canada	4516	-	2018
Croatia	2220	48.04%	2020
Cyprus	1691	36.71%	2020
Czechia	4128	24.13%	2020
Denmark	7692	34.07%	2020
Estonia	3846	40.72%	2020
Finland	7527	-	2020
France	4926	28.55%	2020
Georgia	1624	52.54%	2021
Germany	5393	22.73%	2020
Greece	4010	39.57%	2020
Hungary	4358	26.81%	2020
Iceland	6088	35.96%	2018
Ireland	4769	36.52%	2020
Italy	2672	34.50%	2020
Latvia	2159	48.82%	2020
Lithuania	3728	44.86%	2020
Luxembourg	4920	26.84%	2020
Montenegro	747	51.39%	2019
Netherlands	5912	25.17%	2020
North Macedonia	753	58.12%	2021

Norway	6699	-	2020
Poland	3288	35.44%	2020
Portugal	5215	41.96%	2020
Republic of Moldova	788	50.83%	2021
Romania	953	46.28%	2020
Russian Federation	2722	-	2020
Serbia	2231	52.47%	2021
Slovakia	3164	39.75%	2020
Slovenia	4932	32.30%	2020
Spain	3109	39.85%	2020
Sweden	7930	29.79%	2020
Switzerland	5552	-	2019
Ukraine	587	47.27%	2021
United Kingdom of Great Britain and Northern Ireland	4684	-	2019
United States of America	4821	-	2019

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

According to Table 3.12, between 2011 and 2019, North America displayed steady growth in scientific publications, with Canada seeing a rise from 2,158 to 2,528. Meanwhile, Europe presented mixed results. Northern Europe's standout was Iceland, with a jump from 3,169 to 4,595 publications. Southeast Europe's Bulgaria also impressed, moving from 474 to 740, whereas Serbia showed modest growth, from 651 to 777. Western Europe's powerhouse, Germany, maintained a consistent rise, whereas France experienced a slight decline from 1,436 in 2011 to 1,487 in 2019.

Table 3.12. Publications per million inhabitants in Europe and North America
In descending order based on the value in 2019

Country	2011	2015	2019	Trend
Switzerland	4082	4557	4823	
Iceland	3169	3825	4595	
Denmark	2979	3844	4332	
Norway	2730	3072	3715	
Sweden	2851	3352	3690	
Finland	2615	2969	3244	
Netherlands	2453	2701	3009	
Luxembourg	1937	2599	2920	
Ireland	2169	2194	2645	
Austria	2089	2383	2576	

Canada	2158	2293	2528	
Belgium	2147	2404	2512	
Slovenia	2220	2348	2478	
United Kingdom	1931	2137	2354	
Portugal	1486	1939	2311	
Liechtenstein	2231	2376	2236	
Estonia	1439	1783	2231	
Israel	1971	2055	2192	
Cyprus	1037	1329	2073	
Czech Republic	1556	1973	2031	
Germany	1629	1763	1824	
Spain	1386	1539	1740	
Italy	1288	1517	1711	
Greece	1398	1449	1632	
United States of America	1509	1547	1619	
Malta	658	1202	1605	
France	1436	1510	1487	
Croatia	1236	1233	1405	
Slovakia	917	1157	1252	
Lithuania	859	974	1193	
Poland	795	1031	1156	
Latvia	723	922	1057	
Hungary	875	936	1040	
Serbia	651	707	777	
Montenegro	369	522	748	
Bulgaria	474	509	740	
Romania	569	652	710	
Russian Federation	297	415	661	
Turkey	400	462	518	
Armenia	329	340	416	
North Macedonia	290	366	364	
Bosnia & Herzegovina	206	249	351	
Ukraine	177	209	310	
Georgia	211	233	294	
Belarus	178	178	241	

Azerbaijan	95	76	130	
Albania	73	103	127	
Republic of Moldova	84	90	114	

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO (2021)

3.5 Latin America and the Caribbean

The landscape of R&D intensity is variable in Latin America and the Caribbean. Since 2015, the region's research intensity has remained relatively stagnant. Brazil stands out as a consistently leader, investing over 1 per cent of its GDP in R&D, although the country has experienced a recent decline in research intensity like other countries in the region, such as Chile, Colombia, Costa Rica and Mexico. Conversely, other countries such as El Salvador, Guatemala, Paraguay and Uruguay have witnessed increases.

The region's R&D is primarily funded by the government (58 per cent) and is predominantly carried out by universities (41 per cent) (UNESCO, 2021). However, this government investment is insufficient to significantly boost industrial research. Existing disparities in R&D investments across countries highlight the potential for growth and the need for increased investment to fully leverage innovation for the region's economic and social advancement. Despite the efforts of the Ibero-American and Inter-American Network for Science and Technology Indicators (RICYT) in supporting statistical production over more than 25 years, several countries, including Bolivia, Ecuador, Nicaragua and most Caribbean nations, still lack regular data – a trend indicating that STI development might not be a priority for some governments (ibid.).

Table 3.13. GERD as a percentage of GDP in Latin America and the Caribbean (2010–2021)
In descending order based on the most recent value

Country	Most recent value	Year
Brazil	1.17%	2020
Argentina	0.53%	2020
Cuba	0.52%	2020
Uruguay	0.45%	2020
Ecuador	0.44%	2014
Costa Rica	0.37%	2018
Chile	0.34%	2019
Venezuela (Bolivarian Republic of)	0.34%	2014
Mexico	0.30%	2020
Colombia	0.29%	2020
Bermuda	0.23%	2020
Peru	0.17%	2020
El Salvador	0.17%	2020
Panama	0.17%	2021
Paraguay	0.16%	2020
Nicaragua	0.11%	2015

Trinidad and Tobago	0.06%	2020
Guatemala	0.06%	2021
Honduras	0.06%	2019

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: UNESCO Institute for Statistics

While there has been a general upward trend in the number of researchers in Latin America and the Caribbean over recent years, disparities among countries are still evident, as seen in Table 3.14. Argentina is a noteworthy case with 1,237 researchers per million inhabitants recorded in 2020. This nation has seen a rise in researchers since 2010, in contrast with R&D intensity indicators (Table 3.13) where the trend has been less positive. The case of Guatemala, which had only 14 researchers per million inhabitants in 2021, highlights the challenges faced by smaller countries in developing a substantial pool of researchers. A major factor influencing the density of researchers in the region is the increase in the number of PhD students since 2015. For instance, countries such as Colombia have experienced significant growth, starting in 2010 with 0.1 PhD students per thousand of the population aged between 25 and 64, and ending 2021 with 0.744 students per the same demographic. Similarly, Mexico started 2010 with 0.39 PhD students per thousand of the population in the same age bracket and finished 2020 with 0.79 students.[23] Another aspect of interest is the representation of women in research. As shown in Table 3.14, several nations in the region, including Guatemala (58.27 per cent) and Argentina (52.89 per cent), have commendable levels of women participation, reflecting wider efforts to achieve gender parity in professional fields. However, there is clearly room for improvement in countries such as Chile, where representation of women stands at just 35.07 per cent, indicating a need to address gender inclusivity within the realm of research.

Table 3.14. Researchers per million inhabitants and share of women researchers in Latin America and the Caribbean (2010–2021)

In alphabetical order based on the names of the countries

Country	Researchers per million inhabitants	Share of female researchers	Year
Argentina	1237	52.89%	2020
Bolivia (Plurinational State of)	164	-	2010
Brazil	888	-	2014
Chile	510	35.07%	2019
Colombia	88	37.65%	2017
Costa Rica	345	44.58%	2018
Ecuador	399	41.27%	2014
El Salvador	73	36.52%	2019
Guatemala	14	58.27%	2021
Honduras	190	49.76%	2019
Mexico	349	-	2020
Panama	39	49.33%	2013
Paraguay	130	50.65%	2020

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Trinidad and Tobago	639	50.34%	2020
Uruguay	795	50.22%	2021
Venezuela (Bolivarian Republic of)	291	56.09%	2020

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

According to the *UNESCO Science Report (UNESCO, 2021)*, from 2015 to 2019, the number of scientific outputs in leading scientific journals saw a surge of 25 per cent, culminating in 135,000 publications by 2019. Brazil emerged as the predominant contributor, accounting for nearly half of these publications. However, the most significant growth was observed in Ecuador at 171 per cent, trailed by the Dominican Republic (98 per cent), Honduras (97 per cent) and Peru (85 per cent). While Brazil's leadership in sheer numbers is apparent, Table 3.15 depicts a contrasting narrative. Here, nations such as Chile and Uruguay lead in South America concerning publications per million inhabitants. Some Caribbean Community (CARICOM) countries exhibit a dense publication ratio in relation to their population. This suggests that the influx of universities over the past four decades is slowly fostering a research culture in these smaller states with modest populations. Additionally, these nations consistently feature international authors in their publications over 67 per cent of the time. In particular instances like Grenada, this figure can escalate to 95.3 per cent (UNESCO, 2021).

Table 3.15. Publications per million inhabitants in Latin America and the Caribbean
In descending order based on the value in 2019

Country	2011	2015	2019	Trend
St Kitts & Nevis	222	1133	1931	
Grenada	674	958	1857	
Chile	375	506	633	
Uruguay	281	341	465	
Barbados	254	294	394	
Dominica	282	464	362	
Brazil	249	298	352	
Argentina	243	255	274	
Trinidad & Tobago	239	181	242	
Colombia	107	155	222	
Ecuador	28	85	215	
Costa Rica	118	149	209	
Bahamas	81	104	203	
Antigua & Barbuda	45	75	196	
Mexico	132	150	184	

Panama	95	120	171	
St Vincent & Grenadines	9	27	163	
Cuba	179	163	143	
Jamaica	94	84	114	
Belize	42	80	100	
Suriname	22	55	98	
Peru	37	56	96	
St Lucia	40	84	66	
Guyana	21	39	54	
Paraguay	16	29	48	
Venezuela	60	48	38	
Bolivia	21	25	29	
Dominican Republic	7	11	22	
Honduras	8	10	19	
Nicaragua	14	15	18	
Guatemala	8	14	15	
El Salvador	7	12	11	
Haiti	6	9	9	

Note: The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value. The bars are not comparable between columns.

Source: UNESCO Institute for Statistics

4. The global landscape of STI policy instruments: Insights and trends

In the realm of policy-making, particularly in science, technology and innovation (STI), the importance of solid, evidence-based decision-making processes cannot be overstated. Only by meticulously gathering and carefully analyzing data can the design process for new policies be properly informed, ensuring that they are truly responsive, efficient, and effective. The use of comprehensive databases presents qualitative and quantitative data on national policies and instruments in STI policy, and plays a crucial role in this context (see Box 4.1).

Box 4.1. Examples of international databases on STI policies

UNESCO Global Observatory of Science, Technology and Innovation Policy Instruments (GO-SPIN)

The GO-SPIN platform is pivotal to UNESCO's STI policy work. The platform enhances connections with Member States, offers resources for capacity-building and enables benchmarking in support of policy-making. In addition, GO-SPIN functions as a comprehensive repository of global STI information, with a focus on developing countries, particularly Africa and Least Developed Countries (LDCs). Moreover, the platform monitors the impacts of UNESCO's normative efforts on key legislative and policy instruments, as well as other relevant legislative and regulatory tools.

Information on the GO-SPIN platform is compiled and aggregated through the GO-SPIN methodology, which assesses each policy instrument using standardized analysis fields. The online platform includes over 1,200 examples of instruments implemented worldwide, particularly in developing countries. Each policy instrument is linked to corresponding Sustainable Development Goals (SDGs) targets, which enhances its relevance and impact.

Access to UNESCO GO-SPIN: https://gospin.unesco.org

GO SPIN FOR SCIENCE POLICY
Global Observatory of Science, Technology and Innovation Policy Instruments

EC-OECD Science, Technology and Innovation Policy (STIP) Compass

The Science, Technology and Innovation Policy (STIP) Compass is the product of a collaboration between the European Commission and the Organisation for Economic Co-operation and Development (OECD) which makes available qualitative and quantitative data on national STI policy trends on a single platform. The portal is designed to be a central hub for policy research and advice, aiding government officials, analysts and scholars in monitoring and analysing STI policies. The STIP Compass sources its data primarily from national responses to the EC-OECD STI Policy survey, conducted biennially, supplemented by other open data sources including statistics and scholarly publications.

The platform offers over 700 interactive dashboards, advanced search functions and intelligent filtering for exploring and comparing STI policies across various themes. The data are presented in a machine-readable format for ease of analysis and reusability, thereby supporting evidence-based policy-making. However, users should exercise caution due to the self-reported nature of the information. In particular, variations in detail and completeness among countries' reports may affect cross-country comparisons and the interpretation of data implications on policy efficiency and focus.

Access to STIP Compass: https://stip.oecd.org/stip

STIP COMPASS

Source: UNESCO GO-SPIN platform[24]; EC-OECD (2020)

24 https://gospin.unesco.org

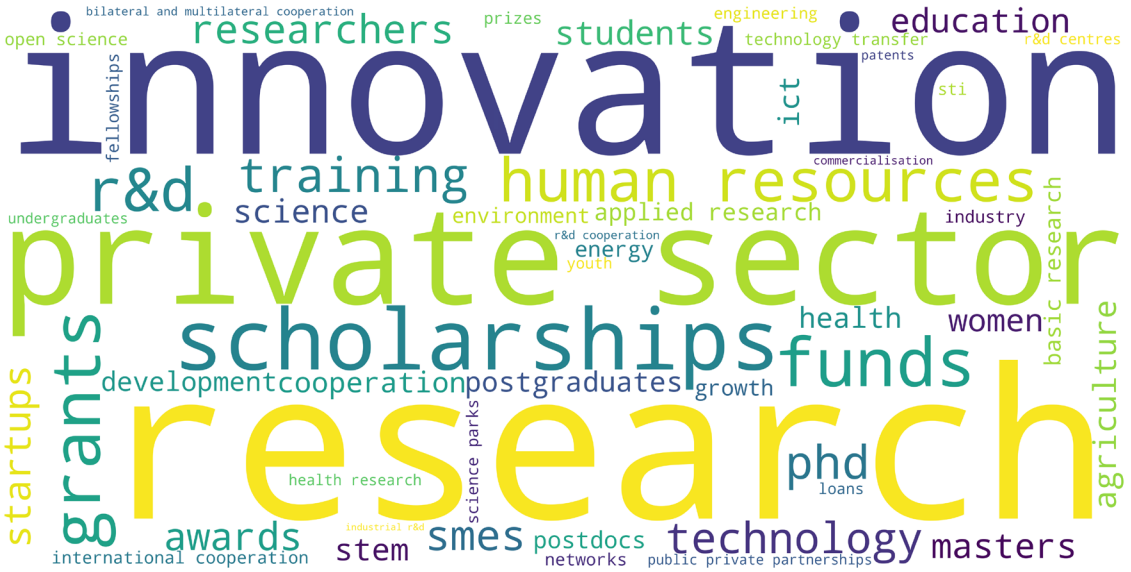
This chapter offers an in-depth exploration of policy instruments catalogued by UNESCO GO-SPIN. It presents a comprehensive outlook, region by region, effectively illustrating the diverse components that constitute the global STI policy landscape. At the heart of this analysis are short case studies from a variety of countries. Each case serves as a distinct narrative, shedding light on the unique objectives, implementation strategies and outcomes of pivotal STI policy instruments. Through this approach, the chapter seeks to equip decision-makers with insights essential for navigating the path toward sustainable development via informed STI strategies.

This exploratory approach, however, acknowledges the inherent limitations of the snapshot provided by GO-SPIN resources (see methodology in the Annex), which is limited by the specific time frame of the data collection process and the non-exhaustive nature of the compilation of existing instruments. The scope and depth of the information are contingent upon the extent of the details furnished by individual governments and the data gathered through UNESCO's dedicated efforts in support of STI policy. These factors underscore the necessity for continual updates and dynamic engagement with the database to capture the evolving nature of global STI policy instruments.

Prominent themes and beneficiary groups in science, technology and innovation policy instruments at a global level

In the global landscape of STI policy instruments, as available in UNESCO GO-SPIN platform, certain keywords emerge with pronounced frequency, underscoring their significance on the global stage. The word cloud shown in Figure 4.1 illustrates the prevalence of these keywords across various policy instruments worldwide. Not surprisingly, terms such as 'innovation' and 'research' are among the most prevalent, taking into consideration the policy field. However, the prominence of 'private sector' underlines the imperative to foster business engagement in STI efforts. Similarly, the terms 'scholarships' and 'human resources' reflect the focus on education and skills development across the world. Conversely, terms of lesser prominence, often related to cooperation or sustainability sectors such as energy and the environment, signal areas that may not be an explicit focus of policy instruments and which require more attention.

Figure 4.1. Word cloud of keywords in policy instruments worldwide



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

The visual presentation shown in Figure 4.1 gains additional relevance when juxtaposed with the regional analyses presented in upcoming sections. Each of these word clouds highlights terms based on their regional versus global frequency. These figures elucidate disparities in emphasis across regions serving as a clear indicator of the distinct approaches adopted in tackling their specific challenges and objectives.

Figure 4.2 presents the network graphs that highlight the most prominent beneficiary categories targeted by countries within a region through their policy instruments. This graph specifically focuses on the strongest connections, representing the top quartile of relationships based on the number of countries within the region that support the connected beneficiaries in their policy mix. This means that only connections with the highest level of support are included for clarity and relevance (for more detailed information, refer to the methodology in the Annex). The social network of STI policy instruments' beneficiaries exposes trends in the national policy mix of different regions, thereby revealing the complex and interconnected ways in which these instruments target various groups.

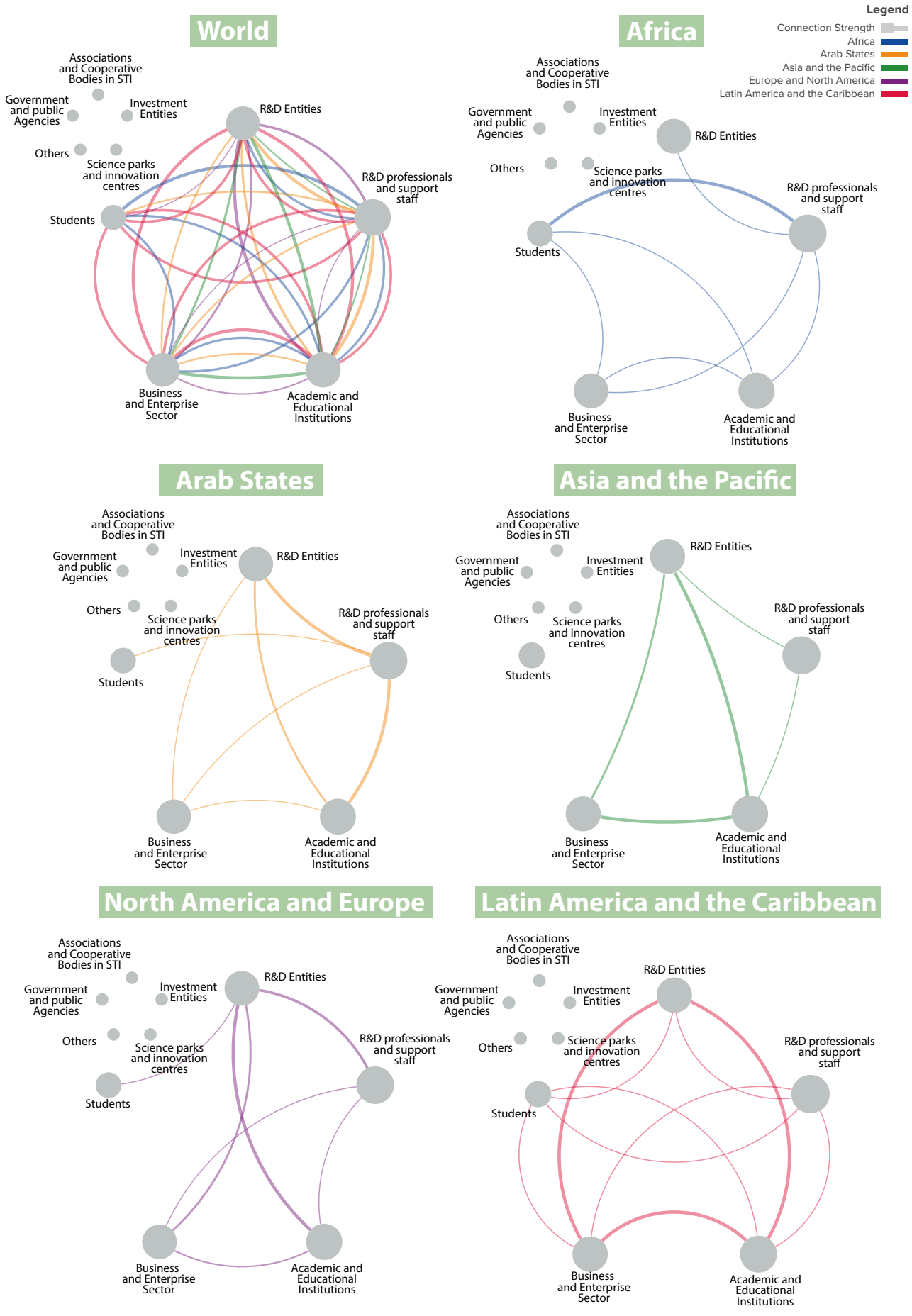
The central nodes in the network, identified by their high level of connectivity, represent the most frequently targeted beneficiary categories of STI policy instruments, with the size of each node indicating its prevalence. The most connected node is 'R&D professionals and support staff', signifying that this category is the primary target across multiple regions. The strength assigned to the connections (as indicated by the line thickness in the figures) indicates the intensity of the relationships, here reflecting the number of countries within the same region with instruments targeting each beneficiary category.

For instance, Figure 4.2 shows that in Africa, all countries include instruments in their policy mix to support both 'Students' and 'R&D professionals and support staff'. Similarly, all Arab States target in their policy mix 'R&D professionals and support staff', 'R&D Entities' and 'Academic and Educational Institutions'. The graph also reveals that in Latin America and the Caribbean, most countries focus on beneficiaries to a similar degree, as shown by the connections strength. However, there is a slight preference for supporting 'R&D Entities', 'Academic and Educational Institutions', and the 'Business and Enterprise sector' show a slight predominance. In the Asia Pacific region, support for these same beneficiaries is strong, but Figure 4.2 also indicates a weaker connection between 'R&D Entities' and the 'Business and Enterprise sector', suggesting that some countries do not include both of these two beneficiary groups in their policy mix simultaneously.

Additionally, Figure 4.2 clearly illustrates a number of beneficiary groups as disconnected, signifying that these are groups not commonly targeted by countries, according to the policy instruments available on the GO-SPIN platform. This might indicate either a lack of policy focus on these groups or a divergence in policy strategies not captured in the database.

Overall, the network map highlights the prevalence of complementary policy instruments aimed at various beneficiaries, suggesting a shared recognition of their critical role in promoting STI activities. It also underscores the potential of such analysis to uncover potential gaps and opportunities in STI policy frameworks.

Figure 4.2. Network analysis of beneficiary categories by Region



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Mapping science and technology policy instruments to sustainable development goals and recommendations for science and researchers

It is widely acknowledged that STI plays a critical role in economic growth and the advancement of progress towards the Sustainable Development Goals (SDGs). However, this contribution requires guidance, as STI should not be perceived as either inherently neutral or universally beneficial (Kranzberg, 1986; Verbeek, 2011; Crivits et al., 2014). Many STI policy instruments adopt a generalist strategy, operating under the presumption that research and innovation efforts will naturally balance out and effectively address critical areas of need. This often results in a broad focus. In contrast, orienting policy instruments toward specific SDGs requires a more targeted and complementary strategy. Table 4.1 illustrates this tendency among the policy instruments compiled on the GO-SPIN platform.

Table 4.1. Linkages between STI policy instruments and the SDGs

Region	Indicator	SDG 1: No Poverty	SDG 2: Zero Hunger	SDG 3: Good Health and Well-being	SDG 4: Quality Education	SDG 5: Gender Equality	SDG 6: Clean Water and Sanitation	SDG 7: Affordable and Clean Energy	SDG 8: Decent Work and Economic Growth	SDG 9: Industry, Innovation and Infrastructure
Africa	Share of region's policy instruments	6.95%	9.27%	4.30%	23.51%	6.62%	0.99%	1.32%	32.12%	65.89%
	Number of policy instruments	21	28	13	71	20	3	4	97	199
Arab States	Share of region's policy instruments	-	2.35%	3.14%	8.24%	0.78%	2.35%	2.35%	32.16%	78.82%
	Number of policy instruments	-	6	8	21	2	6	6	82	201
Asia and the Pacific	Share of region's policy instruments	1.44%	0.72%	3.60%	8.63%	11.51%	1.44%	4.32%	30.22%	83.45%
	Number of policy instruments	2	1	5	12	16	2	6	42	116
Latin America and the Caribbean	Share of region's policy instruments	1.26%	2.52%	2.16%	13.49%	1.98%	1.26%	1.62%	28.42%	77.16%
	Number of policy instruments	7	14	12	75	11	7	9	158	429
North America and Europe	Share of region's policy instruments	-	1.69%	1.12%	3.93%	17.42%	-	3.37%	11.24%	82.02%
	Number of policy instruments	-	3	2	7	31	-	6	20	146
Total	**Share of total policy instruments**	**2.10%**	**3.64%**	**2.80%**	**13.01%**	**5.59%**	**1.26%**	**2.17%**	**27.90%**	**76.29%**
	Number of policy instruments	**30**	**52**	**40**	**186**	**80**	**18**	**31**	**399**	**1 091**

Region	Indicator	SDG 10: Reduced Inequality	SDG 11: Sustainable Cities and Communities	SDG 12: Responsible Consumption and Production	SDG 13: Climate Action	SDG 14: Life Below Water	SDG 15: Life on Land	SDG 16: Peace, Justice and Strong Institutions	SDG 17: Partnerships for the Goals
Africa	Share of region's policy instruments	0.99%	0.99%	1.99%	0.66%	0.66%	2.65%	-	8.61%
	Number of policy instruments	3	3	6	2	2	8	-	26
Arab States	Share of region's policy instruments	-	1.18%	-	-	0.78%	2.75%	-	15.69%
	Number of policy instruments	-	3	-	-	2	7	-	40
Asia and the Pacific	Share of region's policy instruments	-	0.72%	-	1.44%	-	0.72%	0.72%	7.19%
	Number of policy instruments	-	1	-	2	-	1	1	10
Latin America and the Caribbean	Share of region's policy instruments	1.26%	0.54%	0.54%	0.54%	1.80%	1.62%	0.18%	8.09%
	Number of policy instruments	7	3	3	3	10	9	1	45
North America and Europe	Share of region's policy instruments	0.56%	-	-	1.12%	-	0.56%	0.56%	8.99%
	Number of policy instruments	1	-	-	2	-	1	1	16
Total	**Share of total policy instruments**	**0.77%**	**0.70%**	**0.63%**	**0.63%**	**0.98%**	**1.82%**	**0.21%**	**9.58%**
	Number of policy instruments	**11**	**10**	**9**	**9**	**14**	**26**	**3**	**137**

Note: A single policy instrument can target multiple SDGs.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

As the data in Table 4.1 show, the majority of policy instruments are geared toward SDG 9 (Industry, innovation and infrastructure), due primarily to the explicit emphasis on innovation. There are also substantial efforts directed toward SDG 8 (Decent work and economic growth), owing to the widely recognized link between innovation and economic growth. There is a similar emphasis on SDG 4 (Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), reflecting the strong human development component seen in STI policy instruments. In the healthcare or energy sectors, for example, instruments supporting science-based solutions can contribute and positively influence SDG 3 (Good health and well-being), SDG 7 (Affordable and clean energy) and SDG 13 (Climate action). Moreover, integrating STI policy instruments across various sectors can create synergies, fostering progress toward achieving multiple SDGs simultaneously.

Despite these trends, the data show that STI policy instruments could be used more widely to explicitly steer STI activities toward achieving the broader SDGs. Challenge-driven research and innovation funds, which could serve as effective vehicles for addressing specific goals, are not extensively utilized yet, largely because of their complex design and implementation processes. Moreover, a distinct challenge faced by some countries, especially those in the developing and least developed categories, is prioritizing action areas within the STI policy scope. In the realm of international cooperation and regarding SDG 17 (Partnerships for the Goals), the role of STI policy instruments in fostering partnerships for the SDGs is highlighted through various international scholarship programmes. Approximately 42 per cent of the instruments contributing to SDG 17 in GO-SPIN are scholarships. These programmes serve not just as educational initiatives but as channels for international cooperation, embodied within comprehensive educational and diplomatic frameworks.

The Recommendation on Science and Scientific Researchers (UNESCO, 2017a) is a UNESCO instrument that establishes a global standard framework designed to support and enhance policies and practices in science and scientific research. It emphasizes ethical, inclusive, responsible and equitable practices within the scientific community, advocating for universal scientific principles and the rights and responsibilities of researchers. To ensure effective monitoring of the implementation of this Recommendation, UNESCO Member States agreed on ten key areas that constitute the essence of the Recommendation. Through GO-SPIN, UNESCO tracks policy instruments contributing to each of these areas. Table 4.2 describes the relationship between the Recommendation's ten key areas and various STI policy instruments. The table highlights global support according to the number of policy instruments for 'the vital importance of human capital for a sound and responsible science system'. This support is implemented through initiatives like scholarships and research grants with human development components such as post-docs allocations. Furthermore, Table 4.2 highlights 'the role of Member States in creating an enabling environment for science and research', demonstrated by actions such as technical and business assistance programmes. Additionally, the table identifies areas in need of improvement due to the low number of policy instruments associated to them. For instance, stronger commitment is needed for 'scientific integrity and ethical codes of conduct for science and research and their technical applications', which as of September 2023 have no associated instruments recorded in the GO-SPIN database. Similarly additional initiatives are needed that contribute to 'Balancing the freedoms, rights and responsibilities of researchers'. Realizing these commitments could be achieved through initiatives like the European Charter for Researchers, which is a set of good practice for researchers and employers alike. There is also an appeal for 'Promoting science as a common good', which can be advanced by embracing open science policies. These strategies facilitate more inclusive, transparent and accessible scientific exploration, benefiting society at large.

Table 4.2. Linkages between STI policy instruments and the Recommendation on Science and Scientific Researchers

Region	Indicator	1. Science for UN Ideals	2. Science and society	3. Research and informing policy	4. Science as a common good	5. Inclusivity and non-discrimination
Africa	Share of region's policy instruments	8.74%	53.50%	2.80%	-	12.59%
	Number of policy instruments	25	153	8	-	36
Arab States	Share of region's policy instruments	6.30%	51.68%	0.42%	1.26%	0.84%
	Number of policy instruments	15	123	1	3	2
Asia and the Pacific	Share of region's policy instruments	4.90%	42.16%	0.98%	2.94%	16.67%
	Number of policy instruments	5	43	1	3	17
Latin America and the Caribbean	Share of region's policy instruments	3.42%	44.99%	0.98%	0.73%	2.69%
	Number of policy instruments	14	184	4	3	11
North America and Europe	Share of region's policy instruments	4.51%	45.11%	2.26%	4.51%	24.06%
	Number of policy instruments	6	60	3	6	32
Total	**Share of total policy instruments**	**5.57%**	**48.20%**	**1.46%**	**1.28%**	**8.39%**
	Number of policy instruments	**65**	**563**	**17**	**15**	**98**

Region	Indicator	6. Human rights standards	7. Scientific freedom and responsibility	8. Scientific integrity and ethics	9. Human capital	10. Enabling environment
Africa	Share of region's policy instruments	1.75%	1.75%	-	63.99%	57.34%
	Number of policy instruments	5	5	-	183	164
Arab States	Share of region's policy instruments	-	-	-	53.36%	55.88%
	Number of policy instruments	-	-	-	127	133
Asia and the Pacific	Share of region's policy instruments	1.96%	1.96%	-	52.94%	48.04%
	Number of policy instruments	2	2	-	54	49
Latin America and the Caribbean	Share of region's policy instruments	0.73%	0.73%	-	54.03%	46.70%
	Number of policy instruments	3	3	-	221	191
North America and Europe	Share of region's policy instruments	0.75%	0.75%	-	39.85%	34.59%
	Number of policy instruments	1	1	-	53	46
Total	**Share of total policy instruments**	**0.94%**	**0.94%**	**-**	**54.62%**	**49.91%**
	Number of policy instruments	**11**	**11**	**-**	**638**	**583**

Note: A single policy instrument can target multiple key areas of the Recommendation.

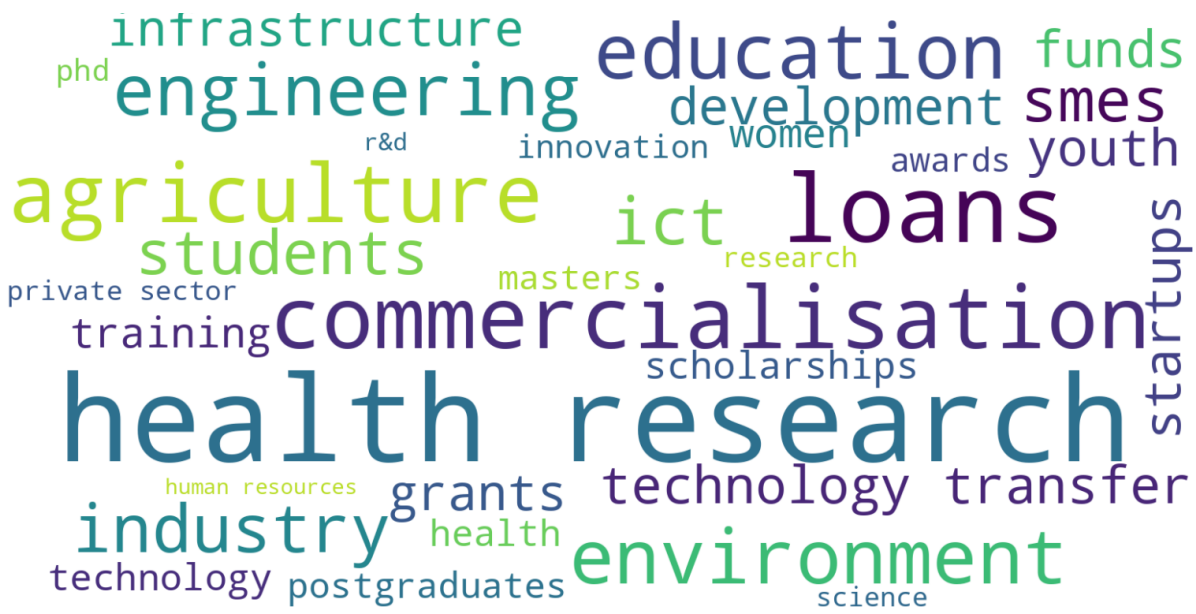
Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

4.1 Africa

The landscape of STI policy in Africa has undergone significant evolution over recent decades. Presently, according to data from the *UNESCO Science Report (UNESCO, 2021)*, the majority of countries have at least one governmental body explicitly charged with overseeing STI, reflecting a growing trend towards the formulation of distinct STI policies and recognizing the integral role of STI within broader sectoral strategies (UNESCO, 2021). This shift mirrors the directives set forth in the *Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) (African Union, 2014)*, which emphasizes the necessity for robust governance structures and comprehensive policy frameworks. Effective implementation of these frameworks is paramount, necessitating not only strategic design but also the establishment of transparent procedures, accountability mechanisms and systems for evaluating the performance of STI initiatives (Africa Union, 2014). Since the inception of GO-SPIN in 2011, the platform has gathered information of approximately 387 policy instruments from African countries, and supported capacity development to strengthen these STI policy frameworks.

The word cloud presented in Figure 4.3 illustrates the most relevant keywords derived from African policy instruments, according to their frequency relative to global trends. This approach helps to identify distinct regional tendencies without overshadowing them with keywords that have consistent significance across all regions. This comparative analysis highlights the importance of specific themes, notably health research in Africa. The prominence of this sector is further corroborated by the substantial volume of scientific publications related to health. Agriculture represents a parallel trend, attributable to the sector's important role in the economy. An emerging focus on commercialization signals a growing ambition to enhance the value of natural resources and support a path from innovation to market. This progression is facilitated by incubation programmes, such as Zimbabwe's Technology Incubation Programme, and institutional backing from entities like the Kenyan Innovation Agency. Additionally, events such as Nigeria's Techno Expo bridge various segments of the value chain and promote access to markets.

Figure 4.3. Word cloud of keywords in policy instruments from Africa



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

According to Table 4.3, approximately 70 per cent of policy instruments in Africa obtain their financial support from governmental allocations. These resources are often insufficient, however, as discussed in section 3.1, and a large proportion of available funds are used towards administrative overheads, often at the expense of actual STI activities. This financial bottleneck stifles the growth potential of STI projects and calls for novel funding alternatives.

Table 4.3. Funding sources used by STI policy instruments in Africa

Funding sources	Share of policy instruments
Government sector	70.16%
Rest of the world government sector	20.00%
Rest of the world international organizations	10.16%
Higher education sector	5.40%
Business enterprise sector	4.76%
Rest of the world private non-profit sector	4.44%
Private non-profit sector	2.86%
Rest of the world business	0.32%
Rest of the world higher education sector	0.32%

Note: A single policy instrument can use multiple funding sources.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based data from the UNESCO GO-SPIN platform

One example of such alternative funding arrangements is the Grant Scheme initiated by Ghana's Council for Scientific and Industrial Research (CSIR) (see Box 4.2). This scheme reallocates a segment of the administrative overhead costs into high potential R&D initiatives. In essence, the grant scheme acts as a gateway to larger grants and positive impact. While the model used by the CSIR Grant Scheme demonstrates potential, it faces a number of challenges, since some donors are reluctant to finance institutional overheads, therefore reducing the size of funds available to the scheme. Additionally, the scheme, as well as other home-grown initiatives, would benefit from extending the operational formalism with manuals and guidelines that could mitigate procedural uncertainties. Such increased formalism, together with the impact of reallocated overhead costs, could strengthen donor confidence in such initiatives mobilizing direct support to the scheme or even building a case for including overhead costs in donations.

Box 4.2. Grant Scheme of the Council for Scientific and Industrial Research of Ghana

National context and challenge targeted

In Ghana, the Council for Scientific and Industrial Research (CSIR) is entrusted with the task of carrying out scientific and technological research to strengthen national development. Operating through a network of 13 research institutions distributed nationwide, CSIR focuses its research on fields that enhance the livelihoods of Ghanaians. However, the available funding for R&D is limited in Ghana, with government allocations from the state budget barely covering the administrative costs of R&D institutions, which are mainly dedicated to salaries. Meanwhile, direct donor funding is inconsistent and often channelled to specific domains. In recognition of this situation, in 2017 CSIR identified the need for a seed funding mechanism to support underfinanced research.

Instrument

To bridge this financing gap, the CSIR introduced a research grant instrument, sustained primarily through internal revenue. By engaging in projects with development partners, CSIR institutes incorporate a 15 per cent overhead as institutional support. Out of this, approximately 2.2 per cent (or 15 per cent of the total overhead) is redirected by the CSIR Head Office to this grant instrument. Under this funding model, only those institutes contributing overheads to CSIR can access this grant. A feature of this approach is its emphasis on inter-institutional collaboration, with grant applications mandating combined submissions from CSIR institutes. Over time, the grant amount has increased from US$2,500 to US$10,000. These funds are earmarked for basic research-related expenses, such as small equipment purchases and publication support, but exclude salary payments.

Implementation strategy

Implementation of the grant instrument, instituted by the CSIR Director General, is led by the Office of the Deputy Director. However, CSIR is in the process of establishing a dedicated Grant and Project Office. The grant framework prioritizes research within CSIR's seven thematic realms, which include: Science and People, Electronics and Information and Communication Technology (ICT), Biomedical and Public Health, and more. Research proposals should highlight the project's industrial relevance and dedication to disseminating findings.

The CSIR website allows for a transparent application procedure. Following submission, a committee comprising internal experts, including emeritus personnel, assesses the proposals. Their dual role involves selecting applications based on overarching challenges and assisting with monitoring throughout the project duration.

Grant monitoring is biannual with mid-term evaluations including on-ground checks. While the monitoring and reporting processes are not completely systematized, a short-term goal of CSIR is to develop a platform to holistically oversee all council grants. Funds are disbursed via the research institutions, with rigorous tracking of expenditures. However, monitoring post-grant completion remains an as yet unfulfilled objective.

Achievements and impact

The Grant Scheme has shown promising results as a catalyst for substantial external funding. For example, in 2016 a project about in vitro growth of coconuts attracted the attention of the National Tree Crop Agency, which subsequently received substantial funding from the World Bank to further the research. Another project during 2020 focused on plantains and bananas, the aim of which was to refine protocols for cost-effective and high-quality planting materials. This initiative aligned with a sub-regional project, validating the research direction. Currently, this project is supported by the International Institute for Tropical Agriculture with funds from the Gates Foundation.

Source: Author from interviews

In terms of strategic objectives, Table 4.4 indicates a strong commitment towards human resources development, as described during the analysis of Figure 4.3, and an important inclination towards innovation promotion and development, with 40 per cent of STI policies in Africa adhering to this goal. Additionally, within this objective, approximately only 15 per cent of instruments draw on R&D innovation funds. The journey to secure governmental endorsement and investment for innovation instruments such as funds is one that encompasses several concerns including governance issues, misuse of funds and lack of sustainability.

Table 4.4. Strategic objectives of STI policy instruments in Africa

Strategic objectives	Share of policy instruments
Human resources development	57.14%
Promotion and development of innovations	40.63%
Promotion of scientific knowledge production	38.10%
Strategic collaboration and policy support	22.54%
Ethical, inclusive and sustainable STI	19.05%
Public engagement and popularization of science	17.14%
Research and innovation infrastructure	13.02%

Note: A single policy instrument can target multiple strategic objectives.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

The Botswana Innovation Fund (see Box 4.3), which is currently operational, embarked on a development trajectory similar to that of the National Research Fund of Botswana, which is currently non-operational. Both funds received support from the World Bank, specifically for the development of operational manuals and other essential guidelines. A critical distinction, however, lies in the proactive initiatives of the Innovation Fund, which successfully engaged with the highest echelons of government. This engagement involved bringing in an agency experienced in managing a similar innovative fund instrument in Israel and convening a comprehensive workshop with all pertinent stakeholders, including ministers. This strategic dialogue illuminated the fund's relevance, which had previously been overlooked by government officials. Another difference is the organizational structure of the two funds. While the National Research Fund operates under a government department characterized by a top-heavy hierarchy, the Botswana Innovation Fund has a hybrid structure. This unique framework affords it enhanced flexibility in managing its programmes, contrasting sharply with the bureaucratic rigidity often found in traditional government departments, which necessitates commitment from ministry-level directors and the Permanent Secretary.

Box 4.3. Botswana Innovation Fund

National context and challenge targeted

Botswana ranks among the top three countries for innovation in sub-Saharan Africa according to the 2023 Global Innovation Index (GII), although its overall standing is 86 out of 132 countries. The GII underscores challenges in the innovation output subindex, where Botswana is placed 110 out of 132. These aspects of Botswana's STI system impede private sector competitiveness, due mainly to low levels of technology adoption. Addressing these challenges requires a mechanism centred on innovation to foster learning, technology adoption and the reconfiguration of technologies to meet local needs. This approach also aligns with Botswana's aspiration to transition into a knowledge-based economy. An instrument to fund innovation has potential to enhance Botswana's STI landscape, based on capitalizing on the nation's favourable macro-environment, relatively robust infrastructure and educated population.

Instrument

The purpose of the Botswana Innovation Fund is to promote innovation through technology, product and business growth in the private sector by awarding cash grants to diverse entities. Eligible recipients include companies and organizations in the Botswana Innovation Hub, along with universities and research bodies, both inside or outside the hub, if subcontracted for R&D by registered entities. The fund also incentivizes skills transfer and training for citizen employees, supporting both institutional and on-the-job training programmes, hence fostering continuous learning.

The fund promotes local intellectual property (IP) creation, innovative prototypes, technology transfer and pre-commercialization across various sectors such as mining, clean, agricultural and health technologies, information and communication technologies (ICTs), Indigenous knowledge systems and knowledge-intensive business services.

Eligible project costs include: salaries for technical and managerial personnel; material costs for prototype or model development; and subcontracting costs (given subcontractors are independent and will not own any project IP); as well as expenses for patenting, travel, licensing, technical trials, manual preparation, quality certification and market proofing. There is no funding cap per project, with grants covering only eligible expenses.

Implementation

The Botswana Innovation Fund was established by statutory order in 2017. This order designated the Permanent Secretary responsible for Tertiary Education, Research, Science and Technology as the administrator of the fund, with the authority to empower any public office or government agency to execute all or any of its duties. Moreover, the statutory order stated that the minister overseeing Tertiary Education, Research, Science and Technology shall appoint a committee, comprised of representatives from both the public and private sectors, to oversee the fund's operations. The Botswana Innovation Hub, a company in which the government holds a majority stake of over 50 per cent, operating under the umbrella of the Ministry of Tertiary Education, Research, Science and Technology, was designated to implement and manage the fund, thereby serving as its Secretariat.

The design of the Botswana Innovation Fund, with support from the World Bank, led to the development of an operational manual. This manual lays out comprehensive guidelines for managing the fund, including the definition of thematic priorities, beneficiaries and types of support. Additionally, it outlines processes and procedures, roles and responsibilities concerning grant application, selection, and monitoring and evaluation. It also offers examples of Calls for Proposals, management of IP and scenarios for appraising the fund after six years of operation, including potential key milestones and performance indicators.

Besides the Committee and Secretariat, the operational manual specifies an additional supporting body: a panel of experts assembled by the Secretariat. This panel contributes to the appraisal of grant applications and advises the Committee in their grant allocation decisions. The panel consists of experts with technological and business experience in innovation, technology and the priority knowledge clusters, alongside various aspects of business risk, ensuring well-rounded evaluations of grant applicants.

The Botswana Innovation Fund selects projects based on merit, emphasizing innovation, IP ownership by a Botswana-registered company, compliance with standards and a limitation of one application per company. Applicants are required to provide proof of sustainable marketability or competitiveness of their products or services, alignment with the fund's priority areas, and positive social and economic impact. The evaluation also considers the team's capability to execute the proposed project, financial viability and whether the business model is replicable or scalable.

The fund also has a formal complaints procedure open to any participant during the grant call for proposals. Complaints must be addressed by the Committee within 30 working days of the complaint being lodged.

Achievements and impact

In 2018, the Botswana Innovation Fund issued its first call for proposals to existing Botswana Innovation Hub members already at the prototype development phase. The Botswana Innovation Fund Committee approved seven projects, granting funding amounting to approximately US$407,000. By June 2022, an investment in at least 25 projects was made, amounting to total funding of approximately US$1.4 million. These projects spanned various sectors including renewable energy, ICT, Indigenous knowledge systems, biotechnology and mining technologies.

Source: Author from interviews

Africa accounts for the largest share of STI policy instruments receiving international financial support. As detailed in Table 4.3, approximately 35 per cent of African instruments are funded either independently or jointly by global entities. The National Research Fund of Mozambique exemplifies this approach, with foreign donations accounting for 90 per cent of the country's R&D budget. This overreliance on foreign funds introduces a degree of unpredictability in funding calls, largely because these are contingent on the variable availability of these external resources. This unpredictability, and the sometimes infrequent nature of calls, creates a situation where, although the National Research Fund (FNI) is recognized as a primary institution for research and innovation grants, its funds often serve as supplementary support. Researchers frequently have access to alternative funding, whether through their institutions' budgets, assistance from external partners or, occasionally, via international collaborations (Gerwen, Longhurst and Mandlate, 2022).

Despite the status of FNI as an autonomous entity, the fund operates under government oversight. While this governance structure potentially enhances sustainability, it also imposes an additional burden on the government of ensuring the allocation of sufficient resources. These resources are essential for employing skilled personnel, managing programmes, and adapting processes and systems in line with the evolving demands of a grant-awarding body. However, the FNI faces challenges in these areas, evidenced by the infrequent revision of its operational procedures and the limited capacity and resources dedicated to financial reporting, monitoring and impact assessment (ibid.). These aspects require attention to fortify the fund's effectiveness and its contribution to the research ecosystem.

Box 4.4. National Research Fund of Mozambique

National context and challenge targeted

Mozambique is confronted with the urgent need to diversify its economy and reduce its dependence on a few key sectors, while also dealing with the adverse impacts of climate change. In light of these challenges, the government has acknowledged that advancing scientific research and innovation can stimulate growth across various sectors, leading potentially to a more resilient economy. Moreover, one of the primary challenges facing the country is lack of consistent funding in the R&D sector, which has hindered the implementation of supportive policies.

In response to this situation, one of the central objectives set by the government under the 2006 Mozambique Science, Technology and Innovation Strategy (ECTIM) was the establishment of funding policies and mechanisms for research and innovation programmes. This objective led to the development of the National Research Fund (FNI).

Instrument

FNI was established to foster the development and exchange of scientific knowledge, promote research and technological innovation, and support the training of researchers. Through the FNI, the government and partners provide financial resources to both public and private sectors engaged in scientific and technological development.

The FNI offers a competitive funding mechanism for a diverse range of activities, including research, innovation, technology transfer and the improvement of research infrastructure. The fund also allocates financial support for strategic projects in areas defined by the government such as climate change, with funds earmarked for this purpose. Furthermore, the FNI engages in donor-coordinated programmes, exemplified by partnerships like the one with the Swedish International Development Cooperation Agency (SIDA), which focuses on international mobility.

Operating primarily at an institutional level, the mandate of the FNI states that beneficiaries cannot be individual researchers, and should secure institutional backing. This approach underscores its commitment to bolstering institutional capacities. Project funding typically spans a three-year period, although this may fluctuate depending on the project specifics. The fund determines financial allocations for projects through a rigorous evaluation and approval procedure, highlighting the FNI's dedication to upholding excellence and ensuring strategic coherence across its funding initiatives. Funding calls are not predictable over time, and depend largely on the availability of funds.

Implementation

The FNI operates as a public entity with its own legal status and administrative independence, functioning under the umbrella of the Ministry of Science, Technology and Higher Education in Mozambique. The fund was established by the government through Decree No. 12/2005, and was subsequently amended by Decree No. 50/2015. The FNI manages an estimated annual budget of around US$5 million for project financing, of which approximately 10 per cent is sourced from the government with the balance from international contributors.

To enhance its strategic impact and governance, the revised statutory framework, Decree 50/2015, mandates the creation of a Consultative Council for the FBI. This body is intended to provide advisory input into FNI's operations and ensure alignment with broader government agendas. However, the Council has been inactive since 2017. The same decree also prescribes the formation of a Management Council, responsible for FNI's administrative oversight, and a Technical Council, tasked with offering consultative guidance on matters related to science, technology and innovation (STI).

A key aspect of the FNI's approach to support research initiatives in Mozambique is the mechanism of calls for proposals. These calls constitute the core-business process around which the FNI is further structured and organized. The approach starts with an application phase, inviting submissions from researchers. Subsequent stages include administrative screening, ethical evaluation and a comprehensive technical-scientific review, ensuring each proposal's compliance, moral integrity and scientific merit. Approved projects advance to a formal ratification process, followed by the finalization of funding agreements. Rigorous monitoring and control measures ensure project adherence to established guidelines, schedules and financial plans, culminating in the project's conclusion. This final phase entails an appraisal of results, acknowledgment

of achievements, extraction of lessons learnt and necessary closure protocols. These processes are further supported by an online grant management and administration system (GMAS).

The FNI has adapted its calls for proposals according to evolving national and international contexts. For example, the fund has incorporated specific categories for innovation-driven and collaborative projects, including public-private partnerships, and initiated a dedicated call for tackling the challenges posed by the COVID-19 pandemic. However, despite these developments, the internal mechanisms and procedures, especially regarding technical assistance to grantees under these new calls for proposals, have remained unaltered and are not specifically tailored to the unique demands of these initiatives. These processes are delineated in operational manuals from 2015, which are currently undergoing a thorough review to integrate lessons leaned from years of execution. This update includes stipulations for projects to report on results and impacts following their conclusion. Additionally, participants will be obliged to attend events orchestrated to publicize findings sponsored by FNI.

Achievements and impact

In 2019, the FNI allocated approximately US$343,000 for 11 research projects, US$70,000 for three innovation projects and US$160,000 for eight COVID-19 initiatives during its tenth call for proposals.

Globally, FNI collaborates with similar entities, fostering research and policy development. By 2021, FNI's international projects included collaborations in Zambia (with the National Science and Technology Council), Malawi (with the National Health Science Research Committee/National Research Council of Malawi), South Africa (with the National Research Foundation) and Namibia (with the National Commission on Research, Science and Technology), focusing on various sectors including health and agro-processing. Additionally, FNI undertook a joint project with Germany's Deutsche Forschungsgemeinschaft (DFG).

Source: Author from interviews; Gerwen, Longhurst and Mandlate (2022)

The Human Development Innovation Fund (HDIF) in Tanzania, funded by UK Aid, offers an alternative governance model (see Box 4.5). While co-designed with the Tanzanian government, the fund's management was delegated to an international consulting firm, selected via a competitive tendering process. This firm established a local office specifically to oversee the project's implementation. Employing such a strategy ensures the availability of qualified personnel from the programme's outset. However, it also introduces challenges, particularly in terms of the governance structure's complexity, which takes the form of a consortia of organizations from different parts of the world with complementary capabilities. These consortia face potential issues in communication, hierarchy and interest alignment. To counter these challenges, it is possible to station all consortium members in one local office, promoting cohesion and unified direction.

Another key challenge is the sustainability of the initiative and the transfer of knowledge to local entities. Despite these potential challenges, the HDIF has been active in stakeholder engagement. Throughout the programme, it maintained consistent interaction with the Commission for Science and Technology (COSTECH) of Tanzania. Additionally, it dedicated resources to capacity-building, thereby facilitating the transfer of expertise to local authorities. This continuous engagement underscored the fund's commitment to not only foster innovation but also empower local stakeholders with the necessary skills and knowledge. In so doing, the initiative aimed to instil a lasting legacy beyond its immediate impact, ensuring that the project's benefits resonate within the Tanzanian scientific and technological community.

Box 4.5. Human Development Innovation Fund of Tanzania

National context and challenge targeted

In Tanzania, efforts to enhance basic services such as education, health and water quality present substantial challenges. Although access to these services has broadened, their quality remains suboptimal. Addressing this issue necessitates fostering innovation and adopting new technologies. Crucial to this approach is the involvement of the private sector and the assurance that technological progress will benefit women and girls, along with promoting South-South collaboration to quicken the adoption of technology.

Acknowledging these needs, the UK Government has recognized that a programme addressing these challenges aligns with its priorities for poverty reduction, improved basic service delivery for the poorest (especially through non-state actors) and fostering innovation for more effective service delivery. This programme also aligns with the Tanzanian government's priorities, as detailed in national and sector policies and plans. The *Tanzania Poverty and Human Development Report 2009* emphasizes the critical importance of service quality and the pivotal role of the private sector in addressing ongoing challenges in educational quality.

Instrument

The Human Development Innovation Fund (HDIF) was established to improve human development outcomes for Tanzania's poorest population. Its primary goal was to cultivate innovative solutions that enhance the quality and value for money of basic services in both the public and private sectors. HDIF operated through three main components. The first, INSPIRE, supports innovation ecosystem enablers such as hubs, creating a nurturing environment for innovations. The second, CATALYSING, focuses on funding new ideas in human development, ranging from pilot projects to large-scale initiatives, and connects innovators with other financial sources to ensure their sustainability. Finally, the TRANSFORM component facilitates a mutual learning and collaboration process between government, funders and the private sector, encouraging the integration of innovative methods into their respective domains.

Implementation

The HDIF in Tanzania, conceptualized by the UK Foreign, Commonwealth & Development Office (FCDO) (formerly DFID) in collaboration with the Tanzanian government, particularly the Commission of Science and Technology (COSTECH), represented a dynamic approach to fostering innovation. The HDIF's design reflected the evolving nature of the Tanzanian innovation ecosystem; over seven years, its theory of change and results framework were continually refined, adapting to new insights and evidence from its implementation.

The fund was executed by a consortium, chosen through a competitive tendering process. This consortium included international private firms, multinational corporations and universities as technical advisors. Their responsibilities spanned project management, operations, technical leadership and fund management, which entailed proposal assessment, grant management and financial oversight.

The Fund's governance structure comprised a board with representatives from FCDO, COSTECH and the HDIF Team leader to oversee implementation. An independent grant committee evaluated and advised on grant applications approval, with the fund manager managing overall operation of the fund. A local implementation team comprising local staff and led by international consortium representatives directed the project.

HDIF introduced a multi-window funding mechanism for piloting and scaling human development innovations. This competitive and structured process was continually refined based on learning from each funding round. A comprehensive Grants Manual guided the fund-making and management processes.

Insights from these rounds led to the creation of specific funding windows for institutional capacity-building, targeting key players in the start-up ecosystems, and for supporting COSTECH's capabilities in fund management, Innovation ecosystem building and evidence-based policy-making.

The funding process took between nine and ten months, and involved multiple stages: launch of a call for proposals with an outreach campaign; receiving and reviewing initial business plans and providing technical assistance; receiving refined business plans and undertaking technical and financial reviews; assessment by an Independent Grant Committee; Financial Responsibility Agreement negotiation; and, finally, agreement signing and fund disbursement.

Achievements and impact

The HDIF invested approximately US$29.14 million in innovative projects that enhance basic services. Throughout its operation, the fund financed 43 innovations across 20 regions in three funding rounds, supporting 48 projects in the health, education, and water, sanitation and hygiene (WASH) sectors. The health sector was the primary beneficiary, accounting for about 46 per cent of this funding. HDIF predominantly supported non-governmental organizations (NGOs), alongside businesses, research institutions and COSTECH.

A key feature of HDIF was the provision of technical assistance via its Business Advisory component, which played a crucial role in enhancing grantees' capabilities from application through to implementation, thus nurturing innovation and establishing a strong ecosystem.

In its concluding phase, a notable accomplishment of HDIF was the establishment of Funguo, its successor programme. Managed by UNDP and funded by the European Union, Swiss embassies and FCDO, Funguo aims to escalate impactful ventures in Tanzania, thereby contributing to the nation's development goals and the Sustainable Development Goals (SDGs).

Source: FCDO (2017); FCDO (2022); HDIF, 'HDIF – Human Development Innovation Fund' [25]; HDIF (2021)

As indicated in Table 4.5., the primary support mechanisms utilized by STI policy instruments in Africa include technical and business assistance. This support is not aimed directly at scientific disciplines but rather focuses on specialized skill development relevant to R&D and innovation management, as well as entrepreneurship. For instance, a notable proportion of the HDIF's recipients were non-governmental organizations (NGOs) suggesting that the Tanzanian private sector entities often did not meet the necessary selection criteria. To bridge this gap, the HDIF's business assistance provided entrepreneurs with guidance on creating business plans, as well as on financial planning and reporting, key factors in evaluating the viability of innovative enterprises. Additionally, the HDIF supported infrastructures such as incubators and accelerators, aiming to foster a stronger ecosystem and promote the sustainability of entities that nurture entrepreneurial and innovative talents. By strengthening these foundations, the HDIF enhanced the prospects for enduring, self-sustained innovation and skills development within the local entrepreneurial landscape.

25 http://hdif-tz.org/ (accessed 13 November 2023)

Table 4.5. Support mechanisms used in STI policy instruments of Africa

Support mechanisms	Share of policy instruments
Technical and business assistance	27.81%
Competitive research grants	26.82%
Scholarships, studentships, fellowships	20.20%
Information and knowledge-sharing services	13.25%
R&D and innovation funds	11.59%
Ecosystem and infrastructure development	11.26%
Others	9.27%
Tax and fiscal incentives	5.30%
Seed and venture capitals	4.97%
Infrastructure grants (research facilities, labs, instruments)	3.64%
Grants for collaborative R&D	1.66%
Matching grants	1.32%
Awards in science, technology and innovation	0.33%

Note: A single policy instrument can use multiple support mechanisms.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Similarly, the Kenyan innovation agency is working to fortify the Technology Transfer Offices (TTOs) of Kenyan universities and research institutes (see Box 4.6). This effort is geared towards enhancing the commercialization of research, a theme of ongoing interest in Africa, as depicted in Figure 4.3. Initiated as a pilot project, this programme engages with a select number of universities and research institutions. The expectation is that by demonstrating positive outcomes, the programme will secure additional commitment from pivotal government stakeholders in Kenya. This enhanced support is critical for customizing the programme and broadening its reach nationally, incorporating an increased number of educational and research entities. The goal is comprehensive, horizontal expansion that capitalizes on national funding pools.

A significant challenge to this endeavour arises when university staff, such as professors and researchers, who typically do not have responsibilities related to institutional frameworks, are required to undertake additional tasks related to their development. These tasks often involve a labour-intensive diagnostic exercise to identify institutional gaps, among other responsibilities. Such additional duties can lead to a more intensive workload, posing motivational risks for these professionals who must balance their primary duties with the demands of this new role. Although these tasks are often led by highly motivated individuals committed to the cause, institutions need to provide adequate support and rewards to ensure that this motivation is sustained. Consequently, ideal institutional support should encompass flexibility in shifting duties, acknowledgment and recognition of their efforts, opportunities for professional development and various non-financial rewards.

Box 4.6. Institutional support for Technology Transfer Offices (TTOs) in Kenyan universities and research institutes

National context and challenge targeted

Kenya aims to become a middle-income country by 2030. To attain this long-term objective, the country has developed an economic framework encapsulated in Vision 2030, which highlights science, technology and innovation (STI) as crucial driver. The STI Act of 2013 further solidifies this approach, creating an institutional framework and acknowledging the commercialization of innovations as essential for the business viability of start-ups and research initiatives from both the public and private sectors.

However, the pathway to successful research commercialization faces institutional hurdles, notably the shortage of well-equipped TTOs in universities and research entities. Existing TTOs often suffer from unclear mandates and inadequate skills, while a coherent commercialization strategy is largely absent, resulting in fragmented efforts across departments. An emphasis on research and publications in senior management tends to eclipse commercialization initiatives, an issue further complicated by insufficient intellectual property (IP) policies, which are crucial for safeguarding of and providing incentives for commercializing innovations, and a disconnect between academia and industry, hindering technology transfer. Despite an increase in IP applications, the conversion to actual grants remains low.

Instrument

The Institutional Commercialization Support programme is designed to collaborate with universities and research organizations, supporting them in refining their systems and processes to effectively commercialize their research outputs. Key activities under this instrument include the review and enhancement of existing TTOs, which play an essential role in transitioning innovations from the lab to the market. Additionally, the programme involves the development and review of institutional policies and strategies to ensure that they are conducive for commercialization efforts. This support extends to fostering research-to-commercialization and industry linkages, which are important for the practical application and market adoption of research outputs. Through these structured interventions, the programme seeks to create a conducive ecosystem for the commercialization of research, thus bridging the gap between academia and industry in Kenya.

Implementation

The Kenyan Innovation Agency (KeNIA), which is national agency responsible for development and strengthening of the Kenyan Innovation Ecosystem, launched a systematic initiative to fortify commercialization support within chosen institutions. A call for expression of interest for institutional commercialization support was disseminated to universities and research centres, which were invited to submit proposals. The selection criteria emphasized the institution's commitment to the implementation of the commercialization work plan to be developed, the presence of infrastructure such as TTOs, established IP policies, tangible steps already taken towards commercialization and a clear gender policy.

Upon evaluation based on the set criteria, five institutions were chosen for the programme. The selected institutions were then asked to designate technical officers, a process overseen by a committee headed by an officer from the KeNIA. Other members of this committee included representatives from the UK's Foreign, Commonwealth & Development Office (FCDO), the African Centre for Technological Strategy and a consultant.

The selected technical officers then participated in an Introductory Meeting, hosted during Kenya Innovation Week, which was held in December 2022. During this session, they were familiarized with the primary objectives, strategies and relevance of the programme. An accompanying workshop assisted these officers in creating individual institutional workplans, pivotal for the programme's actualization. Implementation of these workplans began soon after, with KeNIA, African Centre for Technological Strategy and UK Aid's Africa Technology and Innovation Partnerships (ATIP) making joint institutional visits. The goal behind these visits was to observe application of the workplan, assess progress made and identify any challenges encountered during rollout.

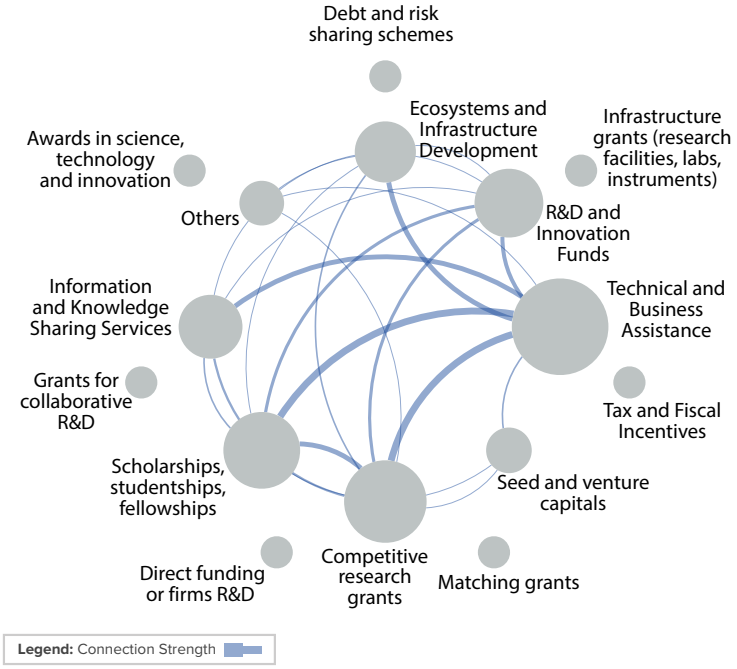
Achievements and impact

The Institutional Commercialization Support programme in Kenya has contributed to strengthening the environment for research and technology transfer. Out of a competitive pool of 19 applications, only five were selected. This initiative brought together a team of 15–20 researchers and technology transfer managers, creating a platform for them to share their experiences with other universities. Beyond the immediate group, there was a ripple effect as participants began to establish their own networks dedicated to the commercialization of professional endeavours. To further amplify the spread of knowledge and experiences, a newsletter is being developed. This will facilitate knowledge sharing and lay the foundation for expansion of the network by recruiting more individuals. One important impact of this programme was the planting of a seed for the establishment of an association specifically for technology transfer managers in Kenya. Following the successful piloting with the five institutions, the programme is being upscaled to phase 2, with 12 new institutions have been selected.

Source: Author from interviews; Kenya National Innovation Agency, 'Institutional Commercialisation Support | Kenya National Innovation Agency'[26]

Figure 4.4 provides a complementary picture illustrating the main mechanisms used in the policy mix with the node size indicating each mechanism's prevalence. The network highlights the top quartile of connections among these mechanisms, showing their inclusion in a country's policy mix. The network also demonstrates the connection strength between mechanisms through lines of varying thickness. This visual representation complements Table 4.5.; the node sizes are consistent with the information in the table, but the network graph further clarifies the most common combinations of mechanisms used by the countries in the region. For instance, in Africa, the mechanisms "Technical and Business Assistance", "Competitive Research Grants" and "Scholarships, Studentships, Fellowships" are present in all countries in the region for which the GO-SPIN Platform has data. Therefore, Figure 4.4 illustrates the connections among these with the thickest lines. Conversely, the figure also shows some unconnected nodes, indicating mechanisms not commonly included in the countries' policy mix.

Figure 4.4. Network analysis of support mechanisms used in STI policy instruments in Africa



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

26 https://www.innovationagency.go.ke/initiatives/institutional-commercialisation-support (accessed 3 November 2023)

4.2 Arab States

According to the UNESCO Science Report (UNESCO, 2021), every Arab State has at least one government agency dedicated to promoting and supporting STI, with 68 per cent of these nations having established an STI policy (UNESCO, 2021). This progress aligns with the objectives set forth in the *Beirut Consensus on Technology for Sustainable Development* in the Arab Region. Adopted in 2018 by the member states of the United Nations Economic and Social Commission for Western Asia (UNESCWA), this agreement underscores a collective commitment to investing in technology and innovation. Member states pledge to invigorate their technological landscapes through legislative and fiscal policy initiatives, stimulate technology transfer and enhance public service delivery via e-governance. Additionally, they aim to finance technological solutions to combat climate change (UNESCWA, 2018). Since the inception of GO-SPIN in 2011, the platform has gathered information of approximately 264 policy instruments from Arab States, and has supported capacity development to strengthen these STI policy frameworks.

Figure 4.5 illustrates the most salient keywords extracted from policy instruments in the Arab States, according to their prevalence in comparison to global patterns. One notable trend is a strategic accentuation on grants as part of the STI policy tools spectrum, with grants accounting for nearly 48 per cent (Table 4.8) of all STI policy tools recorded in GO-SPIN. This statistic highlights a unique methodology in fostering STI ecosystems. Also noteworthy is the implementation of prizes and awards, which make up around 9 per cent of regional STI policy tools. This percentage is higher than those of other regions, underscoring the concerted regional efforts to cultivate a culture of STI excellence and broader societal recognition of STI. Moreover, Figure 4.5 reveals a significant regional commitment to start-ups and entrepreneurship. Data from GO-SPIN indicate that 11 of the 16 countries with data available have instituted at least one policy tool that explicitly endorses these sectors. This focus signals an acknowledgment of the crucial role played by start-ups as economic catalysts, contributing to diversifying economies traditionally reliant on natural resources, including the oil and gas industries.

Figure 4.5. Word cloud of keywords in policy instruments from Arab States

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

One example of an instrument supporting start-ups is the UAE's Mohammed Bin Rashid Innovation Fund (see Box 4.7). Start-ups frequently encounter challenges in securing financing, particularly from traditional banking institutions, which often demand proven success and substantial collateral, requirements that new enterprises usually cannot meet. This fund tries to mitigate the risks for traditional banks through loan guarantees, thereby enhancing start-ups' access to finance as they seek to solidify their presence in the country. However, several impediments have surfaced during the fund's execution; notably, a significant number of proposals were declined due to underdeveloped or absent business plans (PwC, 2018). This indicates a potential deficit in entrepreneurial skills within the market and therefore limited absorptive capacity of the start-up ecosystem to benefit from the substantial funding offered. To counter this challenge, the fund has recently introduced an accelerator component, aiming to offer specialized guidance in these and other areas crucial for start-up success. An additional

strategy to navigate similar challenges involves reducing average loan guarantees to levels more commensurate with the sector's capabilities, necessitating less stringent scrutiny and complementing these with dedicated capacity-building efforts. Concurrently, the fund could broaden its network of financing partners to encompass those capable of supporting growth phases and facilitating international expansion from the UAE, thereby ensuring seamless and efficient support throughout the business lifecycle.

On the operational front, the instrument faces challenges such as a long application process with multiple stages that impede swift decision-making (ibid.). These types of issues present in most selection processes call for efforts to educate potential applicants and strengthen the screening process, as delays often occur due to missing or incomplete documentation, which necessitates extra processing time. These refinements would expedite the process and make the fund more accessible and effective for emerging enterprises.

Box 4.7. United Arab Emirate's Mohammed Bin Rashid Innovation Fund

National context and challenge targeted

In the UAE, a discerned financial gap has been impacting the growing innovation landscape, notably affecting the availability of affordable financing for innovators and start-ups. Despite the region's variety of financial solutions, financing institutions have displayed a conservative risk appetite towards funding innovation. This financing challenge limited the competitiveness of small and medium-sized enterprises (SMEs), affecting both economic growth and employment prospects.

The value of a robust innovation and entrepreneurial ecosystem was recognized as an important component of efforts to diversify the UAE's economy, reduce oil-dependency and heighten the attractiveness of the private sector. The adoption of a National Innovation Strategy in 2015 further supported the critical role of innovation and delineated national priorities to foster growth in this area. This led to the conceptualization of a supportive financial mechanism to bridge the identified financial gap.

Instrument

In 2015, the Mohammed Bin Rashid Innovation Fund (MBRIF) was established by the UAE's Ministry of Finance with an allocation of approximately US$544.4 million. The primary objectives of the MBRIF are to alleviate financial constraints that often impede innovation projects, commercially accelerate the UAE's innovative products and services in regional and international markets, and promote the UAE's reputation and footprint on the international innovation scene.

The fund aims to achieve these objectives by providing guarantees as collateral to financiers who back these innovative ventures. This approach increases: (i) the potential for commercial loans to be issued to such innovative companies and projects, (ii) incentivises respective financiers to issue these loans at lower interest rates compared to market standards, and (iii) reduces the collateral required from the innovators.

The MBRIF allows non-nationals to apply for loans, the only prerequisite being that the business is located or planning to relocate to the UAE.

In 2018, the fund introduced an accelerator programme to provide non-financial support to innovators. The programme's unique member-centric design and services focus on innovator excellence, providing access to an ecosystem of coaches and industry experts. The programme provides support for the development of corporate strategies and business models, facilitates access to markets and talent, and assists with financial strategies, all with the aim of creating job opportunities and ensuring overall positive impacts on the UAE economy.

The fund's sectoral focus is aligned with the priority sectors of innovation as outlined in the National Innovation Strategy. This alignment also resonates with several Sustainable Development Goals (SDGs), channelling resources towards innovations that address critical challenges in key domains such as water, energy and healthcare.

Implementation

The MBRIF was crafted over a year, a process that encompassed the development of a strategy, operating model, funding policy, market sounding, pilot phase and the articulation of intended impacts. The Emirates Development Bank (EDB)

functions as the host and operator, and the fund officially started operations in November 2016 after launching its online application platform.

The MBRIF website serves as a comprehensive resource offering general insights about the fund, stakeholders involved, and the application and revision procedure. Key stakeholders such as the UAE Ministry of Finance, Emirates Development Bank and RAKBANK also disseminate information about opportunities among interested firms.

The application portal is open year-round for interested start-ups and SMEs, although the evaluation of applications and decision-making follows a well-orchestrated two-month cycle. This process is divided into six stages, starting with an online application, followed by an initial review process called 'Due Diligence Light'. After this phase, applicants with favourable ratings are required to pay a service fee, which amount to 0.1 per cent of the total credit requested, paving the way for a more detailed due diligence phase. Recommendations from this analysis are then forwarded to the Advisory and Decision Committee, which renders the final verdict on the application. The final decisions, once ratified by the Ministry of Finance, are communicated to the applicants, and initiate the document signing process with the respective lender, if successful. The entire journey, from application submission to communication of the final decision, should span a maximum of 10 weeks, provided all requisite documents are furnished and the service fee is paid promptly following the request, although on average the process takes about six months.

Achievements and impact

Between November 2016 and the third quarter of 2018, the MBRIF received 153 applications, which translates into an average of 18 new applications per quarter. Over the span of two years, demand for the programme exhibited substantial growth, with applications per quarter rising from 16 in 2017 to 27 in 2018. This surge in interest underscores the programme's growing significance and appeal to potential innovators.

During the same period and out of the total number of applications, 54 were rejected, 83 were still under review and 13 were pending review. Successful applicants were granted a loan guarantee averaging approximately US$1.3 million, facilitated by RAKBANK. This arrangement was unique as it offered a 100 per cent guarantee on the commercial loan amount, providing significantly advantageous loan conditions for the beneficiaries. The absence of need for additional collateral and a substantial reduction in interest rates, from an average of 15 per cent down to around 7 per cent per annum, also represented a notable benefit. This allowed firms to save approximately US$100,000 annually, enhancing their financial stability and capacity for innovation.

All successful applicant companies were micro or small businesses who were able to significantly expand their workforce on the basis of the funding, creating over 30 additional jobs and increasing employment by around 25 per cent on average.

Source: PwC (2018)

A distinctive feature of countries in this region is the significant involvement of the private non-profit sector in funding STI policy instruments. As shown in Table 4.6, approximately 22 per cent of STI policy instruments are financed by this sector. Although there is lack of regular statistical data for many countries in the region on this topic, available indicators reinforce this trend. For instance, private non-profit entities financed 4.3 per cent of gross expenditure on R&D (GERD) in Oman (2018), 1.6 per cent in Kuwait (2014) and 2 per cent in Bahrain (2014), values that are high when compared with other similar countries.[27] These investments highlight the influential role of entities such as the Kuwait Foundation for the Advancement of Sciences, through initiatives such as the Kuwait Foundation for the Advancement of Sciences (KFAS) Innovation Challenge, where a small group of selected companies work with prestigious business schools to develop new initiatives and projects that advance a culture of innovation within each organization. Similarly, the Qatar National Research Fund is making significant strides with programmes like the National Science Research Competition and the Rapid Response Call (RRC) for COVID-19, which supported rapid research-based analysis and outcomes to help Qatar further strengthen its response to the challenges posed by the COVID-19 pandemic.

27 UNESCO Institute for Statistics

Table 4.6. Funding sources used by STI policy instruments in Arab States

Funding sources	Share of policy instruments
Government sector	63.64%
Private non-profit sector	21.97%
Rest of the world government sector	9.85%
Higher education sector	9.09%
Business enterprise sector	4.17%
Rest of the world private non-profit sector	1.52%
Rest of the world business	1.14%
Rest of the world international organizations	1.14%
Rest of the world higher education sector	0.38%

Note: A single policy instrument can use multiple funding sources.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

The trend across the region aligns with the global tendency for large number of STI instruments to incorporate at least one component focused on human resources development (see Table 4.7). However, a distinguishing characteristic emerges when the data on the GO-SPIN platform is examined in more detail. Approximately 25 per cent of the instruments in this region dedicated to human development specifically target undergraduate students. This proportion is the highest globally, setting the region apart, a fact further corroborated by the word cloud presented in Figure 4.5. This emphasis on undergraduate students reflects a strategic investment in youth development, nurturing a foundation upon which advanced skills and innovative thinking can be built for future contributions to science, technology and innovation.

Table 4.7. Strategic objectives of STI policy instruments in Arab States

Strategic objectives	Share of policy instruments
Human resources development	44.32%
Promotion and development of innovations	37.88%
Promotion of scientific knowledge production	32.95%
Strategic collaboration and policy support	30.30%
Public engagement and popularization of science	12.50%
Ethical, enclusive and sustainable STI	7.58%
Research and innovation infrastructure	3.41%

Note: A single policy instrument can target multiple strategic objectives.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

One such instrument, which also explicitly supports public engagement and the popularization of science, is the summer and spring programme offering of the Kuwait Institute for Scientific Research (KISR) (see Box 4.8), designed to enhance the capabilities and scientific curiosity of Kuwait's youth. These programmes play a crucial role in Kuwait's strategic shift from oil dependency to a more diversified economy, emphasizing sectors such as information and communication technologies (ICTs) and renewable energy. By participating in KISR's hands-on programmes, students can enrich their theoretical understanding of these fields through practical experience. Support for these educational endeavours, emanating from both governmental and private sectors, signifies a unified dedication to nurturing educational growth.

Box 4.8. Kuwait's KISR summer and spring training programmes

National context and challenge targeted

In 2010, Kuwait launched the Vision 2035 framework, which aims to address the country's over-reliance on oil markets and the associated sustainability challenges, and transition towards becoming a financial and trade hub both regionally and internationally. One of the guiding goals is fostering 'creative human capital', with a focus on priority sectors such as information and communication technologies (ICTs) and renewable energy. Emphasizing science, technology and innovation (STI) education is crucial in this context to equip the youth with essential skills and knowledge, enabling them to drive innovation and sustain economic growth over the long term. Additionally, the Kuwait Foundation for the Advancement of Sciences (KFAS), one of the key organizations mandated to advance the understanding and application of science and technology in society, has defined in its latest strategy (2017–2021) a strategic area for advocating and fostering STI among the general public, with a particular emphasis on youth.

In light of these ambitions, the government has prioritized programmes that strengthen STI skills among youth, by fostering a robust foundation in STI education.

Instrument

The Kuwait Institute for Scientific Research (KISR) spring and summer student training programmes aim at nurturing an interest in STI among junior, high school and college-level students in the country.

The spring student training programme, spanning two weeks, is tailored for 8th (approximately 13–14 years old) and 9th-grade students (approximately 14–15 years old), and focuses on a single area of specialty such as water resources, the environment, recycling and energy conservation. This programme leverages KISR's laboratories, providing students with a practical entry point to STI with the involvement of KISR's experienced researchers and scientists.

The summer student training programme extends over five weeks and is oriented towards students from high schools (approximately 14–18 years old), technical colleges and universities. The programmes are meticulously designed to offer a balanced blend of theoretical learning and practical exposure in various scientific domains, allowing students to interact and learn from experienced researchers and scientists, thereby bridging the gap between academic learning and real-world scientific application.

Implementation

As of 2023, KISR has conducted 44 editions of the summer student training programme and 34 editions of the spring student training programme. The programmes are scheduled during school holidays to allow students to take advantage of all the activities included in the programme. The summer programme spans five weeks, offering a comprehensive learning experience, while the spring programme is condensed into a dynamic two-week schedule during the spring break.

Each year, KISR designs the content and activities for these programmes, incorporating input from key stakeholders to ensure a comprehensive and current curriculum. The 44th edition of the summer programme covered an array of topics, including: Radiation Chemistry and Physics, Nanotechnology, Genetic Engineering, Reverse Engineering, Health-centric Food Studies, Microbiology, Web Development, Renewable Energy and Raspberry Pi Programming.

Prospective participants can apply through a brief form available on the KISR website. This form outlines the programme and stipulates the acceptance criteria. High-school students must be in the 10th or 11th grade (science section) with a minimum grade point average (GPA) of 75 per cent. University students must be attending scientific colleges in their second

year or higher, with specific requirements for students from various faculties such as Business Administration, Life Sciences and Technological Studies. These students should not be enrolled in summer courses and must maintain a GPA that meets the programme's standards. For university students from Gulf Cooperation Council (GCC) countries, a 'very good' GPA is a prerequisite.

The spring programme, while following a similar structure, is tailored for middle school students. Its 34th edition emphasized diverse subjects such as Engineering Design, Reverse Engineering, Microbiology and its Practical Applications, and the promising field of Microalgae as Kuwait's 'Green Gold.' The curriculum also included a hands-on approach to technology with Raspberry Pi and Arduino programming.

Integral to all these programmes is a blend of scientific and practical training. Students engage in laboratory experiments, field visits, scientific writing and recreational activities, ensuring a well-rounded experience that balances rigorous academic inquiry with interactive learning.

Implementation of these programmes is aided by support from governmental bodies and the private sector. Notable contributors to the 44th summer programme included the Kuwait Foundation for the Advancement of Sciences, the Ahli United Bank of Kuwait, Motion Company and CityBus. This financial backing underscores the commitment of both the public and private sectors to fostering educational development.

Achievements and impact

The summer programme has contributed to the academic and professional journey of approximately 6,100 participants, encompassing high-school and university students as well as individuals with disabilities. The 2023 summer programme witnessed the active engagement of 167 students from universities and secondary schools. One of the most notable outcomes of these initiatives is the number of participants who, upon completing their education, have embarked on doctoral studies and eventually return to contribute to KISR's mission. These individuals, many of whom pursued bachelor's degrees in various scientific disciplines, often cite their formative experiences in the 'Young Scientist' programme as a catalyst for their career choices.

Similarly, the 2023 spring course, tailored for younger academics, has also achieved notable success. It attracted 49 middle school students, offering them an opportunity to explore scientific inquiries and practical learning, planting the seeds for future educational pursuits and potential careers in science and research.

Sources: Author from interviews; KISR (2023a); KISR (2023b)

Similar to other regions, a significant portion of the financing for STI policy instruments in Arab States originates from foreign sources, especially from other governments (see Table 4.6). However, this proportion is small compared to that observed in the African region. A considerable proportion of these foreign funds is typically allocated for grants, with approximately 73 per cent of the instruments financed by foreign governments falling under the category of competitive grant instruments, according to GO-SPIN data. This substantial foreign involvement significantly influences the prevalence of competitive grants within the region, as detailed in Table 4.8.

Table 4.8. Support mechanisms used in STI policy instruments of Arab States

Support mechanisms	Share of policy instruments
Competitive research grants	47.71%
Technical and business assistance	14.12%
Others	12.98%
Scholarships, studentships, fellowships	11.45%
R&D and innovation funds	7.63%
Seed and venture capitals	6.87%
Information and knowledge-sharing services	6.11%
Ecosystem and infrastructure development	4.96%
Tax and fiscal incentives	1.91%
Infrastructure grants (research facilities, labs, instruments)	0.76%
Grants for collaborative R&D	0.38%
Matching grants	0.38%

Note: A single policy instrument can use multiple support mechanisms.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

One example of an instrument that combines a granting mechanism with a dimension of international cooperation, including the mobilization of foreign funds and expertise, is the US-Egypt Science and Technology Joint Fund, which provides financial resources to support costs related to bilateral scientific cooperation projects (see Box 4.9). Egypt is one of only four countries with which the United States has established jointly funded bilateral science and technology agreements (US Embassy in Egypt, 2022). The collaboration produces positive outcomes in the scientific realm, coming from shared commitments on topics of mutual significance for both countries. For instance, the 2023 call prioritizes critical themes such as One Health, Climate Change and the Water-Energy-Food Nexus. This cooperative approach facilitates the exchange of knowledge and expertise from renowned institutions and researchers. Beyond scientific knowledge sharing, these joint programmes play a crucial role in enhancing the institutional capacities of grant-making entities. Government agencies responsible for this programme collaboratively jointly design guidelines but execute their calls independently. This autonomy provides an avenue for these agencies to compare their methodologies with counterparts and assimilate best practices from nations with more established grant expertise, such as the United States. Furthermore, the joint boards that approve selected applications serve as valuable mechanisms for knowledge transfer.

Box 4.9. US-Egypt Science and Technology Joint Fund

National context and challenge targeted

International cooperation in science, technology and innovation (STI) collectively addresses global challenges such as climate change, optimizing solutions through shared knowledge and resources. It fosters technology transfer and capacity-building, especially in less technologically advanced nations, leading to enhanced economic growth. Such collaborations also promote higher-quality research and diplomatic relations among nations, serving both national and global development agendas, showcasing a win-win scenario for all involved.

Egypt recognizes these benefits and has incorporated them into its National Strategy for Science, Technology and Innovation 2030, released in 2019. This strategy includes an explicit component on international cooperation aimed at identifying, activating and developing current agreements; signing new and equal partnership agreements; and attracting international researchers and professors to the technology and scientific field with a view to transferring their expertise and conducting their research in Egyptian universities, research centres, institutes and companies.

Instrument

The US-Egypt Science and Technology Joint Fund, established in 1995, aims to support cooperation between researchers and institutions from both countries, contributing to Egypt's human and economic development. The programme's objectives include promoting scientific research, enhancing the role of STI in economic growth, and expanding applied research and technology commercialization activities.

The fund encompasses several programmes. US-Egypt Junior Scientist Development Visit Grants provided short-term research training visits for Egyptian researchers at US institutions, with funding up to US$25,500 for projects up to nine months. US-Egypt Collaborative Research Grants encourage research collaboration between Egyptian and US scientists with funding up to US$200,000 for each country's research team. US-Egypt Innovation Activities include the Technology Transfer Training Programme for Egyptian professionals engaged in technology transfer, commercialization and innovation, and offer a blend of online and in-person activities with US trainers and mentors. Finally, Innovate Egypt supports early-stage STI and commercialization in Egypt through capacity-building, helping innovators to advance their ventures.

Implementation

The US-Egypt Science and Technology Joint Fund was established through an agreement between the Government of the United States of America and the Government of the Arab Republic of Egypt on Science and Technology Cooperation.

To support the activities of the Joint Fund, each country contributes matching funds, sourced from the United States Agency for International Development (USAID) and the Ministry of Higher Education and Scientific Research (MOHESR). In the United States, the programme's implementation is managed by the National Academies of Sciences, Engineering and Medicine (NASEM), while in Egypt, the Science, Technology and Innovation Funding Authority (STDF) oversees implementation.

The designated implementing agencies in each country have the responsibility of supporting scientific reviews of proposals, managing the technical and administrative facets of selected projects, and nurturing new scientific activities. These activities include innovation and entrepreneurship initiatives that advance bilateral science and technology objectives in the United States and Egypt.

For example, in the US-Egypt Junior Scientist Development Visit programme, STDF leads the application process for junior scientists, while NASEM undertakes the task of attracting interest from US scientist hosts. In the US-Egypt Collaborative Research Grants programme, both agencies are charged with disseminating information about the opportunity, providing guidelines specific to each country's application. These applications include varying conditions related to budgetary limits on eligible costs such as salaries, among others. Likewise, the selection process is conducted independently and in parallel in each country through a rigorous peer review process. The final funding decisions for each proposal are made following a collaborative analysis of US and Egyptian reviews. The decisions of the Joint Board regarding funding are final and binding.

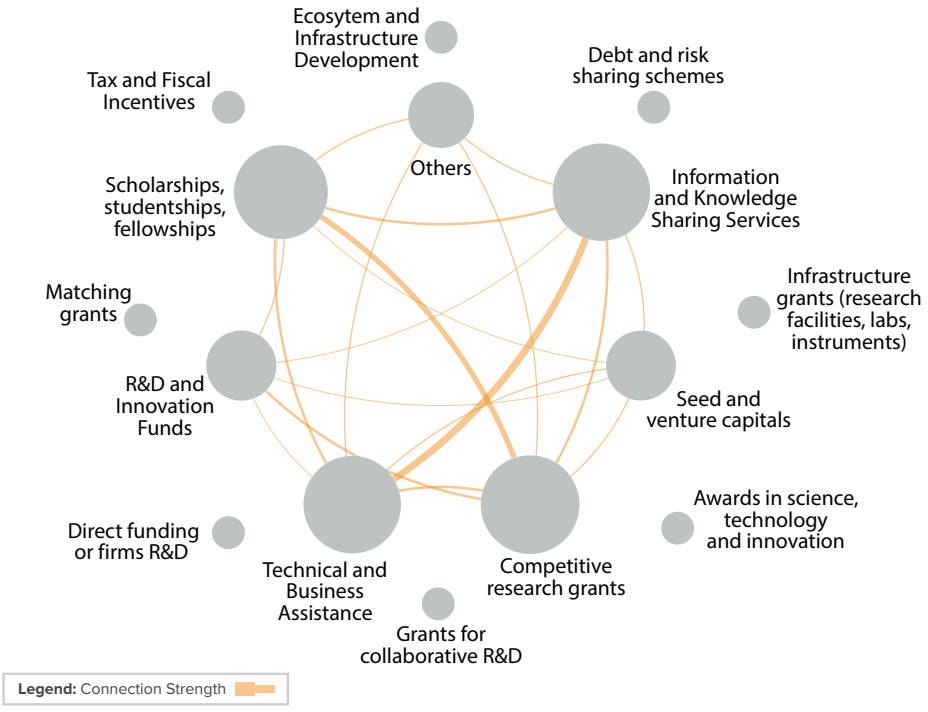
Regarding grant issuance, STDF allocate grants for Egyptian institutions, while the National Academies allocate grants for US institutions. As a result of differences in administrative protocols, the signing of the two grants (one by STDF and one by the National Academies) and the disbursement of funds may not transpire concurrently in each country.

Achievements and impact

Between 1995 and 2020, the Joint Fund has backed 551 two- to three-year basic and applied research projects, engaging with 173 US and 67 Egyptian universities and research institutions. This concerted effort has produced over 564 research papers and 13 patents, embodying the fund's collaborative drive to proffer solutions to global developmental challenges. In 2018 alone, 15 collaborative research grants amounting to US$5 million were approved, targeting critical areas for both nations. These included the development of diagnostic tools for tick-transmitted diseases, a new avian influenza vaccine crucial for controlling the disease in Egypt, textiles imbued with antimicrobial and insect repellent properties, innovative rice straw-processing methods using steam explosion technology, and the fabrication of composite materials for the automotive and airline industries. The subsequent year saw the allocation of 14 joint research grants totalling US$4.5 million, aimed at exploring smart agriculture, energy storage, infectious disease control, desalination technology, and wastewater management and reuse. The persistent endeavours and resultant breakthroughs under the Joint Fund underscore its pivotal role in advancing scientific knowledge and addressing real-world challenges, producing significant impacts at both national and global scales.

Sources: USAID (2019); National Academies of Sciences, Engineering and Medicine of the US, 'U.S. - Egypt Science and Technology Joint Fund | National Academies'[28]; Science, Technology and Innovation Funding Authority of Egypt, 'STDF - Science and Technology Development Fund'[29]

Figure 4.6. Network analysis of support mechanisms used in STI policy instruments in Arab States



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Figure 4.6 depicts the main mechanisms used in the policy mix across countries in the region, with the node size indicating each mechanism's prevalence. The network highlights the top quartile of connections among these mechanisms, showing their inclusion in a country's policy mix. The network also demonstrates the connection strength between mechanisms

28 https://www.nationalacademies.org/our-work/us-egypt-science-and-technology-joint-fund (accessed 22 October 2023)

29 https://stdf.eg/ (accessed 22 October 2023)

through lines of varying thickness. This figure complements Table 4.8; the node sizes are consistent with the information in the table, but the network graph further clarifies the typical combinations of mechanisms used by the countries in the region. For instance, in the Arab States the only two mechanisms used in the policy mix of all countries for which the GO-SPIN platform has data of are "Technical and Business Assistance" and "Information and Knowledge Sharing Services", nonetheless the instruments "Competitive research grants" and "Scholarships, studentships, fellowships" follow very closely with presence in the vast majority of countries. The figure also reveals certain isolated nodes, indicating mechanisms less frequently included in the countries' policy mix.

4.3 Asia and the Pacific

The institutional strength of STI frameworks within the Asia and the Pacific region exhibits considerable diversity. Technological powerhouses such as Japan, South Korea and China and other emerging nations have strong science, technology and innovation (STI) governance systems, substantial investment and high productivity, complemented by continuous governmental support for STI. Concurrently, while at varied stages of STI system evolution, other countries in the region demonstrate a commitment to channelling resources and strengthening institutional backing for science, technology and innovation. Since the launch of GO-SPIN platform in 2018, the platform has gathered information on approximately 146 policy instruments from Asia and the Pacific, and supported capacity development to strengthen these STI policy frameworks.

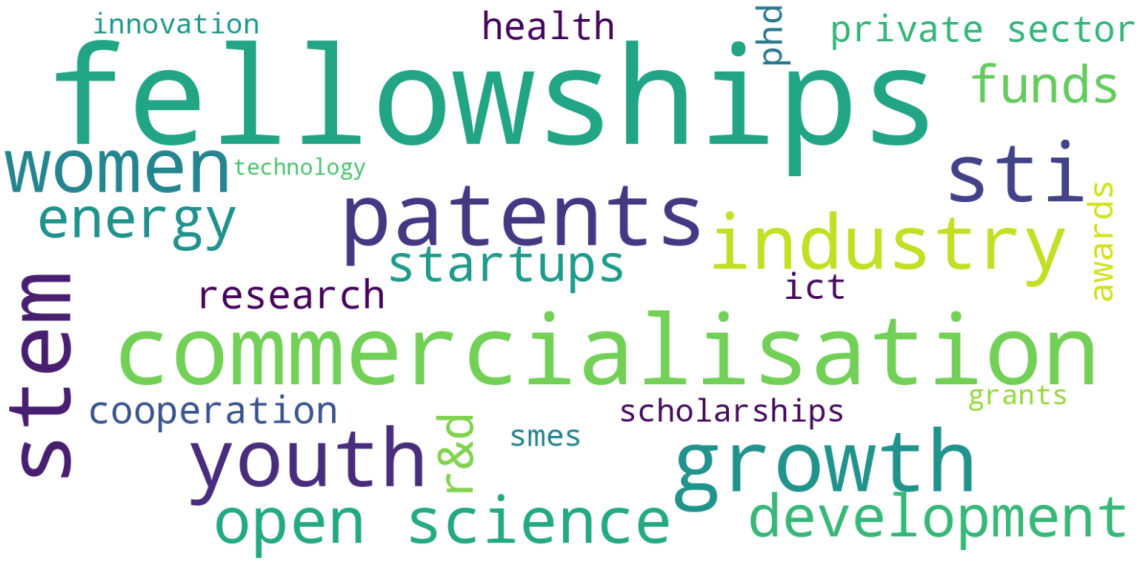
In 2017, the Association of Southeast Asian Nations (ASEAN) countries, recognizing the transformative power of innovation, adopted the ASEAN Declaration on Innovation. This document supports literacy in science, technology, engineering and mathematics (STEM), fosters a conducive regulatory environment for small and medium-sized enterprises (SMEs), encourages their participation in innovative activities, and leverages STI as a pivotal tool in achieving the SDGs, among other objectives (ASEAN, 2017).

Similarly, India has amplified its dedication to STI for the Sustainable Development Goals (SDGs). The nation cemented this political pledge through the 'STI for the SDGs Roadmaps', a strategic framework that accentuates priority goals, particularly SDG 2: Zero Hunger and SDG 3: Good Health and Well-being. This plan is implemented at the provincial level, ensuring tailored approaches that resonate with local realities. Countries in Central Asia have also reaffirmed their commitment to advancing science and technology. A prime example is the STI Agenda 2026, formulated by the Organisation of Islamic Cooperation (OIC). This agenda, featuring 12 critical priorities, advocates for concerted efforts in securing funding and strengthening the effective execution of STI initiatives, thereby catalysing regional development and solidarity among OIC countries (OIC, 2017).

The word cloud shown in Figure 4.7 highlights the importance of fellowships among STI policy instruments in the region, signalling a strategic investment in advanced human capital, particularly at the doctorate and post-doctorate levels. Countries such as Japan, India and Bangladesh have implemented various instruments emphasizing this area, including programmes with a specific focus on underrepresented groups such as Japan's Sechi Kato Programme for women, and initiatives aimed at supporting early career scientists, like India's Swarnajayanti Fellowships for young researchers and the new programme Women in Science and Engineering Post-Doctoral Fellowship (WISE-PDF).[30] Moreover, the analysis underscores a commitment to strengthening STEM fields, particularly among youth. Other themes emerging within the region are commercialization and patenting, notably driven by countries such as China and South Korea that perform well in global patenting activities. Similarly, nations in South East Asia, such as Malaysia are growing into innovation hubs, utilizing policy instruments to explicitly facilitate the task of introducing innovations to markets. An example of Malaysia's efforts is the R&D Commercialization Fund which finances the validation, implementation and commercialization of emerging technologies.

30 WISE-KIRAN, *WISE Post-Doctoral Fellowship (WISE-PDF)*, https://online-wosa.gov.in/wosa/aboutUsPDF (accessed 26 November 2023)

Figure 4.7. Word cloud of keywords in policy instruments from Asia and the Pacific



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

An example of an STI instrument that focuses on developing advanced human resources with an emphasis on youth is the National Science Fund for Distinguished Young Scholars (see Box 4.10). This instrument also emphasizes the prioritization of academic and educational institutions as end beneficiaries in the region, aligning with a wider trend in the region. According to data from GO-SPIN, these beneficiaries account for approximately 48 per cent of the region's instruments. The National Science Fund also represents a proactive approach to address critical national issues, such as limited capacity for renewing the researcher base and mitigating brain drain. Likewise, in response to the low female application rate in China as outlined in section 3.3, the instrument has been adapted to permit an extended age limit for women researchers submitting applications, thereby aiding in reducing this disparity.

One notable aspect of the instrument is its two-tiered selection process. Researchers must first obtain institutional support from their host institution. This requirement not only promotes confidence due to the substantial funding involved, but also streamlines the fund's selection process, serving as an initial screening stage. Additionally, it is important to highlight the institutionalized evaluation process of the fund, which facilitates the identification of challenges, such as women's participation, and promotes solutions to address them.

Box 4.10. China's National Science Fund for Distinguished Young Scholars

National context and challenge targeted

In the early 1990s, the majority of China's top scientific researchers were aged over 50. This presented China with the challenge of an insufficient number of younger scientists to refresh the pool of basic science researchers. In response, the Chinese government fostered the rise of young talent in science and technology, encouraging scholars abroad to return to China and expediting the growth of leading academic researchers on the global frontiers of science and technology.

Instrument

In March 1994, the government established the National Science Fund for Distinguished Young Scholars. Currently, each project awarded under the instrument receives a research grant of approximately US$384,000 for Mathematics or Management Sciences, and US$548,600 for other fields. As of 2022, this fund adopted a ceiling system under which the funder provides a lump sum but does not dictate the distribution of spending, affording research teams the discretion to allocate funds.

To qualify for the grant an applicant must: be under the age of 45, hold a senior professional position (title) or a PhD degree, have experience in leading basic research projects or conducting other basic research, not be employed by foreign institutions and commit to working at a national host institution for no less than nine months per year during the funding period. Postdoctoral

researchers and postdoctoral students are not eligible. Those who have already received a grant and are within the funding period are ineligible to apply for the National Science Fund for Distinguished Young Scholars.

Starting in 2024, the age limit for women researchers applying to the National Science Fund for Distinguished Young Scholars programme will be extended to 48 years old.

Implementation

The National Science Fund for Distinguished Young Scholars is managed by the National Natural Science Foundation of China (NSFC) and regulated by its Programme Management Measures.

The research grant is announced in the NSFC Guide to Programmes and on its website, typically one month before the submission period begins. Applicants initially submit applications to their host institutions through the NSFC system. Upon institutional approval, they are forwarded to the NSFC for eligibility checks based on programme-specific criteria. If rejected, applicants can request an eligibility recheck, with the NSFC required to respond within 60 days.

Following the eligibility check, NSFC employs a two-step review – review by at least three experts, followed by a panel review to shortlist and recommend applications for funding. Final funding decisions are communicated to applicants, who can request a secondary review if dissatisfied, with a 60-day response time from the NSFC.

Annually, a performance evaluation report is published by the NSFC, with the 2022 evaluation conducted by the National Center for Science and Technology Evaluation, assessing programme performances and suggesting improvements. Mid-term project progress is assessed by peer reviews organized by the NSFC, to determine continued funding.

Achievements and impact

From 1994 to 2020, the fund supported 4,582 projects with around US$1.4 million. In 2022, it received 4,612 applications, funding 415 projects with US$223.5 million. Of these, male researchers applied for 4,057 projects of which 359 were funded, while women researchers applied for 555 of which 56 were funded.

Statistics from 2017 show that principal investigators of funded projects secured additional financial support, indicating enhanced project management capacities. The scientific outputs of the 197 projects completed in 2017 gathered 111,209 citations, averaging 23.37 citations per article, significantly exceeding the international baseline of 11.80 times per article in 2016.

The instrument has contributed to the renewal high-level scientific researchers: 80.36 per cent of the "Academician of the Chinese Academy of Sciences"[31] under 60 elected in 2019 were supported by the fund, and all those under 50 had received support.

Sources: Fang et al. (2022); NSFC (2023); NSFC, 'Application Preparation and Submission'[32]; NSFC, 'National Science Fund for Distinguished Young Scholars Project Management Measures'[33]; Yu et al. (2021)

Governments fund STI through various strategic methods, with the primary and most intuitive among these being direct financial support, such as the provision of grants to support R&D and innovation initiatives. As shown in Table 4.9 and Table 4.11, governments are a leading funder and competitive grants are a popular mechanism to fund STI. However, the scope of government funding extends beyond direct financial contributions. Governments invest in mechanisms designed to create an enabling environment for STI to flourish. One such mechanism is the development and maintenance of information systems. These systems represent critical infrastructure collecting, processing and disseminating information crucial for efficient decision-making processes in STI investments.

31 Academicians is the highest title bestowed on scientists in China

32 https://www.nsfc.gov.cn/english/site_1/funding/E1/2022/01-12/25901.html (accessed 18 September 2023)

33 https://www.nsfc.gov.cn/publish/portal0/tab475/info70241.htm (accessed 18 September 2023)

Table 4.9. Funding sources used by STI policy instruments in Asia and the Pacific

Funding sources	Share of policy instruments
Government sector	94.44%
Rest of the world government sector	3.47%
Business enterprise sector	2.78%
Higher education sector	2.78%
Private non-profit sector	1.39%
Rest of the world higher education sector	1.39%
Rest of the world international organizations	1.39%

Note: A single policy instrument can use multiple funding sources.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

An example of such an information system is South Korea's National Science and Technology Information Service (NTIS) (see Box 4.11), an integral part of the country's efforts to foster an open science ecosystem. Through the NTIS the country integrates and provides open access to R&D outputs, among other information, enhancing the accessibility and dissemination of scientific and technological knowledge. The NTIS also plays a pivotal role in informing strategic decision-making at the policy level, particularly in critical areas such as funding allocation and sector prioritization.

However, the design and implementation of the NTIS posed several challenges. Obstacles emerged in harmonizing the disparate systems of multiple ministries and institutes, each of which oversees R&D project data in isolation, and in establishing a uniform protocol for the joint administration, distribution and application of these data. Another significant hurdle was the formulation of a needed legislative framework that enable the implementation of an information system with the expected pan-governmental reach but also ensure alignment with data privacy and security requirements. These challenges were mitigated through a concerted strategy emphasizing the active participation of all pertinent parties and the adoption of a multi-layered governance framework. This approach not only secured backing from the uppermost tiers of government but also instituted mechanisms to accommodate input from all stakeholders. This inclusive strategy extended to data providers, whose contributions were integral to refining the technical aspects of data architecture and connectivity, as well as the strategic facets of data curation, accessibility and application.

Box 4.11. South Korea's National Science and Technology Information Service

National context and challenge targeted

Prior to 2008, information on government-funded national R&D projects in the Republic of Korea was dispersed across various ministries and institutes. This fragmentation led to a lack of awareness about R&D activities undertaken by national entities, often resulting in redundant R&D investments. Recognizing this challenge, the government saw the necessity for a unified governmental cooperation system that facilitated the sharing and collective utilization of standardized R&D information.

Instrument

The National Science and Technology Information Service (NTIS) is the central portal that consolidates, analyzes and provides integrated access to a wide array of information related to national R&D projects and the science and technology field. Its primary objectives are to enhance national R&D investment efficiency by preventing duplicated investments and to bolster research productivity. The platform is designed to cater to a diverse audience, including researchers from universities, research institutes and enterprises. It also serves science, technology and innovation (STI) policy-makers and planners, R&D

project managers encompassing ministries and project management institutes, and is accessible to the general public, ensuring broad outreach and utility.

The NTIS offers an extensive range of information resources. These include announcements for R&D proposals from various ministries and project management institutes, details on project-affiliated researchers, project budgets and comparative data on similarities between projects. Additionally, users can access information on project outputs such as academic papers, patents and reports, with URL links to full texts when available. The platform also enables users to access STI statistics, information on trends in R&D investments, STI policy insights and visual maps that illustrate collaborative networks between researchers or institutes based on keyword searches.

Implementation

Operation of the NTIS is supported by several policy and legal frameworks that promote the development and use of STI knowledge management and distribution systems. Key among these are the Framework Act on Science and Technology, the National R&D Innovation Act and related presidential enforcement decrees. Additionally, the National R&D Information Processing Standard, established under the National R&D Innovation Act by the Ministry of Science and ICT, specifies the R&D information (i.e. metadata) that should be made available to the public via the NTIS system.

The Presidential Advisory Council on Science and Technology oversees the NTIS. It plays an overarching role, focusing primarily on deliberation over major issues concerning the effective dissemination and management of knowledge and information on science, technology and national R&D programmes. Further down the hierarchy is the NTIS Programme Implementation Committee, which possesses an oversight function, but also maintains a direct focus mainly on the coordination of key challenges linked to implementation of the NTIS.

On the operational front, the Ministry of Science and ICT, specifically the Science and Technology Information and Analysis Division, takes charge of coordinating the entire implementation and operation of the NTIS system. The Ministry has established an advisory system consisting of two main bodies: the Research System Advisory Group (comprising staff from pertinent ministries) and the Experts Advisory Group (consisting of experts nominated by relevant ministries). Together, they gather opinions and provide technical counsel about the system. An additional Experts Advisory Group, made up of team leaders from representative ministries and R&D project management institutes, deliberates on strategies for integrating various independent systems from ministries and institutes into the NTIS.

Hands-on operational responsibilities of the NTIS fall mainly to the Korea Institute of Science and Technology Information (KISTI), which collaborates closely with the Korean Institute of Science and Technology Evaluation and Planning (KISTEP). Their principal duties encompass establishing detailed NTIS development strategies, crafting and overseeing integrated systems, and ensuring seamless information sharing with 18 government ministries and R&D project management institutes, as well as ten major R&D output management institutes.

The NTIS service receives funding from the Korean government through the national R&D budget and functions as an ongoing R&D project. Between 2006 and 2023 the government has invested approximately US$6.5 million annually.

Achievements and impact

As of October 2023, the NTIS has provided access to over 9 million records pertaining to national R&D information. This included details on national R&D programmes and projects, human resources, members of project evaluation committees and R&D outputs (e.g. academic papers, patents, reports). Moreover, the NTIS has offered access to a collection of over 171 million records related to science and technology information. These records encompass various outputs (other than from national R&D projects), policy and technology trends and overseas R&D insights.

Projected impacts for the next five years (2023–2027) suggest significant benefits stemming from the NTIS, estimated at around US$830 million. These benefits are not just monetary but also strategic in nature. For instance, the NTIS aids in identifying and reducing duplicated R&D initiatives by evaluating each project proposal's similarity to existing ones. Furthermore, the system promotes research productivity enhancements by allowing for the reuse of open R&D information. This functionality has proven particularly valuable for tasks like scouting suitable R&D collaborators.

Source: Author from interviews

Fostering innovation within the region is a key goal, and is reinforced by the above-mentioned regional commitments and evidenced by a significant allocation of instruments dedicated to this purpose, as shown in Table 4.10. According to GO-SPIN data, the proportion of instruments aimed at this objective ranks second highest, following closely behind Africa.

As illustrated in Figure 4.7, the region exhibits a particular inclination towards the support of commercialization of R&D. Additionally, approximately 74 per cent of these instruments specifically target the private sector, reflecting a concerted effort to strengthen market-ready innovation and entrepreneurship and alignment with regional frameworks.

Table 4.10. Strategic objectives of STI policy instruments in Asia and the Pacific

Strategic objectives	Share of policy instruments
Human resources development	45.21%
Promotion and development of innovations	40.41%
Promotion of scientific knowledge production	33.56%
Ethical, inclusive and sustainable STI	19.86%
Strategic collaboration and policy support	19.86%
Research and innovation infrastructure	10.96%
Public engagement and popularization of science	9.59%

Note: A single policy instrument can target multiple strategic objectives.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

The Cambodian Entrepreneurship Development Fund (see Box 4.12) is an example of STI policy instruments supporting entrepreneurship. Implemented by a private autonomous organization, the fund orchestrates a suite of programmes designed to enhance entrepreneurial capabilities. These programmes focus on providing training, facilitating market connections for local small and medium-sized enterprises (SMEs) and start-ups, and offering access to financial resources. The financial access is promoting through seed investments, a support mechanism that is not widespread in the region (see Table 4.11). The initiatives have produced results in advocacy and capacity-building, with smaller accomplishments in the realm of financial support through seed investments.

A challenge confronting such instruments dedicated to financing innovative solutions is appraisal of the technical merit of proposed projects. On occasion, the required expertise for evaluating innovative ventures is lacking, rendering the technical viability assessment of projects a complex task. This evaluation deficit potentially jeopardizes investment schemes anticipating a return on investment, and mirrors analogous challenges encountered in appraising business plans. Therefore, a critical aspect of the implementation of such funds is the establishment of a proficient administering organization. Such an organization should combine business acumen with scientific insight across a spectrum of disciplines. This combination can furnish a comprehensive assessment of the projects' viability and projected impact, thereby navigating through inherent challenges and driving accomplishment of the instrument's goals.

Box 4.12. Cambodia's Entrepreneurship Development Fund

National context and challenge targeted

The Kingdom of Cambodia is confronted with the task of diversifying its economy, spurring innovation and providing quality employment opportunities for its growing young population. Cambodia has a nascent entrepreneurial ecosystem with 82 per cent of start-ups in their early developmental phase, and 18 per cent in the business scaling stage. A breakdown reveals that 17 per cent of these start-ups are working on technological innovations, 32 per cent are addressing gaps in existing value chains, while the remaining 43 per cent are traditional businesses carving out their niche in the market.

In response to this, the Pentagonal Strategy VI has been crafted as a comprehensive policy blueprint for growth, employment, equity and efficiency, developed in collaboration with key stakeholders and business leaders. Recognizing the importance of nurturing entrepreneurship, the government highlighted the need for a mechanism to cultivate a favourable environment for emerging businesses. Within this framework, the Entrepreneurship Development Fund (EDF) was introduced, underscoring the government's dedication to laying a strong foundation for the nation's entrepreneurial spirit.

Instrument

The EDF is committed to the long-term vision of cultivating a dynamic entrepreneurial ecosystem and bolstering a sustainable small and medium-sized enterprises (SMEs) sector that contributes meaningfully to Cambodia's economic growth. To bring this vision to fruition, the instrument has been structured around four programmes. The first, 'Capacity Upgrading', is geared towards fortifying abilities to access finance and seamlessly integrate technological and digital solutions into daily business operations. The second, 'Business Networking', is centred around developing robust market networks and simplifying market entry processes. The 'Culture Promotion' programme is designed to invigorate the foundations of entrepreneurship, particularly curriculum affiliation in the education system, with a view to increasing the number of quality entrepreneurs in the nation. Finally, the 'Seed Funding' programme offers financial grants to quality SMEs and start-ups in strategic sectors that showcase significant promise, ensuring they have sufficient capital to either commence or scale their ventures.

Implementation

The EDF is a Public Trust Fund that operates under the umbrella of the Ministry of Economy and Finance, as decreed by Prakas No. 135 SHV/BrK on 6 February 2019. A distinctive feature of the EDF is its governance structure. The strategic decision-making body, the Board of Trustees, is made up of distinguished members from the public, private and international sectors. These individuals are chosen based on their expertise and experience within their industries. To ensure the fund's objectives are met, the Board has instituted two entities: the Secretariat Office and Khmer Enterprise. The former is dedicated to the ongoing study and monitoring of policies and programmes to bolster start-ups and SMEs; the latter is tasked with executing the policies ratified by the Board through the deployment of its central programmes.

The EDF operates on foundational principles aimed at maximizing impact. These include ensuring synergistic stakeholder interactions, budgeting predicated on key performance indicators, employing a public-private partnership approach for programme delivery, and striking a balance between ecosystem needs and programme objectives.

To ensure transparency and integrity, the fund is rigorously audited by a globally renowned private firm. Internal audits are also conducted, guided by a meticulously crafted manual.

Achievements and impact

In 2021, the Secretariat Office designed the Medium-Term Strategic Framework for 2021–2023, conducted research on potential agricultural exports, assessed the business impacts of the COVID-19 pandemic and facilitated stakeholder engagements to enhance exports. They also conducted hands-on visits to potential enterprises and processing units.

The EDF played an important role supporting Cambodia's entrepreneurial ecosystem. Under the Capacity Upgrades programme they implemented 14 projects, with 110 additional beneficiaries receiving support, bringing the total to 184 beneficiaries. Through the Business Networking programme, Khmer Enterprise organized 4 networking events and established collaborations with 13 local partners, 11 international partners and 4 public authorities, totalling 28 partners.

Through the Cultural Promotion programme, they developed 52 pieces of content, including 49 promotional videos, and launched an online outreach campaign that amassed 860,000 posts. Lastly, under the Seed Funding programme, Khmer Enterprise implemented 24 assistance package grants, 12 export grants, and 6 grants for food safety and quality upgrades. They also organizes four Khmer product fairs, further supporting and promoting local products.

Sources: Author from Interviews; Khmer Enterprise (2020); Khmer Enterprise (2021)

Table 4.11. Support mechanisms used in STI policy instruments of Asia and the Pacific

Support mechanisms	Share of policy instruments
Competitive research grants	38.81%
Scholarships, studentships, fellowships	25.37%
Others	13.43%
Technical and business assistance	11.94%
R&D and innovation funds	10.45%
Information and knowledge-sharing services	9.70%
Tax and fiscal incentives	7.46%
Ecosystem and infrastructure development	6.72%
Seed and venture capitals	4.48%
Infrastructure grants (research facilities, labs, instruments)	2.99%
Matching grants	1.49%

Note: A single policy instrument can use multiple support mechanisms.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration. Data from the UNESCO GO-SPIN platform

Mongolia's Mon-X instrument (Box 4.13) has adopted a distinctive strategy in its effort to cultivate a culture of innovation and fortify entrepreneurial capabilities. This initiative seeks to nurture social innovation by actively engaging citizens in addressing societal challenges unique to Mongolia. Different regions are factored into the selection criteria of beneficiaries and the identification of priority areas. The programme's execution is facilitated through a public-private partnership, initiated following the government's tendering process. This strategy was employed to harness specific expertise not readily available within governmental structures, thereby enabling more flexible and responsive programme implementation. The success of this public-private partnership is attributed to the symbiotic utilization of complementary skills, significantly benefiting the instrument's overall objectives.

A notable feature of the instrument is its strong regional orientation, embedded from the conceptualization stage. However, the inclusion of various regions, especially those analogous to Mongolia's remote and nomadic areas, introduced complexities during the instrument's dissemination phase. Implementing visibility campaigns and illustrating the modality of programme participation presented logistical challenges. Furthermore, with diverse priorities and societal challenges varying across regions, assembling a panel of experts with the appropriate breadth of knowledge to offer pertinent advice to entrepreneurs proved equally demanding. One of the standout achievements of the programme was Demo Day, an event drawing on the proven competencies of government agencies in organizing STI expositions and similar events. This event was complemented by a well-curated panel responsible for evaluating and selecting the winners, reflecting the programme's comprehensive approach to fostering innovation and entrepreneurial spirit within the region.

Box 4.13. Mongolia's Mon-X

National context and challenge targeted

Mongolia's science, technology and innovation (STI) system faces several challenges. A primary obstacle is insufficient funding and investment in R&D. Additionally, the country's small domestic market is often overwhelmed by imports, potentially stifling local technological progress and innovation. There is also a significant gap in understanding and applying intellectual property rights. This lack not only inhibits innovation but also leaves domestic research vulnerable. In addition, many skilled professionals are leaving Mongolia in pursuit of better opportunities, leading to a shortfall in local expertise. In response to these challenges, the government is emphasizing the development of an innovation-driven mindset among its citizens. This is especially important since innovation can offer solutions to pressing societal issues affecting the country. For example, the impacts of climate change on Mongolia's pastoral societies can lead to socio-economic disruptions.

Instrument

Mon-X is a programme designed to support initiatives that solve problems affecting Mongolian regions and communities, drawing on the participation of citizens through innovation. The instrument focuses on advancing social innovation by fostering a collaborative environment where citizens and the public can actively participate in addressing pressing societal challenges. This approach emphasizes the promotion of individual initiatives while also nurturing an overarching culture of creativity and innovation within the broader community.

The instrument was designed by the Ministry of Education in consultation with various non-governmental organizations (NGOs) experienced in supporting innovation and with start-ups knowledgeable in adapting methodologies to better support a culture of innovation in the country. The instrument has two primary components. The first is centred on promoting and enhancing innovation capacity throughout Mongolia. The second consists of a staged competitive process that results in grants for exceptional products or services presented to the programme. These stages are complemented by training and mentoring to bolster product and service development competencies and solidify the project's business justification. Each winning team receives a grant of US$5,700.

The priority areas delineated by the instrument align with societal challenges identified in Mongolia. Examples of these priorities include: advanced processing of leather, wool and cashmere; manufacturing of thermal materials; introduction of new fuel materials; and the creation of food, human medicines, vaccines and bioproducts using cutting-edge biotechnology derived from agricultural and natural resources, among others.

Implementation

Mon-X is overseen by the Ministry of Education and Science and funded by Mongolia's STI Fund with an overall budget of US$150,000. The programme is implemented through a public-private partnership, established through a public tender according to the Public Procurement Law of Mongolia. Criteria for selection include cost, experience in start-up activities, expertise in organizing similar events, human resources, and experience in training and disseminating knowledge in STI to the public, among other criteria.

Implementation began with the dissemination phase of the programme, which is complemented by capacity-building activities centred on innovation. The aim of this phase is to introduce the programme to various regions and communities throughout the country, and socialize the programme's objectives, anticipated impact, application process and requirements. Simultaneously, sessions designed to enhance knowledge in innovation and entrepreneurship were conducted, establishing a baseline of competencies that potential participants would need for the programme. However, the budget and expected geographic reach of the programme have posed challenges for the recruitment of trainers with sufficient expertise to maximize the impact of this phase.

During the next phase, participants can submit project proposals to the Mon-X website (www.mon-x.mn). Each application is screened to ensure accuracy and completeness, and selection is based on quality of the proposal and regional representation. A key selection criterion is that at least half of the chosen participants must come from provincial regions. The aim is not only to tap into local talent but also to address local challenges – another key selection factor. The results of the selection process, including comprehensive scoring, are posted on the website to ensure transparency.

Given the programme's primary objective of transforming these companies into start-ups, participants are offered online training and mentoring. This support is intended to solidify the start-up's business proposition and to foster the development of its product or service. After a second assessment, a Demo Day is organized where the business strategies and progress made in product or service development are showcased to a jury, which then selects the stand-out projects. The final winners benefit from continued mentoring and guidance.

Achievements and impact

In 2022, a total of 256 projects were registered. The initial selection shortlisted 50 projects, allocating five each to six primary Mongolian regions, with an additional ten projects chosen regardless of region. The second round narrowed the selection down to 18 projects, with 9 projects ultimately selected during the Demo Day.

Source: Author from interviews

Small Island Developing States (SIDS) face unique challenges and strategies pertaining to STI policy. These states, which are also present in other region such as Latin America and the Caribbean, and are characterized by their distinct geographical and socio-economic contexts, necessitate a tailored approach to STI policy. Box 4.14 explores this theme, highlighting how SIDS confront their specific challenges through innovative STI policies, and showcases brief examples of different SIDS leveraging STI to bolster resilience, drive sustainable development, and navigate the complex interplay of developmental, environmental and technological challenges.

Box 4.14. STI policy in Small Island Developing States

Small Island Developing States (SIDS) represent a distinct and important focus area of the global science, technology and innovation (STI) policy landscape. Their unique challenges demand specialized approaches to address their specific needs and contexts.

One example of such an approach is the Small Island Developing States Accelerated Modalities of Action (S.A.M.O.A) Pathway. Adopted in 2014, this international framework is geared towards the myriad needs of SIDS, covering areas such as climate change, disaster risk reduction, economic development, sustainable management of natural resources, health, education and social development. The SAMOA Pathway underscores the importance of enhancing SIDS' capacities in STI, recognizing these as crucial for tackling their distinct development challenges. It advocates for international cooperation, knowledge sharing and the integration of STI into broader development strategies to assist SIDS in overcoming obstacles and achieving sustainable development.

Despite their resource limitations, many SIDS have shown a commitment to establishing science policy instruments that bolster resilience, support sustainable development, and harmonize socio-economic and environmental objectives. For instance, various SIDS have initiated science grants and youth science programmes aimed at promoting STI. An example is the Caribbean Science Foundation's Student Programme for Innovation in Science and Engineering (SPISE), which concentrates on cultivating young talent in the Caribbean. These programmes are instrumental in supporting emerging scientists and fostering a culture of innovation aligned with the Sustainable Development Goals (SDGs)..

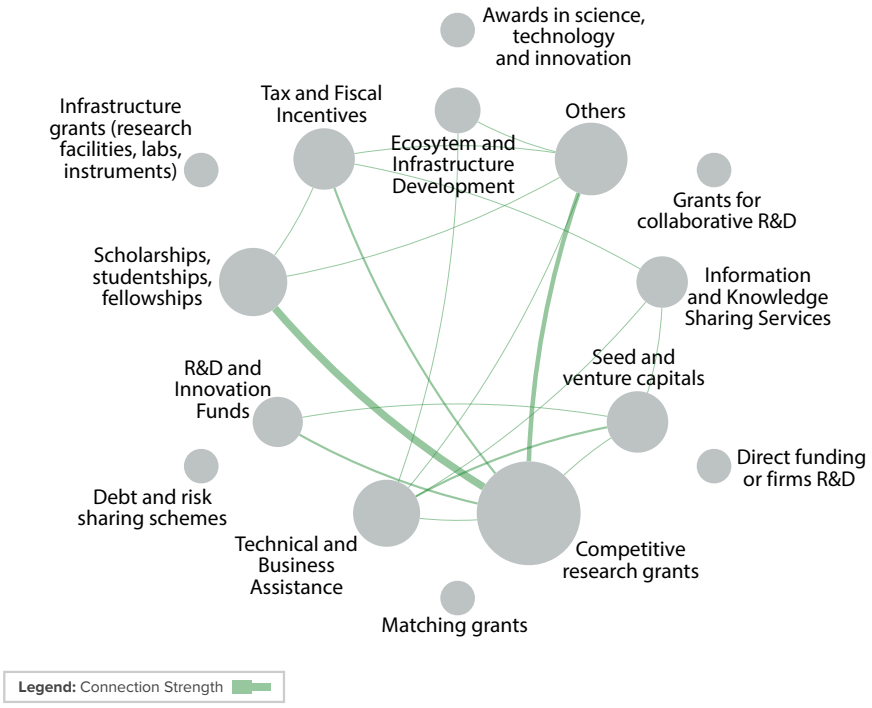
However, the prioritization of STI varies across regions. In the Pacific, for instance, the establishment of new institutions for science and technology often takes a back seat to more pressing concerns such as climate change and renewable energy. This gap in prioritization is exemplified by the unfulfilled proposal to set up a National Research Council in Fiji. Additionally, about half of the Pacific Island countries lack legal frameworks for research. Nevertheless, progress is evident in certain areas, such as Vanuatu's 2018 legislation to protect traditional knowledge related to genetic resources and the 2016 National Ocean Policy calling for a strategy for marine scientific research.

The Pacific Community Centre for Ocean Science, established in New Caledonia in 2015, demonstrates regional recognition of the need for research. This centre, hosted by the Secretariat of the Pacific Community, highlights the growing emphasis on sector-specific and regional-level research initiatives in the absence of dedicated national strategies or science advisory committees. These developments underscore the evolving landscape of STI policy instruments in SIDS, reflecting their steadfast efforts to navigate the intricate interplay of developmental, environmental and technological challenges.

Source: United Nations (2014); UNESCO, GO-SPIN platform[34]

34 https://gospin.unesco.org (accessed 24 October 2023)

Figure 4.8. Network analysis of support mechanisms used in STI policy instruments in Asia and the Pacific



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Figure 4.8 illustrates the predominant mechanisms within the policy framework for nations in this region, with the node dimension reflecting the frequency of each mechanism's usage. The depicted network emphasizes the upper quartile in terms of connectivity among these mechanisms, denoting their role in the nations' policy mix. Additionally, the network delineates the intensity of interlinkages between mechanisms via lines with varying widths. This visual aids in complementing Table 4.11; since the node dimensions align with the table's data, the graph provides further insight into the more common mechanism groupings adopted by the regional countries. In the case of Asia and the Pacific, "Competitive research grants" and "Scholarships, studentships, fellowships" are the sole mechanisms uniformly utilized in the policy mix of every country cataloged in the GO-SPIN database. Uniquely, this region features a variety of support mechanisms for STI, which do not fall under primary categories and are thus aggregated under "Other", this includes initiatives like training programs, forums, fairs, and exhibitions. The illustration also uncovers some stand-alone nodes, highlighting the mechanisms that are less integrated into the policy mix of these countries.

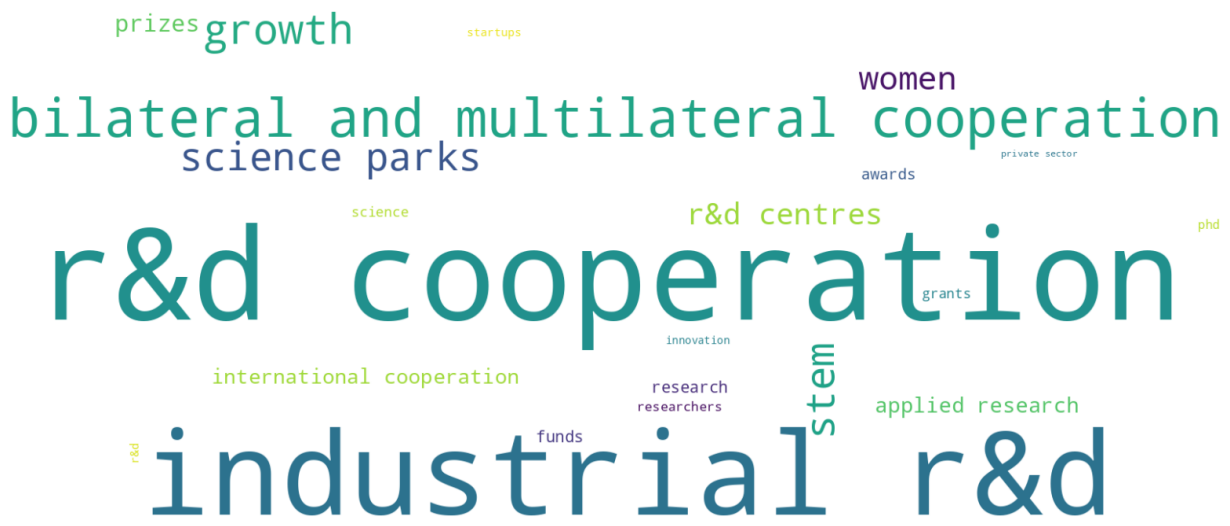
4.4 Europe and North America

In the Europe and North America region, institutional backing for STI is strong and well-coordinated through a myriad of policies and programmes at both the national and regional levels. In Europe, the European Commission (EC) spearheads the drive towards scientific and technological progress, most prominently through initiatives like Horizon Europe, the European Union's ambitious €95.5 billion funding programme for the 2021–2027 period. This effort is further strengthened by a plethora of national-level initiatives across individual European nations, which fuel and foster STI via research grants, tax incentives and the creation of science parks and innovation hubs. Institutional support for STI is equally noteworthy in North America, particularly in the United States and Canada, where federal and state governments, along with private sector partnerships, play a pivotal role in advancing the STI landscape. In the United States, funding programmes such as those managed by the National Science Foundation (NSF) and the National Institutes of Health (NIH), alongside state-funded research grants and private sector-led R&D initiatives, contribute significantly to the flourishing STI ecosystem. Similarly, in Canada, key federal agencies like the Natural Sciences and Engineering Research Council (NSERC) and the Canada Foundation for Innovation (CFI) are instrumental in supporting R&D activities. Since the inception of GO-SPIN in 2011, the platform has gathered information on approximately 192 policy instruments from Europe and North America, and

has supported capacity development to strengthen these STI policy frameworks.

A distinctive feature of the region, as depicted in Figure 4.9 is support for 'R&D cooperation'. The policy instruments documented in GO-SPIN for this region reveal three primary strategies directed at enhancing R&D cooperation. First, there is a concerted effort towards bilateral R&D collaboration, exemplified by programmes such as the Swiss Programme for International Research by Scientific Investigation Teams (SPIRIT) and Bilateral R&D Calls between the Slovak Republic and the Czech Republic. This strategy is further reinforced by comprehensive R&D and innovation initiatives financed under framework programmes such as Horizon 2020 and Horizon Europe, which advocate for extensive collaboration and joint research projects among European entities and beyond. Second, an emphasis on human capital development is observable through international scholarship agreements. Notable examples include the Swiss Government Excellence Scholarships for Foreign Scholars and Artists and the Romanian Bilateral Agreement Scholarships. These programmes are instrumental in fostering international academic exchange and nurturing a global cadre of scientists and innovators. The third approach centres on R&D cooperation within the business and enterprise sector. Specific programmes, such as the Project Centres for Multinational Companies and Israel's Bilateral Industrial R&D Cooperation Programmes with regions like Asia-Pacific and India, underscore this focus. Similarly, 'industrial R&D' is addressed by many STI policy instruments, a finding indicative of the regions' efforts to strengthen the connections between scientific research and industrial application.

Figure 4.9. Word cloud of keywords in policy instruments from Europe and North America



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Table 4.12 details how STI instruments are financed in the region. Governments bear a significant responsibility for funding STI, especially when the end beneficiaries are R&D entities. According to the GO-SPIN platform, 38 per cent of instruments with government funding have R&D entities as beneficiaries. In this context, it is crucial for governments to find alternatives to ensure that funds are allocated to those projects or teams best placed to utilize these resources effectively. Competitive grants are a popular option (see Table 4.14); however, they are better suited for financing individual projects. There is also a need for mechanisms to define institutional funding allocated to R&D institutes and universities.

Table 4.12. Funding sources used by STI policy instruments in Europe and North America

Funding sources	Share of policy instruments
Government sector	84.13%
Rest of the world government sector	9.52%
Higher education sector	7.41%
Private non-profit sector	6.35%
Business enterprise sector	5.82%
Rest of the world international organizations	5.82%
Rest of the world business	1.06%
Rest of the world private non-profit sector	0.53%

Note: A single policy instrument can use multiple funding sources.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Portugal has implemented an institutional evaluation methodology (see Box 4.15) to assess not only the quality, production and impact of R&D entities, but also to allocate resources based on merit. One of the challenges of such schemes is that they are resource-intensive in terms of time, effort and finances, which might deter some countries from participating or place a strain on government resources. For instance, the 2017/18 evaluation consisted of more than 40 evaluation panels, each comprising multiple expert evaluators from institutes around the world, bringing the total number of participating experts into the hundreds. Additionally, the evaluation includes visits requiring extensive logistical preparations. Another requisite for such evaluations is a methodology that is robust yet flexible and adaptable, given the diverse range of R&D entities with varying scopes of work across different countries within the STI ecosystem. This diversity poses a challenge in identifying evaluation criteria that remain fair for all entities involved. A significant aspect of this evaluation process is its assessment of not only the quality of past production but also the quality and prospects of future strategic plans. This approach yields valuable recommendations to further bolster the success and impact of the R&D entities.

Box 4.15. Evaluation of R&D entities of Portugal

National context and challenge targeted

Since 2014, government budget allocations for R&D per inhabitant in Portugal have increased steadily from approximately US$66.3 to US$85 in 2022, representing an increase of 28.1 per cent in eight years. However, this growth rate lags behind the consolidated growth of the 27 EU countries, which stood at 45.2 per cent over the same period. Given the competing demand for resources, Portugal sought ways to enhance the efficiency of its R&D investments. As one solution, the government devised a mechanism to evaluate R&D institutes in order to determine allocations for the pluriannual R&D budget of each institution. This process aimed to improve the quality and efficiency of research activities. By assessing the institutes' past achievements and future projections, the government sought to allocate funds in a manner that would most effectively promote scientific progress.

Instrument

The evaluation system for R&D institutes operates on a periodic basis, with assessments conducted every four to five years by panels of international experts. This evaluation takes into account the R&D activities undertaken in previous years, as well as plans set for the upcoming funding period. The process is complemented by direct interactions with researchers and visits to the respective units during the evaluation phase. At the conclusion of this comprehensive assessment, a quality score is assigned. This score then becomes the basis for determining the multi-annual funding amount until the subsequent evaluation.

R&D institutes that achieve ratings of 'Excellent', 'Very Good' or 'Good' are entitled to specific financial benefits. First, they receive Base Funding, which is adjusted in line with the institute's global classification and also reflects the quality and number of doctoral researchers affiliated with the institute. Second, they are eligible for Programmatic Financing. This type of funding is determined based on recommendations from the evaluation panel, which considers the institute's planned activities and any specific needs that have been identified. Programmatic Financing makes up about one-third of the total funding, and can be utilized in various ways, such as support for hiring doctoral researchers, funding for doctoral scholarships within accredited programmes where the Institute plays a significant role, assistance for participation in European and international networks or infrastructures, and other supportive measures.

The overall budget for the period 2025–2029 is approximately US$659 million of which two-thirds are designated to Base Funding and the remaining to Programmatic Financing. Private for-profit R&D Institutes are not evaluated or eligible for this funding allocation.

Implementation

The Foundation for Science and Technology (FCT) in Portugal manages the evaluation system and provides funds to R&D institutes. This system aligns with the legal framework for R&D institutions (Decree-Law No. 63/2019 of May 16, 'Science Law'), which outlines the general principles of the evaluation, funding and the valorization, access and dissemination of knowledge.

Evaluations are based on voluntary applications from R&D institutions with a minimum of ten full-time equivalent R&D personnel. Applications should detail the composition of the R&D institute, including managing and participating organizations, a description of the institution, its primary scientific contributions, the team of researchers and activity plans for the upcoming period.

The evaluation is conducted by panels organized in scientific fields and composed of internationally recognized evaluators. Each evaluation panel assesses five or more R&D institutes. Their responsibilities encompass assessing R&D units' activities, strategies and future plans, and producing detailed consensus reports with guidance for the subsequent five years. The panel also conducts site visits, which include an R&D institution presentation, facility inspections, interviews with key staff and a private panel session to determine visit findings. They also propose funding allocations and potential adjustments to future plans. Ultimately, the panel compiles a report on the evaluation areas and offers suggestions to enhance the performance of the evaluation system and the Portuguese STI system.

R&D institutes are scored on a scale of 1–5 on three main criteria: (i) quality, merit, relevance and internationalization of R&D activities carried out by integrated researchers over the past five years. (ii) merit of the integrated researchers' team, and (iii) appropriateness of the objectives, strategy, activity plan and organization for the next five years. The first criterion is the most crucial as it highlights previous contributions, followed by the second, the researchers' team merit, and then the third, the unit's future intentions.

The evaluation system incorporates a procedure for submitting and assessing complaints. These complaints are reviewed by a second panel of independent experts who may advise either upholding or altering the decision regarding the periodic evaluation and the designated funding.

Post-evaluation, R&D institutes are required to provide annual progress reports and a comprehensive final report detailing all activities sanctioned for financing. Progress reports should succinctly outline the work done, results achieved and any deviations from the proposed activity plan or the approved budget. These reports should also consider the unique attributes of each institute to ensure the respect, appreciation and preservation of diversity among R&D units. The final report should offer an in-depth account of the work executed during the specified period, encompassing scientific and technical perspectives, knowledge dissemination, societal transfer, internationalization and knowledge valorization. It should highlight the team's primary contributions and management methods, along with a detailed list of publications and other outcomes from the activities, including advanced training initiatives.

Achievements and impact

During the 2018 evaluation process, 348 R&D institutes applied of which 62 were new units and 4 resulted from mergers, totalling 19,418 researchers. The evaluation involved 224 international evaluators from 26 countries, 35 per cent of whom were women, spread across 32 panels. These panels, further supported by 31 external experts from 12 countries, remotely assessed applications and visited all institutes between 17 September 2018 and 21 June 2019.

Some 88 per cent of the evaluated R&D institutes received an 'Excellent', 'Very Good' or 'Good' rating. Some 95 per cent of researchers are hosted by institutes rated as 'Excellent', 'Very Good' or 'Good'. Following this outcome, the FCT funds units rated Excellent, Very Good and Good, allocating €420 million for 2020–2023. Additionally, these units will receive 1,600 new doctoral scholarships, representing an investment of €106 million.

The evaluation reports for each institute also contain specific assessments and recommendations that contribute to improvement of the institutions' plans and organization for the upcoming period.

Source: FCT, 'FCT publishes results of the Evaluation of R&D Units'[35]; FCT (2019); FCT (2023a); FCT (2023b); FCT (2024)

The region holds the distinction of having the largest share of policy instruments (30 per cent) aimed at the objective of ethical, inclusive and sustainable STI (see Table 4.13). Instruments that target this objective are designed to foster a more equitable and responsible STI ecosystem, encapsulating measures such as equitable access to technology, adherence to ethical research guidelines, and the encouragement of environmentally sustainable practices in scientific and technological advancements.

Table 4.13. Strategic objectives of STI policy instruments in Europe and North America

Strategic objectives	Share of policy instruments
Human resources development	36.46%
Promotion of scientific knowledge production	34.90%
Ethical, inclusive and sustainable STI	30.21%
Promotion and development of innovations	27.60%
Strategic collaboration and policy support	20.83%
Research and Innovation Infrastructure	17.19%
Public engagement and popularization of science	10.42%

Note: A single policy instrument can target multiple strategic objectives.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

The United Kingdom of Great Britain and Northern Ireland (UK) has launched the Industrial Strategy Challenge Fund (see Box 4.16), a policy instrument employing a challenge-driven approach to tackle the nation's pressing challenges, framed by an industrialization strategy. This initiative not only aims to prepare the country for the future, but also ensure that society is well-positioned to reap the benefits from these developments. Challenges, as instruments for promoting innovation and problem-solving, are designed to engage a broad spectrum of stakeholders in collaborative efforts. They create a platform where individuals and organizations can come together to address specific issues, often with the incentive of rewards or recognition for successful solutions. Through such challenge-driven initiatives, a conducive environment for creativity, competition and cooperation is created, catalysing viable solutions for complex problems.

One of the key activities within this type of instrument is engaging with stakeholders to identify challenges. These

35 https://www.fct.pt/media/noticias/fct-publishes-results-of-the-evaluation-of-r-d-units/ (accessed 13 October 2023)

challenges not only need to align with existing sectoral policies and strategies, but also require stakeholder buy-in, obtained through their active participation and responsiveness to their needs. However, the stakeholder engagement process adds complexity, costs and time to the instrument's implementation, making it crucial to find an appropriate balance to ensure efficiency and effectiveness. The UK addressed this challenge by progressively increasing the level of stakeholder engagement in subsequent rounds of challenge conception. Another area of complexity lies in the support mechanisms used for each challenge. While generic types of support mechanisms exist that are flexible and usable in different contexts with minor adaptations, addressing complex challenges often necessitates multiple types of support mechanisms. This requires careful consideration of stakeholders' capacities, the market, regulatory context and other factors to identify the appropriate choice and combination of mechanisms. The UK, with its long-standing experience in funding STI through agencies like Innovate UK, has institutionalized various types of support mechanisms, facilitating the successful deployment of varied mechanisms.

As noted earlier, a common area for improvement across most instruments is enhancing the outreach and accessibility of call and application processes. This needs to be strengthened to broaden participation, improve the quality of applications and enhance the efficiency of the selection process. Similarly, a recurring area for improvement is monitoring and reporting, especially at the funding level for the Industrial Challenge Fund, as processes at the project level are well-established by agencies like Innovate UK or the Research Council (Zakaria et al., 2023).

Box 4.16. United Kingdom's Industrial Strategy Challenge Fund

National context and challenge targeted

In 2017, the UK Industrial Strategy set a course for Britain's future, aiming to assist businesses in creating enhanced, higher-paying positions throughout the country. This strategy signifies a major commitment to investing in the skills, industries and infrastructure of the future. Within its framework, the strategy identifies 'Grand Challenges' across diverse sectors such as healthcare, robotics, clean energy and artificial intelligence.

Aligned with this overarching strategy, the UK Industrial Strategy Challenge Fund (ISCF) was established with the main goal of bridging the gap between research and commercial application. Through financial backing and nurturing strategic partnerships, the ISCF aims to advance the development of innovative solutions to grand challenges defined in the UK's Industrial Strategy. ISCF represents the most significant increase in UK science and innovation funding in over 40 years and a key element in achieving the government's ambitious target for the UK to spend 2.4 per cent of GDP on R&D by 2027. The ISCF is supported by approximately US$4 billion of public funds, and complemented by industry contributions, the collective investment in R&D exceeding US$6.5 billion.

Instrument

The ISCF is a challenge-driven research and innovation funding programme. Within a framework established by the 2017 UK Industrial Strategy, the ISCF introduced a total of 20 distinct 'Challenges', each of which is tailored to fostering collaborative, cross-sector research and innovation I initiatives specific to a sector or thematic domain. Across all the ISCF Challenges, there are five main objectives: (i) to amplify the R&D investments made by UK businesses while simultaneously strengthening R&D capabilities and infrastructure; (ii) to champion both multidisciplinary and interdisciplinary research approaches; (iii) to intensify the collaboration between the business and academic sectors; (iv) to nurture synergies between new, smaller enterprises and their larger, established counterparts within the industry's value chain; and (v) to position the UK as an attractive destination for foreign R&D investments.

The fund offers a mix of both traditional and novel funding mechanisms, distributed across the distinct challenges in alignment with the unique market demands of each. The instruments provided encompass collaborative R&D grants with a distinct category for bilateral collaborative grants, research grants and support for the establishment of Centres of Excellence. There are also demonstration grants designed to bridge beneficiaries and supply chains for tailored solutions, feasibility study grants and the development of investment accelerators to mitigate the risks associated with private investments.

Given the variety of funding instruments and challenges, the support provided differs. For instance, feasibility studies, with eligible costs typically ranging from US$325,000 to US$650,000, contrast sharply with the development of Centres of Excellence, where budgets can reach up to US$26 million. Collaborative research grants usually fall between US$2.6 million

and US$5.2 million. The eligibility criteria for each instrument vary based on the nature of the opportunity and the ISCF main objectives. Some grants require the project to ensure 100 per cent co-founding from external partners, while feasibility studies often necessitate the inclusion of at least one small and medium-sized enterprise (SME) and require leading academic institutions or research and technology organizations to apply with external partnerships.

Implementation

The ISCF was announced in 2016, and the first wave of challenges was approved in 2017. In April 2018, UK Research & Innovation (UKRI) was established and charged with overseeing implementation of the ISCF. The fund was initially funded by the Department for Business, Energy & Industrial Strategy (BEIS), but by 2023, the ISCF-related segment of BEIS had transitioned to the Department for Science, Innovation and Technology (DSIT).

In addition to the above-mentioned fund oversight level, the ISCF is implemented through a multilevel structure comprising fund-level, challenge-level governance. Each challenge is developed and implemented by its own governance structure, which in turn reports and contributes to a broader fund-level governance structure, which is supervised by the ISCF Steering Board. Challenge-level governance structures comprise programme boards and advisory groups, Challenge programme teams and Challenge Directors (industry leaders drawn from the relevant sectors recruited to provide strategic leadership and oversight to the challenges). Each challenge is allocated distributed ISCF funds through a range of funding mechanisms and strands designed to support challenge aims and wider fund-level objectives.

As of 2023, there have been three waves of challenges with evolving selection methodologies. In the first wave, challenge selection was conducted by the BEIS, while the most recent iteration included a comprehensive stakeholder engagement process. This process started with expressions of interest submitted to the academy and industry to identify potential challenges related to the Grand Challenges, especially those lacking alternative investment avenues. Following this step, UKRI shortlisted challenges in alignment with the Grand Challenge criteria. This shortlist underwent a review and approval process involving both BEIS and UKRI officials and the Secretary of State. UKRI then drafted a comprehensive business case detailing fund objectives, co-investment targets and management strategies, which was submitted for approval to both the BEIS and HM Treasury. Once approved, UKRI launched competitions for individual projects within the challenges, leading to the awarding of grants. The overall process takes approximately 72 weeks.

Competition assessment processes and monitoring and evaluation processes build on the internal practices of organizations such as Innovate UK, or Research Councils that manage each competition.

UKRI estimated in 2019, that it needed 186 full-time equivalent staff to administer the ISCF.

Achievements and impact

As of 2021, UKRI has invested US$2.3 billion, which helped to mobilize US$595 million from the private sector. The ISCF has identified 24 industrial and societal challenges for which it ran 175 competitions. The fund financed 1,111 projects of which 249 have already been completed. Some 44 per cent of projects funded by ISCF are collaborations between academia and industry. Overall, 1,672 business and 169 academic institutions have been involved.

In terms of impact, and looking at the projects already completed, turnover across the companies involved has grown by over US$1.2 billion.

Source: National Audit Office of the UK (2021); UKRI (2021); BEIS (2017); Zakaria et al. (2023)

Similar to other regions, the most used support mechanisms in the Europe and North America region are competitive research grants, accounting for 45.6 per cent of total policy instruments in GO-SPIN (see Table 4.14). One example of such instruments is the Serbian Research and Innovation Fund (Box 4.17). The fund is a key state entity aimed at enhancing the nexus between science and the economy, and fostering new and strengthening existing innovative enterprises through diverse financial tools. One notable initiative of the fund is the Matching Grants Programme, designed to fuel the knowledge-based growth of innovative enterprises, incentivize international partnerships and augment the number of technology-centric companies. The fund also provides a variety of grant opportunities targeted at young entrepreneurs and start-ups. These include

mini grants for technological innovation, matching grants for the commercialization of research and development, and a collaborative grant scheme for joint R&D projects aimed at new product and service creation. Furthermore, under the Serbia Research, Innovation and Technology Transfer Project, the fund works alongside the Ministry to escalate R&D and innovation in Serbia and to trial a technology transfer system to nurture a knowledge-based economy. It also periodically issues calls for grant proposals aimed at spurring the innovative development of Serbian enterprises.

Table 4.14. Support mechanisms used in STI policy instruments of Europe and North America

Support mechanisms	Share of policy instruments
Competitive research grants	45.60%
Scholarships, studentships, fellowships	15.93%
Others	14.84%
R&D and innovation funds	12.64%
Ecosystem and infrastructure development	11.54%
Information and knowledge-sharing services	7.69%
Technical and business assistance	7.69%
Infrastructure grants (research facilities, labs, instruments)	3.85%
Tax and fiscal incentives	2.20%
Seed and venture capitals	1.65%
Grants for collaborative R&D	1.10%

Note: A single policy instrument can use multiple support mechanisms.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Box 4.17. Serbia's Research and Innovation Fund

National context and challenge targeted

As Serbia positions itself for EU membership, a key priority is increasing competitiveness within the European market. A structural shift in Serbia's growth model was seen as essential, calling for enhanced productivity and a move towards higher-value-added production to strengthen competitiveness and stimulate economic growth. A strategic approach to achieve this aim includes fostering enterprise innovation through increased and more efficient investment in applied R&D, alongside support for the commercialization of research, enterprise formation and the expansion of small and medium-sized enterprises (SMEs).

In alignment with this strategic direction, the Serbian government enacted the Law on Innovation Activity in 2005, which has since undergone several updates, most recently in 2021. These legislative measures aim to improve conditions for the development of innovation activities and to facilitate the integration of Serbia's innovation system into the European Research Area and the Innovation Union. A key instrument introduced through this law is the provision of financial support to innovative enterprises and projects, with a view to driving economic growth and development.

Instrument

The Innovation Fund of Serbia supports the development of innovation through comprehensive support mechanisms that include financial aid, technical assistance and advisory services. The key objectives include fostering ties between science,

technology and the economy, promoting innovative entrepreneurship, and facilitating collaboration between research organizations and private entities for innovation commercialization.

The programmes offered by the fund include:

- *Mini Grants Programme*. Targeting young, private enterprises involved in technological innovation, this programme offers up to US$130,000, accounting for up to 70 per cent of the total project budget, with the requirement that the applicants contribute a minimum of 30 per cent from other private sources.
- *Matching Grants Programme*. Aimed at enterprises seeking substantial funds for R&D commercialization, this programme provides up to US$540,000 for micro and small enterprises, or up to 60 per cent for medium enterprises, requiring them to fund at least 30-40 per cent of the project budget.
- *Collaborative Grant Scheme Programme*. This programme encourages joint R&D projects between the private sector and public R&D organizations to create innovative products, technologies and services. It offers up to US$540,000, covering up to 70 per cent of the budget for small companies, or 60 per cent for medium-sized companies, with a 30–40 per cent co-financing requisite.
- *Katapult*. This accelerator programme offers entry grants from US$22,000 to US$54,000 and co-investment grants matching up to US$325,000 post-acceleration over 12–24 months for start-ups with market traction aiming to scale up.
- *Smart Start*. This programme supports the validation of business ideas and the development of prototypes or minimum viable products, with funding that can cover a maximum of 90 per cent of the total project budget, up to a ceiling of approximately US$58,000.
- *TT Programme*. This programme focuses on building capabilities in technology transfer with full funding of approved project costs up to approximately US$26,000.
- *Innovation Vouchers*. Designed to financially motivate SMEs to engage with R&D institutions, this programme provides vouchers that cover up to 60 per cent of service costs, up to approximately US$9,000.
- *Serbia Ventures – Biotech Programme*. This programme encourages private investment in biotech-focused start-ups, with potential funding up to US$5.4 million, contingent on securing initial investments within a designated period.

Implementation

The Innovation Fund of Serbia, established under the Law on Innovation Activities, is a state instrument dedicated to advancing innovation through the management of financial aids and support services. In 2021, it expanded its competencies to maintain a Register of National Innovation System Entities, which includes innovation and infrastructure entities and business angels. The fund has an autonomous management structure, international auditing, and an Expert Commission of international and diaspora professionals.

Management and oversight of the fund are executed by representatives appointed by the Serbian Government to its Management and Supervisory Boards, with their roles defined in the fund's statute. The fund is steered by a director and a five-member Board of Directors, responsible for operations, while a three-member Supervisory Board monitors the fund's work.

In 2021, the fund implemented an integrated management system, and attained ISO 9001:2015 and ISO 37001:2016 certifications, representing a commitment to a continuous process and quality improvements to meet user needs and maintain trustworthiness. Procedures and employee training for ongoing enhancement are thoroughly documented.

An Expert Commission, formed via a transparent competitive process, evaluates and selects projects for funding. The Commission, as well as overall fund operations is guided by comprehensive guidelines, such as programme operational manuals, instructions for conducting project monitoring, public procurement procedures manuals, co-financing handbooks and many other operational documents.

The fund conducts regular monitoring through various mechanisms tailored to each programme, which include site visits and surveys, among other methods. Certain programmes, such as the Collaborative Grant Scheme Programme, maintain monitoring for up to five years after their conclusion.

The fund's activities are financed not only by the Serbian Government's budget but also through international cooperation funds such as those of the European Union, the World Bank or other bilateral agreements. Government sources contribute approximately 60 per cent of the fund's inflows, covering operational and project funding.

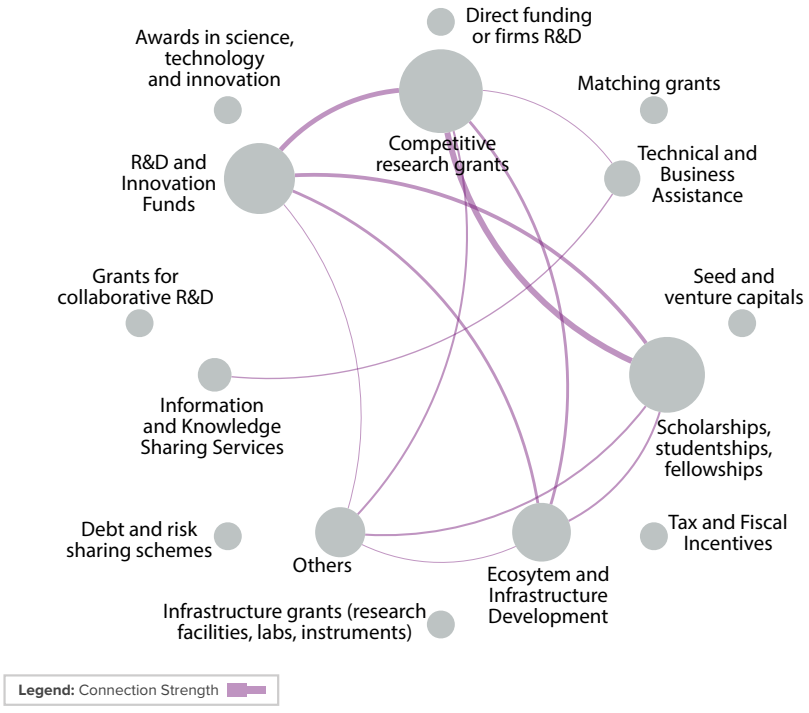
Achievements and impact

From 2011 to 2022, the fund approved approximately US$79.9 million for various initiatives. It distributed approximately US$57.7 million to 392 projects via programmes like Smart Start, Mini Grants, Matching Grants and the Collaborative Grant Scheme. Additionally, innovation vouchers worth approximately US$5.4 million were awarded to 979 entities, roughly US$3.2 million funded proof of concept and technology transfer, approximately US$2.1 million aided Katapult Acceleration Programme participants, and about US$10.9 million were invested in venture capital funds.

Additionally, in 2021, 76 per cent of Collaborative Grant holders and 54 per cent of Matching Grants recipients saw an increase in sales, while 79 per cent of Collaborative Grant holders and 62 per cent of Matching Grants recipients increased their employee numbers.

Source: Innovation Fund of Serbia (2022); Innovation Fund of Serbia, 'Innovation Fund'[36]

Figure 4.10. Network analysis of support mechanisms used in STI policy instruments in Europe and North America



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Figure 4.10 showcases the predominant mechanisms within the policy framework for nations in this region, with the node size indicating each mechanism's prevalence. The depicted network shows the top quartile in terms of connectivity among these mechanisms, representing their inclusion in the nations' policy mix. Moreover, the network maps out the intensity of interlinkages between mechanisms via lines with varying widths. This figure contributes to a better understanding of Table 4.14; while the node dimensions align with the table's data, the figure offers additional insights into the more common

36 https://www.inovacionifond.rs/en/ (accessed 8 November 2023)

mechanism groupings adopted by the regional countries. In the case of Europe and North America, "Scholarships, studentships, fellowships" and "Competitive research grants", are the primary mechanisms uniformly utilized in the policy mix of every country cataloged in the GO-SPIN database, followed closely by "R&D and Innovation Funds". The figure also reveals some isolated nodes, emphasizing the mechanisms that are less integrated into the policy mix of these countries.

4.5 Latin America and the Caribbean

Many countries in Latin America and the Caribbean have instituted public policies and policy instruments to address major issues limiting the advancement of science, technology and innovation (STI). These policies span various areas, from supporting the generation of scientific knowledge to fostering business innovation and entrepreneurship. Similarly, governments are undertaking efforts to strengthen institutional capacity to design and implement successful policies. Key target areas include the organizational structure of the public sector overseeing these policies, as well as the technical, operational and political capacities of relevant public institutions or agencies. Since the inception of GO-SPIN in 2011, the platform has collected information on approximately 773 policy instruments from this region, and has supported capacity development to bolster these STI policy frameworks.

The word cloud shown in Figure 4.11 illustrates the region's emphasis on specialized 'human resources', a term aligned with other keywords such as 'postgraduates' and 'postdocs'. This means that countries are implementing instruments that support higher-level education in order to develop a critical mass of researchers, setting the foundation for a knowledge economy. The policy instruments employed in this context are predominantly scholarships and competitive research grants with explicit components for postdoctoral development. The prominence of the keyword 'networks' implies that the region's policy-makers have recognized the need to foster synergistic collaborations across the STI landscape. Around 30 per cent of countries in the region with available data in GO-SPIN, and 50 per cent of countries in Latin America, feature instruments incorporating this keyword. The tools designed to support networks include competitive grants fostering these connections, as well as information and knowledge-sharing services.

Figure 4.11. Word cloud of keywords in policy instruments from Latin America and the Caribbean

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

As part of human resources development initiatives, some regional policies and instruments are prioritizing underrepresented stakeholders including women and Indigenous communities. Such approaches foster a culture of inclusivity and enable nations to harness a variety of perspectives and skills, which can be instrumental in driving innovation and enhancing organizational performance. This not only promotes diversity and inclusivity, it also reflects a broader societal commitment to equity which benefits advancements in STI. An example of one such initiative is Guatemala's Digital Literacy Workshops for Indigenous Peoples (see Box 4.18).

Through the implementation of these digital literacy workshops, Guatemala has worked to bridge the digital divide for women in Indigenous communities. This initiative has proven successful in not only developing digital skills but also in empowering individuals through the promotion of entrepreneurial capabilities. This contributes to securing livelihoods and alleviates some facets of existing inequalities ingrained in practical customs.

A highlight of the implementation approach used for this initiative is collaborative engagement with local communities. This necessitates partnerships with local entities that are closely aligned with the end beneficiaries. Such partnerships instil trust within the community, given the local partners' familiarity and rapport with the community members, and play a pivotal role in operational aspects such as coordination and the planning and selection of participants, among other benefits.

As the programme unfolded, new thematic areas emerged, requiring collaborations on the part of government to develop content specifically tailored for Indigenous women. As a consequence, constant evolution is at the core of the training programme, underscoring the need for a nuanced approach when working with Indigenous communities, as the introduction of new technologies can potentially provoke culture shocks. For instance, the deployment of video conferencing services may initially feel unnatural to these communities, necessitating a period of adaptation before proceeding with the courses and promoting its use. Such sensitivity to cultural and contextual dynamics is imperative in designing an effective training programme, and underlines the need for a specialized training team that is not only cognizant of local dynamics but also proficient in navigating them. Another insight that emerged from this initiative is the importance of utilizing native languages in programme delivery. However, this simultaneously poses challenges as it can be arduous to find experts proficient both in the programme's content and the pertinent native languages.

Box 4.18. Guatemala's Digital Literacy Workshops for Indigenous Peoples

National context and challenge targeted

Guatemala is among the countries with the highest proportion of Indigenous population in Latin America. According to the Population and Housing Census of 2018, the Guatemala has a population of 14.9 million inhabitants, with 6.5 million (43.75 per cent) self-identifying as members of Indigenous or Afro-descendant communities. Regarding literacy, interethnic disparities predominantly affect Indigenous women: 36.7 per cent of Indigenous women aged 15 and above are illiterate, compared to 9.6 per cent of non-Indigenous men within the same age bracket.

In response to this situation, Guatemala launched the Strategy for the Inclusion of Women and Indigenous Peoples in Science, Technology and Innovation, recognizing Indigenous knowledge and its contribution to Guatemala's development. This initiative promotes activities to strengthen the participation and inclusion of women in science, and to encourage, from childhood, adolescence and youth, interest in scientific and technological vocations.

Instrument

The Digital Literacy Workshops for Indigenous Peoples are biannual events aimed at strengthening understanding and proficiency in utilizing technological tools among Indigenous communities. The workshops are designed to foster empowerment, nurture entrepreneurship skills and assist individuals in establishing their own businesses. The overarching goal is to mitigate existing inequalities and significantly enhance digital inclusion for women residing in rural areas.

The workshops last a total of 20 hours divided into five-hour days for groups of 20 to 30 people. An important aspect of the training curriculum is the design, which ensures coherence with Indigenous knowledge and emphasizes mutual support and solidarity among women participants, with a view to making the content more accessible and relevant to participants. The instrument also includes a follow-up component, ensuring sustained support and furthering the engagement necessary for

meaningful application of skills acquired during the workshops. The workshops offer a blend of theoretical knowledge and practical application, better positioning participants to leverage digital resources, and contribute to the broader objective of socio-economic uplift within their communities.

Implementation

The instrument is operationalized by the National Secretariat of Science and Technology (SENACYT) of Guatemala, which oversees implementation of the training workshops and funds them through its institutional budget. The workshops are implemented by a contractor tasked with designing the programme curriculum, which is formulated in collaboration with, and ratified by, SENACYT. The contractor is also responsible for identifying and onboarding trainers, and for overall execution of the training sessions.

The contracting firm must possess particular areas of expertise including: understanding Indigenous knowledge, exhibiting gender sensitivity, and possessing the flexibility to navigate administrative requirements associated with government contracting, such as credit prerequisites and bureaucratic paperwork. Post-training, the contracting firm provides follow-up reports to assess the retention of knowledge among participants.

Beyond the partnership with the contracting firm, SENACYT collaborates with local entities such as non-governmental organizations (NGOs) or local governmental bodies. This collaboration assists with various logistical and operational aspects of workshop implementation, such as identifying beneficiaries, a process underscored by certain prerequisites like access to personal computing devices and the internet which, given the budgetary constraints, cannot be provided by the training workshop. The collaborative efforts involved also extend to other logistical considerations, such as the procurement of suitable venues for the training sessions.

Furthermore, SENACYT collaborates with government agencies to fill gaps identified in the training programmes, such as the delivery of microfinance sessions facilitated by the Ministry of Economy.

Achievements and impact

Between 2022 and 2023, SENACYT conducted five workshops across different regions of the country, attracting overall between 100 and 150 Indigenous women. These workshops have facilitated the intergenerational transmission of Indigenous traditions and knowledge, such as crafts made from tule. Through digital platforms, Indigenous women are able not only to sell their products but also to demonstrate how to replicate the creation of these crafts, thereby transmitting knowledge across generations.

The iterative approach and positive outcomes have enabled the workshop to evolve into a permanent institutional activity. The goal for 2024 is to increase the frequency from more than two workshops to six workshops per year.

Source: Author from interviews

National governments are typically the main funders of STI policy instruments, as illustrated by Table 4.15. Beyond mere resource allocation, there is a pressing need for governments to ensure the efficient utilization of these resources. Governments therefore need to design, implement and foster a coordinated approach in supporting STI systems. A coordinated approach inherently promotes the efficient use of resources, mitigates redundancy and optimizes the impact of allocated funds. This overarching goal is encapsulated by strategic collaboration and policy support (see Table 4.16).

Table 4.15. Funding sources used by STI policy instruments in Latin America and the Caribbean

Funding sources	Share of policy instruments
Government sector	95.26%
Business enterprise sector	6.06%
Rest of the world international organizations	4.35%
Rest of the world government sector	3.95%
Higher education sector	2.37%
Private non-profit sector	1.05%
Rest of the world higher education sector	0.53%
Rest of the world business	0.40%
Rest of the world private non-profit sector	0.26%

Note: A single policy instrument can use multiple funding sources.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Colombia provides an example of a such coordination instrument. ArCo aims at enhancing the efficiency of public spending (see Box 4.19) through strategic coordination, minimizing function overlap among different entities, streamlining operations and improving governance structures.

The success of this initiative depends on a high level of government commitment, demonstrated by the implementation of formal directives ensuring the participation of all government agencies. However, these directives are not sufficient in and of themselves to ensure participation and success. An initiative like ArCo, which necessitates the involvement of multiple government stakeholders and the collection of extensive data from various programmes and agencies, requires not only motivated stakeholders but also an easily implementable methodology that does not excessively burden government officials. The methodology deployed by ArCo included simple questions, with a reasonable workload for survey completion, despite the multiple engagement points required. Furthermore, to facilitate the process and ensure data quality, the team behind ArCo conducted numerous training sessions to equip stakeholders with knowledge of the methodology and its impact, thereby increasing motivation while also facilitating the participation. This process made operationalization more efficient by reducing data curation efforts.

Continuity and high-level support are crucial for ensuring the sustainability and effectiveness of such initiatives. Streamlining the offerings of policy instruments was also necessary given the need to align or at least not conflict with the interests of various stakeholders. If similar streamlining recommendations are generated periodically by ArCo and left unimplemented, it creates political pressure on the decision-makers involved.

Furthermore, the execution of ArCo not only streamlined the STI support offer in the country, it also offered insights into the design quality of these programmes. Approximately 50 per cent of the scrutinized programmes lacked a logical framework, highlighting a challenge at the design stage. Going forward, ArCo has pinpointed areas for additional work, including implementation monitoring and impact evaluation.

Box 4.19. Colombia's ArCo

National context and challenge targeted

Historically, Colombia has exhibited low investment in R&D, with expenditure reaching 0.32 per cent of GDP in 2019. In comparison, aggregated expenditure for R&D in Latin America and the Caribbean during the same year was 0.67 per cent. Additionally, while Colombia offers a wide array of instruments to support science, technology and innovation (STI) through multiple government bodies, these are difficult to discover or access, constitute one-time offers or are unpredictable over time. As of 2023, 135 instruments of different types are used to promote research, offered by 42 institutions. Only 51 per cent of these instruments are accessible virtually and only 42 per cent are offered on a constant basis.

To address these issues, the Colombian government turned its attention to improving the efficiency of investments in STI, rather maintaining a narrower focus on increasing available resources. Implementation of a dedicated tool to enhance coordination among policy instruments and the organizations offering them, was expected to simplify the offer and facilitate access for end beneficiaries.

Instrument

The Administrative Department of the Presidency of the Republic of Colombia and the National Planning Department (DNP) revamped tools developed for a STI public expenditure analysis conducted in 2015 in collaboration with the World Bank. The resulting instrument, Articulation for Competitiveness (ArCo), was based on five principles: (i) ex-ante analysis of instruments to enhance the agility and efficiency of decision-making; (ii) synchronization with the government's budget cycle to ensure that recommendations are implementable; (iii) provision of intermediary results for organizations offering instruments to facilitate decision-making processes; (iv) user-oriented design to reduce the burden on organizations participating in the coordination instrument and improve access for end beneficiaries; and (v) fostering of policy learning to maintain the instrument through several iterations and enable the collection and application of lessons learned.

The ArCo coordination methodology encompasses the following steps: (i) policy instrument mapping based on a standardized survey in which entities are asked about the objectives, users, types of intervention and resources of their instruments; (ii) functionality testing and auto-diagnosis of aspects related to the design, implementation, monitoring, evaluation and governance of the policy instruments; (ii) development of technical recommendations; and (iv) the implementation of these recommendations and the development of a consolidated instrument offer accessible to end beneficiaries.

Implementation

The ArCo instrument is implemented on a yearly basis by the DNP supported by a technical secretariat hosted by the DNP's Department of Science, Technology and Innovation. ArCo has received institutional support from the highest levels of the Colombian government through a presidential directive and a DNP operational circular. These documents established a mandate for all government organizations offering STI policy instruments to participate in ArCo activities.

Policy instrument mapping is completed via an online survey that incorporates a functionality test. This survey is designed to reduce the response burden on organizations, with 90 per cent of questions requiring either a 'yes' or 'no' response. The survey is conducted at two distinct points throughout the year. When the government defines the Annual Operational Investment Plan, organizations complete the survey with tentative maximum limits of the instrument's budget. The survey is reviewed once more when the General National Budget Liquidation Decree is issued, which defines each organization's definitive budget allocation for the following year. Policy instrument mapping and the functionality test are subject to a data validation step executed by the technical secretariat to verify the information provided by the organizations and to ensure data quality and coherence.

After performance of the mapping exercise and the functionality test, the results are shared among the technical directorates of DNP and all surveyed organizations as part of a participatory process to formulate recommendations. Any organization can submit a recommendation to the technical secretariat.

Recommendations are structured according to five levels: (i) *rescind, terminate instruments* that do not respond to the needs of end beneficiaries and/or to the nation's policy objectives; (ii) *fusion, integrate instruments* within the same entity

that provide the same type of support, with the same objective and to the same end beneficiary; (iii) *define roles, integrate instruments* between organizations providing the same type of support, with the same objective and towards the same end beneficiary in order to offer them a single entry point; (iv) *packaging by types of support, integrate instruments* between organizations that provide different types of support, albeit oriented towards the same objective and end beneficiary; and (v) *generate routes, development of support packages* targeting different objectives for the same end beneficiary, but grouping instruments offering different support from different organizations.

The Technical Secretariat is responsible for the consolidation and curation of the recommendations received. Some of these recommendations are implemented without the need for escalation to higher authorities, while others demand more complex decisions that need to be escalated to the respective ministers. The latter process can take place within the framework of the National System of Competitiveness and Innovation or via bilateral meetings between ministers.

Finally, the offer of policy instruments is consolidated and presented to all end beneficiaries online at www.innovamos.gov.co.

The Technical Secretariat is composed of four individuals employed by the DNP who coordinate implementation of the ArCo initiative. The staff within the Technical Secretariat do not dedicate their full time to implementing this scheme, as they are also have other responsibilities within the DNP. The estimated annual cost of implementing the scheme is approximately US$61,823 consisting of both direct and indirect costs. Direct costs comprise personnel expenses and IT infrastructure, and total US$49,403. Indirect costs are associated with the time invested by more than 800 stakeholders participating in the mapping exercises and the development of recommendations, and amount to an estimated US$12,420.

Achievements and impact

In 2018, the ArCo coordination instrument was piloted on a small scale. It has subsequently been implemented systematically across three national budget cycles, the most recent being 2022/23, adding other topics such as productivity, entrepreneurship, and financial inclusion. Since its introduction, it has generated over 200 recommendations, 70 of which have been successfully implemented. These recommendations have contributed notably to decreasing the quantity of policy instruments from a peak of 614 in 2021 to 417 in 2023.

Source: Author from interviews

Additionally, government funding is often used to address market failures and bridge the gap between various strategic objectives. In the case of Chile, the government aimed to competitively provide core funding to establish and operate research centres, transforming the R&D landscape in Chile by aligning academic pursuits with the practical demands of the productive sector. Box 4.20 describes how this instrument is reshaping the Chilean R&D sphere, catalysing a new era of knowledge transfer and industry-academia collaboration.

Box 4.20. Chile's Scientific and Technological Centres of Excellence with Basal Funding

National context and challenge targeted

In Chile, R&D capabilities have traditionally been centralized in a few key institutions, with universities taking the lead in knowledge generation. While these universities have long-standing connections with society and industry, such ties were largely limited to outreach and engagement activities. Furthermore, there was an apparent significant gap in private sector R&D investment, especially among SMEs, accompanied by a lack of collaborative effort between academia and industry.

In this context, the National Council for Innovation and Development (CNID) identified a key obstacle hindering efforts to enhance knowledge transfer capacity in national centres. Current evaluation systems were prioritizing indicators of scientific excellence rather than measuring impact and outcomes related to technology and knowledge transfer. This led to an incentives problem, with national centres more focused on scientific production than knowledge transfer.

In response to these challenges, the government recognized the need for an instrument capable of realigning incentives and establishing an ecosystem where scientific inquiry is directly linked to industry and business needs. Such an ecosystem is seen as a essential to help Chile become more competitive on the global stage.

Instrument

The proposed solution was the creation of Scientific and Technological Centres of Excellence with Basal Funding, an initiative designed to address national challenges and foster global connections by advancing research in alignment with the needs of the productive sector. Accordingly, this mechanism aims to connect academic excellence with industrial and commercial advancements, thus promoting innovation through technology transfers, patent creations and knowledge dissemination. The centres are designed to facilitate the development of a critical mass of high-level researchers, encouraging companies to adopt innovative practices, and fostering sustainable synergies between science and the business world. This strategic approach is intended to shift Chile from a state of limited private R&D investment to a future where innovation is a defining characteristic of its economic and societal framework.

Each centre is required to have at least six principal researchers, ensuring a robust blend of basic and applied research. In terms of funds, basal funding covers a significant portion of recurring operational costs. This approach provides stable, long-term financial support, allowing the centres to maintain an adequate level of activity and attract additional resources from various sources. The funding model comprise a mix of public funds for scientific research, augmented by private and foreign contributions (20 per cent of the total budget). Additionally, the duration of basal funding is set for five years, with the option of renewal for another five-year period, contingent on the centres' performance and budget availability.

Implementation

Implementation is handled by the National Agency for the Development of Chile (ANID), led by the Centres themselves and the Associative Research Sub-Directorate. Calls for the creation of centres are planned in accordance with budget availability and do not have a pre-established frequency. The budget for the 2021 Call was approximately US$16.2 million.

The process starts with information about the call and application process communicated to all relevant stakeholders. Proposals received undergo an admissibility check to ensure they meet all submission requirements and contain accurate information. Those that fail this stage are declared inadmissible, although applicants can appeal this decision within five business days.

Admitted proposals are then reviewed by two or more international evaluators based on criteria of scientific excellence, adequacy of human resources and the potential to generate new capacities, as well as aspects relating to the Centre's operational strategy, links with the environment, capacity to transfer knowledge and results, organization and governance.

Proposals are also subject to a financial and economic evaluation carried out by a national panel of experts. This evaluation assesses: (i) the potential economic or social impact on Chilean production and service offerings; (ii) the clarity and relevance of the technology transfer and knowledge-sharing strategy for different sectors; (iii) organizational adequacy to meet the proposed objectives and associated ability to attract additional, non-public competitive resources; and (v) coherence of the financial plan and appropriateness of the budget and funding sources.

The proposals are then ranked based on the average score of the above evaluations. The highest-scoring applicants are then invited by an International Advisory Panel to present their Development or Continuity Plans through an oral presentation and may also involve a site visit to obtain a comprehensive view of facilities, operational environment and resources. In situations where finalist proposals obtain identical merit scores, the panel employs a set of prioritization criteria to determine the selection, starting with gender-related factors and regional representation.

Concluding this process, the International Panel conducts final evaluations for each presented proposal. They compile a list of recommendations, accompanied by detailed justifications. This list may also include suggestions and potential conditions to be met during the adjudication process, ensuring a comprehensive and fair assessment of each proposal.

The list may also be modified by the Technical Advisory Committee, a body which can consider additional factors such as the centre's mission alignment, the potential of set goals to achieve programme objectives, the proportion of existing funding in the relevant scientific and technological field, the need to address knowledge gaps in the country. For centres submitting Continuity Plans, the assessment examine how they have implemented public funding already received. The Committee then proposes a final list, specifying any conditions for awarding and the maximum subsidy amount for each proposal. They also create a waiting list of proposals that could receive funding if additional budgetary funds becomes available. Successful applicants are then notified, leading to the signing of a funding agreement that outlines their rights, obligations and financial aspects. Applicants may appeal the decision within five business days following publication of the results.

After the launch of the centres, ANID, with support from the Technical Advisory Committee and international experts, oversees operations. This oversight encompasses evaluation of activities in accordance with the overall plan for the centre, project results, scientific credibility and visibility, dissemination beyond academic circles, governance, alignment of the centre's objectives and collaboration with diverse stakeholders. Centres are required to submit Technical Reports at least annually, providing detailed updates on project progress. These reports may be augmented or substituted by on-site visits.

A centre's plan is deemed complete once its objectives and results are achieved, the final Technical Report is approved, financial commitments are met and public access to the scientific data is secured. Centres have the option to request an extension of up to 12 months, without extra funding, to finalize the plan. After the end of the financing the supported centres are evaluated by the international panel according to their own development plan.

In case of technical or financial non-compliance, ANID will enforce administrative collection procedures and execute guarantees to safeguard the project's technical and financial integrity.

Achievements and impact

As of 2023, 20 centres have received support. According to an evaluation covering the period 2007 and 2019, all centres saw an increase in scientific publication, particularly in engineering, with research quality also improving as evidenced by the impact of the journals where articles were published. In terms of human capital formation, student involvement grew across the centres, with some leading in student numbers and thesis supervision. Regarding knowledge transfer and linkage, there was an overall rise in patent applications and grants. However, outcomes varied significantly among centres in regard to the creation of spin-off companies and the integration of postgraduate students and post-doctorates into the industry. Only six centres managed to acquire 20 per cent of their funding from the private sector, reflecting diverse success levels in technology transfer.

The basal-funded centres significantly boosted scientific collaboration, as shown in Table 4.16 by the increased number of co-authors per publication, especially international co-authors, and more extensive collaborations with various institutions. Additionally, the centres were involved in diverse collaborative ventures with external parties, encompassing joint research and development projects, technical support, and innovation and development activities. This multifaceted engagement positively impacted the broader community, with 54 per cent of surveyed companies acknowledging the centres' substantial economic and social contributions.

One concrete example of this impact is the collaboration between the Institute for Complex Systems Engineering (ISI), the Ministry of Health and ENTEL during the COVID-19 pandemic, which used complex systems analysis and anonymized data to identify areas where quarantine breaches were common. This data-driven approach informed targeted COVID-19 testing and educational campaigns. Additionally, ISI's work assisted in monitoring hospital bed availability, helping to manage healthcare resources more effectively. Their analysis notably quantified the impact of these initiatives in terms of lives saved, showcasing the power of interdisciplinary collaboration in addressing public health crises.

Source: Author from interviews; Verde Ltda (2021)'; ANID, 'Concurso Nacional de Financiamiento Basal para CCTE 2021'[37]

37 https://anid.cl/concursos/concurso-nacional-de-financiamiento-basal-para-ccte-2021/ (accessed 21 August 2023).

The Scientific and Technological Centres of Excellence with Basal Funding provide several lessons. First, this instrument highlighted the need to improve the bases of competition in terms of technological transfer. For Chile, it became apparent that the required 20 per cent of funding supplied from sources other than the public sector was insufficient for sustainable operation and impact. This realization led to the creation of a dedicated unit for technology transfer and extension within the centres, addressing the gap between research and practical application in industry. Support to enhance the visibility of these centres is crucial, which involves striking a balance between available resources and the need for greater public awareness and industry engagement.

Second, effective communication strategies are crucial, and comprehensive training sessions are required to disseminate information about these centres and their objectives. Emphasis should be placed on the importance of technology transfer in the evaluation process to align with the instrument's main goals and minimize the likelihood of receiving basic research proposals.

A third significant lesson is the need to shift the focus of the evaluation process towards outcome-based evaluations. This shift would reduce the administrative burden of applying for and monitoring grants and entails streamlining financial reporting. Public reports should be issued monthly and private ones quarterly to alleviate operational challenges faced by the centres. An associated focus on enhancing metrics for technology development and transfer has aimed to more accurately capture the centres' effectiveness in bridging the gap between academic research and practical, marketable innovations. This ensures that the centres contribute meaningfully to R&D and not merely pursue academic curiosity.

When reflecting on the broad spectrum of STI policy instruments deployed across Latin America and the Caribbean, a significant emphasis emerges on cultivating a skilled workforce to drive scientific and technological progress. In this context, approximately 45 per cent of these policy instruments showcased here focus on human resources development, as detailed in Table 4.16. Furthermore, 67 per cent of these instruments specifically target R&D professionals as beneficiaries, underscoring a strategic focus on bolstering educational programmes and skills development. These initiatives also seek to enhance the quality of research and elevate the recognition of scientific careers.

Table 4.16. Strategic objectives of STI policy instruments in Latin America and the Caribbean

Strategic objectives	Share of policy instruments
Human resources development	44.98%
Promotion and development of innovations	37.94%
Promotion of scientific knowledge production	32.72%
Strategic collaboration and policy support	12.26%
Public engagement and popularization of science	9.65%
Research and innovation infrastructure	5.87%
Ethical, inclusive and sustainable STI	5.48%

Note: A single policy instrument can target multiple strategic objectives.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

One such instrument focused on human resources development and recognition is the Mexico's State Researcher System (see Box 4.21). This system tries to identify active researchers and reward them for the quality of their scientific work. A notable aspect of this instrument is its implementation by the federal government of the state of Tabasco, as opposed to the national government of Mexico. In Mexico, the federal model of governance entails a division of powers between the national government and individual states, each with its own set of regulations and policies such as STI. This model allows states like Tabasco to implement localized initiatives such as the State Researcher System, catering to the specific needs and priorities of their scientific communities, while still operating within the broader framework of Mexico's national STI policy.

Box 4.21. Mexico's State Researcher System

National context and challenge targeted

Human resources for science, technology and innovation in the state of Tabasco, Mexico, face several challenges. Despite a population of 2.4 million, the proportion of residents with advanced degrees is low: as of 2016, 1.2 per cent hold a Master's degree and only 0.18 per cent have attained a doctorate. While there is a notable inclination towards postgraduate studies in the social sciences, education and business, there is a clear deficit in technical fields and engineering. Furthermore, accredited postgraduate education is largely confined to three institutions, narrowing both the accessibility and diversity of advanced courses. This landscape threatens the state's economic dynamism, as the prevailing oil and gas sectors mainly fuel growth in the real estate services, yet have minimal influence on knowledge-driven sectors.

Instrument

The State Researcher System (SEI) of Tabasco is a mechanism that identifies active researchers in the state who are producing quality scientific work. These researchers are both symbolically and financially rewarded for their contributions (e.g. academic papers, patents, etc.). An integral component of this system is the State Researcher Registry (PEI), a database that provides insights into the characteristics of the state's scientific community. The SEI is expected to contribute to the generation of knowledge in the field of scientific research and technological development in the state of Tabasco.

Implementation

The Science and Technology Council of the State of Tabasco (CCYTET) is the primary body responsible for the funding and execution of activities related to the SEI. Implementation is supported by the state's Science and Technology Promotion Law, which seeks to acknowledge notable research institutions and professionals.

The SEI operates under an internal regulation delineated by the Board of Directors of CCYTET. This specific regulation, coupled with the call for proposals, prescribes the criteria for SEI admission and determines the beneficiaries of the system's incentives.

The SEI process functions as follows. Initially, the Directorate of Training Resources and Support for Researchers of CCYTET drafted a call for proposals, including guidelines and incentive allocations based on scoring. This proposal was then reviewed and refined by the SEI's Advisory Council, which is composed of representatives from both state universities and wider industry. Once ratified, the proposal was made public, and an online application registration process began.

In subsequent phases, the Directorate assesses the scientific contributions of applicants. Simultaneously, the Advisory Council undertakes a comprehensive review of all applications. After evaluations are finalized, the outcomes are validated in a meeting of the Advisory Council and then relayed to the applicants. In cases of discrepancies or disputes, a designated period is set aside for appeals. This entire procedure culminates in a formal awarding ceremony.

Achievements and impact

SEI membership has expanded from 53 in 2000 to 921 in 2022. When adjusted for the population of Tabasco, this equates to a rise from 2.9 to 22.9 SEI researchers per thousand population between 2000 and 2022.

In the early stages of the instrument, all selected SEI researchers were granted financial incentives. However, by 2022, only 59.7 per cent of them received such benefits. Additionally, the average incentive diminished from US$371 in 2000 to US$91 in 2022. In 2022, the top 10 scored researchers received approximately US$592.

Scientific output has been increasing, with scientific, technological or innovative products reported by SEI members, growing from 1,154 in 2019 to 1,953 in 2021.

Source: Consejo de Ciencia y Tecnología del Estado de Tabasco, 'Consejo de Ciencia y Tecnología | Del Estado de Tabasco | CCYTET'[38]; Gualavisi et al. (2023)

38 https://www.ccytet.gob.mx/index.html (accessed 9 October 2023)

Since its inception, the State Researcher System has successfully supported and motivated researchers to conduct high-quality scientific work, significantly contributing to expanding the researcher base in the region. However, as this base continues to grow, the system faces challenges concerning the efficacy of its incentives. One aspect of these challenges is budgetary; the proliferation of researchers implies a dilution of financial incentives, rendering them less substantial. Additionally, the system is witnessing a generational shift within the researcher base. This renewal presents an opportunity to engage younger researchers and establish structured career development paths, fostering a conducive environment for long-term growth and continuity in scientific exploration.

A complementary example of instruments supporting the development of human resources is the Paraguayan programme detailed in Box 4.22, which aims to create and strengthen postgraduate programmes. This initiative addresses the lack of a critical mass of researchers due to limited offer of adequate education programmes.

Advanced postgraduate studies not only cultivate a cadre of well-trained experts in various fields but also enhance the quality and quantity of research output. By investing in these programmes, countries can ensure a steady flow of skilled researchers equipped with the knowledge and tools necessary to drive technological advancements and tackle complex challenges. Moreover, a robust postgraduate education infrastructure attracts global talent, encouraging knowledge exchange and collaboration.

Such improvement in the quantity and quality of human resources has been pursued by Paraguay since 2014. The initiative for the Creation and Strengthening of Master's Degrees and Doctorates of Excellence has allowed for institutional learning, improving the application process by upgrading from paper applications and physical submissions to digital information systems. The systems involved have adopted open data principles, contributing to the process's credibility and transparency. Applicants can create profiles, fill in their basic information and documents, which, once validated, do not need to be resubmitted for future applications.

However, it is well known that the application and evaluation processes of these instruments are complex. Therefore, a good practice is to periodically reengineer these processes, incorporating feedback mechanisms with beneficiaries to improve operations, including by defining roles, functions and implementing suitable information systems.

The main challenge, however, lies in the fact that institutional learning is often embedded within individuals. Public organizations frequently do not employ essential staff for the implementation of these programmes on a permanent basis. As a result, when funding ceases, these valuable, trained human resources are often forced to leave the organization. This leads to a loss of accumulated knowledge and expertise. Additionally, it necessitates the retraining of new individuals in processes with steep learning curves once funding becomes available again.

Box 4.22. Paraguayan instrument for the creation and strengthening of Master's degrees and doctorates of excellence

National context and challenge targeted

Paraguay's science and technology ecosystem is currently in a phase of development and strengthening, having identified a need to increase its scientific human resources. Levels are low at 250 researchers per million inhabitants in 2021 compared to some neighbouring countries, such as Argentina (1,237 in in 2020), Brazil (888 in 2014) and Chile (550 in 2019). The rate of development of new, highly skilled human capital in Paraguay is another indicator of low performance, especially when compared to the Latin American average. Paraguay has also reported limited availability of high-level training relative to the region, with few postgraduate programmes aimed at training researchers. In 2021, only 0.49 per cent of students in Paraguay enrolled in doctoral programmes, compared to 1.33 per cent in Brazil and 0.77 per cent in Argentina, during 2019.

Paraguay has also recognized the limited availability of national advanced education programmes, as existing higher education programmes emphasize professionalization over research. Consequently, the country's 2017 science, technology and innovation policy outlined a strategy to strengthen human resources by focusing on the creation and strengthening of postgraduate programmes for the development of exceptional human capital in R&D. This included facilitating student access to such programmes.

Instrument

The Creation and Strengthening of National Postgraduate Programmes initiative is designed to promote the development of postgraduate education, focusing on Master's and doctoral degrees with an academic and research orientation. Its primary goal is to equip researchers with the skills needed to design, manage and develop impactful R&D projects in scientific, technological and social sectors.

Under this initiative, the Paraguayan National Council for Science and Technology (CONACYT) selects and provides funding for projects that can be newly designed postgraduate programmes developed for a specific call or those previously supported by CONACYT which are initiating a new cohort. For ongoing programmes, alignment with the thematic requirements of each call is essential, providing an opportunity to showcase innovative pedagogical methods, with each programme undergoing a rigorous evaluation of their management and performance in their concluding cycle. The funding instrument covers a range of educational project costs including enrolment fees, compensation for faculty and mentors, procurement of reagents and materials for laboratory practices, expenses for examination boards, graduation costs of students, and charges for transcripts and/or certificates of studies.

The initiative also incorporates a scholarship programme for students admitted to these selected postgraduate courses. Two types of scholarships are offered: a full scholarship covering all academic expenses including tuition fees, enrolment and other requirements set by the higher education institute (HEI), in addition to living expenses; and an academic scholarship, which solely covers academic costs like tuition and institutional fees. The funding provided for tuition amounts to approximately US$3,000 for Master's programmes, and around US$8,300 for PhD programmes. Monthly living stipends are also offered, amounting to approximately US$600 for Master's students and US$900 for PhD students.

Institutions can apply to receive support for the development and enhancement of the same programme only during three cohorts of students.

Implementation

The instrument is implemented under the Paraguayan Programme for the Development of Science and Technology (PROCIENCIA) by CONACYT. The instrument is conceived as a multistage process that has been evolved since 2008, when it was initially implemented to allocate funding to postgraduate programs under the Science, Technology, and Innovation Development Support Program (PROCIT). PROCIT has laid the foundation for the structure and design of the PROCIENCIA Program.

The implementation process begins with a dissemination stage, during which HEIs are invited to participate. This initial phase focuses on detailing the general bases and conditions (GBC) along with the application procedures. A key component of this stage is to educate participants about these bases, ensuring that they clearly understand the timelines, eligible costs and evaluation procedures. This clarity is vital not only for the benefit of the participants, but also for the efficient execution of subsequent stages in the instrument's implementation.

The pre-postulation stage is next during which institutions submit identification data, institutional conditions and project details. During the following pre-admission stage, CONACYT's technical team review this information and documentation to ensure compliance with the GBC.

In the postulation stage, applicants fill out necessary modules in the Science and Technology Information System (SPI), attaching pertinent documents and evidence. This digital system, an evolution from initial paper-based applications, streamlines the process and is evolving to also encompass monitoring aspects.

The subsequent admission stage involves detailed verification and analysis of these data and documentation by the technical team to ensure GBC adherence. Then, in the evaluation stage, admitted proposals are peer-reviewed by international peers, based on GBC criteria and scores, to maintain impartiality in the relatively small domestic higher education circle.

The following selection stage consists of the generation of a results report based on ranking scores and GBC criteria, endorsed by CONACYT. The process culminates with the communication of results, with selection resolutions published on the CONACYT website for transparency and broad dissemination.

Scholarships linked to the selected programmes adopt a similar yet more streamlined application and selection process, omitting the pre-approval steps.

During implementation of the educational programmes by beneficiaries, CONACYT conducts monitoring through site visits and periodic reporting. This approach has been instrumental in identifying cases where the supported programmes lack the necessary research focus, leading to enhancements in the GBC and the selection process. A similar follow-up process exists for students who have received scholarships. Finally, programmes that have received support on multiple occasions undergo an evaluation to assess their performance and impact.

Achievements and impact

The initiative facilitated the establishment of 35 postgraduate programmes from 2014 to 2022. A key indicator of its impact is that the majority of institutions have sustained these programmes beyond the support period. Additionally, the programmes funded by CONACYT are in the process of accreditation, which emphasizes the commitment to high educational standards. Institutions like the National University of Asuncion have benefited from this initiative, with all supported programmes required to achieve accreditation to ensure quality.

The initiative also supported 675 students of which 220 received full scholarships, enabling them to pursue postgraduate education through these programmes. As a result of this scholarships with incentives approach, students were able to dedicate themselves fully to their studies, a factor crucial in their transition from professional degrees to research-oriented programmes. This outcome significantly boosted research capacity within universities.

Source: Author from interviews; Fernando Bienvenido (2022)

Another challenge of this initiative is the sustainability of the new programmes developed. To address this issue, the Paraguayan initiative offers scholarships, a popular mechanism (see Box 4.22), which in this case has been used to ensure university income during the first cohorts of students. One effective avenue for sustainability is to promote quality accreditation for the supported programmes. Gaining accreditation not only enhances the programme's reputation, it also attracts a broader base of students and, potentially, alternative funding sources such as industry partnerships, alumni support or tuition fees. Other strategies might include developing strong alumni networks that contribute back to the programme. This approach would establish industry linkages that provide both financial support and real-world relevance to the curriculum, and integrate the programme into larger institutional frameworks that ensure steady funding and administrative support. The key is to create a self-reinforcing cycle of quality, reputation and financial viability that makes these programmes resilient in the face of changing funding landscapes.

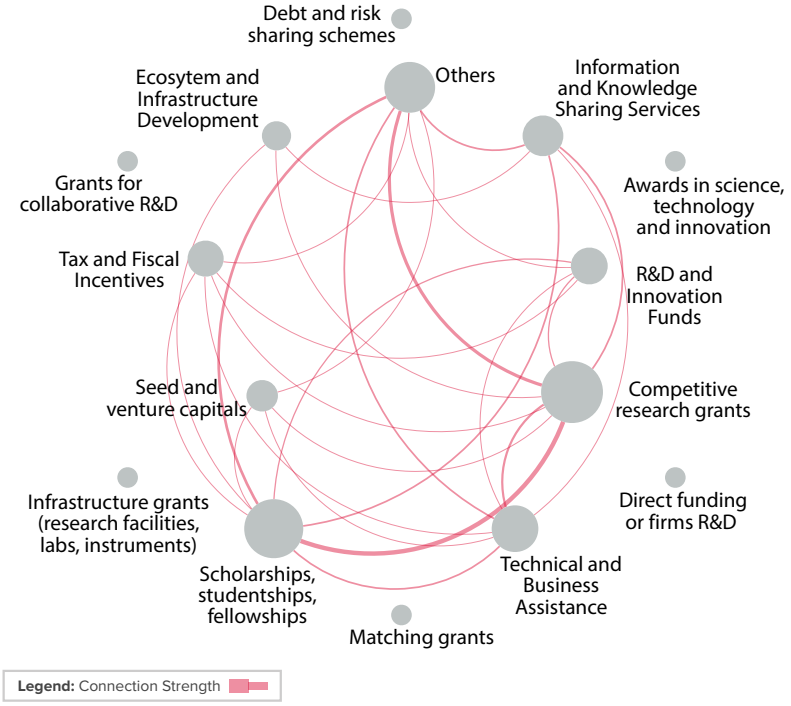
Table 4.17. Support mechanisms used in STI policy instruments of Latin America and the Caribbean

Support mechanisms	Share of policy instruments
Competitive research grants	40.68%
Scholarships, studentships, fellowships	23.38%
Technical and business assistance	8.78%
Others	8.65%
R&D and innovation funds	8.11%
Information and knowledge-sharing services	5.81%
Tax and fiscal incentives	3.92%
Matching grants	3.51%
Ecosystem and infrastructure development	3.11%
Seed and venture capitals	2.84%
Infrastructure grants (research facilities, labs, instruments)	1.08%
Grants for collaborative R&D	0.54%
Direct funding of firms R&D	0.27%
Debt and risk sharing schemes	0.14%

Note: A single policy instrument can use multiple support mechanisms.
The length of each bar represents the value's proportion relative to the highest value in its column, with the longest bar indicating the maximum value.

Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

Figure 4.12. Network analysis of support mechanisms used in STI policy instruments in Arab States in Latin America and the Caribbean



Source: Author's elaboration based on data from the UNESCO GO-SPIN platform

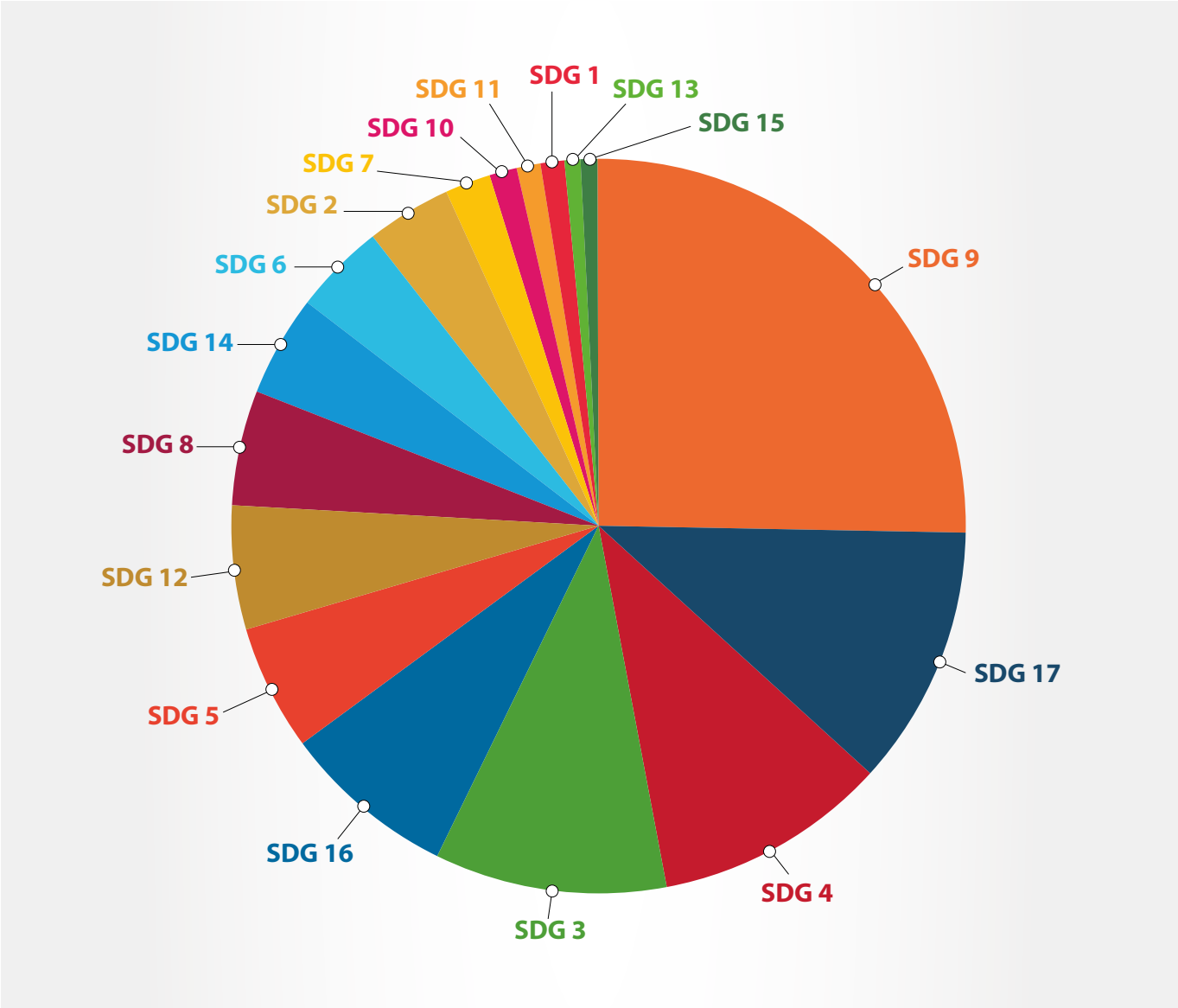
Figure 4.12 showcases the key mechanisms employed in the policy mix across countries in Latin America and the Caribbean, with the node size representing each mechanism's prevalence. The network highlights the top quartile of connections among these mechanisms, representing their inclusion in a country's policy mix. The network also demonstrates the strength of the connections between mechanisms through lines of varying thickness. This figure complements Table 4.17 ; the node sizes align with the table's information, but the network graph uncovers the typical combinations of mechanisms utilized by countries in the region. For instance, in Latin America and the Caribbean, the policy instruments employed are more diverse, as evidenced by the many interconnections of various strength. However, there are still some instruments that predominate. For example, "Competitive Research Grants" and "Scholarships" are the only two mechanisms used in the policy mix of all countries with data in the GO-SPIN platform. The mechanisms "Technical and Business Assistance" and "Information and Knowledge Sharing Services" closely follow, being present in the vast majority of countries. The figure also reveals certain isolated nodes, indicating mechanisms less frequently included in countries' policy mixes.

5. Conclusions and recommendations

Science, technology and innovation (STI) policy represents a nexus crucial to global progress, offering a comprehensive toolkit to address the intricacies of the contemporary world's sustainability challenges, and simultaneously, to promote global peace and prosperity. In an era characterized by *The 2030 Agenda for Sustainable Development* and its 17 Sustainable Development Goals (SDGs), STI policies have taken a central place on the stage as essential drivers of progress. The SDGs, with their ambitious objectives, encompassing a wide range of global challenges, rely heavily on scientific and technological advancements, as well as the implementation of innovative policies for their successful realization.

Integrating this perspective, the analysis in this report directly relates to the SDG goals, targets, indicators, and data series. Figure 5.1 organizes the 17 SDG thematic areas ordered by their prevalence in this report. Notably, the most prominent ones are SDG 9 (Industry, Innovation, and Infrastructure), SDG 17 (Partnerships for the Goals), SDG 4 (Quality Education), and SDG 3 (Good Health and Well-being).

Figure 5.1. Reflection on linkages to most relevant SDGs and targets based on this report



Source: LinkedSDGs[39] based on this report

39 An app that automatically extracts key concepts related to sustainable development from text documents and links them to the most relevant sustainable development goals, targets, indicators and series. The 17 SDGs are articulated into 169 targets, 230 indicators, and over 400 data series that help to measure the progress towards achieving the SDGs. https://linkedsdg.officialstatistics.org/#/

This publication provides an examination of STI policy instruments, covering diverse regions and themes, and extracting valuable insights into the design, implementation and impact of these policies. However, it acknowledges the inherent limitations of the snapshot provided by GO-SPIN resources, which is limited by the specific time frame of the data collection process and the non-exhaustive nature of the compilation of existing instruments. The scope and depth of the information are contingent upon the extent of the details furnished by individual governments and the data gathered through UNESCO's dedicated efforts in support of STI policy.

This concluding chapter extracts the essence of this publication's findings, exploring their significance, implications and the contributions they make to the field of STI policy. It underscores the importance of rigorous data collection, monitoring and a thorough evaluation of STI policy instruments. This process is essential for understanding their effectiveness and for guiding strategic adjustments that can enhance their impact on global challenges.

Key messages

Designing and implementing effective STI policy instruments

In the discourse on STI policy formulation and implementation, a clear delineation between policy and policy instruments is essential. Policy, as defined, is a strategic institutional statement focusing on high-level issues with a long-term perspective, whereas policy instruments are tactical and operational mechanisms geared towards resolving the issues identified by the policy. The interplay between policy and its instruments is vital, as a single policy typically necessitates multiple instruments due to the multifaceted nature of policy issues. Therefore, an integrated mix of policy instruments is pivotal, designed to mutually enhance rather than undermine their effects, while focusing on the core issue at hand.

The different stages of innovation and the capabilities within the STI system function as crucial frameworks for determining the suitability of policy instruments. For instance, at the early R&D stage, research grants and scholarships are indispensable to mitigate risks and develop a critical scientific mass, respectively. As innovations advance, venture capital and technical extension services become crucial, especially during the pre-commercialization and internationalization phases for SMEs. The policy instrument mix evolves along the innovation journey, reflecting the progression in innovation activities and STI system capabilities.

A notable challenge for STI policy-makers is the often limited information regarding the suitability of policy instruments for diverse problems and policy contexts. It is imperative that the design and implementation of policy instruments are rooted in an evidence-based diagnosis that aligns with the identified issues, ensuring coherence with other policies to enhance their collective efficacy. Moreover, it is a good practice to consider alternative instruments based on comparative criteria such as efficiency, effectiveness and context appropriateness. The design should also envisage clear objectives, target audiences, eligibility criteria, and a robust monitoring and evaluation framework to ensure continuous learning and refinement for future policy designs.

Effective implementation accentuates planning, coordination and execution phases, alongside management quality to optimize resource utilization and achieve desired outcomes. It also underscores the significance of stakeholder engagement, transparent beneficiary selection practices, and clear communication on eligibility criteria and benefits. Additionally, a comprehensive programme information management system is crucial for managing applications and assessing the benefits derived from various instruments, thus contributing to the overall success and impact of STI policies.

Overview of regional advancements in STI

The exploration of global and regional progress in STI presents a nuanced landscape shaped by varying levels of investment, human capital and STI infrastructural maturity. Key STI indicators, crucial for policy formulation and evaluation, reveal a dynamic interplay with the SDGs, especially demonstrated through the GII and SDG Index analysis. In particular, initial STI advancements significantly propel SDGs, albeit with diminishing returns as nations attain higher innovation levels. Hence, emerging STI systems in some regions present a fertile ground for impactful investments, whereas matured systems necessitate strategic resource allocation for optimal outcomes.

Figures 5.2 and 5.3 provide a comparative insight into the strategic priorities and support mechanisms underpinning STI policy instruments across different regions. This comparison highlights the differing priorities and approaches regions adopt in response to their unique challenges and levels of STI maturity. This juxtaposition between regional strategies

and their implementation nuances underscores the diverse pathways nations take in integrating STI into their development agendas, each adapting to their unique socio-economic contexts and challenges.

In Africa, despite the Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) (African Union, 2014), R&D investments remain below the recommended 1 per cent of GDP, with external sources significantly funding these endeavours. Only Egypt is approaching a 1% GERD/GDP ratio. The region's R&D human capital is yet to reach its potential, marked by a general lack of gender parity and a low researcher-to-population ratio. However, scientific publication volumes are rising across Africa, due in part to a high share of international co-authorship (UNESCO, 2021).

R&D investment in the Arab States is modest compared to GDP, which in some cases is heavily driven by revenue from the hydrocarbon sector. However, a shift has been noted with the UAE and Egypt increasing R&D expenditure, aligning with broader economic and educational goals. R&D funding resides primarily in government and higher education sectors, with private sector involvement trailing, except in the UAE. Initiatives like STI observatories are being established to overcome data monitoring challenges. Meanwhile, a rise in researcher density and gender parity has been observed, propelled by international recruitments and increased PhD enrolments. The region's level of scientific publication, heavily influenced by international collaborations, shows progress, particularly in countries recruiting global researchers.

In Asia, R&D investment is low in Central and South Asian nations, while research expenditure in East Asian countries aligns with global leaders and is growing in parts of Southeast Asia and Oceania. Notable variations exist in researcher distribution across the region, with nations such as China, Japan, Malaysia, the Republic of Korea and Singapore showing the greatest researcher density. Despite increasing PhD enrolment in South Asia, a brain drain challenge persists. Gender parity in research roles is diverse, with numerical gender parity having been attained in a growing number of Asian countries (Indonesia, Malaysia, Mongolia, the Philippines, Sri Lanka, Thailand and Uzbekistan) but remaining elusive in Japan and the Republic of Korea, in particular. The region is also seeing a rising trend in scientific publications, led by nations such as the Republic of Korea and Singapore which have a high publication density. Remarkable growth has also been observed in Indonesia. In 2017, the Indonesian government linked the publication of research in international, indexed journals to the review of scientists' career performance. Among other policy instruments adopted in recent years, both Indonesia and Thailand have introduced a 300% tax rebate for firms on their research expenditure (UNESCO, 2021). These trends reflect a varied but advancing STI landscape across the region.

The regions of Europe and North America continue to be strongholds of scientific research with substantial R&D spending, propelled largely by the private sector. Countries like Denmark, Finland and Iceland are particularly notable for their high researcher density relative to population size, showcasing a robust STI infrastructure. Gender disparity in research roles is pronounced in certain EU nations, while others like North Macedonia show a balanced representation. Scientific publication growth is steady across North America and varies within Europe, with countries like Germany and Iceland showing positive trends, while performance in some East European countries is modest.

Lastly, Latin America and the Caribbean present a mixed landscape in R&D intensity. Brazil emerges as a leader in this domain, albeit with a recent declining trend mirrored by other nations in the region. A general upward trend in the number of researchers has been observed, with positive developments in gender equality. Between 2015 and 2019, scientific outputs surged by 25 per cent, led by Brazil, though smaller nations like Chile and Uruguay excel in publications per million inhabitants, reflecting a gradually growing research culture.

The global landscape of STI policy instruments: Insights and trends

Evidence-based decision-making is essential in STI policy formulation, driven by robust data collection and analysis. Databases like UNESCO's GO-SPIN and OECD's STIP Compass play an important role in obtaining empirical evidence that promotes effective policies and policy instruments. These databases are dynamic tools aiding in comparative analyses and evidence-oriented research, thus providing stakeholders with actionable insights.

In analyzing the landscape of STI policy instruments within global frameworks such as the SDGs, a trend emerges towards a generalist STI policy instrument, with an underlying assumption that markets will self-regulate and allocate resources to areas that need them most. Despite the pronounced alignment of policy instruments towards SDG 9 (innovation), SDG 8 (economic growth) and SDG 4 (education), there exists a broader potential to orient STI activities to address more directly the extensive array of SDGs. Similarly, within the context of the *UNESCO Recommendation on the Status of Scientific Researchers*, the of policy instruments with the principles of the recommendation is not yet explicit,

suggesting a broader potential for agreement on the need for, for example, 'scientific integrity and ethical codes of conduct for science and research and their technical applications' (UNESCO, 2017b).

The African region is emphasizing robust governance and comprehensive policy frameworks through the *Science, Technology and Innovation Strategy for Africa 2024 (STISA-2024) (African Union, 2014)*. The majority of countries have at least one governmental body explicitly charged with overseeing STI, and there is a growing trend towards the development of explicit STI policies in the region, with policy instruments demonstrating a significant focus on health research and agriculture. Funding comes mainly from governmental allocations, although alternative sources of funding, like Ghana's Grant Scheme, are being explored to address financial bottlenecks. A growing emphasis on commercialization is seeking to enhance the added value of natural resource and market participation, including through exports. International financial support is notable, yet brings funding unpredictability. Support mechanisms are geared towards specialized skill development, fostering a robust ecosystem for innovation and entrepreneurship, indicative of a broader regional ambition to support STI's role in economic development.

In the Arab States, every country has a government agency dedicated to promoting and supporting STI, with the majority having established an STI policy. A distinctive strategy observed is the prominent use of grants as part of the STI policy tools spectrum. Additionally, the allocation of prizes and awards underscores efforts to cultivate a culture of STI excellence and promote the recognition of science within society. The region has showcased a significant commitment towards start-ups and entrepreneurship. Emphasis is also placed on engaging students in human development instruments, signalling a strategic investment in youth development to foster innovative thinking. International collaborations are also highlighted in the region's instruments, leveraging global partnerships for STI advancement, addressing critical global challenges, and striving towards economic diversification and sustainable development. Furthermore, the private non-profit sector emerges as a significant player in funding STI policy instruments.

Figure 5.2. Regional comparison of top five strategic objectives of STI policy instruments

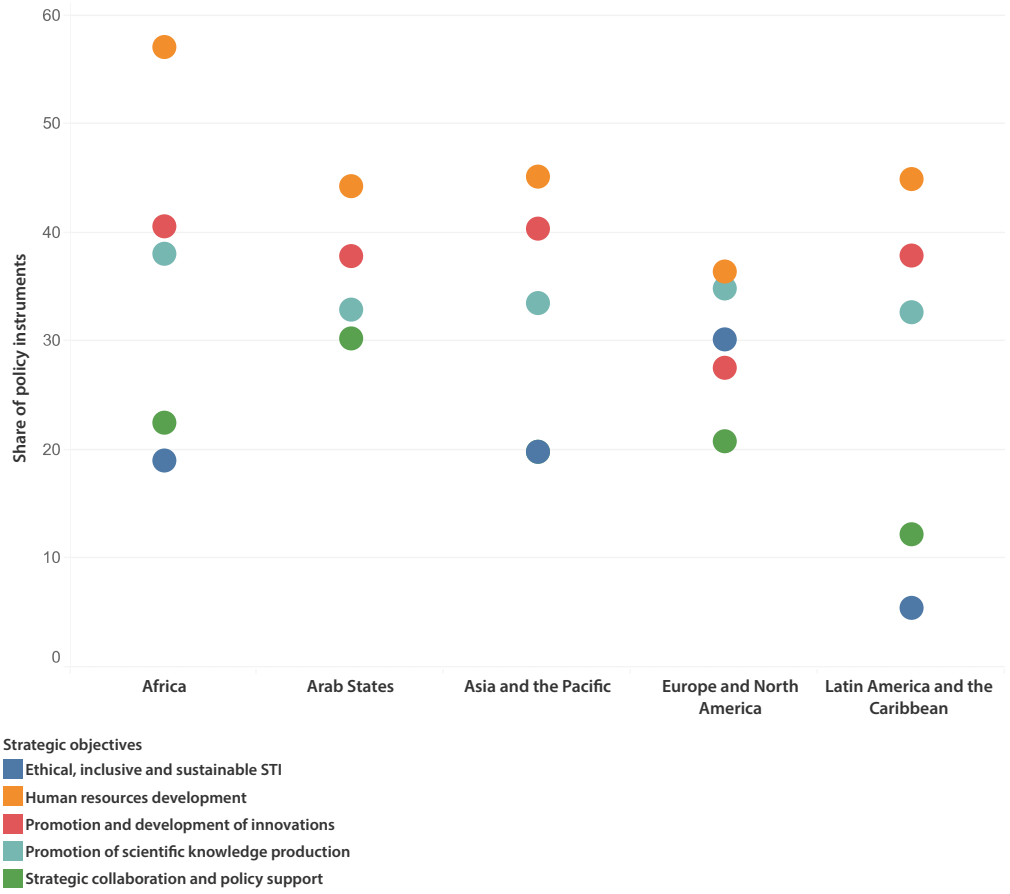
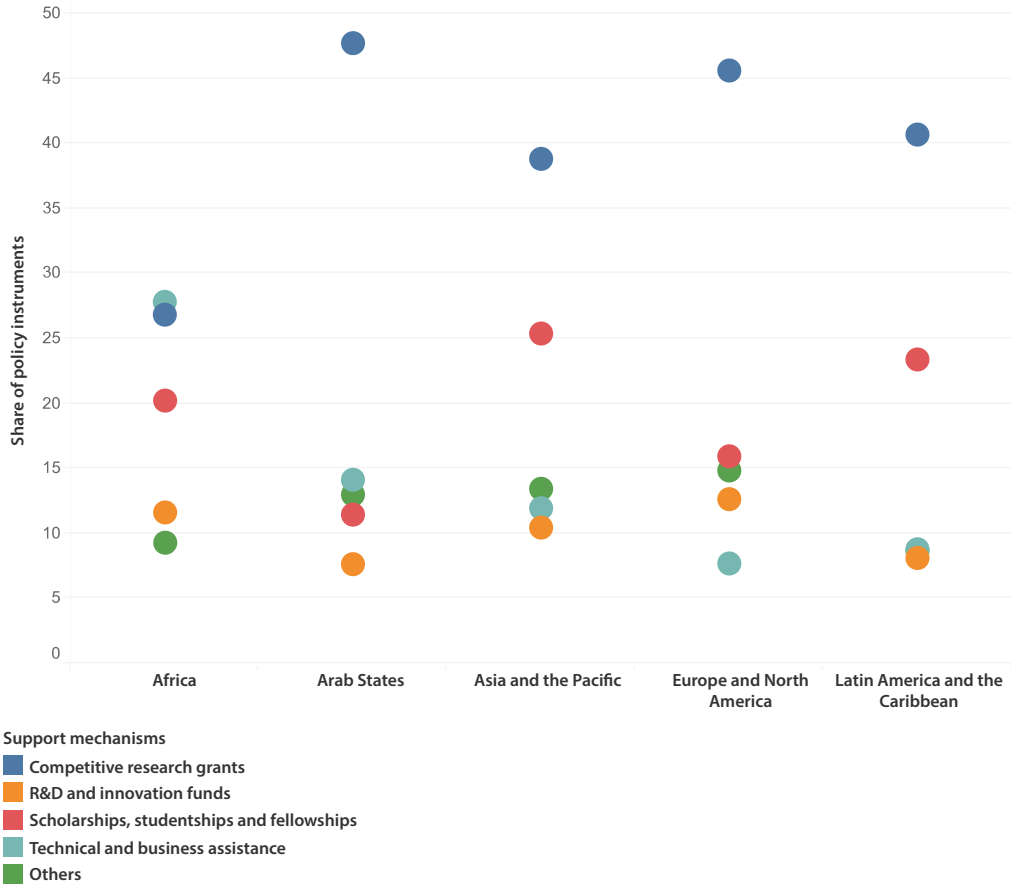


Figure 5.3. Regional comparison of top five support mechanisms of STI policy instruments



The Asia-Pacific region has demonstrated a strategic focus on advanced human capital development through various fellowship programmes which focus on doctorate and post-doctorate levels. An emphasis on commercialization and patenting is propelled by nations like China and South Korea, alongside mechanisms fostering innovation and entrepreneurship in less developed countries. Additionally, approximately 74 per cent of the analyzed instruments targeting this objective specifically cater to the private sector, showcasing a concerted effort to bolster market-ready innovation and entrepreneurship in alignment with regional frameworks.

In Europe and North America, R&D cooperation is a distinctive feature, with initiatives promoting human capital development and international academic exchange. Governments significantly finance STI, with competitive grants being a popular mechanism. However, these governments also dedicate significant resources in the form of block funding to their R&D institutions. Consequently, some nations have devised evaluation methodologies to allocate these funds efficiently and on a merit basis. Of particular note is the emphasis on ethical, inclusive and sustainable STI, fostering equitable and responsible technological advancements with a drive to improve gender equality, and using increasingly recognised mechanism such as challenge drive instruments.

In Latin America and the Caribbean, public policies and policy instruments are being utilized to propel STI, tackling challenges ranging from knowledge generation to business innovation and entrepreneurship. An emphasis on higher education, via scholarships and research grants, aims to foster a knowledge-based economy. Additionally, around 45 per cent of STI policy instruments focus on human resources, with 67 per cent of these targeting R&D professionals. This strategy contributes to elevating the stature of scientific careers while promoting educational and skills development. Efforts are also underway to strengthen institutional capacities for effective policy design and implementation. Moreover, national governments are recognized as the primary funders of STI policy instruments, accentuating the need for efficient resource utilization and strategic coordination. Inclusivity is promoted by prioritizing under-represented stakeholders such as women and Indigenous communities in human resources development initiatives. Consequently, the region showcases a multi-faceted approach to nurturing a conducive STI landscape, aligning resources and policy frameworks to tackle distinct challenges, while fostering inclusivity and strategic collaborations.

Implications and recommendations

The examination of STI policy instruments across diverse regions reveals critical implications for policy-makers and stakeholders worldwide. These implications stem from findings regarding the design, implementation and impact of STI policies, as well as the global landscape of STI progress and policy instruments. Based on these insights, the following recommendations are offered to enhance the effectiveness of STI policy instruments and their alignment with global sustainability objectives:

- *Evidence-based design and comparative analysis*. In the design and implementation of STI policy instruments, it is essential to adopt an evidence-based approach that integrates both quantitative and qualitative data. Quantitative data provides measurable insights crucial for the scope and impact of STI initiatives, while qualitative data offers an in-depth understanding of societal and human dimensions that may elude numerical analysis. Specialized databases such as UNESCO's GO-SPIN and OECD's STIP Compass are instrumental in this process. They not only aggregate extensive quantitative indicators, but also gather qualitative insights regarding policy objectives, beneficiaries, and implementation, amongst others. Moreover, these platforms enable a comparative analysis, allowing policymakers to assess the efficiency, effectiveness, and context-appropriateness of different STI policy instruments. By analyzing policies across various regions and socio-economic contexts, these databases facilitate the identification of best practices and support the adaptation of strategies to local needs, thereby enhancing the effectiveness and adaptability of STI policies instruments. Moreover, some countries have established their own specialized databases at the national level. These localized databases play a crucial role in harmonizing STI policy instruments with national priorities and contextual specificities.

- *Strategic integration and flexibility*. The instruments analyzed are concentrated in areas like human resources and innovation development, primarily supported by scholarships and research grants. This situation suggests a need to promote the adoption of a more diverse and tailored policy mix approach. This approach should recognize the significant variations in national STI capacities, not only across countries but also within national industries, each operating at varying stages of development. Policymakers must acknowledge the broad spectrum of available policy instruments and tailor an optimal mix to their specific STI realities. Key reflections include expanding

the scope of policy instruments beyond prevalent areas, and mechanisms strategically targeting gaps in STI capacities, aligning policies with evolving STI capabilities, prioritizing sustainability, and continuously assessing and adapting these policies. This nuanced approach ensures that policy interventions are comprehensive, adaptable, and sustainable, effectively fostering the development of robust and responsive STI systems.

- *National governments primarily finance policy instruments*. In less developed regions, limited R&D funds are often allocated to personnel and administrative expenses, leaving little resources for STI activities. This situation makes donor funds essential. However, these funds come with challenges, such as inconsistent financing and potential expertise loss after funding ceases. To manage donor-funded programmes, new organizations are either established or additional temporary staff are brought into government agencies. Both approaches risk losing valuable expertise once the funding dries up. As a result, diversifying funding sources is essential to ensure consistent support for the scientific community and to safeguard expertise in STI policy design and execution, thereby benefiting the policy-making sector.

- *Financial support considerations in design*. In designing STI policy instruments for less developed regions, simply aiming to mobilize the maximum amount of funds can be risky, unnecessary and potentially inefficient. Large financial opportunities often bring with them stringent requirements, presuming that the market can meet them. Yet, emerging STI systems may not have the capability to capitalize on such opportunities. Hence, it is essential to evaluate the system's capacity to absorb funding, especially when mechanisms extend beyond grants, and to set funding limits that align with existing capacities.

- *Comprehensive programme management and transparency*. A notable shortcoming of STI policy instruments in less developed regions is their weak programme design, with minimal effort made towards a systematic approach that includes logic frameworks or results-based management practices. This design approach complicates communication with beneficiaries, and also hinders obtaining buy-in from higher levels of government. The design of STI policy instruments thus requires skilled human resources and institutional capacity for thorough planning, coordination and execution. It furthermore necessitates transparency and active stakeholder engagement.

- *Continuous monitoring and evaluation for adaptation*. Despite growing sensibilization about the importance of evaluations, these are seldom conducted. Therefore, it is essential to establish robust monitoring and evaluation frameworks and integrate them into the organizational culture for ongoing assessment to facilitate learning and refinement. This approach ensures policies instruments remain effective and adaptive to changing circumstances.

- *Stakeholder communication and engagement*. In the majority of STI policy instruments analyzed through case studies, communication with stakeholders emerged as a significant weakness. In certain scenarios, these shortcomings restricted the broad dissemination of funding opportunities; in others, they led to an increased operational workload due to incorrectly filled applications, or posed challenges in pinpointing priority sectors and understanding their specific needs. Thus, it is imperative to enhance stakeholder communication strategies and foster active engagement to address these issues effectively.

- *Transforming policy instrument applications into learning opportunities*. The application and evaluation procedures of policy instruments serve as vital learning opportunities for both governments and beneficiaries. The application process not only helps identify gaps in institutional capacity, it also pinpoints areas where beneficiaries may struggle to meet requirements. Recognizing these capacity gaps is crucial, as it guides the development of new instruments tailored to address specific needs. Furthermore, the evaluation process is instrumental in highlighting the learning needs of beneficiaries. It is therefore imperative to engage evaluators who possess not just the relevant skill set but also the capability to offer feedback that is constructive. Effective feedback can equip beneficiaries with valuable insights, enhancing their prospects in future calls for proposals. To this end, it is essential to ensure that evaluators are adept at recognizing achievements and areas for improvement, and that they can communicate this in a manner that facilitates learning and growth.

- *Strategic resource allocation for SDGs*. Incorporating the SDGs into the framework of STI policy instruments is still not commonplace. While some methodologies, like challenge or mission-driven instruments, are in use, they are intricate to design and execute. Therefore, it is advisable to progressively direct more resources towards specialized instruments. These should strategically prioritize sectors and areas aligned with the SDGs, offering the promise of significant benefits. Giving directionality to STI policy instruments to address challenges outlined in the SDGs is essential.

- *Global collaboration and knowledge exchange*. Countries are leveraging cooperation to strengthen their STI capacities. Some regions have experienced notable success in amplifying scientific production and fostering the exchange of knowledge and expertise. This is not limited to collaborative scientific projects; joint R&D funds co-implemented by agencies from partnering nations also provide valuable learning opportunities in STI policy design and execution. As such, it is recommended to expand international collaboration in STI policy instruments to tackle global challenges, enhance knowledge sharing and hasten innovation and progress.

- *Inclusive and equitable policies*. While a noticeable efforts have been made to utilize STI policy instruments in support of gender equality in STI, it is crucial to enhance inclusivity by promoting under-represented stakeholders, including Indigenous communities. Initiatives focused on inclusive human resource development can pave the way for a richer and more innovative STI landscape that will benefit from different forms of knowledge systems.

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Annex: Methodology

Introduction

The analysis developed in this publication utilized a diverse range of quantitative and qualitative data sources, coupled with a complementary combination of analytical approaches. This methodological strategy was deemed essential for an in-depth exploration of the multifaceted dimensions and impacts of STI Policy instruments in achieving the Sustainable Development Goals.

Furthermore, the publication aimed at synthesizing and reducing the complexity of data insights to enhance their analytical interpretation, while simultaneously revealing the deeper insights embedded within the data and the patterns identified. This methodological chapter presents a short summary of the methodological decisions taken during the elaboration of the publication, and highlights the limitations of the present study. The methodology will describe data sources, analytical techniques, and limitations.

Data sources

Gathering precise and reliable data from multiple sources is vital for a robust analysis. The table below describes the various information sources used to develop each chapter of the publication. This overview reveals how different resources, including literature reviews, GO-SPIN platform, and interviews, contribute to shaping each chapter. As illustrated by the table, different areas draw upon a diverse array of information sources.

Table A.1. Sources of information

Chapter and information sources	Literature review	GO-SPIN Platform	Interviews
1. Introduction	***	*	NA
2. Designing and implementing STI policy instruments	***	*	*
3. Overview of regional advancements in STI	***	*	*
4. The global landscape of STI policy instruments: Insights and trends	**	***	***
5. Conclusion and recommendations	***	***	***

***	Critical contribution
**	Medium contribution
*	Limited contribution

Literature review

A thorough literature review was conducted, encompassing a diverse range of sources. Academic literature played an important role in providing theoretical underpinnings, conceptual frameworks, and empirical evidence on STI policy design and implementation.

Parallel to academic literature, reports from international organizations such as UNESCO, UNIDO, and the World Bank, amongst others, were reviewed. These reports offered valuable perspectives on framing STI policy for the SDGs as well as identifying some trend and best practices.

National official documents were also used to supplement interviews and build the case studies presented in chapter 4 of the publication. The development of some case studies from developed countries was primarily based on documents due to the wealth of information readily available, particularly in the form of evaluation reports.

Complementing the literature review, statistical information from internationally comparable sources was analyzed. Data from organizations such as the UIS and the World Bank, and reports like the Global Innovation Index and the Sustainable Development Index, among others, facilitated a quantitative evaluation of R&D indicators. This statistical analysis enabled the identification of patterns and correlations between STI investments and sustainable development outcomes.

GO-SPIN platform

GO-SPIN is a methodological tool to map national science, technology, and innovation (STI) landscapes and analyze STI policies and their implementation. The open-access platform offers a database with analytical tools for the use of decision-makers, parliamentarians, universities, knowledge brokers, companies, specialists, and the general public, with a complete set of diverse information on STI policies. Some of the modules of the platform are:

- *National and international policy interventions for the sciences, engineering, technology, and innovation.* This module includes Analysis of policy documents; Analysis of organizational ecosystems; Inventory of legal frameworks for STI; Inventory of operational policy instruments.
- *UNESCO Focus Areas.* This module facilitates the exploration of STI Policy information related to STI for the SDGs, Women in Science, Technology, Engineering, and Mathematics, the Recommendation on Science and Scientific Researchers, the UNESCO Recommendation on Open Science, and the Recommendation on the Ethics of Artificial Intelligence.
- Therefore, the GO-SPIN platform was used as the main source of data to explore the trends of policy instruments in countries around the world. The platform has information for 1691 STI policy instruments from 116 countries in all regions of the world.

Interviews

Interviews were conducted with representatives of 16 countries across the world, mostly representing developing countries. The country representatives were contacted through UNESCO's networks. Efforts, to the extent possible, were made to prioritize organizations that have actively collaborated with UNESCO, have first-hand information on STI Policy Instruments, and provide a diverse regional representation as well as a variety of policy instruments.

The interviews were essential to develop case studies for each region and identify the bottlenecks and good practices in implementing policy instruments.

Analytical techniques

The publication used a combination of qualitative and quantitative methods, ensuring a holistic and nuanced understanding of the design and implementation dimension of policy instruments. A brief description of these methods is as follows:

Qualitative analysis

- Government representatives' interviews. Engaging with government representatives directly involved in the design and implementation of STI Policy instruments, allowed for gathering qualitative insights through semi-structured interviews. The interviews were structured to thoroughly understand a policy instrument's framework and its effects within a specific national context. Initially, the questions aim to uncover how the policy problem was identified and given precedence, followed by the establishment of the instrument itself, its objectives, target group, funding mechanism, stakeholder involvement, and how it aligns with other policy initiatives, amongst other dimensions. The implementation segment covers the setup of governance and responsibilities, communication methods, selection criteria, delivery mechanisms, monitoring, evaluation, and knowledge management practices. It also seeks to quantify the reach and financial deployment of the policy. The impact portion evaluates the main results and long-term effects. Complementary questions, intended for analytical rather than case study use, look into the challenges and motivations behind the instrument's design, execution, and evaluation, extracting lessons and considering what might be done differently. These questions also assess whether regional priorities have influenced the policy's development and implementation and conclude by contemplating the forms of regional and international support that could prove beneficial.
- Case study analysis. As a result of the interviews, a selection of regionally representative case studies was elaborated to provide insights into the practical implementation and outcomes of STI policies instruments. Each case study is developed and analyzed based on the national context and challenge targeted, the instrument goals and objectives, the instrument implementation, and its achievements and impacts.
- Document analysis. A review of academic papers, policy documents, policy instrument evaluations, white papers, official statements, provides a deeper understanding of the intentions, scope, and directives of STI policy instruments. This involves content analysis and thematic coding to identifying the following: prevalent themes and principles in STI policy design and implementation for the sustainable development goals; specific policy instruments being implemented by different countries and organizations; and the effectiveness of STI policy initiatives in achieving their intended outcomes.

Quantitative analysis

- Data analytics. Utilizing available datasets, the publication illustrates performance trends across regions in selected STI indicators and used statistical methods and visualization techniques to uncover patterns. In the case of data related directly to STI Policy Instruments, raw data from the GO-SPIN Database was extracted to facilitate the data pre-processing steps, such as cleaning, data transformation and normalization, outlier detection and handling, amongst others. One of the pre-processing steps used to achieve a more synthetic analysis was to group some of the categories found in the taxonomies defined in the GO-SPIN methodology. This was suggested to achieve more

synthetic analysis and also because many categories were considered outliers given large differences in the distribution of instruments amongst these categories. To achieve this, in consultation with the UNESCO team, a simplified categorization was developed with efforts to minimize the loss of granularity and maximize the utility and simplicity of the analysis. The tables below illustrate the recategorization.

Table A.2. Redefinition of strategic objective categories

GO-SPIN Strategic Objective	New Strategic Objective
a. Strengthening the production of new endogenous scientific knowledge	**Promotion of Scientific Knowledge production**
b. Strengthening the infrastructure of research laboratories in the public and private sectors	**Research and Innovation Infrastructure**
c. Human resources for research, innovation and strategic planning. Capacity building,education and training of specialized human capital for (1) the production of new scientific knowledge, (2) development of new technologies, (3) promotion of innovation within the productive and services systems and (4) management of the knowledge society.	**Human Resources Development**
d. Strengthening gender equality for research and innovation	**Ethical, Inclusive, and Sustainable STI**
e. Strengthening the social appropriation of scientific knowledge and new technologies	**Public Engagement and Popularization of Science**
f. Development of strategic technological areas and new niche products and services with high- added value. Promotion and development of innovation in the production of goods and services. Promotion of start-ups in areas of high technology	**Promotion and Development of Innovations**
g. Strengthening programmes on science education at all levels (from primary school to postgraduate)	**Human Resources Development**
h. Promotion of the development of green technologies and social-inclusion technologies	**Ethical, Inclusive, and Sustainable STI**
i. Promotion of indigenous knowledge systems	**Ethical, Inclusive, and Sustainable STI**
j. Research and innovation eco-system: strengthening co-ordination, networking and integration processes which promote synergies among the different actors of the national scientific technological and productive innovation system (i.e. government, university and productive sectors)	**Strategic Collaboration and Policy Support:**
k. Strengthening the quality of technology foresight studies to: assess the potential of high-value markets, develop business plans for high-tech companies, construct and analyze long-term scenarios and provide consulting services and strategic intelligence	**Strategic Collaboration and Policy Support:**

l. Science diplomacy, strengthening regional and international co-operation, networking and promotion of STI activities	**Strategic Collaboration and Policy Support:**
m. Awards in science, technology and innovation	**Public Engagement and Popularization of Science**
n. Ethics of science, technology, and innovation and responsible innovation	**Ethical, Inclusive, and Sustainable STI**
o. Research and innovation activities for the promotion of peace building	**Ethical, Inclusive, and Sustainable STI**
p. Open science	**Ethical, Inclusive, and Sustainable STI**
q. Mobility of researchers at national, regional, and international levels	**Human Resources Development**
r. Promotion of science parks and innovation centres	**Research and Innovation Infrastructure**

Table A.3. Redefinition of beneficiary categories

GO-SPIN Beneficiaries	New Beneficiaries
Academies of sciences, engineering, social sciences, humanities, etc.	**R&D Entities**
Ad hoc associations	**Associations and Cooperative Bodies in STI**
Business/enterprises (public or private) at different categories (corporations, SMEs, etc)	**Business and Enterprise Sector**
Co-operatives related with STI	**Associations and Cooperative Bodies in STI**
Commissions of Ethics of Science and Technology,Bioethics, etc.	**Associations and Cooperative Bodies in STI**
Foundations (public or private)	**Associations and Cooperative Bodies in STI**
Graduate students	**Students**
Individual researchers or professionals, PhD holders, higher-education teachers	**R&D professionals and support staff**
Institutes and other research centres (public or private)	**R&D Entities**
Institutional small investors and angel funds	**Investment Entities**
Others	**Others**
Public institutions	**Government and Public Agencies**
R&D non-profit organizations (public or private)	**R&D Entities**
R&D Professional Associations	**Associations and Cooperative Bodies in STI**
Research groups	**R&D Entities**
Science parks and innovation centres	**Science parks and innovation centres**
Secondary and primary schools (public or private)	**Academic and Educational Institutions**
Technical and support staff for STI activities	**R&D professionals and support staff**
Technical training centres (public or private)	**Academic and Educational Institutions**

Trade unions for STI personnel (researchers, technicians, administrative)	**Associations and Cooperative Bodies in STI**
Undergraduate students	**Students**
Universities, colleges, tertiary education institutions (public or private)	**Academic and Educational Institutions**

Table A.4. Redefinition of strategic support mechanism categories

GO-SPIN Support Mechanism	New Support Mechanism
a. Competitive research grants	**Competitive research grants**
b. Infrastructure grants (research facilities, labs, instruments)	**Infrastructure grants (research facilities, labs, instruments)**
Block Funding	**Block Funding**
c. Loans and tax credits	**Tax and Fiscal Incentives**
d. Creation of, and support for, technological poles and centres of excellence, science parks and innovation centres	**Ecosystem and Infrastructure Development**
e. Tax and Fiscal Incentives	**Tax and Fiscal Incentives**
f.i Technical assistance: Technology matching services	**Technical and Business Assistance:**
f.ii Technical assistance: Technology extension services	**Technical and Business Assistance:**
g. Scholarships, studentships, fellowships	**Scholarships, studentships, fellowships**
h. Seed and venture capitals	**Seed and venture capitals**
i. Trust funds/Sectoral Funds	**R&D and Innovation Funds**
Innovation procurement schemes	**Innovation procurement schemes**
Innovation vouchers	**Technical and Business Assistance:**
j.i Information services: Specialised knowledge services	**Information and Knowledge Sharing Services**
j.ii Information services: Market intelligence services	**Information and Knowledge Sharing Services**
k. Research Funds	**R&D and Innovation Funds**
l. Grants for collaborative R+D	**Grants for collaborative R+D**
m. Awards in science, technology and innovation	**Awards in science, technology and innovation**
n. Matching grants	**Matching grants**
o. Technology diffusion assistance schemes	**Technical and Business Assistance:**
p. Innovation Funds	**R&D and Innovation Funds**
s. Direct funding of firms R+D	**Direct funding of firms R+D**
t. Debt and risk sharing schemes	**Debt and risk sharing schemes**
u. Others	**Others**

- Word clouds of STI policy instruments keywords. The publication employed a word cloud analysis as a key analytical technique to visually represent the relative frequency and prominence of various terms associated with STI Policy Instruments in the context of sustainable development goals. This methodology involved the collection and aggregation of relevant policy instruments from the GO-SPIN platform and the extraction of keywords from them. Each word was reviewed and refined, translated to English, and similar terms were unified, ensuring a focus on the most pertinent terms. Following this, a frequency analysis was conducted to identify the most recurrent words within the groups of key words. Relative frequency, as opposed to simply word occurrence, was used since it provides a more nuanced view of regional patterns. By using relative frequency, it is possible to distinguish between commonly used keywords inherently present in a study about STI, such as Research, Innovation, and others, and highlight only those terms that differentiate the region.
- Social network analysis of support mechanisms of STI policy instruments. The publication employed Social Network Analysis (SNA) to illustrate the STI policy mix across each region. This analytical technique enabled the mapping and visualization of the complex interrelationships between different policy instruments employed across countries within these regions. In the network diagram, each node represents a distinct STI policy mechanism, and the size of each node is directly proportional to its prevalence in the regional policy landscape. This allows for an immediate visual grasp of the most prominent policy instruments within the region. Furthermore, the network illustrates the top quartile of connections among these policy instruments, signifying their co-occurrence in the policy mixes of different countries. These connections are represented by lines, with the thickness of each line indicating the strength of the relationship between the connected mechanisms. Such visualization not only highlights the key mechanisms that form the backbone of STI policy in regions but also sheds light on how these mechanisms are interlinked, revealing patterns of co-implementation and synergy. Through this Social Network Analysis, it is possible to provide a nuanced understanding of the regional policy dynamics, uncovering strategic combinations of policy instruments that are pivotal in steering the region towards its sustainable development goals.

Limitations

This publication, while comprehensive in its approach to examining STI policy instruments for the sustainable development goals, acknowledges some inherent limitations that need to be considered when interpreting its findings.

A limitation arises from the use of the GO-SPIN platform, which, while instrumental in providing a structured data, also means that the findings are limited to the information available in this repository. This limitation depends on direct reporting from official government sources and institutional efforts to expand coverage, neither of which are comprehensive. This constraint potentially leads to an incomplete representation of the global STI policy landscape. It is important for readers to be aware that the dynamic nature of STI policies means that new instruments may have emerged, or existing ones may have evolved post-data collection, affecting the report's comprehensiveness. To address this limitation, the report supplements GO-SPIN data with literature reviews, interviews with government representatives, and analysis of national documents.

A limitation of quantitative data, especially in developing countries, is the quality and reliability of STI indicators. In some cases, data may be outdated, incomplete, or non-existent. To mitigate the impact of this limitation, the report employs rigorous data pre-processing steps, including data cleaning, transformation, normalization, and outlier handling. Additionally, the triangulation of data sources and cross-validation with academic literature and international reports help in enhancing the reliability of the findings.

Another limitation is that the publication relies on interviews for important aspects of the analysis. The interviews were predominantly conducted with representatives from a sample of developing countries. The sample is heavily determined by the level of activity of countries in UNESCO's networks as well as the availability of government representatives during the interview period of the study. Additionally, interviews are subject to the biases and perspectives of the interviewees. The report acknowledges this potential bias and mitigates it by ensuring that the case studies are diverse and their analysis incorporates multiple additional sources.

Finally, the publication's use of visual representation techniques, such as word clouds and social network analysis, while helpful in illustrating complex relationships, can sometimes simplify these dynamics. These techniques are effective in providing an overview but may not capture nuanced interdependencies and subtleties inherent in STI policy instruments. The study mitigates this limitation by complementing these visual techniques with detailed narrative explanations and contextual information. It also uses these techniques judiciously, ensuring that they support rather than replace the analysis.

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Science, Technology and Innovation Policy Instruments for the Sustainable Development Goals

A global outlook

This publication examines the landscapes of science, technology and innovation (STI) policy instruments across regions, explores relevant STI indicators, and elucidates their relationship with the Sustainable Development Goals (SDGs). Through this comprehensive analysis, it aims to equip decision-makers with insights to design and implement evidence-based STI policy instruments. In particular, the publication provides a diverse array of examples of instruments to address different policy objectives, accompanied by relevant good practices. Furthermore, the inclusion of case studies covering different regions provides invaluable real-world perspectives on the design, implementation, and impact of STI policy instruments.

The report's recommendations emphasise evidence-based design, diversified funding sources, comprehensive program management, continuous monitoring, stakeholder communication, and transformative learning from policy instrument applications. Additionally, it highlights the need for strategic resource allocation for SDGs, global collaboration and inclusive policies that promote gender equality and support under-represented stakeholders for a more dynamic STI landscape.

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