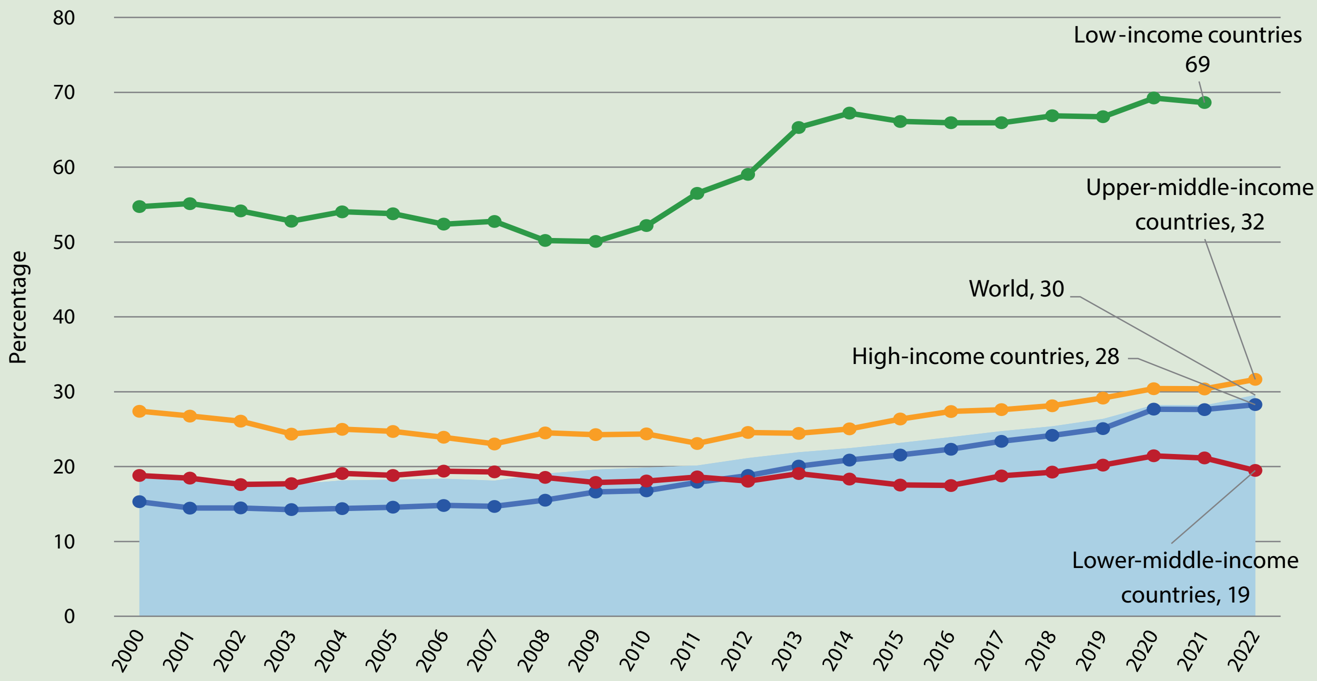
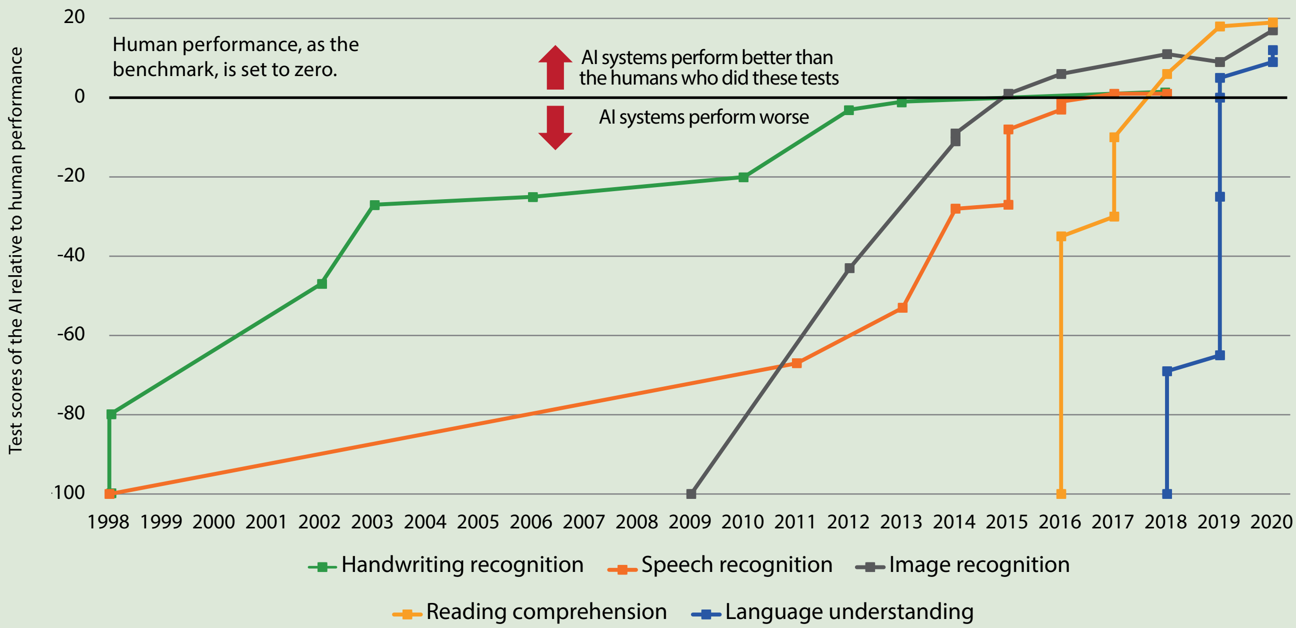
Science, technology, innovation and capacity building ***in numbers***

Technological advances have made significant contributions to the SDGs, including increasing renewable energy's share in electricity production.

Share of electricity production from renewable sources

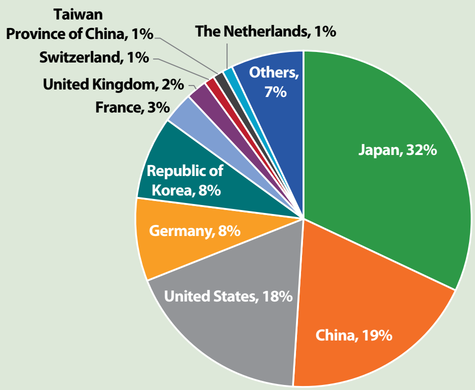


Over the past two decades, there has been a rapid advancement in the global technological frontier, illustrated by the development of artificial intelligence.



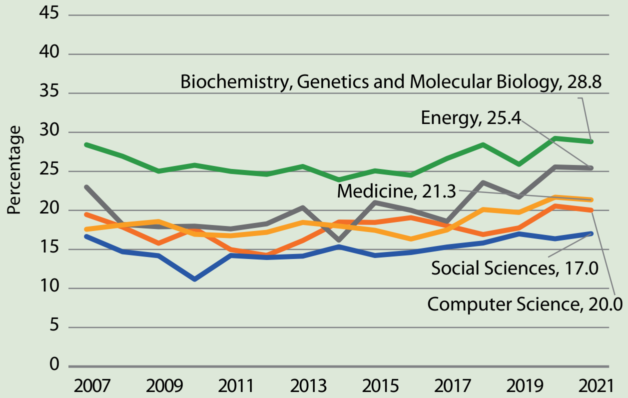
Innovation remains highly concentrated, exemplified by the green technology sector where industrial firms from just seven countries account for 90 per cent of all patenting activities.

Green patenting of industrial firms, 2022



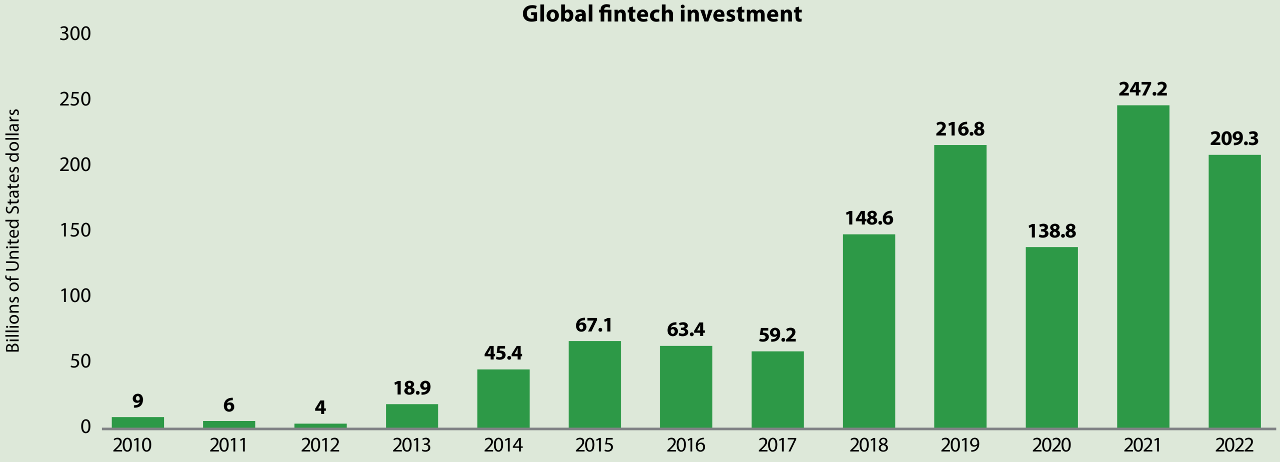
Many developing countries have experienced limited progress in international scientific cooperation, affecting technology diffusion.

Share of scientific publications in middle-income countries involving international collaboration, median

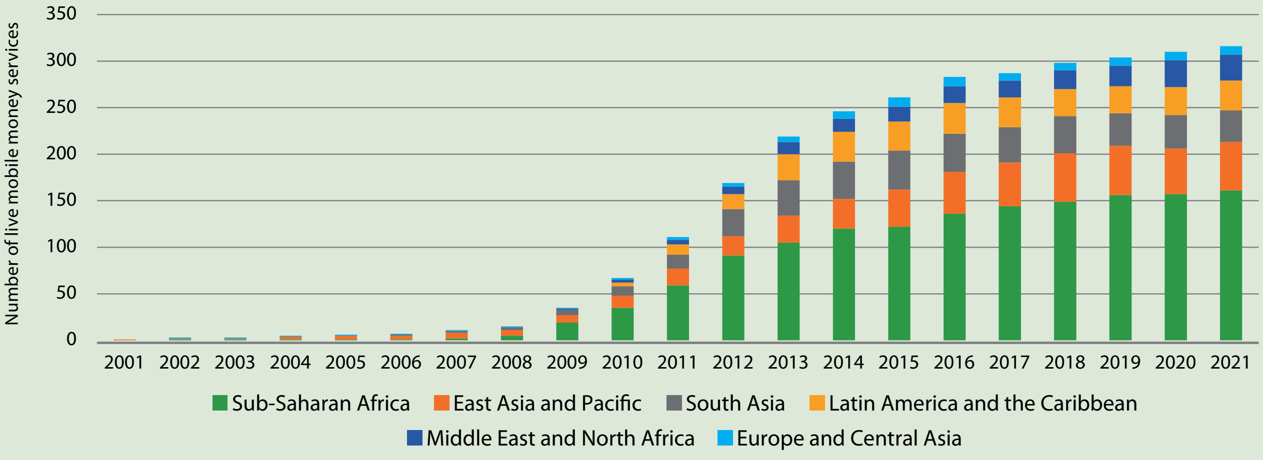


From 2010 to 2022, global fintech investment increased 23-fold, with technological innovations boosting financial inclusion but also presenting new challenges.

Global fintech investment



Globally, the number of mobile money service increased from 1 in 2001 to 316 in 2021, strongly driven by developments in sub-Saharan Africa.





Chapter III.G

Science, technology, innovation and capacity building

1. Key messages and recommendations

Technology holds great promise in advancing sustainable development and improving resilience. Advances in technological progress have expanded economic opportunities, enhancing productivity, creating new industries and business models and contributing to poverty eradication. Science, technology and innovation (STI) have made significant contributions to safeguarding people's well-being, saving millions of lives during the COVID-19 pandemic. Technologies are also keeping hopes alive that the world can still address some of the most critical environmental threats that the planet is facing, such as climate change and biodiversity loss. The past two decades have seen the transformation of artificial intelligence (AI) from a niche field to a central pillar of technological advancement; generative AI could accelerate and amplify the positive development impacts of technologies.

Although it offers significant opportunities, technological change can, however, have unintended consequences for economic, social and environmental outcomes and human rights. Labour market transformation spurred by technological advances demands careful policy responses to avoid significant job losses and greater economic inequality. Generative AI in particular could cause substantial job loss—with a disproportionate impact on the women's labour force. The misuse of technologies can infringe on human rights, including privacy, as AI-driven business models that rely on access to massive personal data are often inadequate at data protection. AI could also erode public trust in institutions through accelerating the spread of misinformation and disinformation and reinforcing biases. Furthermore, the environmental footprint of some frontier technologies can be significant, increasing energy consumption and water usage and resulting in a surge in electronic waste.

The benefits and costs associated with rapid technological change are unevenly distributed. Innovation and technology diffusion between and within countries have been uneven, leading to disparate opportunities for countries and communities to harness technological advancements, with rapid technological change sometimes outpacing the ability of societies to adapt. Indeed, the global technological landscape remains characterized by a high geographic concentration of innovation. The top 10 countries for patent applications—as a rough proxy for innovation activities—have consistently accounted for at least 87 per cent of all patents since 1980. Recent data suggests this trend will continue and possibly become even starker with frontier technologies. The concentration of innovation activities does not inherently hinder global development, provided there is an adequate and effective diffusion of technology and knowledge. However, technology diffusion within and across countries has slowed down in the last few decades, partly driven by the increasing complexity of technologies and innovations that raises the level of required complementary investment in physical and human capital, infrastructure and institutions. Another reason is the complex intellectual property rights landscape that countries have to navigate. Geoeconomic fragmentation—as characterized by an increase in trade barriers, strategic interventions by governments, data localization and other measures—could also diminish international technology spillover.

The growing recognition of STI in driving development trajectories and achieving the Sustainable Development Goals (SDGs) necessitates a rethink of the role of STI policy within national and global development frameworks. Mission-oriented, multi-stakeholder STI policies should be placed at the centre of development frameworks. Such policies should aim to ensure effective coordination between technology and other sectors, between public and private actors and across systemic levels (regional, national and international) to steer technological change towards addressing pressing development challenges.

To ensure innovation and technology diffusion patterns that are consistent with sustainable development, countries need to invest in education and training, infrastructure and institutions and to ensure appropriate levels of market competition and protection of intellectual property rights. It is also important to acknowledge that the provision of technology access does not automatically lead to its widespread adoption due to a lack of financing, inadequate technological awareness and literacy, behaviour inertia, and cultural and social norms. A gender-transformative approach is needed to close the gender-digital divide by addressing gender-related barriers to education and digital tools, and by ensuring online safety, security and privacy.

Financing plays a key role in advancing the development of innovation systems. Different types of financing are needed at different stages of technological progress, depending on the maturity of the technology industry and financial markets and the overall institutional environment of a country. Merit-based grants from government, seed funds, venture capital funds, crowdfunding, traditional banks and stock markets could all play a role as firms move along the innovation cycle.

International cooperation in STI has yielded successes but the formulation of the international STI agenda has historically skewed towards the perspective of developed countries. A shift towards a more inclusive and participatory approach is needed. STI cooperation at the international level is also limited by an overall lack of sizeable and stable funding. The notable fluctuations in official development assistance (ODA) for STI in multilateral organizations pose challenges for international cooperation particularly because STI initiatives typically require stability and long-term planning due to their extended operational timelines.

The rapid expansion of the financial technology (fintech) industry has facilitated greater financial inclusion, but significant gaps remain in access to credit and financial services while new risks have arisen. Policymakers need to create socioeconomic and institutional conditions, not least broader levels of equality, to ensure that all members of society can benefit from advances in fintech. At the same time, they also need to carefully monitor and address the emergence of new, powerful actors in the financial sector. The entry of major tech firms in finance has significant implications for financial market stability, competition, consumer privacy and financial integrity. Given the complex trade-offs among different policy goals, financial sector regulators need to work with industry regulators and competition and data authorities to strike an optimal balance.

The Fourth International Conference on Financing for Development provides an opportunity to address the enduring challenges that countries have faced in generating, accessing and applying technologies that advance sustainable development. The Conference presents an opportunity to identify and address domestic and international hurdles that limit countries' capacity for innovation and technology absorption, and that lead to entrenched asymmetries between countries and firms in the global technology landscape. The Conference could also identify principles to direct the design, execution and evaluation of frontier technologies, including AI-based tools, within the fintech industry.

There are two main sections in this chapter. The first section highlights some of the development opportunities and challenges that technology brings. It will discuss the rapid evolution of the global technology frontier and the uneven innovation and technology diffusion between and within countries. The section will conclude with a discussion of policy areas where concerted efforts are needed to ensure the overall positive and inclusive impacts of technology, as well as the United Nations system's role in supporting capacity-building in countries. The second section will narrow the scope to fintech. It will include an overview of the evolving landscape of fintech, following by a discussion of its impacts and policy implications in the areas of financial inclusion, market stability, competition, consumer privacy and financial integrity.

2. The transformational but uneven impacts of rapid technological change

2.1 STI as a key driver of progress on the SDGs: Opportunities and challenges

Technology has made important contributions to the pursuit of the SDGs, but unintended consequences of technological progress can also impede progress. STI is contributing to improving people's lives, promoting prosperity and protecting the planet. Technology has dramatically improved information flow, supporting people to make economic choices that improve productivity and reduce poverty. It has improved health outcomes and longevity, including saving millions of lives during the COVID-19 pandemic. Moreover, by supporting more real-time evaluation of risks and risk-absorbing capacity, technology also improves the resilience of countries and communities, safeguarding economic, social and environmental advances. At the same time, technological progress can have unintended consequences and its benefits are unevenly distributed, exacerbating inequalities across multiple dimensions.[1] The pursuit of efficiency—enabled by structural changes and technological advances—often comes with significant social and environmental costs. The main challenge for policymakers is thus to mitigate these risks and ensure that technology acts as a catalyst for positive transformation and the realization of the SDGs through a "mission-oriented" STI approach (see section 2.4).

The evolution of the financing for development agenda reflects the growing recognition of the dramatic and potentially transformative impacts of technologies on development progress and on development finance itself. STI has always been considered a key means of implementation for sustainable development; in a major expansion of the financing for development outcomes, STI and capacity-building were added as a separate action area in the Addis Ababa Action Agenda in 2015. The Addis Agenda stresses the importance of public policies and finance to spur innovation and notes with concern the uneven innovative capacity, connectivity and access to technology that exists within and between countries.

Implications for the pursuit of the SDGs: People, planet, prosperity

Technological progress lies at the heart of economic growth, catalysing new industries and business models, expanding economic

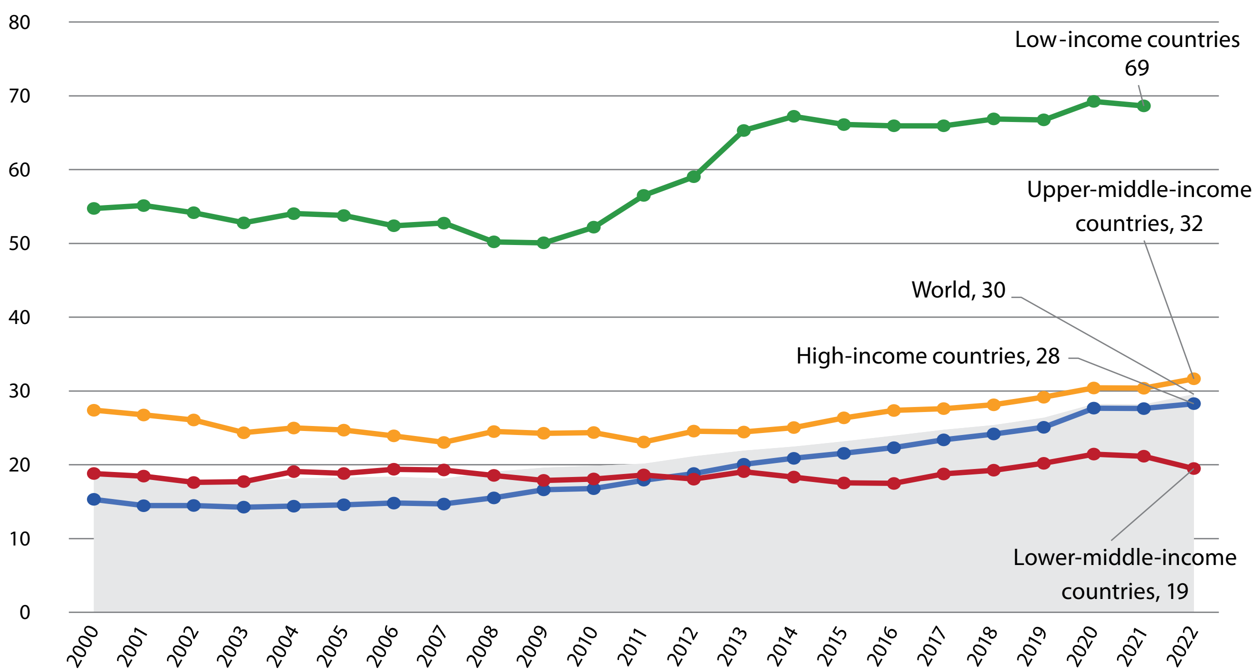
opportunities and enhancing productivity. Over the past 25 years, the impacts of novel technologies, foremost digital technologies, on the economy and society have been profound and multifaceted, reshaping fundamental aspects of market transactions and value creation.[2] Advances in technology have also supported progress across the SDGs. These contributions are too many to note in this report; some prominent examples are listed below.

Technological advances have made dramatic contributions to safeguarding people's well-being, with advances in healthcare a prominent example. COVID-19 vaccines saved over 14 million lives globally during the first year of their administration.[3] Several of these vaccines deployed mRNA technology, which is now also being used to develop vaccines for dozens of other diseases. Going forwards, integration of AI with other cutting-edge technologies could significantly improve the assessment and management of health risks, leading to the development of more effective healthcare strategies. AI also improves gene-editing tools and expands the ability to modify biological systems, which paves the way to address some of the most difficult medical challenges that humanity faces. Advancements in DNA sequencing technologies, coupled with the steadily declining costs of sequencing procedures, are unlocking new possibilities for genetic therapies targeted at diseases like HIV, beta thalassemia, cancer and more.

New technologies are keeping alive the hope that we can still address some of the most critical threats facing the planet on the environmental front. Climate change and energy scarcity have catalysed the rapid development of innovative, cleaner energy technologies and significant improvements in energy storage. Renewable energy technologies help to bring power to economically disadvantaged and remote areas, thanks to scalable and cost-effective off-grid solutions.[4] Although the full potential of renewable energy remains untapped, its usage is growing as the technology improves and becomes more affordable (figure III.G.1).[5] Two decades ago, renewable energy was often dismissed as too expensive or inefficient. Today, due to technological advancements, the costs of solar and wind energy have plummeted (figure III.G.2), making them competitive with traditional fossil fuels. For example, solar photovoltaic was 710 per cent more expensive than the cheapest fossil fuel-fired solution in 2010, but in 2022 it cost 29 per cent less than the cheapest fossil fuel-fired solution.[6]

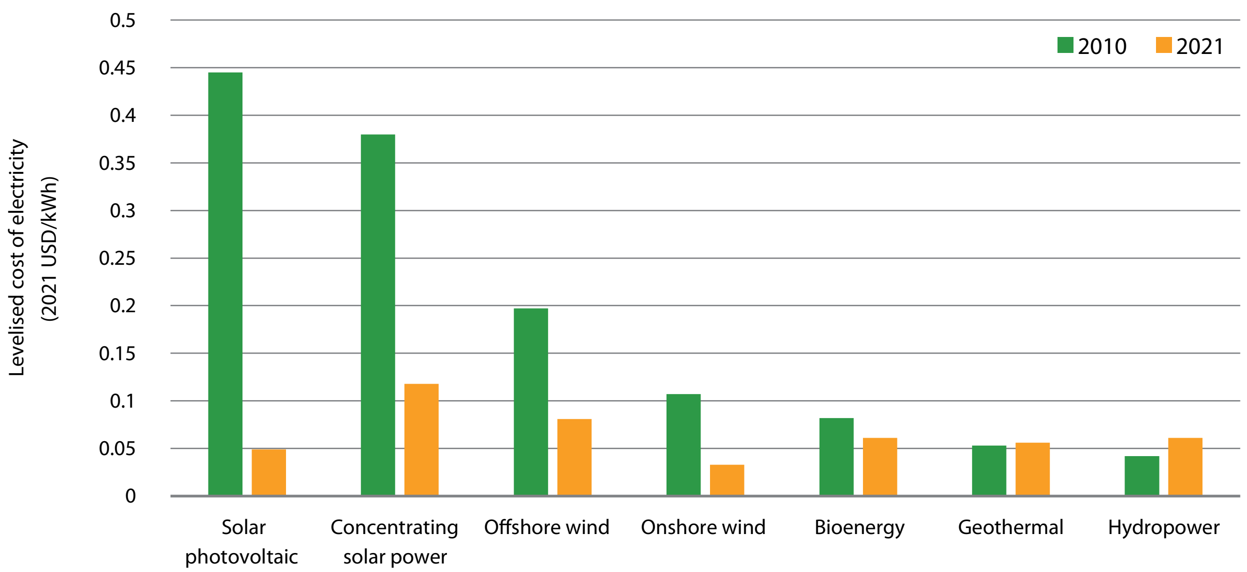
A key component that enhances the efficiency of renewable energy sources is advanced energy storage technology, which minimizes energy waste. With the variable nature of renewable energy production from sources like wind, solar and tidal, the capacity to store substantial amounts of electricity and release it upon demand is essential. Concurrently, developments in battery technology, including increased energy density and faster recharging capabilities, are boosting the feasibility of electric vehicles (EVs) as a sustainable alternative to traditional internal combustion engine vehicles. Between 2010 and 2022, the global number of electric cars increased around 1,000-fold, with China a major force behind this dramatic increase (figure III.G.3).[7] Moreover, the invention of new battery types is broadening the affordability and accessibility of a diverse range of EVs.

Figure III.G.1
Share of electricity production from renewable sources, 2000–2022
(Percentage)



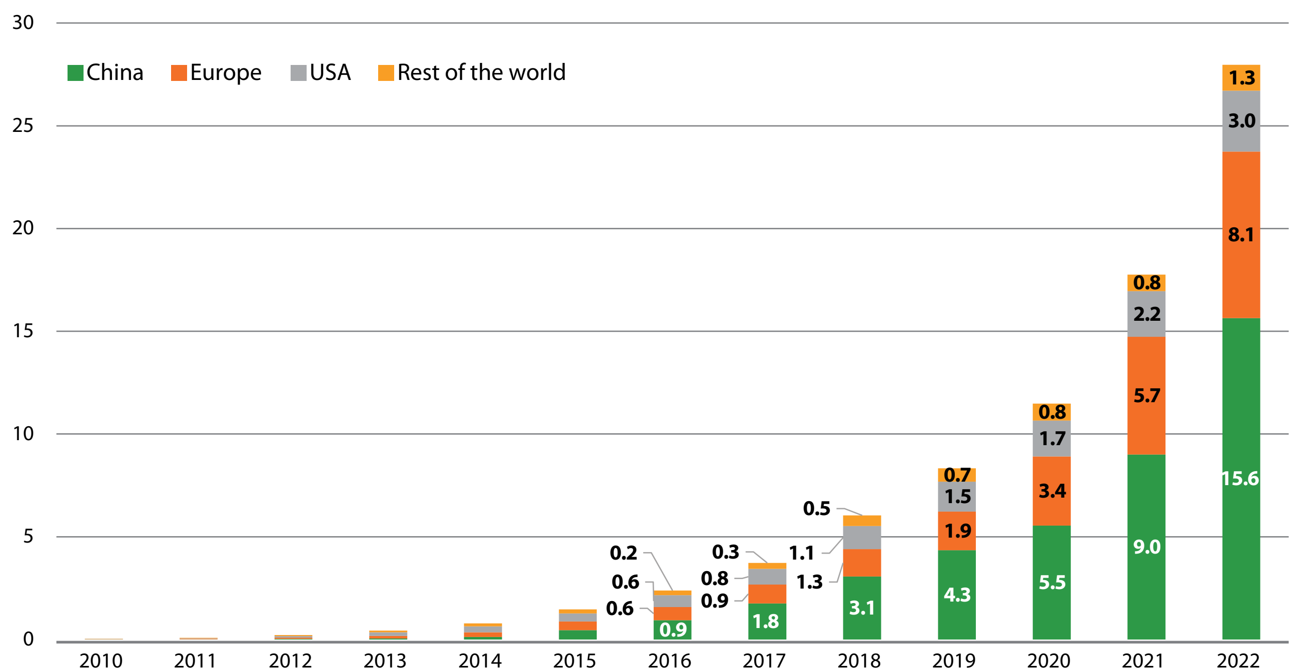
Source: UN DESA elaborations based on Our World in Data (2023).
Note: Renewable energy sources in this chart include biomass, hydropower, solar, wind, geothermal and marine energy. The shaded grey area denotes the percentage of electricity produced through renewable globally.

Figure III.G.2
Global weighted average cost of electricity from renewable power technologies, 2010 versus 2021
(2021 United States dollar/kWh)



Source: IRENA (2023).

Figure III.G.3
Global electric car stock, 2010-2022
(Millions)



Source: UN DESA elaborations based on IEA's Global EV Outlook 2023 data.

Climate-smart agricultural practices—including those making use of nuclear science and applications—have been used to improve agricultural productivity and food security in the face of climate change.[8] [9] Agroecology and precision farming have helped to enhance resilience and adaption to changing climate conditions.[10] Furthermore, innovative radiation technologies offer solutions to tackle plastic pollution, from isotopic tracing techniques for monitoring in the ocean to recycling plastic using radiation technology.[11]

Digital technologies have also contributed to economic growth and poverty reduction. Digital technologies can reduce transaction and coordination costs, making market mechanisms more effective and increasing the scale and scope of individual firms.[12] The reduction in search costs in digital environments has greatly improved the scope and quality of searches and information diffusion,[13] facilitating a more efficient and informed decision-making process as individuals and businesses can access a broader range of information and options with minimal effort.[14] This has contributed to poverty alleviation efforts, for example through access to mobile money, which decreases the consumption poverty of households, with reductions greater among households headed by women.[15] Another example is the use of mobile applications and digital platforms that allow smallholder farmers to access timely information on weather forecasts, market prices and agronomic practices, which empower them to make informed decisions and improve productivity, thus contributing to poverty eradication.[16] Internet penetration is also associated with a reduction in the extreme poverty headcount.[17]

However, the benefits of technological progress are unevenly distributed and new technologies also create new risks and challenges across economic, social and environmental dimensions. For example, automation enabled by advanced digital production technologies has contributed to inequality—both by increasing the capital share of national income, with capital income less evenly distributed than labour income across households, and by favouring higher-skilled workers. These workers have skills that are more complementary to new technologies and can increase their relative productivity and wages, while automation increasingly displaces routine and repetitive tasks, thereby worsening wage inequality.[18] [19] The overall effect of automation on the labour market would depend on a range of factors, including labour scarcity and policy measures.[20]

Automation also reduces the comparative advantage that many developing countries enjoy due to lower labour cost, necessitating new development strategies. More automated production processes that rely less on labour diminish the labour cost-based comparative advantage that many developing countries have exploited to integrate into global production networks and value chains. As labour costs become less relevant, this could lead to reshoring of production to developed countries; recent empirical evidence suggests that the impact of automation on reshoring is indeed positive and significant.[21] This puts the pursuit of development models based on export-oriented industrialization into question. Many developing countries are now facing the prospect of "premature deindustrialization", which entails the shift into service-based economies without experiencing an extended period of industrialization that is crucial for improving overall economic productivity.[22]

The misuse of technologies can threaten human rights. Technologies like AI that rely on massive amounts of data for training, while transformative, can infringe on human rights, including but not limited to privacy. Private information revealed to an AI chatbot could be stored and reused for model training without users' knowledge.[23] In recent years, breaches and leaks have occurred in the databases of corporations that hold the personal data of millions of customers, exposing them to risks of identity or financial fraud. Furthermore, AI-based moderation tools allow social media platforms to quickly censor unfavourable opinions, curtailing freedom of expression.

Without careful management, the environmental footprint of frontier technologies can also be significant.[24] Increased data consumption results in higher global electricity and water usage by data centres and distributed ledger technologies. The prevalence of electronic products such as smartphones and small-scale, off-grid solar panels with a short working life also raises growing concerns over the adverse environmental impacts of critical mineral extraction and electronic waste.[25] All these pose substantial environmental challenges, especially for developing countries.[26]

Enhancing resilience

Technologies can enhance resilience and help to preserve hard-earned development gains. The recent period of cascading crises has underlined the importance of improving resilience against shocks. Economic, social and environmental gains made over years can be quickly reversed in crisis times if countries are inadequately prepared to detect, absorb and recover from these adverse shocks.

Technologies can deliver more efficient, rapid and reliable resilience evaluations and enable better decision-making during and after shocks.[27] [28] For example, data can enhance the planning, design and maintenance of resilient infrastructure by supporting more accurate projections of population growth, urbanization and climate change impacts.[29] The Internet of Things helps to collect, communicate and process real-time data, generating faster warnings and enabling more rapid emergency and policy responses. Mobile phone-based communication and alert systems help to enhance risk-informed communication, which improves the accuracy and timeliness of disaster risk information and has increased community participation in disaster risk reduction.[30] AI allows machines to learn and accumulate experience. This can help to automate the process of improving data collection and processing. For example, drones for remote automated collection of videos and photographs can use AI algorithms to instantaneously interpret the condition of infrastructure, enabling more accurate real-time assessment of hazardous conditions.[31] Drones can also be used to deliver emergency supplies in the case of collapsed infrastructure or dangerous or remote locations.

2.2 Rapid evolution of the global technology frontier

The global technology frontier has evolved rapidly in recent decades. Rapid technological advancements have occurred along with increasing innovation complexity[32] and this pace is set to increase due to frontier technologies that range from AI to biotechnology.

AI has transformed from a decades-old niche field of study to a cornerstone of technological advancement. In 2000, two AI development milestones were the creation of a robot that could recognize and simulate emotions with its face, and a humanoid robot that could deliver trays to customers in a restaurant setting. At that time, no AI system could provide reliable handwriting, speech or image recognition at a human level, not to mention reading comprehension and language understanding. However, in the intervening years, AI has made significant strides, enabled by the exponential growth of data availability that, in turn, is made possible by the rapid rise in Internet penetration. Algorithms have evolved from basic pattern recognition to complex neural networks capable of deep learning. As figure III.G.4 shows, AI systems have made rapid progress in executing human tasks over the past two decades.[33] They have become steadily more capable in language and image recognition and outperforming humans in all these domains in a standardized test setting, even though they still perform worse than humans in some real-world cases.

Since the AI chatbot ChatGPT was released to the general public for testing in 2022, no AI technology has garnered more attention than generative AI—algorithms that can be used to create new content, including text, code, audio, images and videos.[34] The number of generative AI users has since soared and the upward trend is expected to continue going forwards, as the recent evolution of customized AI agents and multimodal and hybrid AI models can further extend the reach of the technology. It is projected that the generative AI market will grow from $11.3 billion in 2023 to $76.8 billion by 2030.[35]

Generative AI has the potential to accelerate and amplify the positive and negative impacts of technology as was discussed in the previous section. For example, it can be used in drug discovery and molecular design, supporting the initial design phases of the material discovery processes that help to quickly produce candidates for experimentations.[36] It can generate educational content such as quizzes, exercises and interactive simulations, which enhances the learning experience for students.[37] Generative AI can also be used to enhance the prediction and modelling of ecological changes and population dynamics, which enables researchers to create accurate, proactive strategies to protect endangered species. While the evidence remains tentative, generative AI could also serve as a general-purpose technology that enhances the productivity of many sectors and the provision of public services, thus improving people's living standards. At the same time, its ability to engage in complex activities, such as coding, product design, creation of marketing content and strategies or analysis of legal documents, suggests that it could be highly disruptive in labour markets, affecting a wide set of work activities that have so far been considered "safe" from risks of automation—tasks that require expertise, social interaction and creativity. In this view, AI may be considered more threatening to some higher-skill workers who have skills sets that can be more easily replaced by the technology. On the other hand, in countries where such skills are scarce, AI could serve as a complementary resource to support development while these countries build up their human capital.

The labour market impacts of generative AI could vary widely across country income groups due to different occupational structures. In low-income countries, an ILO study estimated that only 0.4 per cent of total employment is potentially exposed to the automation effects of generative AI, whereas the estimate for high-income countries is 5.5 per cent.[38] The effects are also differentiated across gender. For example, in high-income countries, the share of jobs held by women that could potentially be automated by generative AI is 7.8 per cent, more than double the 2.9 per cent share of jobs held by men, as female-dominant occupation groups such as clerical jobs are most exposed to the technology. Meanwhile, the share of jobs with high augmentation potential—meaning jobs that cannot be completely automated and could be complemented by generative AI—is also greater for jobs held by women than for jobs held by men across all income groups. Similarly, an IMF study found that higher-income countries are more susceptible to the job displacement effects caused by AI adoption but are also better positioned to take advantage of its complementary effect on labour productivity.[39] Within countries, it was also concluded that women workers are more exposed to the effects of AI but have more potential for their work to be complemented by the technology.

Box III.G.1
Technology's disruptive impact on institutions

Technological change not only affects production processes but also impacts and—in some cases—transforms institutions, including rules and regulations, cultures and social norms. It can alter the balance of power between different public and private actors, including government, civil society and corporations. For example, the rise of social media has created a powerful channel for the public to voice its opinions in amplified ways that were inconceivable two decades ago. Public complaints communicated on social media platforms have been shown to elicit greater policy responses than complaints made through private channels.[40] Technologies—if properly employed—can improve public participation in the policymaking process and hold policymakers to account.

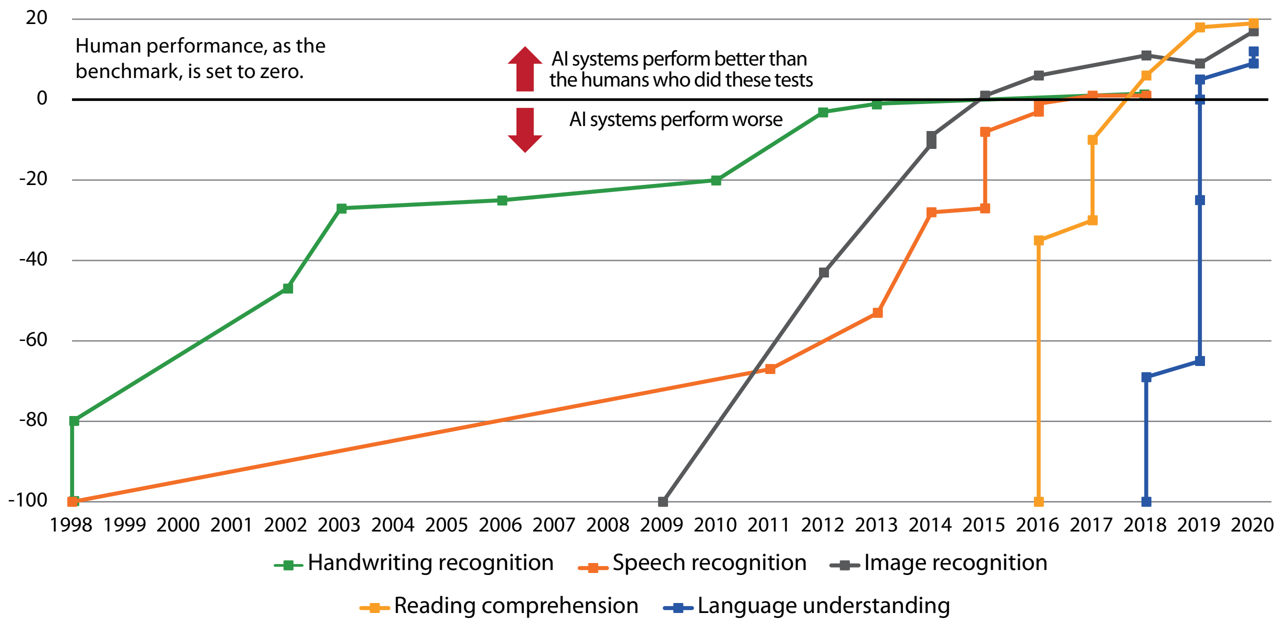
However, if misused, technology can undermine trust in institutions. It can destabilize political systems if it is used to undermine the quality and truthfulness of information that feeds into public debate. AI systems, if trained using data embedded with biases, can perpetuate societal prejudices, leading to data-driven discrimination. For example, discrimination in lending by fintech lenders occurs through algorithmic scoring, with the lenders charging minority borrowers more for purchase and refinance mortgages.[41] The rapid evolution of technologies also demands a more agile form of governance that can more quickly adapt to changing social, economic and environmental conditions. A lack of commensurate reforms to ensure that the governance model is fit for purpose will erode public trust in institutions.

Moreover, the growing dominance of major actors in technology sectors raises the risk of regulatory capture. Major firms could secure advantages over smaller rivals or new market entrants via political means, negatively affecting consumer welfare in the long run. Major social media firms also hold a central position in playing an intermediary role in public debates, including interactions between the public and governments, with the potential to shape political outcomes. The increased social and political influence of so-called Big Tech—sometimes across national borders—demands a rethink of technology policy and governance to ensure accountability, fairness and inclusiveness.

Figure III.G.4

Evolution of language and image recognition capabilities of artificial intelligence systems since the turn of the century

(Test scores of the AI relative to human performance)



Source: UN DESA, adapted from Roser (2022).
Note: The capability of each AI system is normalized to an initial performance of -100.

Historically, technological advancements, although initially disruptive to the labour market, have ultimately contributed to economic expansion and job creation in the long term. Whether generative AI will yield a similar outcome will depend on investment in human capital and adjustment of economic structures and business models that allow workers to take advantage of such technology in their work, rather than being replaced by it. The aforementioned estimates of generative AI's employment effects also suggest that the direction of the gendered impact of the generative AI-induced labour market transition will hinge on how well the transition is being managed and whether the shift would lean more towards automation or augmentation.

Generative AI could also, however, become a powerful vehicle for misinformation and disinformation, further eroding trust in institutions and between people. Its affordability and accessibility lower the barrier of entry for disinformation campaigns.[42] Generative AI can be used to manipulate the videos and messages of public figures, including government officials, in order to spread false information. Additionally, the easy access to generative AI tools can erode public trust in factual information, even when it is verifiable. As AI-generated content becomes more prevalent online, it could lead to increased scepticism among people, causing them to doubt the authenticity of any information, thus undermining the effectiveness of public debate that is central to good policymaking.

2.3 Persistent technological divide

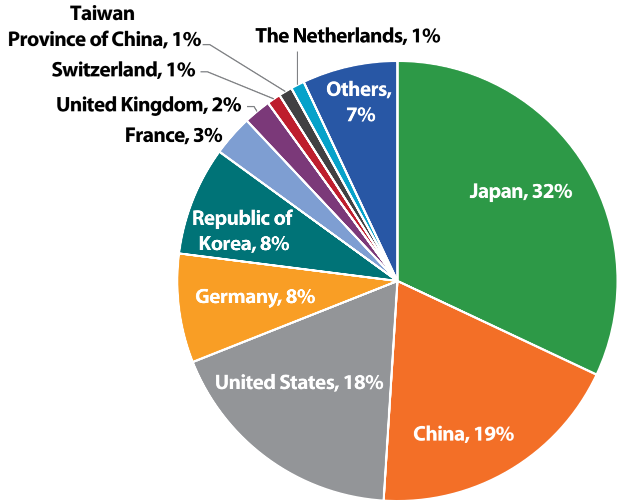
Rapid technological advancement often coincides with growing inequality as the benefits from innovation are not equitably distributed across different geographies and demographics. This historical trend has also played out with the rise of digital technologies over the past several decades. Developing countries, particularly the 45 least developed countries (LDCs), face a range of barriers both to creating new technologies and to accessing them: inadequate infrastructure, insufficient physical and human capital investment, lack of financing on the right terms, and missing or incomplete institutions. The development and use of frontier technologies in production is often concentrated in a few large companies, primarily from developed countries. This situation raises concerns about wealth concentration, market competition and potential abuses of market power, perpetuating inequalities over time.[43]

High geographic concentration of innovation

The persistently high geographic concentration of research and development (R&D) and related assets—observed over the last decades—has first-order implications for the global economy and the technology divide.[44] The top 10 countries for patent applications have consistently contributed to at least 87 per cent of the worldwide total since 1980.[45] The dominance of the leading countries continues in frontier technologies.[46] For instance, 90 per cent of all patenting activity in the field of smart manufacturing is concentrated in 10 countries.[47] The concentration is even higher in green technology creation, with industrial firms from seven countries accounting for 90 per cent of all patenting activity (figure III.G.5).[48] With the exception of China, these countries are all high-income economies, which indicates a significant skew towards wealthier nations in terms of innovation and technological development. Moreover, what is notable is the high concentration of innovation activities and slow technological diffusion within these leading countries themselves, which indicates an even higher level of uneven distribution of innovation and technology access at the more granular firm level (more discussion on this in a later section).

The geographic concentration of innovation and related innovation disparities are due to many factors, including capital (human, physical and financial), institutions, path dependencies, and business and research incentives. One important factor is the presence of localized knowledge spillovers.[49] Often, it is a dense cluster of successful firms, qualified suppliers and shared resource arrangements within a geographic area, particularly in cities with dense networks and diverse resources, that creates an environment ripe for innovation.[50] These entities, in close proximity to each other, engage in frequent and often informal exchanges of ideas and knowledge, creating a vibrant, interactive ecosystem that catalyses innovation. Indeed, empirical studies have shown that a greater pool of relevant technological knowledge in close geographic proximity of a firm significantly increases its chances of conducting innovation activities and the persistence of such activities.[51] As these innovation clusters grow, they attract more resources and talent, often at the expense of other less established regions.[52] This can lead to a self-reinforcing cycle where already successful areas continue to grow, while others lag behind.

Figure III.G.5
Green patenting of industrial firms, by country of owners, 2022
(Percentage)



Source: UN DESA elaborations based on Lavopa and Menéndez (2023).
Note: Green patents are broadly defined here as technologies or applications that mitigate or adapt to climate change.

Uneven access to and usage of technology between and within countries

The concentration of innovation activities does not inherently hinder global development, provided there is an adequate and effective diffusion of technology and knowledge. However, technology diffusion has slowed down in the last few decades, both within and across nations, with major implications for productivity growth and broader sustainable development.[53]

One possible driver of slow technology diffusion is the increasing complexity of technologies and innovations. Such complexity has raised the level of complementary investment in infrastructures, productive capital, skills and capabilities of the workforce that is necessary for technological innovations and successful adoption of new technologies.[54] It amplifies a longstanding obstacle to technology adoption in developing countries, which is the inadequate investment in the national innovation systems. This can be illustrated by the substantial disparities in internet speed and data use that impede digital gains for low- and middle-income countries.[55] For instance, in 2023, median broadband speeds in high-income countries were between five and ten times faster than those in low-income countries.[56] The frontier technology readiness index—a comprehensive measure to evaluate the capability of nations to effectively implement and benefit from cutting-edge technologies—has also shown that there is a persistent capability gap between lower-income countries and those at the capability frontier.[57] While the capability of many upper-middle-income and some lower-middle-income countries moved closer to the frontier between 2008 and 2021, the gap between the capability of low-income countries and the frontier remains as great as ever (figure III.G.6).

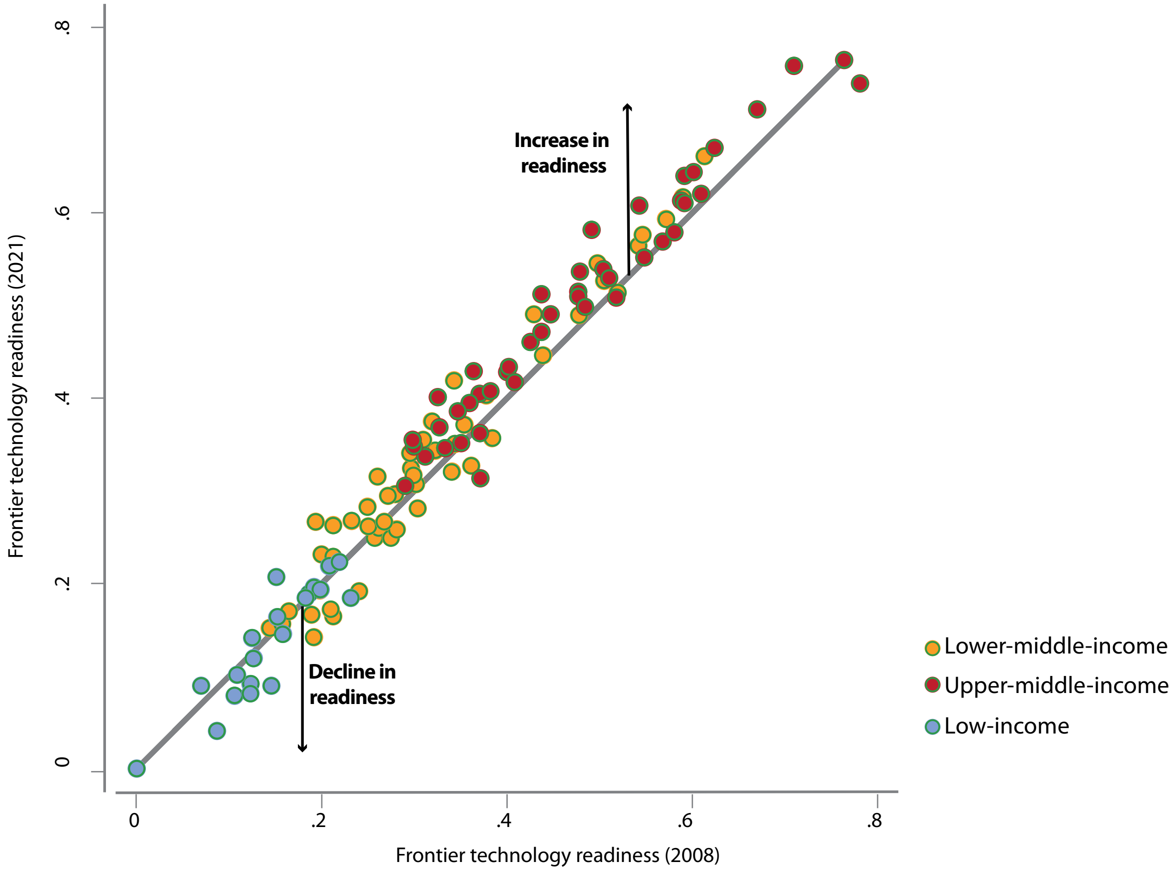
There is also a noticeable slowdown in technology transfer between developed and developing countries.[58] While the international protection of intellectual property rights provides important flexibilities, it remains tight and complex, making it difficult for developing countries to access technologies that support sustainable development and to manage their own innovation systems.[59] Even within countries, there is a persistent gap in technology adoption and use between "frontier firms" and the rest of the economy.[60] Frontier firms lead technological adoption, leveraging cutting-edge technologies to enhance productivity and competitiveness. However, the rest of the economy, particularly small- and medium-sized enterprises (SMEs), often struggle to keep pace with rapid technological changes. A similar pattern can be observed with regard to diffusion of AI technologies. While global firm-level surveys have suggested a broad-based adoption of AI technologies in business operations across regions,[61] national firm-level surveys show that the adoption of AI is predominantly done by large firms.[62] This suggests AI adoption is highly uneven within countries, including in developed ones.

A specific barrier to widespread adoption of AI technology is that the current leading AI models are trained mainly on knowledge produced by and relevant to developed countries. It reflects the reliance of researchers on Internet data for model training, which is predominantly in English and a small group of other languages.[63] As such, outputs of these models might be less useful for developing countries, which could further exacerbate the technology divide. This will have to be addressed by training AI models using data that is more relevant to specific regions or countries. Singapore's Southeast Asian Languages in One Network (SEA-LION) model—a family of large language models that are specifically trained for the Southeast Asia region—is an example of such an initiative.[64]

Innovation and technology diffusion amid geoeconomic fragmentation of the global technological landscape

Geoeconomic fragmentation puts global integration, STI cooperation and technology diffusion at risk (see chapter II and chapter III.D

Figure III.G.6
Frontier technology readiness, 2008 versus 2021



Source: UN DESA calculations based on UNCTAD's Frontier Technology Readiness Index data.
Note: Each dot represents a country. A country that stays below the 45-degree line means that its frontier technology readiness declined in 2021, compared to 2008. Conversely, a country that stays above the 45-degree line means readiness improved in 2021.

for discussions on other impacts of such fragmentation).[65] Data on trade barriers, for example, shows signs of such fragmentation: After declining for most of the twentieth century, trade restrictions have significantly increased in the past few years.[66] Technology and innovation, which have long been central to geopolitical competition, are particularly vulnerable to geoeconomic fragmentation. The quest for technological leadership has historically been a strategic imperative for nations, often involving efforts to prevent critical technologies from being acquired by strategic competitors.[67]

Trade barriers to high-tech inputs and services, strategic intervention by governments, limited market access, data localization and other measures could diminish international technology spillover and discourage R&D investment. This disruption could lead to a widening technology gap between nations, undermining the global technological progress that has been made over decades. Even for countries at the technological frontier, protecting critical technologies from foreign competitors is becoming increasingly complicated, as technological innovation is now characterized by a high degree of interdependence and multinational collaboration. In attempting to prevent others from accessing sensitive technological applications, these countries may inadvertently risk undermining their own technological capabilities.

2.4 STI policy, international cooperation and capacity-building

Evolution of STI policy approaches

There is a wide diversity of STI policies across different countries. This diversity reflects the unique political, economic and cultural contexts of each country that shape their distinct strategies in advancing STI. Yet two broad overall approaches can be distinguished: narrower STI policy approaches that focus on addressing market failures, such as information asymmetries and non-rivalry in the use of technology knowledge; and a broader innovation system approach that aims to address system failures that impede learning and innovation.[68] These systemic failures include infrastructural (such as physical and science and technology infrastructure), institutional (which includes "hard" institutions such as regulation and the legal system and "soft" institutions such as social norms and values, entrepreneurial culture, and so forth), network (which concerns the interaction between actors in the innovation system), and capabilities (which include competencies and resources).

Beyond addressing market and systemic failures, there is a growing call for STI policy to put greater emphasis on directing

technological change to address development challenges. This also reflects the better understanding of technologies' potential and the importance of STI policy directed at addressing major social challenges in driving development progress. The SDGs can serve as a natural benchmark for this "mission-oriented" STI policy approach; and detailed proposals have been put forth for how countries can develop related STI policy roadmaps for achieving the SDGs.[69] The evolution towards the mission-oriented approach also means that STI policy needs to be placed at the centre of national and global development frameworks to enable policymakers to better address policy coordination problems, including between technological and sectoral systems, between government agencies and private institutions and across systemic levels (regional, national, international).

Supporting innovation and technology diffusion

Concentrated innovation activities and weak technology underline the need for policies that facilitate access to new technologies and support the capacity of economies, households and businesses to adopt and harness these technologies effectively. There needs to be a concerted push for investments in education, training and reskilling programmes as well as in infrastructure and institutions that strengthen innovative and absorptive capacity, which include context-appropriate competition policy and protection of intellectual property that respects the international legal norms.

To ensure that technological advances are geared towards addressing pressing development challenges, the innovation process should involve a diverse group of researchers, end users and intermediaries who can translate needs and values between producers and users. Gender parity in research, and science, technology, engineering and mathematics (STEM) fields needs to be improved, given the significant underrepresentation of women in these fields (with only one in three researchers globally women; and just over one fifth of all science, engineering, and information and communication technology (ICT) jobs held by women). A notable example of international cooperation on this front is the Equity 2030 Alliance launched by the United Nations Population Fund (UNFPA). The Alliance, a global effort to accelerate gender equity in science, technology and financing solutions by 2030, convenes entities and industries across the globe to take action with the aim of closing gender equity gaps by 2030. The joint effort enables entities to share and learn from best practices, ensuring the inclusion of women in all their diversity throughout the innovation lifecycle of solutions.

Minimizing the unequalizing effects of technologies should more generally be a core objective of STI policy. In light of the potentially dramatic labour market impacts, STI policies should guide technological development to be labour-complementary rather than labour-replacing. To this end, countries can consider measures such as improving tax codes to equalize the marginal tax rates for hiring and training labour, investing in equipment and software, increasing the voice of workers and directing funding for more labour-complementary R&D.[70] Compensatory mechanisms are also important where the adoption of new technologies produces both winners and losers. Social protection plays a key role here, as does education and training that equips workers with the appropriate skills and supports them in transitioning to new jobs.

Financing for innovation

Financing plays a central role in supporting innovation and technological diffusion as well as guiding technological change. Different types of financing are needed to fund innovations, depending on the maturity of the technology and financial markets and the overall institutional environment of a country.[71] Basic research and science is mostly publicly funded; but even in the initial phases of product development, where failure risk is high, funding often comes from merit-based public grants or from equity investors. The latter usually involves participation from angel investors, seed funds and venture capital funds and permits investors to oversee business operations and exert considerable control to mitigate investment risks. In the past two decades, crowdfunding through digital platforms has also gained traction as a novel funding method for early-stage innovation. Only as innovative projects progress to more advanced stages of development does the role of traditional financial intermediaries like banks and capital markets become more prominent.

To spur innovations that advance sustainable development and ensure public access to such innovations, the public sector can and should play a key role in financing and incentivizing research. Public financing allows innovators to recover R&D costs without having to rely on selling their innovations in private markets that could limit diffusion. This can be secured through direct financing (for specific research activities), decentralizing direct financing (e.g. tax credit for research) or a prize financing system (i.e. government awards a prize for successful innovation).[72] Governments can also use these financial tools to promote socially and environmentally desirable technologies and to maximize public benefits.[73]

Ensuring sufficient innovation and technology diffusion also requires appropriate market competition and protection of intellectual property rights. Competition authorities need to consider both ex ante measures that focus on developing the necessary environment for healthy market competition and ex post measures that target specific incidences of anticompetitive behaviours.[74] These considerations must account for changes in how firms compete in the new era of the data economy and the implications for consumer welfare.[75] Intellectual property systems play an important role in creating a conducive and reliable environment for the transfer of technology, and they need to be tailored to a country's stage of development and technological capability, as noted in the *Financing for Sustainable Development Report 2023*. Governments' innovation and intellectual property policies should take advantage of the flexibilities provided in the Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) to support technology diffusion. Countries can also consider other intellectual property approaches that might serve them better to mitigate the trade-offs between incentivizing R&D investment and facilitating the spread of the innovations. These could include the knowledge commons approach that underpins the "open source" movement and a public finance-driven innovation approach.

Access does not automatically translate into widespread adoption.[76] Even when new technologies are markedly superior to existing options, they have not always been widely embraced. In this context, there is a growing recognition of the critical role of feedback loops between supply and demand in the innovation process and specifically how user feedback can effectively guide the allocation of resources and innovation capabilities to meet the needs of society or the market.[77] Other factors hindering demand for welfare-enhancing technologies also need to be tackled, such as lack of financing, inadequate technological literacy and awareness of new technologies, behaviour inertia, and cultural and social norms.[78] Gender-transformative approaches must be at the centre of efforts to increase technology adoption and close the technology divide: addressing gender-related barriers to education and digital tools, meeting women and girls where they are and embedding digital skills into existing programmes; equipping educators with inclusive, gender-responsive ICT integration skills; and ensuring safety, security and privacy online.[79] Such efforts all require narrowing the gender gap in Internet access. In 2022, only 63 per cent of women were using the Internet compared to 69 per cent of men; and the gap was even greater in lower-income countries, with 21 per cent of women online compared to 32 per cent of men.[80]

International cooperation and capacity-building

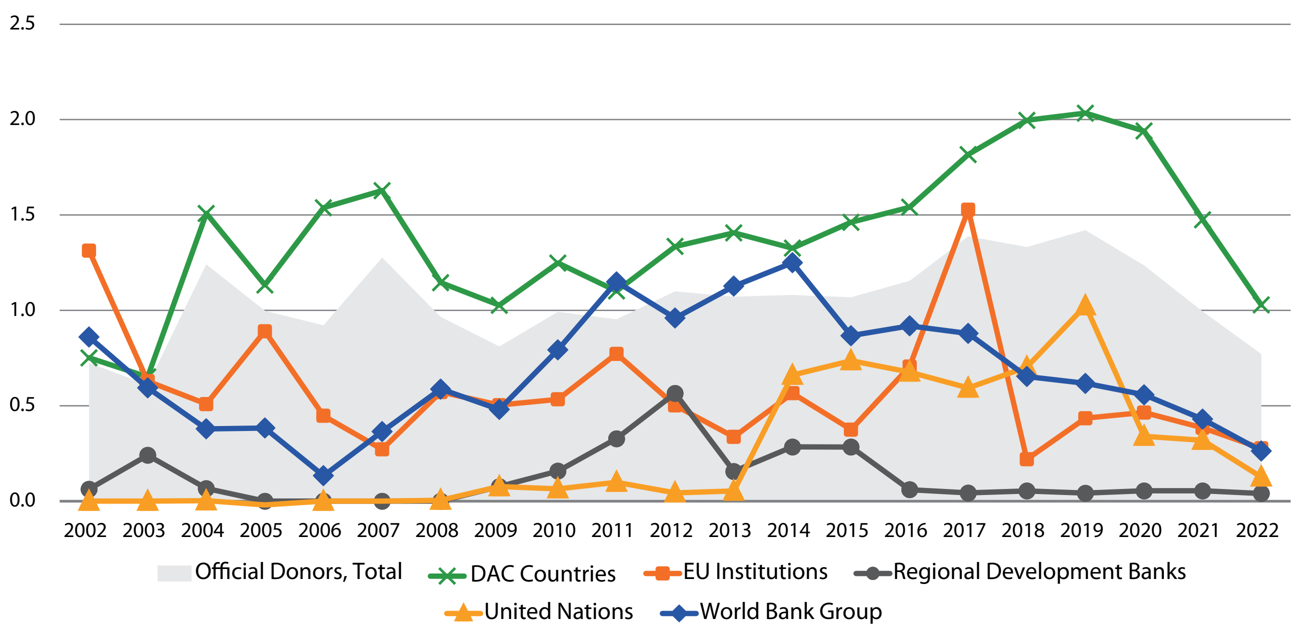
Growing technological complexity, the fast pace of technological change and its significant impact across countries call for a collaborative approach to STI. A plethora of cross-border initiatives have been established over the past 20 years. At the regional level, some notable initiatives include the ASEAN Plan of Action on Science, Technology and Innovation 2016–2025, the African Union's STI Strategy for Africa 2024, and the Asia-Pacific Economic Cooperation's Policy Partnership for Science, Technology and Innovation. Also of note are successful experiences with international collective research, which equitably incorporates the views and priorities of different partners. For example, the European Organization for Nuclear Research (CERN) and the Consultative Group on International Agricultural Research (CGIAR) offer useful references for the design and operation of inclusive and equitable collaboration mechanisms based on open science and co-creation. The IAEA Nuclear Harmonization and Standardization Initiative is an example of a platform that facilitates regulatory collaboration among countries.

Despite the success of these initiatives, the formulation of the international STI agenda and the evolution of the global innovation system have historically been skewed towards the perspective of developed countries.[81] A shift towards a more inclusive and participatory approach is therefore needed. This requires stakeholder engagement and practical support measures to create a collaborative setting for facilitating exchanges of knowledge among different actors and recognizing the needs of countries with fewer resources.

International cooperation in STI remains limited by a generalized lack of sizeable and stable funding. In terms of concessional financing for STI, the share of ODA in STI did not appreciably increase between 2002 and 2022 (figure III.G.7). Including all official donors, while the share of STI in total ODA increased between 2016 and 2019, it has since declined and in 2022 reached its lowest point since 2003. ODA for STI is also very volatile.

International cooperation on scientific research also diverges between country groups. Whereas high-income countries have seen a broad-based increase in international cooperation across different fields of STI over the past decade or so, many developing countries—with the exception of some larger developing economies—have seen limited progress (figure III.G.8). This partly reflects the limited STI capacity of many developing countries, which hinders their efforts to engage in cross-border collaboration.

Figure III.G.7
Share of official development assistance related to science, technology, and innovation, 2002–2022
(Percentage)

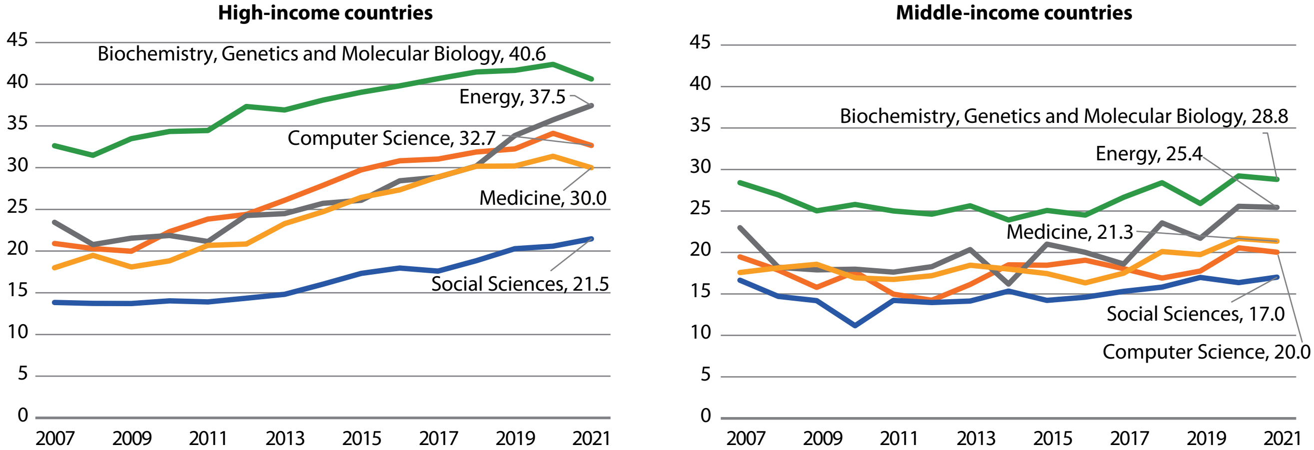


Source: UN DESA calculations based on OECD Creditor Reporting System data retrieved from OECD.Stat.
Note: STI ODA includes the following sectors: Technological research and development, Research/scientific institutions, Medical research, Agricultural research, Forestry research, Fishery research, Environmental research, Energy research, and Educational research. Shares computed using gross ODA disbursement at constant prices.

Figure III.G.8

Share of scientific publications involving international collaboration, by country income group and field, 2007–2021

(Percentage)



Source: UN DESA calculations based on data from OECD Data Explorer.

Note: Data contains 41 high-income countries, and 19 middle-income countries. For each field, the value shown is the median value of the respective country income group.

International efforts to support innovation activities and accelerate technology uptake need to be scaled up. A concerted effort is needed to ensure alignment of the international protection of intellectual property rights with the pursuit of sustainable development. The international intellectual property rights system should allow policy space for countries at different development stages to manage their intellectual property system to support their industrial and STI strategies.[82] Greater efforts are also needed to support STI cooperation between developing countries through South-South and triangular cooperation, taking advantage of their similar development and technological conditions that could make their experiences more replicable. Countries also need to collaborate on establishing internationally accepted principles for developing technology standards and ensuring consistent interpretation and application of these principles, which is essential for supporting technology diffusion.[83] Strong international cooperation on competition policy is needed to narrow the divergence between jurisdictions in terms of antitrust enforcement, which would reduce regulatory arbitrage and allow governments to fully enforce competition laws that provide a level playing field for smaller domestic firms against their bigger international competitors. International support for capacity-building is crucial and must give special attention to marginalized communities and vulnerable groups. Incorporating gender-responsive approaches into capacity-building programmes ensures that women and girls have equal opportunities to participate and benefit from STI advancements.

United Nations efforts to harness STI for sustainable development

As the United Nations focal point for STI for sustainable development, the Commission on Science and Technology for Development (CSTD) discusses policy issues raised by rapid technological change and advances the understanding of science and technology policies. Recent discussions include data for development, global STI cooperation and green technology for sustainable development.[84] The CSTD also serves as the focal point in the system-wide follow-up to the outcomes of the World Summit on the Information Society, promoting the sharing of information and knowledge about the major trends, impacts, opportunities and challenges of digital development.[85]

The Technology Facilitation Mechanism (TFM), through the organization of the annual multi-stakeholder forum on STI for the SDGs (the STI Forum), has played a key role in facilitating discussions on STI cooperation in support of the SDGs.[86] The TFM has also launched the global pilot programme on STI for SDGs roadmaps to support developing countries to envision and plan actions, track progress and foster a learning environment to harness STI to achieve the SDGs. The CSTD and TFM are among the most prominent United Nations platforms to engage with key stakeholders, facilitate exchange and cooperation in STI, and build consensus on a common vision that reflects the needs and aspirations of all countries.

Apart from strategic planning, capacity-building is an important area of international cooperation in STI. Within the United Nations system, the UN Interagency Task Team on STI for the SDGs (IATT) under the TFM serves as a collaboration hub, with 47 United Nations entities and 150 staff members active in 10 workstreams.[87] This includes a workstream on capacity-building, which designs and delivers training courses and workshops on STI policy for the SDGs, including a global repository of training materials, guidelines and case studies for policy implementation, particularly for developing countries.[88] The capacity-building workstream has delivered a series of nine training workshops on STI policy and instruments for the SDGs for around 1,200 STI officials from 74 countries, with 51 per cent of the participants women. To build capacity in STI policymaking, the United Nations Conference on Trade and Development (UNCTAD) offers customized training for developing countries,[89] complementing the national STI policy reviews conducted in 19 countries to identify the key strengths and weaknesses of their innovation systems, establish strategic priorities and integrate STI policies into national development strategies.[90] In 2023, the United Nations Industrial Development Organization (UNIDO) launched a methodology to assess readiness for industrial innovation in developing countries, which also serves as a capacity-building tool for policymakers.[91]

The United Nations Technology Bank for Least Developed Countries champions technology transfers by aligning the technology demands of LDCs with appropriate solutions through three pillars of work.[92] The first pillar is the country-specific Technology Needs Assessment (TNA) to map key development challenges facing LDCs and identify the technologies, innovative solutions, skills and knowledge that LDCs need to address them. The second pillar is the design of context-specific technology transfer projects and programmes guided by the TNAs, with the current focus on agriculture and food systems; environment, climate change and resilience; health; and education and digital skills development. The third pillar is the development of STI capacities in LDCs, including to ensure sustainability of the support provided by the Technology Bank. Other major programmes that support technology and knowledge transfer, in particular environmentally sound technologies, include the Global Environment Facility and the Climate Technology Centre and Network. To date, the Technology Bank has completed 12 TNAs covering five countries in 2020, six in 2022 and one in 2023. It is expected that five more TNAs will be completed in 2024. To further enhance the Technology Bank's capacity and effectiveness, Member States have called on international partners to provide voluntary financial and in-kind resources in the Doha Programme of Action for LDCs for this decade from 2021 to 2030.

Given the cross-border implications of AI development and use, global coordination is needed. In October 2023, the United Nations Secretary-General convened a multi-stakeholder AI Advisory Body consisting of experts from government, the private sector and civil society to undertake analysis and advance recommendations for the international governance of AI. The Body will seek to link and coordinate with existing initiatives, including that of the European Union and the Group of Seven (G7) Hiroshima AI Process.[93] A core objective of the Body is to identify effective forms of AI governance, informed by an examination of existing models of technology governance that have worked in the past. Recommendations from the Body—regarding international cooperation on AI governance, scientific consensus on risks and challenges, and key opportunities and enablers to leverage AI for achieving the SDGs—will feed into the Global Digital Compact proposed for adoption by Heads of State at the Summit of the Future in September 2024. In December 2023, the Advisory Board released an interim report on governing AI for humanity.[94] In its preliminary recommendations, the interim report proposed five guiding principles for AI governance: (1) AI should be governed inclusively, by and for the benefit of all; (2) AI must be governed in the public interest; (3) AI governance should be built in step with data governance and the promotion of the data commons; (4) AI governance must be universal, networked and rooted in adaptive multi-stakeholder collaboration; and (5) AI governance should be anchored in the United Nations Charter, international human rights law and other agreed international commitments such as the SDGs.

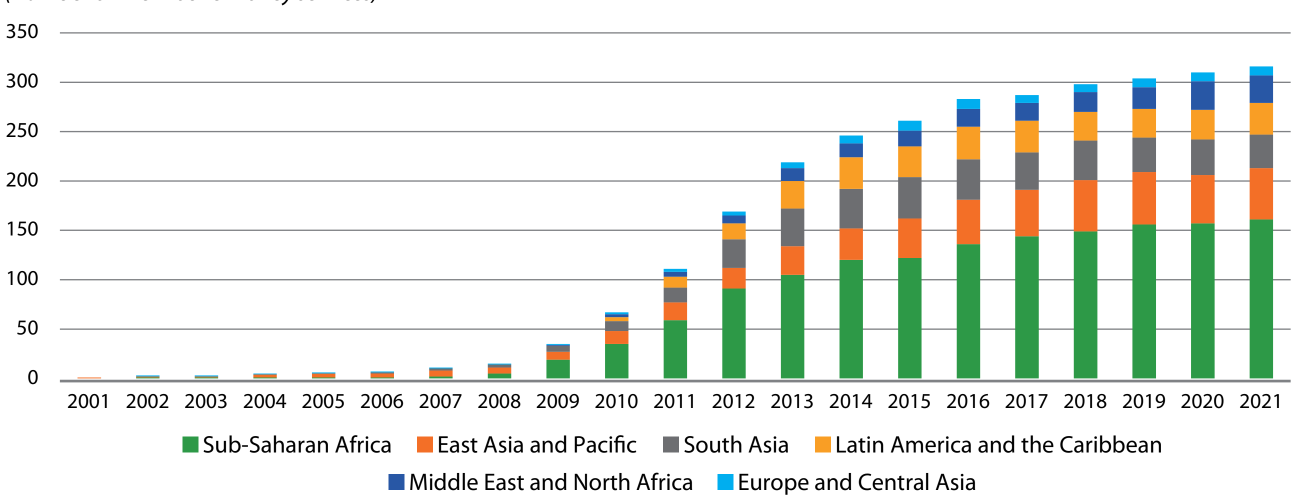
3. Technology and financing for development: Fintech and the implications of STI for action areas of the Addis Agenda

3.1 Fintech

Evolution of fintech over the past 20 years

The global financial landscape is undergoing a transformation, driven in large part over the last two decades by the rapid growth of "fintech"—technology that provides financial solutions based on a combination of modern financial services and emerging technologies. The proliferation of the Internet and the advent of online

Figure III.G.9
Availability of mobile money services, 2001–2021
(Number of live mobile money services)

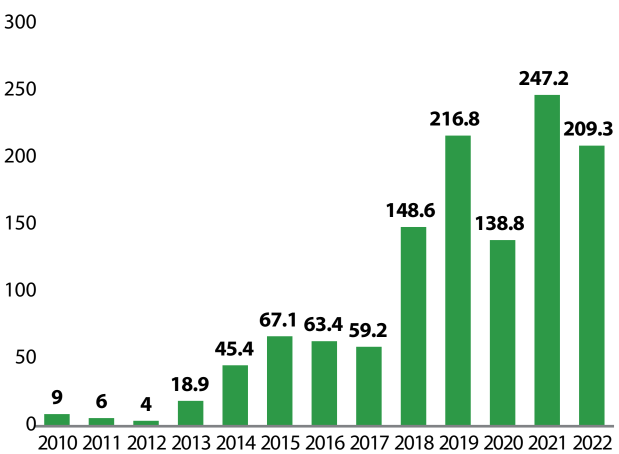


Source: GSMA (2023).

banking in the early 2000s laid the foundation for the iterations of fintech that followed. Digitalization efforts within traditional financial institutions paved the way for more profound technological integration in the financial sector. Mobile money services provided by telecoms and fintech firms and accessed through local agents and text-based phones emerged as a more affordable and convenient way to access digital financial services (figure III.G.9).[95] For example, over 35 per cent of adults in sub-Saharan Africa use a mobile money account.[96] The popularization of Internet-enabled smartphones since the mid-2000s provided another impetus for change. Mobile banking applications emerged, leveraging smartphone technology to facilitate on-the-go access to bank and fintech accounts and improved financial management. This period also saw the rise of digital payment platforms that simplify online transactions, followed by a diversification of fintech services, with innovations including automated trading systems, peer-to-peer lending and the early stages of blockchain and cryptocurrency technologies.

The 2008 world financial and economic crisis had a catalytic effect on the expansion of the fintech sector.[97] Post-crisis regulatory reforms that focus on traditional financing institutions, a period of heightened public distrust of these institutions, pressure to reduce operational costs and a contraction of the interbank markets have allowed the emergence of new entrants to the financial sector,[98] marking the beginning of the fintech era. This era is defined by the explosion in the number of financial service providers and the application of rapidly developing technology at the retail and wholesale levels, which is reflected by the significant increase in global investment in fintech companies (figure III.G.10), with the primary momentum fed by growth in the United States.[99] In 2023, an estimated 26,000 fintech companies operated globally, up from around 12,000 in 2019. This growth is expected to continue: Fintech sector revenues are projected to grow sixfold from $245 billion in 2021 to $1.5 trillion in 2030, moving from 2 per cent to 7 per cent of the $12.5 trillion in global financial services revenue.[100]

Figure III.G.10
Global fintech investment, 2010–2022
(Billions of United States dollars)



Source: Statista.
Note: The values shown are investment into fintech companies worldwide.

Periods of significant innovation and technological advancement often give rise to economic bubbles; this has also played out in the fintech market.[101] The meteoric rise and rapid fall of cryptocurrencies—as shown in figure III.G.11—serves as a poignant illustration of this dynamic.[102] Advocates for cryptocurrencies evoked a new paradigm of monetary exchange that needs no trusted intermediaries. In the end, the crypto financial system failed to deliver full decentralization,[103] and the rapid and speculative investment in these digital currencies has led to extremely high volatility, with spillover effects to the broader financial market.[104]

Fintech and financial inclusion

Advances in fintech have facilitated financial inclusion. Fintech providers have enhanced access to and the use of digital financial services for individuals and micro-, small and medium-sized enterprises (MSMEs). They have improved the affordability and personalization of financial products services that make them more relevant for diverse customer needs. Prominent examples include mobile payment services such as M-PESA in Kenya and online payments and messaging apps in developing countries such as China and India.[105] During the COVID-19 pandemic, fintech companies played a notable role in enabling quick-yet-contactless deployment of government support measures via digital financing to MSMEs and individuals, especially those living in marginalized and poor communities. This included transfers of government emergency funds and digitizing social protection payments and pensions. Fintech can also support MSMEs with sending and receiving funds through peer-to-peer platforms and raising funds through crowdfunding platforms. The extensive data that fintech firms collect offers high-frequency visibility into firm performance and opportunities for embedded financial products that collateralize future sales to clients. This can help to reduce collateral requirements and monitoring costs and can thus provide firms and households with loans they might not otherwise be able to access.

Complementary investments are needed to fully realize the potential of fintech and mitigate risks. The inclusive potential of fintech can only be fully realized with improvements in the public's access to technology, digital literacy skills, complementary digital infrastructure that enables the development and use of fintech, and commensurate regulatory frameworks that allow for innovation while managing risks where they emerge—be that from traditional or new providers. For example, the success of M-PESA in Kenya was predicated on a combination of factors, including high phone ownership, a large physical network of agents that allows easy exchange between cash and mobile money, a nimble regulatory approach, an effective marketing campaign that focused on urban migrant workers, and bank branch closures of significant scale around the time the mobile payment service was launched.[106] These factors are not easy to replicate, which is reflected in the fact that mobile money services have not gained universal traction across developing countries.

Furthermore, the unbanked population using fintech solutions often faces risks similar to those they might face in the formal financial system, such as the lack of financial and digital literacy skills to navigate a technology platform. They are also more susceptible to predatory lending practices and higher interest rates. Fintech, moreover, has not fully delivered on its promise to close the gender gap in access to financial services, as use of the technology by women is

Figure III.G.11
Global cryptocurrency market capitalization, 28 April 2013–7 January 2023
(Trillions of United States dollars)

Source: CoinMarketCap.

hindered by equipment costs, inadequate literacy skills, and discriminatory social norms and laws that disadvantage women in many countries.[107] Governments need to work with financial institutions—both new and established—to implement targeted policies alongside fintech development, to improve women's access to financial services and the Internet and to address the differences in attitudes, discrimination and social norms and laws that marginalize women's access in many countries.

The implications of fintech for financial sector development—market stability, competition, consumer privacy and financial integrity

The entry of new actors, including Big Tech, into the financial services sector presents opportunities for improving financial inclusion, economic efficiency and financial stability, but it also poses intricate policy challenges. Without appropriate regulation, fintech could destabilize financial markets, infringe on consumer privacy and undermine financial integrity. Although traditional regulatory principles are applicable to these new actors for financial activities, their unique data-driven business model—which enjoys economies of scale, network effects and the resultant "winner-takes-most" dynamics—means that their financial activities necessitate not only financial regulation but also competition policy and data privacy laws.[108]

Fintech could contribute to financial stability by strengthening decentralization and diversification, deepening financial markets and improving efficiency and transparency in the delivery of financial services. Preliminary evidence suggests that the use of fintech platforms for capital raising in advanced economies has played a role in improving financial stability, possibly through some of these aforementioned channels.[109] Established financial institutions in countries with high regulatory quality and government effectiveness have benefited from increased competition from fintech firms.[110] Well-designed regulations can establish a level playing field—one in which new fintech firms can succeed and incumbent financial institutions are protected from unfair competitive behaviours.

However, fintech can also incentivize riskier activities and exacerbate the cyclicality of financial markets, especially in a suboptimal regulatory environment. Reduced profit margins resulting from increased competition from fintech could create difficulties for established banks in building the capital buffer necessary to absorb losses and maintain solvency.[111] If regulations are inadequate, reduced profit might incentivize them to engage in riskier lending and investment activities, with implications for market stability. Lending activities facilitated by fintech platforms may also involve greater financial risk due to concentration and overreliance on data-driven algorithms in risk evaluations and credit-related decisions, which could lead to herding behaviours.[112] Moreover, fintech can amplify market volatility as it significantly increases the speed and ease of moving money in response to financial market performance. AI can expedite and reinforce the cyclical nature of financial conditions through the automation of risk assessments and credit approvals that tend to fluctuate with economic cycles. To mitigate the risks posed by fintech firms to market stability, it is essential to consistently evaluate and update the licensing framework for financial service providers, taking into consideration emerging entities with innovative business models.[113] Moreover, there is a need to strengthen requirements for capital, liquidity and operational risk management to adequately represent the diverse risks associated with various fintech business models.

One of the primary concerns regarding fintech is the extensive collection and analysis of personal data, which is central to the success of the business model but could infringe on consumer privacy. Fintech firms gather vast amounts of sensitive information, including on spending habits, financial history and geographic locations, which poses a risk of privacy breaches. Cyberattacks targeting fintech companies have become more sophisticated, raising the risk of personal data being stolen or misused. There is also the issue of consent and transparency. Often, users are not fully aware of how their data is being used or to what extent it is shared with third parties, leading to a lack of control over their own personal information. Moreover, the use of AI in fintech further complicates privacy issues. These technologies can make decisions based on user data that might discriminate against certain groups or invade personal privacy without explicit consent. For example, algorithms might make credit decisions based on factors that are not transparent to users. Concerns regarding data privacy and misuse of personal data could deter consumers from sharing their personal data with fintech firms, which would undermine their business models and competition in the financial sector. Legislative efforts to strengthen consumers' control over their own personal data and increase transparency and accountability in data use have shown some success in mitigating the trade-off between consumer privacy protection and promotion of competition.[114] Stronger data protection incentivizes consumers to share their personal data, which allows fintech firms to screen loan applications more effectively and offer lower rates.

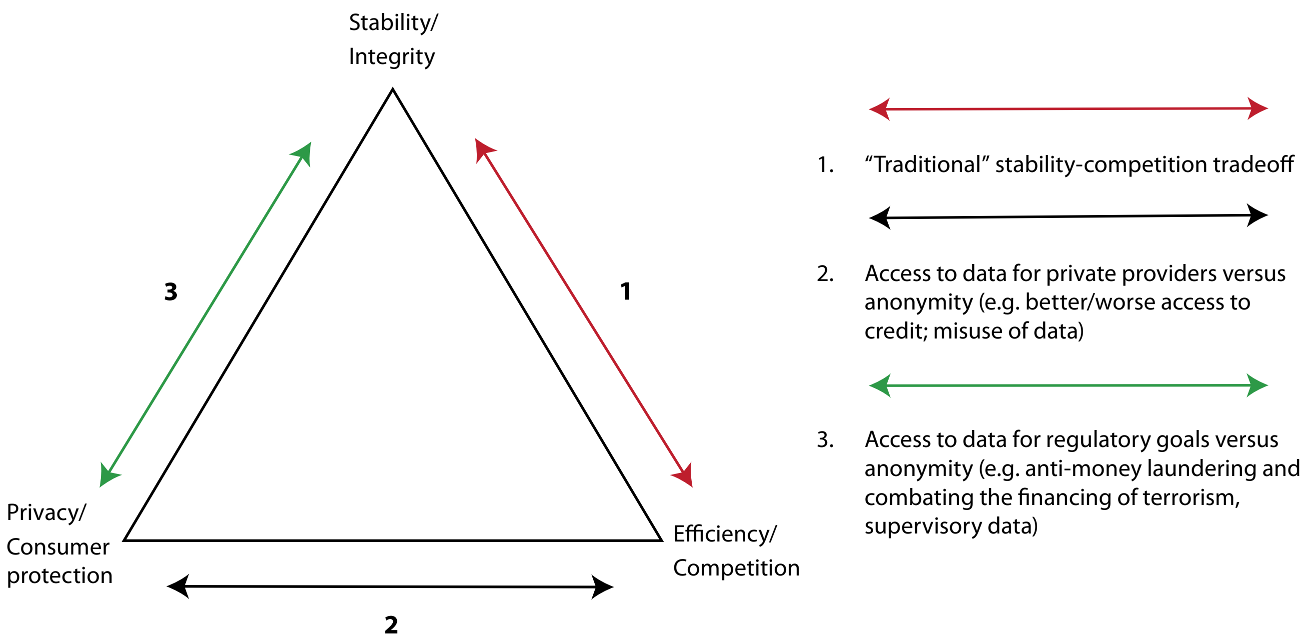
Fintech has heightened the potential for fraud in financial markets. Advanced algorithms and machine learning capabilities, while designed for efficiency and better financial decision-making, can also be used to engineer sophisticated fraudulent schemes. High-frequency trading algorithms, for instance, can be manipulated to create false market trends, misleading investors and disrupting market stability. The rapid pace of transactions in fintech also means that fraudulent activities can proliferate quickly and cause significant harm to consumers and investors before they are detected.

Furthermore, the digitalization and automation provided by fintech platforms have created conditions that could be conducive to illicit financial flows. The anonymity and speed offered by certain fintech services, especially those involving cryptocurrencies and blockchain technology, can be exploited for money laundering and the financing of illegal activities. These platforms can obscure the origins of illicit funds, making it challenging for regulatory bodies to trace and prevent these flows. The decentralized nature of some fintech applications further complicates regulatory oversight, allowing cross-border transactions to bypass traditional monitoring systems. To address fintech's impact on financial integrity, regulators need to prioritize transparency in fintech firms' operations, transactions and business models as well as anti-money laundering (AML) compliance, and adopt stringent measures to detect and prevent financial crimes. Fintech firms need to utilize technology-compatible AML solutions to comply with AML regulations and conduct robust due diligence and compliance checks through reliable sources, given conventional AML solutions utilized in the traditional financial sector are not sufficient in the current technology context.

Overall, policy measures should aim at the broader goals of consumer welfare rather than a narrow focus on market competition or financial stability. In the case of fintech, understanding how common policy tools affect welfare outcomes is complex. For instance, standard financial regulations might conflict with the goals of competition policy and data privacy laws, and vice versa.[115] The complex public policy trade-offs among financial stability and market integrity, efficiency and competition, and data privacy and consumer protection—summarized in figure III.G.12—call for cooperation between financial sector regulators, industry regulators and authorities overseeing competition and consumer privacy protection.[116]

Figure III.G.12

Policy trade-offs between stability, efficiency, and privacy protection in the context of digital transformation in finance



Source: Feyen, and others (2021).

Box III.G.2
Implications of STI for action areas of the Addis Ababa Action Agenda

In addition to the profound implications for the financial sector and financial sector stability (action areas B and F), technological advances have also contributed to progress and created new opportunities in other actions areas of the Addis Agenda, mainly by improving efficiency and transparency.

Public finance: Digitalization improves tax collection and public service delivery. The increased use of digital payments enables better verification of taxpayers' economic conditions and helps to formalize and tax undocumented economic activities. "Smart contracts" can automate transactions such as licensing, revenue collection and social transfers.[117] An example is the blockchain-based digital identity card of Estonia, which allows its citizens to access public, financial and social services and pay taxes.

Digitalization also increases fiscal transparency and accountability. Online platforms for public financial data allow the public to track government spending and revenues. Distributed ledger technologies can be used to create immutable records of transactions, reducing the potential for corruption and mismanagement. Overall, the combination of higher-quality data, enhanced data management systems and increased computer processing power contributes to the better design of fiscal policies.

International development cooperation: Digitalization can improve international development cooperation through timely and better-targeted responses, reduced risk of fraud and a better understanding of impacts, thereby contributing to better programme and project design and implementation. For example, big data and AI technologies can help to identify, predict and target poverty interventions when information from traditional sources, such as administrative data, is lacking. Also, by increasing transparency and accountability in development cooperation, technologies could help to increase general public willingness to provide support.

Trade: Technology impacts trade by enhancing efficiency and expanding market access. Advances in ICT streamline supply chain management and improve logistics. E-commerce platforms break geographical barriers, allowing SMEs to access global markets. Additionally, digital payment systems and fintech solutions facilitate smoother and faster cross-border transactions, which supports international trade. Digitally delivered services, an increasingly important component of trade, leverage ICT for cost efficiency, broader reach and enhanced tradability (see chapter III.D).

Debt: Advanced data analytics tools enable more accurate and timely analysis of economic and financial data, which helps to predict market trends, assess credit risks and evaluate the impact of various macroeconomic scenarios on debt sustainability. Such tools could help to make informed decisions regarding debt issuance, restructuring and repayment.

Also, digitalization can help developing countries to overcome some bond issuance bottlenecks regarding market infrastructures, including central clearing systems, securities custodians, calculation agents and rating agencies. [118] With the use of distributed ledger technologies, digital platforms for bond issuance can simplify the process and reduce the time and costs involved by reducing the number of actors involved in the bond issuance process, automating issuance and distribution, reducing the need for human oversight and improving efficiency in settlement. [119] [120]

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