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Diversifying economies in a world of accelerated digitalization

Report of the Secretary-General

Summary

Strategies for economic diversification in the context of rapid digitalization are explored in this report, focusing on how policymakers in developing countries can design responsive policies in order to capitalize on the benefits of frontier digital technologies. The shift from export-oriented industrialization to technology-led transformation is examined, highlighting the opportunities and challenges faced in developing countries in diversifying economies, as well as the need to rethink industrial and innovation policies, to drive structural transformation and industrial upgrading. In addition, preparedness in countries to harness digitalization for economic diversification is discussed, focusing on the three key areas of infrastructure, data and skills. Finally, the important role of digital public infrastructure, open innovation, capacity-building and international governance is underscored, in enabling developing countries to keep pace with technological advancements and to diversify industries with higher value added production that benefits all sectors of society.

Introduction

1. At its twenty-seventh session, in April 2024, the Commission on Science and Technology for Development selected "Diversifying economies in a world of accelerated digitalization" as one of its priority themes for the 2024–2025 intersessional period.

2. The secretariat of the Commission convened an intersessional panel meeting on 21 and 22 October 2024 to deepen understanding of this theme and to support the Commission in its deliberations at its twenty-eighth session. This report is based on the issues paper prepared by the secretariat, the findings and recommendations of the panel, country case studies contributed by Commission members and contributions from United Nations entities.[1]

3. Economic diversification is essential for resilient and inclusive growth and is a key part of Sustainable Development Goal 9; target 9.5 of which is to enhance scientific research and upgrade the technological capabilities of industrial sectors in all countries, in particular developing countries. UNCTAD member States, in the Bridgetown Covenant, highlighted the need to transform economies through economic diversification.[2] However, many developing economies remain reliant on a narrow range of commodities, making them vulnerable to external shocks. The accelerated pace of digitalization boosted by continuous technological advancements could open a transformative path for developing countries, to build robust, high-value industries and foster sustainable growth. However, the potential of digitalization for economic diversification remains constrained in many developing countries due to weak digital infrastructure, the lack of digital skills, limited access to relevant technologies and financial constraints, among other issues. Some challenges are particular to local contexts, yet many extend beyond national boundaries and require attention from the international community. In this regard, recent agreements, including the Pact for the Future adopted by the General Assembly in September 2024, represent commitments to international cooperation on harnessing digitalization to foster inclusive growth and bridge global digital divides.

I. Opportunities for and challenges in economic diversification in the digital era

4. Economic development involves a process of structural transformation that consists of the reallocation of economic activities from relatively simple to increasingly diversified and complex productions, which require more knowledge-intensive inputs and generate higher value added outputs. Economic diversification is a path-dependent process in which new economic activities build upon capacities developed for existing activities.[3] The concept of economic complexity posits that countries are more likely to develop and export a product that is similar to the products already exported.[4] In other words, existing technological and

[1] Contributions from the Governments of Austria, Belize, Brazil, Cuba, Ecuador, the Gambia, Germany, Indonesia, the Islamic Republic of Iran, Latvia, Oman, Peru, the Philippines, Poland, Portugal, the Russian Federation, South Africa, Switzerland, Türkiye, the United Kingdom of Great Britain and Northern Ireland, the United States of America and Zambia, as well as the Economic and Social Commission for Asia and the Pacific, the Economic and Social Commission for Western Asia, the International Telecommunication Union, the Office of the Secretary-General's Envoy on Technology, the Organisation for Economic Co-operation and Development (OECD), the Technology Bank for the Least Developed Countries and the World Intellectual Property Organization are gratefully acknowledged. For all documentation from the intersessional panel meeting, see https://unctad.org/meeting/commission-science-and-technology-development-2024-2025-inter-sessional-panel.
Note: All websites referred to in this report were accessed in January 2025.

[2] TD/541/Add.2.

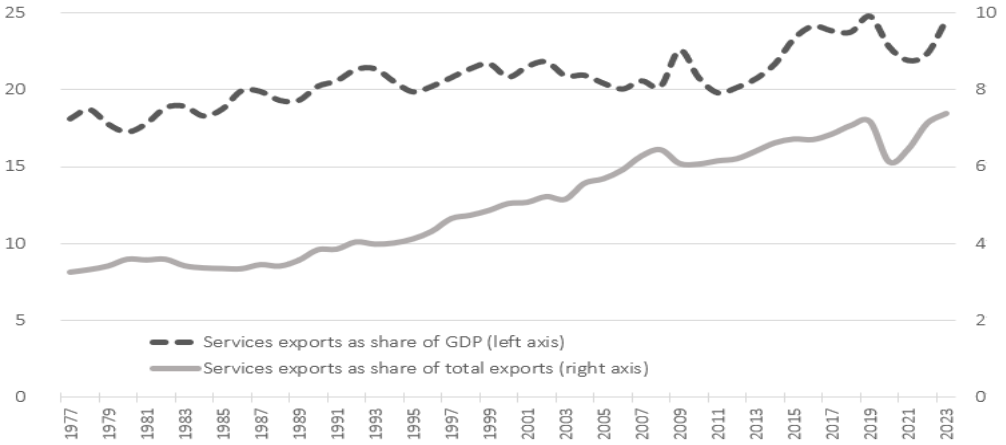
[3] Hausmann R, Hwang J and Rodrik D, 2007, What you export matters, *Journal of Economic Growth*, 12(1):121–125.

[4] Hidalgo CA and Hausmann R, 2009, The building blocks of economic complexity, *Proceedings of the National Academy of Sciences*, 106(26):10570–10575.

productive capabilities shape diversification opportunities and development is associated with diversification into products with higher-than-average complexity within a country.

5. Participating in global value chains is perceived as a significant driver of economic growth and diversification, enabling developing countries to specialize in niche areas in larger global industries through learning-by-exporting and upgrading. However, the benefits of participation in global value chains may be undermined by several factors that limit the potential for technology diffusion, sometimes resulting in a process of premature deindustrialization.[5] This phenomenon, characterized by a decline of the manufacturing sector at an earlier stage of economic development and a lower peak level of industrialization compared with historical norms, has been driven by skill- and capital-based technological changes that increase labour productivity in advanced economies yet undermine the comparative advantage of low-cost labour in developing economies. In addition, advancements in information and communications technology and shifts in global markets are reshaping opportunities for economic diversification and challenging traditional export-oriented models. Digital platforms and data monetization are fuelling a shift towards knowledge-intensive services sectors and digital-driven growth (figure 1). Against this background, it is important to consider technological change and the way it impacts both global markets and the local economy, to understand options for industrial upgrading and successful economic diversification. As the global economy shifts toward services and digitalization, the role of industrial policies in supporting the adoption and development of new technologies needs to be considered, as well as in the creation, dissemination and absorption of productive knowledge in an economy.

Figure 1
Increasing importance of service exports
(Percentage)



Source: UNCTAD calculations, based on data from the World Bank.
Abbreviation: GDP, gross domestic product.

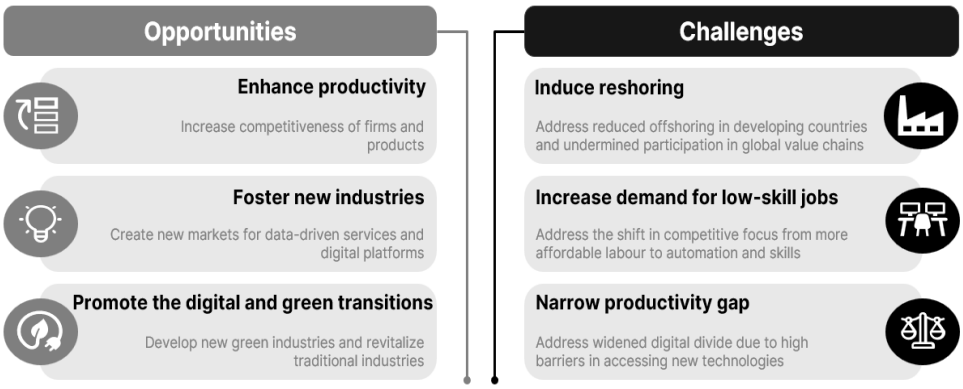
6. Fast progress in computing power, connectivity and related technological advancements have led to the emergence of digital frontier technologies in a fourth industrial revolution, often referred to as industry 4.0 technologies, enabling unprecedented data generation and connectivity that enhance competitiveness and productivity. Such technologies include the Internet of things, artificial intelligence, big data, blockchain, fifth-generation, three-dimensional printing, robotics and drones.[6] Artificial intelligence applications have proliferated in different sectors in recent years, and the increasing capabilities and adaptability of new algorithms signify a potential paradigm shift, with artificial intelligence augmenting both other industry 4.0 technologies and traditional technologies.

[5] Rodrik D, 2016, Premature deindustrialization, *Journal of Economic Growth*, 21:1–3.
[6] UNCTAD, 2023, *Technology and Innovation Report 2023: Opening Green Windows – Technological Opportunities for a Low-Carbon World* (United Nations publication, sales No. E.22.II.D.53, Geneva).

7. Industry 4.0 technologies share some common features that are applicable across sectors and could support developing countries in diversifying economies through three channels. First, empirical evidence shows that developing countries actively engaged with industry 4.0 technologies have higher growth rates in both GDP and manufacturing value added, driven by productivity gains.[7] That is, the manufacturing sector is likely to gain significantly from improvements in processes, products and organizational structures through more effective and flexible automation, the decentralization of tasks and the enhanced integration of hardware, software and connectivity in production systems. Second, industry 4.0 technologies have served to create new markets centred on data-driven services and digital platforms, such as digital advertising, financial technology, telemedicine and electronic commerce. Third, industry 4.0 technologies could drive both technological upgrading and environmental improvements, thereby supporting the digital and green transitions. For example, industry 4.0 technologies can help promote the development of new green industries related to renewable energy sources and electric mobility, thereby offering opportunities for developing countries to diversify economies away from traditional resource-dependent sectors while engaging in a transition towards more sustainable production.

8. Despite potential benefits, industry 4.0 technologies may limit traditional advantages in developing countries and viable opportunities to diversify economies through three main interrelated channels (figure 2). First, industry 4.0 technologies reduce the relative importance of labour costs in the investment and location choices of companies that, coupled with pandemic-related disruptions highlighting the importance of resilient global value chains, may induce firms from developed countries to bring production closer to research and innovation centres or consumer markets, thereby potentially limiting participation by developing countries in global value chains and diversification opportunities. Second, industry 4.0 technologies can further shift competitive focus to automation and skills, thereby altering comparative advantages in global manufacturing and trade. Third, industry 4.0 technologies are likely to widen the productivity gap between developed and developing countries due to existing digital divides. Limited digital infrastructure and access to new technologies hinder many developing countries in integrating digital technologies into the economy. Without proactive policies, developing countries risk missing opportunities for economic diversification, and falling behind.

Figure 2
Industry 4.0 technologies: Opportunities for and challenges in economic diversification



Source: UNCTAD.

II. Rethinking the role of industrial and innovation policies in economic diversification

9. Economic diversification, or the creation of new markets and industries, is grounded in the development, adoption and adaptation of new technologies. Technology-led

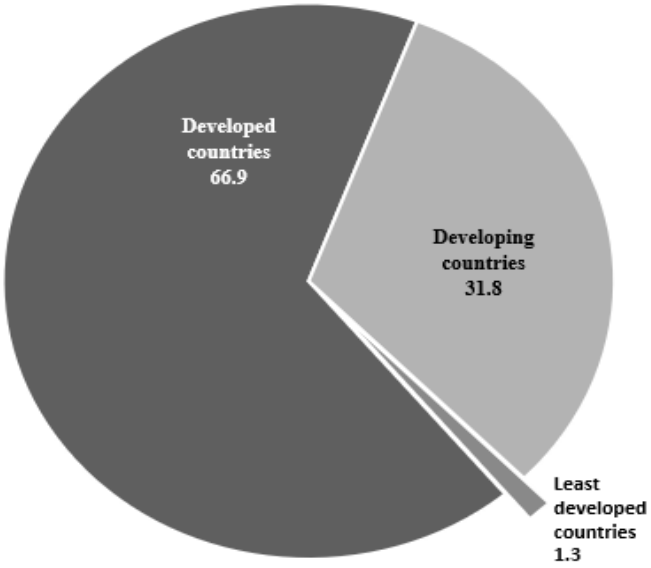
[7] See https://www.unido.org/resources-publications-industrial-development-report-series/idr2020.

diversification is therefore important and should be integrated into policymaking in order to align with the present economic and technological landscape, largely shaped by advances in digitalization. Efforts to drive economic diversification and industrial upgrading require convergence between industrial and science, technology and innovation (STI) policies, in particular to foster technological diffusion, learning and skill enhancement. However, designing and implementing technology-led strategies pose challenges from a policy perspective, as uncertainty, risks and knowledge requirements increase when moving closer to the technological frontier.

A. The rise of industrial policies

10. Industrial policies have gained in importance in public discourse in recent years, often resulting in an increased number of policy interventions intended to support or reorient the development of particular industries. According to Global Trade Alert data,[8] since 2010, most interventions have been made by developed countries and the role of the least developed countries appears marginal (figure 3). New interventions may add to existing interventions rather than replace them and the cumulative number of policies in force therefore continues to increase. The proliferation of policies can make it more difficult for less-endowed countries and firms, particularly developing countries and small and medium-sized enterprises, to identify opportunities and barriers, thus potentially increasing operational burdens.

Figure 3
Share of policy interventions, 2010–2021
(Percentage)



Source: UNCTAD calculations, based on data from Global Trade Alert.

11. Renewed interest in industrial policies has been accompanied by a shift in the types of interventions introduced in the last decade. Overall, the rationale has moved from import-related measures, such as import tariffs, antidumping measures and import tariff quotas, to more direct interventions in domestic productive sectors through financial grants, State loans and capital injections or production subsidies. In addition, in 2022–2023, marked differences in policy interventions were observable across country groups, whereby developed countries

[8] Includes data on actions of Governments in the economic playing field that can induce changes in international commercial flows (goods, services, investment, labour force migration), introducing market distortions or altering the relative treatment of domestic commercial interests, and announcements of unilateral changes by Governments that affect the relative treatment of foreign versus domestic commercial interests (trade in goods and services, investment, labour force migration).

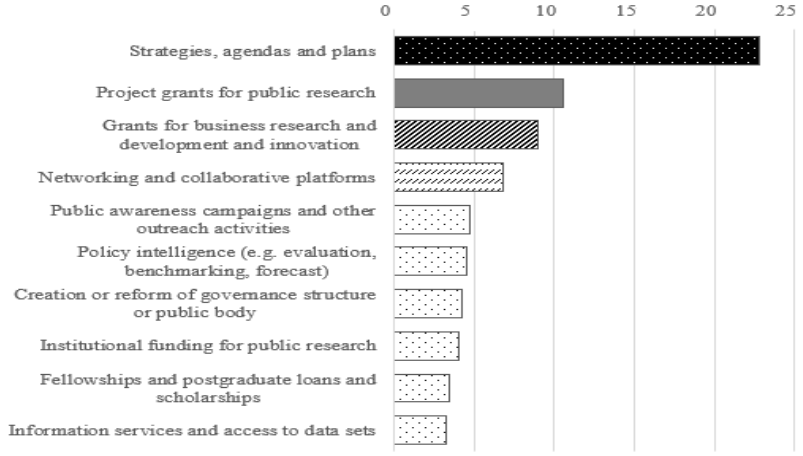
more frequently used controls on commercial transactions and investment or restrictions on imports than other groups; developing countries relied more on financial subsidies to support production or consumption (at 48 per cent, about 10 percentage points higher than the rate in developed countries) and on tariff measures; and the least developed countries primarily supported exports (at over 40 per cent) or applied import taxes to align with local taxes, with subsidies forming a smaller share of interventions (19 per cent) compared with the share in other groups.

B. Science, technology and innovation policies in a world of accelerated digitalization

12. The increasing globalization of the world economy and the diffusion of digital technologies have swung the pendulum of value creation towards knowledge and information, giving rise to the "knowledge economy", in which the share of intangible capital may be higher than that of physical capital. STI are increasingly recognized as drivers of economic growth, development and income improvement and this has been matched by a generalized increase in research and development intensity, that is, research and development expenditure as a percentage of GDP.

13. The increasing importance of technology and digitalization on the policy agenda is reflected in the increasing number of STI policies over the years, with about one in five policy interventions aimed at setting up strategies, agendas and plans, including medium- to long-term guidelines to impart directionality to STI and to define the scopes, principles and objectives of policy action (figure 4). This importance is also reflected in contributions from members of the Commission on Science and Technology for Development, which show that most countries have developed an STI strategy, digital agenda or artificial intelligence plan, to set clear national priorities and road maps in order to guide the digital transformation process. Partnerships between different stakeholders and interactions between Governments, academia or research institutes and industry are key features in tailoring plans to national innovation ecosystems, and the engagement of civil society helps direct technology and innovation toward social needs.

Figure 4
Most frequently used instruments in science, technology and innovation policies, 2010–2022
(Percentage)



Source: UNCTAD calculations, based on data from the OECD STI policy compass.

14. The other two most frequently used instruments involve support for research and innovation activities. Project grants for public research are often provided to higher education or public research institutions to fund basic research, while business research and development grants typically support applied research in addressing particular challenges or helping to transition new technologies to markets. Supporting public and private research through competitive processes helps strengthen innovation potential in a country. Many

countries have developed funding programmes with strong support for small and medium-sized enterprises and startups and some have further mobilized private sector resources and established public–private partnerships, to boost research and innovation investment. Digital technologies have helped improve access to information and research, promoting idea diffusion and encouraging a more participatory approach to science and innovation. Compared with traditional industrial policies, which are relatively static and top-down, an iterative and multi-stakeholder approach is critical in order to accelerate innovation through efficient feedback mechanisms. This is reflected in the emphasis placed on instruments to connect government agencies, research institutions, companies, investors, entrepreneurs and other stakeholders involved in STI activities and to support networking in order to foster collaboration and idea-sharing among different stakeholders.

15. With regard to policies focused on artificial intelligence, data from the OECD artificial intelligence policy observatory show differences in the distribution of instruments between developed and developing countries. Developed countries more commonly use financial instruments to support the development of artificial intelligence technology, such as grants for public research and business research and development and student fellowships, alongside policies that bolster artificial intelligence computing and research infrastructures. Such policies target artificial intelligence development and uptake, as well as overall research capacities, to support a technology-led transformation associated with larger budgets dedicated to research and development and digital frontier technologies. Developing countries often focus on using artificial intelligence technologies in the public sector, particularly through electronic-government practices, which help streamline government processes and address resource constraints. Such efforts should complement, rather than replace, direct interventions aimed at supporting STI and artificial intelligence technologies and creating an environment that fosters business innovation, which are essential in translating declarative policies into tangible outcomes.

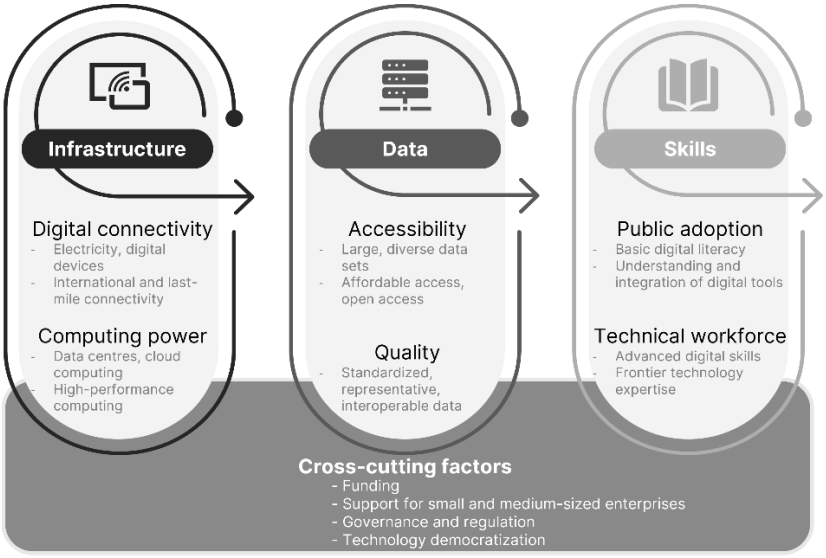
16. Digitalization creates a new environment, to which industrial policies for economic diversification need to adapt. Traditional sector-specific policies need to be updated to support synergies across sectors, technological innovation, digital transformation and the development of knowledge-based economies. Economic diversification policies go beyond supporting the emergence of new industries, to include the promotion of inclusive and dynamic innovation ecosystems, leveraging frontier technologies and adapting to global production and consumption shifts. The distinctive features of digital technologies, such as the data-driven nature and the autonomous decision-making capabilities of artificial intelligence technology, necessitate new regulatory frameworks, including on data governance, privacy protection and the regulation of decision-making processes, to ensure transparency, explainability, inclusivity, ethicality and accountability. In short, supporting structural change and productivity growth needs to account for the direction of technological advancement as an integral policy consideration. To guide technological progress towards the fulfilment of human needs and aspirations and in alignment with national development agendas, a well-coordinated STI strategy is essential in order to engage diverse stakeholders and integrate with other policy domains.

III. Key factors in triggering technology-led diversification and upgrading

17. Based on contributions from member States and international organizations, as well as the literature, the key factors in developing countries capturing the benefits of technology-led diversification are related to infrastructure, data and skills. The effective provision and availability of these critical components of digital transformation are supported by cross-cutting resources such as funding, public support and multi-stakeholder collaboration, emphasizing the need for an integrated approach to preparing countries for technology-led diversification and upgrading (figure 5). The three components are not equally present across countries and many countries have outdated infrastructure and limited technological accessibility, which limit the equitable adoption of technologies. Digital divides reinforce structural inequities both within and between countries. Developed countries tend to have more resources and better infrastructure, to promptly use and apply digital frontier

technologies, and many developing countries face constraints with regard to the basic elements required to access them.

Figure 5
Key factors in harnessing the benefits of technology-led diversification



Source: UNCTAD.

A. Infrastructure

18. The adoption and development of digital frontier technologies depends on robust digital infrastructure, including digital connectivity and computing power. Such systems require sustainable access to natural resources such as energy, minerals and water. The local availability of such resources within a country or region influences national strategies for developing digital infrastructure, shaping how resources are accessed, imported or transported.

19. Digital connectivity provides essential links between actors and systems, to distribute information and computing power throughout and between countries. However, 2.6 billion people, or about one third of the global population, remain offline, with rural areas experiencing inadequate last-mile distribution.[9] In addition, even in regions in which infrastructure is in place, affordability gaps persist, suggesting that instead of focusing solely on broadband penetration, developing countries should also address other challenges, such as improving access to and the affordability of digital devices and services. New technologies can be purchased or brought from outside sources. Digital connectivity can support the adoption of technology, with frontier technologies demanding significant computing power, relying on semiconductors, high-performance storage, data centres and cloud systems. Artificial intelligence technology and big data intensify such needs, making computing power critical for high-technology industries. Building a domestic technology industry can help diversify economies by enabling upgrading in other sectors. However, developing countries face challenges such as limited access to specialized hardware, high-speed computing networks and cloud infrastructure. Computing power is more concentrated than information and communications technology networks, since data centres and supercomputers are often located in prominent industrial or research hubs, to reduce latency time and lower data-transit costs. High-performance semiconductor chips, essential for frontier technologies, are predominantly designed or produced in developed countries, with developing countries reliant on imports or costly domestic development.[10]

[9] International Telecommunication Union, 2023, *Measuring Digital Development: Facts and Figures 2023* (Geneva).

[10] See https://www.semiconductors.org/resources/factbook/.

B. Data

20. Data form the central component of all digital frontier technologies, serving as both the primary input and output in training algorithms and models. The increasing size and exhaustiveness of data, along with computational and transmission speed, have elevated the role of data from simple information to a key asset in improving or building new businesses, as well as decision-making.[11] However, many developing countries face challenges in data acquisition, quality and security, as well as limited storage and processing capacity, often linked with broader infrastructure challenges. Limitations in data access extend to the diffusion of other technologies, since adoption requires algorithms that can be tailored to sectoral needs. To prevent issues related to bias and ensure that models are effectively applied to particular use cases in different realities, data for intended uses, in either an industrial sector or community, are needed. Many developing countries face challenges in accessing sectoral data, although increases in both private data markets and open data approaches offer new avenues for providers and developers to share and acquire the necessary data.

21. To be effectively used, data sets need to be large, of good quality, representative, interoperable, accessible and secure. The ability to achieve these qualities varies by country. Regions with smaller populations have less capacity to generate local data sets and limited digital connectivity can result in incomplete or infrequently updated data. In addition, data may not be available in local languages and outdated technical systems may hinder access and use. The expansion of data collection and processing has heightened concerns about privacy, surveillance and ownership. Developing countries often lack robust data protection laws and face difficulties in implementing safeguards and negotiating with multinational corporations. Cross-border data flows further complicate governance, creating spillover effects and compliance burdens.[12] Existing or draft data governance policies should be assessed and eventually updated, to find a balance between addressing particular concerns and not impeding data accessibility for development in order to address the opportunities and challenges brought by artificial intelligence and other frontier technologies.

C. Skills

22. Technology-led economic diversification requires a skilled workforce with technical expertise ranging from data science and specialized knowledge of artificial intelligence technology to communications, management and other complementary and transversal skills. The widespread adoption of artificial intelligence technology also requires population-wide digital literacy, enabling citizens to engage with such tools effectively. Beyond basic digital skills, the ability to use and understand digital frontier technologies in context is crucial in facilitating wider uptake, including skills such as prompt engineering, data analysis and domain expertise. However, despite global progress, many countries face significant skill shortages.

23. Advanced digital skills are usually developed through tertiary education programmes, yet industry training and partnerships also play a key role. Comprehensive programmes focused on science, technology, engineering and mathematics skills can support reskilling, upskilling and cross-skilling across all ages and societal levels, ensuring a broader talent pool for frontier technologies.[13] Education and training programmes need to address labour concerns linked to frontier technologies, involving inclusion, accessibility and job security. Automation poses a particular threat in developing countries, eroding advantages in low-cost manufacturing. Reskilling initiatives can help workers transition from jobs at risk of automation to emerging roles created by new technologies. Such programmes should

[11] Independent Expert Advisory Group on a Data Revolution for Sustainable Development, 2014, A world that counts: Mobilizing the data revolution for sustainable development, available at https://www.undatarevolution.org/report/.

[12] UNCTAD, 2024a, *Data for Development* (United Nations publication, sales No. E.24.II.D.17, Geneva).

[13] United Nations Office of the Secretary General's Envoy on Technology and International Labour Organization, 2024, *Mind the AI [Artificial Intelligence] Divide: Shaping a Global Perspective on the Future of Work* (United Nations publication).

prioritize vulnerable groups, such as women, youth, older persons, Indigenous Peoples and underserved communities, who face distinct challenges in seizing opportunities in the digital economy. In addition, developing countries face challenges in retaining skilled workers, often losing talent to more developed job markets (known as “brain drain”). This limits the participation of highly skilled individuals in domestic industries, a critical concern in developing countries with already limited expertise. Expatriates may contribute through remittances, yet their departure hinders local economic development and the growth of high-skill industries.

D. Cross-cutting factors

24. Successful technology-led diversification relies on holistic support from the wider social and economic system. There are cross-cutting factors that shape the wider STI ecosystem, including funding, private sector uptake, public support, governance and regulation and the democratization of technology. Many developing countries face challenges in funding research and development, particularly in regions with limited resources for digital infrastructure, data centres and workforce training. Government support can be supplemented by private investment by creating a favourable investment market, supporting a strong startup and entrepreneurship culture and reducing interest rates and tax burdens, for the industrial sector to support the uptake of labour-augmenting technologies. Engagement by the private sector in using and disseminating digital frontier technologies is also important. Small and medium-sized enterprises in particular face significant barriers in adopting frontier technologies, including challenges in securing funding for acquiring new technologies, dealing with outdated equipment that cannot support advanced artificial intelligence systems and lacking managerial expertise in order to adapt business processes and navigate the digital transition.

25. Public support for frontier technologies can stimulate investment, yet there is a global lack of awareness of the role of artificial intelligence and frontier technologies in daily life and their potential in economic transformation. In addition, there are concerns about the lack of oversight and human intervention in decision-making processes and about transparency in the design and functioning of such technologies. Governments can direct public responses by developing policies and regulations that ensure trustworthy and human-centred digital products. The use of frontier technologies introduces new challenges and intensifies existing issues such as those related to cybersecurity, data privacy, intellectual property and ethical use. Effective regulations need to balance supporting industrial growth with protecting the rights of citizens. However, the development and implementation of such policies are often constrained by limited government capabilities, the lack of resources and political instability.

26. Market power and competition are important aspects in digital transformation. The concentration of artificial intelligence and frontier technology development in a few large companies and developed countries limits opportunities for actors from developing countries to develop business potential and generate value from data and data-driven applications.[14] Multi-stakeholder collaboration in knowledge exchange and technology transfer is key in disseminating technology, developing infrastructure for research and development and strengthening capacity in participating countries to meet technology-led diversification needs.

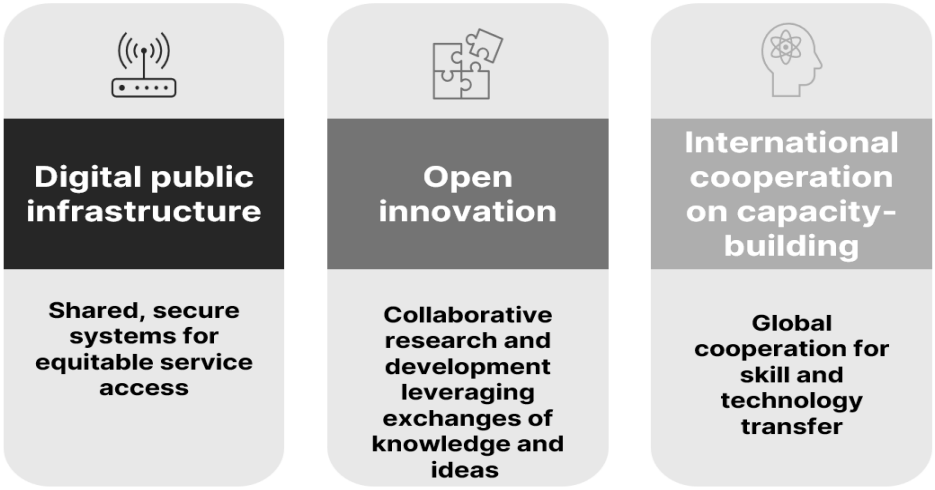
IV. Leveraging frontier technologies for inclusive economic diversification

27. In supporting economic diversification, countries face challenges affecting the inclusive development and adoption of digital frontier technologies. Some of these challenges are particular to local conditions, yet many extend beyond national boundaries and should be considered by the international community. For example, modern digital infrastructure provides global connectivity and underpins global data flows, which

[14] UNCTAD, 2023.

encompass digital trade, international commerce, Internet services and data collection. Skill and knowledge transfers are another cross-border element of the digital transformation, with workers participating in the global labour market through virtual work or migrating to countries with better job opportunities. In addition, a few large multinational technology firms dominate as primary global developers and distributors of frontier technologies and systems deployed across multiple countries. The concentration of power makes ensuring fair competition, to provide widespread opportunities of generating value and business from data, a global concern and requires coordinated international efforts and responses rather than solely national approaches. In this chapter, three strategy areas are detailed for leveraging frontier technologies for inclusive economic diversification and addressing global challenges related to digital infrastructure, data and skills (figure 6).

Figure 6
Leveraging frontier technologies for inclusive economic diversification: Three areas



Source: UNCTAD.

A. Digital public infrastructure

28. Digital public infrastructure is a set of shared, secure and interoperable digital systems that can be built on open standards and specifications in order to deliver and provide equitable access to public and/or private services at the societal scale.[15] Compared with traditional public infrastructure such as roads and bridges, digital public infrastructure is often referred to as the infrastructure of the digital era, comprising digital systems and applications that can be used flexibly and adapted to different use cases and sectors. Supported by a shared physical infrastructure, the digital public infrastructure approach can represent an effective way to address infrastructure challenges in developing countries, such as those involving high-performance storage and security, backup systems, data centres and cloud computing.

29. Digital public infrastructure has emerged as a key enabler of inclusive digital transformation and a catalyst for accelerating progress on achieving the Sustainable Development Goals, with many successful experiences across countries.[16] Such infrastructure has gained prominence in global discussions, with increased international commitment to harnessing the potential for sustainable development. For example, in 2023, the Group of 20 noted that digital public infrastructure offered a promising approach to digital transformation by providing a shared technology infrastructure that could be built and

[15] Group of 20, 2023, Digital economy ministers meeting outcome document and chair summary, available at https://g7g20-documents.org/database/document/2023-g20-india-sherpa-track-digital-economy-ministers-ministers-language-g20-digital-economy-ministers-meeting-outcome-document-and-chair-summary.

[16] See https://www.undp.org/publications/accelerating-sdgs-through-digital-public-infrastructure-compendium-potential-digital-public-infrastructure.

leveraged by both the public and private sectors.[17] Scaling up existing efforts can help countries develop or upgrade digital infrastructure, which can be expensive, and lead to stronger and more inclusive innovative ecosystems.

B. Open innovation

30. In addressing the challenges faced in developing countries in terms of data and skills, the use of open innovation represents an approach to managing the innovation process and enabling knowledge-sharing among countries, institutions, companies and independent innovators. Instead of relying solely on internal capabilities, an open innovation model encourages tapping into the pool of external ideas, to speed up research and development, lower costs and enhance the quality or relevance of innovation outcomes. The European Commission characterizes the concept of open innovation as combining the power of ideas and knowledge from different actors to co-create new products and find solutions to societal needs, as well as creating shared economic and social value, including a citizen and user-centric approach.[18]

31. Concepts of and approaches to open innovation are evolving and there are some useful instruments that can contribute to the set up of a global open innovation strategy for digital frontier technologies. For example, the Group of 20 Research and Innovation Working Group has issued an open-innovation strategy, to help foster international collaboration on STI, which puts forward principles, approaches and tools that can pave the way for inclusive and equitable international initiatives in STI.[19] Open data makes data freely available for access, use, modification and sharing, enabling researchers and developers to experiment with data and create new solutions, as well as enhancing transparency and fairness in new applications. Open-source models, widely adopted in software development, make source codes and designs freely accessible, democratizing knowledge and resources. By providing free and open tools, libraries and frameworks, open-source initiatives enable global collaboration, accelerate innovation and help build transparency and trust in technological development. It is important for the international community to promote the coordination and compatibility of fragmented yet valuable open resources. Connected, interoperable open repositories can enhance the global knowledge base and facilitate access through trusted hubs that ensure the quality and security of open resources.

C. International cooperation on capacity-building

32. Open innovation approaches can deliver to their full potential in a context in which technology transfer is proactively supported, including through the development of absorptive capacity in developing countries. The international community needs to take proactive measures, to promote knowledge and technology transfer to developing countries. International dialogues, exchange networks and technical cooperation initiatives are important in disseminating best practices, strengthening local industries and driving economic diversification. In addition, tailored technical assistance and solutions need to be aligned with local contexts and absorption capacities, to ensure impactful outcomes. Capacity-building is needed with regard to not only technology but also the policies needed to foster capabilities for self-sustaining growth. Activities such as training workshops that help increase capacity to design STI policies or tailored educational programmes and research and development partnerships that advance research and technological skills can equip stakeholders in developing countries to effectively use, adapt and develop digital frontier technologies.

33. Particular attention should be paid to the workforce, as frontier technologies have a significant impact on employment and skill requirements. Reskilling programmes can help

[17] Group of 20, 2023.

[18] See https://op.europa.eu/en/publication-detail/-/publication/3213b335-1cbc-11e6-ba9a-01aa75ed71a1.

[19] See https://research-and-innovation.ec.europa.eu/news/all-research-and-innovation-news/g20-agree-open-innovation-strategy-and-recommendations-diversity-equity-inclusion-and-accessibility-2024-09-20_en.

workers in roles at risk of automation to transition towards new careers, while upskilling enables the enhancement of productivity with advanced tools. Cross-skilling broadens expertise, empowering workers to take on diverse roles and responsibilities. To prepare for such shifts, the international community can help developing countries create robust educational and lifelong training frameworks, which should incorporate up-to-date educational methods, integrate digital skills into curricula and offer tailored training programmes based on the impacts of automation and augmentation in various occupations. Doing so can equip workers to navigate the evolving demands of the digital economy.

D. Emerging discussions on data and artificial intelligence governance

34. There is a wide variety of initiatives by the United Nations and other international organizations that present solutions to accelerating the development and uptake of inclusive digital frontier technologies. However, initiatives are fragmented and would benefit from reinforced coordination. The ongoing discussions on data governance and artificial intelligence frameworks are two examples.

35. Data governance has become increasingly critical, since digital technologies are based on vast and diverse data sets. Most data protection legislation is rooted in the 1980 OECD Privacy Guidelines; the 2016 General Data Protection Regulation of the European Union has set a new global benchmark for data protection by design and by default and has prompted other jurisdictions to develop interoperable standards, to facilitate international data transfer while safeguarding the rights of citizens. One study identified trust, individual rights and public interest as core themes across global data governance frameworks, yet noted significant differences in scope, definitions and approaches.[20] Some privacy protections are included in human rights covenants, yet the absence of global treaties on data processing limits seamless cross-border collaboration. In addition, the underrepresentation of developing countries in data governance discussions risks marginalizing their priorities, resulting in less inclusive and equitable outcomes.[21] Over the years, the Commission on Science and Technology for Development has played a key role in fostering global cooperation in science and technology. The Commission provides a platform through which to address the challenges posed by rapid technological change, advance understanding of science and technology policies, share best practices and support strategic STI planning, particularly in developing countries. Cross-border data flows are a critical driver of the digital economy and interoperability between national, regional and international data policy frameworks is important. In this context, the Commission has been requested to establish a dedicated working group to engage in a comprehensive and inclusive multi-stakeholder dialogue on data governance at all levels as relevant for development, which will report on its progress to the General Assembly in 2026.[22]

36. In addition, the international artificial intelligence governance ecosystem requires greater convergence in order to establish unified standards, frameworks and principles; in 2020 alone, there were over 160 artificial intelligence governance frameworks, but not a single cohesive set of guidelines. The High-Level Advisory Body on Artificial Intelligence, convened by the Secretary-General, has highlighted the need for inclusive governance, putting forward principles to ensure that the potential of artificial intelligence technology can be harnessed while leaving no one behind.[23] Various intergovernmental bodies, including the Council of Europe, the Group of 20 and OECD, have sought to create artificial intelligence frameworks. In addition, new entities such as the Artificial Intelligence Safety Summit, the Global Partnership on Artificial Intelligence and the Hiroshima [Japan] Artificial Intelligence Process Friends Group address different issues in this regard. Most countries involved in global artificial intelligence frameworks are from the Global North, with limited participation

[20] Marcucci S, Alarcón NG, Verhulst SG and Wüllhorst E, 2023, Mapping and comparing data governance frameworks: A benchmarking exercise to inform global data governance deliberations, The Governance Lab.

[21] UNCTAD, 2024a.

[22] A/RES/79/1.

[23] United Nations, High-Level Advisory Body on Artificial Intelligence, 2024, Governing AI [Artificial Intelligence] for Humanity: Final Report, available at https://www.un.org/en/ai-advisory-body.

from the Global South, despite potential impacts on economies and societies. This limited involvement undermines the inclusivity of digital transformation and overlooks the role that developing countries play in the value chains of frontier technologies, as well as environmental risks such as those related to the mining of rare earth minerals, electronic waste and the high level of energy and water consumption involved in computing, data storage and processing.[24] In 2021, the Recommendation on the Ethics of Artificial Intelligence was adopted, applicable to all 194 member States of the United Nations Educational, Scientific and Cultural Organization and, in 2023, the Human Rights Council highlighted the importance of a human rights-based approach to new and emerging digital technologies.[25] In 2024, the General Assembly adopted the Pact for the Future, including the Global Digital Compact, and resolutions on seizing the opportunities of safe, secure and trustworthy artificial intelligence systems for sustainable development; and on enhancing international cooperation on capacity-building of artificial intelligence.[26] These serve to set the foundations for a global governance framework for digital technology and artificial intelligence.

IV. Conclusion and recommendations

37. Driven by rapid technological advancements, the diffusion of digital frontier technologies has transformed economies and societies, shifting the focus of economic diversification from export-oriented industrialization to technology-led transformation. In order to support the shift in value creation towards knowledge, industrial and STI policies should converge, to promote the adoption and development of new technologies, as well as the creation and dissemination of knowledge. Accelerated digitalization boosts productivity and fosters new industries. However, it also poses challenges in developing countries, such as the erosion of comparative advantages based on low-cost labour that, in turn, can widen the productivity gap between developed and developing countries. Without proactive policy measures for harnessing the benefits of digitalization and frontier technologies, developing countries risk falling behind, as seen in past industrial revolutions.

38. In this regard, developing countries may wish to consider the following suggestions:

(a) Strategically position themselves to seize the opportunities offered by digitalization. Governments could engage stakeholders, to identify the potential applications of digital technologies across the economy that can favour economic diversification and industrial upgrading. Instead of a top-down approach, an open and iterative process could help ensure an efficient feedback mechanism and build consensus among stakeholders. Priority should be given to opportunities that align with the national development agenda, such as job creation or the green transition, while considering existing technological and productive capacities. A thorough technology assessment can help assess the opportunities of and challenges related to different technologies;

(b) Develop national strategies for digital technologies. Governments could formulate national strategies to leverage digital technologies, articulating clear visions and feasible road maps of the applications in the economy, including by defining priorities, expected results and monitoring mechanisms, as well as by identifying actions for future development. Apart from sectoral policies, a stronger emphasis needs to be placed on improving data governance and the innovation ecosystem, which are becoming increasingly important in the digital economy. A whole-of-government approach is needed to ensure the alignment of digital and STI strategies and policies with those of other domains, such as the industrial and environmental domains, to leverage possible synergies;

(c) Diversify into digital products and services. Governments could invest in the creative economy and knowledge industries that can thrive in a digital environment. For example, Governments could expand access to digital financial services, such as mobile

[24] UNCTAD, 2024b, *Digital Economy Report 2024: Shaping an Environmentally Sustainable and Inclusive Digital Future* (United Nations publication, sales No. E.24.II.D.12, Geneva).

[25] A/HRC/RES/53/29.

[26] A/RES/78/265; A/RES/78/311.

banking, to promote financial inclusion and support entrepreneurial activities. Governments could also promote innovative entrepreneurship and the growth of electronic commerce platforms, to facilitate trade and access to global markets, particularly for small and medium-sized enterprises;

(d) Build robust digital infrastructure. An accessible, affordable and high-quality digital infrastructure is essential in order to provide digital connectivity and computing power, to support the adoption and development of digital technologies. Governments could mobilize investments from both the public and private sources to create digital public infrastructure systems, such as digital payment and cloud services, to drive technology-led structural transformation and industrial upgrading;

(e) Promote digital literacy and skills development. Governments could prioritize inclusive education and training, to diffuse science, technology, engineering and mathematics skills and digital literacy. Governments could also provide reskilling and upskilling programmes, to help the workforce leverage digital technologies, improve productivity and support the transition to new occupations and tasks brought about by digitalization and economic diversification;

(f) Strengthen public–private partnerships. Public–private partnerships offer significant potential for accelerating the development of digital infrastructure, enhancing capacity-building, generating quality employment and speeding up the innovation process. Lessons from managing existing public–private partnership projects can inform such efforts and it is essential to find a balance between competitive and unconditional grants, as well as between project-based and programme-based support, to safeguard public interest;

(g) Establish regulatory frameworks. Governments need to establish clear and supportive regulations for digital technologies and digital businesses, including artificial intelligence governance, data protection laws and cybersecurity frameworks.

39. To support developing countries in adopting and developing digital technologies for economic diversification, the international community may wish to consider the following suggestions:

(a) Promote the exchange and sharing of technological knowledge and experiences. International dialogues, global networks of exchange and Commission on Science and Technology for Development studies and meetings are useful platforms for sharing good practices and lessons learned on how to harness digital technologies for economic diversification. Exchanges of knowledge and experience can further facilitate collaboration among countries, to accelerate technology adoption and promote innovation;

(b) Enhance capacity-building activities. The international community can support developing countries in creating strong educational and lifelong learning frameworks that integrate digital skills into current curricula and offer customized training programmes based on the degree of automation and augmentation of various industries and occupations. In addition, research and development partnerships among Governments, academia and industries could advance the research and technological skills of all of the parties involved;

(c) Undertake and support technical cooperation projects, to promote the adoption and development of digital technologies for economic diversification in developing countries. For example, the Crop Watch Innovative Cooperation programme uses satellite data to monitor crop conditions, for better agricultural management in developing countries. Such projects should address needs and priorities in developing countries, considering local economic contexts and technological capacities. The Commission on Science and Technology for Development could serve as a platform to facilitate global STI partnerships, hosting expert meetings on shared STI-related priorities and consolidating cooperation experiences;

(d) Set up a global open-innovation strategy. Open-innovation approaches, including with regard to open data and open source, can help in the sharing of knowledge and resources and the improvement of transparency and trust, thereby enabling global collaboration and innovation. A global open-innovation strategy can set a clear direction and principles, to guide technological development and address global challenges effectively. In

this regard, the United Nations can act as a bridge between different international initiatives for open innovation and boost their impacts on a global scale;

(e) Empower policymakers in designing and implementing STI policy. Capacity-building and training help policymakers in developing countries improve awareness and understanding of different policy instruments and incentives. It is important to share international good practices and knowledge of how to bridge industrial and STI policies. The international community, including through the Commission on Science and Technology for Development, could also support developing countries in implementing technology assessment and STI policy reviews, including evaluations at the regional or multi-country level;

(f) Support infrastructure development. The international community should support investments in national infrastructure development, including digital connectivity and computing power, that enable the deployment of digital technologies in production processes, for economic diversification and industrial upgrading, particularly in less-endowed countries. The international community could scale up collective actions on digital public infrastructure, from formulating principles and governance structures to supporting developing countries in implementing digital public infrastructure systems based on local needs and priorities;

(g) Develop a global consensus on ethical frameworks and guidelines. Rapid technological advancement, particularly the increase in artificial intelligence technologies and big data analytics, requires clear ethical frameworks and guidelines in order to prevent misuse and to uphold human rights. The international community should enhance global cooperation, to develop and align ethical frameworks and guidelines on the responsible adoption of digital technologies.