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KEY POINTS

- The green and digital transitions have developed in parallel to date, especially in latecomer countries, but green and digital technologies are increasingly becoming intertwined
- Future policies should focus on aligning green and digital strategies, developing digital competencies and strengthening financial support and international partnerships

Twin transition for global value chains: Green and digital

The green and digital transitions have developed in parallel to date, especially in latecomer countries, but green and digital technologies are increasingly becoming intertwined. In this policy brief, greening and digitalizing options for latecomer countries are examined, along with opportunities for benefiting from this twin transition in global value chains. The focus is on environmental and technological upgrading and on how global value chains can become greener by switching to the use of digital frontier technologies associated with smart manufacturing, often referred to as industry 4.0 technologies.[1]

The greening of global value chains and the twin transition

Global value chains have been at the centre of the global economic framework since the 1990s. Currently, transactions within global value chains comprise about two thirds of the international trade of services and goods. Many developing countries have been able to make use of global value chains based on particular advantages and specializations in intermediate tasks rather than final goods. However, this type of production is unlikely to stimulate sustainable growth. In order for developing countries to reap the full benefits of global value chains, they need to move up the value added stages, to more sophisticated manufacturing and services.

[1] For further information on and analysis of the topics discussed in this policy brief, see 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), available at https://unctad.org/publication/technology-and-innovation-report-2023.

Changes in regulation have increasingly led to environmental upgrading, that is, changes that reduce the ecological footprints of firms. In addition, Governments, leading firms and consumers are increasingly demanding such improvements, which are also required under social and environmental standards. The changes are transmitted throughout a value chain through new designs, standards and specifications, with implications for the entire value chain, including its governance.

The greening of global value chains can take place through the following two approaches, both of which can be supported by digital technologies: producing inputs for green production, such as solar photovoltaic panels and wind turbines; and greening traditional manufacturing industries, such as garments and textiles. Digital technologies, while not inherently climate-friendly, can support the greening of global value chains in multiple ways, including by helping to enhance productivity and improve safety, as well as reducing the environmental impacts of current production and consumption modes, facilitating the introduction of new green technologies and ecoproducts and enhancing the diffusion of business models based on circular economies. The use of smart manufacturing and service technologies, such as advanced robotics, three-dimensional printing, sensors and wireless technologies, leads to automation and the decentralization of tasks. Such technologies can be employed to help monitor environmental standards and detect illegal activities, help optimize logistics and significantly reduce carbon emissions, increase operational efficiency, enable reduced energy consumption and help enhance the design of more environmentally friendly modes of production.[2] For example, the use of three-dimensional printing in the production of lightweight parts for aircraft has been shown to reduce the weight of such parts, reducing aircraft mass and, thereby, fuel consumption.[3] Data processing technologies and the use of big data analytics, cloud computing, artificial intelligence and blockchain technology can aid in the reduction of environmental impacts in production processes or practices. For example, artificial intelligence is employed in smart grids, which optimize green energy use, and blockchain technology can be used in supply chain management, to help reduce the number of recalls and their environmental impacts.[4]

Higher standards introduce both opportunities and barriers for producers. Some suppliers may be unable to invest in new processes and be squeezed out of a value chain.[5] However, new standards may also signal green windows of opportunity for enterprises that can realign accordingly.[6] Well-functioning production and innovation systems depend on deeply embedded suppliers that are also flexible.[7]

The challenge of the slow diffusion of digital technologies in latecomer countries

Industry 4.0 technologies are mostly produced and have been adopted in a few leading economies, notably China, the United States of America and countries in Western Europe.[8] The level of adoption of digital technologies also differs by sector and industry. The computer and machinery industry makes the greatest use of cloud computing and three-dimensional printing, and the transport equipment industry leads in the adoption of the use of industrial robots.[9]

A simplified way to assess the readiness of countries to benefit from the diffusion of industry 4.0 technologies is through the analysis of the level of high-skill employment in an economy as a share of the working population, and the share of high-skill and technology-intensive manufactures in total exports, whereby the higher the level of both indicators, the better positioned a country is to move to smart production (see figure). The best-positioned countries in this regard are the United States and countries in East and South-East Asia and in Europe. Countries considered to be the least prepared, including most developing countries, are those that do not have many high-technology sectors in the economic structure nor many high-skill jobs.

2 See Gale F, Ascui F and Lovell H, 2017, Sensing reality? New monitoring technologies for global sustainability standards, *Global Environmental Politics*, 17(11):65–83; Mangina E, Narasimhan PK, Saffari M and Vlachos I, 2020, Data analytics for sustainable global supply chains, *Journal of Cleaner Production*, 255; and Efficiency Vermont, 2020, How did simple efficiency solutions help Husky save? available at https://www.efficiencyvermont.com/blog/your-story/how-did-simple-efficiency-solutions-help-husky-save.

3 Huang R, Riddle M, Graziano D, Warren J, Das S, Nimbalkar S, Cresko J and Masanet E, 2016, Energy and emissions saving potential of additive manufacturing: The case of lightweight aircraft components, *Journal of Cleaner Production*, (135):1559–1570.

4 See https://positiveblockchain.io/database/electricchain/.

5 Ponte S, 2020, The hidden costs of environmental upgrading in global value chains, *Review of International Political Economy*, 29(3):818–843.

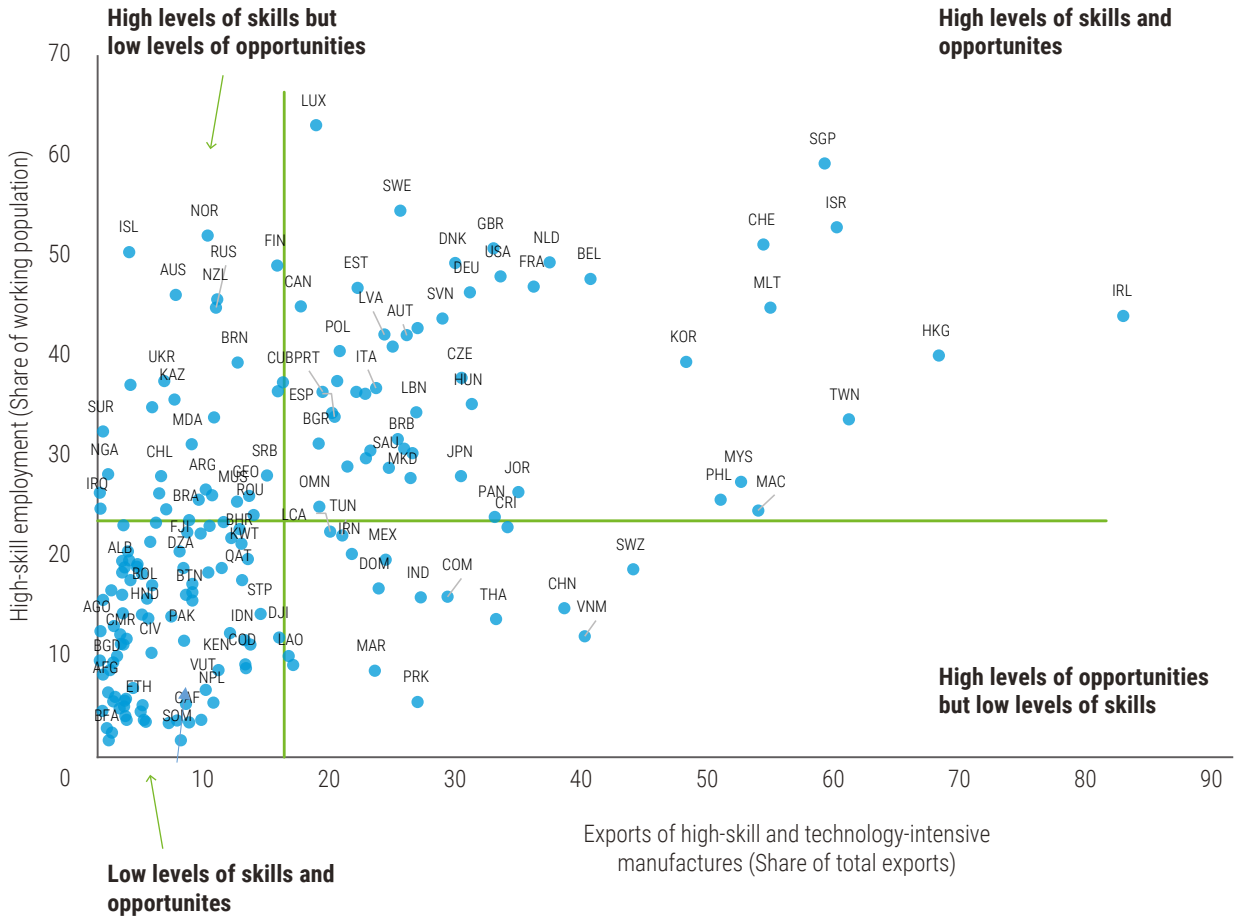
6 Lema R, Fu X and Rabellotti R, 2020, Green windows of opportunity: Latecomer development in the age of transformation toward sustainability, *Industrial and Corporate Change*, 29(5):1193–1209.

7 Pietrobelli C and Rabellotti R, 2011, Global value chains meet innovation systems: Are there learning opportunities for developing countries? *World Development*, 39(7):1261–1269.

8 UNCTAD, 2022, *Industry 4.0 for Inclusive Development* (United Nations publication, Geneva).

9 United Nations Industrial Development Organization, 2020, *Industrial Development Report 2020: Industrializing in the Digital Age* (Sales No. E.20.II.B.49, Vienna).

Determining which economies may initially be better positioned to benefit from industry 4.0: Indicators of readiness
(Percentage)



Source: UNCTAD, 2022.
Notes: The solid lines represent the unweighted global averages under these two indicators. Data labels use International Organization for Standardization economy codes.

Policy recommendations

To seize the opportunities presented by the twin transition, developing countries need to build digital competency and the necessary infrastructure and institutions, enhance innovation capacity and overcome financial barriers. The following policy recommendations may be considered:

- **Align green and digital strategies**. To take advantage of green windows of opportunity arising from the twin transition in global value chain manufacturing, policies need to be cocreated across the energy, environment, industry and foreign investment spheres. Without effective coordination, firms that view environmental upgrading mainly as a cost will be less motivated to adopt green technologies
- **Develop digital infrastructure and skills**. In many developing economies, there is limited access to the Internet, mobile networks and electricity, as well as a lack of human capital and skills.[10] Building stronger information and communications technology infrastructure to provide access to high-quality Internet connections and stable electricity access at a fair rate is crucial in order to meet requirements under industry 4.0. To enhance skills in the adoption, adaptation and creation of new technologies, Governments need to support businesses through, for example, skills development centres and scholarships, with a particular focus on digital skills. Such efforts should also ensure equality and a balance between regions, firms and population groups

[10] UNCTAD, 2021, *Digital Economy Report 2021: Cross-Border Data Flows and Development – For Whom the Data Flow* (United Nations publication, Sales No. E.21.II.D.18, Geneva).

- **Build international partnerships**. Developing countries can benefit from participation in international partnerships that facilitate the adoption of digital technologies. For example, the regional platform Prospecta Americas aims to improve knowledge about technologies such as big data, artificial intelligence, the Internet of things, robotics and blockchain, and to evaluate the economic, social and environmental impacts across member States of the Organization of American States[11]
- **Set standards and regulations**. Meeting international standards helps ensure interoperability and promotes productivity and innovation. In addition, standardization offers benefits in international trade networks and within global value chains, strengthening Sustainable Development Goals-related pillars and addressing impacts on the environment. For example, with regard to international standards established by the International Telecommunication Union, guidelines are available on addressing the environmental efficiency of 4.0 industry technologies. Drafting domestic regulations based on international standards can assist firms in better integrating into the international trade network and reduce potential political concerns regarding security and privacy-related issues
- **Provide financial support**. Investment decisions are driven by the rate of return; if companies are to combine both green and digital objectives, convincing evidence is required of the return on investment, for example in terms of how the greening of global value chains can promote more efficient production processes and the better use of materials. The public sector, in partnership with international donors and development banks, could therefore set up demonstration projects in this regard. Several countries have established innovation and technology funds, at times in collaboration with international donors or multinational development banks. For example, in Peru, the Pro Innovate programme provides funding and technical support for industry 4.0 projects. Such activities may be complemented by foreign direct investment, which Governments can encourage through investment in infrastructure and by incentivizing the adoption of green and digital technologies. For example, in Latvia, the green channel initiative offers a fast track for foreign direct investment in fields such as information and communications technology, bioeconomy, smart materials, smart energy and mobility[12]

[11] See https://www.comcytcentral.org/prospecta-americas.

[12] UNCTAD, 2022.

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