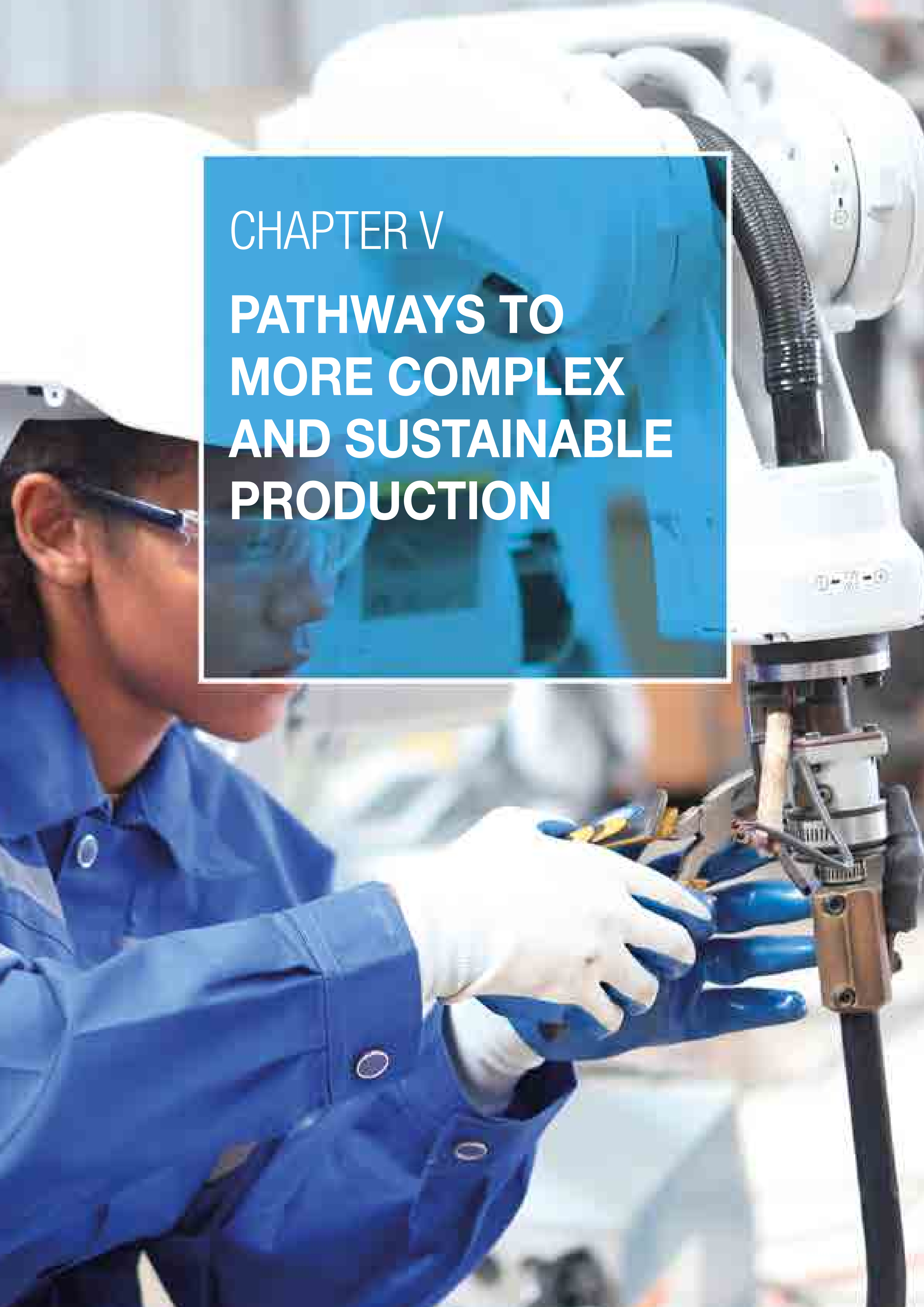
CHAPTER V

PATHWAYS TO MORE COMPLEX AND SUSTAINABLE PRODUCTION



There is a path to diversify towards more complex and greener production, but taking it might be harder for developing countries

Strategic diversification is key because:

- Diversification is path dependent
- Different products within the same industry can have higher or lower levels of carbon footprint
- In general, more complex products have higher carbon footprints

Countries have not followed a path of increasing complexity and reducing emissions

For selecting more complex and greener directions, governments should:

- Strengthen national capacities for analysing these new sectors
- Consider how they can fit into global value chains

Developing countries need to diversify their economies towards sectors that have lower carbon emissions (see Box V-1).[1] In low-income developing countries, economic diversification involves emulating industries in more developed countries – a steady progression that builds on existing industries – it is thus 'path-dependent'.[2] If a country already has the capacity for machinery or electronics production, it can more easily move in a number of directions that build upon this competence. But if it is largely producing primary products, it has fewer starting points. And when basic technologies need to be learned or transferred from abroad, then innovation is likely to require greater government support.[3]

If developing countries follow the previous growth path of the developed countries, then global greenhouse gas emissions will continue to increase rapidly.[4] Analyses of the historical experience are mixed. Some studies indicate that moving to more complex products leads to an initial increase in greenhouse gas emissions per unit of output, followed by a decline.[5] Others have found that increasing economic complexity results in better overall ecological performance.[6]

In either case, countries will need to aim in greener directions, particularly through the use of renewable energy, and concentrating on more knowledge-intensive industries.[7] But whatever path they choose, governments in low- and lower-middle-income developing countries have to act strategically, quickly and decisively; otherwise, they will be left further behind.[8]

Box V 1

Transforming economies through diversification

Transforming economies through diversification is one of the four major transformation needs identified in UNCTAD XV's outcome document, the "Bridgetown Covenant: From inequality and vulnerability to prosperity for all," to move to a more resilient, digital and inclusive world of shared prosperity.[9] This reemphasizes UNCTAD's focus on helping countries understand the benefits and the policies required to foster diversification.

In addition to its technical cooperation programmes which have advised countries in harnessing trade, investment and technology for structural transformation, UNCTAD has produced several Reports on the topic. Some recent examples are:

- The *Least Developed Countries Report 2022 - The path towards the green structural transformation of the LDCs*, which provides elements to help LDCs better understand where they stand in terms of historical responsibilities for climate change, the impact of their participation in the global economy, including GVCs, on material use and carbon emissions, the impact of unilateral trade policies with environmental goals by their trading partners on the sustainable structural transformation of LDCs, and the policy options available for these countries and their development partners to help put their economies on a greener path.
- *The Economic Development in Africa Report 2022* - Rethinking the Foundations of Export Diversification in Africa: The catalytic role of business and financial services, which examined how countries can help foster the growth of a highly competitive, technology-intensive services sector in Africa to drive export diversification.[10] The Report showed how African countries could increase manufacturing productivity, driving the region's economic growth and structural transformation, by addressing barriers to trade in services, boosting relevant skills and improving access to innovative alternative financing.
- UNCTAD's *Catalogue of Diversification Opportunities 2022*,[11] which presents potential new products for export diversification for 233 economies based on analysing their economic complexity and position in the product space. Its objective is to inform governments, the private sector and other stakeholders of the national innovation systems on possible directions for technological transformation of these economies. The catalogue presents information on four main areas: 1) basic statistics regarding diversification, 2) potential new sectors for diversification, considering all products and the markets that offer growing export opportunities, 3) potential new sectors for diversification considering only agri-business products and the markets that offer growing export opportunities, and 4) examples of potential new products with higher export opportunities.

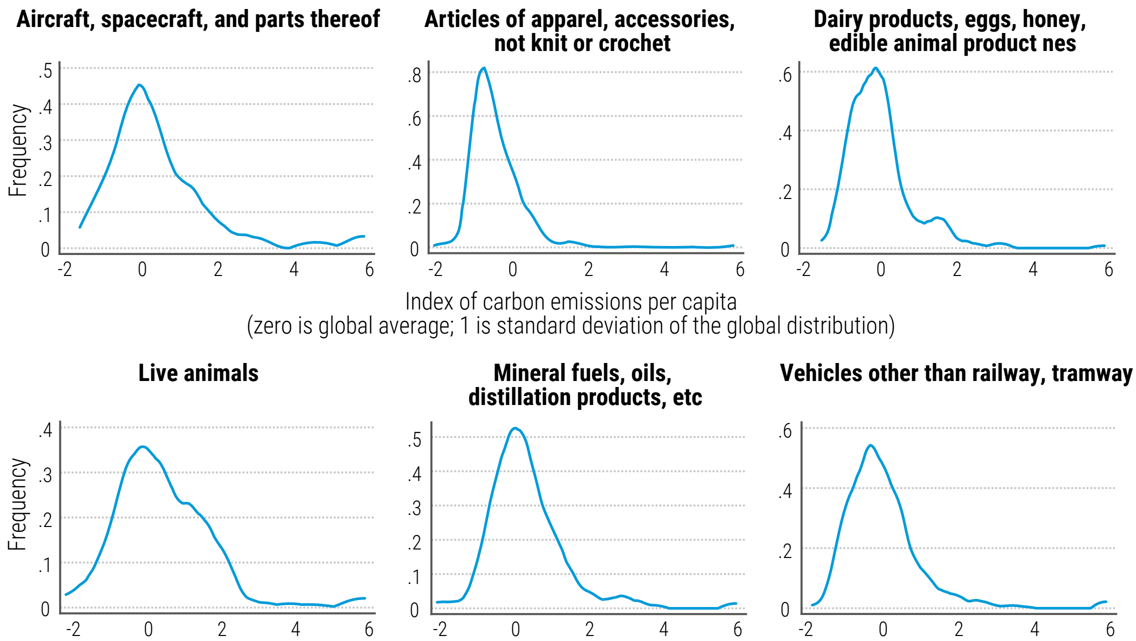
Source: UNCTAD.

A. IDENTIFYING GREENER PRODUCTION

To help countries choose greener pathways, UNCTAD has produced indices of economic complexity and carbon footprints for over 43,000 products exported in international markets.[12] This analysis shows that within each industry, there is a range of carbon emissions similar to a statistically normal distribution. This is illustrated in Figure V-1 which indicates that for apparel the average emissions are lower, with the distribution shifted to the left, while for live animals there is a greater weight on the right.

Figure V 1

Distribution of carbon emissions by products within sectors, 2018



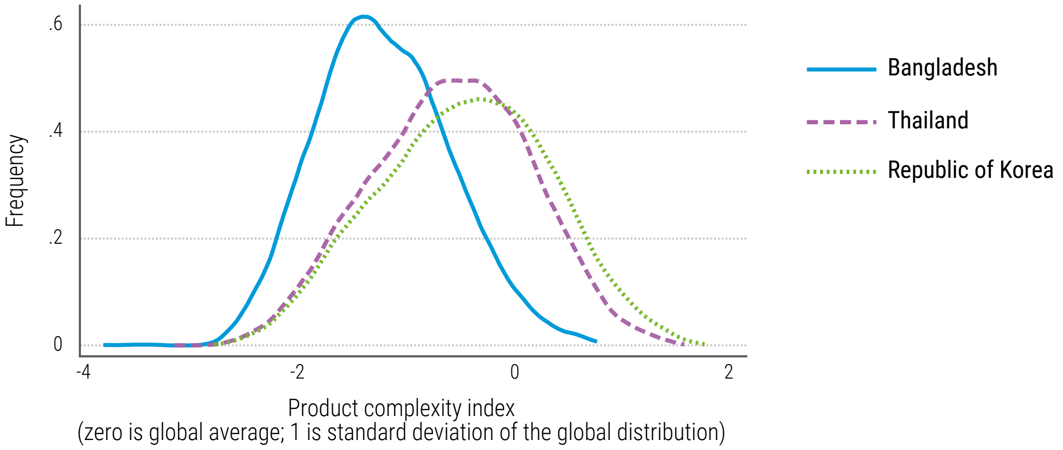
Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

Note: On the horizontal axis, zero represents the global average, and 1 is the standard deviation of the distribution. The vertical axis shows the frequency in which a level of carbon emissions is associated with products within a sector.

The result is similar when considering the output of countries – which generally have products from low to high carbon footprints. This is illustrated in Figure V-2 for Bangladesh, Thailand and the Republic of Korea in 2010. For Thailand and the Republic of Korea the distribution is close to the global average while Bangladesh's product mix is shifted to the left with a lower carbon footprint.

Figure V 2

Distribution of index of carbon footprint, selected countries 2010

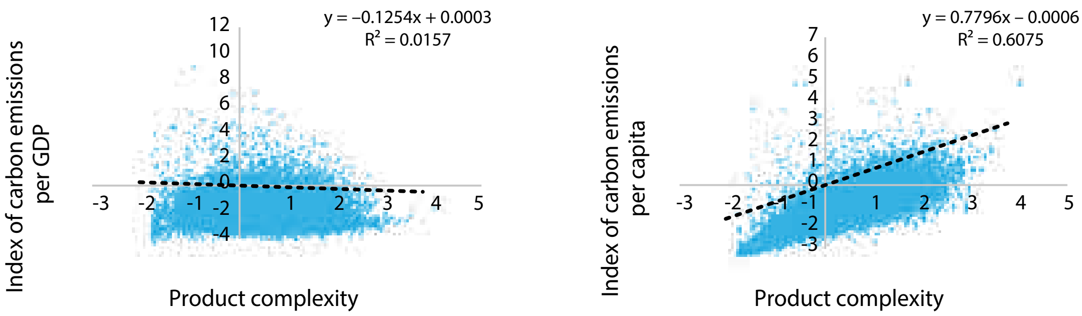


Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

When this output and consumption is taking place in a country that is growing from a low base, there is likely to be an increase in carbon emissions per capita. Over the past two decades, however, that link seems to have been weakening, so that increasing complexity is less likely to result in increasing emissions. As the product mix becomes more complex and more sophisticated, carbon emissions fall per unit of GDP (Figure V-3).

Figure V 3

Association between carbon footprint and product complexity, 2018

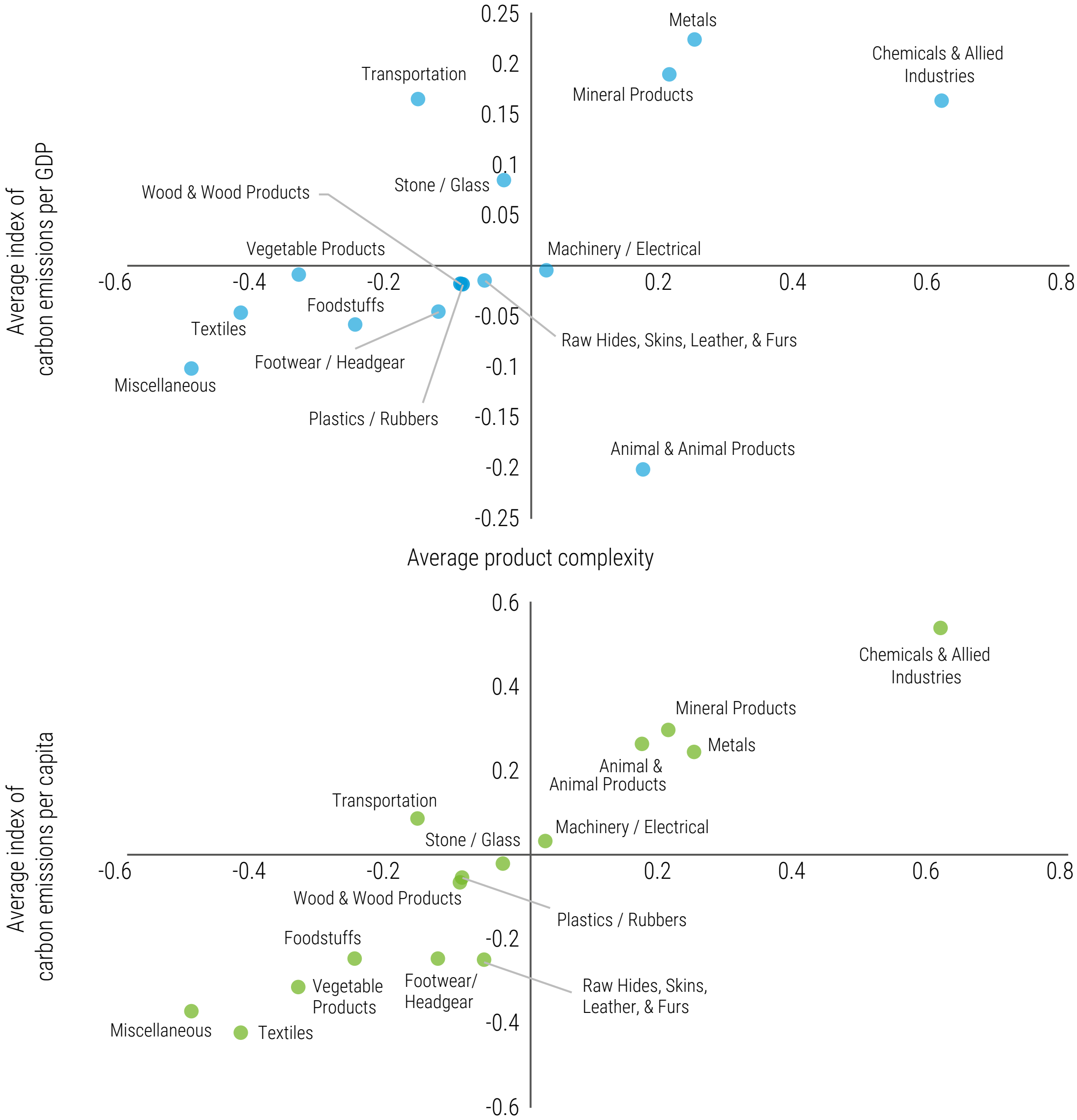


B. PATHS TO GREENER PRODUCTION

Generally, as countries move from agriculture to industry and to medium and high-tech manufacturing there is an increase in 'complexity' which refers to higher levels of technology to be produced.[13] Increasing complexity does not necessarily lead to greener production. Much will depend on the product mix. Figure V-4 compares indices of product complexity and carbon emissions by sectors. The less complex sectors that also have lower carbon footprints are textiles, vegetable products, foodstuffs and footwear. The sectors that are more complex and have higher carbon footprints are chemicals and allied industries, metals and mineral products.

Figure V 4

Green outcomes and complexity by sector, 2018

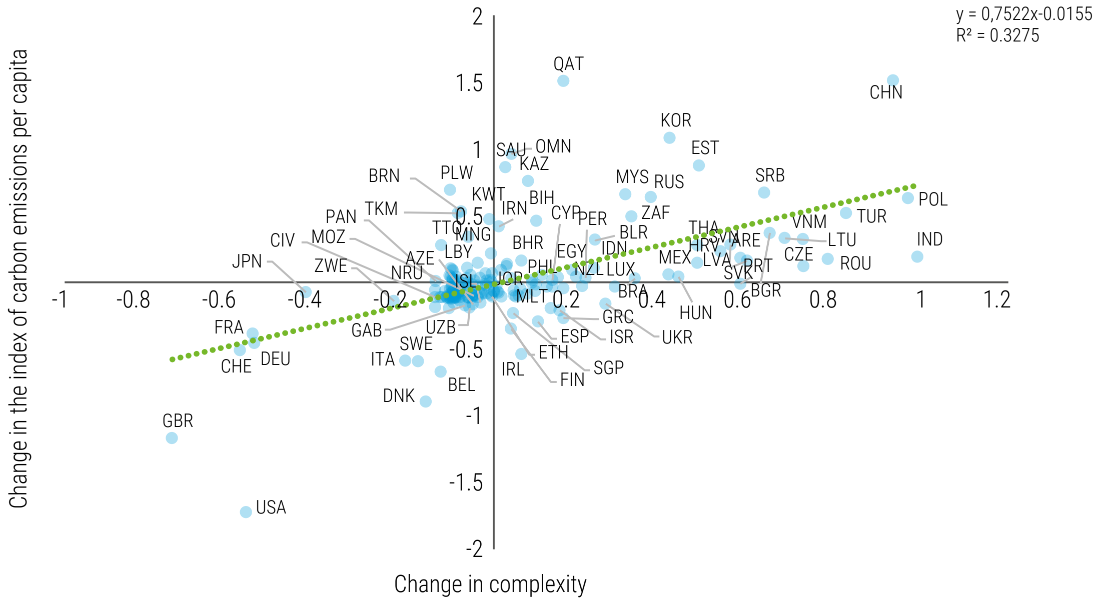


Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).
Note: On both axes, zero represents the global average, and 1 is the standard deviation of the distribution.

Figure V-5 shows how for each country these two indices have changed over the past decades. Some of the countries that have increased their complexity the most are India, Poland, China, Türkiye, Romania, Czech Republic, Viet Nam, Latvia, Lithuania, Bulgaria, and Serbia. These countries have generally also increased their index of emissions per capita. On the other hand, countries have reduced complexity and their indices of carbon emissions include the United States and the United Kingdom.

Figure V 5

Change in complexity and carbon footprint, 2000-2018

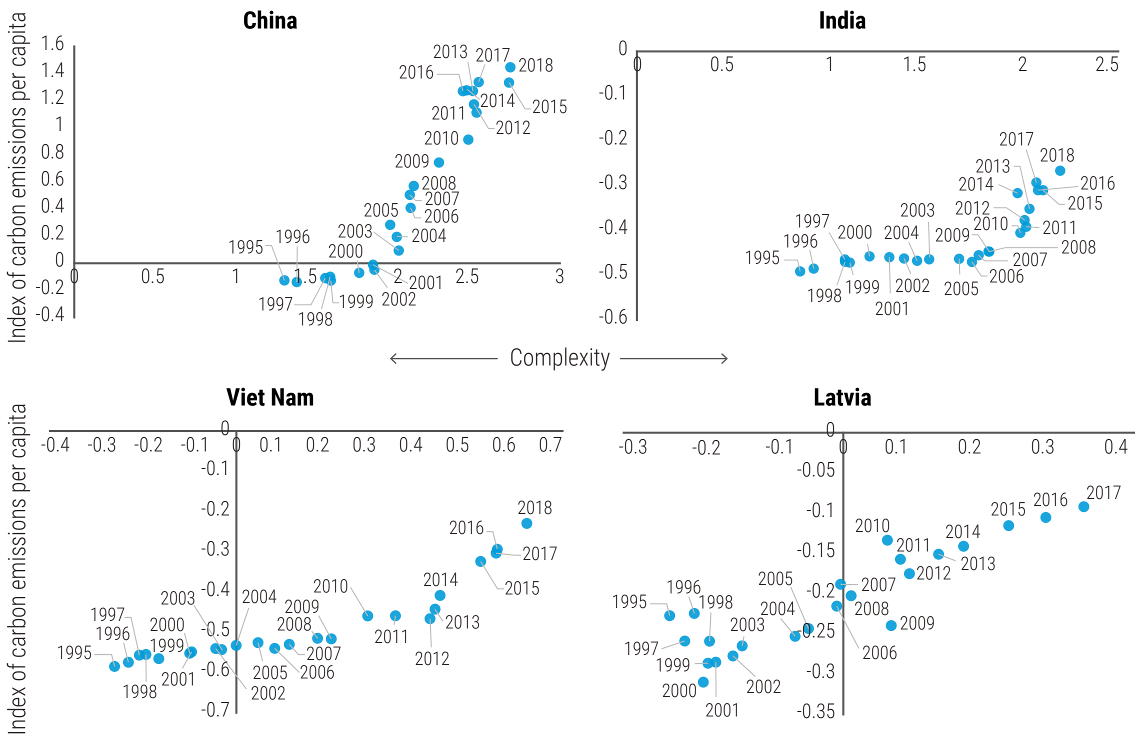


Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).
Note: On both axes, zero represents the global average, and 1 is the standard deviation of the distribution.

China – In the period before entering WTO in 2001, China diversified towards products with about the same level of carbon emissions per capita, using roughly the same technologies. Subsequently, the country diversified towards output that involved higher carbon emissions per capita (Figure V-6).

Figure V 6

Examples of changes in complexity and carbon footprint, selected countries



Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).
Note: On both axes, zero represents the global average, and 1 is the standard deviation of the distribution.

India – Here the rapid increase in the index of carbon emissions per capita was in 2010, though less pronounced than in China. The index of emissions per capita for India is, nevertheless, still much lower than the global average.

Viet Nam – From 1995 to 2018, the country moved from below to above average economic complexity. The increase was faster following the global financial crisis, but the increase in carbon emissions per capita was far below the global average (Box V-2).

Latvia – Since the 2000s, complexity and the index of carbon emissions per capita have increased at a fairly constant rate. The increase in complexity has been accompanied by increasing carbon efficiency, particularly between 1995 and 2007. The index of carbon emissions is below the global average (Box V-3).

Box V 2
Viet Nam thrives with foreign direct investment

Over the past 30 years, the economy has witness unparalleled changes. From one of the poorest nations, Viet Nam has grown into a lower middle-income emerging economy. Between the 1990s and 2019 the poverty rate declined from above 70 per cent to below 6 per cent with average per capita income of $2,700.[14] Average economic growth was almost 7 per cent. This has involved structural transformations away from agriculture to include machinery, footwear, and electronics.

Rapid economic growth has been fuelled by foreign direct investment which between 1990 and 2018 rose from $180 million to $15.5 billion.[15] Beyond footwear and textiles and garments, FDI intensified in industries such as electronics and electrical equipment.

The increase in FDI was a response to national-level strategies. In 1987, the Law on Foreign Investment allowed for FDI via joint state-private ventures and wholly foreign-owned corporations. This was followed in the 1990s by laws on land ownership, and on private enterprise. The 1992 Constitution further encouraged FDI by providing for state guarantee of ownership.

Viet Nam explored new comparative advantages in electronic and telecommunication equipment products through foreign direct investment and active participation in the Asian electronic regional network.[16]

The enhanced economic diversification can be linked to Viet Nam's active participation in international agreements, whether bilateral, plurilateral or through membership of ASEAN. Viet Nam signed the Textile and garment trade agreement with European Community in 1992, acceded to the Association of Southeast Asian Nations (ASEAN) in 1995, and normalized political relations with the United States in the same year. In 1998, Viet Nam joined APEC, and signed the US-Viet Nam Bilateral Trade Agreement in 2000. Assertive international integration culminated in accession to the WTO in 2007 which has enhanced diversification and participation in GVCs. In 2015, Viet Nam engaged with Trans-Pacific Partnership negotiations.

Due to Viet Nam's continuing efforts to integrate into the global trade and investment system, exports of goods and services grow constantly even when neighbouring countries have stagnated or deteriorated.[17]

The Government has established special economic zones (SEZS) which between 2000 and 2014 have attracted $257 billion in FDI. SEZs contribute to 40 per cent of national industrial output and over 50 per cent of export value.[18] Viet Nam has also invested in science and innovation, creating 17 key national laboratories in the mid-1990s. The Law on Science and Technology and S&T Development Strategy (2003) further paved the way for transformation towards a fully-fledged and functional innovation system. [19]

Despite economic growth, Viet Nam's current development path has not led to a lower carbon footprint of production. In 2021, Viet Nam adopted the National Green Growth Strategy for the 2021-2030 period, Vision to 2050.[20] The overall goal of the strategy is to accelerate the process of restructuring the economy in association with growth model transformation to achieve economic prosperity, environmentally sustainability, and social equality. It also aims to facilitate the transition to a green and carbon neutral economy and contribute to reducing global warming.

Source: UNCTAD.

Box V 3

Latvia increases complexity through regional clusters

The expansion and diversification of Latvia's trade from 1995 can be divided into two main periods. The first from 1995 to 2007 involved an intensification of commodity trade and transport when exports were divided equally between services, transport, agricultural goods, and minerals fuels. The second after the financial crisis from 2008-09 saw a shift towards higher value-added production in electronics and chemicals. From 2009 to 2020, the contribution of services was about 25 per cent, of agricultural products around 19 per cent, of electronics 8 per cent, and of chemicals 8 per cent.

Latvia joined the World Trade Organization in 1999 and the European Union in 2004, and in 2014 the euro became the country's currency. The process of joining the European Union has created favourable supply and demand factors that contributed to the expansion and diversification of Latvia's exports. With support from the European Regional Development Fund, Latvia shifted towards electronics and other priority sectors.

From 2009 to 2012, the Government focused on improving the general business environment with direct subsidies and grants to priority sectors aiming to remove constraints.[21] One key policy instrument was the development of regional clusters. The Government led by the Ministry of Economics also supports networking and promotes cooperation among business, research, educational, and other institutions During the period 2009-2015, in total, 13 clusters were supported, of which 11 are in the Riga region: chemistry and pharmacy, furniture, food, IT, mechanical engineering and metalworking, electrical engineering and electronics, light industry, timber construction, sustainable tourism, Industrial energy efficiency, and clean technology cluster.[22]

Source: UNCTAD.

Greener products

Identifying suitable production paths thus is neither easy nor intuitive. Table V-1 lists the world's top 20 products in terms of product complexity and greener production. These are relatively expensive – and involve a larger number of professions, from design to high-precision manufacturing to branding. They are very diverse – ranging from primary commodities such as cocoa paste to precision manufacturing products such as clocks. This list even includes coke, semi-coke of coal, lignite, and gas-fuelled pocket lighters. But their diversity is encouraging since it indicates countries do not need to produce the same things but rather can choose their own unique paths.

Table V 1

Degree of complexity of products that are greener than global average, 2018

Description	complexity	CO_2 / per unit of gdp	CO_2 /per capita
(520291) Garnetted stock of cotton, $145-211	2.41	-1.50	-0.04
(540331) Yarn of viscose rayon, single untwisted nes not retai, $321-1234	2.41	-1.50	-0.04
(842330) Constant weight scales, including hopper scales, $417709+	2.41	-1.50	-0.04
(810810) Titanium, unwrought, waste or scrap, powders, $4678+	2.41	-1.50	-0.04
(720943) Cold rolled iron or non-alloy steel, flat, width >600mm, t 0.5-1mm, nes, $13-14	2.41	-1.50	-0.04
(845819) Horizontal lathes nes for metal, $317867+	2.41	-1.50	-0.04
(180320) Cocoa paste wholly or partly defatted, $105-331	2.41	-1.50	-0.04
(520535) Cotton yarn >85% multiple uncombed <125 dtex, not ret, $45-61	2.41	-1.50	-0.04
(845310) Machinery to prepare, tan, work hides, skins, leather, $114096-158773	2.41	-1.50	-0.04
(270400) Coke, semi-coke of coal, lignite, peat & retort carbo, $15-31	2.41	-1.50	-0.04
(160416) Anchovies, prepared or preserved, not minced, $206+	2.41	-1.50	-0.04
(580429) Mechanical lace, other material (piece, strip, motif), $891-948	2.41	-1.50	-0.04
(700232) Tubes of low expansion glass (Pyrex etc), $862-906	2.25	-2.01	-0.14
(961320) Pocket lighters, gas-fuelled, refillable, $414-463	2.25	-2.01	-0.14
(631010) Used or new rags textile material, sorted, $260+	2.14	-1.46	-0.00
(580639) Woven fabric materials nes, < 30 cm wide, $446-555	2.13	-1.53	-0.03
(852210) Pick-up cartridges, $5100-8966	2.09	-1.85	-0.06
(551221) Woven fabric >85% acrylic staple fibres, unbl/bleache, $390-472	2.09	-1.85	-0.06
(950611) Snow-skis and parts, $1505-1920	2.09	-1.84	-0.18
(911280) Clock, etc cases, except metal, $3244-3894	2.09	-1.84	-0.18

Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

Note: In the measures of complexity, index of CO_2 per capita and index of CO_2 per GDP, zero represents the global average, and 1 is the standard deviation of the distribution.

C. COMPLEXITY AND GREENNESS

For this report, UNCTAD investigated the connection between carbon footprints and complexity for over 100 economies over the period 1996 to 2015.[23] The analysis considers the influences on carbon emissions of economic complexity, FDI, trade openness, innovation measures, and environmental policy stringency. It assesses the impact of previous CO_2 emissions, GDP per capita, population, energy intensity, and electricity production from oil, gas and coal. The results are summarized in Table V-2.

Table V 2
Factors affecting complexity and carbon footprint

Variable	Impact on index of carbon footprint	Impact on complexity
Economic complexity	Temporary increase but long-term reduction. The increasing impact is less for developing countries, along with some evidence that the long-term reduction effect is stronger in developing countries.	.
FDI	Increase	Non-significant
Trade openness	Reduction, but less with developing countries	Increase
Number of researchers in R&D	Reduction	Increase
Research and development expenditure	Increase, but less with more open trade	Increase
Environmental policy stringency	An inverted U-shaped relationship	Increase
Energy intensity of primary energy	Increase	Reduction
Electricity production from oil, gas and coal	Increase	Reduction

Source: UNCTAD.

Economic complexity – Initially, economic expansion and a greater use of resources increases the carbon footprint. Later however, more complex and sophisticated products can embed environmentally friendly technologies.[24] Notably, the initial temporary increase is less for developing countries. There is also some evidence that long-term reduction effect is greater in developing countries[25] – opening up windows for addressing employment, economic growth and environmental sustainability, and for their firms to adopt sustainable practices in their supply chains.[26]

Energy use – This depends on intensity and type of energy use. Emissions will increase if primary energy and electricity production is from oil, gas or coal.

Foreign direct investment – FDI can help developing countries move to more complex production but generally at the expense of higher levels of emissions.[27]

Trade openness – Trade with other countries generally enhances complexity, while also diffusing green technologies, spreading better environmental practices, and fostering investment in renewable energy.[28] Meanwhile, increase in trade can also lead to an increase in energy consumption, which in turn causes increased environmental degradation. Therefore, this reduction effect is less in developing countries with more relaxed or non-enforced regulations. This underlines the importance of strengthening environmental regulations and giving preference to trade opportunities that can facilitate clean technology transfer and build green innovation capacities.

Research and development – Historically having more people working in R&D has increased carbon emissions since many researchers have been working on fossil energy.[29] On the other hand increasing R&D expenditures on renewable energy seems to have no significant impact on CO_2 emissions probably because of the persistently low use of renewable energy.[30] It is also worth noting that R&D expenditure increases emissions intensity less as countries become more open to trade.

Energy intensity – Having primary energy and electricity production from oil and gas is associated with higher complexity but also higher emissions.[31] Policymakers should break away from the energy path dependency and ensure that renewable energy is more competitive.[32]

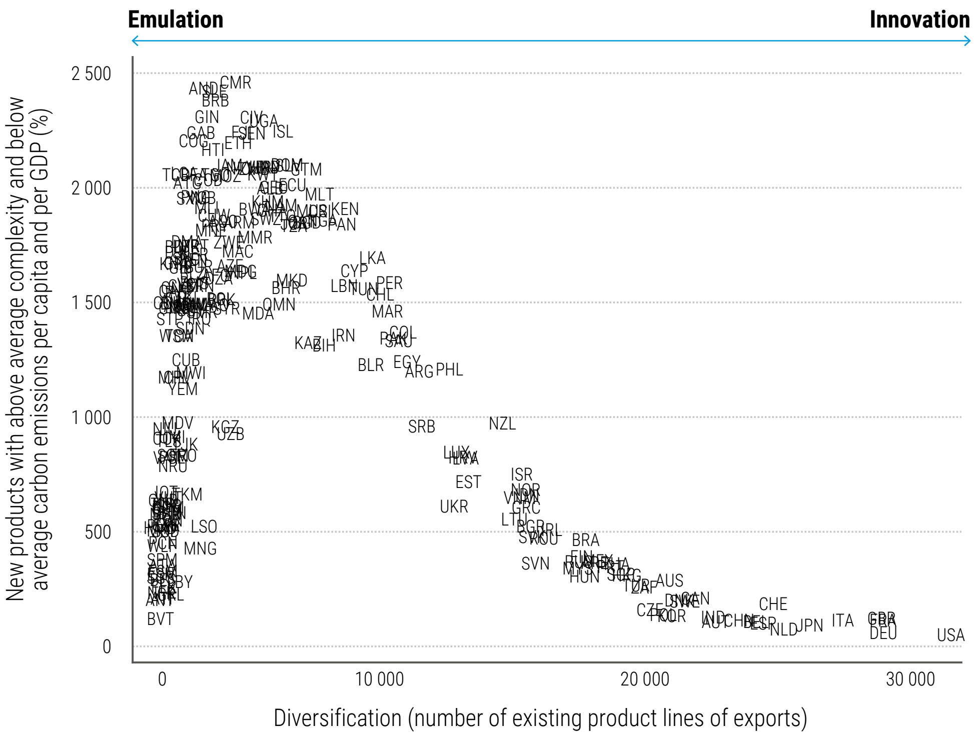
Environmental policy – Empirical literature suggests an inverted U-shaped relationship. Initially stringent policies only lead to improvements in the environment beyond a certain threshold.[33]

Opportunities for diversification

When the existing product mix is limited, countries have more options to diversify in greener directions (Box V-4). For the UNCTAD analysis this remains true for up to around 3,000 products. Beyond that point, the number of potential new products that are both more complex and greener tends to fall off (Figure V-7).

Initially, developing countries can diversify largely by emulating the paths of other countries. But those opportunities diminish as diversity increases, so countries need to set their own paths. For China, Brazil, India and South Africa, for example, the more important strategy is now innovation. They thus have to increase support to R&D and the creation of original knowledge and new and greener products. This will increase the opportunities for entrepreneurs to discover and invest in business with better social outcomes.

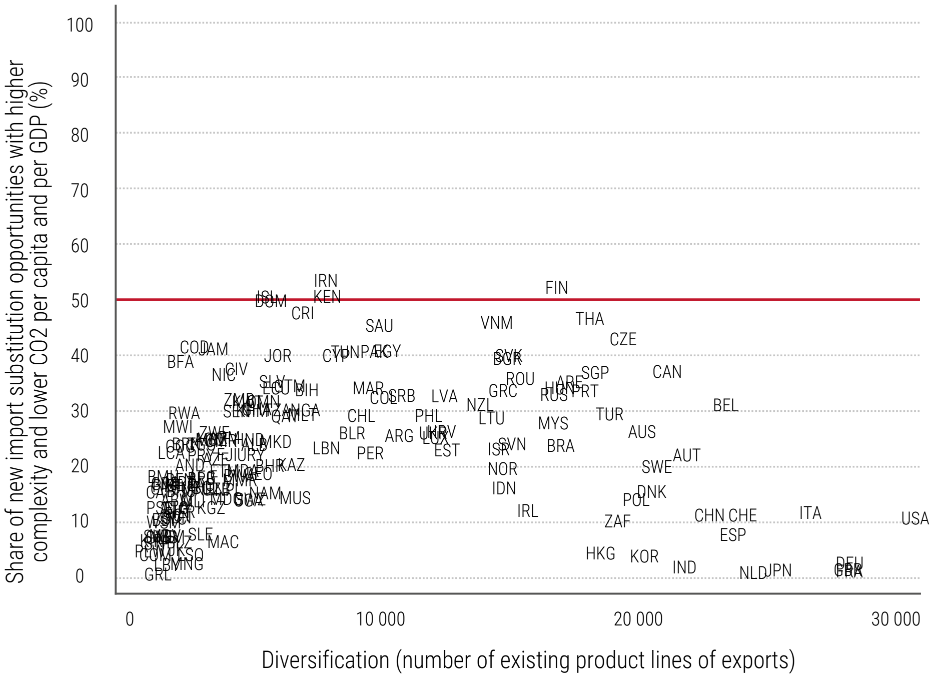
Figure V 7
Emulation vs innovation



Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

While most countries can diversify to more complex products, some are in a better position to achieve greener outcomes. These include Andorra, Barbados, Cameroon, Chad, Côte d'Ivoire, Dominican Republic, El Salvador, Ethiopia, Guatemala, Honduras, Kenya, Panama, Saint Lucia, Senegal, Sri Lanka, and Uganda. This may start with import substitution. In Figure V-8 this shows opportunities for developing countries such as Iran and Kenya as well as developed countries such as Finland.

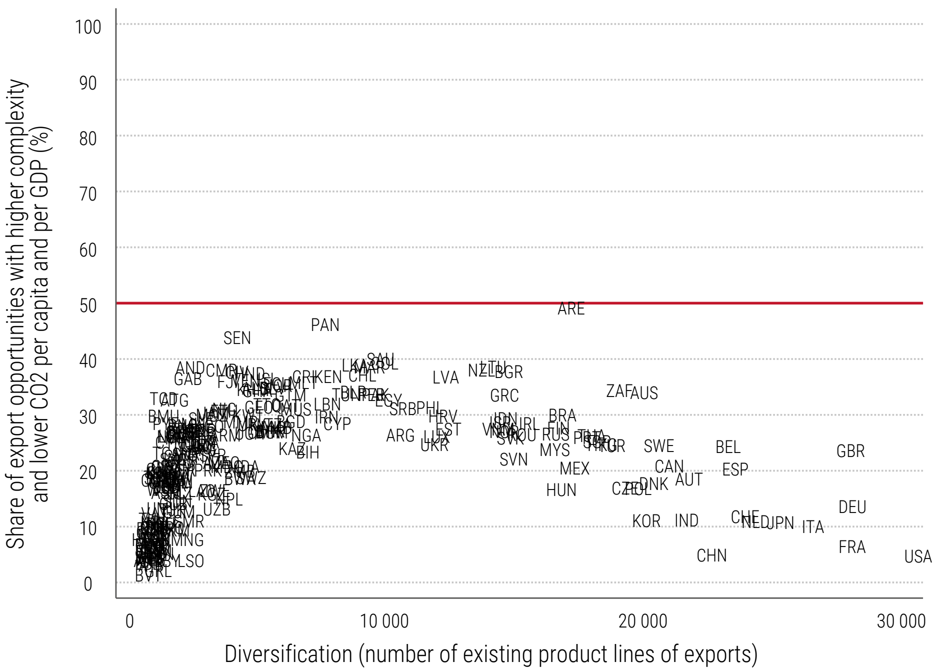
Figure V 8
Import substitution opportunities for diversification



Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

In other cases, the products likely to attract entrepreneurs are those that are in high demand for exports – as for Senegal, Panama and the United Arab Emirates (Figure V-9).

Figure V 9
Export opportunities for diversification



Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

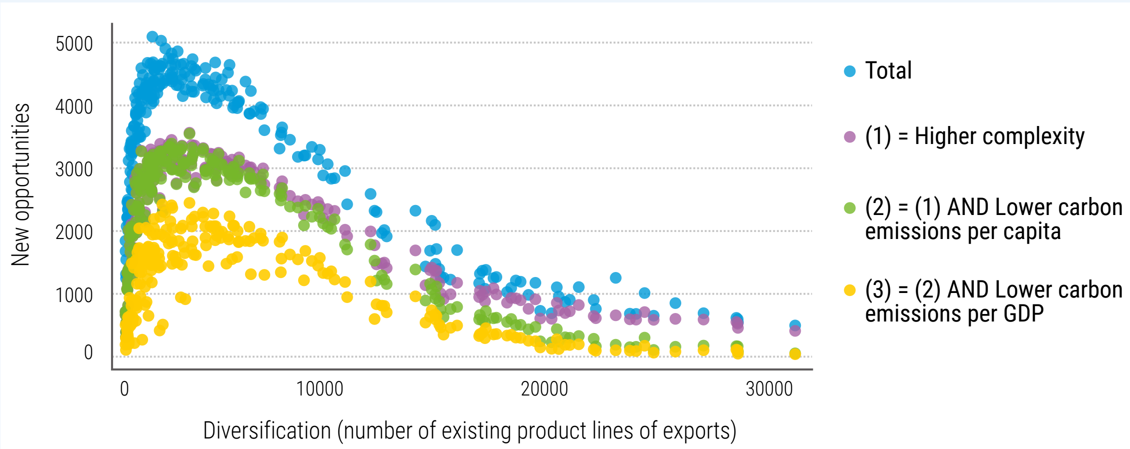
Box V 4
Opportunities for green diversification

The figure below shows the number of opportunities relative to the number of existing products in a country's product mix. Each dot represents one of the 234 economies analysed. The position of the blue dots represents the number of existing products and the number of potential new products for diversification given its proximity in the product space. The red dots add another requirement. They represent the number of existing products and potential new products that are close in the product space and that have complexity higher than the average complexity for that country. At lower levels of diversification there is a sizeable difference between the blue and red dots, but when countries move past 10,000 products, the difference becomes smaller.

The green dots add the further requirement of carbon emissions lower than the global average. For countries with low levels of diversification, the green requirement does not reduce the number of opportunities. On the other hand, as countries diversify it becomes harder to find new products that are both more complex and greener.

Orange dots in the figure represent new opportunities for diversification that are more complex and are associated with lower carbon emissions per capita and per GDP. In this case, the extra requirement makes it harder for less diversified countries to find these opportunities. Therefore, as countries diversify, the likelihood of further diversifying towards more complex and greener products change in a non-linear away, which is summarized in the figure below.

Association between number of existing and potential new products



Source: UNCTAD based on data from the United Nations Commodity Trade Statistics Database (COMTRADE).

Number of potential new product as countries diversify

	Economy	
	Less diversified	**More diversified**
Average complexity and carbon emissions.	High compared with the level of diversification of the economy. It is relatively easy to find potential new products for diversification.	Low compared with the level of diversification of the economy. As countries diversify, there are fewer opportunities for diversification based on products that already exist elsewhere in the world.
With complexity above country's average	Much lower than the total number of potential new products. It is more challenging to find new products that also contribute to increasing the level of technological capacity of the economy.	Not much less than the total number of potential new products. The opportunities for diversification are likely to also be associated with higher complexity.
With complexity above country's average and carbon emissions per capita below global average	About the same number of potential new products that are more complex. Thus, it is likely that by finding new and more complex products, these would also be associated with lower carbon emissions per capita.	Lower than the potential new products that are more complex. As countries diversify, their firms have to make an extra effort to diversify towards products that are also associated with lower carbon emissions per capita.
With complexity above the country's average and carbon emissions per capita and per GDP below global average	The extra requirement of lower carbon emissions per GDP significantly reduces the number of potential new products for diversification.	About the same number of potential new products that have lower carbon emissions per capita.

Source: UNCTAD.

D. OPPORTUNITIES FOR GREENER PRODUCTION

Identifying and prioritizing new sectors

For selecting more complex and greener directions, policymakers are faced with incomplete information as well as continuing changes in technology and demand. Governments must therefore strengthen their capacities for assessing and analysing potential new sectors. This will mean taking into account the country's existing technological and productive capacities and the availability of natural resources such as wind or agricultural waste. They also need to consider how their companies can fit into global value chains. And, as green windows open, policymakers must be prepared to adjust their institutional frameworks.

These assessments should be participatory and involve a wide range of stakeholders. Within government, for example, this would include ministries of science, technology and innovation, trade, industry, and education – all of which can increase national STI capacity and improve systems of innovation. In this, they can be supported by specialized academic and research institutions. Policymakers also need to draw in expertise from the private sector, people who know what it takes to build capacity within firms and who understand the business environment. Just as important, they need to engage with civil society organizations who know the concerns and priorities of those in vulnerable situations. And throughout all this they should balance the contributions of women and men to ensure clear gender perspectives.

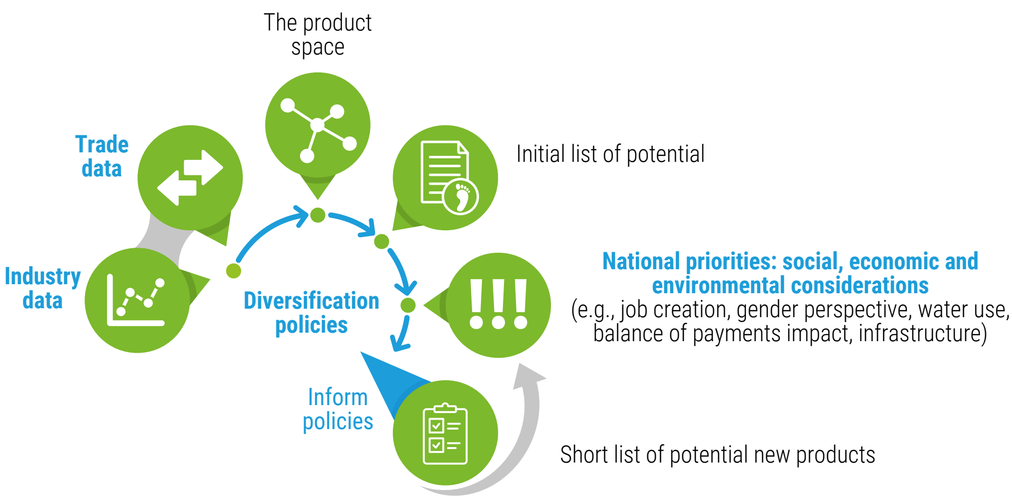
This will require all the essential trade and industry data, with the latest information on what the country is producing and exporting (Figure V-10). Policymakers can then apply concepts such as 'growth diagnostics economic complexity' and 'product space'. The evaluation can also take advantage of international resources, such as UNCTAD's Catalogue of Diversification Opportunities 2022,[34] the ITC

Export Potential Map[35] and the Atlas of Economic Complexity provided by the Harvard Center for International Development.[36]

Governments, the private sector and development partners can then consider each product, taking into account social, economic and environmental considerations. They can look at them from the perspective of job creation for example, and in particular for boosting women's employment. They can consider what infrastructure is required and how it uses resources, including water, FDI-based light manufacturing, or any other strategy for industrialization.

This interactive process should produce a shortlist of potential products and will need to be repeated every few years to take into account changes in the countries' production structures and in opportunities in international markets.

Figure V 10
Identification and selection of realistic opportunities for diversification



Source: UNCTAD.

Fostering new sectors

Countries that want to compete in new sectors, will need 'infant industry' policies to enable entrant firms to reach the levels of productivity required to compete with more technologically advanced countries. Subsequently this support can be phased out so that further increases in productivity are guided by competition and market incentives.[37]

To foster green technology, governments can also take specific measures such as establishing clusters of industries developing green technology, starting pilot and demonstration projects, and setting out technology road maps (Box V-5).[38]

In China, for example, the government has established "megaprojects of science-research" to build knowledge and experience within domestic firms, who can learn through experimentation with different technical designs.[39] Similarly, in Chile with the involvement of international investors the National Development Agency (CORFO) is setting up several pilot projects to support the development of a green hydrogen industry.

All these activities will need finance, which can be through dedicated funds. In Austria, for example, the Ministry of Climate Protection and Environment planned to implement a €300-million investment subsidy budget for green energy in 2022.[40] In Belgium, the Walloon Government plans to invest more than €160 million to lay the foundations for the hydrogen and synthetic fuels economy.[41]

Box V 5
Instruments for fostering green technologies

Clusters

Austria – To strengthen hydrogen research and contribute to the national hydrogen strategy, Graz University of Technology and Montanuniversität Leoben are intensifying their activities through a hydrogen cluster that comprises 19 universities and research institutes and several companies in Austria's Green Tech Valley.[42]

Belgium – Created in 2011, GreenWin is a regional competitiveness cluster in Wallonia dedicated to the industrial and environmental transition of chemicals, innovative construction and renovation processes and materials, and environmental technologies (Green Techs). GreenWin organizes unlikely encounters between companies of all sizes, the academic and scientific communities and key partners to consider new products. The goal is to stimulate the creation of complete value chains in Wallonia, generate new sustainable, eco-responsible and non-relocatable industrial sectors, and contribute to creating and maintaining sustainable Walloon jobs. To this end, each project supported by GreenWin is subject to a life cycle analysis.[43]

Belarus – Electrotransport is an innovation and industrial cluster that has been created to develop and manufacture new means of electric transport and its components and to coordinate the research and technology, education and industry sectors. Several electric vehicles have been developed within the cluster, for example, electric buses, and autonomous trolleybuses.

Demonstration areas and projects

Philippines – The Department of Science and Technology (DOST) Region IVB Office, through its Provincial S&T Office in Marinduque led the 6M-project on the deployment of solar energy systems to 29 rural health units regionwide. The DOST Marinduque office also serves as a demonstration area for "green building" using solar energy systems. As a result, different government agencies in the province signified interest in adopting solar energy systems.

India – The Department of Science & Technology (DST) works at the initial stages of the technology and innovation chain for cleaner, more productive, and competitive production. DST supports R&D, technology concepts, experimental proof, and technology demonstration projects on Clean Energy.

Russian Federation – In February 2021, a pilot programme was launched to deploy plots of land as 'carbon polygons'. Within a carbon polygon, highly qualified personnel can develop and test technologies for controlling the balance of climatically active gases in natural ecosystems. In addition, the polygon provides training in state-of-the-art methods of environmental control, advanced technologies for low-carbon industry, agriculture and municipal economy. The initiative is expected to play a key role in developing a reliable nationwide system for monitoring greenhouse gas emissions in ecosystems.

Switzerland – The Swiss Federal Office of Energy Pilot and Demonstration Program supports the development and testing of new technologies, solutions and approaches in the area of economical and efficient use of energy, energy transmission and storage as well as the use of renewable energies. The programme is positioned at the interface between research and the market and aims to bring new technologies to market maturity. [44]

Technology roadmaps

Türkiye – The Ministry of Industry and Technology and TÜBİTAK are carrying out "Green Growth Technology Roadmap" studies for the iron-steel, aluminium, cement, chemicals, plastics and fertilizer sectors – which are critical for the Turkish economy and have high carbon emissions. Priority R&D and innovation themes will be detailed, in cooperation with the Ministry of Industry and Technology, leading to STI and investment support programmes to enable private sector organizations to adapt to green transitions.[45]

Chile – The economic development agency, CORFO, has developed the "Transforma" Strategic Programmes, including the Roadmap for the Sustainable Management of Construction and Demolition Waste, and the Ministry of Agriculture has drawn up the roadmap, Circular Economy of Agroindustry.[46]

Peru – The Roadmap towards a Circular Economy in the Industry Sector was approved to establish State actions to support manufacturing and processing in their transitions from linear to circular economic models.

Source: UNCTAD based on contributions to the Commission on Science and Technology for Development from UNEP and the Governments of Austria, Belarus, Belgium, Chile, India, Peru, the Philippines, the Russian Federation, and Switzerland.

Participating in global value chains

By participating in global value chains countries can diversify – producing and exporting new products or upgrading existing output to have greater value added.[47] Some policies for promoting integration into GVCs are improving transportation infrastructure, as well as supporting for trade and for trade facilitation, lowering tariff and non-tariff barriers particularly for intermediate goods, and lowering barriers to trade in services. Other less targeted policies are investing in basic and dedicated education, fostering university-industry linkages, and reforming intellectual property laws and patent processes.[48]

Within value chains governments can consider more targeted policies, such as support for small and medium-size enterprises with finance for new machinery and other requirements for upgrading. They can also create training or demonstration centres as well as industrial institutes.

1 This analysis responds to UNCTAD's mandates and complements its ongoing analytical work focusing on fostering economic diversification for structural transformation. In particular, it complements the analysis presented in The Least Developed Countries Report 2022, which examined ways to create a path towards the green structural transformation of the LDCs.

2 Reinert, 2008; Hausmann and Hidalgo, 2011; Petralia et al., 2017

3 Lall, 1992,Freire, 2019

4 IPCC, 2007

5 Such as in an analysis of the relationship in a selected group of 18 top economic complexity countries (Abbasi et al., 2021), selected European Union countries with low and high economic complexity (Neagu and Teodoru, 2019), a group of countries when considering the impact on environmental performance index (EPI), the per capita ecological footprint of consumption, and the per capita ecological footprint of production (Kosifakis et al., 2020), a group of 86 countries with different development levels (Laverde-Rojas and Correa, 2021), and a study on Colombia (Laverde-Rojas et al., 2021), and another on Brazil (Swart and Brinkmann, 2020).

6 Kosifakis et al., 2020, Boleti et al., 2021

7 Chu, 2021

8 Mealy and Teytelboym, 2020

9 UNCTAD, 2021d

10 UNCTAD, 2022f

11 UNCTAD, 2022d

12 The term economic complexity refers to the level of non-tradable capabilities in the economy as defined in the strand of literature on economic complexity (see, for example, the seminal paper Hidalgo and Hausmann, 2009, and a review of this literature in (Freire, 2021b)). More complex products are considered to require higher levels of technology to be produced. The index of carbon footprint of a product assesses the level of carbon emissions per capita associated with the countries that export that product. The methodology for the calculation of these indices is presented in the background paper prepared for this chapter: Freire (2023). Opportunities in greener diversification trajectories. Available at https://unctad.org/webflyer/technology-and-innovation-report-2023.

13 UNCTAD research also identifies a positive significant impact of CO_2 emission on the economic complexity index, which may result from a reverse causality. Moreover, the quadratic term of GDP exerts a negative and significant impact on the complexity index, which suggests a concave relationship between GDP and the economic complexity index.

14 WTO Trade Policy Review: Viet Nam, 2021

15 UNCTADstat, 2022

16 Hong, 2021

17 OECD, 2018a

18 OECD, 2018a

19 OECD and World Bank, 2014

20 Ministry of Industry and Trade (MOIT) of the Socialist Republic of Vietnam, 2021

21 Soms, 2016

22 Garanti and Zvirbule-Berzina, 2013

23 UNCTAD analysis is based on longitudinal data and a dynamic linear model. For more details see the background paper prepared for this chapter: Ni Zhen and Freire C (2023). The interlinks between the economic complexity and carbon footprint: differentiated analysis for developed and developing countries. Available at https://unctad.org/webflyer/technology-and-innovation-report-2023.

24 Neagu, 2019; Can and Gozgor, 2017

25 Seuring and Müller, 2008

26 Furthermore, UNCTAD research conducted the subgroup analysis for developed and developing countries on the link between economic complexity and carbon emissions, which corroborates the robustness of our previous findings. For more details see the background paper prepared for this chapter: Ni Zhen and Freire C (2023). The interlinks between the economic complexity and carbon footprint: differentiated analysis for developed and developing countries. Available at https://unctad.org/webflyer/technology-and-innovation-report-2023.

27 FDI has the potential to contribute to increasing complexity of production in developing countries, but historically it is associated with higher levels of emission in the receiving countries (e.g., Omri et al., 2014; Shahbaz et al., 2015). FDI inflows may provide direct capital financing, generate positive externality to stimulate further economic growth, which eventually leads to environmental degradation (Lee, 2013).

28 Shahbaz et al., 2017; Yu and Qayyum, 2021

29 Koçak and Ulucak, 2019

30 Koçak and Ulucak, 2019; Amri, 2018; Cheng et al., 2017; Garrone and Grilli, 2010

31 Neagu, 2019

[32] Bilgili et al., 2017

[33] Wolde-Rufael and Mulat-Weldemeskel, 2021, 2021 UNCTAD research has not discovered significant impact of environmental policy stringency in reducing CO_2 emission, due to a limited number of observations. The estimation sample reduces to around 400 observations when controlling for environmental policy stringency, which greatly hampers the validity of dynamic model.

[34] UNCTAD, 2022d

[35] ITC Export Potential Map: Spot export opportunities for trade development, 2022

[36] The Atlas of Economic Complexity by Harvard Growth LAB, 2022

[37] Reinert, 2009

[38] For in depth analysis of smart specialization strategies and their implementation, see (Foray, 2014, 2016).

[39] Lilliestam et al., 2019

[40] Renewables Now, 2022

[41] UNCTAD, 2022d

[42] Greentech, 2022

[43] Greenwin, 2022

[44] Bundesamt für Energie, 2022

[45] UNCTAD, 2022b

[46] CORFO, 2022

[47] UNCTAD, 2018b

[48] UNCTAD, 2018b