



UNITED NATIONS
INDUSTRIAL DEVELOPMENT ORGANIZATION



INDUSTRIAL DEVELOPMENT REPORT 2022

THE FUTURE OF INDUSTRIALIZATION
IN A POST-PANDEMIC WORLD



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Foreword



The COVID-19 pandemic has had a devastating impact on economies, societies and people around the globe. Not only has there been a dramatic loss of life. The virus has also triggered the worst recession since the end of World War II, affecting the livelihoods and incomes of workers, employees and households. Never has a twin health and economic crisis spread so quickly and so widely. The progress made to date towards achieving the goals of the 2030 Agenda for Sustainable Development, including the tremendous achievements in global poverty reduction, is under serious threat of being reversed.

The socioeconomic impact of the pandemic amplified pre-existing disparities within and across societies. Before the pandemic, global and national inequalities were already increasing along social, ethnic, gender and demographic lines. As the COVID-19 pandemic spread, its impact has been felt more acutely in some segments of society than in others. As factories and offices closed their doors, and as unpaid care work increased, the double burden faced by women workers intensified. Further, youth unemployment is on the rise again in many countries.

Global inequalities, including unequal access to healthcare, vaccine inequity and the digital divide, remain largely unaddressed. The global economy cannot fully recover from the COVID-19 pandemic unless internationally coordinated actions are taken. The industrial sector must be central to these efforts.

The COVID-19 crisis has demonstrated that manufacturing remains the backbone of our economies. Yet, it also shows the vulnerability of our production systems to sudden shocks. For the recovery to take hold, it is critical to understand how the pandemic has

affected the industrial sector and the prospects for the future of industrialization, as economies have started to rebound and recover. The *Industrial Development Report 2022* contributes to this discussion by providing evidence at the country, industry and firm level to document the different impacts of the crisis, and by examining the factors of resilience and vulnerability in those same contexts.

The main finding of this report is that industrial capabilities are of fundamental importance for resilience. Not only does the industrial sector generate employment and income opportunities. During the pandemic, the sector provided access to essential goods and services for populations all over the world, including food products, medical equipment and pharmaceutical products.

Indeed, this report reveals that countries with stronger manufacturing capabilities and more diversified industrial sectors have weathered both the economic and the health impact of the COVID-19 pandemic better than their peers. Findings documented in the report strongly reaffirm the centrality of Sustainable Development Goal 9 (SDG 9) to the achievement of the 2030 Agenda for Sustainable Development. Beyond supporting resilience, manufacturing also plays a fundamental role in driving shared prosperity. The industrial sector creates jobs, incomes, innovations and multiplier effects that also ignite other parts of the economy, as it serves as an integrator also between agriculture and the service sector.

In addition, the report demonstrates how the uptake of new, advanced digital production technologies helps strengthen resilience. Firm-level data collected by UNIDO in developing and emerging industrial economies across Africa, Asia and Latin America suggests that investments in digital technologies have been integral to efforts at softening the blow of the pandemic across firms and industries. Digital technologies have been critical in helping firms

navigate the shift to remote and hybrid forms of work. They have also helped to maintain a consumer base and reach new consumers during an extremely challenging and uncertain period.

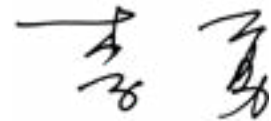
Preparing for the future will thus require that countries around the world strengthen their manufacturing and digital capabilities and promote mutual learning and knowledge-sharing. Particularly in developing economies, governments and business leaders must strive to foster the development of domestic production capabilities to ensure long-term resilience in a rapidly changing global industrial landscape. This alone is not enough. To build back better, countries also need to accelerate the shift to a green industrial sector while ensuring that no one is left behind.

Indeed, environmental sustainability and social inclusiveness must become the key components of post-pandemic industrial policies aimed at achieving the Sustainable Development Goals. Countries must mainstream sustainable energy solutions, circular economy models, as well as resource-, energy-efficient and cleaner production in their industrial development planning. Post-pandemic industrial policies should also target and prioritize improving the situation of those vulnerable actors who were in many ways most affected by the crisis, particularly small and medium-sized manufacturing enterprises and women, youth and informal industrial workers. These

job-generating interventions will help power the post-pandemic recovery.

The achievement of the 2030 Agenda in a world that is recovering from the COVID-19 pandemic will require accelerated and coordinated efforts by the international community. This report calls on Member States to address gaps in vaccine rollout and access to ensure global immunization against COVID-19. Over the medium to long term, the international community should strive to strengthen government capabilities, tackle the digital divide, foster a green transition and promote local industrial resilience, especially in the least developed countries.

I thank the UNIDO team and the international experts who worked on this report. I believe the *Industrial Development Report 2022* represents a timely and essential contribution to the analysis of the COVID-19 crisis. It is my hope that it will also become a useful analytical tool in supporting planning efforts for a swift recovery from the crisis and in building resilience.



LI Yong
Director General, UNIDO

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Technical notes and abbreviations

References to dollars (\$) are to United States dollars, unless otherwise indicated.

This report classifies countries according to two primary groupings: *industrialized economies* and *developing and emerging industrial economies*. See Annex C for a complete list of countries and economies by region and industrialization level.

The remaining annexes contain more detailed information about methodology and classifications. Annexes A and B provide further tables and indicators complementary to those in the text of Parts A and B of the report.

In-text values in non-\$ currencies are generally followed by a \$-approximation, which in all cases is based on the average exchange rate for the relevant year.

Components in tables may not sum precisely to totals shown because of rounding.

4IR	Fourth industrial revolution	MNEs	Multinational enterprises
ADP	Advanced digital production	MSME	Micro, small and medium enterprise
AI	Artificial intelligence	MVA	Manufacturing value added
BRICS	Brazil, Russia, India, China and South Africa	NGO	Non-governmental organization
CIP	Competitive Industrial Performance	OECD	Organisation for Economic Co-operation and Development
CO₂	Carbon dioxide	PPE	Personal protective equipment
DEIEs	Developing and emerging industrial economies	PPP	Purchasing power parity
ESG	Environmental, social and governance	R&D	Research and development
FDI	Foreign direct investment	RDBs	Regional development banks
GDP	Gross domestic product	RFID	Radio-frequency identification
GHG	Greenhouse gas	S&T	Science and technology
GVC	Global value chain	SDG	Sustainable Development Goal
ICT	Information and communication technology	SIDS	Small Island Developing States
IDR	Industrial Development Report	SME	Small and medium-sized enterprise
IEs	Industrialized economies	STEM	Science, technology, engineering and mathematics
IEA	International Energy Association	UN	United Nations
IFR	International Federation of Robotics	UNCTAD	United Nations
IIP	Index of Industrial Production	UNDESA	United Nations Department of Economic and Social Affairs
ILO	International Labour Organization	UNDP	United Nations Development Programme
IMF	International Monetary Fund	UNDRR	United Nations Office for Disaster Risk Reduction
IoT	Internet of Things	UNIDO	United Nations Industrial Development Organization
ISIC Rev 4	International Standard Industrial Classification Revision 4	WFP	World Food Programme
ISID	Inclusive and Sustainable Industrial Development	WHO	World Health Organization
LDCs	Least developed countries		

Glossary

Additive manufacturing (AM): Commonly known as 3D printing, it refers to the use of special printers to create three-dimensional physical objects from 3D model data by adding layer-upon-layer through material extrusion, directed energy deposition, material jetting, binder jetting, sheet lamination, vat polymerization and powder bed fusion. AM is opposed to subtractive manufacturing methodologies, which use molds or rotating milling cutter to remove material from a solid block of material (Eurostat 2017).

Advanced digital production (ADP) technologies: Latest evolution of digital technologies applied to production and one of the core technological domains associated with the fourth industrial revolution. ADP technologies result from the combination of hardware (advanced robots and 3D printers), software (big data analytics, cloud computing and artificial intelligence) and connectivity (the internet of things). When applied together to manufacturing production, they give rise to the concept of smart production—also referred to as the smart factory, or Industry 4.0 (UNIDO 2019b).

Artificial intelligence (AI): Branch of computer science seeking to develop devices that simulate the human capacity to reason and make decisions. The term usually refers to the employment of AI techniques (such as machine learning, deep learning, computer vision, natural language processing, neural networks, fuzzy logic and self-organizing maps) to provide machines and systems with human-like cognitive capabilities, such as learning, adapting, solving problems and perception (UNIDO 2019b).

Big data: Data characterized by greater volume (vast amount of data), velocity (frequency or speed by which data are generated, becomes available and changes over time), variety (different sources and

format of complex data, either unstructured or structured) and granularity than ever available previously (OECD 2017; Eurostat 2017).

Business model: An abstract representation of an organization—be it conceptual, textual and/or graphical—of all interrelated architectural, co-operational and financial arrangements designed and developed by an organization, as well as all products and/or services the organization offers based on these arrangements that are needed to achieve its strategic goals and objectives (Al-Debi et al. 2008).

Cloud computing (CC): Ubiquitous, convenient, on-demand network access to a shared pool of configurable computing resources (such as networks, servers, storage, applications and services) that can be rapidly provisioned and released with minimal management effort or service provider interaction (Eurostat 2017).

Competitive Industrial Performance (CIP) Index: Composite index based on three dimensions (capacity to produce and export manufactured goods; technological deepening and upgrading; world impact), capturing the ability of a country to produce and export manufactures competitively and to transform structurally (UNIDO 2021a).

Corporate social responsibility (CSR): A management concept whereby companies integrate social and environmental concerns in their business operations and interactions with their stakeholders (CEC 2001).

Dynamic capabilities: A specific subset of industrial capacities available for the absorption, adaptation and improvement of given productive techniques, as well as innovations across different organizational and technological functions (Andreoni 2021).

Energy efficiency: The ratio of a system's energy inputs to its output. Since inputs and outputs can

be measured in more than one way, energy efficiency has no single meaning. In economics, energy efficiency is the ratio of the value of output to the quantity or cost of energy inputs—the amount of economic activity produced from one unit of energy (UNIDO 2011).

Fourth industrial revolution (4IR): The latest wave of technological breakthroughs, which comes after the First (between 1760 and 1840, triggered by steam engine together with the mechanization of simple tasks and the construction of railroads), the Second (between the late 19th century and early 20th century, rose with the advent of electricity, the assembly line and mass production), and Third (since the 1960s, whose main engines were the development of semiconductors and mainframe computing together with the introduction of personal computers and the internet) industrial revolutions (UNIDO 2019b).

Global value chain (GVC): A value chain is the full range of activities that firms and workers do to bring a product from its conception to its end use and beyond, including design, production, marketing, distribution and support to the final consumer. When firms are located in different economies, the value chain is considered global (UNIDO 2019b).

Greenhouse gases (GHG): The atmospheric gases responsible for causing global warming and climate change. The major GHGs are carbon dioxide (CO₂), methane (CH₄) and nitrous oxide (N₂O). Less prevalent—but very powerful—greenhouse gases are hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF₆) (UNFCCC 2021).

Inclusive and sustainable industrial development (ISID): Long-term industrialization that drives development along three aspects: creating shared prosperity by offering equal opportunities and equitable distribution of benefits to all; advancing economic competitiveness; and safeguarding the environment by decoupling the prosperity

generated by industrial activities from excessive natural resource use and negative environmental impacts.

Industrial capabilities: The personal and collective skills, productive knowledge and experiences embedded in physical agents and organizations that are needed to drive production in manufacturing industries. These capabilities range from the skills needed to invest in new technologies and design new products to the ability to organize the production process and coordinate actors along the supply chain. Strong industrial capabilities are a critical factor in preparing socioeconomic resilience in the face of adverse events such as a global pandemic (Andreoni 2011).

Informal sector: Portion of the economy that is operated outside the purview of government and formal economy, thus is not taxed or included in most statistics (UNIDO 2013).

Innovation: The implementation of a new or significantly improved product (good or service) or process, a new marketing method, or a new organizational method in business practices, workplace organization or external relations (OECD/Eurostat 2005).

Internet of things (IoT): Next iteration of the internet, where information and data are no longer predominantly generated and processed by humans—which has been the case for most of the data created so far—but by a network of interconnected smart objects, embedded in sensors and miniature computers, able to sense their environment, process data and engage in machine-to-machine communication (UNIDO 2019b).

Machine learning: An application of AI, machine-learning systems use general algorithms to figure out on their own how to map inputs to outputs, typically being fed by extensive sample datasets (Brynjolfsson et al. 2017). These systems can improve their performance on a given task over time by amassing experiences and large volumes of data such as big data.

Megatrends: Major trends that are shaping and redefining the global economy and the collective future in profound ways. These forces are rooted in deeper structural shifts related to the process of technological change, socio-demographic transitions, and the human footprint on the Earth.

Pandemic: Disease outbreak that becomes globally spread as a result of the spread of human-to-human infection (Doshi 2011). Beyond the debilitating, sometimes fatal, consequences for those directly affected, pandemics have a range of negative social, economic and political effects. These tend to be greater where the pandemic is a novel pathogen, has a high mortality and/or hospitalization rate and is easily spread (WHO 2005).

Process innovation: Implementation of new or significantly improved production or delivery methods, including significant changes in techniques, equipment or software (OECD/Eurostat 2005).

Product innovation: The introduction of goods or services that are new or significantly improved in their characteristics or intended uses (OECD/Eurostat 2005).

Resilience: The ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management (UNDRR 2020).

Resource efficiency: Use of the Earth's limited resources in a sustainable manner while minimizing impacts on the environment (European Commission 2017).

Research and development (R&D): Creative work undertaken on a systematic basis to increase the stock of knowledge, including knowledge of man, culture and society, and to use this stock of knowledge to devise new applications. The term covers basic research, applied research and experimental development (OECD 2002).

Robot: A machine programmed by a computer capable of carrying out a series of more or less complex actions automatically. An industrial robot is an automatically controlled, reprogrammable and multipurpose manipulator in three or more axes (either fixed in a place or mobile), which can be used in industrial automation applications such as manufacturing processes (welding, painting and cutting) or handling processes (depositing, assembling, sorting and packing) (Eurostat 2017).

Robust industries: Manufacturing industries that at the global level have been impacted less by the COVID-19 induced crisis: Food; Tobacco; Paper; Chemicals; Pharmaceuticals; Computers and medical equipment; Electrical equipment; Machinery.

Stringency: Strictness of “lockdown style” policies that primarily restrict people's behaviour (Hale et al. 2021).

Smart Production Systems: Use of machine-to-machine communication or other systems based on data exchange between machines and components; use of digital twin technology to model individual products; use of real-time sensors for data acquisition and adjustment; use of cobots, augmented reality, additive manufacturing, real-time production management, artificial intelligence and/or big data analytics to support the management of production (UNIDO 2019b).

Sustainable Development Goal No. 9 (SDG 9): Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation. This goal promotes raising industry's share of employment and GDP by 2030, integrating small-scale industrial and other enterprises into value chains and markets, upgrading infrastructure and industries with greater resource-use efficiency, using clean and environmentally sound technologies and industrial processes, boosting scientific research, upgrading technological capabilities and encouraging innovation (UN 2015).

Value added: Measure of output net of intermediate consumption, which includes the value of materials and supplies used in production, fuels and electricity consumed, the cost of industrial services such as payments for contract and commission work and repair and maintenance, the compensation of employees, the operating surplus and the consumption of fixed capital (UNIDO 2015).

Vulnerable industries: Manufacturing industries that at the global level have been impacted more by the COVID-19 induced crisis: Beverages; Textiles; Apparel; Leather; Wood; Printing; Petroleum; Plastics; Other non-metallic products; Basic metals; Metal products; Motor vehicles; Other transport equipment; Furniture; Other manufacturing industries.

Overview

The future of industrialization in a post-pandemic world

COVID-19 pandemic has shaken the world in a way no other crisis has done in recent history

The COVID-19 pandemic has shaken the world unlike any other crisis in recent history. What began as another outbreak of a flu-type disease in a confined, specific location in the fall of 2019 soon became an unstoppable wave that transformed every aspect of daily life globally. From work to commerce and social interaction, all human activities have been affected by the pandemic and the measures taken to contain it.

But the socioeconomic impact has been uneven across countries

The socioeconomic impact of the pandemic, however, has been very different across regions and countries, reflecting deep underlying differences in their resilience against extreme events. As countries prepare for the future, it is important to understand what policies aimed at manufacturing have worked and what have not. This ambitious goal requires revisiting not only the types of responses given during the early and middle phases of the pandemic, but also the structural characteristics that shaped those responses and will continue to shape them in the future.

Industrial Development Report 2022 *(IDR 2022) brings new insights on this along four dimensions*

To do so, Part A of the IDR 2022 looks more deeply at four important issues in the following sequential order:

- Pre-existing structural factors shaping countries resilience (Chapter 1)
- Responses given by firms and governments to support industry (Chapter 2)
- Megatrends likely to shape the future of industrial development (Chapter 3)
- Policies to support an inclusive, sustainable and resilient industrial recovery (Chapter 4)

Setting the stage

Chapter 1 begins the analysis by looking at the salient features of the crisis, the diversity of effects and the channels through which it affected industrial production. One key aspect that the chapter highlights is the crucial role of existing industrial capabilities in supporting broad socioeconomic resilience, and hence, softening the impact of the pandemic.

Documenting responses from firms and governments

Against this backdrop, Chapter 2 does a deep dive into the impact of the pandemic on manufacturing firms around the world and the main factors that supported their resilience and their responses. It also documents the type of responses given by governments to support the industrial sector and soften the impact of the crisis.

Looking into the future

Chapter 3 assesses the prospects for the future of industrialization, revisiting the observed impacts of the pandemic on global manufacturing within a broader perspective that considers other ongoing megatrends that are redefining the global landscape of industrial production. A key contribution of the chapter is examining the extent to which the pandemic is likely to accelerate these trends, as well as the factors of resilience that will be needed to be better prepared for the future.

Building back better

Chapter 4 closes Part A of the report with a discussion on policy options for achieving an inclusive, sustainable and resilient industrial recovery. Like any other traumatic experience, the COVID-19 pandemic should also be taken as an opportunity to learn and build back better—more prepared for future events of this nature and placing the achievement of the UN 2030 Agenda of Sustainable Development as the main compass steering the recovery.

“ A health emergency that soon turned into a socioeconomic crisis without precedent

PART B of the report complements the analysis with additional industrial statistics

The second part of the report complements the analysis conducted in Part A by presenting more detailed evidence derived from various industrial statistics, including indices of industrial production, trade, employment and competitiveness. It also discusses important challenges posed by the pandemic for the collection of industrial data.

COVID-19 and the importance of industrialization

Unexpected outbreak of COVID-19

Back in December 2019, debates around the future of industrialization concentrated on several global trends expected to (re)shape the world industrial production landscape, including digitalization, industrial greening and global rebalancing. No one suspected that a major unexpected event was on its way: the emergence of SARS-CoV-2 (COVID-19).¹ First observed when cases of unexplained pneumonia were noted in the city of Wuhan, China, the virus quickly spread across country borders and became the worst global health emergency since the N1H1 influenza pandemic 100 years ago. And the health emergency soon turned into a socioeconomic crisis without precedent.

Health emergency that soon became a global crisis

During 2020, world gross domestic product (GDP) fell by 3.3 percent, the deepest global recession in 70 years (IMF 2021b). The sudden stop in economic activity led to an estimated loss of 255 million full-time employment jobs (ILO 2021e). Even more dramatically, about 97 million more people are projected to be living in poverty because of the pandemic (Mahler et al. 2021).

Despite a quick recovery, world economic activity is still largely below pre-pandemic projections

The global economy rapidly bounced back and by 2021 was expected to surpass even pre-pandemic levels. Despite this recovery, however, overall output loss

triggered by the pandemic continues to be huge. Compared with pre-pandemic GDP projections, the most recent figures indicate a GDP that is almost 5,900 billion purchasing power parity (PPP) dollars lower—a decline of 4.2 percent (Figure 1). To give some perspective to this drop, the amount is equivalent to the combined GDPs of Brazil and Turkey.

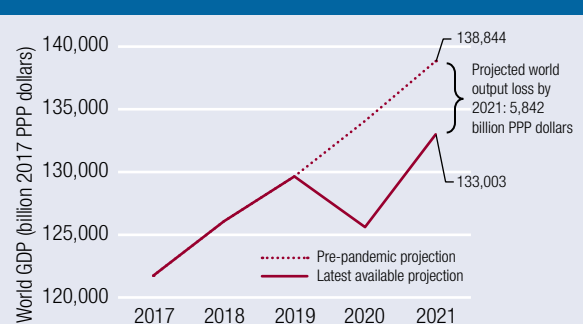
Economic impact was uneven across regions

The impact on economic activity has been different across regions (see Figure 2).² Industrialized economies (IEs) have been less affected than developing and emerging industrial economies (DEIEs). Estimated output loss by 2021, compared to pre-pandemic estimates, is on average 3.9 and 7.7 percent, respectively, for each group. But the range of impacts is also much more pronounced in DEIEs, where the projected losses range from a maximum of 13.8 percent in Small Island Developing States (SIDS) to a minimum of only 1.4 percent in China.

Diversity of impact shows differences in the socioeconomic resilience of countries

This diversity reflects two interrelated sets of factors: on the one hand, the severity of the health emergency and the type and effectiveness of the policies

Figure 1
Estimate of world output loss due to COVID-19 by 2021



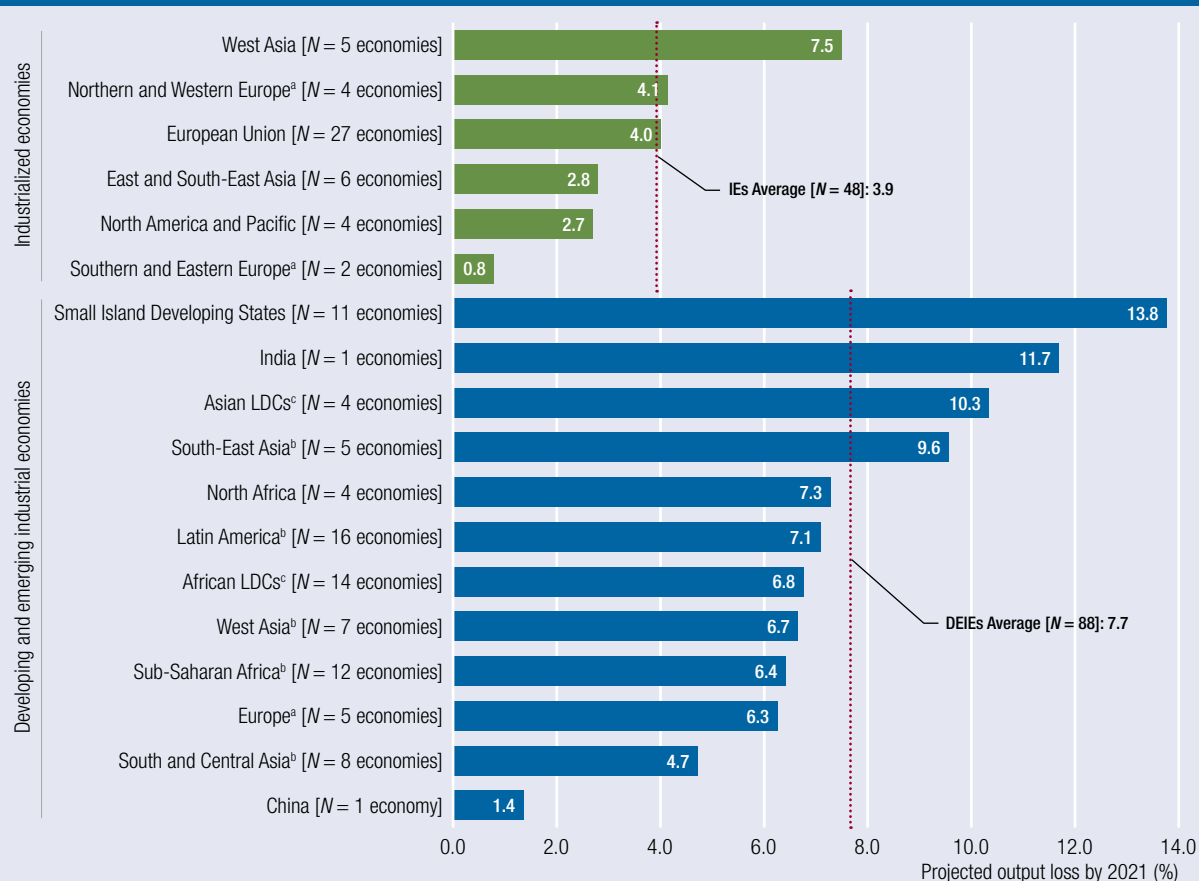
Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions).

Note: Projected world output loss by 2021 is defined as the difference in 2017 PPP dollars between the level of GDP projected before the pandemic (October 2019, dotted line) and the latest available projection (October 2021, solid line). GDP = gross domestic product; PPP = purchasing power parity.

“ The economic impact was uneven across regions

Figure 2

Estimated output losses due to COVID-19 by 2021, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The figure shows simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as a share of the pre-pandemic projection. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

implemented to contain the virus; on the other hand, the level of socioeconomic resilience of countries against extreme events like the pandemic.³ Socio-economic resilience, in turn, depends on the type of responses given and the structural characteristics that shaped those responses.

Containment measures were key to curbing the spread of the virus, but came with economic costs

At the initial stage of the pandemic, a country's success in containing the virus was mainly influenced by the type of measures taken, the effectiveness of their implementation and their timing. Some countries

managed to contain the pandemic effectively and quickly; others did not. The measures implemented, however, came with a cost. In the medium to long run, the economic benefits of these measures have been shown to be greater than their costs (IMF 2020). But, in the shorter run, stricter containment measures were associated with larger drops in economic activity.

COVID-19 vaccines and the two-speed recovery

With the development of COVID-19 vaccines, success in controlling the health emergency has rapidly turned towards the speed of vaccine rollout, as the effectiveness of vaccination allows countries to lift

“ Strong manufacturing systems helped countries weather the crisis better

containment measures and reignite economic activity. For this reason, the speed of economic recovery—and hence the overall output loss projected by 2021—heavily depends on the opportunities of countries to access and roll out COVID-19 vaccines. Vaccination at the global level, however, had two different speeds: by October 2021, IEs had, on average, about 60 percent of their population fully vaccinated, whereas this was the case for only 28 percent of the population in DEIEs. This created a global divide of two blocs: a group of countries that can start normalizing economic activity (almost all IEs) and those that must still contend with prospects of resurgent infections and rising COVID-19 death tolls (IMF 2021b).

Countries with stronger manufacturing systems weathered the crisis better

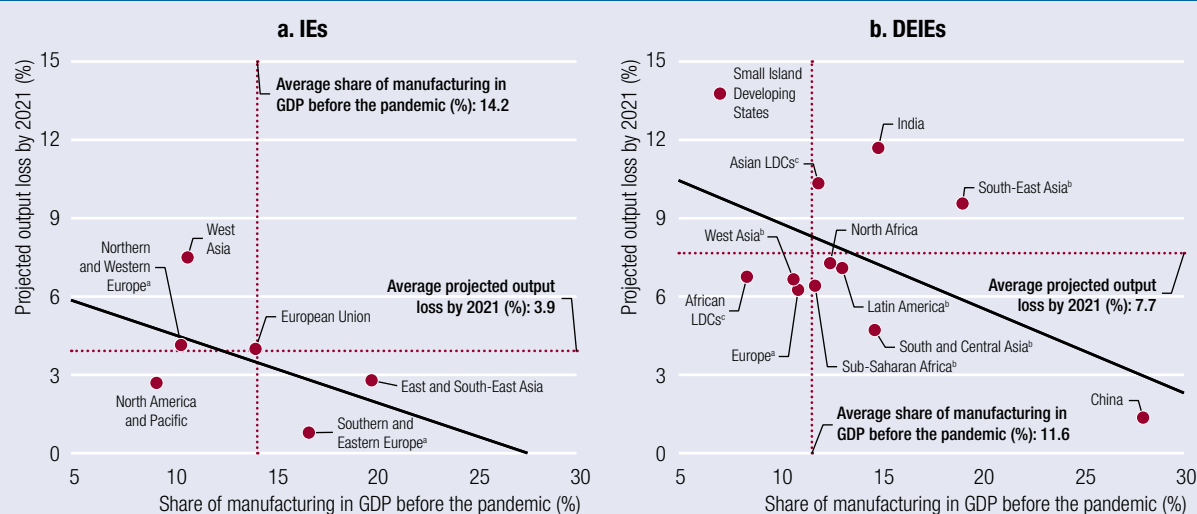
Even after taking into account the severity of the pandemic and the stringency of containment measures, the economic impact of the pandemic continues to be widely different across countries, reflecting other factors of resilience that also came into play. IDR 2022

shows that a country’s industrial capabilities and the size of its manufacturing sector constituted two important factors of resilience against the crisis: countries with stronger manufacturing systems have weathered the economic crisis better than the rest. As shown in Figure 3, a clear negative association is observed between the projected output losses by 2021 (vertical axis) and the relative size of the manufacturing sector in 2019 (horizontal axis), both for IEs and DEIEs. This provides an initial indication that stronger manufacturing sectors are associated with lower projected output losses—a point that will be explored in more detail in subsequent sections of this overview.

Manufacturing contributes to the sustenance of life, helps in tackling emergencies and supports the recovery

Why is manufacturing important in times of a crisis like the COVID-19 pandemic? Among other factors, because the industrial sector contributes to three important dimensions of resilience (see Figure 4): (1) manufacturing industries are vital to providing

Figure 3
Impact of COVID-19 on economic activity by 2021 and relative size of the manufacturing sector before the pandemic, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss) and UNIDO MVA Database 2021 (UNIDO 2021b) (MVA share).
 Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as share of the pre-pandemic projection. The solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; MVA = manufacturing value added; SIDS = Small Island Developing States.

“ Manufacturing is key to pandemic recovery and socioeconomic resilience

Figure 4

The role of manufacturing industries in strengthening socioeconomic resilience

 <p>CRITICAL TO LIFE AND NATIONAL SECURITY</p>	<ul style="list-style-type: none"> ■ Manufacturing provides goods that are critical for the sustenance of life—including food, drink, medicines, clothing, fuel and other basic necessities. ■ Manufacturing provides inputs (such as machinery, components, systems and engineering services) to critical national infrastructure (such as transportation, electricity and communication).
 <p>CRITICAL TO TACKLING EMERGENCIES</p>	<ul style="list-style-type: none"> ■ Manufacturing provides strategically important products and assets in combatting certain types of emergencies. ■ A shortage of COVID-19-critical items hindered countries’ ability to respond to the crisis. ■ Different types of goods are required during different emergencies.
 <p>CRITICAL TO ECONOMIC RECOVERY AND GROWTH</p>	<ul style="list-style-type: none"> ■ Historically, manufacturing has been dubbed the “engine of growth” because of its contribution to productivity, trade, jobs and innovation. ■ In a number of countries, manufacturing industries have offered “pockets of resilience” supporting recovery from COVID-19, as well as from previous crises.

Source: UNIDO elaboration based on the background paper prepared by López-Gómez et al. (2021).

essential goods that are critical to life and national security; (2) manufacturers play a role in supplying goods critical to tackling the emergency itself; and (3) the manufacturing sector contributes to the recovery and growth of national economies.

Manufacturing is also a key driver of sustainable development

Beyond supporting resilience in times of shocks, manufacturing also plays a fundamental role in driving shared prosperity. This sector creates jobs, incomes, innovations and multiplier effects that can also ignite other parts of the economy. For this reason, industrialization and the achievement of Sustainable Development Goal (SDG) 9 is also key for the achievement of many other SDGs from the UN Agenda 2030 (Figure 5).

Linking COVID-19 to industrial production

Manufacturing industries thus play major roles in strengthening resilience and driving broad-based socioeconomic development. But the manufacturing

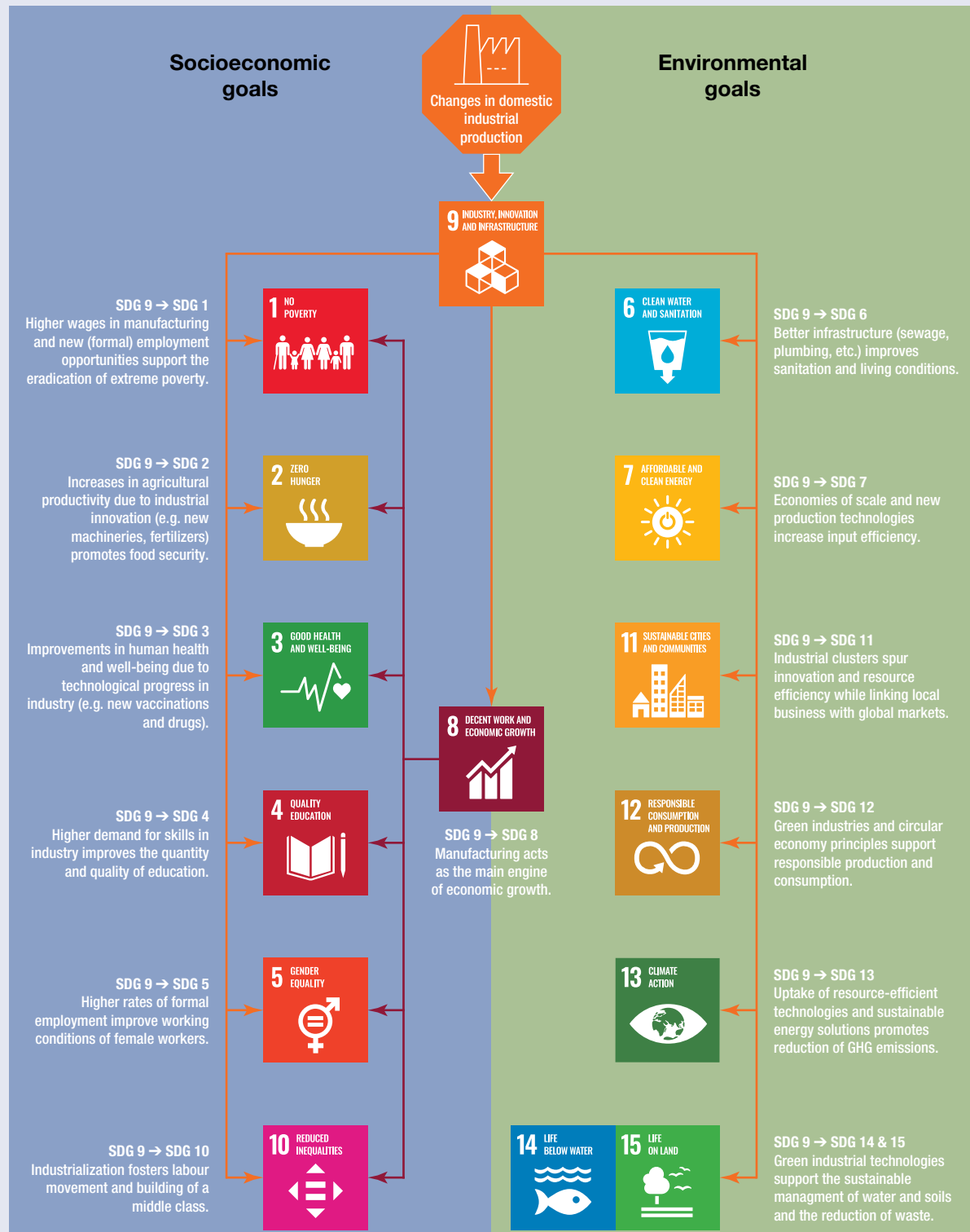
sector itself was also subjected to COVID-19-related risks through several channels of impact (see Figure 6). IDR 2022 features a framework that highlights two distinguishing features of the crisis: the simultaneous impact on both the demand and supply side of industrial production (as represented by the blue and yellow areas of Figure 6) and the truly global nature of the crisis which affected all the world’s countries, triggering domestic (darker part of the figure) and global (lighter part of the figure) channels of impact.

Framework is used to assess how industry around the world has been impacted by the pandemic

Building on this framework, the report assesses how manufacturing industries around the world have been impacted by the crisis, who were the most vulnerable actors and what factors of strengths were observed among those countries and actors that best weathered the crisis. The evidence presented shows that the impact of the crisis has been highly heterogeneous across all levels of analysis: regions, sectors, firms and workers.

Industrial production is directly linked to the achievement of the SDGs

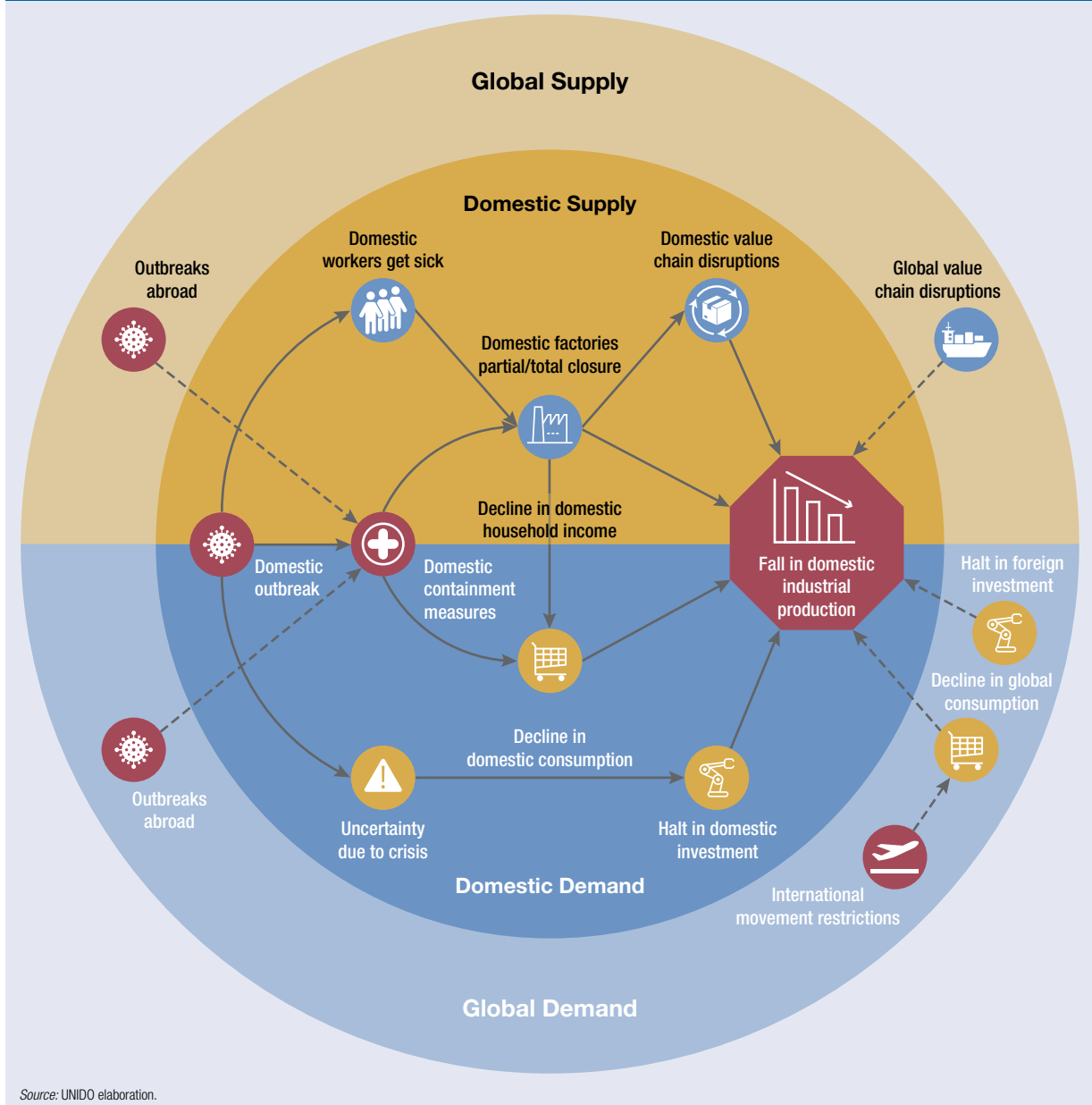
Figure 5
From industrial production to the UN Agenda 2030 for Sustainable Development



Source: UNIDO elaboration based on UNIDO (2020b).
Note: GHG = greenhouse gas; SDG = Sustainable Development Goal.

COVID-19 affected the global and domestic industrial production ecosystem

Figure 6
The framework: Connecting the COVID-19 outbreak to industrial production



Source: UNIDO elaboration.

Who were the most affected?

Heterogeneity across regions

Different capacities to absorb the shock

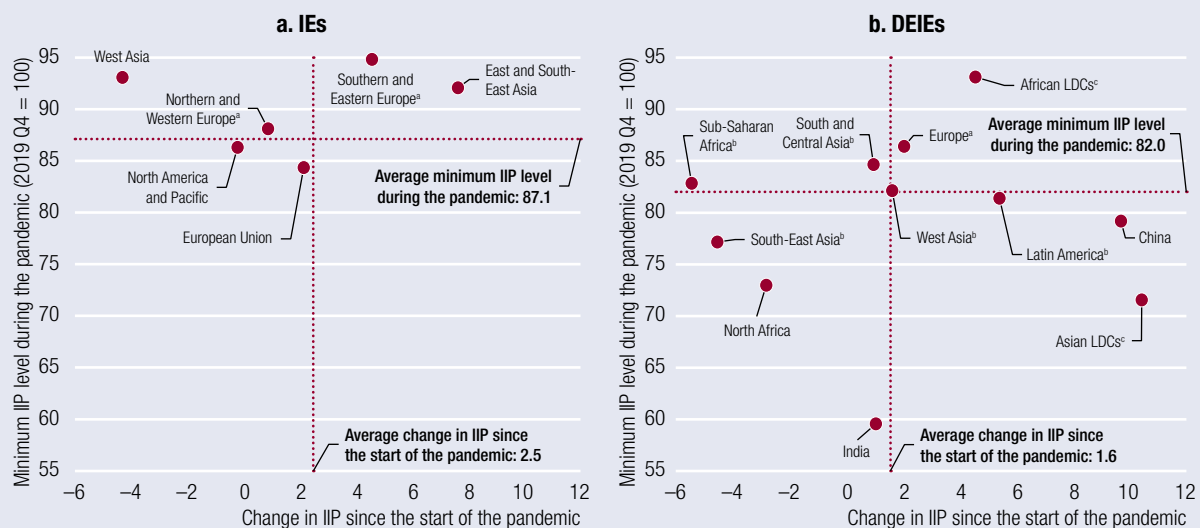
The industrial sector has been hit in different ways by the pandemic across different regions of the world

(Figure 7). Whereas some country groups have been deeply shaken by the crisis and show very large declines in industrial production during the worst quarters of the pandemic, other groups have been less affected and industrial production did not fall in those groups as dramatically. This is shown in the vertical axis of Figure 7, which shows the minimum level observed, on

Speed of pandemic industrial recovery varied by region

Figure 7

Impact of COVID-19 on industrial production and the speed of recovery across economy groups, 2019 Q4–2021 Q2



Source: UNIDO elaboration based on UNIDO Quarterly Index of Industrial Production Database (UNIDO 2021 d).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. The IIP is seasonally adjusted. Country coverage by group is reduced due to data availability. The change in IIP since the start of the pandemic (horizontal axis) is defined as the difference in the level of IIP between 2019 Q4 and 2021 Q2 (latest available data). Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; IEs = industrialized economies; IIP = Index of Industrial Production; LDCs = least developed countries; SIDS = Small Island Developing States.

average, for each group. Overall, DEIEs were hit more strongly than IEs, but the heterogeneity within this group was also much larger—ranging from African least developed countries (LDCs), which show very little impact, to India, which shows a decline of more than 40 percent in industrial production after the initial shock of the pandemic.

Different capacities to accommodate and recover

By the same token, the speed of recovery in different economy groups has been very different: some countries had already surpassed the pre-pandemic levels of industrial production by the second quarter of 2021, while others were still largely behind. This is shown in the horizontal axes of panels a and b in Figure 7, which present the relative change in industrial production since the start of the pandemic (that is, comparing the second quarter of 2021 with the fourth quarter of 2019) for each group. Looking at the two dimensions together it is possible to identify four distinctive situations, depending on whether the initial shock was above or below the groups' average and whether the

observed growth since the start of the pandemic has been above or below the groups' average.

Heterogeneity across industries

Manufacturing industries were also impacted differently

Not all manufacturing industries have behaved in the same manner. Some industries have been more affected than others, as were the countries specializing in what are considered more vulnerable industries. The contrasting behaviour of different industries can be illustrated by looking at the evolution of production at the global level, for the corresponding industry, and comparing the depth of the initial impact of the crisis and how fast they managed to recover afterwards (see Figure 8).

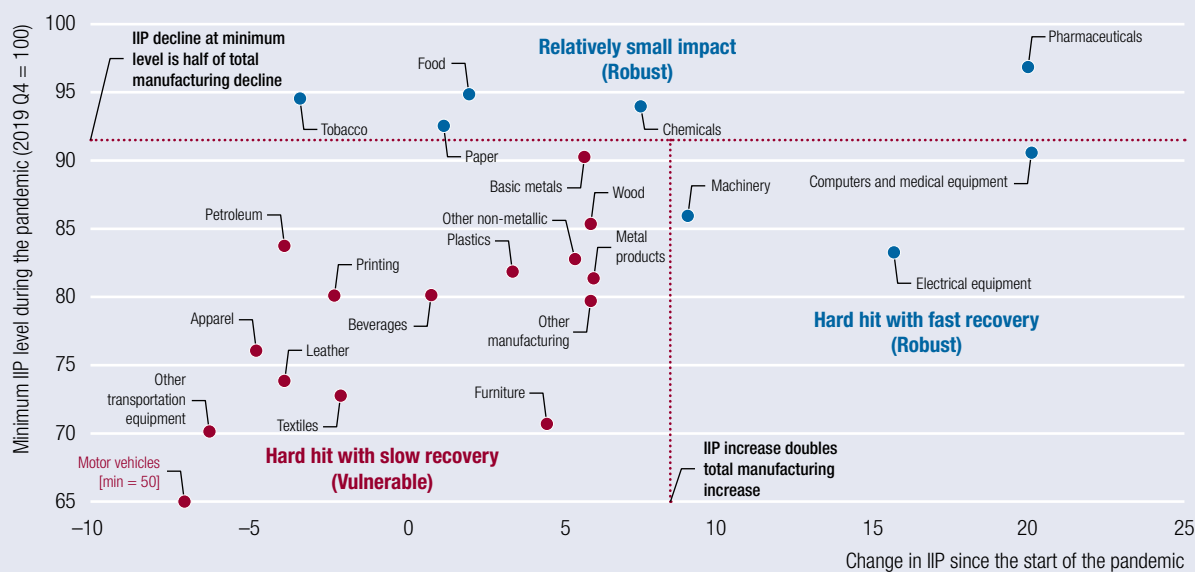
Two types of industries: Robust and vulnerable to the COVID-19 shock

Schematically, two types of industries emerge from the analysis. Those that suffered a comparatively small

Labour-intensive industries were more vulnerable to the shock

Figure 8

Typology of global industries according to the observed impact of COVID-19 and the speed of recovery, 2019 Q4–2021 Q2



Source: UNIDO elaboration based on UNIDO Quarterly Index of Industrial Production Database (UNIDO 2021d).

Note: The IIP is seasonally adjusted. The figure shows weighted averages for all countries with available data. Dotted lines show the thresholds used for the characterization of the global industries. The change in IIP since the start of the pandemic (horizontal axis) is defined as the difference in the level of the IIP between 2019 Q4 and 2021 Q2 (latest available data). IIP = Index of Industrial Production.

impact or experienced a strong, negative impact but managed to recover very fast (industries in blue in Figure 8), and the rest (industries in red), which were hard hit and have not shown fast rates of recovery. Industries that either presented a decline due to the pandemic that is half than the average decline (horizontal line) or growth that doubles the average growth during the period (vertical line) are characterized as “robust.” Those below these thresholds are characterized as “vulnerable.”

Robust industries include producers of essential goods, health and computers

The groups obtained using these thresholds are in line with other characterizations in the literature. Among the robust industries are producers of essential goods (food and chemicals, but also paper); industries that faced increasing demand as a result of the health emergency (pharmaceuticals, computers and medical equipment); and capital-intensive, high-tech industries that managed to bounce back rapidly from the initial impact (machinery and electrical equipment). Vulnerable

industries include labour-intensive industries (apparel, leather, textiles, furniture, other manufacturing) and some capital-intensive industries. Among these are industries that have been particularly hard hit by cross-border containment restrictions (motor vehicles, other transport equipment, petroleum).

Heterogeneity across firms

Small and medium-sized enterprises (SMEs) in vulnerable industries were much more impacted

The COVID-19 pandemic also had a major but highly asymmetric impact on manufacturing firms. Primary data collected by UNIDO and partners for this report show a common thread across DEIEs: SMEs have been disproportionately impacted by the shock when compared to large enterprises. Within each size category, firms operating outside manufacturing activities (especially in services) or in COVID-19-vulnerable industries (as defined above) have been the most impacted. In some cases, the difference can be in an order of magnitude of more than 10 times. SMEs in vulnerable

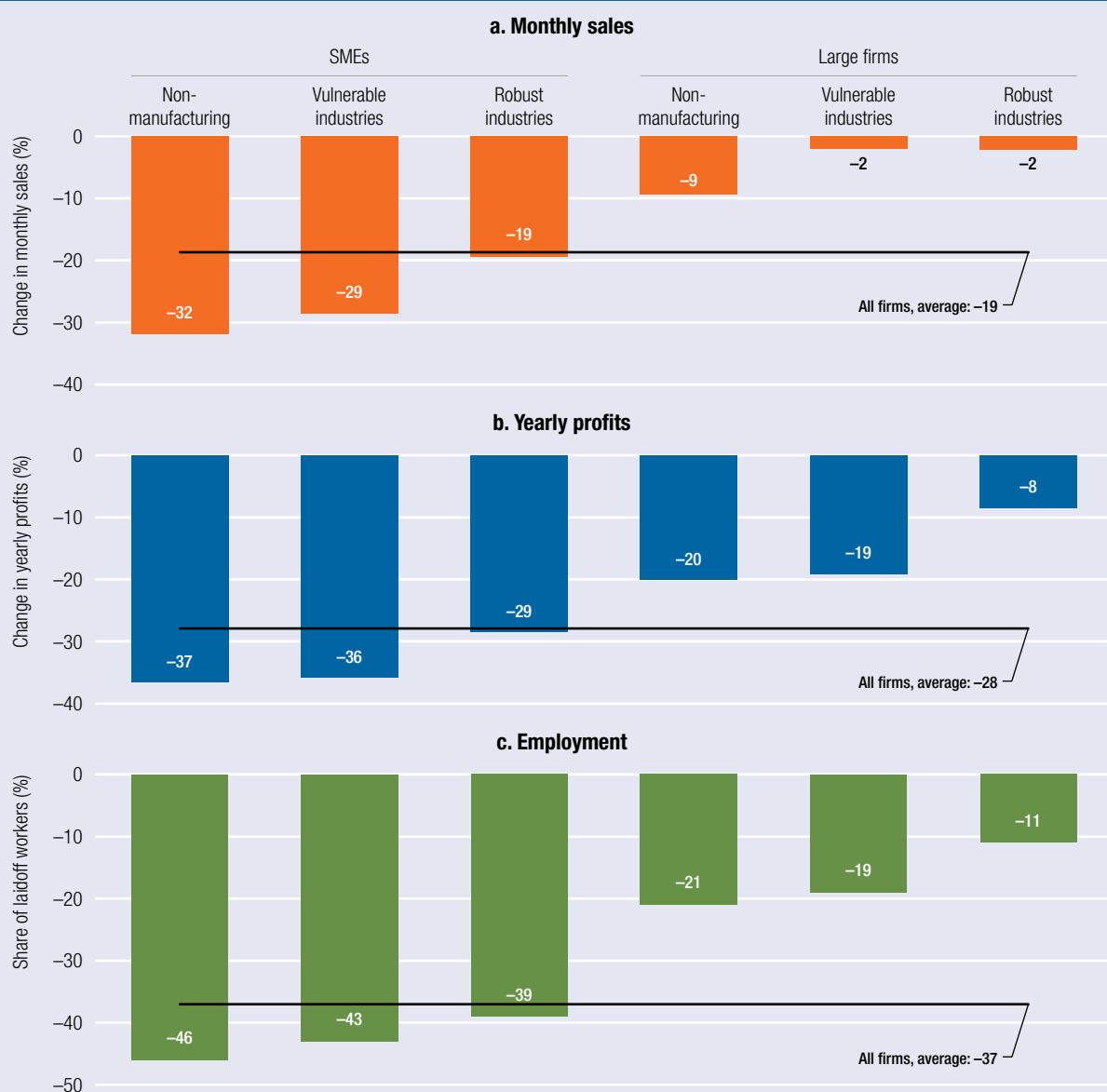
SMEs were more negatively impacted than large firms

industries, for instance, reported a decline in sales after the pandemic that, on average, was 14 times larger than the one reported by large firms in robust industries (Figure 9).

SMEs' vulnerability puts at risk the achievement of social inclusion

The deeper impact on SMEs raises large concerns when it comes to social inclusiveness, as this type of

Figure 9
Impact of COVID-19 on firms: Drop in sales, profits and employment by firm category, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries classified based on Figure 8. Non-manufacturing sectors include: agriculture, mining, utilities, construction and services. Panels a and b show the average change in monthly sales and yearly profits. The change in monthly sales refers to the value of monthly sales the month before the survey with respect to the same month one year before ($N = 2,975$). The change in yearly profits refers to the value of profits in 2020 compared to 2019 ($N = 2,971$). Panel c shows the average drop in employment, corresponding to the average share of laid-off workers over the total number of workers in December 2019, considering only firms that declared they have laid off workers ($N = 1,513$). Layoffs refers to total workers who have been laid off due to the COVID-19 pandemic. The sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

Female and temporary workers were affected more negatively by the pandemic

firm employs the vast majority of workers in DEIEs. Moreover, most marginalized groups, such as women and informal workers, tend to be overrepresented in the labour force of small firms. Thus, if on one hand small firms are important vectors of inclusiveness into the labour market for marginalized groups; on the other hand, a particularly negative impact of the crisis on these firms places a higher risk of job losses on a large share of the labour force, especially its most vulnerable members.

Heterogeneity across workers

Female and temporary workers suffered more

The data collected for IDR 2022 also show that the most vulnerable groups of workers have been affected more than the rest. In fact, the pandemic has disproportionately affected women workers as reflected by the larger elasticity of employment with respect to changes in monthly sales for women when compared to that of men (Figure 10). This indicates that a given

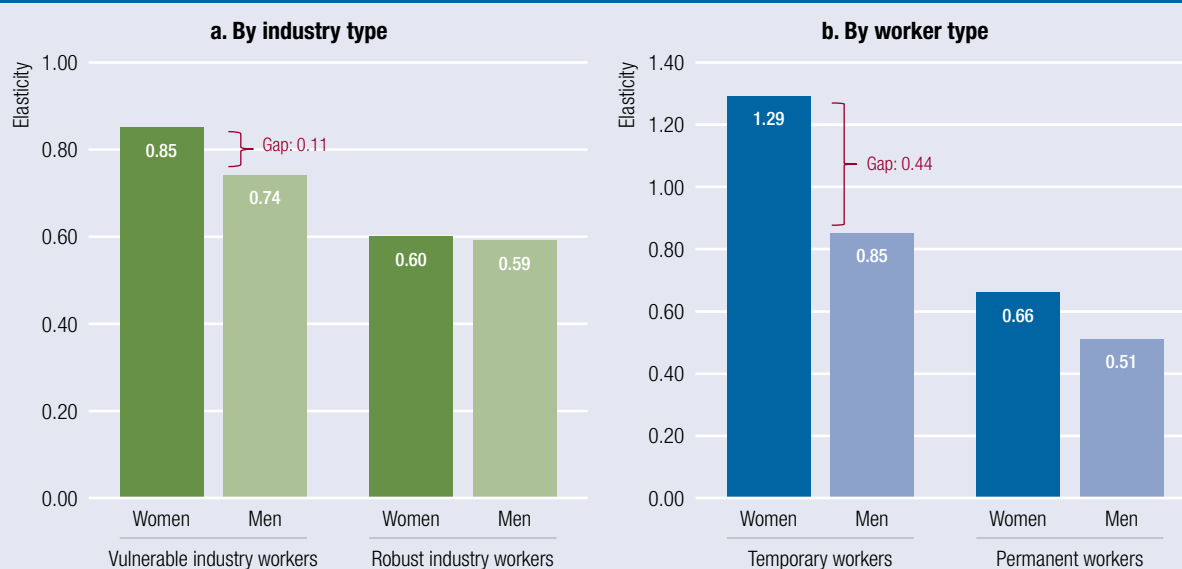
decrease in sales is associated with a larger decrease in the number of female workers than of male workers. The gender gap in elasticity is larger in vulnerable industries, where all workers are already more at risk of losing their jobs. And it is even more pronounced for temporary workers. This result stresses the urgent need to decrease gender segregation and discrimination in manufacturing to lower women's vulnerability to employment losses during crises.

Why did some countries do better?

Diversity of outcomes observed reflects differences in underlying factors of resilience

The differences in impact observed at various levels of analysis—regions, countries, firms and workers—underscore again differences in the contexts in which actors operate and their capacity to respond to the crisis. That is, differences in pre-existing factors that strengthen (or weaken) socioeconomic resilience and differences in the type of responses that firms and

Figure 10
Elasticity of employment: The gender gap, 2019–2021



Source: UNIDO elaboration based on the background paper prepared by Braunstein (2021), derived from the data collected by the UNIDO COVID-19 firm-level survey (2021).
Note: Robust and vulnerable industries classified based on Figure 8. Permanent workers work for a term of one or more fiscal years. Temporary workers work for a term of less than one fiscal year. The charts show the elasticity of employment with respect to sales, which indicates the percent fall in the number of workers for every 1 percent fall in the value of monthly sales. The *change in monthly sales* refers to the value of monthly sales the month before the survey with respect to the same month one year before. The fall in employment corresponds to the average share of laid-off workers due to the COVID-19 pandemic over the total number of workers in December 2019. The considered sample includes only manufacturing firms that provided valid responses on women's share of workers, women's share of workers laid off, and change in monthly sales ($N = 1,055$). The sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

Pre-existing factors affect socioeconomic resilience

governments managed to articulate, conditioned by these factors.

Pre-existing factors

Channels of impact have been softened/amplified by several factors at the country, industry and firm level

The channels of impact presented above show their effects on manufacturing firms. As illustrated in Figure 11, the pandemic and the measures needed to contain it (upper part of the figure) triggered various channels of impact both from the demand and supply-side of production (second line of boxes). Factors at the country level—for example, degree of integration with global markets, importance of domestic demand, fiscal space to implement support policies and level of industrial

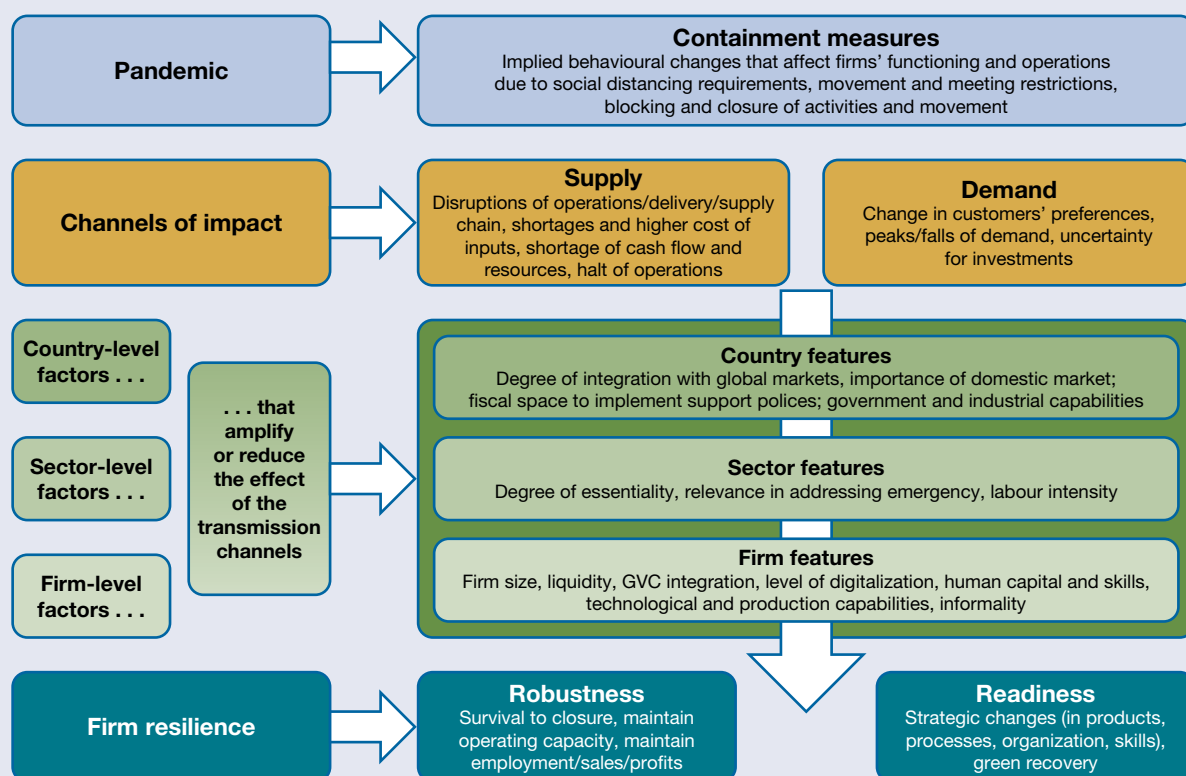
capabilities—at the sector level—for example, labour intensity, degree of essentiality, importance to address emergency—and at the firm level—for example, size, liquidity, skills, export orientation and digitalization—shape the severity of these impacts and determine the overall resilience of manufacturing firms.

Two dimensions of resilience: “Robustness” and “readiness”

Two dimensions of resilience are explored in the IDR 2022: “robustness” (the capacity to absorb the shock) and “readiness” (the capacity to transform and recover from the shock).⁴ At the firm level, robustness is associated with the capacity to survive, maintain operations, sales, profits and employment, while readiness is associated with the capacity to implement strategic changes in operations.

Figure 11

Country-level, sector-level and firm-level factors shaping manufacturing firms’ resilience during the COVID-19 pandemic



Source: UNIDO elaboration based on the background paper prepared by Pianta (2021).
Note: GVC = global value chain.

Industrial capabilities have been a key ingredient of pandemic resilience

Strong industrial capabilities cushioned the impact

The consequences of the channels of impact depend, therefore, on how these various factors come into play and define the balance between vulnerabilities and factors of resilience. Because of this, the impact of the pandemic was highly uneven at all levels of analysis. However, after controlling for all these factors together, IDR 2022 finds that at both the country and firm levels, industrial capabilities have been a key ingredient of resilience.

UNIDO's index to capture industrial capabilities

Industrial capabilities are the personal and collective skills, productive knowledge and experiences embedded in physical agents and organizations needed for firms to perform different productive tasks, absorb new technologies, and coordinate production along the supply chain. UNIDO's Competitive Industrial Performance (CIP) Index can be taken as a rough proxy of countries' underlying capabilities in manufacturing production. It combines three dimensions:

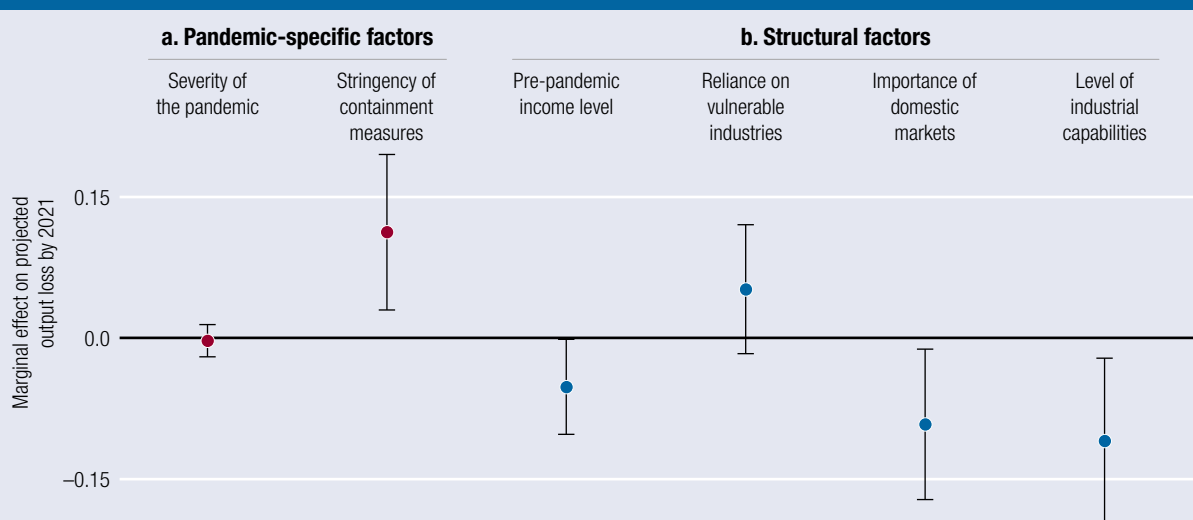
(1) capacity to produce and export manufactured goods; (2) technological deepening and upgrading; and (3) world impact. The higher the score on any of these dimensions, the higher the country's industrial competitiveness and its score on the CIP Index.

Higher industrial capabilities at the country level mitigated the impact on economic activity

An econometric analysis of the determinants of the projected output loss by 2021 across countries sheds light on the role played by industrial capabilities. The exercise included three factors expected to amplify the economic impact of the crisis—severity of the health crisis, stringency of containment measures and reliance on vulnerable industries—and three factors expected to buffer the impact—level of incomes, relative size of domestic markets and level of industrial capabilities. Interestingly, the result of the analysis is that the level of industrial capabilities is both negative (that is, reduces the projected output loss) and highly significant (Figure 12).

Figure 12

Determinants of COVID-19 impact on economic activity by 2021: The role of industrial capabilities



Source: UNIDO elaboration based on Hale et al. (2021), IMF (2019; 2021b), UNDESA (2021) and UNIDO (2021a; 2021b).

Note: Econometric estimates for 127 countries with available data for all variables used in the model. The figure depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the average marginal effects of the variables of interest on the projected output loss of each country for the year 2021. A linear model with cluster-robust standard errors was implemented. Regional dummies were included. *Severity of the pandemic* is defined as the cumulative level of COVID-19 reported deaths per 1 million people by October 2021; *stringency of containment measures* is defined as the cumulative average level of Oxford's Stringency Index by October 2021; *pre-pandemic income level* is defined as the 2019 per capita GDP in PPP dollars; *reliance on vulnerable industries* is defined as the share of vulnerable industries on MVA in 2015; *importance of domestic markets* is defined as the share of domestic absorption on final demand in 2019; *level of industrial capabilities* is defined as the level of UNIDO CIP Index in 2019. See Lavopa et al. (2021) for more details on the methodology used. CIP = Competitive Industrial Performance; GDP = gross domestic product; MVA = manufacturing value added; PPP = purchasing power parity.

Digitally advanced firms were able to better resist the crisis

Higher industrial capabilities also softened the impact on manufacturing firms

The same is true when it comes to manufacturing firms: turning from country-level data to firm-level data (from the World Bank Enterprise Surveys) an analysis of two indicators of performance—survival of the firm and change in employment—also shows that industrial capabilities played a crucial role in softening the impact of the crisis (Figure 13). Here, again, manufacturing firms in countries with higher industrial capabilities have been, on average, more robust during the pandemic. Even when controlling for other factors likely to affect firm performance—such as size, age, ownership and export intensity—and considering similar levels of stringency and severity, the positive association of CIP Index scores with firm survival

and lower employment losses remains significant. Counterbalancing the negative impacts of severity and stringency, industrial capabilities tend to mitigate the impact of the crisis also at firm level, thus fostering firms' robustness.

Digitalization has also been a key factor of resilience

Another factor of resilience identified in the data collected for this report relates to the level of digitalization of the firms and, in particular, the adoption of advanced digital production (ADP) technologies. Digitally advanced firms—those using the latest vintages of digital technologies in their production process—were indeed able to better resist the crisis in terms of impact on sales, profits and laid-off workers

Figure 13
Determinants of COVID-19 impact on manufacturing firms: The role of industrial capabilities



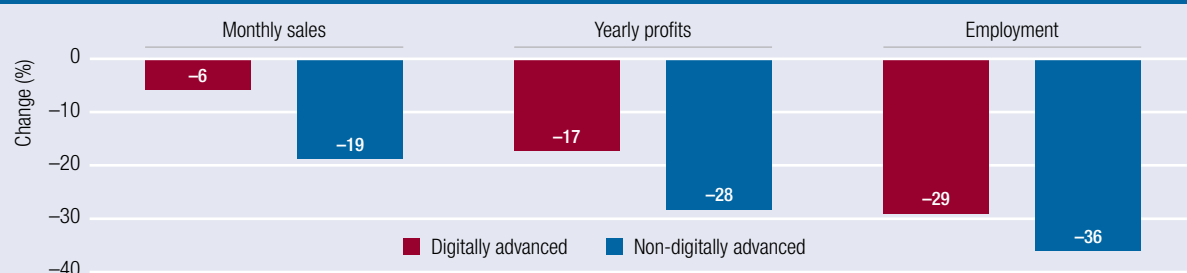
Source: UNIDO elaboration based on the background paper prepared by Naidoo and Tregenna (2021), derived from the data collected by the World Bank COVID-19 Follow-up Enterprise Survey (first round, 2020/21), Hale et. al. (2021) and UNIDO (2021a).

Note: The analysis uses the data collected by the World Bank COVID-19 Follow-up Enterprise Survey in 13 DEIEs (first round, 2020/21). Only manufacturing firms have been considered. The main variables of interest are *severity of the pandemic*, defined as the cumulative level of COVID-19 reported deaths per 1 million people at the time of the survey; *stringency of containment measures*, defined as the cumulative average level of Oxford's Stringency Index at the time of the survey; and *level of industrial capabilities*, defined as the level of UNIDO CIP Index in 2019. Panel a depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the average marginal effects of the variables of interest on the probability of firm survival, obtained through the implementation of a probit model with robust standard errors ($N = 2,217$). *Firm survival* is proxied with a binary variable that takes the value of 1 if the firm is fully operational at the time of the follow-up survey, and 0 if it closed operations (temporarily or permanently). Panel b depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the marginal effect of the variables of interest on employment growth, obtained through the implementation of a regression analysis controlling for firm survival with a two-step Heckman procedure ($N = 2,228$). *Employment growth* is defined as the logarithmic difference between the number of employees at the time of the baseline survey and the number of employees at the time of the follow-up survey. See Naidoo and Tregenna (2021) for a detailed description of the used sample, the variables and the methodology. CIP = Competitive Industrial Performance; DEIEs = developing and emerging industrial economies.

“Pandemic’s impact was also shaped by the type of responses given

Figure 14

Digitalization and firms’ robustness: Drop in sales, profits and employment by digitally advanced and non-digitally advanced firm type, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Manufacturing firms adopting ADP technologies are defined as digitally advanced and non-ADP adopters as non-digitally advanced. The figure shows the average change in sales and profits. The *change in monthly sales* refers to the value of monthly sales the month before the survey with respect to the same month one year before ($N = 2,301$). The *change in yearly profits* refers to the value of profits in 2020 compared to 2019 ($N = 2,303$). The figure also shows the average drop in employment, corresponding to the average share of laid-off workers over the total number of workers in December 2019, considering only firms that declared they have laid off workers since the beginning of the pandemic ($N = 1,183$). *Layoffs* refers to total workers who have been laid off due to the COVID-19 pandemic. The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. ADP = advanced digital production; DEIEs = developing and emerging industrial economies.

(Figure 14). For instance, the drop in sales experienced by digitally advanced firms was more than three times smaller than non-digitally advanced ones.

Types of responses

Pandemic’s impact was also shaped by the type of responses given

The type of responses to the crisis also shaped the final impact. IDR 2022 documents the responses to the

pandemic on the manufacturing sector by both manufacturing firms and governments in DEIEs.⁵

Five types of transformational changes were implemented by manufacturing firms

When it comes to firms, five types of responses have been identified (see Table 1) based on original data collected for this report. These responses are considered transformational changes as they imply strategic changes in the organizations, operations, routines as

Table 1

Transformational changes in DEIEs per the UNIDO COVID-19 firm-level survey

Change	Definition	Share of firms implementing changes
Organizational change	Introduced organizational changes to fulfil new health and safety requirements (that is, remote work arrangements, new protocols or standards, new professional roles to supervise health and safety measures)	64%
Business activity online	Started or increased business activity online and delivery of goods or services (for example, online sales, new delivery modes, new distribution channels)	37%
New product	Released new product(s) to meet changing market demands	30%
Repurposing	Converted, partially or fully, production to address the health emergency (for instance, producing medical equipment, masks, sanitizers)	22%
New equipment	Introduced new equipment to reduce the workers needed on the shop floor (for instance, through the automation of some production processes)	20%

Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Firms could select one or more of the listed transformational changes in response to the question “Did the firm experience any of the following changes in response to the COVID-19 outbreak?” Response options were not exclusive, and a firm could select more than one transformational change. Only manufacturing firms have been considered ($N = 2,781$). The sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

“ More than 60 percent of surveyed firms introduced some organizational change

well as business models of the firms. These changes pursued two aims: a more proactive one, to exploit opportunities created by the shock, and a more defensive one, to cope with the constraints imposed by the crisis and thrive through the crisis to re-orient towards the new normal.







Organizational changes were very frequent among surveyed firms

According to the collected data, more than 60 percent of surveyed firms introduced some organizational

change to fulfil new health and safety requirements brought on because of the pandemic. The high rate of implementation of this type of change reveals how largely the organization of work and production in manufacturing sectors may have changed in response to the pandemic. This change also includes remote work arrangements, whose introduction was actually rather diffused even among manufacturing actors. Another transformational change frequently adopted has been starting or increasing business activity online (37 percent). A smaller share of surveyed firms (20–30

Figure 15

How digitalization can facilitate the introduction of response strategies to the COVID-19 pandemic crisis

Channels of impact	ADP technologies-enabled response strategies
<p>Supply</p>	<p>Digital strategic response</p>
<p> Domestic factories partial/total closure</p>	<ul style="list-style-type: none"> Remote factory management through connected machines and IoT
<p> Disruptions in domestic and international value chains</p>	<ul style="list-style-type: none"> Increased flexibility of supply chains through increased traceability of parts and products (i.e. use of RFID) In-house realization with 3D printing of unavailable inputs and components Increased options of providers through digital platforms
<p> Shortage of staffing, leading to reduced processing capability</p>	<ul style="list-style-type: none"> Labour-substituting automation (i.e. advanced robotics, integrated factory automation) Use of digital technologies to minimize physical contact and allow for remote working (i.e. remote monitoring, remote working arrangements, virtual meetings) Digitalization of activities (business processes, administration, finance) Development of digital skills
<p> Restricted access to specialist service to attend machinery</p>	<ul style="list-style-type: none"> Real-time remote technical assistance through augmented and virtual reality Fewer unnecessary interventions thanks to predictive maintenance
<p>Demand</p>	<p>Digital strategic response</p>
<p> Reduced consumer spending power</p>	<ul style="list-style-type: none"> Improved demand monitoring via integration with online platforms Expanded online sales and digital channels of distribution Advanced logistics and contactless delivery to minimize physical contact with customers Increase digital customer relations Diversify towards higher-value added customized digital products (i.e. servitization, smart and connected products, 3D printed tailored solutions) Improved storage of perishables with smart sensors; improved stock management
<p> Increased demand for medical equipment</p>	<ul style="list-style-type: none"> Faster time-to-market of new (or converted) products due to faster modelling, prototyping, and testing with the help of AR and/or VR, digital twins and 3D printing

Source: UNIDO elaboration based on the background materials prepared by Calza et al. (2021) and Andreoni et al. (2021).

Note: ADP = advanced digital production; AR = augmented reality; IoT = Internet of Things; RFID = Radio Frequency Identification; VR = virtual reality.

ADP technologies helped firms implement response strategies to the pandemic

percent) introduced the remaining types of changes listed in the survey question.

Large enterprises resisted and responded better to shocks

Further disaggregation by size and industry presented in the report indicates that SMEs constantly displayed a lower-than-average introduction of almost each type of transformational change. This result confirms that larger firms are not only better at resisting but also at responding to shocks.

Digitalization also supported firms' readiness to respond

The relevant role of digitalization in the global response to the pandemic, through the adoption of ADP technologies (UNIDO 2019b), is also revealed in firms' responses to the survey. Digitalization can facilitate the implementation of response strategies to the COVID-19 pandemic shock (Figure 15). For example, digital competences facilitate the shift to remote work; industrial application of the Internet of Things (IoT) or virtual reality facilitates the reorganization of production processes to respect safety

measures and enable social distancing; additive manufacturing solutions can help deal with the shortage of certain inputs or replace them.

Digitally advanced firms introduced changes more often

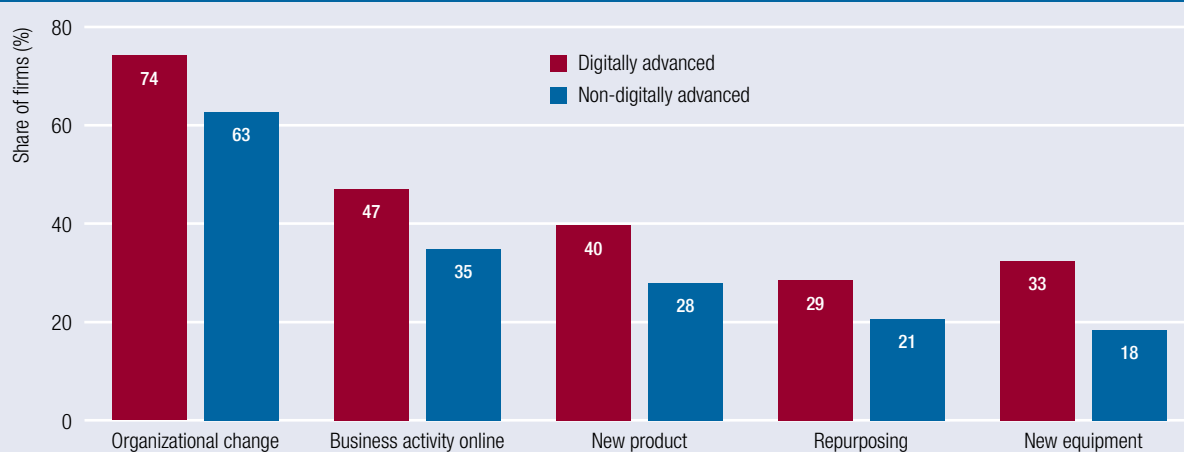
The data collected for this report point towards the existence of a positive correlation between the adoption of ADP technologies and the response strategy of firms. Digitally advanced firms introduced each of the five transformational changes more frequently than non-digitally advanced ones, with the difference across these two groups being larger than 10 percentage points for nearly all five changes (Figure 16).

Policy response also played a key role in mitigating the impacts of the crisis

When the exceptional difficulties emerging from the crisis became clear to policymakers, with many firms struggling to survive and incapable of formulating adequate and rapid responses to the pandemic, most countries acted quickly to mitigate its negative impacts. In the first period of the crisis, governments perceived the

Figure 16

Digitalization and firms' readiness: Share of firms that experienced a transformational change by digitally advanced and non-digitally advanced firm type, 2020–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Manufacturing firms adopting ADP technologies are defined as digitally advanced and non-ADP adopters as non-digitally advanced. The figure shows the share of firms that selected a transformational change in response to the question "Did the firm experience any of the following changes in response to the COVID-19 outbreak?" (N = 2,698). Response options were not exclusive and a firm could select more than one transformational change. The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. ADP = advanced digital production; DEIEs = developing and emerging industrial economies.

Industrial policy responses focused on short-term relief measure

urgent need for swift interventions to offset falls in demand and supply chain disruptions. Data collected by UNIDO from surveys of policymakers reveal that the implementation of measures such as deferral of credit payments, access to new credit, tax exemptions or deductions, deferral of rents and wage subsidies was particularly frequent (between 73 and 37 per cent of respondents) (Figure 17). On the other hand, medium- to long-term measures such as research and development (R&D) grants and subsidies for investments and innovation were implemented to a relatively lower extent (between 14 percent and 22 percent of respondents). These results confirm that at the initial stage of the pandemic, policymakers' actions were mostly oriented towards providing immediate relief to firms for their short-term payments.

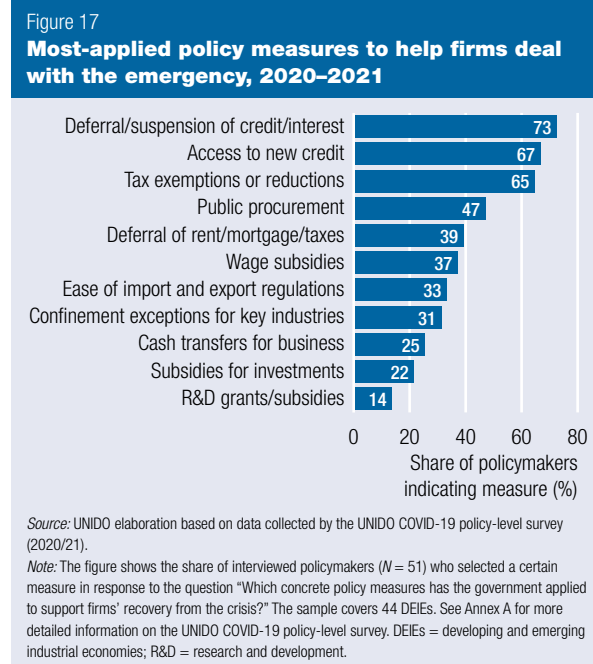
Policy responses supported resilience, especially where capabilities were not adequate

The industrial policies implemented to mitigate the impact of the crisis were sometimes also oriented towards boosting the resilience of the economic system, especially when firm-level capabilities were not adequate. Analysis conducted for this report documents many examples of measures adopted by DEIEs to react promptly in each phase of the emergency—prevention, preparedness, reaction and recovery—to strengthen the resilience of the manufacturing sector (Table 2).

What can we expect for the future?

Long-run impact of the pandemic depends on its interplay with other (pre-existing) megatrends

As countries struggle to recover from the crisis and set out along a new path of prosperity, some key questions have emerged: what impacts from the crisis are here to stay and might affect the future of industrial development? And to what extent will the factors of resilience continue to be the same or not in the year to come? To address these questions, IDR 2022 goes beyond the analysis of the impacts observed so far and assesses the



extent to which these impacts might affect other forces which were already re-shaping the future of industrialization globally long before the COVID-19 outbreak. These forces—the megatrends—are rooted in deeper structural shifts related to the process of technological change, socio-demographic transitions and humanity's carbon footprint.

Three megatrends are particularly important for industrial development

The megatrends affecting the future of industrialization can be broadly defined as profound transformations that (1) last several decades, (2) deeply affect the social as well as the economic and political spheres of industrial development, and (3) have global impact. Research commissioned for this report identified three megatrends that are particularly relevant in this regard (see Altenburg et al. 2021):

- *Digitalization and automation of industrial production*, as technological innovation and the deployment of ADP technologies affect essentially all spheres of business development and deeply change the competitive advantages of firms and nations

“ Digitalization, power shifts and production greening are shaping future industrialization

Table 2

Policy goals and measures fostering resilience in the manufacturing sector: Examples from dealing with the COVID-19 pandemic

Phases of emergency	Dimension of resilience	Goal	Examples of adopted measures and activities
Prevention	Robustness	Implementation of actions to avoid exposure and to reduce the vulnerability of manufacturing industries to existing and emerging risks	Building “sovereign capabilities,” especially to produce critical and strategic goods Minimizing vulnerability of industrial assets
Preparedness	Robustness	Development of emergency plans for delivering manufacturing goods and capabilities as needed in the event of disasters	Identifying and stocking resources (i.e. personnel, equipment, inputs) needed to face potential risks and disasters Promoting the development and enforcement of business continuity planning in manufacturing sector
Reaction	Readiness	Ensuring the continuous operation of the affected manufacturing sector when an emergency event is imminent or immediately after it occurs	Maintaining adequate production and provision of critical goods during emergency Increasing direct engagement of the public organizations in production and distribution Implementing support policies for manufacturing firms to continue operations
Recovery	Readiness	Execution of restoration plans for disaster-affected industrial sectors Identification and use of lessons learned as input for future industrial strategy	Strengthening production capabilities and industrial digitalization Promoting green manufacturing

Source: UNIDO elaboration based on the background paper prepared by López-Gómez et al. (2021).

- *Global economic power shifts*, especially the emergence of Asia as a dominant hub of global industrial production and China’s structural transformation towards a knowledge-driven, high-income economy, as these developments imply a major restructuring of trade flows and global value chains
- *Greening of industrial production*, as the need to reduce environmental footprints, and in particular to decarbonize economies, calls for radically different business models and systemic transformations with far-reaching effects on the positioning of DEIEs in the world economy

Megatrends are interrelated in multiple ways and create both challenges and opportunities

These megatrends are interrelated in multiple ways, and together will shape the direction of structural change and of industrial development in particular.

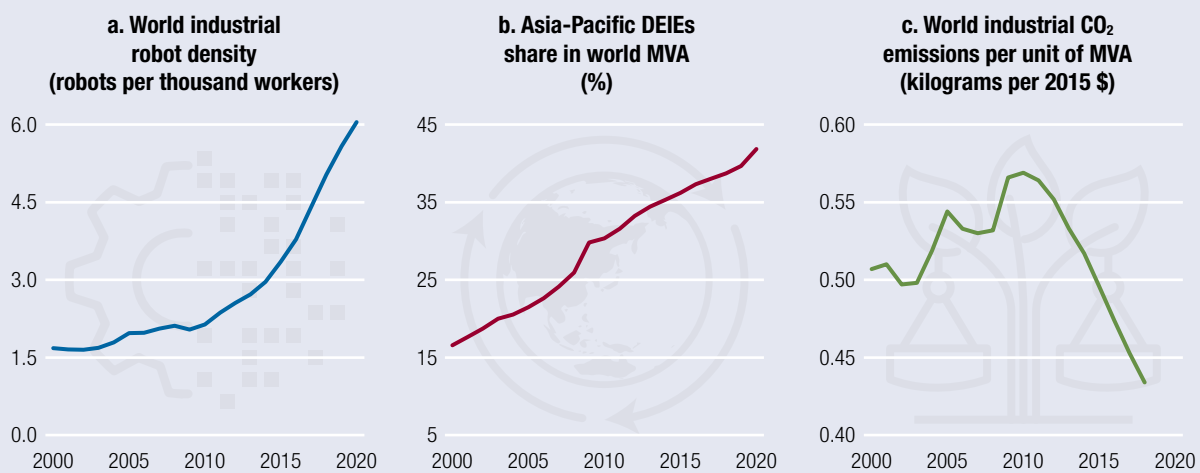
Some industries and business models are declining in the shadow of these trends, whereas others are emerging and expanding. This creates opportunities as well as threats for all economies. Yet, how this plays out depends in part on existing economic structures and coping strategies.

Three indicators can illustrate the speed and magnitude of these developments

Three indicators serve to illustrate the speed and magnitude of each of these trends (Figure 18). First, the evolution of industrial robot density in manufacturing industries at the global level, which in the last 20 years has increased fourfold and has sharply accelerated since 2010. Alongside robotics, many other digital technologies are transforming the industrial landscape, as documented in the IDR 2020. Second, the rapid shift in global industrial production towards

COVID-19 affected the pace of the megatrends

Figure 18
Three megatrend shaping the future of industrial development



Source: UNIDO elaboration based on: panel a: IFR (2020) and ILO (2021c); panel b: UNIDO MVA database 2021 (UNIDO 2021b); panel c: IEA (2021) and UNIDO (2021b).
Note: Industrial robot density is defined as the total stock of industrial robots in the 78 countries covered by the IFR and the total number of manufacturing workers in that same group reported by the ILO. Economy groups are defined in Annex C. CO₂ = carbon dioxide; DEIEs = developing and emerging industrial economies; MVA = manufacturing value added.

DEIEs—especially in Asia—becomes clear when looking at the changing share of Asia-Pacific DEIEs in world manufacturing value added (MVA). From about 15 percent in 2000 this share jumps to almost 45 percent by 2020. Third, the trend towards a greening of industrial production is illustrated by the declining amount of carbon dioxide (CO₂) emissions contained in each unit of MVA produced at the global level. Up to 2010, this indicator has been increasing, but a sustained decline after 2010 puts the 2018 level 15 percent below that of 2000. Much more will need to be done to achieve the targets of carbon neutrality by 2050, but this indicator, at least, points to a turning point in the previous trend towards increasing environmental degradation per unit of industrial production.

Each of these megatrends has been affected by the pandemic

The evidence collected for the IDR 2022 suggests that the COVID-19 crisis has affected the pace of all these megatrends. In some cases, this COVID-19-driven acceleration is already evident, such as the spread of e-commerce in all regions of the world, including the less developed ones. In others, however, the empirical basis for assessing the structural effects is weak and

the analysis can only present incipient trends. But in all cases, the evidence points to the same direction: the megatrends will continue to operate in the years to come. And understanding their interplay with the social and economic consequences of the pandemic will, thus, be crucial for promoting an inclusive and sustainable industrial development (ISID).

COVID-19 and digitalization

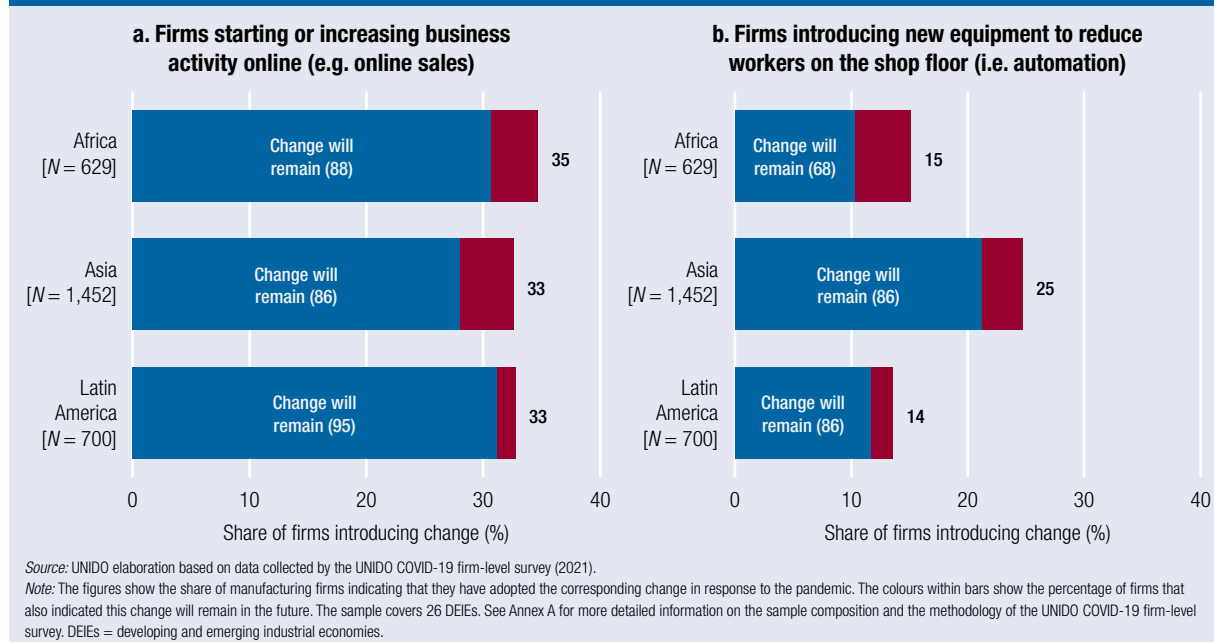
Signs of accelerated industrial digitalization

There are strong indications that the pandemic has boosted digitalization, including in developing countries. As can be seen in Figure 19, about one-third of firms surveyed for this report indicated that they have introduced or increased online activity due to the pandemic (left panel). Moreover, the vast majority of those firms (from 86 percent in Asia to 95 percent in Latin America) expect this change to remain in the future. The pandemic has also forced many manufacturing firms to make decisions on automation (right panel). This is particularly important in Asia (25 percent of firms) but also non-negligible in Africa and Latin America, where about 15 percent of firms indicated introducing this change in response to the

“ Digitalization continues to be unequal across countries and firms

Figure 19

Digitalization among manufacturing firms due to the pandemic in selected DEIEs, by region, 2021



pandemic. Here, too, the majority expect to keep the change introduced.

Adoption of ADP technologies, however, continues to be unequal across countries and firms

Crucial in helping mitigate the socioeconomic impacts of the pandemic, ADP technologies are likely to become a key enabling factor for countries to achieve ISID and the SDGs. However, translating the digitalization opportunity into reality is challenging. The interdependence of different technologies—which characterizes many ADP technologies—means that their adoption is hardly a seamless process. Among firms, differences in size, capabilities and the availability (or lack thereof) of a supporting innovation system account for a large share of today’s digital divide. Particularly in DEIEs, SMEs tend to lag behind their larger peers.

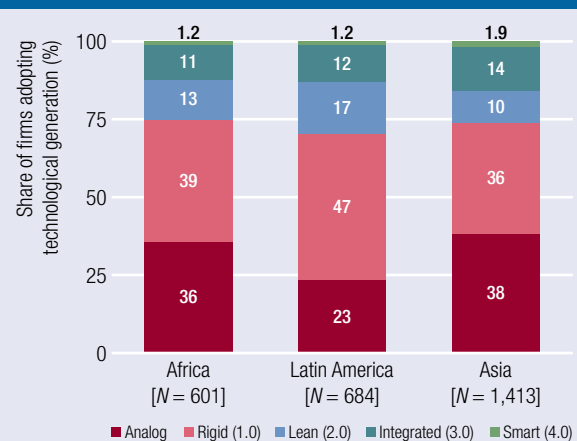
Unequal adoption of ADP technologies creates a strong digital divide within DEIEs

Evidence collected for this report showed that only a small share of DEIE manufacturing firms is already

engaging with ADP technologies (Figure 20). In all three regions covered by the survey—Africa, Asia and Latin America—the average share of firms using

Figure 20

Diffusion of ADP technologies among manufacturing firms in selected DEIEs, by region, 2021



Extreme digital capability gaps in DEIEs limit ADP technology diffusion

4.0 technologies in their production process is still below 2 percent. The vast majority of firms in DEIEs are either not relying on digital technologies or using very outdated ones. Taken together, analog technologies and generation 1.0 technologies account for more than two-thirds of the sample in all regions. This highlights, once again, the extreme digital divide that exists within DEIEs. Such a divide poses a challenge because, not only are there few firms adopting ADP technologies, but lead firms that are already adopting these technologies find it difficult to link backwards and forwards and nurture their supply chain. When the digital capability gap is extreme, as it is in DEIEs in these regions, the diffusion of ADP technologies is thus very limited due to both technological and structural constraints.

Fostering further ADP technology diffusion: An important priority in the post-pandemic

Against this backdrop, fostering the diffusion of ADP technologies is an important priority. In DEIEs, ADP technologies are often applied through retrofitting: by, for instance, adding sensors to machines, factories and products. Basic, enterprise-level capabilities in manufacturing production and innovation are therefore key to diffusion. At the same time, the provision of digital infrastructure must take into account digital divides related to enterprise size and gender, as well as consider the needs of other vulnerable and disadvantaged groups.

COVID-19 and global shifts in manufacturing production

Signs of accentuated shift of global industrial production towards Asia

Available evidence suggests that the pandemic may have also accentuated the megatrend of a shift towards Asia. Despite being impacted hard at the beginning of the pandemic, China's manufacturing sector was able to return quickly to its pre-pandemic growth rates, partly due to very strong containment measures taken by the government. Conversely, the fall in

production in industrialized countries tended to be more prolonged. As a result, the shares of China and other Asian DEIEs in global manufacturing production continued to grow even in 2020 and 2021 (Falk et al. 2021).

Asian manufacturing firms already increasing future investments

Aggregate data on manufacturing are also supported by the firm-level evidence collected for this report. Despite the effects of the pandemic on the global economy, during the first half of 2021, 52 percent of Asian firms expected to increase investments in new equipment and 54 percent predicted increases of investments in new software (see Figure 21). These responses contrast with those of other regions, where the majority of firms expect to reduce or merely maintain those levels of investments—particularly Africa, which shows the largest expected declines in investment. If these trends continue, the rebalancing towards Asia might accelerate further in the years to come.

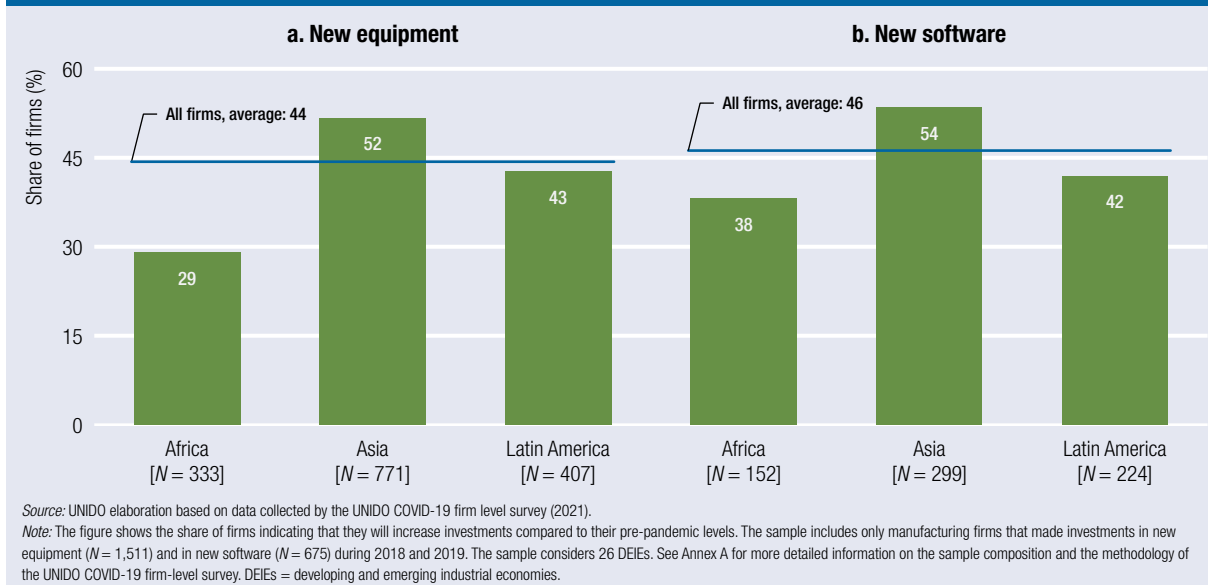
Changes in the organization of global production: From “just-in-time” to “just-in-case”

Not only is COVID-19 expected to affect the geography of global industrial production—by accelerating a movement towards East and South-East Asia—but also the way it is organized across borders through global value chains (GVCs). While it is too early to grasp the full implications of the COVID-19 crisis for GVCs, there is a wide consensus that the pandemic will affect the global organization of production. Business decisions are already perceived as being shifting. “Lead” firms—large multinational enterprises (MNEs), which coordinate innovation and production activities across borders—are being forced to adopt more sophisticated risk management, a move that can be described as switching from “just-in-time” to “just-in-case” management. To ensure continuity in output delivery, larger stocks of inputs and final products might be required, as well as a process of diversification in the sourcing of materials and intermediates.

COVID-19 is expected to accelerate the production shift toward Asia

Figure 21

Manufacturing firms expecting to increase post-pandemic investments in selected DEIEs, by region, 2021



New concerns about back-shoring and value-chain shortening

Changes in business planning are not the whole story, however. A widespread concern is that the vulnerabilities exposed by the pandemic might nudge some firms to consider either shortening their value chain or bringing it closer to final consumers (“reshoring”). Political pressure, particularly in IEs, might also factor in these decisions. At the same time, however, the growth prospects of many DEIEs—particularly, but not only, in East Asia—is likely to act as a counterweight, with MNEs shifting from efficiency- to market-seeking modes of engagement with developing and emerging industrial economies. At least for the time being, the diversification of suppliers might prove to be a more resilient and cost-efficient choice for lead firms, relative to the domestication of entire supply chains.

COVID-19 and industrial greening

Industrial greening: Some signs of behavioural changes

When it comes to industrial greening, the COVID-19 crisis seems to have had mixed effects. During the

initial phase of the crisis, GHG emissions fell quickly and abruptly. But their level rebounded rapidly as industrial operations resumed in 2021 (Karapinar 2021). Still, there are signs that at least part of the changes to a greener global economy are here to stay. As Figure 22 illustrates, manufacturing firms in developing countries expect the pandemic to trigger the adoption of environmentally friendly practices. This trend is more noticeable in Africa and less so in Latin

Figure 22

Adoption of environmentally friendly practices due to COVID-19 in selected DEIEs, by region, 2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm level survey (2021).

Note: The figure shows the share of manufacturing firms indicating that the pandemic will trigger the adoption of new environmentally-friendly practices to a great, moderate or no extent. The sample covers 26 DEIEs. See Annex A for more detailed information on the sample composition and the methodology of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

Industrial greening will alter countries' comparative advantages

America, but positive expectations can be seen across the three regions where data have been collected.

Two reasons driving incipient change in behaviour: Green conditionalities and firms' awareness

Though still not at the pace needed to achieve the SDGs' environmental targets, firms are increasingly adopting environmentally friendly practices. This change in behaviour is encouraged by the growing proposition and implementation of green packages and the rising demand of donors and investors to incorporate environmental factors in firms' operations. Firms are also adopting these practices due to the growing awareness about their economic benefits. When it comes to climate change, improved efficiency producing value added by reducing emissions can go hand in hand with better firm performance and competitiveness, making countries and firms more resilient to shocks.

Industrial greening will alter comparative advantages

Over the long run, industrial greening is likely to affect the balance of competitive advantages for firms in established industries in both IEs and DEIEs, but also to entirely alter countries' comparative advantages by engendering entirely new industries. The changes associated with economic and societal transitions towards greener energy are almost entirely unpredictable. Navigating this complex and rapidly changing landscape is likely to require considerable investments in capability building—particularly among DEIEs—and in adaptation.

In preparing for the future countries should take into account these megatrends

The megatrends are likely to radically alter the industrial landscape in the years to come. The interaction between these trends and the ongoing COVID-19 pandemic is complex. Yet, as countries gradually recover from the sanitary and economic crisis, the megatrends will remain and possibly accelerate, in both pace and intensity.

Coping with the megatrends requires strengthening industrial capabilities

As these megatrends intensify, countries will need to adapt and strategically engage with them. The importance of industrial capabilities for long-term resilience—which was evident during the pandemic, as diversified industrial sectors helped weather the twin sanitary and socioeconomic crises—suggests that only by investing in the accumulation of production capabilities within the framework of a diversifying manufacturing sector will countries be able to continue coping with and taking advantage of these megatrends.

Industrial greening and digitalization also require accumulation of industrial capabilities

The future of ISID crucially depends on the accumulation of manufacturing capabilities. Just as it is difficult to imagine a resilient public health system without an industrial infrastructure to supply it, so it is hard to plan for a greener future without the capabilities to design, manufacture and deploy renewable infrastructure. Similarly, the evolutionary nature of ADP technologies means that leapfrogging into a digital economy is likely impossible without a solid foundation of firm-level skills in production and innovation on which to build.

How can we build a better future?

Building back better

Popularized as a concept in the aftermath of the 2004 Asian tsunami, the term “building back better” summarizes the intention to coordinate efforts at the local and global levels towards achieving a new level of recovery after a major disaster (Clinton 2006). Beyond restoration to what existed previously, this recovery should enable a promising and safer development path for affected communities.

Industrial policies of the future need to put SDGs at the centre

Aligning industrial policies with the building back better narrative means putting them to work for

SDGs should be integral to any post-pandemic industrial policy

the achievement of the SDGs, taking into account the megatrends that are likely to shape the future of industrialization as well as the tangible risk of global disasters like the COVID-19 pandemic. Domestic efforts alone will not be enough to build back better, and the international community is therefore called to strengthen efforts in supporting the most vulnerable countries of the world.

Robust statistical systems are needed to monitor the recovery and steer policy

Industrial policy cannot be implemented in the dark. To guide programmes that support the recovery and build resilience, an important pre-condition is a flexible, innovative and well-resourced statistical information system that can provide the data that are needed, when they are needed and how they are needed, in terms of coverage and level of disaggregation. The COVID-19 pandemic created new challenges to the global statistical system, but it also exposed pre-existing information gaps that need to be filled in order to verify that the recovery is leaving no one behind.

Industrial policies for a green recovery

Industrial greening should be at the core of post-COVID recovery programmes

The greening of industry needs to be placed at the core of post-COVID recovery programmes. This can be achieved by adopting sustainability standards for the production of industrial goods, the introduction of low carbon technologies and by implementing, more broadly, policies to stimulate the demand for low carbon technologies and “green skills.”

Industrial policies should promote a transition towards green industries

After recovery, the policy focus should shift to the strengthening of new productive and innovative capabilities related to green industries that promote a transition from “low-quality” activities to “high-quality” activities. While concrete actions will depend on the specificities of production systems in individual countries, different policy objectives can be set for the short and long term (Table 3).

Table 3

Priority areas for industrial policies that promote the post-pandemic greening of industry

Areas	Short term	Long term
Decarbonization	<ul style="list-style-type: none"> Adoption of decarbonization goals at the core of recovery programmes 	<ul style="list-style-type: none"> Adoption of objectives for manufacturing and export of low-carbon products/ technologies
Structural change	<ul style="list-style-type: none"> Reorienting existing productive capabilities to integrate green industrial value chains (following comparative advantage) 	<ul style="list-style-type: none"> Promotion of new productive and innovative capabilities (defying existing comparative advantage)
Global integration	<ul style="list-style-type: none"> Foreign direct investment (FDI) promotion in green industries 	<ul style="list-style-type: none"> Supplier development programmes and promotion of knowledge and technology transfer to trigger innovation and spill-over effects
Standards and innovation	<ul style="list-style-type: none"> Foster awareness of sustainability standards to boost the demand for green goods 	<ul style="list-style-type: none"> Scale-up of low-carbon R&D support
Green skills	<ul style="list-style-type: none"> Establish national competency frameworks for the re-training/repurposing of skills from “dirty” to “clean” manufacturing 	<ul style="list-style-type: none"> Expansion of education and training certification programmes related to sustainable manufacturing

Source: UNIDO elaboration based on the background paper prepared by Lebdioui (2021).
Note: R&D = research and development.

“ Industrial policy should promote social inclusion

Industrial policies for an inclusive recovery

Industrial policies should target vulnerable actors

Industrial policies should also promote development in a socially inclusive manner. In the current context, this means paying special attention to the actors that have been more vulnerable to the pandemic, helping them to recover in the short term and supporting the strengthening of their resilience in the medium-long term (see Table 4).

One key avenue to social inclusiveness is job creation, especially for the most vulnerable actors

Socially inclusive industrial policies should not only aim at creating jobs but also increasing the participation of informal workers, youth and especially women in the manufacturing sector. The post-COVID-19 scenario offers strategic opportunities to advance industrial development that is both gender-inclusive and sustainable.

Strengthening women’s participation through industrial policies

Three key principles can guide industrial policies intended to strengthen and expand women’s participation in the economy:

- Bringing a gender-aware perspective to the employment challenges of increasing technological intensity and automation in industry;
- Increasing women’s access to industrial sector work, particularly in the context of targeted growth of “green jobs”;
- Identifying social infrastructure and investments in the care economy as part of industrial policy.

Going digital

Industrial policies should exploit technology “pull” and “push” pressures strategically

Industrial policies should also support the digitalization of manufacturing. The speed at which countries will achieve this goal heavily depends on the existing capabilities. In middle-income countries that have some basic industrial capabilities in place, the goal would be to explore ways to adopt digital applications across those sectors seeking potential avenues for leap-frogging. That involves both sectors that are mainly users of digital technologies—such as agroindustry, consumer goods, chemicals and pharmaceuticals—and sectors that are suppliers, such as capital goods and information and communication technology (ICT).

Table 4

Priority areas for industrial policies that promote post-pandemic development in a socially inclusive manner

Actors	Short term	Long term
Industries	<ul style="list-style-type: none"> • Support continued operations of the most affected and essential industries through targeted support packages • Enable the repurposing of production to address contingent situations in vulnerable and essential sectors 	<ul style="list-style-type: none"> • Foster the recovery, reorientation and strengthened resilience of most-affected industries
Firms	<ul style="list-style-type: none"> • Ensure SMEs survival through targeted support 	<ul style="list-style-type: none"> • Facilitate the uptake of new technologies (especially ADP technologies) in SMEs • Build capacity in SMEs to better incorporate risk management • Promote market diversification
Workers	<ul style="list-style-type: none"> • Enhanced safety net provision for vulnerable segments of the population 	<ul style="list-style-type: none"> • Support employability of vulnerable workers

Source: UNIDO elaboration.

Note: ADP = advanced digital production; SMEs = small and medium-sized enterprises.

Industrial policy should integrate planning for resilience and risk management

Industrial policy must exploit such “pull” and “push” pressures strategically.

Governments need to articulate innovation and industrial policies to foster ADP technology adoption

In addition, governments need to better articulate innovation and industrial policies to advance the adoption of digital technologies in production, foster investments in R&D and productive diversification to boost the ability to respond to demands for new design and product development, and incentivize and shape the capabilities of designers and producers to meet customized demands.

Digitalization opportunities depend on the countries’ stage of industrial development

The evolutionary nature of ADP technologies means that for firms in lower-income economies, learning opportunities abound. Many “traditional” sectors are being reshaped by ADP technologies, including textiles and apparel—with the use of CAM-CAD laser-cutting technologies, 3D printing for prototypes and functional fabrics—and agriculture, with the rise of precision farming. For the group of emerging

industrial economies, other opportunities open up. There are digital applications in many sectors that can be used as leapfrogging avenues. Take the automotive sector, for instance, where firms from DEIEs increasingly participate, owing to their involvement in GVCs. Here, basic ADP capabilities can be built in the digitalization of monitoring and tracing processes, predictive maintenance and production optimization—all supported by sensors and the IoT. For all countries, policies are needed to steer and maximize technology deployment while reducing the costs and risks associated with adoption.

Factoring in future risks

Industrial policies should integrate planning for resilience and risk management

One important lesson stemming from the pandemic is that countries need to build and strengthen their resilience to the risks associated with extreme events of this nature. Post-pandemic industrial policies need to integrate planning for resilience and risk management. The biggest risk is losing years of industrialization efforts to one major external shock. Table 5 summarizes some

Table 5

Policy targets for disaster risk management-friendly industrial policies

Risk management	Goals	Suggested policies
Prevention	<ul style="list-style-type: none"> Implementation of actions to minimize exposure and to reduce the vulnerability of manufacturing industries to existing and emerging risks. 	<ul style="list-style-type: none"> Sponsor training, events and consultations to build awareness and facilitate knowledge exchanges. Map local capabilities and supply chain risks and vulnerabilities. Support R&D, technology transfer and local production of critical and strategic goods that are prone to shortages during a global emergency. Minimize vulnerability of industrial assets.
Preparedness	<ul style="list-style-type: none"> Development of emergency plans for delivering manufacturing goods and capabilities as needed in the event of disasters. 	<ul style="list-style-type: none"> Create emergency task forces to address disasters. Identify and stock resources needed to face potential risks and disasters. Support development and enforcement of business continuity planning and management in manufacturing with emphasis on SMEs. Foster hazard monitoring and early warning systems in manufacturing.

Source: UNIDO elaboration based on the background papers prepared by López-Gómez et al. (2021) and Santiago and Laplane (2021).

Note: SMEs = small and medium-sized enterprises; R&D = research and development.

“ International policy coordination is needed to build back better from COVID-19

relevant industrial policy goals that promote industrialization and industrial resilience focusing on issues of prevention and preparedness against emerging disasters.

Role of the international community

Efforts of individual countries will not be enough

The global nature of the economic crisis resulting from the COVID-19 pandemic highlights that, without renewed commitments to strengthen multilateralism, national efforts to build back better will be insufficient, and may make the recovery fragile, uneven and uncertain.

Multilateral organizations and regional development banks should support the recovery efforts

The COVID-19 experience stresses the importance of multilateral platforms such as the UN system and the G20 to tighten collaboration with international financial organizations and regional development banks (RDBs), and to coordinate with non-governmental organizations (NGOs) to provide necessary support for manufacturing in developing countries. These entities should use their expertise to provide policy advice and build capabilities, helping developing countries improve their crisis management capabilities, ensure their manufacturing capacities remain operational in the face of global disasters and recover quickly from disasters. These functions add to more traditional roles of development partners in assisting countries in the identification of priority industries, in the design of measures to remove bottlenecks for their development, in the formulation of policies to bolster domestic investment and attract FDI to achieve ISID.

To build back better, coordinated actions of the international community are imperative

Intensified international industrial policy coordination should help in boosting a fast and sustainable recovery that leaves no one behind. This requires improving access to finance and technology, enhancing governance mechanisms to secure uninterrupted flows of essential goods and a more even distribution of the cost of disruptions in global value chains and establishing selective policies and performance criteria to encourage innovation and create complementarities. Improved international frameworks for trans-boundary disaster risk management and placing environmental sustainability at the forefront of recovery efforts will also be essential to building back better post-pandemic.

Call for action to the international community

The IDR 2022 calls on the international community to actively engage in building a better post-COVID-19 future. The proposals highlighted in the illustration below articulate concrete steps in this direction. The illustration distinguishes between actions to be taken in the short term to alleviate the economic and social effects of the pandemic, and actions to be taken over the longer term, which are geared to building back better through inclusive and sustainable development. They are inspired both by the analysis of the data presented throughout the report, and by the discussions held at UNIDO's High-Level Expert Group Consultation held in May 2021.⁶ With this urgent appeal, the report hopes to guide recovery post-pandemic and contribute to mobilizing the necessary efforts for the achievement of the 2030 Agenda for Sustainable Development.

Building Back Better:

A Call For Action to the International Community – to Support an Inclusive, Sustainable and Resilient Industrial Recovery



Priorities for the Short Term

Support global efforts to contain COVID-19 and ensure that the fight against the pandemic and subsequent recovery leaves no one behind.

CALL FOR ACTION **Address vaccine rollout and access, ensuring global protection against COVID-19**

- Accelerate production and deployment of COVID-19 vaccines, especially to developing countries
- Eliminate export restrictions on ingredients essential to COVID-19 vaccines and medications
- Expand technology transfer commitments to increase the global manufacturing capacity of the vaccines and treatments



Goals for the Medium to Long Term

Coordinate global efforts to address future development challenges and ensure that the world builds back better through inclusive and sustainable means.

CALL FOR ACTION **Expand the policy space**

- Promote recapitalization of development banks
- Facilitate developing countries' efforts to expand fiscal space needed for recovery packages

CALL FOR ACTION **Strengthen government capabilities**

- Assist governments in design of SDG-oriented industrial strategies
- Support revitalization of synergistic partnerships with the private sector
- Support sustained, long-term investments in public institutions

CALL FOR ACTION **Tackle digital divides**

- Support establishment of an international programme that creates and shares knowledge of advanced digital production technologies
- Scale investment and strengthen domestic capacities in digital infrastructure, education, skills and R&D

CALL FOR ACTION **Foster a green transition**

- Scale investments in industrial decarbonization, energy switching and circular economy principles
- Facilitate global access to green technologies
- Foster partnerships created to fight COVID-19

CALL FOR ACTION **Promote local industrial resilience**

- Foster opportunities for local production capabilities in health-related strategic goods and devices
- Integrate crisis resilience, risk management and socio-economic goals into industrial policy practices

Notes

1. See WHO (2021) for a detailed analysis of the emergence of COVID-19.
2. The country classification used in this report combines two dimensions: geographical location and level of industrial development. The classification distinguishes 18 areas, 6 within industrialized economies (IEs) and 12 within developing and emerging industrial economies (DEIEs). Within the latter, a further division is made to distinguish least developed countries (LDCs) and Small Island Developing States (SIDS) from the rest. Two countries are considered separately due to their size: China and India. See Annex C for the detailed list of economies included in each group.
3. The *Industrial Development Report 2022* (IDR 2022) follows the definition of resilience proposed by the United Nations Office for Disaster Risk Reduction: the “ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner . . .” (UNDRR 2020).
4. The distinction between robustness and readiness is based on the background paper prepared by Andreoni (2021).
5. For further details on the type of response strategies implemented by manufacturing firms in DEIEs see Seetharaman and Parthiban (2021).
6. For further details on UNIDO’s High-Level Expert Group Consultation see: <https://www.unido.org/news/unido-convenes-experts-consider-manufacturing-responses-covid-19-and-lessons-be-learnt>.

Part A

**The future of
industrialization
in a post-
pandemic world**

Chapter 1

Resilience in the time of COVID-19: The role of industry

1

RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Key messages

- The pandemic has brought profound negative effects to the economies and societies of developing countries and put the achievement of several Sustainable Development Goals (SDGs) at risk.
- This impact, however, has been highly heterogeneous across countries and industries, reflecting differences in underlying factors that shape socioeconomic resilience.
- Large domestic markets and strong manufacturing sectors have contributed positively to socioeconomic resilience during the current crisis.
- The composition of manufacturing also mattered: some “essential” industries (food, chemicals, pharmaceuticals) and some capital- and technology-intensive industries (medical equipment, computers) have been affected less than the rest, while labour-intensive industries (textile, wearing apparel, leather, furniture) or those facing containment restrictions (vehicles, petroleum) have been affected more.
- Beyond these structural characteristics, strong industrial capabilities have been key to successfully dealing with the effects of the crisis—even in countries with relatively small domestic markets and/or that are reliant on vulnerable industries.

Introduction

The COVID-19 pandemic has shaken the world unlike any other crisis in recent history. What began as another outbreak of a flu-type disease in a confined, specific location soon became an unstoppable wave that transformed every aspect of daily life. From work to commerce and social interaction, all human activities have been affected by the pandemic and the measures taken to contain it.

Unlike socioeconomic crises of the past, COVID-19 simultaneously triggered supply-side and demand-side effects that drastically slowed the economic activity of countries. These effects reinforced each other in a vicious circle that, to date, have been difficult to revert.

But what made this crisis unique is that it rapidly became a truly global phenomenon, from which no country was exempt. In continents from Asia to Europe, to North America and then to Latin America and Africa, all countries faced their own outbreaks, and all were affected by a sudden stop in domestic and global economic activity.

As countries struggle to move forward and prepare for the future, it is important to understand what policies aimed at manufacturing worked and what did

not. This ambitious goal requires revising not only the types of responses given during the early and middle phases of the pandemic, but also the structural characteristics that shaped those responses and will continue to shape them in the future.

This chapter begins this review by looking at the salient features of the crisis, the diversity of its effects and the channels through which it affected industrial production. One key aspect that the chapter highlights is the crucial role of existing industrial capabilities in supporting broad socioeconomic resilience and, hence, in softening the impact of the pandemic.

From epidemic to global recession and beyond

Back in December 2019, debates around the future of industrialization concentrated on a number of global trends that were expected to (re)shape the world industrial production landscape. These included, among others:

- The rapid digitalization of production and technological breakthroughs related to the fourth industrial revolution, which were expected to transform the way manufacturing production takes place;

“ All human activities have been affected by the pandemic

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RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

- The rebalancing of world industrial production, from the North-Atlantic “traditional” industrial core towards East Asia and the rise of China as the main powerhouse of industrial production; this was expected to open new windows of opportunity as it left room for new players to start up the industrialization ladder but, at the same time, it posed challenges for those already established; and
- The greening of industrial production to tackle growing concerns related to global warming and environment degradation, which was expected to result in increasing regulations on industrial production methods, creating new barriers but also opportunities for developing countries.

However, no one suspected that a major unexpected event was on its way: the emergence of SARS-CoV-2 (COVID-19).¹ First observed when cases of unexplained pneumonia were noted in the city of Wuhan, China, the virus quickly spread across country borders and became the worst global health emergency since the N1H1 influenza pandemic a hundred years ago.

A brief history of the sweep of COVID-19 through the globe

Unlike outbreaks of past decades, the COVID-19 virus disseminated rapidly across all regions of the world and has been very difficult to contain (see Figure 1.1).

The first COVID-19-related deaths were reported in Asia early in 2020, but the epicentre of the pandemic soon moved to Europe and North America with a dramatic first wave during the spring of that year. By July 2020, the epicentre had moved to Latin America, with devastating effects that only marginally declined during the second half of the year, just to rise again steadily at the start of 2021. Europe and North America also faced a second wave during this period, but these regions experienced a sharp decline in mortality rates after the first quarter of 2021, probably in response to unprecedented mass vaccination efforts. Throughout this period, Africa was the least impacted region in terms of reported deaths per million, but it

also witnessed two peaks during 2021. Asia, which managed to control the situation during 2020 and the first quarter of 2021, started to show sharp increases of reported deaths in April 2021, driven mostly by the exponential growth of cases in India.

Each wave of the pandemic was followed by different sets of policies that tried to contain the domestic outbreaks. These policies included, among others, school and workplace closures, cancellations of public events, restrictions on gatherings, closure of public transport and stay-at-home requirements. The Oxford COVID-19 Government Response Tracker’s Stringency Index provides a synthetic indicator of these measures, recording the strictness of “lockdown style” policies from zero (least strict) to 100 (most strict).²

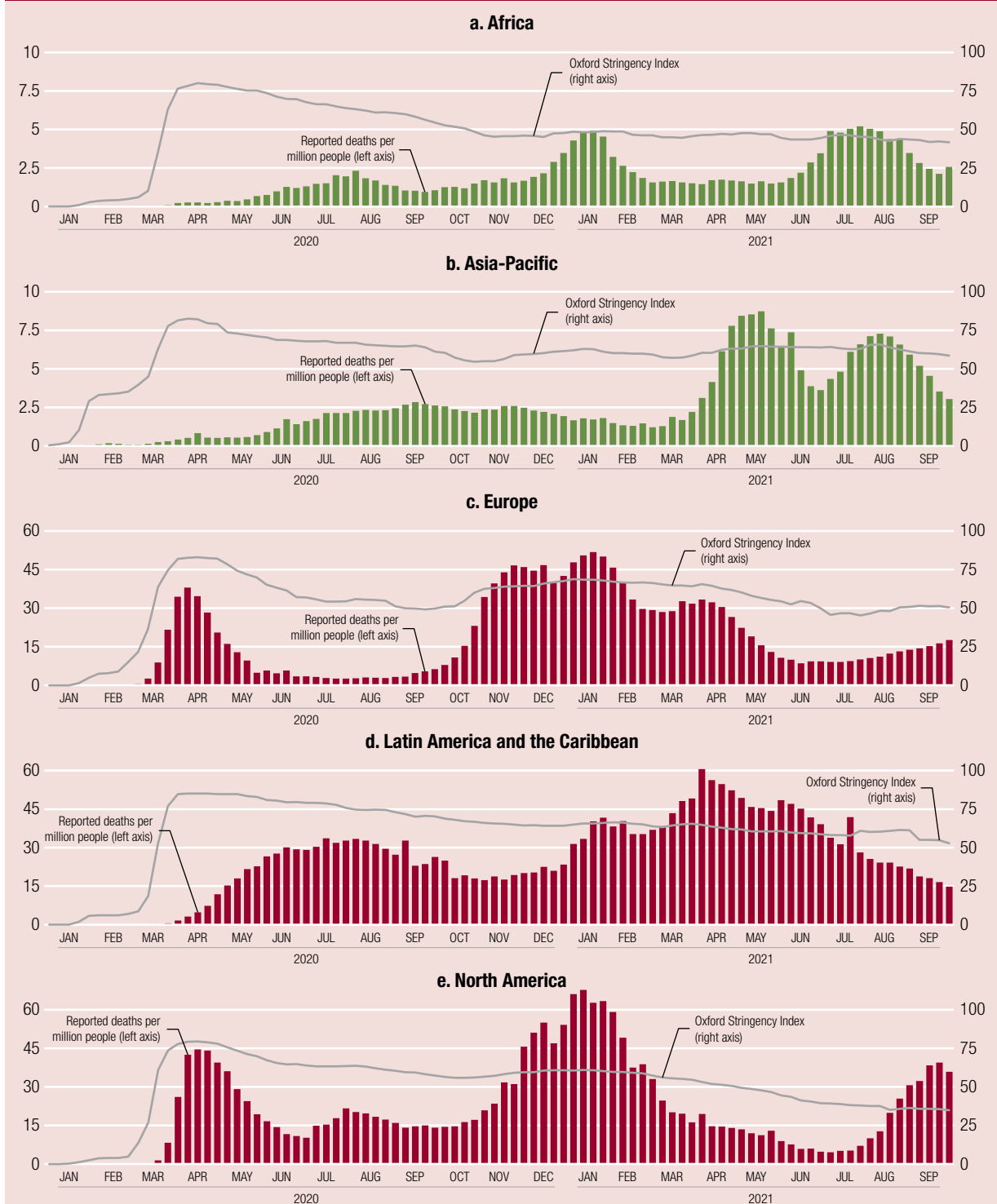
As shown in Figure 1.1, after a common jump across all regions in the level of stringency—by April 2020 all regions showed an average Stringency Index score of about 75—each region followed a distinctive path. On average, Asian economies tended to maintain high levels of stringency despite the relatively lower severity of the pandemic, as reflected by the lower levels of COVID-19 reported deaths per million people.³ European economies presented a more pro-cyclical trend, in which stringency was drastically reduced after the end of the first wave, increased again during the second wave, and decreased afterwards. North America presented a lower but more stable level of stringency throughout, whereas in Latin America and the Caribbean and in Africa, levels of stringency steadily declined after the initial jump despite subsequent increases in cases.

As a result, all countries have been affected both by the health emergency and the side effects of the containment measures implemented to stop the spread of the virus. And the health emergency soon turned into a socioeconomic crisis without precedent (see Figure 1.2).

During 2020, world gross domestic product (GDP) fell by 3.3 percent, the deepest global recession in 70 years (IMF 2021b). The sudden stop in economic activity had a direct impact on employment: during 2020, working hours at the global level declined

“ The virus quickly spread becoming the worst global health emergency since 100 years ago

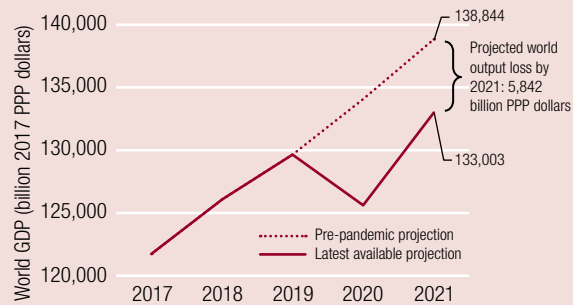
Figure 1.1
Severity of the COVID-19 pandemic and stringency of containment measures across geographical regions, January 2020–September 2021



Source: UNIDO elaboration based on Hale et al. (2021); population taken from IMF (2021b).
Note: Regional averages of the Oxford Stringency Index are weighted by countries' 2019 populations. Africa and Asia-Pacific are presented in a different colour to highlight that the scale used is different from the other regions. The Oxford Stringency Index records the strictness of "lockdown style" policies from zero (least strict) to 100 (most strict).

“ The health emergency soon turned into a socioeconomic crisis without precedent

Figure 1.2
Estimate of world output loss due to COVID-19 by 2021



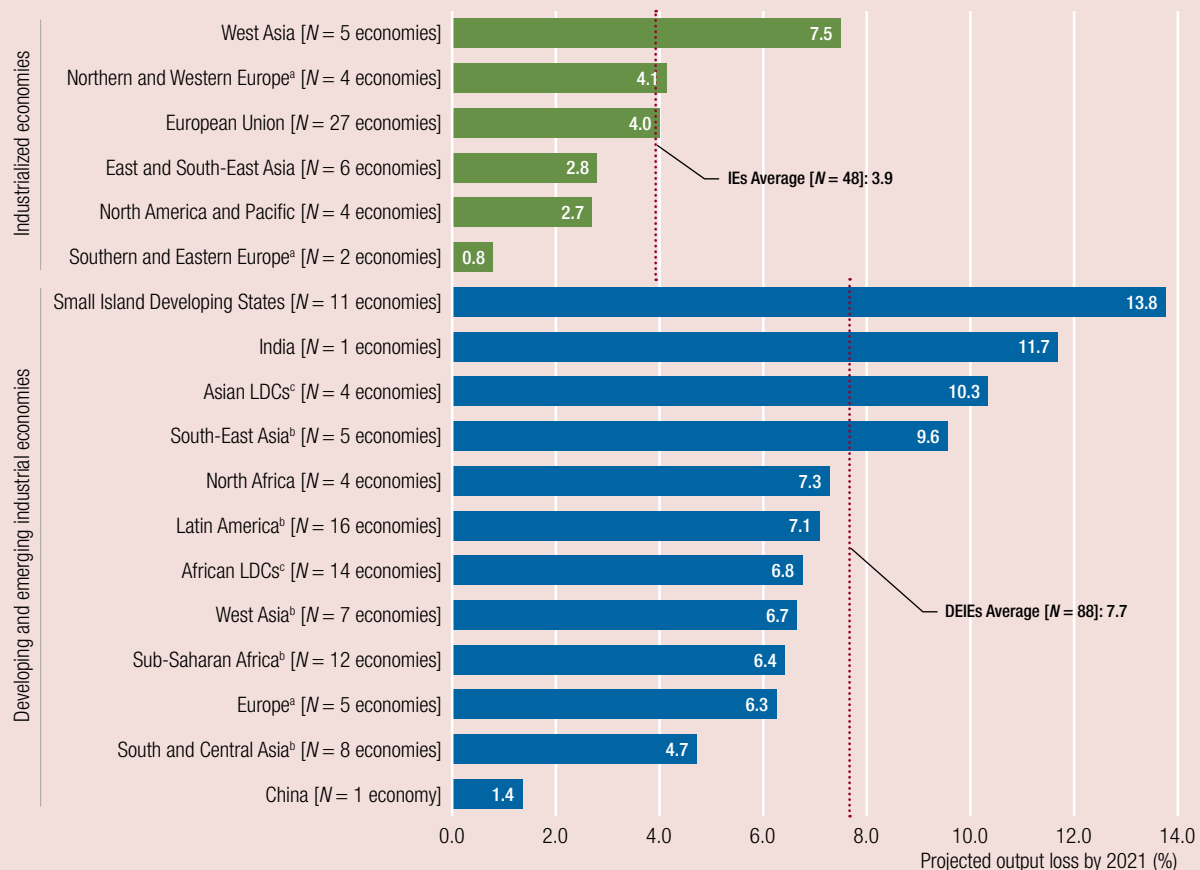
Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions).

Note: Projected world output loss by 2021 is defined as the difference in PPP dollars between the level of GDP projected before the pandemic (October 2019, dotted line) and the latest available projection (October 2021, solid line). GDP = gross domestic product; PPP = purchasing power parity.

8.8 percent compared with the total hours projected in a no-pandemic scenario. That is equivalent to a loss of 255 million full-time employment jobs (ILO 2021e). Even more dramatically, extreme poverty increased 15.3 percentage points relative to the 2020 projections made before the pandemic. This is equivalent to 97 million more people living in poverty because of the pandemic (Mahler et al. 2021).

The initial shock was partially reverted during 2021. As depicted in Figure 1.2, the global economy rapidly bounced back and already by 2021 was expected to surpass the pre-pandemic level. Despite this recovery, however, the overall output loss triggered by the pandemic continues to be huge. Compared with the

Figure 1.3
Estimated output losses due to COVID-19 by 2021, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The figure shows simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as a share of the pre-pandemic projection. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

“ The impact on economic activity has been different across regions

GDP projected before the pandemic, the most recent figures indicate a GDP that is 5,800 billion purchasing power parity (PPP) dollars lower—a decline of 4.2 percent. To give some perspective to this drop, the amount is equivalent to the combined GDPs of Brazil and Turkey.

The impact on economic activity has been different across regions (see Figure 1.3).⁴ Industrialized economies (IEs) were less affected than developing and emerging industrial economies (DEIEs).⁵ The estimated output loss by 2021, compared to the pre-pandemic estimates, is 3.9 and 7.7 percent on average in each group. But the range of impacts is also much more pronounced in DEIEs, where the projected

losses range from a maximum of 13.8 percent in Small Island Developing States (SIDS) to a minimum of only 1.4 percent in China.

Within IEs, oil-rich economies of West Asia together with Northern and Western Europe and the European Union (EU) have been the most impacted by the crisis, with output losses over pre-pandemic estimates of 7.5 and 4 percent by 2021. Among DEIEs, the most impacted were the SIDS, India, Asian least developed countries (LDCs), and South-East Asian DEIEs. South and Central Asian DEIEs (excluding India) and China, instead, rank among the groups with the lowest projected declines in output by 2021.

Box 1.1

Containing the virus: The experience of the Republic of Korea

During 2020, the Republic of Korea managed to flatten the epidemic curve without implementing an extended lockdown or other stricter measures adopted in other industrialized economies (IEs). A key aspect of this success was strong collaboration across the government—including the president's office, the Ministry of Health and Welfare (KMHW) and the Korean Center for Disease Control and Prevention—with the scientific community and industry. The KMHW rapidly developed an effective testing procedure, which the Ministry of Food and Drug Safety prioritized for sign-off by putting through a quick review. Officials then passed this testing technology to four diagnostic companies that rapidly manufactured kits and distributed them to national and local governments. This made it possible to build hundreds of high-capacity screening clinics, offering innovative solutions for mass testing in record time. In a matter of weeks, 600 testing centres were established with a total capacity of 15,000–20,000 tests per day.

Government capabilities turned out to be critical for the containment of the infection as well. The Republic of Korea adopted a targeted and integrated approach whereby infected patients were isolated and provided with health and economic support to increase compliance. This made it possible for businesses to stay up and running. Furthermore, hundreds of epidemiological intelligence officers were deployed to implement the test-and-trace system. These officers were armed with a wealth of data, including credit card transactions and closed-circuit television footage, to track chains of potential infections and to isolate infected people. These data were also made public so that citizens could reduce their

risk of infection and track their own movements. Finally, the capacity of the health system was scaled up rapidly, with new health workers employed and new temporary health facilities built in the most affected areas. The supply effort for personal protective equipment (PPE) was addressed through a centralized procurement process. This allowed domestic private companies to be integrated into supplying masks and other PPE. The country's large industrial base and its high level of coordination along key supply chains and conglomerates made coordination and provision at scale possible.

This government readiness and responsiveness was partially the result of lessons learned from challenges faced by the Republic of Korea in containing the Middle East Respiratory Syndrome (MERS) in 2015. The government learned from that experience and developed an updated and well-articulated infectious disease response plan. The plan goes beyond general guidelines and assigns clear responsibilities across government and public institutions at all levels. It also ensured the creation of enough system-level spare capacity and structures to respond rapidly to an extreme event. Without building spare capacity in the health system, these capabilities would have not been readily available.

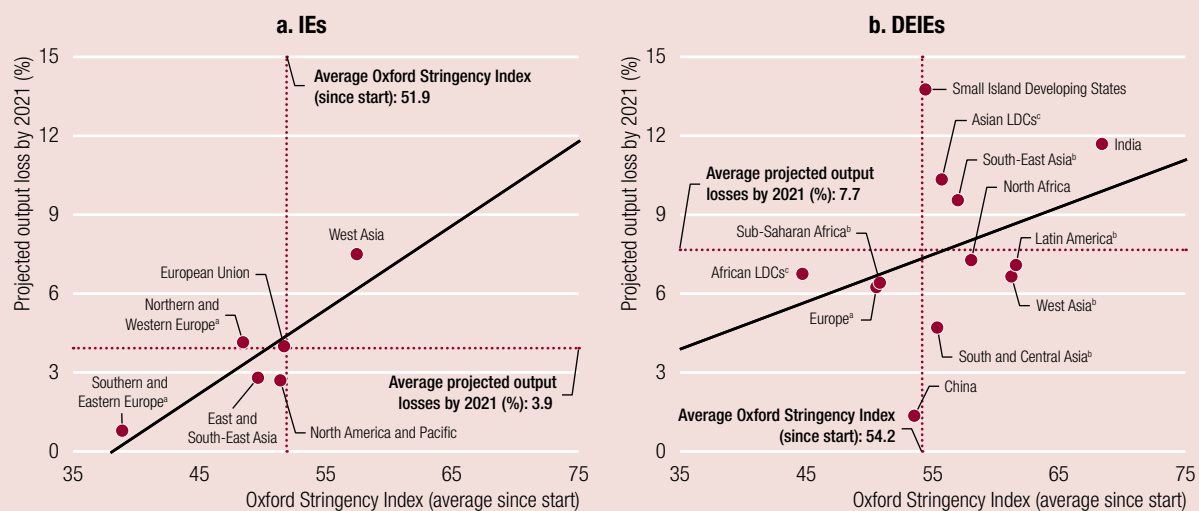
So far, the strategy followed by the Republic of Korea has proved to be very successful. As of 1 October 2021, this country reported 2,500 deaths due to COVID-19 and its projected output loss for 2021 is only 1.6 percent in comparison with the International Monetary Fund (IMF)'s pre-pandemic projection of output for that year.

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

Some countries managed to contain the pandemic effectively and quickly; others did not

Figure 1.4

Level of stringency of containment measures and estimated output losses by 2021, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss by 2021) and Hale et al. (2021) (Stringency Index).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The figures show simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and is presented as a share of the pre-pandemic projection. The Oxford Stringency Index records the strictness of "lockdown style" policies from zero (least strict) to 100 (most strict). The figure shows the average scores for this index between 1 January 2020 and 1 October 2021. The solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

Measures to contain the pandemic: From restrictions to vaccines

What factors can explain these differences? First is whether the country was successful in controlling the health emergency. At the initial stage, a country's success was mainly influenced by the type of containment measures taken, the effectiveness of their implementation and their timing. Some countries managed to contain the pandemic effectively and quickly; others did not. This had direct consequences for the overall impact of the pandemic on economic activity within each country (see Box 1.1).

The measures implemented to contain the pandemic, however, came with a cost. In the medium to long run, the economic benefits of these measures have been shown to be greater than their costs (IMF 2020). But, in the shorter run, stricter containment measures were associated with larger drops in economic activity (see Figure 1.4). In both IEs and DEIEs, there is a positive association between the average level of stringency since the start of the pandemic and the projected output loss by 2021.

With the development of vaccines, success in controlling the health emergency is rapidly turning towards the speed of vaccine rollout, as this enables countries to lift containment measures and reignite economic activity (see Figure 1.5). For this reason, the speed of economic recovery—and hence the overall output loss projected by 2021—heavily depends on the opportunities of countries to access and roll out COVID-19 vaccines.

As shown in Figure 1.5, faster vaccination campaigns (proxied by the shares of the population fully vaccinated by October 2021) are associated with a greater ability to lift containment measures (proxied by the change in the Stringency Index since the start of the campaigns).⁶ This is particularly noticeable in the cases of Northern and Western Europe and the European Union among IEs, and West Asia and Latin America among DEIEs; these regions are leading the ranks of fully vaccinated people and presenting larger declines in the level of stringency in their containment measures (lower-right quadrant in both panels of Figure 1.5).

Vaccination at the global level had two different speeds and created a global divide

Vaccination at the global level, however, had two different speeds: by October 2021, IEs had, on average, about 60 percent of their population fully vaccinated, whereas this was the case for only 28 percent of the population in DEIEs. This created a global divide of two blocs: a group of countries that can start normalizing economic activity (almost all IEs) and those that will still contend with prospects of resurgent infections and rising COVID death tolls (IMF 2021b). As discussed later in this chapter, at the roots of this divide lie the extreme differences in the development of local pharmaceutical production capacity for essential medicines and vaccines, which constrains the possibility of DEIEs to access vaccines and other pharmaceutical products at scale and affordability (see Box 1.2).

Success in containing the pandemic, however, does not guarantee less socioeconomic impact (see Figure 1.6). In fact, even in countries with similar characteristics in terms of the severity of the health emergency and the stringency of the containment measures—as

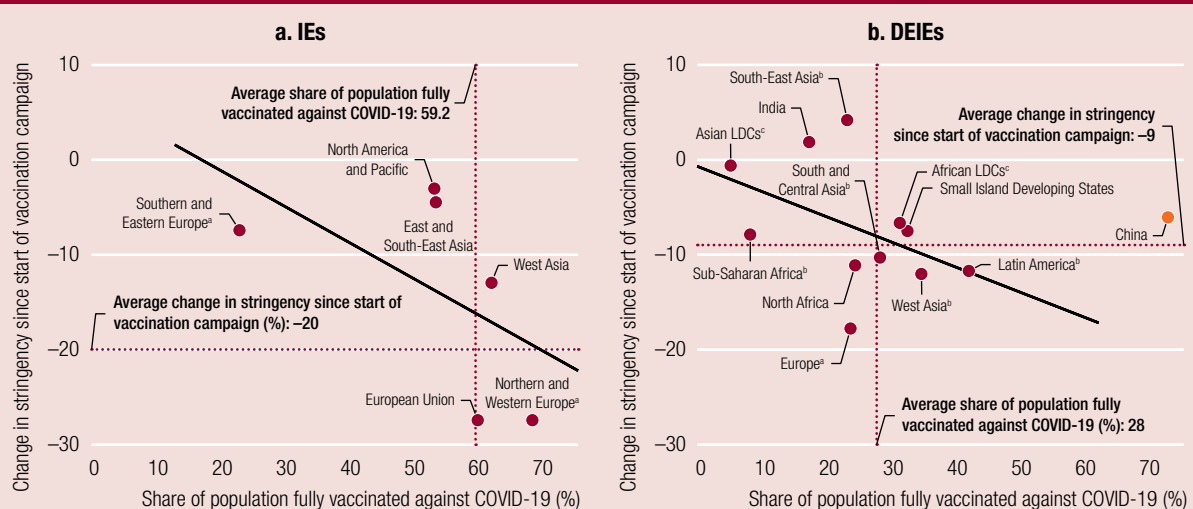
depicted by the regions of the figure—a wide range of outcomes in terms of output losses remains. These outcomes are reflected by the size of the bubbles in Figure 1.6: the largest losses are not necessarily located in those regions characterized by the largest severity and stringency.

Ultimately, the socioeconomic impact of the crisis depends on a broad set of factors that shape the resilience of countries. In general terms, *resilience* can be defined as “the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management” (UNDRR 2020).

Structural factors of resilience and the role of manufacturing industries

To fully understand why the pandemic had such diverse socioeconomic impacts across countries, one needs to

Figure 1.5
COVID-19 vaccine rollout and the lifting of containment measures, October 2021



Source: UNIDO elaboration based on Hale et al. (2021) (Stringency Index) and Our World in Data (population fully vaccinated against COVID-19).
 Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. Only countries that had 1 percent or more of their population fully vaccinated by 1 October 2021 have been considered. The start of the vaccination campaign is defined as the day in which a country surpasses one dose administered per hundred people. The change in stringency since start of vaccination campaign is defined as the difference in the score of the Oxford Stringency Index at the start of the vaccination campaign and the score on 1 October 2021. The Oxford Stringency Index records the strictness of “lockdown style” policies from zero (least strict) to 100 (most strict). The solid line indicates the linear regression estimate. In the case of DEIEs, the estimate excludes China, which is considered as an outlier in terms of the share of population fully vaccinated against COVID-19. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

Success in containing the pandemic does not guarantee less socioeconomic impact

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RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Box 1.2

The global pharmaceutical industry and COVID-19 vaccines

The COVID-19 pandemic has unveiled the vulnerabilities that all countries—but especially developing ones—face in accessing vaccines and other pharmaceutical products affordably and at scale. The pharmaceutical industry accounts for turnovers on the order of hundreds of billions of US dollars globally. In 2018, total spending on pharmaceutical products accounted for 8.5 percent of the GDP in Europe, 16.9 percent in the United States and 10.9 percent in Japan. The North American market alone accounts for half of the world's spending in pharmaceutical markets. Developing and emerging economies in Asia, Africa and Latin America account for less than 25 percent of the global market (EFPIA 2020).

While the industry is global, it is also dominated by a few major players. For example, the vaccine market alone before the pandemic accounted for around \$35 billion in sales. Four multinational companies account for 80–90 percent of the global supply of vaccines; they control this market either directly or indirectly by orchestrating complex supply chains and production establishments via licencing, contract development and manufacturing organizations. Smaller companies exist and tend to spin out from universities and other public research facilities. However, given the huge costs associated with clinical trials (especially Phase III trials) and drug manufacturing, smaller firms' products pipelines tend to be absorbed within larger global players via acquisition or various forms of licencing.

Vaccine development is typically hugely time and capital intensive and involves several risks. The average time needed to bring a candidate vaccine to market is more than 10 years. Capital investments for manufacturing vaccines are on the order of several millions of dollars (from \$70 to \$500 million) and involve a commitment of resources in highly specialized

assets. Even when trials have been successful and the vaccine formulation optimized, manufacturing readiness for production at scale must be built at the levels of both the plant and the supply chain. Vaccines contain several components, including active and added ingredients, and their volumes must match production at scale. Operating with large-scale volumes of ingredients affects the behaviour of the microorganisms used to produce active components of the vaccine, the biochemical and physiological interactions between components—and ultimately the amount of vaccine produced. Throughout this process, several tests are needed to make sure that the final product is as effective as the one developed through lab-scale experiments. Not only are these processes and steps complex, but some of them are also specific to the vaccine platform used.

Given these features, it is not surprising that COVID-19 vaccine manufacturing has been largely concentrated in advanced economies, except for a few countries with a widely developed pharmaceutical industry. Preparing for the future requires further efforts in the development of pharmaceutical industry capability in developing countries. This can be achieved only with the active support of the international community and structural reforms to the current Trade-Related Aspects of Intellectual Property Rights (TRIPS) regime acknowledging public contribution to vaccine development and its global public good nature. In building back from the COVID-19 crisis, local pharmaceutical production capacity for essential medicines and vaccines will be a critical priority to reduce dependency on international donations and to ensure resilience and preparedness for future crises.

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

examine the structural characteristics that shape overall resilience and assess the types of responses provided by firms and governments within the limits imposed by the pre-existing structural characteristics.

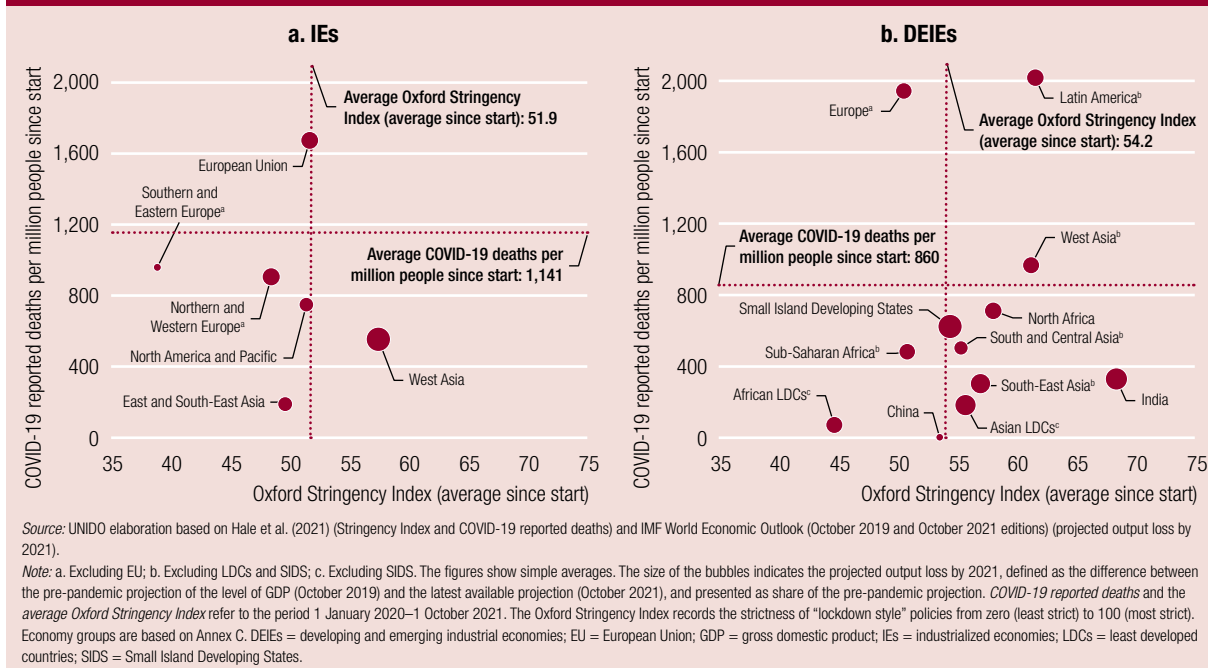
Which structural characteristics are relevant to this discussion in the case of the COVID-19 pandemic? Another look at Figure 1.6 shows that one feature of prime importance is the sectoral composition of the economy. On the one hand, economies that are more oriented towards services were more affected in their economic activity regardless of how severe the health emergency was. The social distance measures and travel

restrictions required to contain the virus had a harder impact on service activities than the rest. This becomes clear in the case of SIDS, which rely heavily on tourism activity. Despite presenting below average levels of severity and levels of stringency close to the DEIE's average, this group of countries shows the highest projected output loss by 2021 (see Box 1.3).

On the other hand, however, the COVID pandemic has also demonstrated that countries with stronger manufacturing systems have weathered the economic crisis better than the rest (see Figure 1.7). In stark contrast to the positive association observed

“ The impact of the crisis depends on a broad set of factors that shape resilience

Figure 1.6
Severity, stringency and economic impact: Where different economy groups stand, October 2021



between the Stringency Index scores and projected output losses, in this case a clear negative relationship emerges, for both IEs and DEIEs. This means that larger shares of manufacturing in GDP before the crisis (in this case, in 2019) are associated with lower projected losses in GDP growth.

The same is true when looking at the impact of COVID-19 on jobs (see Figure 1.8). Countries with larger manufacturing sectors have witnessed lower declines in overall working hours during 2020. This points again to the fact that the pandemic has hit service sectors more severely because of the nature of the shock. But, at the same, it also reflects the higher quality typically associated with manufacturing jobs, which are more stable, better paid and usually provide more benefits than non-manufacturing jobs, especially those from informal activities in services. This point will be discussed in further detail in the next section.

Besides offering more stable jobs than other sectors of the economy, manufacturing industries also play a key role in strengthening the socioeconomic resilience of countries faced with an extreme event such as

the COVID-19 pandemic. Among other factors, the industrial sector contributes to three dimensions of resilience (see Figure 1.9): (1) manufacturing industries are vital to providing essential goods that are critical to life and national security; (2) manufacturers play a role in supplying goods critical to tackling the emergency itself; and (3) the manufacturing sector contributes to the recovery and growth of national economies.

The manufacturing sector thus plays a crucial role in building the socioeconomic resilience of countries and regions. But the industrial sector itself has been severely affected by the pandemic, though with different levels of intensity across countries (see Figure 1.10). Whereas some country groups have been particularly deeply shaken by the crisis and show very large declines in industrial production during the worst quarter of the pandemic, other groups have been less affected and industrial production did not fall in those groups so dramatically. This is visible in the vertical axis of the figure, which shows the minimum level of production observed, on average, for each group. Overall, DEIEs were struck more forcefully than IEs,

“ To become less vulnerable SIDS need to advance their productive transformation

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RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Box 1.3

Challenges for Small Island Developing States

Small Island Developing States (SIDS) are a distinct group of islands facing unique social, economic and environmental vulnerabilities associated with their geographical particularities. SIDS are highly vulnerable to external economic and financial shocks (UNCTAD 2021b). Their small population size, remoteness from international markets, high transportation costs and a heavy reliance on services—particularly tourism—are among the key factors explaining SIDS’ economic vulnerability (UN-OHRLLS 2021).

These economies have been hit particularly hard by the COVID-19 pandemic and the international travel restrictions imposed to contain the spread of the virus. These measures have directly affected tourism flows at the global level. Tourism is the primary socioeconomic pillar of most SIDS, so the COVID-19 crisis has had devastating effects on their economies. On average, two in three people in these economies work in services, often in jobs related to tourism.

International tourist arrivals declined by 47 percent in SIDS during the first quarter of 2020; it could take up to four years for international tourism to recover to levels observed in 2019 (UN WTO 2021). As a result, these countries experienced a dramatic fall in GDP, estimated at 9 percent on average in 2020. Moreover, their recovery during 2021 was very slow (only 1 percent, on average), which places the latest estimates of GDP almost 14 percent below the 2021 GDP projected before the pandemic (see Figure 1.3). This shock has been translated into massive layoffs and sharp declines in foreign exchange and tax revenues. Women and informal workers have been particularly impacted.

Many governments took measures to help local firms during the pandemic. According to the data collected in the UNIDO COVID-19 firm-level survey, in Mauritius, for instance, around three-quarters of firms have received at least one type of public support, such as wage subsidies and access to credit. However, almost all firms surveyed expected that the crisis will have long-term negative consequences. Firms in Mauritius and other SIDS will still need additional support to build back better.

Crucially, to become less vulnerable to future crisis, these economies need to advance their productive transformation to diversify their economies and reduce their reliance on services; this is particularly important to reduce the risk from shocks in tourism flows. Industrial development can play an instrumental role in this ambitious endeavour.

To mobilize the agenda for promoting structural change in the region, in 2014 the UN adopted the Accelerated Modalities of Action Pathway (SAMOA Pathway), an overarching UN framework for guiding efforts to achieve the development aspirations of SIDS. Taking the SAMOA Pathway into consideration, UNIDO has developed its Small Island Developing States Strategy 2019–2025. Based on this strategy, UNIDO has launched several country- and regional-level Technical Cooperation (TC) projects that focus on four priority areas of the SAMOA pathway: sustainable, inclusive and equitable economic growth; climate change (including chemical and waste management); sustainable energy; and means of implementation.

Source: UNIDO elaboration.

but the heterogeneity within this group was also much larger—ranging from African LDCs, which show very little impact, to India, which shows a decline of more than 40 percent in industrial production after the initial shock of the pandemic.

By the same token, the speed of recovery in different economy groups has been very different: some countries had already surpassed the pre-pandemic levels of industrial production by the second quarter of 2021, while others were still largely behind. This is shown in the horizontal axis of the figure, which presents the relative change in industrial production since the start of the pandemic (that is, comparing the second quarter of 2021 with the fourth quarter of 2019). Looking at the two dimensions together it is possible to identify

four distinctive situations, depending on whether the initial shock was above (below) the groups’ average and whether the observed growth since the pandemic started was above (below) the groups’ average.

What have been the main channels of impact connecting the health emergency with the dramatic fall in industrial production observed during 2020? And which factors explain the different impact of these channels across countries? The next two sections will address these questions.

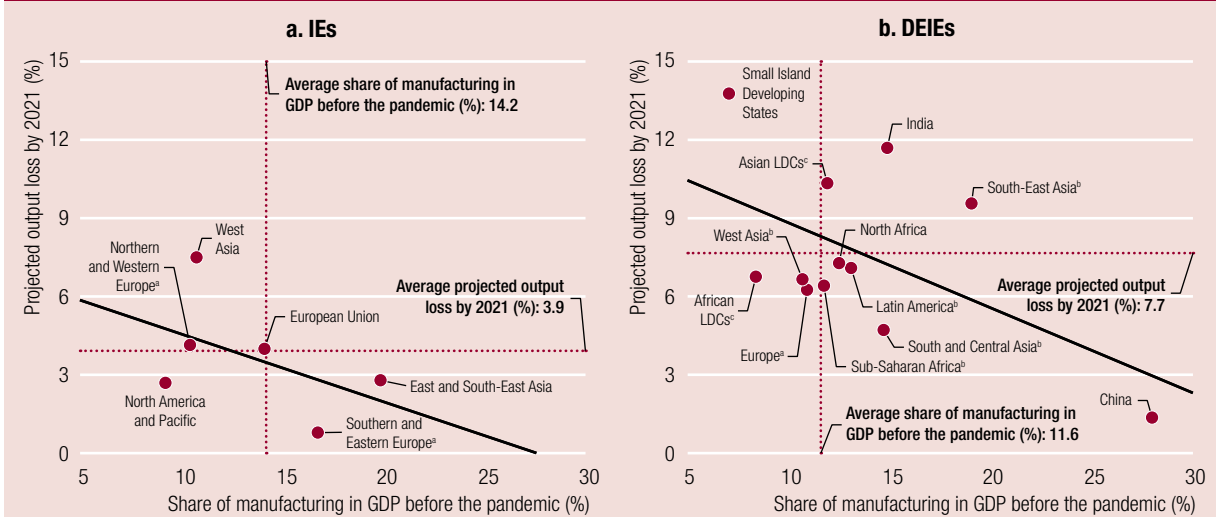
Mapping the crisis

This section presents a simple conceptual framework that links the COVID-19 outbreak with industrial production. This framework is used to identify the

Countries with stronger manufacturing systems have weathered the economic crisis better

Figure 1.7

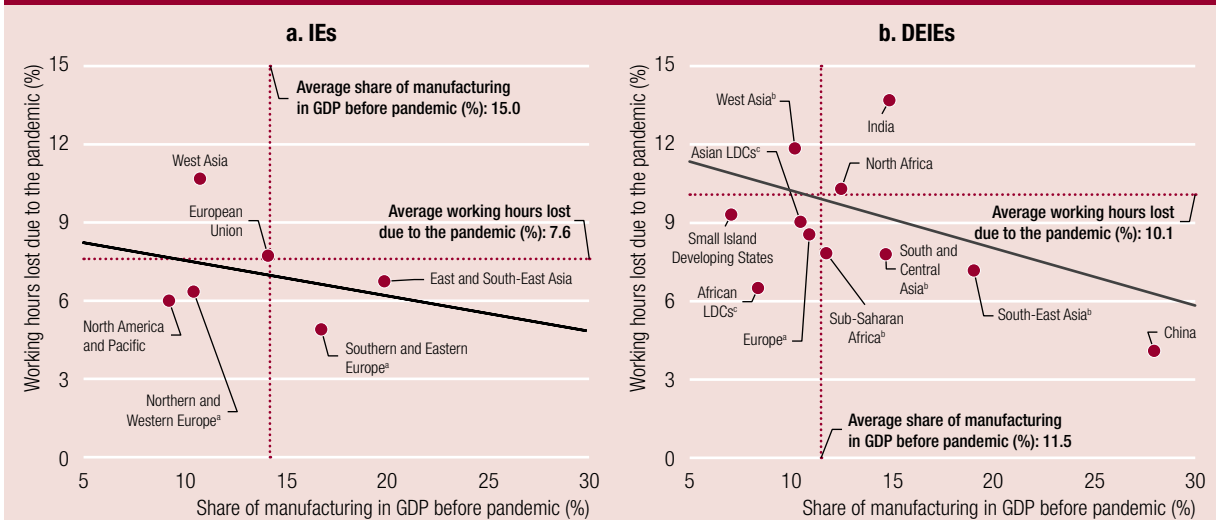
Impact of COVID-19 on economic activity by 2021 and relative size of the manufacturing sector before the pandemic, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss) and UNIDO MVA Database 2021 (UNIDO 2021b) (MVA share).
 Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. *Projected output loss by 2021* is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as share of the pre-pandemic projection. The solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; MVA = manufacturing value added; SIDS = Small Island Developing States.

Figure 1.8

Impact of COVID-19 on jobs during 2020 and relative size of the manufacturing sector before the pandemic, across economy groups



Source: UNIDO elaboration based on ILO (2021e) (working hours lost due to pandemic) and UNIDO MVA Database 2021 (UNIDO 2021b) (MVA Share).
 Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. *Working hours lost due to the pandemic* refers to the year 2020 only and are expressed relative to the total hours worked during 2019. They were estimated by the ILO following the approach described in ILO (2021e). The solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

Manufacturing plays a crucial role in building the socioeconomic resilience of countries

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RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Figure 1.9

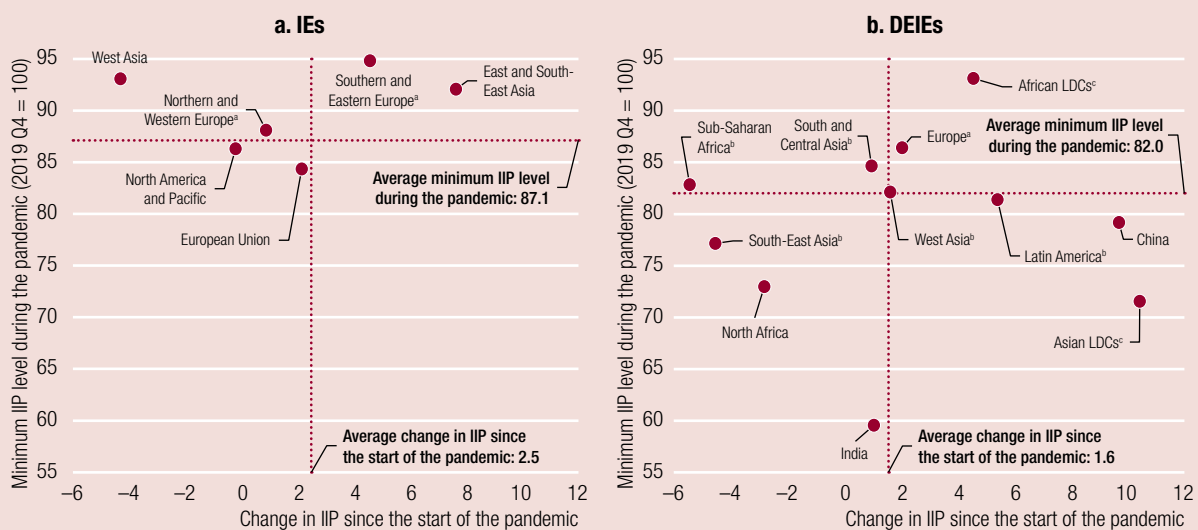
The role of manufacturing industries in strengthening socioeconomic resilience

- CRITICAL TO LIFE AND NATIONAL SECURITY**
 - Manufacturing provides goods that are critical for the sustenance of life—including food, drink, medicines, clothing, fuel and other basic necessities.
 - Manufacturing provides inputs (such as machinery, components, systems and engineering services) to critical national infrastructure (such as transportation, electricity and communication).
- CRITICAL TO TACKLING EMERGENCIES**
 - Manufacturing provides strategically important products and assets in combatting certain types of emergencies.
 - A shortage of COVID-19-critical items hindered countries' ability to respond to the crisis.
 - Different types of goods are required during different emergencies.
- CRITICAL TO ECONOMIC RECOVERY AND GROWTH**
 - Historically, manufacturing has been dubbed the “engine of growth” because of its contribution to productivity, trade, jobs and innovation.
 - In a number of countries, manufacturing industries have offered “pockets of resilience” supporting recovery from COVID-19, as well as from previous crises.

Source: UNIDO elaboration based on the background paper prepared by López-Gómez et al. (2021).

Figure 1.10

Impact of COVID-19 on industrial production and the speed of recovery across economy groups, 2019 Q4–2021 Q2



Source: UNIDO elaboration based on UNIDO Quarterly Index of Industrial Production Database (UNIDO 2021d).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. The IIP is seasonally adjusted. Country coverage by group is reduced due to data availability. The change in IIP since the start of the pandemic (horizontal axis) is defined as the difference in the level of IIP between 2019 Q4 and 2021 Q2 (latest available data). Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; IEs = industrialized economies; IIP = Index of Industrial Production; LDCs = least developed countries; SIDS = Small Island Developing States.

“ The crisis simultaneously impacted the demand and the supply side

main channels of impact and the underlying factors that can help explain the different socioeconomic outcomes presented in the previous section.

Connecting the pandemic to industrial production

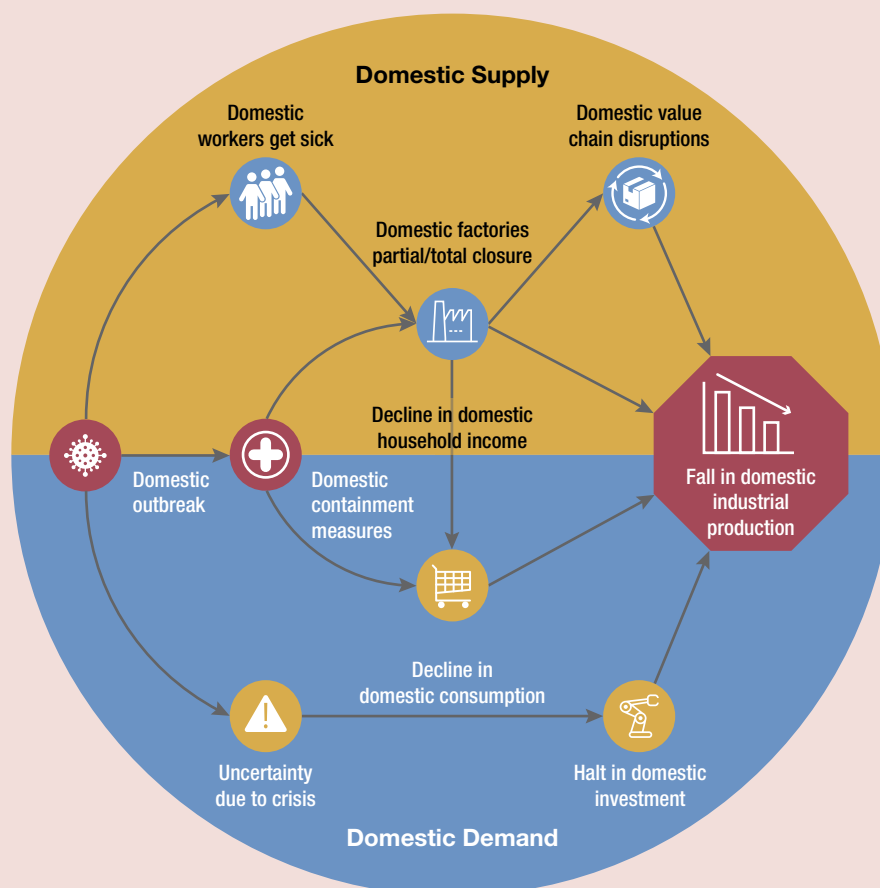
A first distinguishing feature of the COVID-19 crisis is its simultaneous impact on both the demand side and the supply side, illustrated in Figure 1.11. The figure presents the channels of impact within a country (referred to here as *domestic channels*).

On the supply side (the upper part of the figure), the outbreak of the pandemic initially affected domestic industrial production through a health-related channel, as manufacturing workers got sick

and factories closed or reduced their production. This was the case in the early stages of the crisis, when isolated outbreaks led to the closure of some factories. As the virus continued to spread, domestic authorities began introducing a number of containment measures that directly affected the operations of local factories and, consequently, overall industrial production. This effect was exacerbated when local supply chains were disrupted. It was also exacerbated when firms that had not previously been directly impacted by local restrictions could no longer produce because of shortages in key inputs and components.

In most cases, the supply-side effects triggered a decline in economic activity. These initial supply-side effects were reinforced and magnified by the

Figure 1.11
The framework: Connecting the COVID-19 outbreak to industrial production (domestic channels)



Source: UNIDO elaboration.

“ A second distinguishing feature of the COVID-19 crisis is its truly global nature

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RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

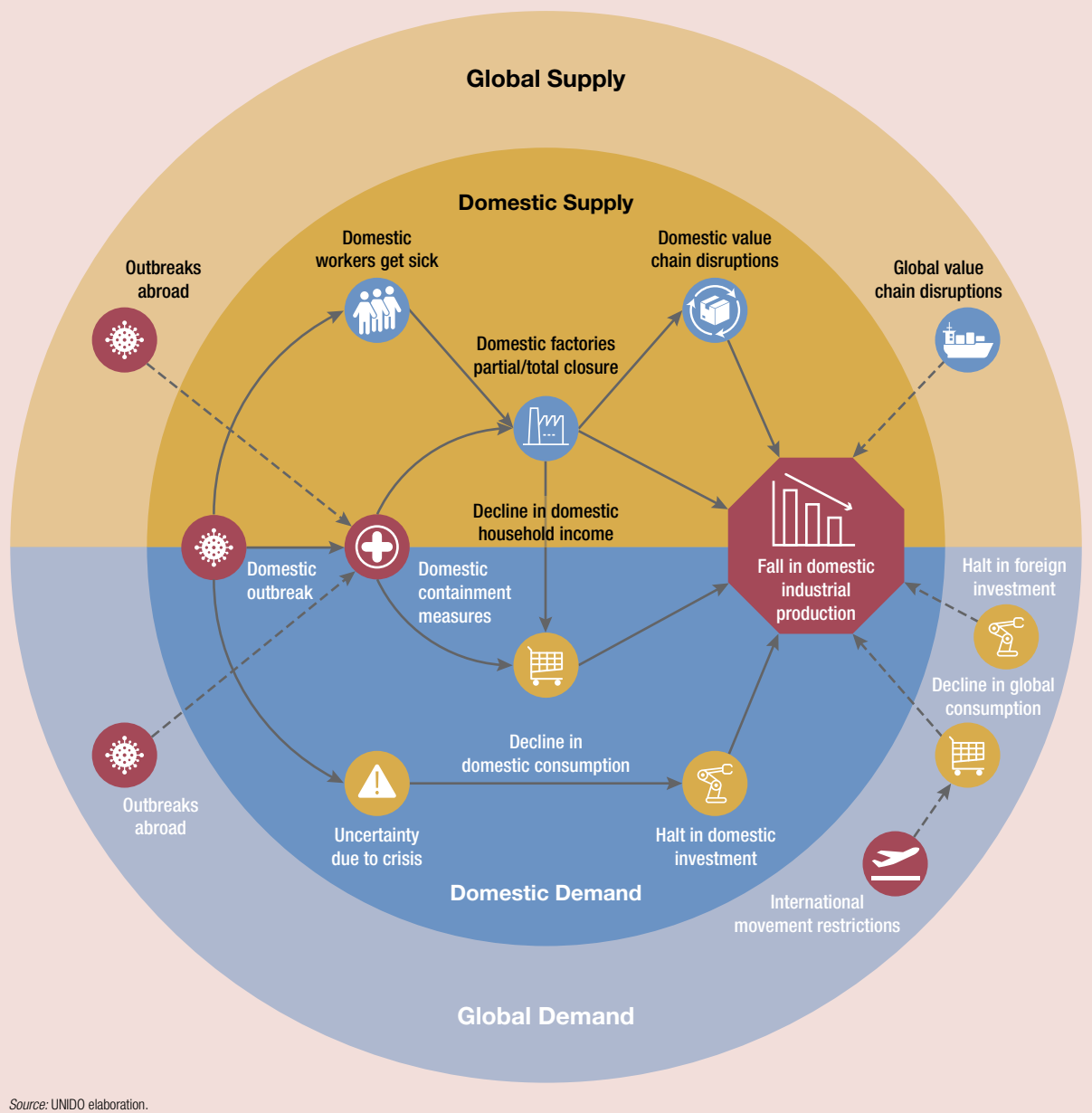
demand-side effects that followed (the lower part of Figure 1.11). The impact of COVID-19 on the domestic consumption of industrial goods tended to be very high because of the combined effect of the containment measures (most of which had a direct impact on the retail sector) and the decline in household income due to layoffs resulting from factory closures or reduced operations. This self-reinforcing effect was

spurred by a plunge in investments, as firms and investors postponed or cancelled investment projects as a result of the uncertainty generated by the crisis.

The narrative for one economy is comparable with that for nearly all other economies around the world: a second distinguishing feature of the COVID-19 crisis is its truly global nature. This is depicted in Figure 1.12, which expands the framework to consider

Figure 1.12

The framework: Connecting the COVID-19 outbreak to industrial production (domestic and global channels)



Source: UNDO elaboration.

“ These channels operates differently depending on the context and responses implemented

global supply and demand channels of impact as well as domestic ones. It also underscores the fact that outbreaks abroad can trigger domestic preventive measures that initiate/reinforce the local effects, even in countries that successfully contained the first waves of the pandemic.

On the supply side, global value chain (GVC) disruptions severely impacted globalized domestic firms, which faced difficulties delivering their orders because of shortages of key components. These shortages became evident even before COVID-19 turned into a pandemic, as several GVCs were disrupted by the outbreak in China in the initial phase of the crisis. Almost two years later, shortages and disruptions of value chains continue to be a key element of concern around the world. Although supply has played an important role in this regard, the most detrimental effects were again attributable to the demand side.

As the epidemic turned into a pandemic and countries began implementing containment measures, global demand for manufactured goods dipped significantly and export-oriented firms saw a sharp decline in their orders. The slump in global demand had three complementary sources: (1) a general decrease in global consumption; (2) a halt in foreign direct investment and (3) the imposition of international travel restrictions, which had an unprecedented impact on tourism-related activities.

The combined effect of these channels of impact also leads to sudden increases in some key global prices such as internationally traded energy sources, raw materials, chips and electronic components, chemicals and food. Such changes in international prices are likely to have a major, highly differentiated and persisting effect on the recovery after the COVID-19 crisis. These price increases originated in the disruptions in supply systems discussed above in combination with broader problems of technological change, complications in the organization of shipping and logistics, the vulnerability of just-in-time supply systems, the presence of market power by oligopolistic firms and the imbalance of power between advanced and less developed economies (Pianta 2021).

A specific problem concerns food prices. According to the Food and Agriculture Organization of the United Nations (FAO) and the World Food Programme (WFP), the increase in world food prices has reached 30 percent above the average for 2014–2016. This rise is particularly strong in DEIEs and LDCs in Africa and Asia, with increases in the cost of the food basket of more than 30 percent (compared with the previous five years) for many countries in sub-Saharan Africa, as well as for Pakistan, Turkey, and Viet Nam. This rise is disproportionately hitting the poorest countries and those affected by major conflicts, leading to an estimated 320 million people who lost access to adequate nutrition in 2020 alone (FAO et al. 2021).

For DEIEs and LDCs with high foreign debt and a strong dependence on the imports of high-tech goods, an increase in import prices, international interest rates and foreign debt servicing may compromise balances of payments and government budgets, which in turn risks slowing their post-pandemic recovery and opening up new fronts of domestic crisis (Pianta 2021).

Taken together, the framework depicted in Figure 1.12 identifies seven channels through which the pandemic directly affected industrial production. Figure 1.13 summarizes these channels and provides snapshot evidence on how severe each of them have been for manufacturing firms operating in a subset of DEIEs, building on a recent survey on the impact of COVID-19 conducted by UNIDO across 26 countries.⁷ Figure 1.14 illustrates the importance of each of these channels and their differential impacts across different types of firms.








Each of these channels operates differently, depending on the country context and the responses to the pandemic implemented by domestic actors. The importance of the channels also depends on the type of firm affected (see Figure 1.14). The major concern for most firms is typically either the fall in consumer demand due to the crisis or the increased cost of inputs. This is very stable across the regions where the survey took place (Africa, Asia and Latin America) and across type of firm (small and medium-sized enterprises, or SMEs, and large firms). In all groups, two-thirds of

“ The major concern for firms was either the fall in demand or the increased cost of inputs

1

Figure 1.13

Channels of impact and evidence from selected DEIEs

Supply		Evidence from manufacturing firms
	Domestic factories partial/total closure	6% of firms surveyed dropped from business and 31% temporarily closed for at least 4 weeks; 10% temporarily closed for more than 3 months.
	Disruptions in domestic value chains	71% of firms surveyed indicated facing shortage of inputs since the beginning of the COVID-19 pandemic.
	Disruptions in global value chains	This amount jumps to 77% in the case of those firms that self-reported as participating in global or regional value chains.
Demand		Evidence from manufacturing firms
	Decline in domestic consumption	For 39% of firms surveyed, decline in clients' purchases was the #1 problem faced.
	Halt in domestic investment	28% of firms are planning to reduce their investments in new equipment.
	Halt in foreign investment	This amount jumps to 34% in the case of FDI firms.
	Decline in foreign consumption	41% of exporting firms indicated fall in demand as the #1 problem faced.

Source: UNIDO elaboration based on UNIDO COVID-19 firm-level survey (2021).

Note: Blue = domestic supply; yellow = domestic demand; green = international supply and demand. FDI = foreign direct investment.

Figure 1.14

Top five most important challenges faced by manufacturing firms in selected DEIEs since the start of the pandemic, across regions and firm types

Order of importance	SMEs [N = 2,010]			Large firms [N = 1,039]		
	Africa	Asia	Latin America	Africa	Asia	Latin America
1	Increased cost of inputs (33%)	Fall in demand due to crisis (34%)	Increase cost of inputs (33%)	Fall in demand due to crisis (34%)	Increase cost of inputs (34%)	Increase cost of inputs (30%)
2	Fall in demand due to crisis (31%)	Increase cost of inputs (26%)	Fall in demand due to crisis (32%)	Increase cost of inputs (28%)	Fall in demand due to crisis (27%)	Fall in demand due to crisis (25%)
3	Supply chain disruptions (10%)	Fall in demand due to restrictions (10%)	Supply chain disruptions (12%)	Supply chain disruptions (14%)	Supply chain disruptions (10%)	Supply chain disruptions (14%)
4	Fall in demand due to restrictions (9%)	Workers shortage due to restrictions (9%)	Fall in demand due to restrictions (9%)	Fall in demand due to restrictions (8%)	Workers shortage due to restrictions (9%)	Workers shortage due to illness (13%)
5	Problems in delivering (8%)	Problems in delivering (8.5%)	Workers shortage due to illness (4%)	Workers shortage due to restrictions (6%)	Problems in delivering (7%)	Fall in demand due to restrictions (8%)

Source: UNIDO elaboration based on the data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Problems are ranked by the share of firms in each group indicating that problem as the most important faced since the beginning of the pandemic. The survey sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

“ The long-run impact of COVID will depend on how it interplays with the megatrends

firms indicate one of these two as the most important problem faced. Supply chain disruptions and fall in consumer demand due to the containment measures implemented by governments are the third and fourth main problems reported. After that comes shortage in workers, typically related to the containment measures (in the cases of Asia and Africa) but also related to the illness itself in countries where the severity of the pandemic has been particularly strong (mainly in Latin America). To different degrees, all channels presented in the conceptual framework are acknowledged by manufacturing firms.

Implications for inclusive and sustainable industrial development

As discussed earlier, the magnitude of impact faced by different countries—and its duration—depend on their level of socioeconomic resilience.

The short-term (observed) impact of the crisis depends on a country's structural characteristics (which define the robustness of its ability to absorb shocks) and the type of responses it implemented (which reflect the country's readiness to manage the shock).

In the long run, the impact of COVID will depend on how it interplays with the other megatrends likely to affect industrial development in the years to come, reviewed earlier in this chapter; it will also depend on other existing structural problems, such as a lack of skills, weak infrastructure or low productivity. Understanding the long-term effects of the pandemic on industrialization therefore also requires an analysis of the relationship between the channels discussed above and these megatrends (see Chapter 3 for this discussion).

The future of industrialization will also depend on the actions and measures the international community and governments around the world take today to (re)direct the world towards an inclusive, sustainable and resilient recovery, and to build back better from the COVID-19 pandemic (as will be discussed in Chapter 4).

Understanding the short-run and long-run impacts of the pandemic on the manufacturing sector

is especially important because industrial production has broad effects on sustainable development and on the capacity of countries to achieve the SDGs. As discussed in UNIDO (2020b), the industrial sector plays a fundamental role in driving shared prosperity—this sector creates jobs, incomes, innovations and multiplier effects that can also ignite other parts of the economy. For this reason, the achievement of SGD 9 is also key for the achievement of many other SDGs from the UN Agenda 2030 (see Figure 1.15). The pandemic's detrimental effect on the industrial sector can thus reinforce the direct impact of the crisis on all dimensions of sustainable development.

A fall in industrial production, closed factories and laid-off workers lead to higher unemployment, greater income inequality and more poverty, negatively affecting the realization of SDGs 1, 5 and 10 in both the short and the long run. These negative impacts are magnified by the fact that the most affected actors tend to be those already vulnerable: SMEs and female and youth workers.

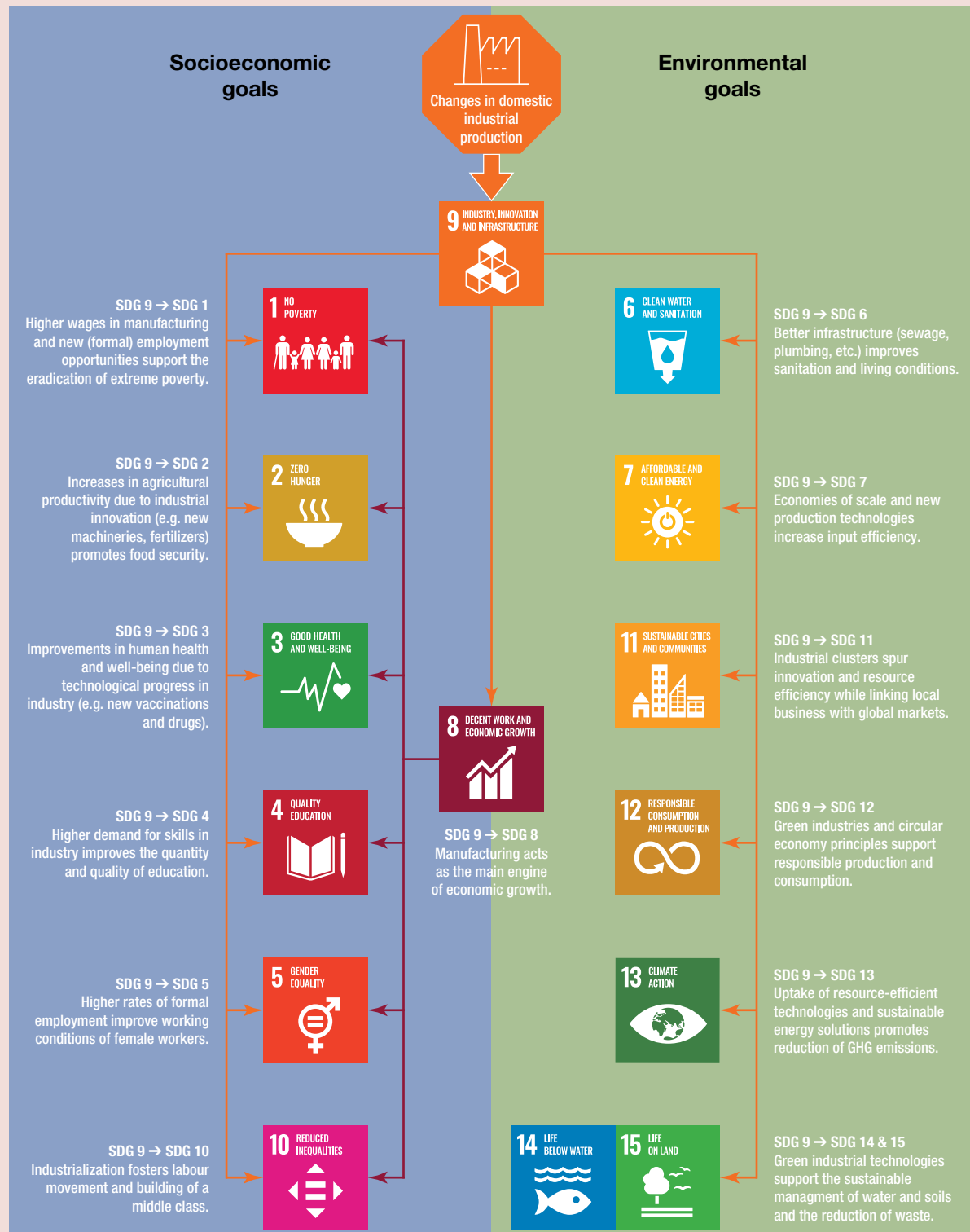
The analysis for this report confirms the vulnerability of female workers in the face of the pandemic (Braunstein 2021). Here again, it is possible to distinguish both demand-side and supply-side factors explaining the higher exposure of women to the channels described above (see Table 1.1)

The simultaneous effects of these demand-side and supply-side channels led to a decline in women's labour force participation during 2020, which was much larger than that for men. Available data from the International Labour Organization (ILO)'s short-term labour force statistics indicate an average decline for women's labour force participation in DEIEs of 6.1 percent in 2020, which is 50 percent above that for men. Even more dramatic is the decline in the employment-to-population ratio for women, which fell by 7.8 percent in 2020. As this fall was more pronounced than in the case of men, the relative ratio—that is, the gender gap in employment rates—dropped by 1.7 percentage points. Such a decline would be equivalent to about one-fourth of all progress in the last 30 years in terms of the female employment rate as compared with

Industrial production has broad effects on the capacity of countries to achieve the SDGs

Figure 1.15

From industrial production to the UN Agenda 2030 for sustainable development



Source: UNIDO elaboration based on UNIDO (2020b).
Note: GHG = greenhouse gas; SDG = Sustainable Development Goal.

“ The most affected actors tend to be those already vulnerable: SMEs and female workers

Table 1.1

The disproportionate effects of the pandemic on female workers

Factor type	Effects
Demand-side factors	<ul style="list-style-type: none"> Globally, women are concentrated in the sectors hardest hit by lockdowns and closures, including manufacturing, accommodation and food service, retail and hospitality, and real estate business and administrative activities. Together, these industries employ 40 percent of women versus 37 percent of men. Within manufacturing, women working in export-oriented production were at particularly high risk of job loss or cuts in hours as a result of the supply chain disruptions and the slowdown in global trade triggered by the pandemic. Women also tend to rely more than men on informal, small enterprise and self-employment activities. These are the types of occupations more exposed to closure and declining demand. Traditional social norms and gender-based discrimination in deciding who to let go when demand declines also magnifies the impact on female workers.
Supply-side factors	<ul style="list-style-type: none"> Women's disproportionate responsibility for unpaid care work puts most of the burden of the increased need for unpaid care induced by the pandemic on women (such as school and childcare closures, the need to care for the sick, problems at long-term care facilities necessitating transfers home). The short-term withdrawals of women to bear the increased need for unpaid care might lead to longer-term reversals in the progress achieved on gender inequality in the labour market.

Source: UNIDO elaboration based on the background paper prepared by Braunstein (2021).
 Note: These issues are not confined to any particular region but are observed globally.

the male rate.⁸ If this trend is not reversed, not only will women lose ground in terms of their employment rate compared to that of men, but it will also amount to a loss of seven years of progress on gender equality in employment (Braunstein 2021).

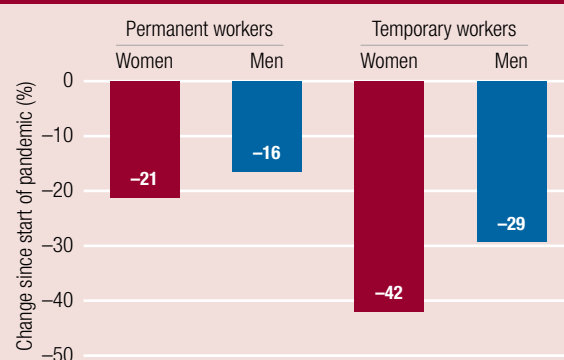
Within manufacturing it is also possible to see a more severe impact on women than men, especially among those with temporary jobs (see Figure 1.16).

Women's experience illustrates the finding that the effects of the pandemic have been particularly severe on the most vulnerable actors of society, bringing attention to important issues about the social inclusiveness dimension of inclusive and sustainable industrial development (ISID) and the achievement of those SDGs related to socioeconomic goals of the UN 2030 Agenda (left part of Figure 1.15).

In clear contrast, the economic recession triggered by the pandemic slowed economic activity in major greenhouse gas (GHG)-intensive subsectors of industry, which led to significant reductions in GHG emissions compared with previous years (Karapinar 2021). This could potentially bring positive effects on those SDGs related to environmental sustainability. However, this effect was not universal—the impact of the

crisis on GHG emissions varied significantly across countries. Moreover, even the global decline in emissions during 2020 was still below the yearly decline needed to meet the goals of the Paris Agreement (UN 2020).

Figure 1.16
Drop in employment: Temporary and permanent workers, by gender



Source: UNIDO elaboration based on the background paper prepared by Braunstein (2021), derived from the data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Permanent workers work for a term of one or more fiscal years. Temporary workers work for a term of less than one fiscal year. The figure shows the average fall in employment, corresponding to the average share of laid-off workers over the total number of workers in December 2019. Only firms that provided valid responses on women's share of workers, women's share of workers laid off, and change in monthly sales are considered (N = 1,055). The sample covers 26 DEIs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIs = developing and emerging industrial economies.

The industrial sector's carbon dioxide (CO₂) emissions decreased by 6 percent globally in 2020, but with large differences across countries (see Figure 1.17). India, for instance, accounted for the largest drop in CO₂ emissions, amounting to a fall of almost 15 percent during 2020—equivalent to more than 20 percent of the world's reductions in CO₂ industrial emissions in that year. This contrasts with the case of China, where emissions fell by 3 percent, or about 11 percent of the total reduction in emissions worldwide.

Clearly, the different impact of the crisis on economic activity explains an important part of the difference in countries' GHG emissions declines. But this was not the only factor at play. Industry composition and each country's energy mix were also key elements behind the heterogeneous behaviour of GHG industrial emissions (Karapinar 2021). India, for instance, was not only severely hit by the crisis (as seen before in terms of output losses) but also affected most severely

in all energy-intensive manufacturing industries—textiles, paper, refined petroleum, chemicals and basic metals. In clear contrast, China was affected relatively mildly in these industries, so the contrast between pre- and post-pandemic emissions in that country was more limited.

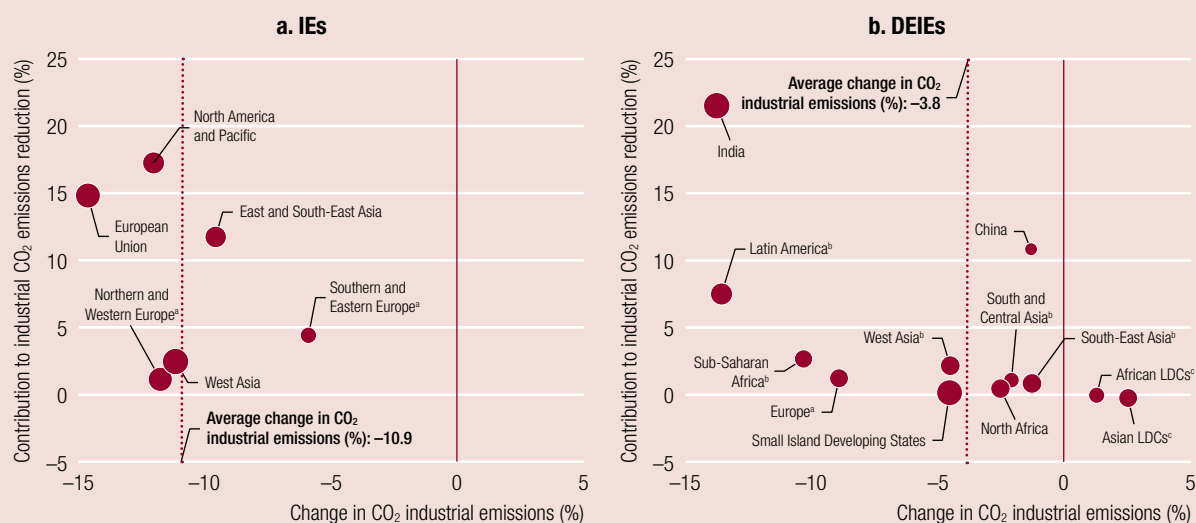
Changes in the energy mix were also observed during the crisis. During the first half of 2020, the carbon intensity of energy production decreased across all major regions (IEA 2021). Countries opted for renewable energy sources because of their low operating costs and because they offered priority access to the grid. However, the electricity mix reverted to previous trends in the second half of 2020 and has remained at roughly pre-pandemic levels. Hence, the effect of the changes observed in the energy mix during the crisis on industrial GHG emissions is likely to be limited.

It follows that most of the reduction in GHG emissions is likely to be temporary and will revert with the recovery. The prospect of achieving carbon neutrality

“ The impact of the crisis on GHG emissions varied significantly across countries

Figure 1.17

Estimated reduction in industrial CO₂ emissions and contribution to total reductions across economy groups, 2020



Source: UNIDO elaboration based on the background paper prepared by Karapinar (2021), using data derived from IEA (2021) (CO₂ industrial emissions) and IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss in 2020).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. Change in GHG industrial emissions refers to the difference between the sum of all CO₂ emissions in that group in 2019 and the sum in 2020. Industrial CO₂ emissions for these years have been estimated based on the countries' manufacturing carbon intensity reported for 2018 by the IEA (2021). The size of the bubbles indicates the projected output loss in 2020, defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021), and presented as a share of the pre-pandemic projection. Economy groups are based on Annex C. CO₂ = carbon dioxide; DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

“ The crisis brought resource efficiency and the circular economy to the forefront

by mid-century, which the Paris Agreement implies, will largely depend on post-crisis industrial policies and practices. An important aspect to consider is that the crisis has brought discussions of resource efficiency and the circular economy to the forefront of the industrial sector’s policy agenda. A substantial potential exists to improve resource efficiency and reduce energy consumption, and hence to improve supply security, resilience and competitiveness (see Box 1.4).

In fact, since the beginning of the pandemic, many governments have launched packages and measures aimed at economic recovery. They include primarily the energy, transport and food sectors. While some of these packages include a set of green measures directed towards promoting renewable energy, electrifying vehicles and retrofitting buildings, some brown measures—such as fossil fuel subsidies or relaxed environmental regulation—have also been observed. Whether and to what extent green measures will predominate in the post-COVID-19 era and whether they will successfully initiate transformational change in the industrial sector will depend on a range of political and policy factors to be discussed in subsequent chapters of this report.

Why did some countries do better? Factors shaping socioeconomic resilience

The diversity in the impact of the pandemic across countries documented earlier in the chapter reflects differences in underlying structural factors of resilience and differences in the types of responses given by manufacturing firms and governments. This section focuses on the former, looking into three broad structural factors: industry composition, global integration, and existing industrial and government capabilities. Responses from firms and government constitute the core of the next chapter.

Industry composition and economic resilience

As shown in the previous section on mapping the crisis, economies with larger manufacturing sectors have, on average, suffered less in terms of socioeconomic impact. However, not all manufacturing industries have behaved in the same manner. Some industries were more affected than others, as were the countries specializing in those more vulnerable industries. The contrasting behaviour of different industries can be

Box 1.4

Promoting energy efficiency and renewable energy deployment in SME clusters in India

The Indian manufacturing sector relies primarily on coal, oil and gas for energy generation. Among these energy sources, coal continues to be the dominant fuel. Among the most energy- and emission-intense manufacturing agents are micro-enterprises and SMEs (MSMEs), particularly in industries such as the metallurgic and metals industry, glass and ceramics production, and agro-processing activities. Often co-located in clusters, MSMEs are estimated to contribute around 45 percent of manufacturing output and 40 percent of exports, and to be a substantial source of employment generation.

Stimulating the diffusion of energy-efficient practices and renewable energy sources within India’s manufacturing MSME clusters will therefore have an important impact on environmental sustainability. With this goal in mind, UNIDO has selected 12 energy-intense clusters to work with. The project works at the level of both clusters and national policy.

Helping MSMEs switch to energy-efficient and renewable technologies will improve the productivity and competitiveness of local firms while reducing their overall CO₂ emissions, and thereby improve the local environment.

MSMEs face numerous technological as well as demand- and supply-side barriers to the adoption of energy-efficient practices including, crucially, lack of awareness of the economic and environmental benefits of new technologies. Against this backdrop, the project focuses on capability building to support MSMEs plan and implement energy-efficient practices and renewable deployment. It also aims at strengthening the capacity of local providers of energy-efficient and renewable energy technologies and finance, including cluster-level organizations, and to disseminate knowledge and best practices among the 12 clusters.

Source: UNIDO elaboration.

“ Not all manufacturing industries have behaved in the same manner

1

RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

illustrated by considering four contrasting examples: pharmaceuticals, food products, electrical equipment and wearing apparel (see Figure 1.18).

Each panel in Figure 1.18 shows the evolution of the Index of Industrial Production at the global level for the corresponding industry. The four industries have been ordered according to two criteria: the depth of the initial impact of the crisis and how quickly they managed to recover afterwards.

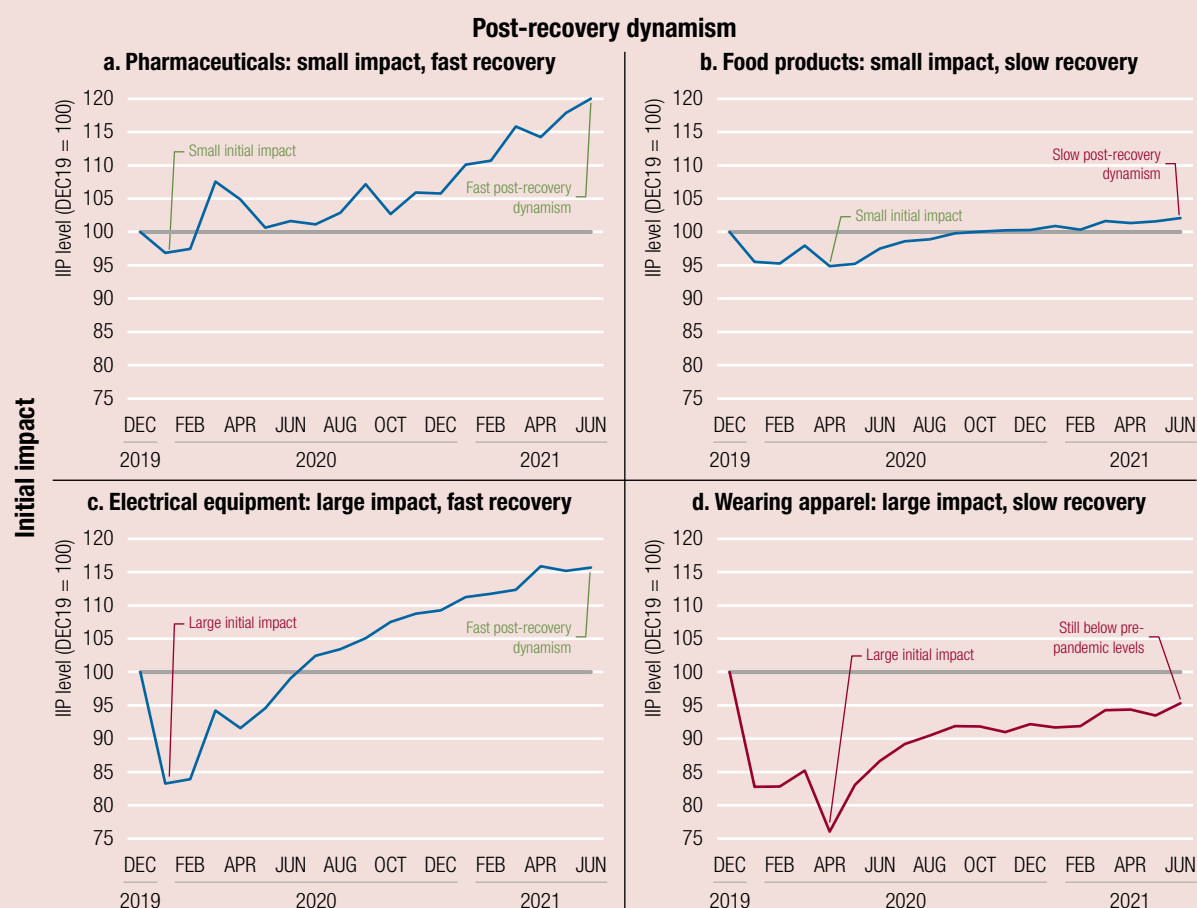
The first case—pharmaceuticals—illustrates the trajectory of those industries that were less affected by the pandemic, and even faced a demand boost due to the nature of the crisis. The initial shock was very small

(falling only 3 percent), and in February 2020 the industry was already operating at pre-pandemic levels. Health requirements to face the pandemic also created a strong demand for pharmaceuticals, and production continued to rise at a steady pace, reaching 20 percent above the pre-pandemic level by June 2021.

The second case—food products—illustrates the trajectory of industries that produce goods that, by their nature, have been typically defined as “essential” by governments around the world and were exempted from most of the containment measures and movement restrictions imposed to contain the virus. In these industries, the shock of the crisis has been relatively

Figure 1.18

Evolution of monthly index of world industrial production for selected industries: Differences in initial impact and post-recovery dynamism, December 2019–June 2021



Source: UNIDO elaboration based on UNIDO Monthly Index of Industrial Production Database (UNIDO 2021c).

Note: The IIP is seasonally adjusted. The figure shows weighted averages for all countries with available data (36 IEs and 44 DEIEs). DEIEs = developing and emerging industrial economies; IEs = industrialized economies; IIP = Index of Industrial Production.

Two broad sets of global industries are distinguished: robust and vulnerable

smaller, but the growth rate after reaching the pre-pandemic levels—when the index again surpassed 100—has not necessarily been quick. Food products, for instance, have grown only 2 percent between August 2020 and June 2021.

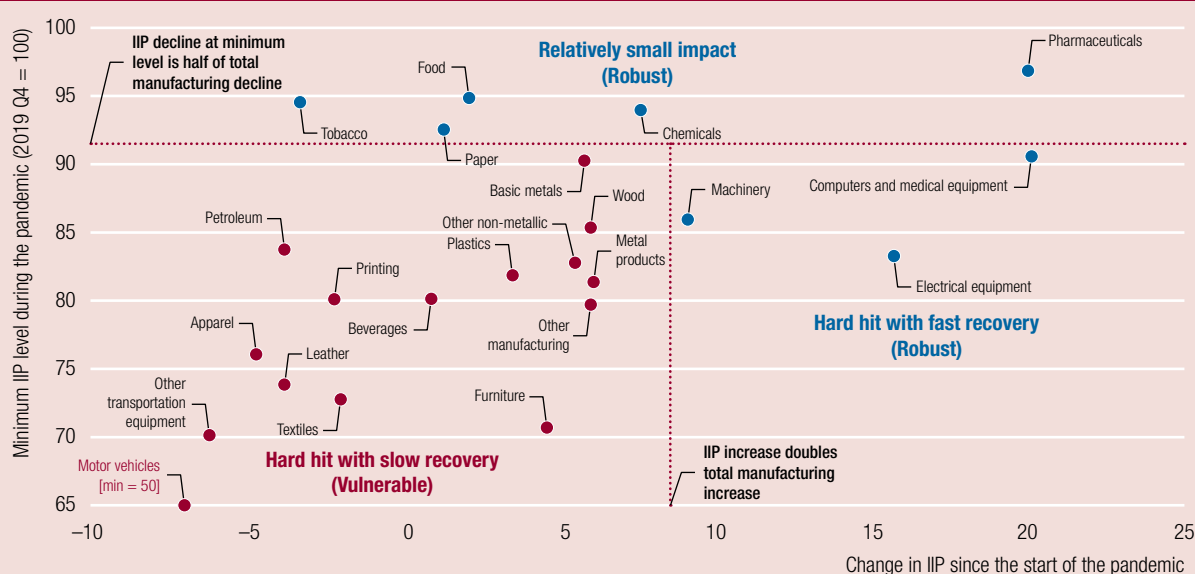
The third case—electrical equipment—presents a trajectory that, despite showing a very strong initial impact (falling by 17 percent in only two months), managed to recover very quickly. As seen in the figure, by June 2020 this industry was already operating at pre-pandemic levels and one year later was almost 16 percent above that level.

These three industries can be regarded as robust in the face of the COVID-19 crisis: they either were not severely hit by the initial impact or, if they were, they managed to recover very quickly and remained robust after recovering their pre-pandemic levels. The fourth case—wearing apparel—illustrates the opposite trajectory: this industry not only was very severely hit by the initial impact (losing almost 25 percentage points in just four months) but it did not manage to recover afterwards. By June 2021, the level of

industrial production of wearing apparel was still 5 percent below its pre-pandemic levels. Such behaviour reflects a larger vulnerability to the type of channels of impact triggered by the pandemic. Declines in demand, disruptions of value chains and initial shortages of workers were all elements directly affecting industries such as wearing apparel, characterized by their high labour intensity, high levels of fragmentation across national borders, low wages and low levels of innovation.

The cross-industry differences illustrated by these examples needs to be factored in when analysing why some countries were more affected by the pandemic than others. Two broad sets of global industries are distinguished with this purpose: robust ones—those behaving like pharmaceuticals, food or electrical machinery—and vulnerable ones—those behaving like wearing apparel. The distinction is done by comparing the two dimensions depicted in Figure 1.18 (namely, minimum level of production after initial impact and rate of growth during recovery phase) against the global average for all industries covered

Figure 1.19
Typology of global industries according to the observed impact of COVID-19 and the speed of recovery, 2019 Q4–2021 Q2



Source: UNIDO elaboration based on UNIDO Quarterly Index of Industrial Production Database (UNIDO 2021d).
 Note: The IIP is seasonally adjusted. The graphs show weighted averages for all countries with available data. Dotted lines show the thresholds used for the characterization of the global industries. The change in IIP since the start of the pandemic (horizontal axis) is defined as the difference in the level of the IIP between 2019 Q4 and 2021 Q2 (latest available data). IIP = Index of Industrial Production.

“ This typology of industries is quite stable when looking separately at IEs and DEIEs

in the UNIDO data set—23 industries of the International Standard Industrial Classification Revision 4 (ISIC rev 4) at 2 digits (see Figure 1.19). Industries that either show a decline due to the pandemic that is half the average decline (horizontal line) or growth that doubles the average growth during the period (vertical line) are characterized as “robust.” Those below these thresholds, instead, are characterized as “vulnerable.”

The groups obtained using these thresholds are in line with other characterizations in the literature.⁹ Among the robust industries are producers of essential goods (food and chemicals, but also paper), industries that faced increasing demand as a result of the

health emergency (pharmaceuticals, computers and medical equipment) and capital-intensive, high-tech industries that managed to bounce back rapidly from the initial impact (machinery and electrical equipment). Vulnerable industries include labour-intensive industries (apparel, leather, textiles, furniture, other manufacturing) and some capital-intensive industries. Among these are industries that have been particularly hard hit by cross-border containment restrictions (motor vehicles, other transport equipment, petroleum).

This typology of industries is also quite stable when looking separately at IEs and DEIEs (see Table 1.2). Five industries come up as robust in both country

Table 1.2
COVID-19 robust and vulnerable industries, across economy groups

ISIC rev. 4	Industry	World	IEs	DEIEs
C10	Food	Robust	Robust	Robust
C12	Tobacco	Robust	Robust	Robust
C17	Paper	Robust	Robust	Vulnerable
C20	Chemicals	Robust	Robust	Vulnerable
C21	Pharmaceuticals	Robust	Robust	Robust
C26	Computers and medical equipment	Robust	Robust	Robust
C27	Electrical equipment	Robust	Robust	Robust
C28	Machinery	Robust	Vulnerable	Robust
C11	Beverages	Vulnerable	Vulnerable	Vulnerable
C13	Textiles	Vulnerable	Vulnerable	Vulnerable
C14	Apparel	Vulnerable	Vulnerable	Vulnerable
C15	Leather	Vulnerable	Vulnerable	Vulnerable
C16	Wood	Vulnerable	Robust	Vulnerable
C18	Printing	Vulnerable	Vulnerable	Vulnerable
C19	Petroleum	Vulnerable	Vulnerable	Vulnerable
C22	Plastics	Vulnerable	Vulnerable	Vulnerable
C23	Other non-metallic	Vulnerable	Vulnerable	Vulnerable
C24	Basic metals	Vulnerable	Vulnerable	Robust
C25	Metal products	Vulnerable	Vulnerable	Robust
C29	Motor vehicles	Vulnerable	Vulnerable	Vulnerable
C30	Other transport equipment	Vulnerable	Vulnerable	Vulnerable
C31	Furniture	Vulnerable	Vulnerable	Vulnerable
C32	Other manufacturing	Vulnerable	Robust	Vulnerable

Source: UNIDO elaboration based on UNIDO Monthly Index of Industrial Production Database (UNIDO 2021c).

Note: The ISIC column shows the International Standard Industrial Classification Revision 4 classifications. ISIC = International Standard Industrial Classification; IEs = industrialized economies; DEIEs = developing and emerging industrial economies.

Countries more reliant on COVID-19-vulnerable industries show larger output losses

groups: food, tobacco, pharmaceuticals, computers and medical equipment, and electrical equipment. At the other end of the spectrum, 11 industries are identified as vulnerable in both groups: beverages, textiles, apparel, leather, printing, petroleum, plastics, other non-metallic, motor vehicles, other transport equipment and furniture. The remaining seven industries show contrasting dynamics across the two groups.

The specific industry dynamic observed in each country differs as a result of other structural conditions shaping socioeconomic resilience. However, it is to be expected that countries oriented more towards the COVID-19-vulnerable industries identified above would—on average—receive a larger economic shock than the rest.

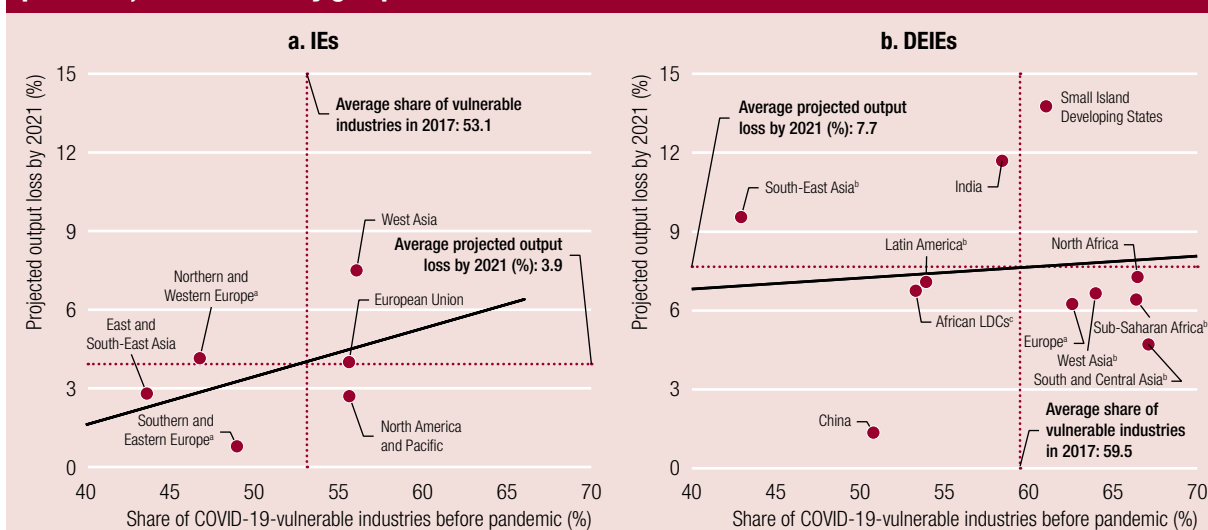
A comparison of the pandemic's impact on economic activity across countries confirms this intuition (see Figure 1.20). Countries where the manufacturing sector is more reliant on COVID-19-vulnerable industries show larger output losses than the rest. This is visible in both IEs and DEIEs, though it seems to be more pronounced in the former group.

The discussion above confirms the importance of an economy's sectoral composition as a factor shaping resilience. On one hand, countries with larger manufacturing sectors tend to show less dramatic impacts on their socioeconomic indicators. On the other hand, however, the composition of manufacturing also matters: countries with industrial sectors oriented more towards those industries most vulnerable to the type of shock triggered by the pandemic, by definition, will suffer more from its impact.

Global integration, domestic markets and socioeconomic resilience

The global nature of the COVID-19 crisis implies that, other things being equal, economies that depend to a large extent on exports and imports are more vulnerable to the international channels of impact discussed above.¹⁰ Using this logic, a relatively closed economy may be more resilient in the face of the disruptions of the crisis, as both a fall in demand and supply shocks could be contained with domestic policies. The same applies to the sources of capital investment: a

Figure 1.20
Impact of COVID-19 on economic activity by 2021 and share of COVID-19-vulnerable industries before the pandemic, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss) and UNIDO MVA Database 2021 (UNIDO 2021b) (share of vulnerable industries).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. Vulnerable industries classified based on Table 1.2. The graphs show simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as a share of the pre-pandemic projection. The share of vulnerable industries calculated over total MVA refers to the year 2015. Solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; MVA = manufacturing value added; SIDS = Small Island Developing States.

“ Countries with larger domestic demand show smaller projected output losses

lower reliance on foreign direct investment (FDI) and a greater availability of domestic savings for funding industrial investment may help countries, economies and other stakeholders react more quickly to the challenges posed by the pandemic.

Particular attention should be given to the degree of integration of countries with the global economy and to the possible contribution of domestic markets to a greater resilience against external shocks. Some evidence of this is presented in Figure 1.21: countries and regions with larger shares of domestic absorption (that is, larger shares of private and public consumption and investment) in aggregate demand tend to show smaller projected output losses during the pandemic (see the negative relationship in both panels of the figure). A major exception to this rule seems to be India (see panel b), which, despite having a huge domestic market, has witnessed one of the largest impacts on economic activity in the world.

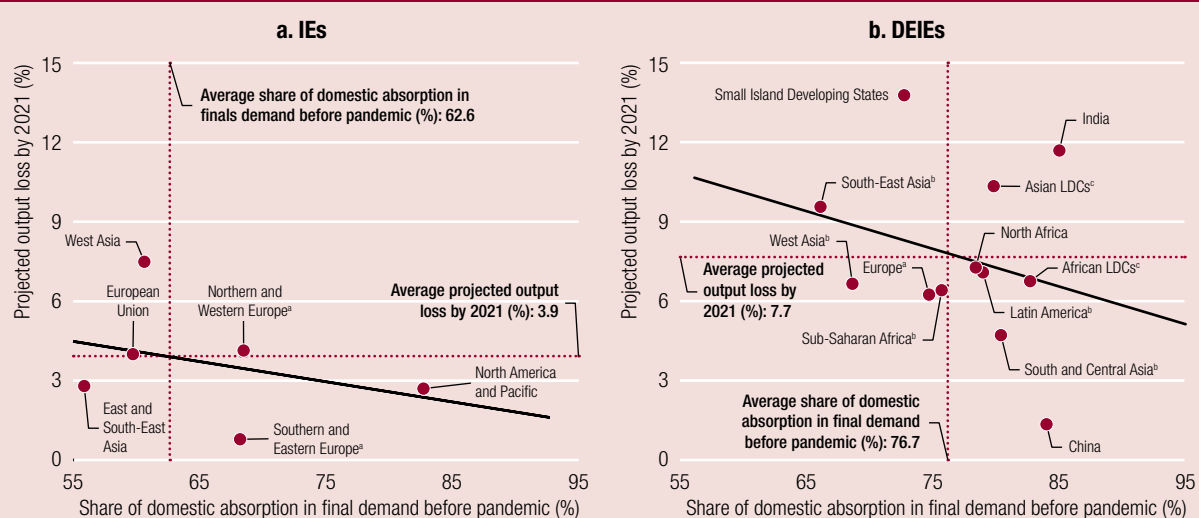
This finding suggests that domestic demand can play a crucial role in restoring growth. Whereas larger economies on average experienced lower output losses,

countries with smaller, more open economies that rely on world exports—and services such as tourism—and drivers of growth had more pronounced negative economic effects, even in cases where export growth has resumed.

A second element to consider is the extent to which engagement with global production networks might have magnified the negative impacts of the crisis on a nation's economy. Especially at the beginning, disruption to these networks severely hampered production.¹¹ Regardless of how serious this impact has been, strong reliance on GVCs might have negative impacts on countries' socioeconomic resilience that go beyond the risk of GVC disruptions. If export-serving industries engaging with GVCs have few production linkages to the domestic economy, then the positive spillovers of the process of industrialization in the national economy will be weak. In addition, because the pandemic crisis has hit hardest those services that rely on international trade, weak integration between manufacturing and services could become an additional source of vulnerability.

Figure 1.21

Impact of COVID-19 on economic activity by 2021 and relative size of domestic demand, across economy groups



Source: UNIDO elaboration based on IMF World Economic Outlook (October 2019 and October 2021 editions) (projected output loss) and UNDESA (2021) (Domestic absorption).

Note: a. Excluding EU; b. Excluding LDCs and SIDS; c. Excluding SIDS. The graphs show simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as share of the pre-pandemic projection. Share of domestic absorption in final demand refers to the year 2019.

The solid line indicates the linear regression estimate. Economy groups are based on Annex C. DEIEs = developing and emerging industrial economies; EU = European Union; GDP = gross domestic product; IEs = industrialized economies; LDCs = least developed countries; SIDS = Small Island Developing States.

“ The organization of global production is changing towards greater regional orientation

The organization of global industrial production also seems to be changing, as a result of the pandemic, in the direction of greater regional orientation and consolidation of some activities. These factors may increase the resilience of industrial production in countries with greater control of their value chains, while further weakening the position of economies with low domestic participation in value added. The changing relative importance of geographical areas will play a role in these developments, with East Asia significantly expanding its importance (Pianta 2021). These elements will be explored further in the next chapters of the report.

Existing industrial capabilities and socioeconomic resilience

Beyond the structural factors commented on previously, what seems to make the largest difference in

explaining a country's resilience to the negative impacts of COVID-19 is the level of its industrial capabilities.

Industrial capabilities can usually be broadly identified and defined as personal and collective skills, productive knowledge and experiences embedded in the physical agents and organizations needed for firms to perform different productive tasks as well as to adapt and undertake in-house improvements across different technological and organizational functions including investment and financing, product design, internal process organization and deployment of technologies in production, external linkages and supply chain coordination. From a dynamic efficiency and innovation perspective, the absorption, adaptation and improvement of given productive techniques, as well as innovations across different organizational and technological functions, depend mainly on the availability of a specific subset of industrial capabilities often identified as

Box 1.5

UNIDO's Competitive Industrial Performance (CIP) Index

Industrial competitiveness is key to inclusive and sustainable industrial development (ISID). It shapes sectoral specialization and consequent structural change. It thus also determines the contribution of industry to overall prosperity and long-run sustainable growth. UNIDO assesses and benchmarks industrial competitiveness through its Competitive Industrial Performance (CIP) Index. This index measures how much a country's manufacturing sector contributes to development—how well industries produce goods and sell them in domestic and foreign markets, and thus contribute to structural change (UNIDO 2019b).

The CIP Index covers three main dimensions. The higher the score on any dimension, the higher the country's industrial competitiveness and its CIP Index.

- **Capacity to produce and export manufactured goods:** This dimension provides a comparable measure of a country's manufacturing production for either local or foreign consumption. It is assessed by (1) manufacturing value added (MVA) per capita and (2) manufacturing exports per capita.
- **Technological deepening and upgrading:** This dimension assesses the types of goods a country's manufacturing sector produces. Because technology-intensive goods create technological spillovers and reduce vulnerability to price shocks, producing them and, further, exporting them is rated as having higher expected

benefits than producing lower-tech goods. This dimension is taken into account by (1) industrialization intensity, which captures the role and technological complexity of a country's production, and (2) export quality, which captures the technological complexity of the export bundle.

- **World impact:** The more a country participates in global markets, the greater its ability to benefit from agglomeration and scope and scale effects, perhaps attracting shared infrastructure investments and expanding trade agreement negotiating power. The world impact dimension is measured by the country's impact on (1) world MVA and (2) world manufacturing exports.

Since structural change is long term, changes in the country's CIP Index are likely to follow the implementation of policies to increase competitiveness by several years. Accordingly, it can be used to help policymakers plan, align, evaluate and monitor policies. First, as it assesses countries' industrial performance across the three dimensions, it can be used as a tool to make comparisons with competitors or regional neighbours. Second, by highlighting areas in which other countries achieve higher CIP scores, the index can guide policies for future development. Finally, by analysing the manufacturing sectors of countries that perform poorly, it can highlight inefficiencies in allocating factors of production, such as labour and capital.

Source: UNIDO elaboration.

UNIDO's CIP Index is taken as proxy of countries' underlying capabilities in manufacturing

innovation or dynamic capabilities. All these productive, technical and innovation abilities (to make goods and services) are individually or collectively held, but they are always collectively constructed and deployed within productive organizations and their industrial ecosystems under specific social conditions (Andreoni 2021).

UNIDO's Competitive Industrial Performance (CIP) Index can be taken as a rough proxy of countries' underlying capabilities in manufacturing production. It combines three dimensions: capacity to produce and export manufactured goods, technological deepening and upgrading, and world impact (see Box 1.5). The higher the score on any of these dimensions, the higher

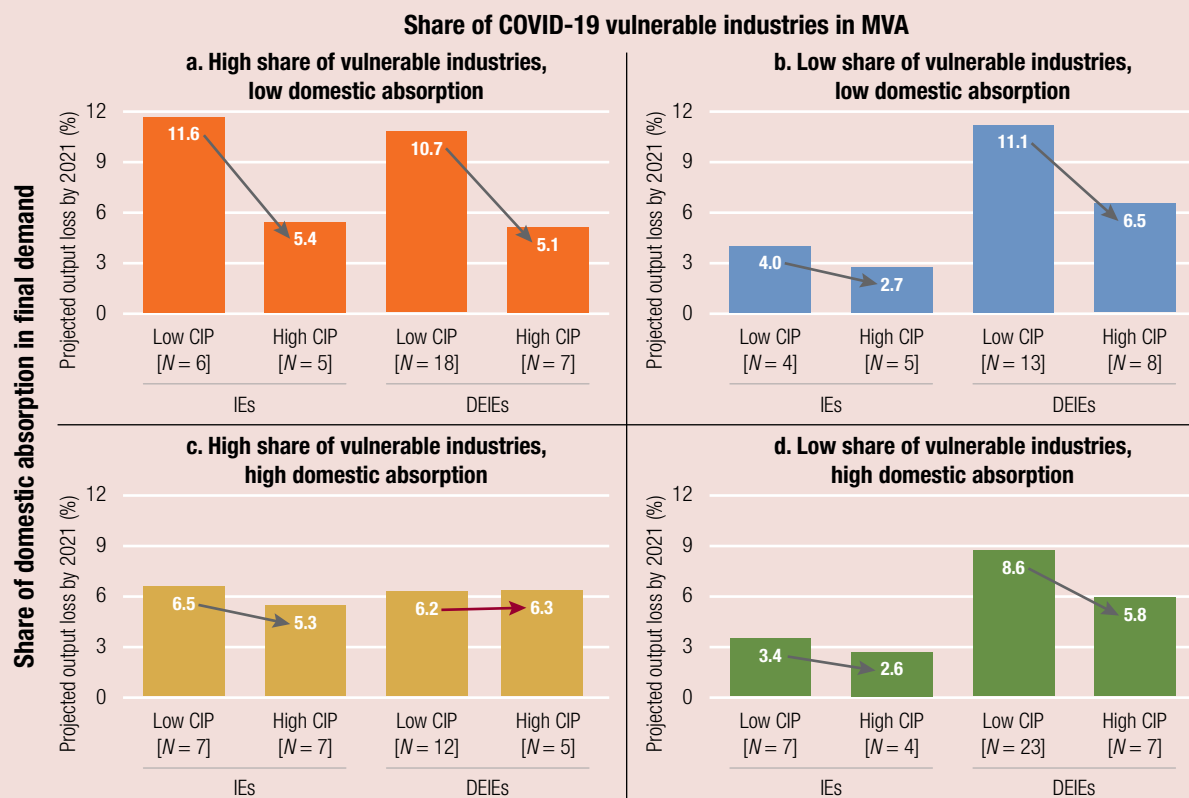
the country's industrial competitiveness and its overall CIP Index score.

The discussion above indicates that higher shares of vulnerable industries in manufacturing and stronger reliance on foreign demand—that is, smaller domestic markets—tended to magnify the negative impacts of the COVID-19 pandemic. To what extent have the negative impacts associated with the reliance on exports and vulnerable industries been offset or reduced by strong industrial capabilities?

One way of addressing this question is to split countries according to their average levels in these two dimensions—importance of vulnerable industries and reliance on foreign demand—and see whether, within

Figure 1.22

Comparison between the average impact of COVID-19 on economic activity by 2021 on countries with similar structural characteristics and different levels of industrial capabilities



Source: UNIDO elaboration based on IMF (2019 and 2021b), UNDESA (2021) and UNIDO (2021a and 2021b).

Note: Vulnerable industries classified based on, Table 1.2. The graphs show simple averages. Projected output loss by 2021 is defined as the difference between the pre-pandemic projection of the level of GDP (October 2019) and the latest available projection (October 2021) and presented as a share of the pre-pandemic projection. Country groups (low versus high shares of domestic absorption in final demand and of COVID-19 vulnerable industries in MVA) are defined using the corresponding average values for IEs and DEIEs presented in Figure 1.20 and Figure 1.21. Within each panel, Low and High CIP are defined comparing a country's CIP Index level against the average level of the corresponding sub-group. The CIP Index expresses the industrial competitiveness of countries and is taken as a proxy of their level of industrial capabilities. CIP = Competitive Industrial Performance; DEIEs = developing and emerging economies; GDP = gross domestic product; IEs = industrialized economies; MVA = manufacturing value added.

“ Countries with stronger industrial capabilities show lower projected output losses

each group, countries showing higher industrial capabilities in 2019 were less affected by the crisis. This is done in Figure 1.22, which distinguishes countries with high (low) shares of vulnerable industries in manufacturing value added (MVA) and small (large) domestic markets. Interestingly, in all cases but one—DEIEs with a large share of vulnerable industries and large domestic markets—countries with stronger industrial capabilities show, on average, lower projected output losses due to the pandemic. From this simple comparison it appears that industrial capabilities have been key to countries’ ability to absorb, accommodate and respond to the shock.

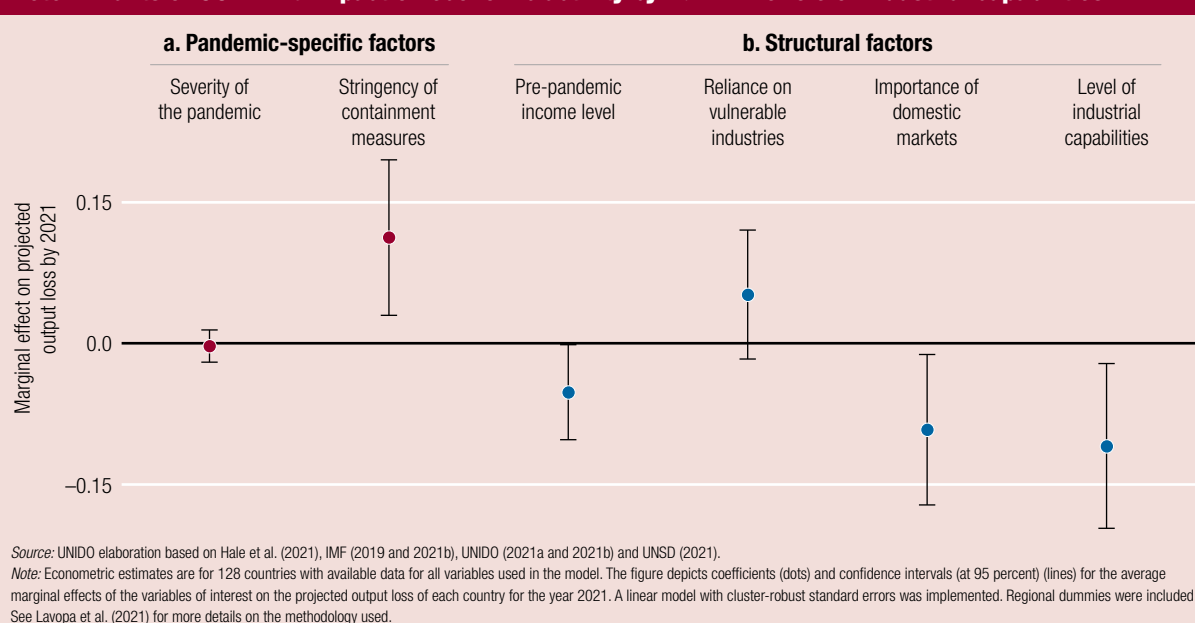
The evidence shown in Figure 1.22, however, considers only two of the many factors shaping countries’ socioeconomic resilience and documented so far in the chapter. For instance, this figure does not take into account differences in the severity of the pandemic (in terms of infections and diseases) and the level of stringency of the containment policies implemented. As discussed in the first section of this chapter, these “pandemic-specific” factors have been key determinants of the different socioeconomic impacts.

To address all the factors documented in the chapter, an econometric exercise was undertaken to analyse the main determinants of the projected output losses by 2021.¹² Six determinants were explored:¹³

- The severity of the pandemic (proxied by the total reported deaths due to COVID-19 between 1 January 2020 and 1 October 2021, per million inhabitants);
- The stringency of containment measures (proxied by the average Stringency Index score between 1 January 2020 and 1 October 2021, calculated by the Oxford COVID-19 Government Response Tracker);
- Pre-pandemic income level (as captured by the per capita GDP for 2019 in PPP international dollars);
- Reliance on vulnerable industries (proxied by the 2015 share of COVID-19-vulnerable industries on MVA);
- The importance of domestic markets (proxied by the 2019 share of domestic absorption on final demand); and
- The level of industrial capabilities (proxied by the CIP Index for 2019).

Figure 1.23

Determinants of COVID-19 impact on economic activity by 2021: The role of industrial capabilities



“ Not all systems show readiness to adapt and transform and create solid bases for the recovery

1

RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

The results of this econometric exercise confirm the important role played by industrial capabilities in supporting the socioeconomic resilience of countries during the COVID-19 pandemic (see Figure 1.23). Factors lying above the horizontal axis (zero impact) are those that magnified the effect of the crisis. These include the stringency of containment measures and the reliance on COVID-19-vulnerable industries.¹⁴ From these two, however, the only statistically significant factor at 95 percent is the level of stringency. Factors lying below the horizontal axis, instead, are those that cushioned the impact of the crisis. They include the income level, the size of domestic markets and the level of industrial capabilities. From these factors, only the last two (domestic markets and industrial capabilities) are statistically significant. Interestingly, industrial capabilities are the single most important factor to reduce the impact of the crisis from the ones considered.

The evidence presented emphasizes once again the importance of building industrial capabilities to be better prepared for the future.

Industrial capabilities, however, are a broad concept. They range from the skills needed to invest in new technologies and design new products to the ability to organize the production process and coordinate actors along the supply chain. More specifically, what types of capabilities are important to support socioeconomic resilience when facing an extreme event such as the COVID-19 pandemic? Work commissioned for this report investigated this issue and identified two broad sets of capabilities (Andreoni 2021):

1. Capabilities conferring system *robustness* to shocks—that is, capabilities that support the ability of the country to resist, absorb and accommodate the emerging and unexpected needs and challenges arising from a crisis; and
2. Capabilities conferring system *readiness* to change—that is, capabilities that are needed to adapt, transform and recover at a later stage of the crisis when it becomes clear that the overall system needs more sustainable solutions that address the roots of the crisis.

This distinction is important because some systems might be resilient in terms of being able to resist, absorb and accommodate but they might find it more difficult to adapt, transform and recover. Indeed, all systems have some degree of robustness associated with their existing capabilities and capacity. The extent to which they are sufficiently robust depends on the systemic nature and challenges posed by an extreme event such as the pandemic. Not all systems show readiness to adapt to altered circumstances and transform themselves by creating solid bases for a sustained and sustainable recovery. Readiness results from dynamic capabilities spread across the ecosystem of organizations, institutions, sectors and markets. There might be also the opposite case where socioeconomic systems are well equipped from a readiness-to-change perspective but find themselves vulnerable to crisis because they have lost a number of more basic capabilities that confer robustness to the system.

Table 1.3 provides two taxonomic lists of capabilities associated with robustness and readiness in industry. When it comes to robustness, industrial and economic activities—especially in strategic sectors—must be able to retain sufficient supply capability, secure needed commodities and keep people employed in a safe setting.

While robustness is central to coping with the immediate needs and negative impacts of an extreme event, such as a global pandemic, it does not guarantee success. Given the systemic uncertainty that extreme events pose to socioeconomic systems, even a robust system can find itself unable to move out of a crisis. This is particularly the case when extreme events are unprecedented and prolonged. Robustness can deteriorate quickly and if the system is not ready to reform—that is, if it cannot offer innovative solutions towards a more sustained and sustainable recovery—it can collapse.

While robustness can be partially achieved by planning—for example, by building some spare capacity in strategic supply capacity—readiness depends on a more complex and broad set of dynamic capabilities within industries. Dynamic capabilities involve significant

Industrial capabilities need to be supported and complemented by government capabilities

Table 1.3

Industrial capabilities most needed for resilience: Robustness and readiness

Industry robustness <i>Resist, absorb and accommodate</i>	Industry readiness <i>Adapt, transform and recover</i>
<p>Productive capabilities in strategic sectors for medical devices and other equipment (domestic-based, specialized resources/tech availability, ramping up)</p>	<p>Productive, technological and innovation capabilities in strategic sectors for medical devices and other equipment (domestic-based, innovation driven, tech-innovation scalability)</p>
<p>Productive capabilities in strategic sectors for pharmaceuticals (domestic-based, specialized resources/tech availability, ramping up)</p>	<p>Productive, technological and innovation capabilities in strategic sectors for pharmaceuticals (domestic-based, innovation driven, tech-innovation scalability)</p>
<p>Supply-chain redundancy capabilities for strategic sectors and inputs (multiple and diversified sources access, domestic-based, ramping up)</p>	<p>Supply-chain ecosystem capabilities for strategic sectors and inputs (multiple and diversified sources access, domestic based, cooperative competition oriented)</p>
<p>Repurposing capabilities in strategic sectors and supply chain inputs (flexibility, retrofitting, ramping up)</p>	<p>Innovation-chain ecosystem capabilities and risks-rewards governance arrangements (sustainable cooperation, public purpose oriented, challenge driven)</p>
<p>Productive capabilities in other strategic sectors</p>	

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

ability to innovate; they also rely on several sets of cumulated capabilities as well as the agility to experiment and change in a fast-changing environment.

But industrial capabilities alone can hardly provide sufficient robustness and readiness to the system. They need to be supported and complemented by government capabilities. Historically, state formation and industrialization have been linked by a mutually supportive relationship (Andreoni and Chang 2019). Industrialization—a process of continuous change in the productive structure of the economy and extent of the market—has been shaped by the state via industrial and innovation policy. The formation of state institutions, governance and bureaucracy structures has played a key role. Equally, industrialization and the formation of new powerful organizations and interests have shaped the political economy of the state, its internal structural formation and policymaking. Lack of industrialization and premature de-industrialization have often played the opposite role—that is, they have reduced the capacity of the state to deliver on its key

functions. Thus, state and industry are linked by a mutually constitutive, historically path dependent and dynamic relationship.

As in the case of industrial capabilities, it is also possible to distinguish robustness and readiness capabilities within governments (see Table 1.4). Government robustness capabilities are key for coordinating and implementing a set of proactive and containment measures and for leveraging state capacity embedded in public agencies, the health sector and related infrastructure. Government readiness capabilities are about unleashing innovations and wealth resulting from those innovations, and about maintaining socio-political stability at the same time—that is, exercising *stable-agility*. These capabilities are also about shaping markets through regulations, industrial policy and other demand-side measures such as functional procurement.

The two sets of capabilities—industrial and governmental—interact in the process of dealing with a crisis such as the one created by COVID-19.

“ IEs tend to be strong in robustness capabilities across both government and industry

1

RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Table 1.4

Government capabilities in supporting socioeconomic resilience

Government robustness <i>Resist, absorb and accommodate</i>	Government readiness <i>Adapt, transform and recover</i>
Public health facilities for prevention, testing and containment (capillarity, agility, multi-level coordination)	Public basic science and technology research institutions (university based, industry oriented, public-purpose driven)
Public health facilities for care provision and treatment (capillarity, redundancies, repurposing)	Public technology intermediate institutions for scaling up (capillarity, technology services oriented, quasi-public good, technology focused)
Public procurement for medical devices and pharmaceuticals (strategic control, flexibility, reliability, accountability)	Public procurement for bio-med-pharma innovation and market creation (long term, strategic and functional)
Logistics infrastructure for distribution (capillarity, reliability, agility)	Public finance for innovation and industrial restructuring (long term, public purpose/challenge driven and conditional)
Public authority/agency for certification of medical devices and pharmaceuticals (reliability, agility, multi-actor coordination)	Public corporations and strategic control of critical technologies and production for national security (long term, strategic, resilience focused)
Multilevel government institutions for targeting and coordination (capillarity, stable-agility, multi-actor coordination)	Public authority/agency for certification of medical devices and pharmaceuticals (reliability, agility, multi-actor coordination)
	Multilevel government institutions for experimentation and coordination (experimentation, stable-agility, multi-actor coordination)

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

A country would ideally show both high levels of government and industry robustness at early stages of the crisis and high levels of government and industry readiness at later stages. If both types of capabilities are present and are well aligned in responding to the crisis, we would expect limited socioeconomic impact and a fast recovery spurring several structural and institutional reforms increasing the resilience of the system even further. In the opposite scenario—often common in DEIEs—low levels of government and industry robustness would trigger a set of interdependent crises that, over time, can further weaken the system, resulting in very detrimental impacts for society and the economy.

The actual circumstances faced by countries will depend on the extent to which:

1. At early stages of a crisis, necessary robustness capabilities are or are not present in one or both main sectors of the system—government and industry—and the two sectors are capable of coordinating and aligning their short-term efforts and immediate responses; and
2. At later stages of the crisis, necessary readiness capabilities are or are not present in one or both main sectors of the system—government and industry—and the two sectors are capable of coordinating and aligning their long-term efforts and strategic changes.

In general terms, IEs tend to be strong in robustness capabilities across both government and industry but not necessarily in readiness capabilities. DEIEs, instead, tend to face a crisis from a robustness

DEIEs face the crisis with serious weakness in the welfare system and weak industry base

standpoint that shows serious weakness in the government and welfare system as well as a weak industry base. For example, in the case of COVID-19, limited testing capacity and limited development of the domestic pharmaceutical and chemical industries, especially in African countries, also meant that many DEIEs ran out of supplies and found it difficult to ramp up the availability of intensive care units and import key therapeutic devices such as ventilators. Underdevelopment of the pharmaceutical industry is caused by both a lack of productive capabilities and a lack of procurement systems that effectively promote domestic production.

The case of COVID-19 vaccines is a case in point. The availability of specific capabilities in the health system—in particular, in the production and distribution of vaccines—becomes a crucial element for the future recovery of economies, as seen earlier in this chapter. But many lower-income countries lack the necessary capabilities to tackle the pandemic by importing, replicating or producing the quantity of necessary vaccines to avoid the spread of the virus. Should lower-income countries not have the necessary capabilities to produce vaccines, the production of vaccines from high-income countries may still not be sufficient (or accessible) for the entire world. Padma (2021) reports that vaccines could reach poor countries only in 2023.

However, even among DEIEs there are pockets of capabilities nested in both the government and the industrial sector that could be leveraged to increase the overall robustness of the system and its response to crises such as the pandemic. In many cases, these have been developed as a response to previous crises. In fact, previous health crises such as pandemics can offer the opportunity to develop robustness capabilities. The extent to which these capabilities are or are not present in a system to help a country face the next crisis depends on their accumulation and continuous investment (this is illustrated by the case of the Brazilian Oswaldo Cruz Foundation, described in Box 1.6).

Moving forward, a key question is how DEIEs can leverage these pockets of capabilities to provide a coordinated response to the current crisis and prepare better for the future. That is, how can countries move

towards strengthening both the robustness and the readiness of their industry and government sectors? An important lesson from the COVID-19 pandemic is that countries that have shown the highest degree of resilience in the face of the crisis are those that have built resilience into their systems over several years and managed to align these two sets of government and industry capabilities.

An urgent need for international policy coordination to tackle global divides

As documented in this chapter, the COVID-19 pandemic has had devastating effects on countries and societies around the world, putting at risk the achievement of the SDGs and reinforcing pre-existing inequalities and vulnerabilities. The impact, however, has been uneven across countries and regions.

The diversity of impact is explained by a combination of factors, including the severity of the health emergency and the effectiveness of the measures implemented to contain the virus, the structure of the economy and composition of the industrial sector, the type of integration with the global economy and the importance of domestic markets, and the level of existing capabilities to face an extreme event like the pandemic.

An important finding from the analysis is that manufacturing matters when it comes to socioeconomic resilience. The level of industrial capabilities and the size of the manufacturing sector are found to strengthen the capacity of countries to absorb external shocks: countries with larger manufacturing sectors and stronger industrial capabilities have, on average, weathered the crisis better than the rest.

But having a strong industrial sector is not enough. The readiness of actors to quickly adapt and respond to the crisis is almost as important as the capacity to absorb the shock, as this will determine the speed and direction of the recovery in the years to come. This takes on particular importance in those countries showing weaker industrial and government capabilities. The evidence suggests that the more competitive countries will recover first, heightening inequalities

“ Pockets of capabilities in government and industry can be leveraged to increase robustness

1

RESILIENCE IN THE TIME OF COVID-19: THE ROLE OF INDUSTRY

Box 1.6

Building readiness capabilities: The case of the Brazilian Oswaldo Cruz Foundation

The coronavirus pandemic reached Latin America later than other continents; however, its evolution there has been increasingly dramatic and that continent witnessed a rapid acceleration in the first months of 2021, especially in its largest country: Brazil. By October 2021, the cumulative number of cases and deaths in that country reached over 21 million and 600,000 respectively, making Brazil one of the countries hardest hit in the world by the pandemic.

Despite this bleak scenario, Brazil has also shown some important pockets of resilience—in terms of both robustness to shock and readiness in its health-industrial complex. The response of one of its most prominent institutions in the health sector—Fiocruz (Oswaldo Cruz Foundation)—highlights the importance of cumulating capabilities in health institutions to increase overall structural resilience to crises.

Fiocruz is a 120-year-old institution integrating biomedical and pharmacological science research alongside its work in health technological innovation, production of drugs, health surveillance, health care provision, education, and information and communication. Throughout its history, Fiocruz has developed a track record in health research, vaccination and drug manufacturing both nationally and internationally (for example, with its world-leading and path-breaking research on Zika).

Throughout the pandemic, Fiocruz has developed a comprehensive response to the crisis, leveraging its wide range of technological capabilities and research institutes to provide an integrated response. In February 2020, Fiocruz started promoting training courses on diagnostic methods for laboratories in Brazil and Latin America; in March of that year it started diagnostic test production and in May it built a dedicated hospital centre for Covid-19 focused on the treatment of severe COVID-19 cases.

Starting in June 2020, Fiocruz also became an anchor institution in Latin America in the race towards the development and clinical trials of a vaccine. At the end of June, the Ministry of Health announced an agreement with the biopharmaceutical company AstraZeneca for the production, by Fiocruz, of the vaccine being developed by the University of Oxford. Through this technology transfer agreement, Fiocruz

acquired even more significance in the Brazilian response to the crisis, both in terms of producing and distributing a safe vaccine through the country's health system and in starting a number of innovative experiments towards developing a domestic vaccine.

Fiocruz was able to enter this critical partnership with AstraZeneca thanks to its previous investments in capabilities and infrastructure development. Specifically, the Institute of Technology in Immunobiological Products (Bio-Manguinhos)—the Fiocruz unit responsible for manufacturing and supplying vaccines, biodrugs, pharmaceutical drugs and diagnostic kits—was an essential piece of the infrastructure needed to absorb the vaccine technology and ramp up vaccine manufacturing.

In December 2020, Bio-Manguinhos shifted up a gear by signing a deed for land with the Government of the State of Rio de Janeiro needed to build the largest vaccine manufacturing facility in all of Latin America: the Industrial Complex of Biotechnology in Health (Cibs).

Since January 2021, the Brazilian Health Regulatory Agency (Anvisa) has authorized two vaccines for emergency use: one of them was the Oxford-AstraZeneca vaccine produced by Fiocruz. On January 29, Fiocruz also submitted an application to register the Oxford-AstraZeneca vaccine and concluded the journey begun in June 2020 when the agreement was signed. Only six months after the Technology Order Agreement, Fiocruz started the production of a COVID-19 vaccine. Production capacity was expanded in March 2021 with the introduction of a second production line to reach a total capacity of around 1 million doses a day (the first production line in operation had a capacity of 300,000 doses per day). The absorption of the technology has thus not only developed alongside an expansion of production capacity but has also provided innovative research into vaccine platform technologies and new immunizers against COVID-19. By October 2021, Fiocruz was involved in the development of six other vaccines, with various national and foreign partners. Bio-Manguinhos also has two internal vaccine projects based on 100 percent national technology.

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

between countries, and that weak health systems and low vaccination rates will greatly hinder recovery. This could have serious implications for industrialization, poverty and the future achievement of the SDGs.

Addressing these challenges will require coordinated actions from the international community. These actions should be built on a solid understanding of which responses worked and which ones did

Addressing the pandemic challenges require coordinated actions from the international community

not; what megatrends are likely to shape the future of industrialization; and how future policies should be designed to support an industrial recovery that is

inclusive, sustainable and resilient to future shocks. The next three chapters of the report will shed light on all these aspects.

Notes

1. See WHO (2021) for a detailed analysis of the emergence of COVID-19.
2. The Stringency Index is part of the Blavatnik School of Government, University of Oxford COVID-19 Response Tracker. It records the strictness of “lockdown style” policies from zero (least strict) to 100 (most strict). For details, see Hale et al. (2021). In three large countries where the information is available—Brazil, China and the United States—the analysis conducted in this chapter uses the sub-national-level data and calculates the average country-level index weighting the sub-national scores by their share in the country’s total population. This approach provides a more accurate picture of the restrictions faced by a country’s population where sub-national governments had significant autonomy in choosing the containment policies.
3. Throughout this report the term *severity* is used to indicate COVID-19-related deaths per million people.
4. The country classification used in this chapter combines two dimensions: geographical location and level of industrial development. The classification distinguishes 18 areas, 6 within industrialized economies (IEs) and 12 within industrializing ones. Within the latter, a further division is made to distinguish least developed countries (LDCs) and Small Island Developing States (SIDS) from the rest. Two countries are considered separately because of their size: China and India. See Annex C for the detailed list of countries included in each group.
5. The analysis of this chapter considers a sample of 136 economies (48 IEs and 88 DEIEs) for which data are available across the main variables of interest. Taken together, these economies represent 94 percent of the world population. See Annex C for the complete list of countries included in the analysis.
6. Because the beginning of a vaccination campaign is difficult to determine, the starting point is set as the day a country surpasses one dose administered per hundred people.
7. Annex A provides details of the survey and the country coverage.
8. As documented in Braunstein (2021), between 1991 and 2019 the mean gain in women’s relative employment in DEIEs was 6.9 percentage points.
9. See, for instance, ECLAC (2021) and Seetharaman et al. (2021).
10. This section is based on the background contribution prepared by Pianta (2021).
11. See, for instance, Baldwin and Freeman (2020), Baldwin et al. (2020), and Castañeda et al. (2021).
12. See background note prepared by Lavopa et al. (2021) for the details of the approach used.
13. The analysis also included regional dummies to distinguish between the broad regions presented in Figure 1.1, namely: Africa, Asia-Pacific, Europe, Latin America and the Caribbean, and North America.
14. In this exercise, the negative impact of the severity of the pandemic is almost fully captured by the variable related to the stringency of containment measures, as countries that failed to contain the virus typically ended up imposing longer and stricter containment measures. This explains the near zero effect of *severity of the pandemic* in the econometric regression results reported in Figure 1.23.

Chapter 2

Dealing with the pandemic: Responses from firms and governments

Key messages

- The COVID-19 crisis has widened existing socioeconomic gaps, disproportionately affecting already vulnerable actors—particularly small and medium-sized enterprises (SMEs) and informal and female workers.
- Industrial capabilities were a key ingredient of resilience against the pandemic crisis: manufacturing firms with stronger production capabilities and firms operating in countries with stronger industrial capabilities suffered less, on average, than the rest.
- Digitally advanced firms tended to be more responsive to the challenges posed by the pandemic crisis. Thanks to their advanced production capabilities, they could improve readiness and, thus, mitigate the negative economic impacts of the crisis more effectively over time.
- Government policies also played a significant role in mitigating impacts through short-term reaction measures and—to a lesser extent—risk management measures and medium- and long-term interventions to improve capabilities.

Introduction

The COVID-19 crisis has had a diverse impact across countries and regions around the world. The diversity of outcomes stems from many factors, some related to pre-existing conditions and others related to the types of responses given during the shock. Chapter 1 discussed some country- and industry-level conditions that have shaped the resilience of countries against the crisis. This chapter moves one step further and analyses pre-existing factors of resilience and the responses given by manufacturing firms and governments.

The chapter starts by reviewing how the channels of impact discussed in Chapter 1 can transfer the effect of the crisis at firm level (micro level), amplifying or reducing the severity of its implications on the basis of specific country- and industry-level features as well as firm-level characteristics. It then investigates the drivers of firm-level resilience along the two dimensions identified in Chapter 1—robustness and readiness—with special attention to the role played by industrial and production capabilities in fostering manufacturing firms' resilience. It describes and analyses the impact of the COVID-19 pandemic crisis at the micro level, looking at the most-affected firm categories. It then reviews firms' response strategies, aiming at transforming firms' operations and business models to adapt to new scenarios. Finally, the discussion turns to government responses. Here the chapter presents

and discusses original information on industrial policy's role in addressing and mitigating the short-term impact of the crisis, emphasizing the growing attention placed on risk management and on more medium- to longer-term interventions.

The firm-level analyses presented in this chapter are conducted using an original and novel data source: the *UNIDO survey on the impact of COVID-19 on manufacturing firms around the world* (onwards referred to as the *UNIDO COVID-19 firm-level survey*).¹ Developed and implemented by UNIDO in partnership with local governments, industry associations and other international agencies, this survey was designed to gather information on the challenges faced by manufacturing firms during the pandemic, its short-term and expected economic impact, and firms' responses to the crisis. The survey collected primary data over the period November 2020–June 2021, covering about 4,000 manufacturing firms in 26 developing and emerging industrial economies (DEIEs) in Africa, Asia, and Latin America.

Robustness—the ability of a firm to resist, absorb and accommodate a shock—is necessary to survive crises. The data collected by the UNIDO COVID-19 firm-level survey reveal that, even though the vast majority of firms have been affected by the crisis, they exhibited a high degree of heterogeneity. As illustrated in Chapter 1, some manufacturing industries were

“ The pandemic had a major but highly uneven impact on firms

2

DEALING WITH THE PANDEMIC: RESPONSES FROM FIRMS AND GOVERNMENTS

more robust to resist the impacts of the pandemic and/or were able to recover faster. The collected data indicate how the impact of the crisis has been diverse across firms even within the same country and industry, and that firm-level features played a role both in shaping the impact of the pandemic and in the ability of individual firms to resist, respond and recover. Small and medium-sized enterprises (SMEs) suffered the largest impact in terms of lost profits and sales. This suggests that, even if sectoral distinction matters, firm size can, in large part, account for the observed differences in terms of impact.

The pandemic crisis also disproportionately affected actors with lower pre-pandemic performances and those in worse pre-pandemic conditions. This holds for both firms and individuals—across the board, the most vulnerable groups have been particularly affected. Individual characteristics of workers—such as type of occupation, working conditions, level of education, and gender—can exacerbate the effect of the channels of impact. In this regard, this chapter also discusses how a gender perspective can offer a useful lens into the uneven consequences of the COVID-19 pandemic on social inclusion.

Readiness—the ability to adapt, transform and recover—is crucial for looking beyond the crisis and creating a solid base for a sustained and sustainable industrial recovery. Firms can react to external shocks by adapting their business models, organization structures, labour modalities and operations. Original evidence produced for this report shows that several different response strategies were implemented by several firms to cope with and respond to the pandemic crisis (Seetharaman and Parthiban 2021). Their reactions can accelerate the megatrends introduced in Chapter 1, whose discussion will be further developed in Chapter 3. For instance, an analysis of annual company reports reveals that the pandemic may have accelerated the adoption of digitalization as a way to mitigate the negative effects of social distancing measures on production processes. Moreover, according to the findings of the UNIDO COVID-19 firm-level survey, the pandemic may have also triggered the

adoption of more environmentally friendly practices at the firm level (see Chapter 3). This is in line with the findings that firms are starting to embrace a new way of thinking about disasters and risks by adopting environmental practices to reduce natural risks related to climate change.

Why are some manufacturing firms more robust to economic turmoil and more responsive to shocks than others? This chapter shows that both dimensions of resilience can be associated with specific capabilities. First, resilience is associated with industrial capabilities, which are systemic capabilities related to a country's capacity in terms of physical and institutional infrastructure and regulations. These capabilities are also identified as “tenacious societal characteristics” that influence the responses of given societies to economic opportunities (Abramovitz 1986, p. 387). As discussed in Chapter 1, industrial capabilities underlie a country's ability to drive production in manufacturing industries. Second, firm-level capabilities associated with the ability of the individual firm to perform routines, innovate, and increase competitiveness (Lall 1992) can make a difference in fostering resilience. The chapter presents some new empirical evidence about how actors with lower capabilities and those that operate in a low-industrial capability context have been more exposed to the negative effects of the pandemic crisis. Stronger capabilities help mitigate the negative consequences of the shock.

Policy has been playing a major role during the economic crisis triggered by the COVID-19 pandemic. This chapter analyses the main industrial policy responses implemented by governments to ease its negative effects. This analysis is based on another original primary source: the *UNIDO COVID-19 policy-level survey*.² The survey collected information from more than 50 policymakers in 44 DEIEs in African, Asian, and Latin American countries to get an overview directly from policymakers of the adopted approaches to respond to the crisis.

An analysis of these data reveals how policy interventions played an instrumental role in helping the firms tackle the emergency during the initial stage of

Country-level factors converge to amplify or reduce the effects

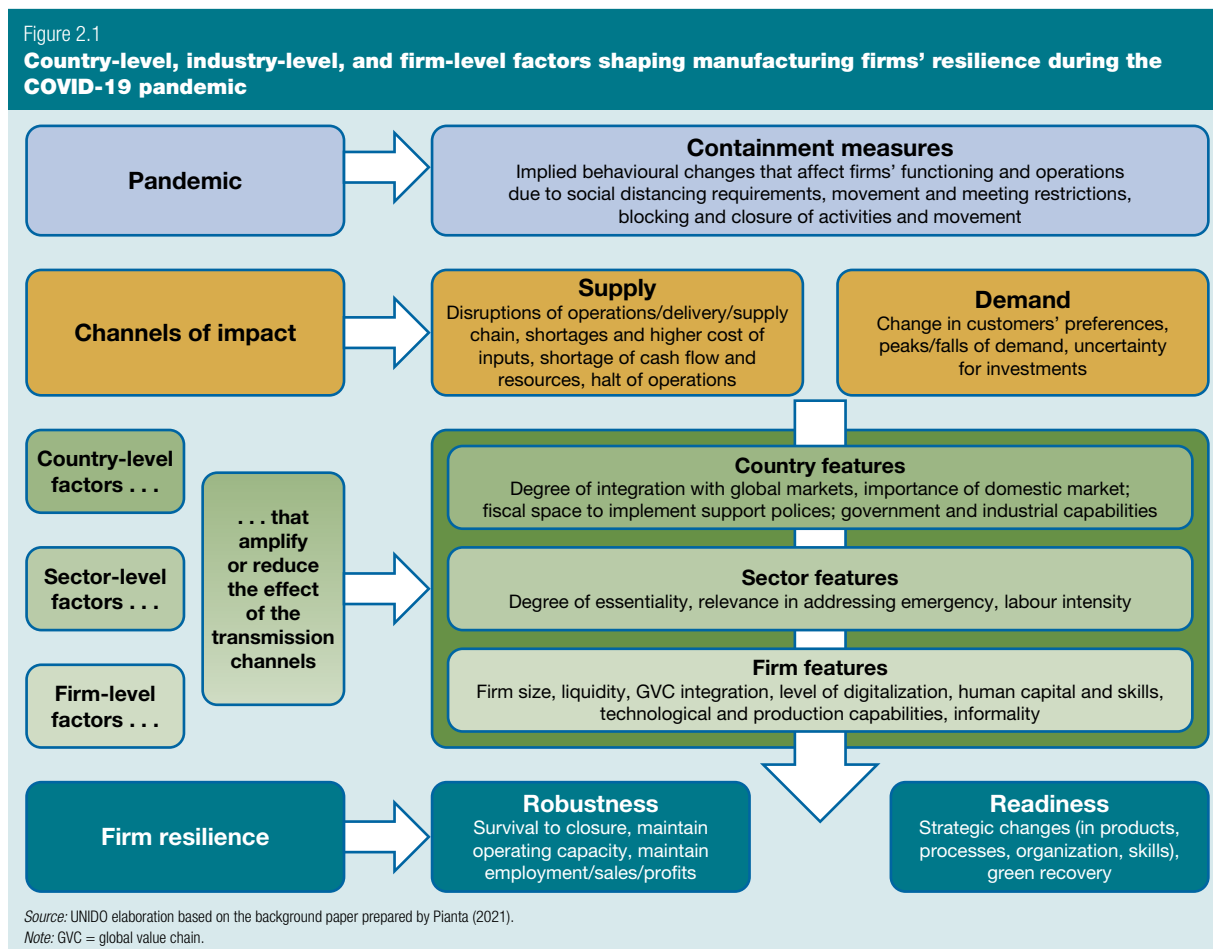
the pandemic—for example, with measures to help firms cope with liquidity problems and/or avoid layoffs. Still, as there is growing concern about the risks associated with global value chain disruptions, health issues, and climate change-related disasters, policy attention needs to progressively shift towards a more medium- to long-term perspective to increase industrial and production capabilities. Moreover, it needs to shift towards the fostering of industrial resilience through the adoption of a risk management approach.

In sum, the concept of resilience is significantly but not sufficiently incorporated from a strategic point of view into policy interventions. Growing attention is being placed on measures aimed at reducing the vulnerability to external shocks of firms and other economic actors. Although future trends are always hard to predict, some consequences of the pandemic crisis

are becoming visible: the actions of international organizations and policies are going to be crucial to influence the evolution of future scenarios.

The pandemic crisis and socioeconomic resilience: From countries to firms

The channels of impact on industrial production introduced in Chapter 1 ultimately transfer their effects on manufacturing firms. The final outcome for firms, however, depends on a host of factors that can amplify or reduce the effect of these channels. These factors are specific to the firms and to the context—country and sector—in which they operate. Figure 2.1 represents how these interrelations between the different factors and levels of analysis can enhance or weaken resilience at the firm level.



“Sector- and firm-level factors define the balance between vulnerabilities and resilience

2

DEALING WITH THE PANDEMIC: RESPONSES FROM FIRMS AND GOVERNMENTS

As seen in Chapter 1, to curb the spread of the virus most governments around the world implemented measures such as lockdowns and movement restrictions (see “Containment measures” in Figure 2.1). These containment measures have been the result of the very nature of the pandemic and implied changes in the behaviours of individuals and organizations. These changes shaped the effects of the channels of impact on manufacturing firms, such as sudden changes in demand or supply. For instance, while some firms experienced a steep increase in demand as a result of the nature of their productions, others faced labour shortages and/or higher input costs as a consequence of supply chain disruptions.

As also seen in Chapter 1, other country-level (macro) factors converge to amplify or reduce the effects of these channels. Examples include the degree of exposure of firms to international trade and the effectiveness of governments in tackling the crisis (Pianta

2021). Country-level industrial capabilities can also contribute to mitigating these effects. Table 2.1 provides a more detailed description of how the channels of impact and country-level factors could potentially transfer the consequences of the pandemic to manufacturing firms.

The consequences of the channels of impact can be highly uneven. Sector- (meso) and firm-level (micro) factors come into play and define the balance between vulnerabilities and factors of resilience. As noted in Chapter 1, industrial composition and sectors matter: cross-industry differences need to be factored in when analysing why some countries have been more affected by the pandemic than others. This also holds at the firm level: those operating in vulnerable industries have been more exposed to the negative impact of the pandemic than firms in robust industries.³ Robust industries include, among others, industries producing goods identified generally as “essential”

Table 2.1

Channels of impact and macro factors: Transferring the effects of the COVID-19 pandemic to manufacturing firms

Channel of impact	Vulnerabilities	Factors of resilience	Potential challenges at firm level
Demand	Fall in demand (due to restrictions and/or fall in income), dependence on few customers, shift in location of production	Stable or increased demand for products, diversified markets, oligopolistic power, public demand	Deep fall or rapid rise in demand during recovery with higher prices, efforts to enter/expand markets (niches, new technologies, new locations), relevance of domestic private and public demand
Supply	Production and value chain disruptions, temporary closure or interruption of operations, input and labour shortages, shipping bottlenecks	Diversified supply chains, advanced technologies, higher skills, manufacturing-service integration, industry composition, production of essential goods, strong industrial and productive capabilities	Input shortages (such as microchips), higher commodity prices, higher cost of inputs, weakness of production links (such as health equipment, vaccines), limits of just-in-time approach, relevance of greater vertical integration, acceleration of technological and industrial changes
International openness	Deep dependence on export markets for mass products, new competitors, trade uncertainty, trade restrictions	Strong position in global value chains, large domestic market, secured trade agreements	Decline of international demand, higher shipping costs, longer transport time to new locations, moves to diversified regional value chains, limited reshoring, relevance of domestic market
Government policies	Lack of national industrial policy, weak investment in knowledge, weak infrastructure, low country-level capabilities	Public demand, credit, industrial and technology policy for upgrading and transitions, government capabilities	Design and implement industrial policies to fill gaps in capabilities (health, vaccines, chips, digital infrastructures) and encourage an ecological transition

Source: UNIDO elaboration based on the background paper prepared by Pianta (2021).

“ Firms in non-manufacturing and in vulnerable industries experienced more closures

by governments because of their importance during the pandemic, such as health-related products, pharmaceutical products and food (see Fana et al. 2020).⁴ Essential industries firms remained less exposed to containment measures and often experienced a steep rise in demand, which led to boosts in production.

Finally, firm-level conditions and characteristics also shaped the effect of the channels of impact across firms (see “Firm features” in Figure 2.1). The availability of liquidity was an example: when containment measures or a drastic fall in demand affected production, available liquidity allowed firms to continue meeting expenditures (such as rents, wages and fixed costs) despite a dramatic reduction in sales. As discussed later in this chapter, actors that are typically more liquidity- and resources-constrained, such as SMEs and informal firms, tend to be particularly vulnerable to economic shocks (ILO 2020). This chapter dedicates special attention to the role played by firm-level production capabilities in influencing a firm’s ability to resist and react to the COVID-19 pandemic crisis.

Robustness: Resisting the pandemic crisis

This section looks at robustness from the perspective of the impact of the pandemic on manufacturing firms. In line with the definition of robustness provided in Chapter 1, it discusses what characteristics and capabilities are important to a firm’s ability to resist, absorb and accommodate shocks.

Identifying firms’ vulnerabilities and strengths

The COVID-19 pandemic had a major but highly asymmetric impact on firms. Using the data collected by the UNIDO COVID-19 firm-level survey, this section investigates the impact of the COVID-19 pandemic on manufacturing firms. When possible, findings from the UNIDO survey are complemented with information from the World Bank COVID-19 Follow-up Enterprise Survey.⁵

The industrial perspective offers a first level of analysis to investigate the impact of the crisis on

manufacturing firms. In line with Chapter 1, two broad categories of manufacturing industries—vulnerable and robust—are considered. A second level of analysis is concerned with firm size, with the distinction between SMEs and large enterprises.⁶ Crossing these two dimensions, results are presented as disaggregated by firm categories according to their size and sector. When data availability allows, figures from manufacturing firms are compared with those from actors in non-manufacturing sectors.

Data confirm that, although the negative impact of the pandemic has affected most surveyed firms, it has been extremely heterogeneous—with SMEs in vulnerable sectors being the most exposed to particularly deep negative outcomes.

The pandemic crisis and firm closure

An analysis of the data from the World Bank COVID-19 Follow-up Enterprise Survey shows that, on average, firms in non-manufacturing sectors and those in vulnerable industries suffered more temporary and permanent closures immediately after the pandemic outbreak (Figure 2.2). The pandemic channels of impact related to demand and supply were particularly intense in these sectors, causing a more generalized financial disruption, liquidity issues, and severe economic losses. This affected the performance of firms and their ability to survive the crisis. Using a sample of 31 developing countries from the same survey, Banerjee and Kharroubi (2020) found that high short-term debt and low earnings relative to interest expenses are the two most significant financial predictors of firm exit during the COVID-19 pandemic crisis.

Within the manufacturing sector, firms in vulnerable industries were less robust to financial stress, whereas firms operating in robust industries, such as those manufacturing essential goods (for example, food and pharmaceutical products), were able to continue producing to match the existing demand despite the mobility and physical restrictions imposed by governments in many countries. These firms faced a lower risk of closing.

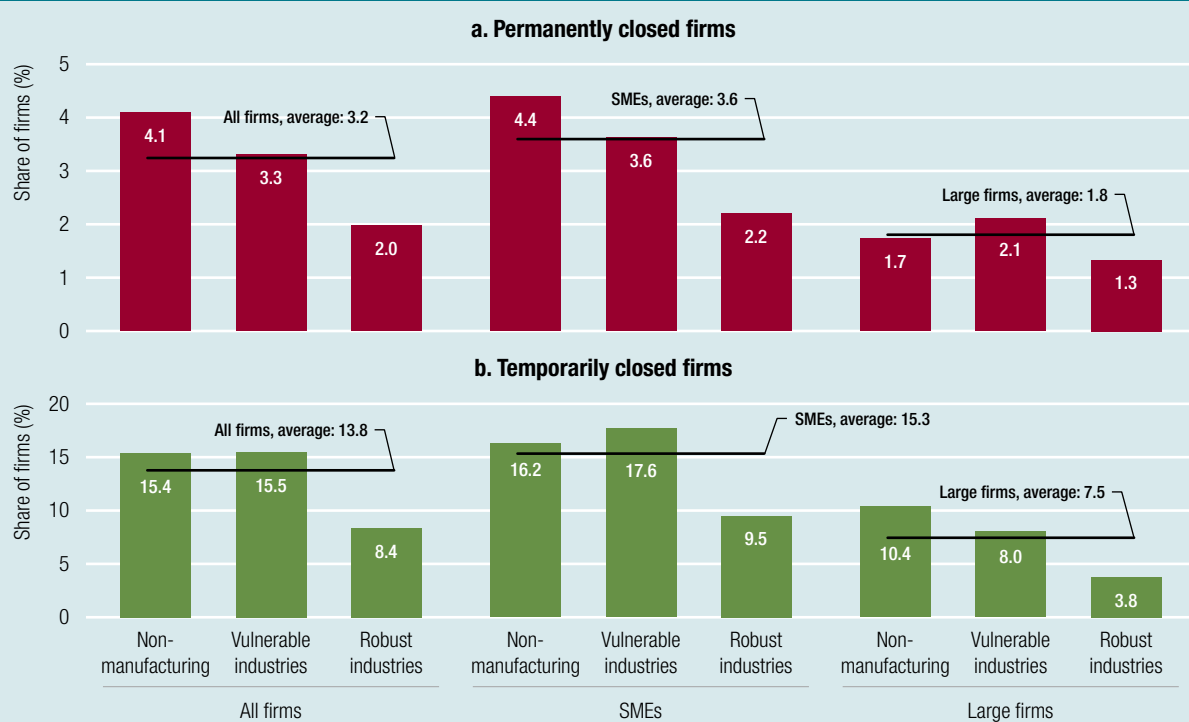
“ SMEs were more negatively affected than large enterprises, regardless of their sector

2

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Figure 2.2

Firm closures: Share of businesses temporarily and permanently closed by firm category, 2020



Source: UNIDO elaboration based on the data collected by the World Bank COVID-19 Follow-up Enterprise Survey (first round, 2020/21).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries are classified based on Chapter 1, Table 1.2. The figure shows the share of firms that closed operations (temporarily or permanently) by end July 2020. The considered sample refers to the first round of data collected by the World Bank COVID-19 Follow-up Enterprise Survey in 18 DEIs ($N = 8,449$). See Annex A for more details on the data used from the World Bank COVID-19 Follow-up Enterprise Survey. DEIs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

Still, even within the same group of industries, the impact of the pandemic on firms' survival is more pronounced for small-sized firms. This suggests that, when disruption in operations coupled with contraction in demand lead to acute pressure on cash flow, large corporations can ride out such liquidity challenges with relative ease, while SMEs tend to be subject to more financing constraints, face greater restrictions to market access and are less likely to remain in operation (Adian et al. 2020). Firm size played an amplifying role for the immediate impact of the crisis on business survival.

A wide crisis

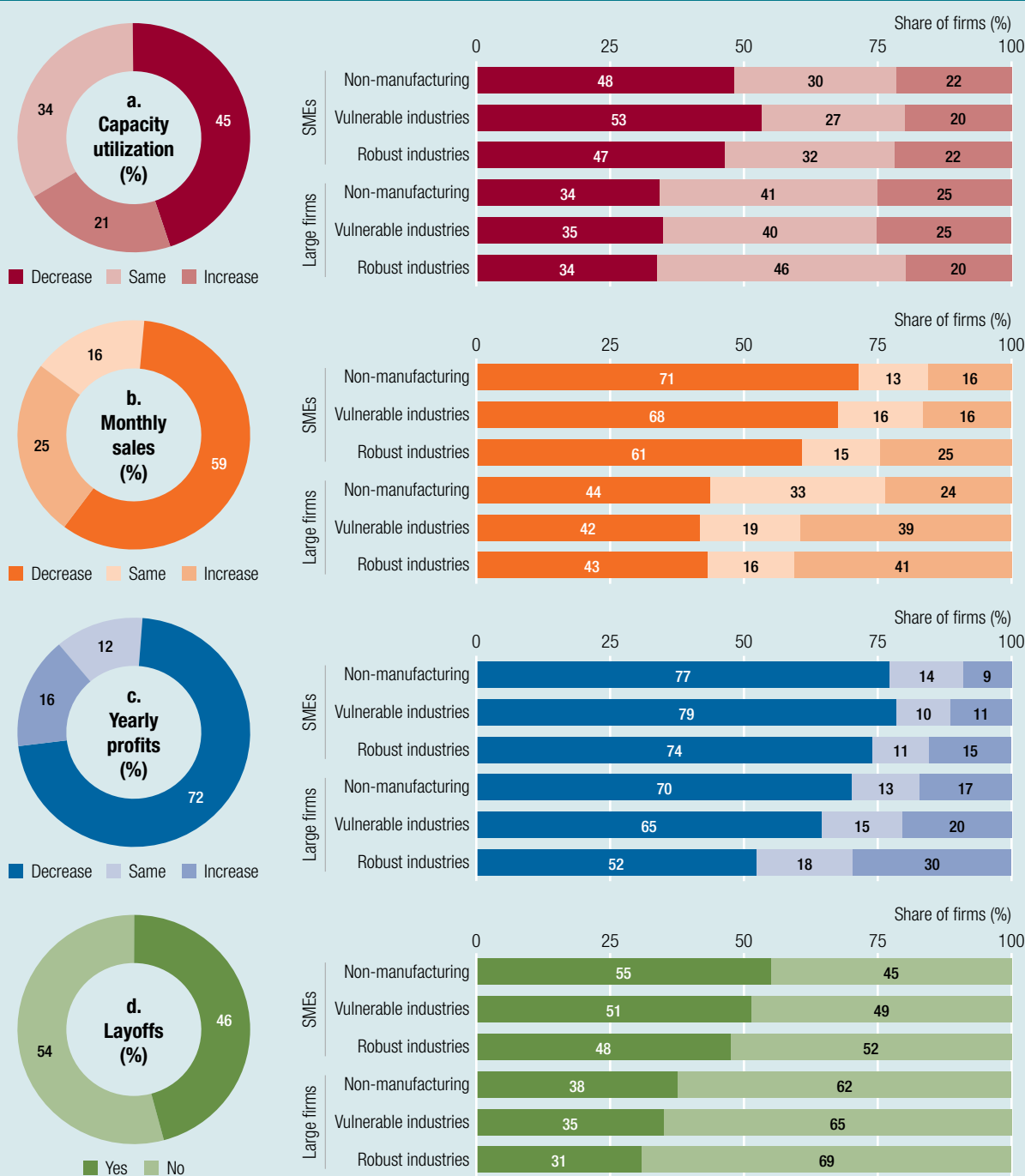
The information provided by the UNIDO COVID-19 firm-level survey on several performance indicators—change in capacity utilization,⁷ yearly profits, monthly sales, and the share of laid-off workers—gives an idea

of the severity of crisis both in terms of how widespread and how deep it was for some actors.

The pandemic generated situations in which drops in demand and/or disruptions to supply chains put firms in a position where they had to underutilize production factors. In these circumstances, labour could not make full use of its potential because of movement and physical restrictions, and capital equipment was only partially utilized. The UNIDO COVID-19 firm-level survey data confirm that capacity utilization declined in almost one out of two firms compared with the end of 2019 (Figure 2.3, panel a). It also confirms that SMEs were more negatively affected than large enterprises, regardless of their sector: the percentage of firms with declining capacity utilization was 53 percent for SMEs in vulnerable industries, which is higher than the 35 percent for large firms in these same industries.

More than 70 percent of surveyed firms experienced a decline in yearly profits in 2020

Figure 2.3
Impact of COVID-19 on firms: Share of firms that experienced a decrease, increase or no change on capacity utilization, sales, profits and worker layoffs by firm category, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).
 Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries classified based on Chapter 1, Table 1.2. Non-manufacturing sectors include: agriculture, mining, utilities, construction, and services. The figure shows the share of firms experiencing an increase, decrease or no change in their capacity utilization, sales, profits, and workers laid off. The circular donut charts show the composition of the sample by the impact on the indicator. The bar charts show the composition of the sample by the impact on the indicator for each firm category. The change in *capacity utilization* refers to the difference of the average level of capacity utilization two months before the survey with respect to December 2019 ($N = 3,557$). The change in *monthly sales* refers to the value of monthly sales the month before the survey with respect to the same month one year before ($N = 2,981$). The change in *yearly profits* refers to the value of profits in 2020 compared to 2019 ($N = 2,804$). *Layoffs* refers to total workers who have been laid off due to the COVID-19 pandemic ($N = 3,316$). The sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

“ The crisis disproportionately affected firms with already lower pre-pandemic performances

An analysis of the changes in profits and sales demonstrates how comprehensive the impact of the crisis was. More than 70 percent of surveyed firms experienced a decline in yearly profits, while nearly 60 percent reported a decline in monthly sales (Figure 2.3, panels c and b, respectively). Data confirm once again the disparity in impact across firms: in all sector categories, more SMEs presented a higher percentage of declining sales and profits than large enterprises.

The economic stress generated by the COVID-19 pandemic induced many firms to lay off workers, even though many countries implemented policies to protect jobs or had in place labour-market institutions protecting employment in manufacturing. About 46 percent of surveyed firms laid off workers (Figure 2.3, panel d). One out of two SMEs had to reduce their labour force as a result of the pandemic, while for large firms in robust industries this percentage is less than

one-third. This result may reflect the fact that SMEs tend to face more difficulties in accessing and benefiting from employment-protection measures (that is, wage subsidies) implemented by governments.

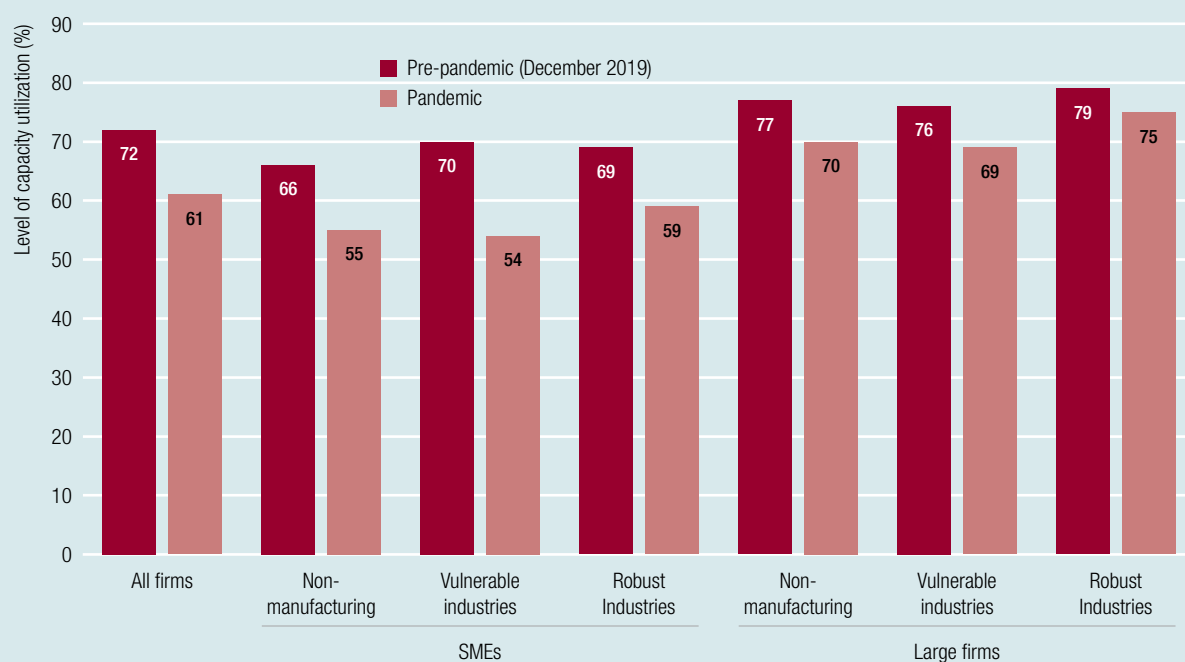
A deep crisis

How deep was the fall in firms' performance? The UNIDO COVID-19 firm-level survey data reveal that SMEs have not only been affected more frequently and in larger numbers than large firms, but also more severely, regardless of the sector. But within each firm size category, manufacturing firms showed greater robustness than those in non-manufacturing industries.⁸ As noted in Chapter 1, this has to do with the fact that non-manufacturing sectors were particularly hard hit by restrictions and containment measures.

Focussing on the manufacturing sector, some actors could take more advantage of the crisis: firms in some

Figure 2.4

Impact of COVID-19 on firms: Level of capacity utilization by firm category, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries classified based on Chapter 1, Table 1.2. Non-manufacturing sectors include: agriculture, mining, utilities, construction, and services. The figure shows the average level of capacity utilization in December 2019 (pre-pandemic) and two months before the survey (pandemic) ($N = 3,557$). The sample covers 26 DEEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

“ Firm size is relevant in shaping firm-level impact on profits and sales

robust industries—such as pharmaceutical products—could sustain and increase their business as a result of the urge to increase the production of medicines and vaccines necessary to tackle the crisis (UNIDO 2020a). In each firm size category, these firms performed better than firms in vulnerable industries.

The average decline in the level of capacity utilization experienced by surveyed firms was about 11 percentage points (Figure 2.4). This decline has been deeper for SMEs in vulnerable industries: their average level of capacity utilization decreased sharply (16 percentage points), this decline being about one-third larger than that experienced by large firms in the same industries (10 percentage points). Although large firms were operating at a higher average level of capacity utilization than SMEs in December 2019, they experienced a smaller drop after the outbreak of the pandemic. Thus, the crisis disproportionately affected firms with already lower pre-pandemic levels of capacity utilization.

The value of profits and sales declined on average by 28 percent and by 19 percent, respectively (Figure 2.5). These averages hide a large disparity: the drop in profits was more than 4 times larger for SMEs in vulnerable industries than for large firms in robust industries; for sales, the drop was about 14 times greater for SMEs in vulnerable industries. SMEs in non-manufacturing sectors report an even larger drop in sales and profits than SMEs in manufacturing. In line with the findings presented in Chapter 1, the collected microdata confirm the stronger impact of the pandemic on firms in vulnerable industries and in non-manufacturing sectors. In addition, they indicate that also firm size is very relevant in shaping firm-level impact: even when operating in the most affected sectors, larger firms were better able to protect their revenues during economic turbulence than SMEs.

All firms that reduced employment because of the pandemic crisis dismissed, on average, 37 percent of their workers (Figure 2.5). This average reached 43 percent and 46 percent for SMEs in vulnerable industries and in non-manufacturing, respectively.

These dramatic figures confirm that small firms' workers tend to be the most vulnerable to economic shocks (ILO 2020). An even broader impact has been contained thanks to government measures, such as income support and a freeze on layoffs. The International Monetary Fund (IMF) estimates that at least 54 million jobs were protected by such actions in 2020 (IMF 2020), but these measures may have only helped to postpone future job and wage losses (Pianta 2021). The role of government policies will be discussed more in depth in the last section of this chapter.

The pandemic's effects on vulnerable workers

The previous section showed how severely the pandemic crisis affected SMEs in DEIEs. This is particularly problematic since small enterprises, together with self-employment, constitute most of the total employment in low- and middle-income countries. Moreover, most marginalized groups of workers, such as informal and women workers, tend to be over-represented in small firms (Braunstein 2021). On the one hand, small firms are important vectors of inclusiveness into the labour market for marginalized groups. On the other hand, a particularly negative impact of the crisis on these firms places a higher risk of job losses on a large share of the labour force, especially its most vulnerable parts.

When not accompanied by labour protection mechanisms, the contraction of employment can lead to a strong negative shock in disposable income, with dramatic consequences on inclusiveness. A survey conducted in July 2020 in 30 countries reported decreases in income and savings ranging from 30 percent to 80 percent. Moreover, between 20 percent and 60 percent of respondents also reported they feared for their jobs (Euart et al. 2020).

However, even when in place, labour protection measures typically exclude informal workers. This means excluding a large share of employment in lower-income countries from protection, as 61 percent of the world's employed population is part of the informal economy and more than 9 out of 10 informal workers

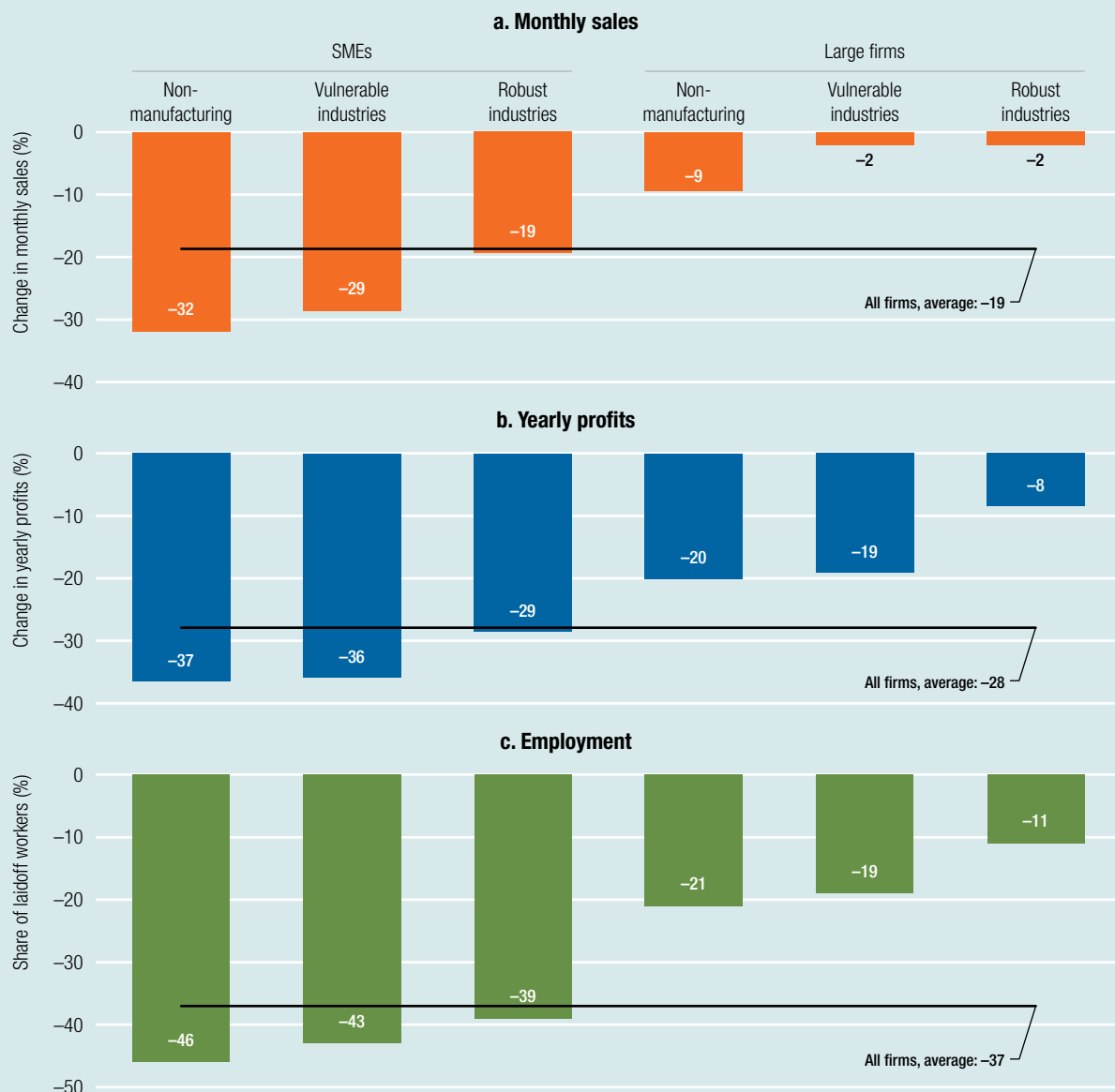
Small firms' workers tend to be the most vulnerable to economic shocks

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Figure 2.5

Impact of COVID-19 on firms: Drop in sales, profits and employment by firm category, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries classified based on Chapter 1, Table 1.2. Non-manufacturing sectors include: agriculture, mining, utilities, construction, and services. Panels a and b show the average change in monthly sales and yearly profits, obtained considering all surveyed firms and all valid responses. The *change in yearly profits* refers to the value of profits in 2020 compared to 2019 ($N = 2,971$). The *change in monthly sales* refers to the value of monthly sales the month before the survey with respect to the same month one year before ($N = 2,975$). Panel c shows the average drop in employment, corresponding to the average share of laid-off workers over the total number of workers in December 2019, considering only firms that declared they have laid off workers ($N = 1,513$). *Layoffs* refers to total workers who have been laid off due to the COVID-19 pandemic. The sample covers 26 DEIEs. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

are located in developing countries (ILO 2018). This is in line with the findings of a recent study on the effect of the pandemic on the informal sector, according to which 30 percent of households in Côte d'Ivoire and 20 percent in Ethiopia lost their employment as

consequence of the COVID-19 shock (Leininger et al. 2021). The loss in employment resulted in a reduction of income for 60 percent of households in Côte d'Ivoire and 56 percent in Ethiopia, and it increased the number of households living below the international

“ Women workers in manufacturing faced disproportionate risk of job loss compared with men

poverty line from 28 percent before the pandemic to 47 percent after pandemic in Côte d’Ivoire, and from 45 percent before to 67 percent after in Ethiopia. This severe effect of the pandemic on the informal sector can in part be explained by limited government support: in Côte d’Ivoire only 7 percent of households in the informal sector received some type of government support; this was merely 4 percent in Ethiopia.

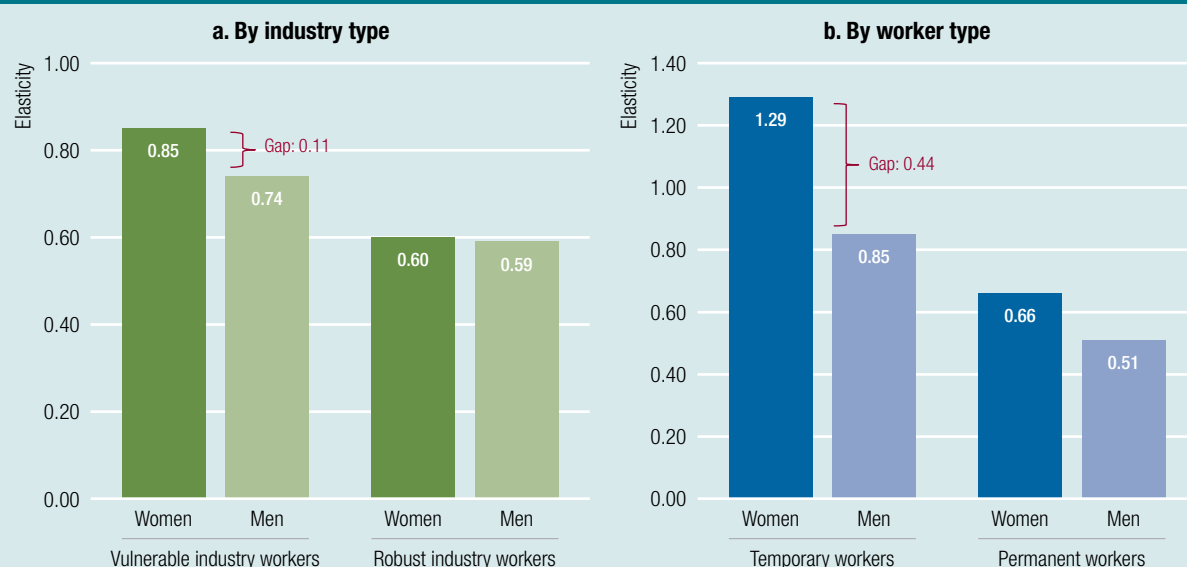
The pandemic crisis has disproportionately affected women workers. As seen in Chapter 1 (see Figure 1.16), the observed job loss for female workers is partly driven by gender segregation in industry,⁹ but gender discrimination can also play a role when deciding who to let go during periods of crisis. An analysis of gender-disaggregated data conducted for this report confirms that women in manufacturing faced disproportionate risks of job loss compared with men (Braunstein 2021). Using data from the UNIDO COVID-19 firm-level survey, elasticity of employment with respect to changes in monthly sales turns out to be higher for female than for male workers (Figure 2.6):

a given decrease in monthly sales is associated with a larger decrease in the number of female workers than of male workers.

The gender factor worsens the situation for those already facing inferior work conditions and less secure sources of income: the gender gap in elasticity is larger in vulnerable industries, where all workers are already more at risk of losing their jobs in response to declines in sales than workers in robust industries. The “gender effect” is even more pronounced when looking at worker type. The elasticity gap is much larger for temporary workers, who are already associated with a double elasticity of employment to sales compared with permanent workers (Figure 2.6).¹⁰ Moreover, women are also more likely to be temporary workers than men are, as evidenced by women’s higher share of the temporary workforce than the permanent one in the considered sample (51 and 35 percent, respectively) (Braunstein 2021).

These results are in line with the argument that gender norms and stereotypes may play a role as job

Figure 2.6
Elasticity of employment: The gender gap, 2019–2021



Source: UNIDO elaboration based on the background paper prepared by Braunstein (2021), derived from the data collected by the UNIDO COVID-19 firm-level survey (2021).
Note: Robust and vulnerable industries classified based on Chapter 1, Table 1.2. Permanent workers work for a term of one or more fiscal years. Temporary workers work for a term of less than one fiscal year. The charts show the elasticity of employment with respect to sales, which indicates the percent fall in the number of workers for every 1 percent fall in the value of monthly sales. The change in monthly sales refers to the value of monthly sales the month before the survey with respect to the same month one year before. The fall in employment corresponds to the average share of laid-off workers due to the COVID-19 pandemic over the total number of workers in December 2019. Layoffs refers to both temporary and permanent workers who have been laid off due to the COVID-19 pandemic. The considered sample includes only firms that provided valid responses on women’s share of workers, women’s share of workers laid off, and change in monthly sales ($N = 1,055$). The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

“ Having a strong and competitive manufacturing sector matters for firm-level robustness

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scarcity increases. When facing economic duress and an increasing scarcity of jobs, women are likely to be seen by employers as more marginal workers, thus easier to lay off when sales decline and the first to be squeezed to accommodate changes in labour demand (Seguino and Braunstein 2019). Decreasing gender segregation and discrimination in manufacturing would lower women’s vulnerability to employment losses during crises.

As noted in Chapter 1, the pandemic crisis is threatening to reverse decades of progress on gender equality and women’s empowerment towards the achievement of Sustainable Development Goal (SDG) 5. Women are more at risk than men of losing their jobs and their sources of income during the pandemic or its immediate aftermath, but gender equality is being challenged also by the possible longer-term negative consequences on poverty and inequality. In addition to a potential progressive deterioration of skills due to unemployment and lack of training, an increased load of housework and unpaid care—such as childcare made necessary because of school closures and the need to care for sick household members—has disproportionately fallen on women and may hinder women’s ability to perform at work as well as their participation in labour markets. Together these increase the risk of *labour market scarring*, where short-term withdrawals from the paid labour force can lead to longer-term reversals in the progress obtained on gender inequality (Braunstein 2021). This is a very concerning prospect, both for gender equality and for the contributions that women’s participation in paid work can make to inclusive and sustainable growth and development, which can seriously compromise achieved and future progress towards SDG 5.

At the roots of robustness: Capabilities to resist the storm

As highlighted in Chapter 1, industrial capabilities helped cope with the COVID-19 pandemic, mitigating the negative consequences of the crisis at country-level. This section presents new evidence that a country’s industrial capabilities are also associated

with greater firm-level robustness. It then discusses the role that firm-level production capabilities and digitalization play in enabling firms to resist and remain afloat through difficult circumstances such as a pandemic crisis.

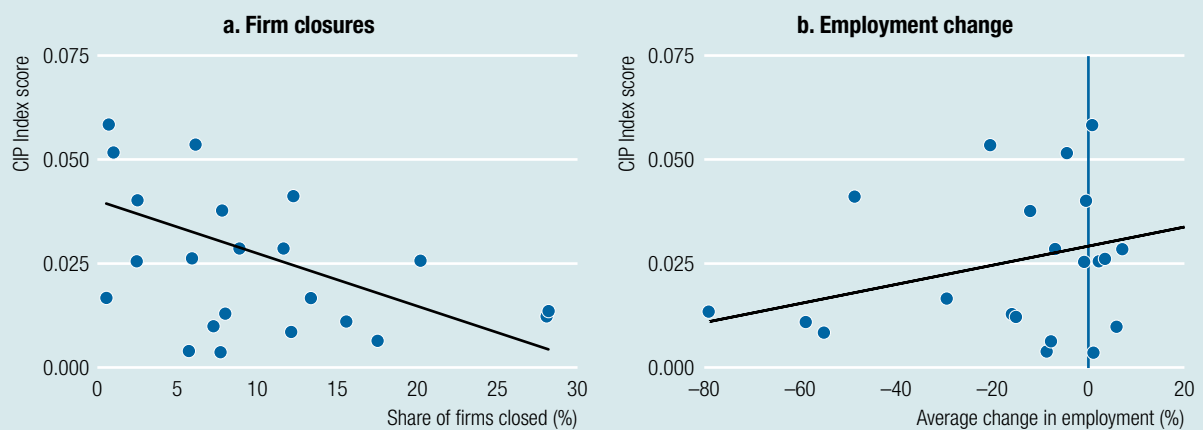
Industrial and production capabilities to foster firms’ robustness

A look at the data collected by the World Bank COVID-19 Follow-up Enterprise Survey in selected DEIEs suggests that having a strong and competitive manufacturing sector matters for firm-level robustness. Higher levels of country-level industrial capabilities—as in Chapter 1, proxied by UNIDO’s Competitive Industrial Performance (CIP) Index—are negatively correlated with the likelihood of firms to close operations (temporarily or permanently) and positively correlated with employment creation (Figure 2.7). This suggests that firms located in countries characterized by higher industrial capabilities may have been better shielded from the negative impact of the pandemic crisis.

A study conducted for this report empirically tested the role played by a competitive and sophisticated manufacturing sector in mitigating the firm-level impact of the pandemic crisis (Naidoo and Tregenna 2021). Using the data on manufacturing firms from the World Bank COVID-19 Follow-up Enterprise Survey in 13 DEIEs, the study found evidence that the severity of the pandemic (measured in reported COVID-19 deaths per 1 million people) and the stringency of government measures (measured by the Stringency Index)¹¹ were significantly negatively associated with firm-level outcomes, such as the probability of survival and of experiencing employment losses. Still, manufacturing firms in countries with higher industrial capabilities (measured by the CIP Index score) have been, on average, more robust in the face of the pandemic: even when controlling for stringency and severity, the positive association of CIP Index scores with firm survival and lower employment losses remained significant (Figure 2.8). This result further confirms the evidence emerging from Chapter 1 that,

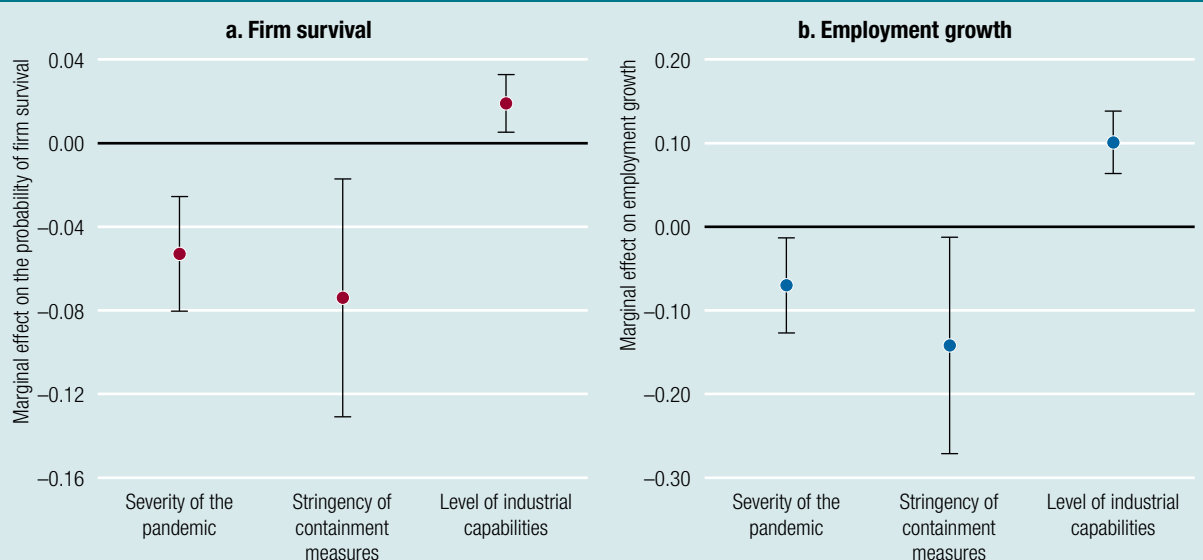
Firms in countries with higher CIP Index have been better shielded from the impact

Figure 2.7
Industrial capabilities, firms' survival and changes in employment, 2020–2021



Source: UNIDO elaboration based on UNIDO CIP 2021 Database (UNIDO 2021a) (CIP Index 2019 score) and the data collected by the World Bank COVID-19 Follow-up Enterprise Survey (first round, 2020/21).
Note: The figure uses the first round of the data collected by the World Bank COVID-19 Follow-up Enterprise Survey in 23 DEIEs. Only manufacturing firms have been considered. The UNIDO CIP Index (y axis) expresses the industrial competitiveness of countries and is taken as a proxy of their level of industrial capabilities. In panel a, the *share of firms closed* refers to firms that closed operations (temporarily or permanently) at the time of the follow-up survey ($N = 14,535$). In panel b, the *change in employment* refers to the difference between the number of employees at the time of the baseline survey and the number at the time of the follow-up survey ($N = 10,283$). See Annex A for more details on the data used from the World Bank COVID-19 Follow-up Enterprise Survey. CIP = Competitive Industrial Performance; DEIEs = developing and emerging industrial economies.

Figure 2.8
Determinants of COVID-19 impact on manufacturing firms: The role of industrial capabilities



Source: UNIDO elaboration based on the background paper prepared by Naidoo and Tregenna (2021), derived from the data collected by the World Bank COVID-19 Follow-up Enterprise Survey (first round, 2020/21), Hale et al. (2021) and UNIDO (2021a).
Note: The analysis uses the data collected by the World Bank COVID-19 Follow-up Enterprise Survey in 13 DEIEs (first round, 2020/21). Only manufacturing firms have been considered. The main variables of interest are the *severity of the pandemic*, defined as the cumulative level of COVID-19 reported deaths per 1 million people at the time of the survey; *stringency of containment measures*, defined as the cumulative average level of Oxford's Stringency Index at the time of the survey; and *level of industrial capabilities*, defined as the level of UNIDO CIP Index in 2019. Panel a depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the average marginal effects of the variables of interest on the probability of firm survival, obtained through the implementation of a probit model with robust standard errors ($N = 2,217$). *Firm survival* is proxied with a binary variable that takes the value of 1 if the firm is fully operational at the time of the follow-up survey, and 0 if it closed operations (temporarily or permanently). Panel b depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the marginal effect of the variables of interest on employment growth, obtained through the implementation of a regression analysis controlling for firm survival with a two-step Heckman procedure ($N = 2,228$). *Employment growth* is defined as the logarithmic difference between the number of employees at the time of the baseline survey and the number of employees at the time of the follow-up survey. See Naidoo and Tregenna (2021) for a detailed description of the used sample, the variables and the methodology. CIP = Competitive Industrial Performance; DEIEs = developing and emerging industrial economies.

“ Production capabilities shielded manufacturing firms from employment losses during the crisis

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counterbalancing the negative impacts of severity and stringency, country-level industrial capabilities mitigate the impact of the crisis at firm level as well, fostering firms' robustness towards an external shock.

Highlighting the importance of having a strong, sophisticated and competitive manufacturing sector for manufacturing firms' robustness, these results underscore the crucial role of industrial policy for an inclusive and resilient industrial development. A country's manufacturing sector can indeed be influenced and strengthened by policy choices: the stronger a country's manufacturing sector is, the more it can help mitigate the impact of external crises on individual manufacturing firms, including by softening the socio-economic consequences on firm-level employment, which has relevant implications for inclusiveness.

The same study (Naidoo and Tregenna 2021) also empirically analysed firm-level outcomes as a function of firm-level determinants. In particular, it investigates the role of firm-level capabilities in sheltering surviving firms from the negative impact of the pandemic crisis.

Firm-level capabilities can broadly be classified in two groups: investment and technology capabilities, and production capabilities (UNIDO 2019b). The first capabilities are related to investments in research and development (R&D), in fixed assets and in technological innovation; the latter captures the accumulated in-company learning from daily experiences and from learning-by-doing originating from repeated operations and activities. Production capabilities are thus related to previous experiences and to managerial ability and skills—in particular, those abilities and skills that, once embedded in agents, organizations and routines, allow for maintaining existing production systems and continuity of operations, performing different productive tasks, as well as adapting and undertaking operational improvements and integrating new technologies in production processes (Andreoni 2011; Avenyo et al. 2021). The acquisition of these capabilities can be associated, for example, with adopting an internationally recognized quality certification (such as ISO 9001) or with providing formal training to the workforce (for example, training to foster quality

and productivity through incremental improvements in production systems, such as in Kaizen (see Hosono et al. 2020).

The study proposes two separate indices for firm-level capabilities:¹² an index for technological capabilities, comprising investments in R&D and in new fixed assets, innovation and share of foreign ownership; and an index for production capabilities, comprising the presence of quality certifications, conducting training for employees, export intensity and years of experience of managers (Naidoo and Tregenna 2021). Results of the empirical analysis show that production capabilities maintain a positive and significant effect on shielding manufacturing firms from employment losses during the COVID-19 pandemic crisis, even when taking into account other country- and firm-level factors (including technological and industrial capabilities). This result supports the argument that production capabilities contribute to protecting firms' activities and employment during severe shocks.

Considering the definition of the index for production capabilities, the positive effect of these capabilities can be associated with having an internationally recognized quality certification, with good management practices and with providing training to the workforce. Training improves the quality of the workers, making trained workers more skilled for the execution of routines and production processes, but it is also costly, which further increases the opportunity cost of laying off trained workers. Another recent empirical study offers additional evidence on the role of production capabilities: using data from the World Bank COVID-19 Follow-up Survey in 16 countries, Grover and Karplus (2021) found that good management practices were associated with better economic performance during the pandemic crisis.

Finally, production capabilities may have been acquired through exposure to previous crises. During these past crisis episodes, firms have been able to accumulate internal knowledge and develop what can be called *crisis capabilities*, which can play an important role in terms of building preparedness to face other similar events (Ritter and Pedersen 2020). Being

Digitally advanced firms were more robust to the impact of the pandemic shock

prepared is crucial for robustness to shocks. As discussed in the last section of this chapter, helping firms build preparedness should become a relevant dimension of industrial policies for resilience.

Digitalization and firms' performance during shocks

The importance of production capabilities in strengthening firm-level robustness is reinforced by their role in fostering firm-level digitalization. According to the *Industrial Development Report 2020* (IDR 2020) (UNIDO 2019b), production capabilities are crucial for the adoption of advanced digital production (ADP) technologies (see Box 2.1), as they facilitate firm-level technological upgrading and retrofitting of new technologies in manufacturing production processes. This positive association between the adoption of ADP technologies and production capabilities represents an additional channel to strengthen firms' robustness. Thanks to mastering an advanced set of

production capabilities, digitally advanced firms tend to be more robust to severe external shocks.¹³

The data collected by UNIDO's COVID-19 firm-level survey support this argument: on average, digitally advanced firms were better able to resist the crisis in terms of impact on sales, profits and laid-off workers (Figure 2.9). The fact that digitally advanced firms may be more robust to negative shocks is confirmed by a survey carried out in the United Kingdom among manufacturing firms: 46 percent of respondents agreed that digitalization capabilities and past investments in digital technologies helped them survive the COVID-19 crisis (MakeUK 2020).

Whereas the UNIDO COVID-19 firm-level survey shows that digitalization is associated with a more contained impact, it is important not to overlook the potential risks related to the digitalization-employment trade-off. Digitalization and, in general, technological change can substitute for labour; yet IDR

Box 2.1

Advanced digital production technologies: A new technological wave transforming the industrial landscape

Advanced digital production (ADP) technologies represent the latest evolution of digital technologies applied to industrial production. These entail digital technologies such as the Internet of Things (IoT), big data analytics, artificial intelligence (AI) and additive manufacturing, and advanced robotics and cobots, among others. Often clustered together under the label "Industry 4.0," the integrated application of these technologies in production enables the collection and analysis of vast amounts of data, the seamless interaction between smart machines and the combination of the physical and virtual dimensions of production.

Despite their potential, detailed information on the diffusion and adoption of ADP technologies is still scarce, especially for actors in developing and emerging industrial economies (DEIEs). In 2019, UNIDO pioneered the collection of firm-level data on the diffusion of ADP technologies with the implementation of the firm-level survey "Adoption of digital production technologies by industrial firms." Instead of concentrating on specific technological solutions or devices, this survey asked firms to select the set of production technologies that best represented their technological level among five possible "technological generations," ordered according

to the degree of technological sophistication: from the simplest ones (analog, non-digital) to the most cutting-edge ADP technologies—those associated with "smart" (generation 4.0) or "integrated" (generation 3.0) technologies—passing through technologies employed in "rigid" (generation 1.0) and "lean" (generation 2.0) modes of production. Smart and integrated production technologies approximately coincide with the concept of Industry 4.0, as their application allows exploiting the full potential of advanced digital technologies in terms of connectivity and flexibility. Firms that identified their technological level as smart (generation 4.0) or integrated (generation 3.0) are defined as ADP-adopters or as digitally advanced.

The UNIDO COVID-19 firm-level survey, implemented as a side project of the *Industrial Development Report 2022* (IDR 2022), followed the same approach in collecting data on ADP technologies in DEIEs (see Annex A). The information gathered allows for obtaining an original and rather unique comparative map of the diffusion of ADP technologies in manufacturing firms around the world (see Chapter 3).

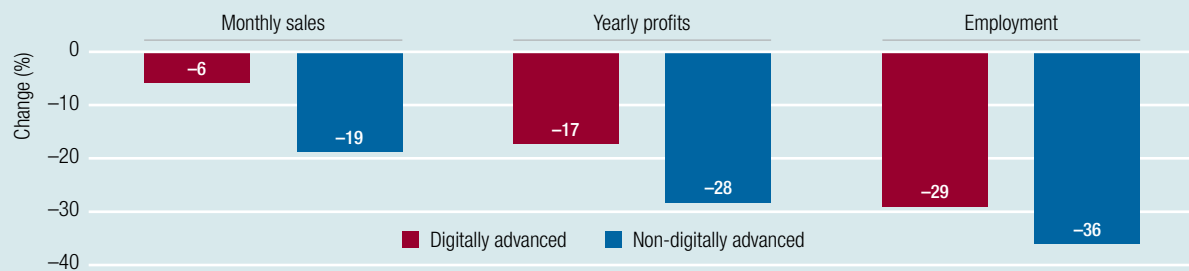
Source: UNIDO elaboration based on UNIDO (2019b).

Building production capacity takes time and requires learning and accumulating knowledge

2

Figure 2.9

Digitalization and firms' robustness: Drop in sales, profits and employment by digitally advanced and non-digitially advanced firm type, 2019–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Manufacturing firms adopting ADP technologies are defined as digitially advanced and non-ADP adopters as non-digitially advanced. The figure shows the average change in sales and profits. The change in *yearly profits* refers to the value of profits in 2020 compared to 2019 ($N = 2,303$). The change in *monthly sales* refers to the value of monthly sales the month before the survey with respect to the same month one year before ($N = 2,301$). The figure also shows the average drop in employment, corresponding to the average share of laid-off workers over the total number of workers in December 2019, considering only firms that declared they have laid off workers since the beginning of the pandemic ($N = 1,183$). The change in *employment* refers to total workers who have been laid off due to the COVID-19 pandemic. The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. ADP = advanced digital production; DEIEs = developing and emerging industrial economies.

2020 provided evidence that technological change (in particular automation related to the introduction of robots into the production system) can have not only a direct effect on employment, but also indirect effects on the rest of the value chain in terms of better quality and cheaper selling prices of final goods that can be reflected in higher employment (UNIDO 2019b).

Three main messages emerge from this section. First, the impact of the pandemic on firms, especially those lacking production capabilities and without a favourable industrial context, has been wide and deep. But it is still not clear how the COVID-19 crisis will affect manufacturing firms in the medium to long term. The need to manage this uncertainty calls for adequate policy interventions in the medium to long term.

Second, in addition to country-level industrial capabilities, a sounder firm-level industrial experience and accumulated knowledge in industrial production turns out to be an asset to resist the storm. Production capabilities seem to be key to firms' ability to go through and resist a crisis, as they are intrinsically associated with the ability of firms to run manufacturing processes and maintain continuity of operation.

Third, considering how production capabilities offer the double advantage of facilitating firm-level

digitalization and strengthening firm's robustness, policy should pay more attention to fostering production capabilities. In addition, production capabilities' contribution to protecting employment levels during the pandemic also highlights their importance for inclusiveness and for mitigating the socioeconomic consequences of the crisis. By fostering the development of production capabilities, policy could target all these goals. As discussed more thoroughly in the final section of this chapter, policies can attempt to reduce the persistence of negative impacts by boosting the acquisition of capabilities and by introducing risk management into industrial policy, in order to increase robustness, readiness and the overall resilience of firms and countries.

As many firms in developing countries lack these firm-level capabilities, they become particularly exposed to the impacts of crises without a concrete strategy for recovering. Building production capacity takes time, as they require a medium- to long-term process of learning and accumulating knowledge (UNIDO 2019b). Still, the association of production capabilities with activities such as providing training and obtaining quality certifications makes room for effective actions for their development in DEIEs. In this regard, UNIDO has been actively promoting

“ Resilience lies in firms’ ability to adapt operations in response to the crisis

compliance with international standards on several products (Box 2.2), including personal protective equipment and medical devices (see also Box 2.3).

Readiness: Responding and adapting to a new normal

The previous section highlighted that industrial and production capabilities matter for firms’ robustness towards negative shocks. This section focuses on firm-level readiness, which refers to how firms were able to cope with the crisis. As already observed in Chapter 1, the two dimensions of resilience do not necessarily come together: not all actors that are able to resist a shock can be as well able to respond, transform and adapt to it (Andreoni 2021).

Hence, how did manufacturing firms respond to the COVID-19 crisis? And which types of firms have been better able to react and adapt to the new normal? This section completes the discussion on features and determinants of firm-level resilience by documenting the strategies introduced by manufacturing firms in response to the COVID-19 pandemic. It also discusses

what features are important for a firm to be able to react to the pandemic crisis. An analysis of how firms have been responding to the COVID-19 pandemic crisis is an essential step towards a better understating of the shifts in contours of industrial development in a post-pandemic world.

Identifying responses: An overview of firm-level response strategies

Firms can react in different ways to crises: they can opt for a “wait-and-see” approach, buying time to see how the situation is evolving and, if necessary, dipping into their rainy day reserves, or they can react quickly and strategically adapt their operations and business models in response to the crisis. Industrial resilience ultimately lies in the ability to pursue the latter approach.

When facing a shock, each firm interweaves a variety of response strategies by drawing on its capabilities and resources. Firms can react by implementing strategic changes in their organizations, operations, routines and business models¹⁴ (Amis and Greenwood 2020).

Box 2.2

Leveraging quality standards and digital technologies for a more inclusive industrial development: The application of traceability solutions in the case of Sri Lankan spices

Internationally recognized quality standards have become increasingly crucial to countries’ participation in trade and global value chains. Besides representing an important driver for the acquisition of firm-level production capabilities, having good quality infrastructure and reliable accreditation processes can help a country enhance competitiveness, strengthen its industrial sector and become more integrated with international trade flows and production networks, ultimately pursuing a path of inclusive and sustainable industrialization through the achievement of Sustainable Development Goal (SDG) 9 (Calzadilla-Sarmiento 2020).

UNIDO has been playing an important role supporting standard conformity assessment and offering a series of tools to help fulfil the demand for quality services in developing and emerging industrial economies (DEIEs). The UNIDO project “Strengthened food safety and quality compliance for selected Sri Lankan spices through the application of traceability solutions” represents a good example of how fostering production capabilities by adopting international

quality standards can come along with technological upgrading towards more advanced digital technologies.

This project is supporting the introduction of an information and communication technology (ICT)-based traceability system in Sri Lankan spice producers. This allows transparency to be increased along each stage of the supply chain by verifying compliance with internal (product specifications) and external (market and regulatory) requirements. Meeting food safety standards, in turn, can provide access to new market opportunities, spurring the economic growth of this industry and improving the livelihoods of farmer communities. Standards and quality-related best practices can also diffuse from export to domestic supply chains, which share common business operators. This can have positive spillovers on poverty alleviation and inclusiveness, as larger numbers of workers in the informal sector, particularly women and youth, could be absorbed into productive jobs in the formal sector.

Source: UNIDO elaboration.

“ Firms implemented responses to face challenges and adapt to new normality

2

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This helps them keep responding to requests of stakeholders, such as customers, suppliers and employees (Kirsch et al. 2011). However, crises can also bring new opportunities: firms' strategic reactions can entail new methods of production as well as new products and markets or can give rise to new or transformed business models grounded on new capabilities (Ritter and Pedersen 2020). As discussed in Chapter 3, crises can also accelerate technological transformation.

Thus, response strategies can in general pursue two aims: exploiting opportunities created by the shock, or coping with the threads and constraints imposed by the crisis (Buchheim et al. 2020; Donthu and Gustafsson 2020). In the case of the COVID-19 pandemic, for instance, firms in severely affected sectors were more likely to employ a more defensive approach in their response, at least immediately after the outbreak of the crisis. Conversely, firms producing goods with growing demand and stable supply of inputs were in a position to exploit the opportunities the crisis presented. Responses by firms can, nonetheless, also encompass both these goals over time, being defensive during the outbreak of the shock and proactive in its aftermath.

In the case of the COVID-19 pandemic crisis, firm-level response strategies entailed a combination of different strategic changes. These included, for instance, repurposing production into manufacturing health care products; proactive searching of alternative sources of inputs; redesigning processes to secure the health of workers, including remote and home working; managing production with a reduced workforce; modifying product designs and developing new products to meet changing demand; and altering distribution methods to ensure last-mile access and exploring new distribution channels, such as contactless delivery (Meester and Ooijens 2020; Seetharaman and Parthiban 2021). As discussed later in this section, effective implementation of these strategies requires capabilities that may be owned by a constrained group of firms.

Building on the findings of new and original research works produced for this report, the following sections provides both a qualitative and a quantitative

perspective on firms' response strategies towards the COVID-19 pandemic crisis.

A qualitative approach: Clusters of response strategies

A study conducted for this report sheds further light on the response strategies followed by manufacturing firms in a developing and emerging country context (Seetharaman and Parthiban 2021). Considering the specific nature of the pandemic (that is, contagion from contact and the need for social distancing), this study identifies the sector of operation and the degree of labour intensity as main dimensions defining the response strategies, grouping these into four clusters. Table 2.2 summarizes the main response strategies identified by the study and Table 2.3 reports some examples.

According to an analysis of companies' annual reports over the period 2020–2021 in seven DEIEs,¹⁵ firms implemented different immediate and strategic responses to face the challenges emerging from the crisis and to adapt to the new normality. After experiencing a short initial phase of disorientation at the outbreak of the pandemic, firms in robust industries—especially those producing essential goods, such as food or medical products—could continue their production processes, even if this became conditional to the adoption of health-related protocols and safety measures. Their strategic responses mostly focused on finding solutions to maintain or increase the volume of production and to satisfy a sustained or growing demand, which often required an increase in non-conventional distribution channels (that is, online platforms, contactless delivery).

Conversely, firms in vulnerable and non-essential industries had to come up with different immediate and strategic responses. These included re-orienting production towards essential goods or products with growing demand (see Box 2.3) and rebranding existing products with communication campaigns to boost consumer's discretionary spending. Moreover, many of these firms—especially SMEs that typically have lower liquidity reserves—had to reconsider investments and/or restructure finance.

“ Sector and labour intensity concur to define firms’ responses to the pandemic crisis

Table 2.2

Four clusters of response strategies

	Vulnerable industries	Robust industries
Non-labour intensive	<p>Main challenges</p> <ul style="list-style-type: none"> • Fall in demand • Stay customer-relevant • Liquidity stress 	<p>Main challenges</p> <ul style="list-style-type: none"> • Maintain/expand production volumes to fulfil stable/growing demand • Maintain delivery • Maintain/expand supply/input source
	<p>Immediate response</p> <ul style="list-style-type: none"> • Halt in production • Temporary closure • Reduce scale of operations 	<p>Immediate response</p> <ul style="list-style-type: none"> • Resume operation with enforcement of emergency and health protocols • Remote work arrangements (if possible)
	<p>Strategic response</p> <ul style="list-style-type: none"> • Repurpose to use idling capacity and diversify products to tap into increasing demand • Rebrand existing products and communication campaigns to enhance consumer’s discretionary spending • Financial restructuring and cost curtailment • Implement digital channels of distribution and online sales 	<p>Strategic response</p> <ul style="list-style-type: none"> • Maintain/expand production • Add to logistic capabilities to face lockdown-induced distributional challenges • Chase non-conventional distributional channels (adoption of contactless delivery, increase online presence, online sales) • Digitalize product and services (digital platform, digital customer relations) • Search for new input sources if supply chain is disrupted • Increase business agility
	<p>Main challenges</p> <ul style="list-style-type: none"> • Enable distancing of workers • Reduce use of workforce • Fall in demand • Stay customer-relevant • Liquidity stress 	<p>Main challenges</p> <ul style="list-style-type: none"> • Cope with labour shortages due to illnesses, movement restrictions, social distancing • Enable distancing of workers • Reduce use of workforce • Maintain/expand production volumes to fulfil stable/growing demand • Maintain delivery • Maintain/expand supply/input sources
Labour intensive	<p>Immediate response</p> <ul style="list-style-type: none"> • Halt in production • Temporary closure • Reduce scale of operations • Replace/redeploy workforce 	<p>Immediate response</p> <ul style="list-style-type: none"> • Resume operation with enforcement of emergency health protocols • Remote work arrangements (if possible)
	<p>Strategic response</p> <ul style="list-style-type: none"> • Increase factory automation • Repurpose to use idling capacity and diversify products to tap into increasing demand • Rebrand products, communication campaigns to enhance consumer’s discretionary spending • Financial restructuring and cost curtailment • Implement digital channels of distribution and online sales 	<p>Strategic response</p> <ul style="list-style-type: none"> • Implement health protocols to prevent contagion; provide hand sanitizers, thermal scanners, masks and cleansing agents • Maintain/expand production • Increase factory automation • Rearrange shop floor and change work shifts to minimize contact and deal with labour shortages • Redesign and modularize manufacturing processes to minimize contact and deal with labour shortages • Add to logistic capabilities to face lockdown-induced distributional challenges • Chase non-conventional distributional channels (adopt contactless delivery, increase online presence, online sales) • Digitalize products and services (digital platform, digital customer relations) • Search for new input sources if supply chain is disrupted

Source: UNIDO elaboration based on the background paper prepared by Seetharaman and Parthiban (2021).

“ Labour intensity exacerbated the consequences of social distancing and movement restrictions

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Table 2.3
Examples of response strategies

	Vulnerable industries	Robust industries
Non-labour intensive	<ul style="list-style-type: none"> Halt in automotive production <i>“The stringent lockdown measures enforced led to almost no sales in automobiles in the months of April and May 2020.”</i> —Maruti Suzuki India Ltd, Annual Report 2019/20 Repurposing of perfume production <i>“The newly set up perfume manufacturing plant in Manpura, Himachal Pradesh, was re-purposed in quick time to manufacture hand sanitizers and service increased demand.”</i> —ICT Ltd., Annual Report 2019/20 	<ul style="list-style-type: none"> Suppliers of inputs to health and hygiene product manufacturers struggled in keeping up with demand <i>“The demand for chlorine-based products, which are used in health and hygiene products such as disinfectants, witnessed a big spike in last quarter of financial year, with a 10% YoY growth.”</i> —Grasim Industries Ltd, Annual Report 2019/20 Food industry expanded production due to peaking demand <i>“Britannia Industries said it will invest to open more factories as demand for packaged food, including biscuits, has exceeded production capacity.”</i> —The Economic Times 2020 Chasing non-conventional distribution channels <i>“More than a dozen consumer goods companies have started selling products directly to consumers. That is circumventing traditional trade and distributor networks in areas where last-mile delivery has been disrupted due to Covid-19 restrictions.”</i> —Peermohamed and Malviya 2020
Labour intensive	<ul style="list-style-type: none"> Repurposing textile production <i>“Some firms diversified into . . . PPE manufacture and export in a big way . . . Massive investments have been made for setting up completely vertical manufacturing facilities for manufacturing PPE gowns and all kinds of masks.”</i> —Beximco, Annual Report 2019/20 Beverage producers expand online sales <i>“The challenges in distribution and selling of alcoholic beverage products [forced to] modify selling strategies and more direct-to-consumer options for volume recovery. These . . . focus more on off-premise channels, telesales and online selling supported by strategic online partnerships to ensure availability in relevant channels.”</i> —San Miguel Food and Beverage Inc. Annual Report 2020 Opportunity from online sale for jewellery and leather industries <i>“The [online] channel generally caters to low ticket items only, but as a consequence of disruptions caused by the ongoing pandemic COVID-19 scare, this channel is expected to gain traction and gain popularity with the customers for even higher category jewellery.”</i> —PC Jeweller Ltd, Annual Report 2019/20 <i>“The company . . . is expanding its e-commerce footprint by ramping up its presence in online marketplaces allowing delivery in over 1,300 cities, rolling out home delivery from across 900+ stores and giving customers option to shop from the comfort of their homes via WhatsApp Chat with their neighbourhood stores.”</i> —Bata India Ltd, Annual Report 2019/20 	<ul style="list-style-type: none"> The sugar industry encouraged the adoption of mechanized harvesting <i>“Availability of migrant labour for cane harvesting could be impacted. Deployment of local harvesting labour and self-harvesting is being focussed upon. Farmers are being encouraged for increasing the share of mechanised harvesting.”</i> —EID Parry Ltd, Annual Report 2019/20 Firms adopted “social distance technologies” to minimize social contact <i>“The Siemens engineers, sitting in their homes, looked at the digital imprint of the machine which was captured real time through a 3D-glass worn by a person at the site. Directions were given remotely . . . just as the engineer would have done sitting inside the machine at the side.”</i> —Mathew 2020

Source: UNIDO elaboration based on the background paper prepared by Seetharaman and Parthiban (2021).
Note: Examples are based on the analysis of annual reports and of other secondary data produced for this report by Seetharaman and Parthiban (2021).

“ Labour-intensive firms were more likely to implement automation programmes

Box 2.3

Industrial repurposing as an effective response to the COVID-19 crisis in Africa

As the COVID-19 pandemic hit, shortages of critical supplies—including masks, ventilators and test kits—emerged in several countries. A rapid solution to address these shortages, industrial repurposing can represent a challenge for small and medium-sized enterprises (SMEs) in developing and emerging industrial economies (DEIEs). Hurdles include the need to adapt existing manufacturing processes and procedures so that new product lines can be launched from scratch using idle capacity and—particularly in the case of medical goods—meet stringent quality and medical standards in a very short time.

Against this backdrop, UNIDO has been providing technical assistance to help firms in developing and emerging economies turn the COVID-19 crisis into an opportunity through industrial repurposing.

UNIDO's West Africa Competitiveness Programme aims at promoting the export competitiveness of partner countries by strengthening local and regional value chains for agro-industrial and light manufacturing products. When the pandemic broke out and demand for hand sanitizer intensified, UNIDO helped 38 cosmetics producers in Ghana switch production, implement standard operating procedures and

meet regional quality standards and official registrations. As physical stores were forced to shut down temporarily, UNIDO ran online workshops and social media marketing. By the end of 2020, Ghanaian producers had adopted 38 international standards for medical face masks, personal eye protection, surgical clothing and drapes, medical gloves and lung ventilators.

The adaptation of UNIDO's Mashrou3i project (“My project” in Arabic) poses another example of action taken to support local firms to recover. Before the pandemic, the initiative helped textile firms producing clothes and apparel to enhance competitiveness by providing them with technical training and assistance. Following the outbreak of the COVID-19 crisis, the project started supporting Createx—a family-run Tunisian textile firm that had lost an important client because of the pandemic—convert its business production so that it could supply Tunisian schools, health facilities and hospitals with goods critically needed to fight the pandemic. Thanks to technical assistance given by Mashrou3i, Createx was able to invest in new equipment and integrated new digital tools to produce and screen print workwear.

Source: UNIDO elaboration.

Within both vulnerable and robust industries, some firms had to deal with the additional burden of being more labour-intensive.¹⁶ SMEs were more likely to be in this situation, as they tend to be far more labour-intensive than larger-scale enterprises operating in the same industry (for example, in the case of manufacturing metallic products).

Labour intensity exacerbated the consequences of social distancing and movement restrictions on manufacturing firms in two major ways, requiring the adoption of additional strategic responses. First, even firms that could remain operational faced difficulties in maintaining their level of activity because of labour shortages resulting from movement restrictions and the illnesses of workers. In India, for instance, the possibility that SMEs could maintain operations was challenged by the lack of migrant workers, as many of them returned home and could not move due to mobility restrictions. Similar situations occurred in other countries, such as Thailand (Seetharaman and Parthiban 2021). Second, the need to respect social distancing

required the consolidation of safety protocols, which have a cost that includes the reorganization of activities on shop floors, the rescheduling of production shifts, and the introduction of dedicated professional roles to guarantee health measures. Labour-intensive firms have therefore been more likely to introduce strategic responses to increase the efficiency of their production processes and/or implement automation programmes as a strategy to minimize the risk of future disruption and maintain competitiveness, especially from a medium- to long-term perspective (Seetharaman and Parthiban 2021).

Although the pandemic is expected to be a transient phenomenon, it may have long-term consequences on the behaviour of both suppliers and consumers. While firms try to navigate and cope with the conditions they currently face, they should also sense and shape the future: response strategies should be developed with a medium- and long-term perspective in mind so the firm can position itself competitively in the new post-pandemic context. The analysis of the annual reports

More than 60 percent of surveyed firms introduced organizational changes

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revealed that many firms have started reinforcing their digitalization: the adoption of ADP and Industry 4.0–associated technologies has been happening much faster than originally anticipated on account of the pandemic, especially in labour-intensive industries (Seetharaman and Parthiban 2021). This has important implications for the future of industrial development, as discussed next in Chapter 3.

Yet, the ultimate consequences of this acceleration of digitalization and automation in labour-intensive industries are still to be seen. This may lead to a widening of the gap between SMEs and larger firms. SMEs tend to lag behind in terms of capabilities required for the adoption of more advanced production technologies (UNIDO 2019b), thus making the introduction of automation a less-viable response for most of them. Moreover, as highlighted at the end of previous section, women’s participation in manufacturing tends to concentrate in more labour-intensive industries with lower wages, especially in DEIEs where labour costs are a central driver of competitiveness. It has been recognized that women tend to lose these jobs as industries upgrade (Kucera and Tejani 2014; Tejani and Milberg 2016; Seguíno and Braunstein 2019). These consequences would affect inclusiveness. As further discussed in Chapter 4, policies can play a role in rebalancing the consequences of the pandemic crisis across sectors and workers and in fostering an inclusive industrial development.

A survey-based perspective on firms’ response strategies: Transformational changes

The data collected by the UNIDO COVID-19 firm-level survey complement the analysis based on companies’ annual reports. The survey inquires about the immediate and strategic responses implemented by manufacturing firms, offering an original overview of the transformational changes introduced at firm-level in response to the COVID-19 outbreak in DEIEs. These transformational changes have been summarized in the five typologies described in Table 2.4.

More than 60 percent of surveyed firms introduced some organizational changes to fulfil new health and

safety requirements (Figure 2.10). The widespread implementation of this change reveals how largely the organization of work and of production in manufacturing sectors may have been altered in response to the pandemic. This type of change also included remote work arrangements, whose introduction turned out to be rather diffused even among manufacturing actors. Another transformational change frequently adopted was starting/increasing business activity online (37 percent). This result is in line with other evidence showing that the use of an online platform increased markedly during the first half of 2020 when lockdowns were implemented by many countries, which made businesses shift their transactions to online marketplaces (OECD 2021).

Three considerations are worth mentioning. First, on average, easier and cheaper transformational

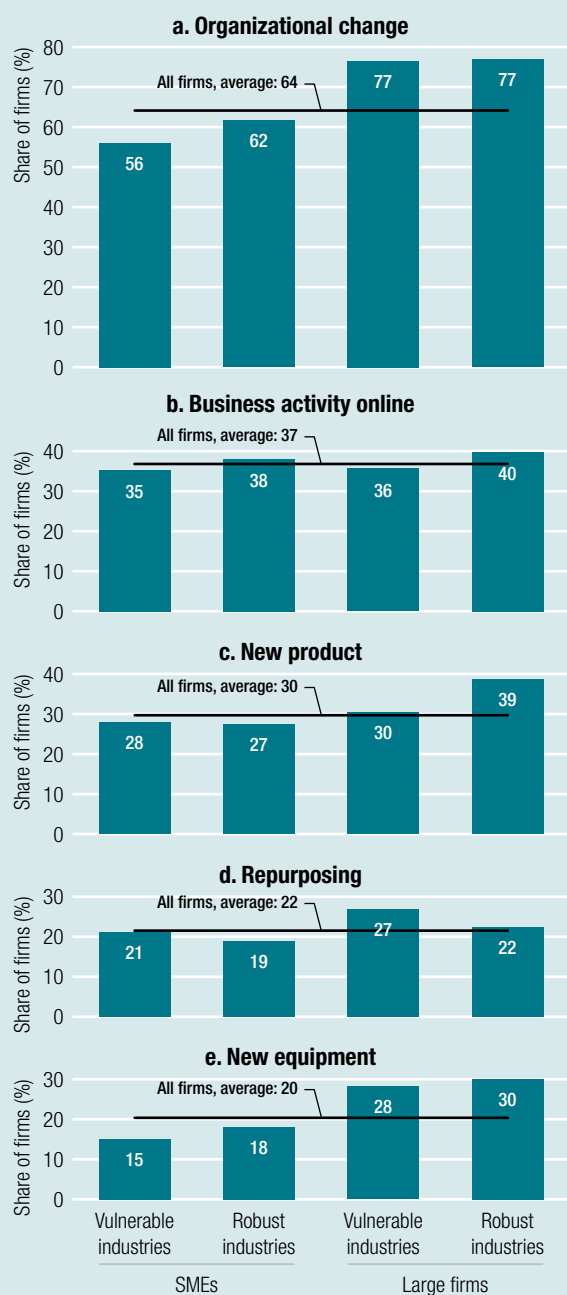
Table 2.4
Transformational changes in DEIEs per the UNIDO COVID-19 firm-level survey

Change	Definition
Business activity online	Started or increased business activity online and delivery of goods or services (for example, online sales, new delivery modes, new distribution channels)
New product	Released new products to meet changing market demands
Repurposing	Converted, partially or fully, production to address the health emergency (for instance, producing medical equipment, masks, sanitizer)
New equipment	Introduced new equipment to reduce the numbers of workers needed on the shop floor (for instance, through the automation of some production processes)
Organizational change	Introduced organizational changes to fulfil new health and safety requirements (for example, remote work arrangements, new protocols or standards, new professional roles to supervise health and safety measures)

Source: UNIDO elaboration based on the UNIDO COVID-19 firm-level survey (2021).
Note: Firms could select one or more transformational change in response to the question “Did the firm experience any of the following changes in response to the COVID-19 outbreak?” Response options were not exclusive, and a firm could select more than one transformational change. See Annex A for more details on how the five types of transformational changes have been defined based on the data collected by the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

“Larger firms are better not only at resisting shocks but also at responding to them

Figure 2.10
A snapshot of firm-level readiness: Share of firms that experienced a transformational change by firm category, 2020–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: SMEs have up to 99 employees. Large firms have 100 or more employees. Robust and vulnerable industries classified based on Chapter 1, Table 1.2. The figure shows the share of firms that selected a transformational change in response to the question “Did the firm experience any of the following changes in response to the COVID-19 outbreak?” ($N = 2,781$). Response options were not exclusive and a firm could select more than one transformational change. The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies; SMEs = small and medium-sized enterprises.

changes have been more popular. This is not surprising: moving to online sales is likely to be less financially and operationally demanding than acquiring a new machine or converting production. This is confirmed when looking at the adoption of changes by firm size: whereas changes in business activity online are quite even across SMEs and large firms, differences are evident for introducing new equipment.

Second, with the already-mentioned exception of increasing or starting business activity online, SMEs displayed lower rates of change implementation than large firms. This suggests that relatively small firms are less likely to have the resources and/or the capabilities needed to introduce strategic responses than large enterprises. Hence, larger firms are better not only at resisting shocks but also at responding to them.

Third, a clear sectoral pattern does not emerge: robust industries display on average a larger share of firms introducing a transformational change, but within each firm size category the difference between industries is in most cases negligible. Repurposing is the only case where a relatively larger share of firms operate in vulnerable industries. This result is consistent with the firms’ response strategies summarized in Table 2.2, according to which firms in vulnerable industries tend to undertake strategic responses aiming at re-orienting production towards essential goods or goods with growing demand.

Digitalization: A readiness-enhancing factor







Which types of firms have been better able to transform their business models to tide them over the crisis and adapt to the new normal? Answering this question requires understanding which capabilities are important for firms’ readiness.

According to Andreoni (2021), readiness stems from dynamic capabilities spread across the ecosystem of organizations, institutions, sectors and markets. These dynamic capabilities allow firms to perceive opportunities and to seize them by refining their business models and operations, and by transforming their structure and processes to respond to external shocks

“ Production capabilities act as the engine of transformation in manufacturing firms

Figure 2.11

How digitalization can facilitate the introduction of response strategies to the COVID-19 pandemic crisis

Channels of impact	ADP technologies-enabled response strategies
Supply	Digital strategic response
 Domestic factories partial/total closure	<ul style="list-style-type: none"> Remote factory management through connected machines and IoT
 Disruptions in domestic and international value chains	<ul style="list-style-type: none"> Increased flexibility of supply chains through increased traceability of parts and products (i.e. use of RFID) In-house realization with 3D printing of unavailable inputs and components Increased options of providers through digital platforms
 Shortage of staffing, leading to reduced processing capability	<ul style="list-style-type: none"> Labour-substituting automation (i.e. advanced robotics, integrated factory automation) Use of digital technologies to minimize physical contact and allow for remote working (i.e. remote monitoring, remote working arrangements, virtual meetings) Digitalization of activities (business processes, administration, finance) Development of digital skills
 Restricted access to specialist service to attend machinery	<ul style="list-style-type: none"> Real-time remote technical assistance through augmented and virtual reality Fewer unnecessary interventions thanks to predictive maintenance
Demand	Digital strategic response
 Reduced consumer spending power	<ul style="list-style-type: none"> Improved demand monitoring via integration with online platforms Expanded online sales and digital channels of distribution Advanced logistics and contactless delivery to minimize physical contact with customers Increase digital customer relations Diversify towards higher-value added customized digital products (i.e. servitization, smart and connected products, 3D printed tailored solutions) Improved storage of perishables with smart sensors; improved stock management
 Increased demand for medical equipment	<ul style="list-style-type: none"> Faster time-to-market of new (or converted) products due to faster modelling, prototyping, and testing with the help of AR and/or VR, digital twins and 3D printing

Source: UNIDO elaboration based on the background materials prepared by Andreoni et al. (2021) and Calza et al. (2021).

Note: ADP = advanced digital production; AR = augmented reality; IoT = Internet of Things; RFID = Radio Frequency Identification; VR = virtual reality.

(Teece 2018). Hence, for business enterprises, dynamic capabilities are crucial assets enabling them to respond to crises and recover.

In the case of manufacturing firms, dynamic capabilities go hand in hand with production capabilities. The previous section highlighted the importance of production capabilities for firm-level robustness; these capabilities also combine to shape firm-level readiness. In fact, production capabilities are critical to overcome uncertainty introduced by a crisis and to maintain existing production systems through new forms of

organizational integration (Andreoni 2021). They act as the engine of business transformation in manufacturing firms, ultimately fostering resilience.

The role of production capabilities in facilitating the adoption of ADP technologies (UNIDO 2019b) is also relevant for firm-level readiness. The superior production capabilities of digitally advanced firms represent a valuable asset when a firm needs to define and implement a response strategy, as digitalization can facilitate the implementation of response strategies to the COVID-19 pandemic shock. For example, digital

Digitally advanced firms introduce transformational changes more frequently

competences facilitate the shift to remote work if these competences are compatible with duties and tasks to be performed. The industrial application of ADP technologies such as the Internet of Things (IoT) or virtual reality facilitates the reorganization of production processes to respect safety measures and enable social distancing (for example, remote maintenance, and monitoring). Additive manufacturing solutions (3D printing) can help deal with the shortage of certain inputs or replace them. Figure 2.11 provides an overview of how digitalization can, in practice, support the introduction of strategic changes by manufacturing firms.

The data collected by the UNIDO COVID-19 firm-level survey point towards the existence of a positive correlation between the adoption of ADP technologies and a firm's response strategy. Digitally advanced firms introduced each of the five transformational changes more frequently than non-digitally advanced ones, with the difference across these two groups being larger than 10 percentage points for almost every change (Figure 2.12).

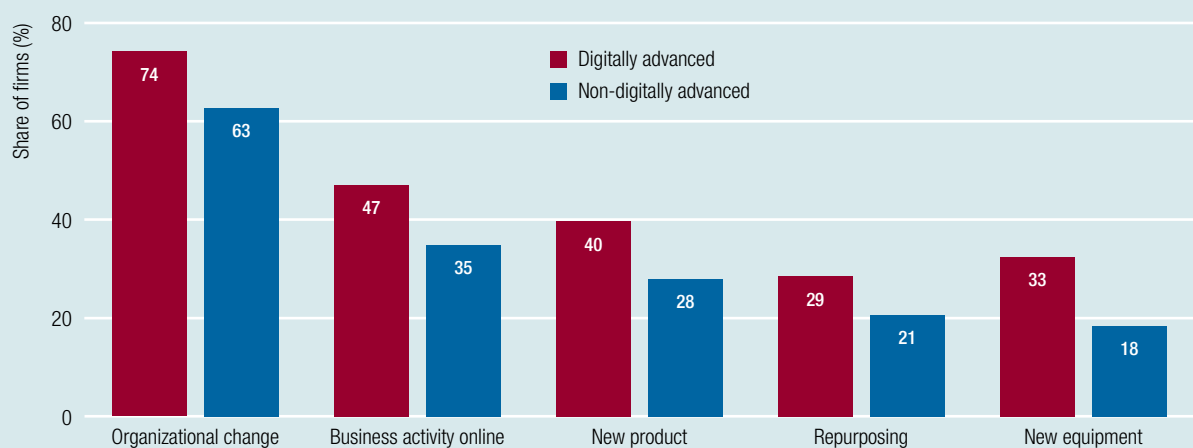
An econometric exercise conducted for this report provides novel empirical evidence of the relationship

between firm-level digitalization and readiness. Using the data from the UNIDO COVID-19 firm-level survey, the adoption of ADP technologies was found to be positively and significantly associated with the probability of introducing a transformational change, even when controlling for other relevant firm-level characteristics (sector, size, innovation and past investment in software) (Calza et al. 2021) (Figure 2.13). Other firm-level capabilities-related factors—such as having introduced an innovation or having invested in new software before the pandemic outbreak—were also positively correlated with the implementation of transformational changes.

Showing that firms respond and react to the pandemic crisis on the basis of their capabilities, these results further highlight the importance of firm-level capabilities and advanced digitalization in strengthening resilience and helping firms be better prepared for the post-pandemic future. The pandemic has brought firms' digitalization to the attention of practitioners, policymakers and international organizations as an important goal for action. This acknowledgement of the role of digitalization in fostering resilience should lead to an increase in the deployment of policy

Figure 2.12

Digitalization and firms' readiness: Percent of firms that experienced a transformational change by digitally advanced and non-digitally advanced firm type, 2020–2021

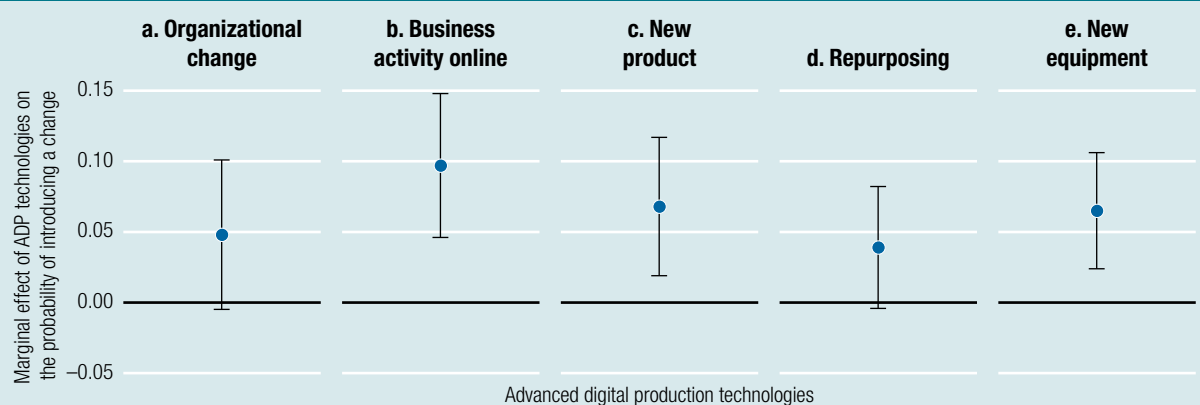


Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Manufacturing firms adopting ADP technologies are defined as digitally advanced and non-ADP adopters as non-digitally advanced. The figure shows the share of firms that selected a transformational change in response to the question "Did the firm experience any of the following changes in response to the COVID-19 outbreak?" (N = 2,698). Response options were not exclusive and a firm could select more than one transformational change. The sample covers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. ADP = advanced digital production; DEIEs = developing and emerging industrial economies.

Figure 2.13

Drivers of firm readiness: The effect of adopting ADP technologies on transformational changes



Source: UNIDO elaboration based on the background paper prepared by Catza et al. (2021), derived from the data collected by the UNIDO COVID-19 firm-level survey (2021).
 Note: The analysis uses the data collected by the UNIDO COVID-19 firm-level survey (2021) in 26 DEIEs. Only manufacturing firms have been considered. The main variable of interest is a binary variable that takes the value of 1 if the firm can be classified as digitally advanced (adopters of ADP technologies), and 0 otherwise. The figure depicts coefficients (dots) and confidence intervals (at 95 percent) (lines) for the average marginal effects of the variable of interest on the probability of firm introducing a transformational change, obtained through the implementation of individual probit models with robust standard errors ($N = 2,514$). The introduction of a transformational change is proxied with a binary variable that takes the value of 1 if the firm selected a transformational change in response to the question "Did the firm experience any of the following changes in response to the COVID-19 outbreak?", and 0 otherwise. See Annex A for more detailed information on sample composition of the UNIDO COVID-19 firm-level survey. ADP = advanced digital production; DEIEs = developing and emerging industrial economies.

instruments for industrial recovery supporting the adoption of ADP technologies and the development of digital capabilities (López-Gómez et al. 2021).

Supporting resilience: An industrial policy response

This section looks at the role that policy has played in helping firms deal with the pandemic crisis. The section starts by exploring how the COVID-19 pandemic crisis has challenged industrial policy responses, requiring policymakers to come up quickly with measures reacting to the emergency. It then discusses the importance of integrating resilience as a guiding principle into industrial policy, drawing examples from international experiences during the COVID-19 pandemic.

Industrial policymaking during the pandemic

According to Weiss (2015), the role of industrial policy is "to facilitate structural change in favour of higher productivity activity" (Weiss 2015, p. 1). In a time of crisis, this definition calls on policymakers to transform every challenge into an opportunity. It requires identifying the strategic directions and implementing

the instruments needed to support firms in adapting to the new evolving context.

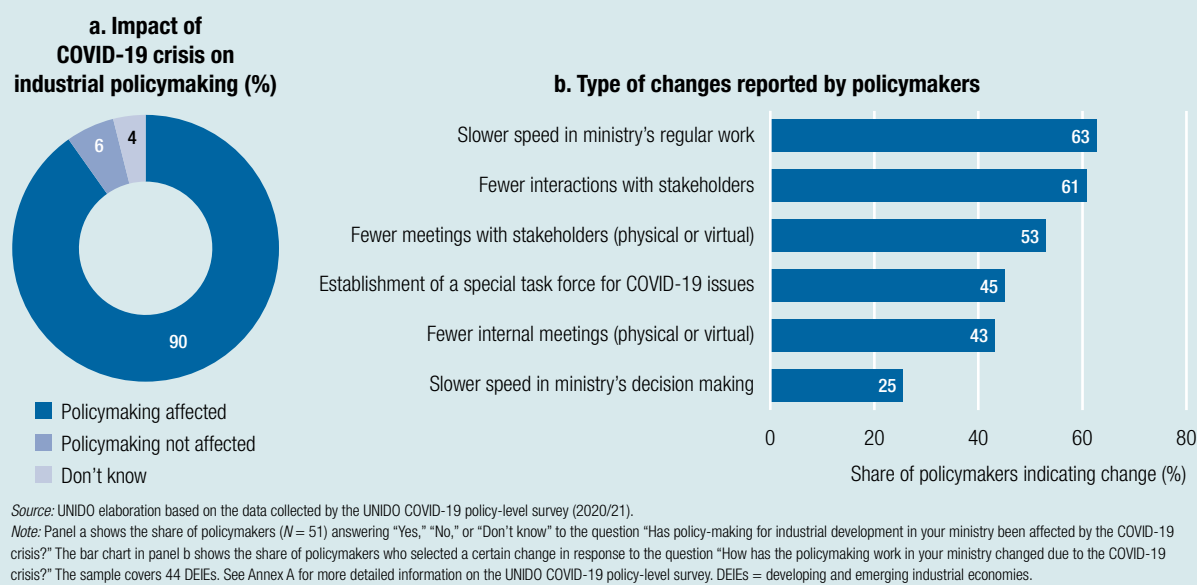
The COVID-19 pandemic crisis represented a unique opportunity to raise awareness about the importance of policy to govern crises. This renewed role of policies has been acknowledged also by the recent European Union (EU) Industrial Strategy, which is intended to ensure that European industrial ambition takes into account the circumstances following the COVID-19 crisis and to steer the recovery towards a more sustainable, digital, resilient and globally competitive economy (European Commission 2021).

How has industrial policymaking in DEIEs been affected by the pandemic crisis? Which directions and policy instruments were prioritized by non-industrialized and lower-income economies? The policy landscape in DEIEs is a little-explored field and the pandemic crisis has emphasized the need for more analysis.

Offering a fresh look at the policy landscape in DEIEs during the COVID-19 crisis, the analysis of the data collected by the UNIDO COVID-19 policy-level survey provides new insights on the directions and instruments put in place to support firms coping with the crisis. It emerges that about 90 percent of

“ Most interviewed policymakers identified the lack of budgetary resources as their main problem

Figure 2.14
Changes in policymaking: The effect of the COVID-19 pandemic crisis on policymaking process, 2020–2021

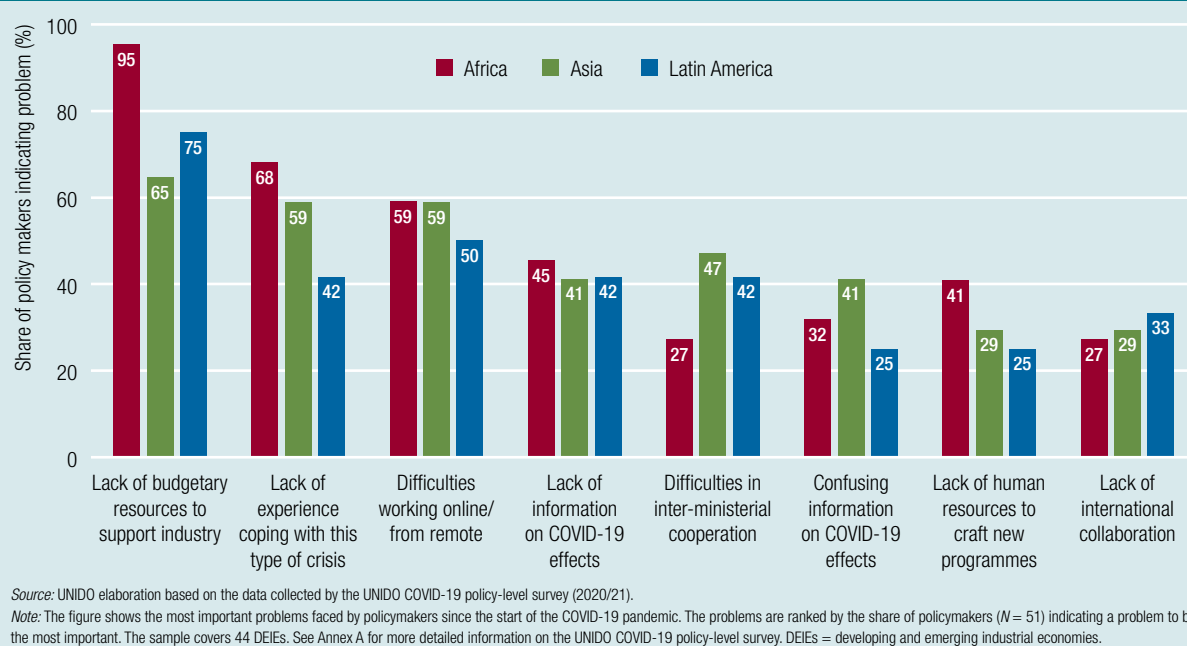


policymakers acknowledged that policymaking has changed since the start of the crisis (Figure 2.14).

When asked to highlight the main problems faced in providing adequate policy responses to the crisis,

policymakers in all regions identified the lack of budgetary resources as their first main problem (Figure 2.15). Considering that the pandemic is an unexpected and unique event, the lack of experience in

Figure 2.15
Most important problems faced by policymakers in selected DEIEs, by region, 2020–2021



Initial policymakers' actions were oriented to providing relief for firms' payments

2

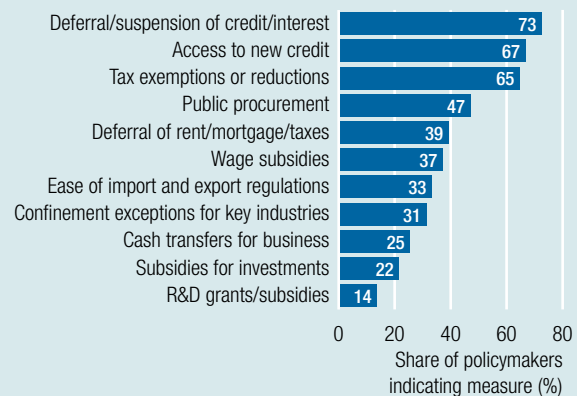
DEALING WITH THE PANDEMIC: RESPONSES FROM FIRMS AND GOVERNMENTS

dealing with this type of crisis was another of the main challenges faced.

When the exceptional difficulties emerging from the crisis became clear to policymakers, with many firms struggling to survive and being incapable of formulating adequate and rapid responses to the pandemic, most countries acted quickly to mitigate its negative impacts. In the first periods of the crisis, governments perceived the urgent need for shifting towards policy interventions to mitigate the negative impacts deriving from falls in demand and supply chain disruptions (see Box 2.4).

An analysis of the data collected for the UNIDO COVID-19 policy-level survey reveals that the immediate implementation of economic relief measures—such as deferral of credit payments, access to new credit, suspension of interests, tax exemptions or deductions, deferral of rents, wage subsidies—was frequent (between 73 and 37 percent of respondents) (Figure 2.16). Conversely, medium- to long-term measures such as R&D grants and subsidies for investments and innovation were implemented to a relatively lower extent (between 14 percent and 22 percent of

Figure 2.16
Most-applied policy measures to help firms deal with the emergency, 2020–2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 policy-level survey (2020/21).

Note: The figure shows the share of interviewed policymakers ($N = 51$) who selected a certain measure in response to the question "Which concrete policy measures has the government applied to support firms' recovery from the crisis?" The sample covers 44 DEIEs. See Annex A for more detailed information on the UNIDO COVID-19 policy-level survey. DEIEs = developing and emerging industrial economies; R&D = research and development.

respondents). These results confirm that, at the initial stage of the pandemic, policymakers' actions were mostly oriented towards providing immediate relief to firms for their short-term payments.

Box 2.4

Relief and support measures to tackle the COVID-19 crisis: The case of Indonesia

The government of Indonesia adopted several countermeasures and recovery interventions to tackle the consequences of the COVID-19 pandemic crisis on the industrial sector:

- The government issued Industrial Operational Permits and Activity Mobility (IOMKI) to support continuity in industrial sector operations. Companies that have an IOMKI are required to report contagion-containing activities (that is, the implementation of health protocols) that will then be validated by task forces at different government levels. This measure has proven to be effective in controlling the spread of COVID-19 in the industrial environment and preventing larger numbers of layoffs.
- The government promoted a mapping of the industrial sectors affected by COVID-19 to inform targeted support interventions for different industries. For industries that have been hit harder, intensive assistance and coordination to meet their needs for raw materials and simplify industrial exports were provided. For industries with high demand (such as medical devices and pharmaceutical

products), efforts were made to maintain performance and increase productivity, including interventions such as repurposing production for medical inputs, setting input standards for medical devices (personal protective equipment, or PPE, and masks) and making domestic ventilator prototypes to handle the COVID-19 emergency.

- Several general stimulus packages for the industrial sector were put into place, including electricity subsidies for most affected industries, postponement of tax payments and relaxation of import permits for industrial raw materials.
- With a more structural perspective, the government promoted the establishment of development centres for small and medium-sized enterprises (SMEs) to facilitate their access to raw materials and inputs, and to encourage the application of digital technology through several start-up development programmes for industry and the professional requalification of laid-off workers.

Source: UNIDO elaboration based on the inputs provided by the government of Indonesia

“Data suggest a mismatch between expected and actual effectiveness of support measures

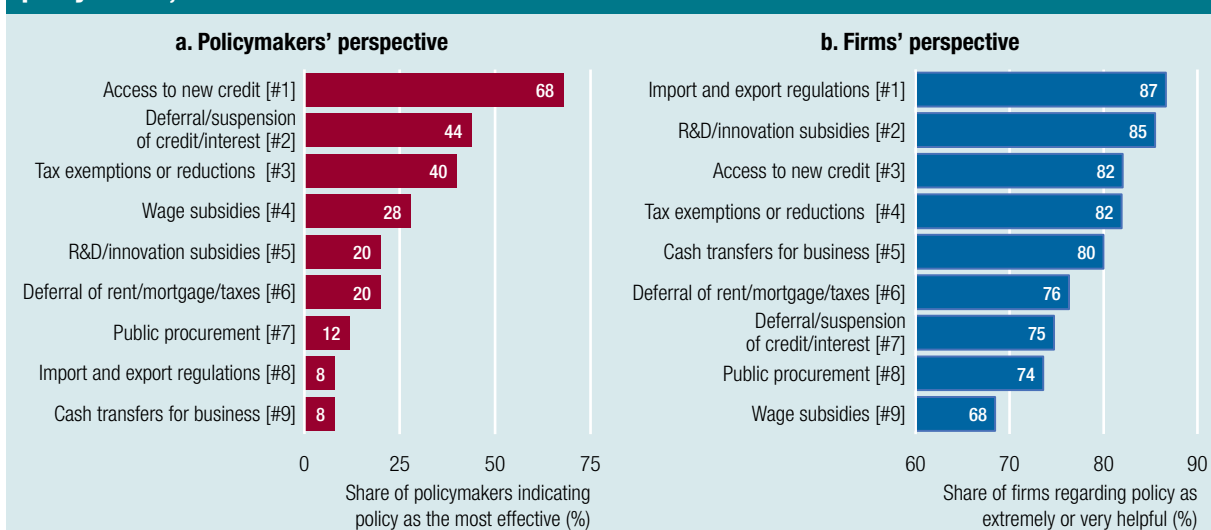
Using a set of countries with data available for both UNIDO COVID-19 firm- and policy-level surveys, an interesting comparison can be drawn in terms of the most effective policies to deal with the crisis (Figure 2.17). The short-term measures representing an immediate relief for the liquidity difficulties were appreciated by both policymakers and recipient firms (access to credit, which ranks #1 for policymakers and #3 for firms), with almost 70 percent of policymakers indicating them as very effective and more than 80 percent of manufacturing firms finding these measures extremely useful.

Although the majority of firms that benefited from the support measures consider the shorter-term and emergency interventions to be helpful, firms tended to value equally longer-term and structural interventions, such as trade regulations (which ranks #1) and R&D subsidies (which ranks #2). In contrast, policymakers tend to think that emergency actions are more effective than structural interventions (R&D subsidies ranks #5 and trade regulations only #8). The fact that

a policy measure such as R&D grants—which is a medium- to long-term measure—has not been widely implemented in the surveyed countries (see also Figure 2.16) but has been very much appreciated by firms, suggests a possible mismatch between expected and actual effectiveness of policy measures in support to firms.

Industrial policy has been crucial to keep manufacturing businesses afloat during the COVID-19 containment effort (Hartwich and Isaksson 2020). Still, the UNIDO COVID-19 policy-level survey indicates that most of the adopted policy interventions had a short-term emergency approach. This result highlights the need for industrial policy to strategically re-orient its directions towards more forward-looking actions, whose implementation has to be grounded on medium- to long-term instruments and a better management of risks. With the evolution of the pandemic, the call for integrating resilience as a guiding principle of industrial policy is becoming more pressing.

Figure 2.17
Most effective policy responses to deal with the crisis: A mismatch of perceptions between firms and policymakers, 2020–2021



Source: UNIDO elaboration based on the data collected by the UNIDO COVID-19 firm-level survey and the UNIDO COVID-19 policy-level survey (2020/21).

Note: Panel a shows the share of policymakers indicating a policy measure to be the most effective in supporting firms coping with the crisis. Panel b shows the share of firms indicating a policy measure to be extremely or very helpful in coping with the crisis. The sample considers observations from 23 DEIEs covered in both surveys. Two policy measures from Figure 2.16 (Ease of import and export regulations and Confinement exceptions for key industries) are not shown as they were not included in the firm-level survey. See Annex A for more detailed information on the UNIDO COVID-19 firm-level and policy-level surveys. DEIEs = developing and emerging industrial economies; R&D = research and development.

“ Industrial policymaking space needs to be enriched with measures for risk management

2

DEALING WITH THE PANDEMIC: RESPONSES FROM FIRMS AND GOVERNMENTS

Industrial policy to support socioeconomic resilience and build back better

As seen in Chapter 1, the economic crisis triggered by the COVID-19 pandemic has shed light on the importance of the industrial sector for socioeconomic resilience. In the aftermath of the pandemic, industrial policy can play a crucial role in building a stronger industrial sector, particularly where firm-level capabilities are not adequate.

The previous section highlighted the findings of the UNIDO COVID-19 policy-level survey, showing that policymakers have mostly reacted through short-term-oriented interventions. Effective action to boost inclusive and sustainable industrial development (ISID) should, nonetheless, ensure the reduction of future negative impacts and increase robustness and resilience over time. As mentioned by a recent report from UNESCAP (2021), long-term growth depends on the decline of the magnitude and frequency of negative impacts from shocks. Thus, industrial policy should embrace an updated perspective, entailing a broad range of measures and actions to foster socioeconomic resilience. To increase resilience and improve robustness and readiness in manufacturing sectors, decision makers need to enrich the traditional industrial policymaking space that targets industrialization and strengthening industrial capabilities with measures for improving risk management through interventions aimed at strengthening resilience by fostering prevention, preparedness, reaction and recovery.

Industrial policies aiming at integrating resilience and risk management as a guiding principle should be based on understanding the potential risks stemming from modern manufacturing activities. These can be grouped into three categories: *supply risk* (the possibility of an event occurrence that may cause failures from supplier/s); *operational risk* (the possibility of an event that may affect the firm's internal ability to produce goods and services); and *demand risk* (the possibility of an event that may affect the likelihood of customers placing orders) (López-Gómez et al. 2021).

As manufacturing value chains have grown more complex, interdependent and geographically

dispersed, they have become particularly vulnerable to disruptive events. In fact, the COVID-19 pandemic has affected the complex and interconnected systems of value chains, triggering all mentioned risk categories.

However, though extreme in its scope and implications, the COVID-19 pandemic is only one of the possible disruptive events that could trigger and exacerbate risks. An intense debate is emerging on the risks arising from climate change, such as environmental issues and natural disasters, from political instability, or from other major sources of uncertainty. The increased likelihood of the surge of new sources of risk makes the discussion about a more resilience-based perspective in industrial policies more urgent. This call for resilience to be integral to industrial policy goes far beyond the exceptional situation of the COVID-19 pandemic to other sources of risk.

How can countries ensure that their industrial sectors are less vulnerable and better prepared for future shocks? How can policy measures, activities and instruments integrate the principle of resilience?

A study conducted for this report proposes an industrial policy toolkit to help countries integrate resilience in industrial policymaking (López-Gómez et al. 2021). The framework underlying the toolkit has been informed by the Sendai Framework for Disaster Risk Reduction 2015–2030, which provides guidance to integrate disaster risk management and reduction and building resilience into policies (UNDRR 2015). By reflecting on the risks to the manufacturing sector and on the lessons from the COVID-19 pandemic crisis, the proposed policy toolkit lays the conceptual foundation for how industrial policy could incorporate the principle of resilience. It presents an illustrative menu of policy measures, actions and instruments to help countries address risks and strengthen resilience in manufacturing sector across the four phases of emergency management: *prevention*, *preparedness*, *reaction*, and *recovery*.

The “two Ps”—*prevention* and *preparedness*—are aligned with the concept of robustness. *Prevention* entails measures aiming at reducing vulnerability and

“Prevention entails measures to reduce vulnerability and exposure to future disasters

exposure to the risk of future disasters, through actions containing any potential damage *ex ante*. *Preparedness* evokes measures aiming at mapping relevant resources and developing plans to reduce the negative impact on the industrial sector in the occurrence of a shock. The “two Rs”—*reaction* and *recovery*—are contiguous to the idea of readiness. *Reaction* captures the capacity to respond *ex post* to a disaster by executing the emergency plans and ensuring the continuation of operations and production in manufacturing sector.

In this respect, the measures associated with reaction evoke most of the short-term measures included in the UNIDO policy survey (see Figure 2.16). *Recovery* entails measures to restore and improve industrial production in the medium to long term, through actions aiming at developing and strengthening systemic and firm capabilities, and in line with the principles of sustainable development and of “build back better.”

Table 2.5 summarizes policy goals and measures in each of the four phases of emergency management.

Table 2.5

Policy goals, measures and instruments fostering resilience in the manufacturing sector: Examples from dealing with the COVID-19 pandemic

	Goal	Measures and activities	Instruments	Country examples of instruments	
Prevention—robustness dimension	Implementation of actions to avoid exposure and to reduce the vulnerability of manufacturing industries to existing and emerging risks	Building “sovereign capabilities,” especially to produce critical and strategic goods	International collaboration (i.e. South-South cooperation)	Cuba: Development of two vaccines against COVID-19 (<i>Soberana II</i> and <i>Abdala</i>) as a result of public investment in biotech research institutes and state-owned enterprises combined with South-South cooperation	
			Creation of knowledge hubs		
			Public and public-private investments		
	Plans for national industrial development	Nigeria: Allocation of funds to boost local manufacturing in critical sectors and support the expansion of national production capacity in the production of reagents and other consumables used for COVID-19 testing			
Preparedness—robustness dimension	Development of emergency plans for delivering manufacturing goods and capabilities as needed in the event of disasters	Minimizing vulnerability of industrial assets	Development and enforcement of regulations in critical sectors	European Union: <i>EU General Data Protection Regulation (GDPR)</i> to minimize risks related to cyber-security	
			Identifying and stocking resources (i.e. personnel, equipment, inputs) needed to face potential risks and disasters	Engagement of stakeholders (public and private) in task forces	Nigeria: <i>Presidential Task Force on COVID-19</i> to coordinate efforts in addressing the pandemic (i.e. delivering health services, social protection support)
			Mapping domestic capabilities and resources (physical and human) to address shortages	Building strategic stockpiles of critical items (i.e. PPE, medical products, food)	Ireland: Development of a database of spare logistic capacity to map and coordinate the efforts of manufacturers, suppliers and buyers of critical medical items
			Promoting the development and enforcement of business continuity planning	Providing advisory services and trainings to most vulnerable firms	Nigeria: Establishment of national strategic stockpiles to address the demand for PPE, medicines and food
				India: <i>Business Continuity Planning Toolkit</i> offering services to minimize disruptions due to the pandemic and building enterprise resilience, in particular for micro-enterprises and SMEs and start-ups	

(continued)

“ The COVID-19 pandemic may accelerate the integration of resilience into industrial policy

Table 2.5 (continued)

Policy goals, measures and instruments fostering resilience in the manufacturing sector: Examples from dealing with the COVID-19 pandemic

	Goal	Measures and activities	Instruments	Country examples of instruments
Reaction—readiness dimension	Ensuring the continuous operation of the affected manufacturing sector when an emergency event is imminent or immediately after it occurs	Maintaining adequate production and provision of critical goods during emergency	Relaxing import regulations on critical items (i.e. PPE, medical supplies)	Bangladesh: Suspension of duties and taxes on imports of medical supplies, including protective equipment and test kits
			Incentives (i.e. tax exemptions, fiscal incentives, credit) to scale up production of critical items (i.e. PPE, medical supplies)	China: Provision of loans, corporate and value added tax deductions, funds for patent and trademarks for firms producing or converting production to critical supplies (i.e. masks, medical clothing, disinfectant solutions, thermometers)
		Increasing direct engagement of the public organizations in production and distribution	Engaging the public sector (i.e. organizations, institutions, state-owned enterprises) in production and distribution of critical items (i.e. PPE, medical supplies)	Nigeria: Prototypes for ventilator and disinfection devices (to be produced in the country) developed by the <i>National Agency for Science and Engineering Infrastructure (NASENI)</i>
			State as a coordinator of the emergency response	Viet Nam: Central government as main coordinator of the emergency response, aligning the efforts of different ministries, research organisations and civil society, and facilitating the collaboration of private sector and public research organisations for the realization, production and export of test kits and PPE
Recovery—readiness dimension	Execution of restoration plans for disaster-affected industrial sectors; Identification and use of lessons learned as input for future industrial strategy	Strengthening production capabilities through industrial digitalization	Implementing job retention schemes (i.e. furlough programmes, wage subsidies)	Cambodia: Furlough scheme for garment manufacturing workers providing a monthly contribution (up to US\$40), accompanied by additional cash transfers for most vulnerable households
			Liquidity support	China: Reduction of electricity fees for affected industries
			Subsidizing inputs (i.e. energy)	China: Establishment of a working group to restore the automotive supply chain, involving Guangzhou Automobile Group Co. and over 400 key suppliers
			Coordinating supply chain	Ethiopia: Support FDI inflow with measures facilitating logistics in export and import processes (i.e. free railway transport of manufacturing goods between Ethiopia and Djibouti)
Recovery—readiness dimension	Execution of restoration plans for disaster-affected industrial sectors; Identification and use of lessons learned as input for future industrial strategy	Strengthening production capabilities through industrial digitalization	Providing funds for innovation and R&D	Peru: <i>Innovar para Reactivar</i> (Innovate to Reactivate) initiative to support the recovery of firms and the development of their innovative capabilities and resilience, in particular in most-affected manufacturing sectors (i.e. textiles and garments)
			Providing financial and technical support for the adoption of digital technologies (i.e. funds and subsidies, trainings)	Chile: <i>Digitaliza tu Pyme</i> (Digitalize your SME) initiative to support 250,000 SMEs by 2022 in taking the digital leap through access to a package of digital tools and online trainings
			Promoting green manufacturing	Fostering sustainable modes of production

Source: UNIDO elaboration based on the background paper prepared by López-Gómez et al. (2021).

Note: FDI = foreign direct investment; PPE = personal protective equipment; R&D = research and development; SMEs = small and medium-sized enterprises.

“ Natural disasters raised awareness of the need to deal with environmental deterioration

Drawing from recent experiences during the COVID-19 pandemic, Table 2.5 also provides some examples of instruments implemented in several countries. Without intending to be exhaustive or representative, or to assess the success of individual interventions or to set benchmarks for their implementation at a larger scale, these examples illustrate a variety of approaches that can be useful to inform industrial policy thinking as countries formulate recovery plans and reflect on how industries can build back better (López-Gómez et al. 2021). As already mentioned, most of the policy measures discussed in previous section fall under the phase of *reaction*.

Countries' growing attention towards the management of risks is still incipient, but the COVID-19 pandemic may accelerate the process of incorporating resilience principles into industrial policy. The UNESCAP report (2021) points out the long-term effects of the shocks on economic growth that may come from a wide array of shock typologies including, among others, trade, epidemics, financial crises and natural disasters. Every shock can be an opportunity to learn lessons about the possible reaction in the short and medium-long term, even though an approach to fully incorporate prevention and preparedness and a long-term recovery plan to boost capabilities is still under development in many countries. Griffith-Jones and Tanner (2016) report that, after the global financial crisis of 2008, countries increasingly recognized the need of boosting resilience, even though te Velde (2018) reports that, in 2018, the attention of many countries towards a medium- to long-term recovery perspective through structural interventions was still insufficient.

Natural disasters related to climate change had also raised awareness of the need to deal with environmental deterioration, even before COVID-19. The international community had been engaged in several initiatives well before the outbreak of the pandemic to improve disclosure of companies' non-financial information on the premise that increasing awareness and understanding of climate-related risks is essential for ensuring the economic system's financial stability

and redirecting private investment towards green projects. The EU, in particular, enacted new regulations to improve disclosure from companies of their non-financial information—that is, disclosure of how sustainability issues affect their performance, position and development, and how their activities, in turn, impact society and the environment.

Sustainability reporting will likely have an impact along the entire value chain, both upstream and downstream (Paccagnan 2021). This can help private and public investors to channel financing towards the most promising risk-revenue projects via an improved prevention and preparedness in risk management. Even when not steered by specific policies, the private sector has been paying more attention to environmental reporting as a way to grasp double dividends on the environment and economic performance. Tett (2020) reports that 88 percent of a globally representative selection of sustainable indices outperformed their non-sustainable peers over the same period. This has happened because companies that are increasingly interested in getting higher ESG (environmental social governance) ratings need to audit their supply chains and change business models where necessary by improving the economic performance, as well as by improving their image to consumers.

Ultimately, the full integration of resilience into the industrial policy agenda will depend on the capacity of countries to develop government capabilities (Andreoni 2021) and on the growing awareness of firms and markets towards risks. This allows a determination of which policy measures and instruments would be most appropriate for an individual country (López-Gómez et al. 2021). The issue will further be developed and discussed in Chapter 4.

Shaping the future of industrialization today: Capabilities and industrial policy

Looking at the experiences of firms and governments in dealing with the COVID-19 pandemic crisis, this chapter analysed the drivers and features of resilience along the dimensions of robustness, readiness, and risk

“ Risk management calls for a higher integration of resilience into industrial policymaking

2

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management. The presented analysis allows some general conclusions to be drawn.

The impact of the pandemic crisis was very heterogeneous across firms: some businesses—such as SMEs and firms in vulnerable industries—were more severely impacted than others. This heterogeneity can lead to a widening of existing socioeconomic gaps, with actors that were already in relatively disadvantaged conditions before the pandemic being more negatively affected and lagging further behind. The cases of SMEs and of temporary and women workers are paradigmatic and raise concerns about their implications for social and economic inclusion. This may be a temporary consequence of the pandemic, or it may increase the gap across actors and economies in a more permanent fashion.

The pandemic has accelerated digitalization and automation (Seetharaman and Parthiban 2021). More firms have started embracing digitalization as a strategic response: if the industrial application of digital technologies was previously motivated mostly by the need to boost productivity and competitiveness, the COVID-19 pandemic accelerated digitalization as a result of increased needs for supply chain predictability, remote working, and workspace and shop floor reconfiguration (López-Gómez et al. 2021). This trend had already started before the pandemic, and it is still not clear which consequences this acceleration may have in DEIEs, particularly in those economies whose industrial structure is dominated by labour-intensive sectors.

If these results are posing more questions on the future of industrialization in DEIEs and non-industrialized countries, the chapter also suggests an answer: country-level and firm-level capabilities are systematically associated with firm-level resilience. Stronger country-level industrial capabilities can mitigate the

negative economic impact of the crisis on manufacturing firms, while production capabilities are positively associated with firm-level robustness and readiness, helping firms navigate and resist a crisis. It is thanks to their advanced production capabilities that digitally advanced firms were more resilient overall than non-digitally advanced ones.

Capabilities and digitalization are not built overnight, nor are they an automatic consequence of investments. Policy can play a big role in their development and acquisition. To build domestic industrial and production capabilities, it is necessary for DEIEs to continue with an industrialization agenda, developing institutional frameworks and expanding the focus of foreign direct investment (FDI) attraction (López-Gómez et al. 2021). Similarly, recognizing the potential of industrial digital technologies for resilience, governments need to reaffirm their commitment to engaging with digitalization by increasing investments in digital infrastructures and digital skills development programmes.

Finally, the chapter looked at policy responses during the pandemic. Facing the dual challenge of delivering emergency responses while enabling a more resilient future, most countries focussed, understandably, on immediate response efforts. However, the responsibility of managing risks calls for a higher integration of the principle of resilience into industrial policymaking, with the goal of strengthening the ability of countries and firms to prevent, prepare, react and recover from negative shocks. Moreover, in line with the emergence of risks triggered not only by the COVID-19 pandemic (for example, climate change), industrial policy measures and instruments should be increasingly seen as complementary to other policy areas (such as environmental policy). These and other policy-related issues will be further discussed in Chapter 4.

Notes

1. For more information on the coverage and the structure of the UNIDO COVID-19 firm-level survey, see Annex A.
2. See Annex A for more detailed information on the UNIDO COVID-19 policy-level survey.
3. Throughout this chapter, *robust and vulnerable industries* refer to the classification in the “World” column of Table 1.2 in Chapter 1.
4. The list of sectors labelled as “essential” varied by country. This report identifies the pharmaceutical products and food industries as essential sectors, because food and medical goods were largely considered by all countries to be necessary to satisfy fundamental needs related to nutrition and to the fight against the health aspects of the pandemic. This definition of *essential sectors* is in line with the sector classifications others have proposed, but these classifications often include also non-manufacturing sectors such as health services, education and administrative services (see Fana et al. 2020).
5. See Annex A for more detailed information of the data from the World Bank COVID-19 Follow-up Enterprise Survey used in the analyses presented in this chapter.
6. This chapter employs a definition of SMEs and large firms based on the number of employees, defining an *SME* as a firm with fewer than 100 employees and *large enterprises* as those with 100 or more employees. This distinction is in line with the definition used in the UNIDO *Industrial Development Report 2020* (IDR 2020) (UNIDO 2019b). We are aware of possible cross-country differences in the definition of SMEs and that our definition excludes some actors that would be considered as medium in some contexts. Still, it is a pragmatic compromise to group firms that are located on the top-left side of firm size distribution.
7. The term *capacity utilization* refers to the relationship between the output produced with the given resources and the potential output that can be produced if capacity was fully used.
8. The category of non-manufacturing sectors includes agriculture, mining, utilities, construction and services.
9. The term *gender segregation* refers to the fact that, independent of their qualifications, women tend to be disproportionately excluded from some higher-quality jobs and to concentrate in lower-paid activities, such as in more labour-intensive and lower-wages manufacturing industries as textile and apparel (see Seguino 2010).
10. The UNIDO COVID-19 firm-level survey employs a definition of worker type based on length of contract: *permanent workers* work for a term of one or more fiscal years, while *temporary workers* work for a term of less than one fiscal year.
11. For more details about the Oxford COVID-19 Government Response Tracker, see Hale et al. (2021).
12. Following Andreoni (2011) and Avenyo et al. (2021), Naidoo and Tregenna (2021) understand production capabilities and technological capabilities as the two key dimensions of firm-level productive capabilities. For technical details on the construction of the indices for technological and production capabilities used in the empirical analysis, see Naidoo and Tregenna (2021).
13. Manufacturing firms adopting advanced digital production (ADP) technologies are defined as *digitally advanced*. Firms adopting ADP technologies are the ones identifying their technological level as smart (generation 4.0) or integrated (generation 3.0). See Calza et al. (2021) for the technical details about how to generate the firm-level indicator for ADP adoption using the UNIDO COVID-19 firm-level survey data. See Figure 3.2 in Chapter 3 for information on the diffusion of ADP technologies and on the share of digitally advanced firms in the sample collected by the UNIDO COVID-19 firm-level survey.
14. A *business model* is defined as “an abstract representation of an organization, be it conceptual, textual, and/or graphical, of all interrelated architectural, co-operational, and financial arrangements designed and developed by an organization, as well as all products and/or services the organization offers based on these arrangements that are needed to achieve its strategic goals and objectives” (Al-Debi et al. 2008, p. 7).

15. Seetharaman and Parthiban (2021) analyse 64 firms (44 in India, 6 in Bangladesh, 2 in Brazil, 3 in Indonesia, 3 in the Philippines, 3 in South Africa and 3 in Thailand), 500 articles from newspapers, 250 reports for disclosure requirements and 4 semi-structured interviews.
16. See Seetharaman and Parthiban (2021) for the applied definition of *labour-intensive industries*. They draw from Sen and Das (2015) for identifying the labour intensity of different industries, but they acknowledge

that there are some issues with using standard classifications. A first issue is that, over time, capital intensity has risen in both labour-intensive industries as well as the comparatively more capital-intensive ones (Basole and Narayan 2020). Second, even if not inherently labour intensive in their core processes, in some industries—such as electronics and electrical appliances, fertilizers and chemicals—the secondary supply and distribution chains may be labour intensive.

Chapter 3

COVID-19 and the megatrends shaping the future of industrial development

Key messages

- Countries need to draw lessons from their pandemic experiences as they plan their economic recovery and industrialization pathways in a post-pandemic period.
- In so doing, they need to take into account three megatrends that are expected to shape the future of industrialization and have been accelerated by the COVID-19 crisis: the digitalization and automation of industrial production; a shift in economic power towards East Asia, especially China; and the greening of industrial production.
- Inclusive and sustainable industrial development (ISID) in a post-pandemic world will require, more than ever, the development of firm-level production capabilities and national ecosystems that can support the absorption and creation of new technologies.

Introduction

The COVID-19 crisis has impacted every country and economy around the world in unprecedented ways. However, as documented in previous chapters, the severity of these impacts has been highly heterogeneous across countries, sectors, industries, firms and households. Certain pre-existing factors have helped some actors weather the crisis more successfully than others. By the same token, some of the responses implemented by firms and governments have proven to be more effective in supporting socioeconomic resilience than others.

As countries struggle to recover from the crisis and set out along a new path of prosperity, some key questions have emerged: what impacts from the crisis are here to stay and might affect the future of industrial development? And to what extent will the factors of resilience continue to be the same or not in the year to come? In this chapter we provide new insights to answer these questions.

To do so, we go beyond the analysis of the impacts observed so far and assess the extent to which these impacts might affect other megatrends which were already re-shaping the future of industrialization globally long before the COVID-19 outbreak. These megatrends are rooted in deeper structural shifts related to the process of technological change, socio-demographic transitions and humanity's carbon footprint.

In socioeconomic terms, these megatrends include demographic shifts, the acceleration of the urbanization

of least developed countries (LDCs), growing inequality, the rise of the middle class and a gradual shift in economic power towards emerging economies, particularly in Asia. From an environmental standpoint, they include the growing awareness of the importance of greening the economy, the increase in environment regulations, the diffusion of circular economy principles, changes in the use of natural resources and changes in consumer behaviour. Finally, trends related to technological changes include, among others, the growing digitalization of production, the expansion of additive manufacturing, big data analytics, cloud computing, cyber-physical systems, data securitization, the Internet of Things (IoT), machine learning, advanced robotics and the rise of the gig economy.

Of these megatrends, three are particularly important in shaping the future direction of industrial development, namely the digitalization and automation of industrial production; the shift in economic power towards emerging economies, especially China; and the greening of industrial production.

COVID-19 and its after-effects are unlikely to change the trajectory of these megatrends already underway, but the pandemic does have the potential to affect their pace. As will be documented in this chapter, in some cases this COVID-19 driven acceleration is already evident—in, for example, the spread of e-commerce in LDCs. In other cases, however, the empirical basis for assessing the structural effects of the pandemic is weak and the analysis can only present

“ Impact of the pandemic has been diverse across and within countries

3

COVID-19 AND THE MEGATRENDS SHAPING THE FUTURE OF INDUSTRIAL DEVELOPMENT

incipient trends. The complexity inherent in the interplay between these ongoing megatrends and the impacts of the pandemic requires collective solutions from countries, enterprises and civil society—solutions that will be discussed in Chapter 4.

Using the evidence presented in Chapters 1 and 2, the next section summarizes the pandemic’s stamp on the global industrial landscape by highlighting its impacts at the country, sector, industry and firm level. The third section introduces the three megatrends expected to re-shape the future of industrialization and analyses how the pandemic has impacted them. The fourth and final section explores the challenges and opportunities posed by both the pandemic and these megatrends to achieving inclusive and sustainable industrial development (ISID) in a post-pandemic world.

The pandemic’s stamp on the global industrial landscape

As documented earlier in this report, the socioeconomic impact of the pandemic has been diverse across and within countries, reflecting underlying

factors of resilience (as defined in Chapter 1) and vulnerability (see Table 3.1). In general terms, industrialized economies (IEs) have been less negatively impacted than developing and emerging industrial economies (DEIEs), in view of their stronger capacity to react and larger policy space to implement fiscal and monetary policies to support firms and households. Among DEIEs, those more oriented towards services and tourism activities—such as the Small Island Developing States (SIDS)—and those that were unable to contain the pandemic have been most affected.

As documented in Chapters 1 and 2, economies with stronger manufacturing capabilities—as proxied, for instance, by their score on UNIDO’s Competitive Industrial Performance (CIP) Index—have weathered the crisis better than their peers, suggesting that there are important synergies and complementarities between public health and industrialization. Domestic market size also mattered: countries with smaller domestic markets and that are more reliant on foreign demand were more impacted than those with large domestic markets.

Table 3.1

Socioeconomic impacts of COVID-19 at different levels of analysis: Factors of resilience and vulnerability

	Less impacted (resilient)	More impacted (vulnerable)
Regions	<ul style="list-style-type: none"> IEs (especially those successful in containing the pandemic and/or rolling out vaccine) 	<ul style="list-style-type: none"> DEIEs (especially SIDS and those economies that were less successful in containing the pandemic)
Countries	<ul style="list-style-type: none"> Countries with strong manufacturing sectors and strong industrial capabilities Countries with large domestic markets 	<ul style="list-style-type: none"> Countries more reliant on service sectors Countries more reliant on foreign markets Countries with weak industrial capabilities
Industries	<ul style="list-style-type: none"> Health-related industries Information technology-related industries Industries producing essential goods (i.e. food, paper, metals) 	<ul style="list-style-type: none"> Labour-intensive industries, producing non-essential goods
Firms	<ul style="list-style-type: none"> Large firms Digitally advanced firms Firms with high production capabilities 	<ul style="list-style-type: none"> SMEs and informal firms Digitally backward firms Firms integrated into global value chains (GVCs) Firms with low production capabilities
Workers	<ul style="list-style-type: none"> Male, formal workers 	<ul style="list-style-type: none"> Female workers Youth workers Temporary and informal workers

Source: UNIDO elaboration based on findings presented in previous chapters.

Note: DEIEs = developing and industrial economies; GVCs = global value chains; IEs = industrialized economies; SIDS = Small Island Developing States; SMEs = small and medium-sized enterprises.

“ Three megatrends will shape the direction of industrial development

In addition, the impact of the pandemic has been diverse across manufacturing industries. Labour-intensive industries producing “non-essential” goods, such as apparel, textiles or leather products, were the most impacted. Industries producing “essential” goods—such as food, paper or chemicals—tended to be exempted from the containment measures and therefore were less affected by the crisis. On the other side of the spectrum, some industries—notably, those related to the health sector and information technology equipment—faced unexpected jumps in demand and even increased their global production levels during the pandemic.

Within all industrial sectors, large and capital-intensive firms seem to have, by and large, escaped the negative impacts of the COVID-19 crisis. In contrast, small and medium-sized enterprises (SMEs)—particularly in vulnerable industries—often needed government support to stay afloat. Large firms have survived thanks to their investment in digital technologies and day-to-day workplace routines and flat hierarchies that these afford, making the shift to remote work easier to navigate. All those firms that had not yet invested in digital technologies were more likely to flounder.

Diverse impacts have been felt within countries too. Economies, both IEs and DEIEs, have always been divided. Income, status and demographics differ across households, and there are deep disparities in size, productivity and capabilities among firms. The pandemic has deepened these divisions. In 2020, for instance, declines in labour market participation were much larger for women than for men.¹ Vulnerable groups, including the youth and the elderly, have also suffered disproportionately from the pandemic.

These heterogeneous impacts of COVID-19 and empirical findings provide countries, industries and firms with crucial information on how to build more resilient and competitive industries and to protect the vulnerable in the future. Keeping this diversity of impacts in mind, we turn now to assess what could be the longer-term effects of the pandemic on the future of industrial development.

Ongoing megatrends of industrial development

To fully grasp how the pandemic will affect the future of industrialization it is important to examine those megatrends that have their roots in the year prior to the pandemic and which are expected to reshape the industrial landscape. The megatrends can be broadly defined as profound transformations that (1) last several decades, (2) deeply affect the social as well as the economic and political spheres of industrial development and (3) have global impact (Naisbitt 1982).

Research commissioned for this report identified three megatrends that are particularly relevant in this regard (see Altenburg et al. 2021):

- **Digitalization and automation of industrial production**, as technological innovation and the deployment of advanced digital production (ADP) technologies affect essentially all spheres of business development and deeply change the competitive advantages of firms and nations;
- **Global economic power shifts**, especially the emergence of Asia as a dominant hub of global industrial production and China’s structural transformation towards a knowledge-driven high-income economy, as these developments imply a major restructuring of trade flows and global value chains; and
- **Greening of industrial production**, as the need to reduce environmental footprints, and particularly to decarbonize economies, calls for radically different business models and systemic transformations with far-reaching effects on the positioning of DEIEs in the world economy.

These megatrends are interrelated in multiple ways and together will shape the direction of structural economic change and of industrial development in particular. Some industries and business models are declining in the shadow of these trends, whereas others are emerging and expanding. This creates opportunities as well as threats for all economies; yet how this plays out depends in part on existing economic structures and coping strategies.

“Mastery of ADP technologies is a key enabling factor for industrial development”

3

COVID-19 AND THE MEGATRENDS SHAPING THE FUTURE OF INDUSTRIAL DEVELOPMENT

Understanding how these megatrends will react to and reinforce the social and economic consequences of the pandemic will, thus, be crucial for promoting ISID. Industrial development, in turn, constitutes the primary source of income generation for most economies, allows sustained increases in living standards for all people, and provides the technological solutions to the environmental challenges of the future. More specifically, technological progress is the foundation of efforts to achieve environmental objectives, such as increased resource and energy efficiency.

In the next sub-section, we explore these emerging trends and how they unfold in different ways, the pace at which they move across developed and developing countries, and what opportunities and risks these megatrends hold for countries seeking to achieve ISID.

Progressive diffusion of advanced digital production technologies

As presented in the *Industrial Development Report 2020* (IDR 2020), ADP technologies—often labeled Industry 4.0 technologies—are the latest evolution of digital technologies applied to manufacturing. These technologies—which include Artificial Intelligence (AI), advanced robotics, the Internet of Things (IoT), additive manufacturing, big data analytics and cloud computing, among others—are transforming the industrial process and inducing important changes along value chains and within firms.

Despite being often associated with the idea of a fourth industrial revolution (4IR), ADP technologies build on engineering and organizational principles of previous industrial revolutions. To be fully operational, ADP technologies need to combine three components: hardware, software and connectivity. Considering that both hardware and software technologies largely rely on already-existing technologies, the novelty of ADP technologies comes from increased connectivity and unprecedented levels of complexity and interdependency. Accordingly, their rise should be seen more as an “evolutionary transition” than as a “revolutionary disruption” (Andreoni and Anzolin 2019).

As documented in Chapter 2, the COVID-19 crisis highlighted how ADP technologies are a crucial ingredient of resilience. Across the board, ADP technology and digital capabilities have become more important, resulting in the need for countries to invest in digital infrastructure and the digital readiness of their workforces. Indeed, the diffusion and mastery of ADP technologies are likely to become a key enabling factor for countries to continue pursuing industrial development in the future.

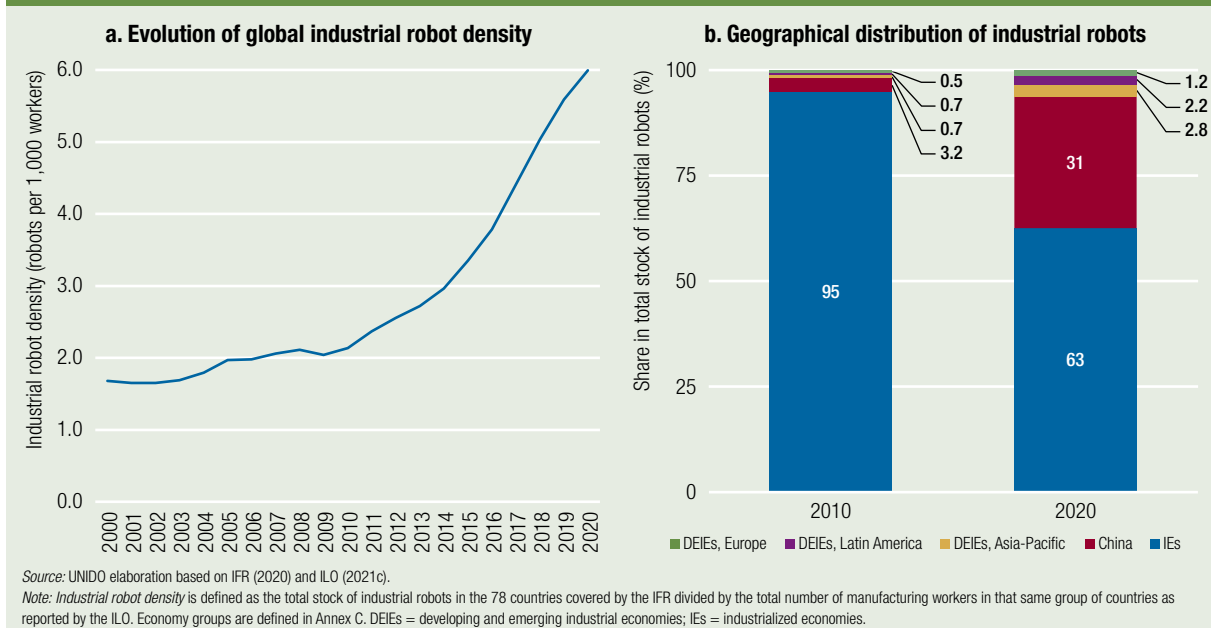
The fact that digital innovations are highly inter-related with and deeply embedded in essentially all industries makes assessing their market value challenging. Yet, analysts recognize growing business opportunities associated with it. Projections from UNCTAD indicate that the market size of these new technologies will grow from a total of \$350 billion in 2018 to more than \$3 trillion in 2025, with the size of the IoT sector growing more than 10 times and robotics nearly 15 times (UNCTAD 2021c).

The value and centrality of ADP technologies is boosted by their connection to some of the business model innovations that have reshaped not only manufacturing, but also services—particularly in the realm of transport and logistics—and marketing over the past decades. Consider, for instance, e-commerce. The deployment of ADP technologies has unlocked tremendous potential in reaching new consumers via electronic sales channels, as exemplified by the widespread use of ADP tools and application by e-commerce giants around the globe (Altenburg et al. 2021).

Particularly within the manufacturing sector, the rapid diffusion of ADP technologies in recent years becomes evident when looking at the sharp increase in industrial robot density (see Figure 3.1, left panel). Whereas in 2000 there were just 1.7 industrial robots per 1,000 manufacturing workers, by 2020 this share had tripled and today stands at around 6 robots per 1,000 workers. The acceleration of this trend is particularly visible after 2010 when robot density began growing at a much faster pace at the global level. Despite this promising global growth forecast, the diffusion of advanced technologies remains unequal and

“ The majority of firms in DEIEs do not rely on digital technologies or use outdated ones

Figure 3.1
Global industrial robot density, 2000–2020, and share in total stocks of industrial robots, 2010 vs. 2020



concentrated in few economies—mostly industrialized countries and China. As seen in the right panel of Figure 3.1, although the number of robots per 1,000 workers has jumped since 2010, more than 90 percent of the share in total stocks of industrial robots in 2020 were held by China (31 percent) and IEs (63 percent). Notably, the last decade has witnessed an impressive jump in China, from only 3 percent of the world stock of industrial robots to more than 30 percent.

Going beyond robots and looking at the broader set of ADP technologies, the IDR 2020 found that a selected group of 10 frontrunning economies accounted for 90 percent of global patents in this field and 70 percent of global exports of capital goods embedding these technologies.² A large gap separates this group from the rest of the world. In fact, most other countries have not yet done any significant steps in the development and production of these technologies (UNIDO 2019b). Even within frontrunner economies, ADP technologies seem to have diffused in just a few firms and industries, with significant differences remaining in the adoption rates across different types of firms and industrial sectors. In Germany,

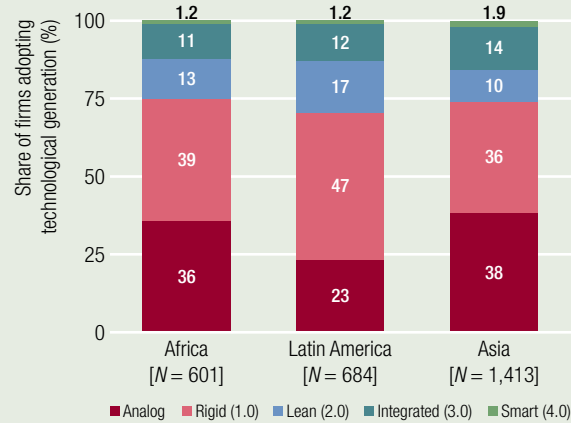
for instance, which is the top global exporter of ADP capital goods, robot users accounted for only 8.2 percent of the industrial plants in 2018, while in the non-manufacturing sector, 0.9 percent of the plants had installed robots (Deng et al. 2021).

The adoption of ADP technologies is even more modest in developing countries. Evidence collected by UNIDO’s COVID-19 firm-level surveys (see Annex A for more details on the surveys) shows that only a small share of manufacturing firms is already engaging with ADP technologies in developing countries (see Figure 3.2). In all three regions covered by the survey—Africa, Asia and Latin America—the average share of firms using 4.0 technologies in their production process is still below 2 percent. The vast majority of firms in DEIEs are either not relying on digital technologies or using very outdated ones: taken together, analog technologies and generation 1.0 technologies account for more than two-thirds of the sample in all regions.

This finding highlights, once again, the extreme digital gap that exists within DEIEs. This gap poses a challenge because not only are there few firms adopting

“ There are strong indications that the pandemic has boosted digitalization

Figure 3.2
Diffusion of ADP technologies among manufacturing firms in selected DEIEs in Africa, Asia and Latin America, 2021



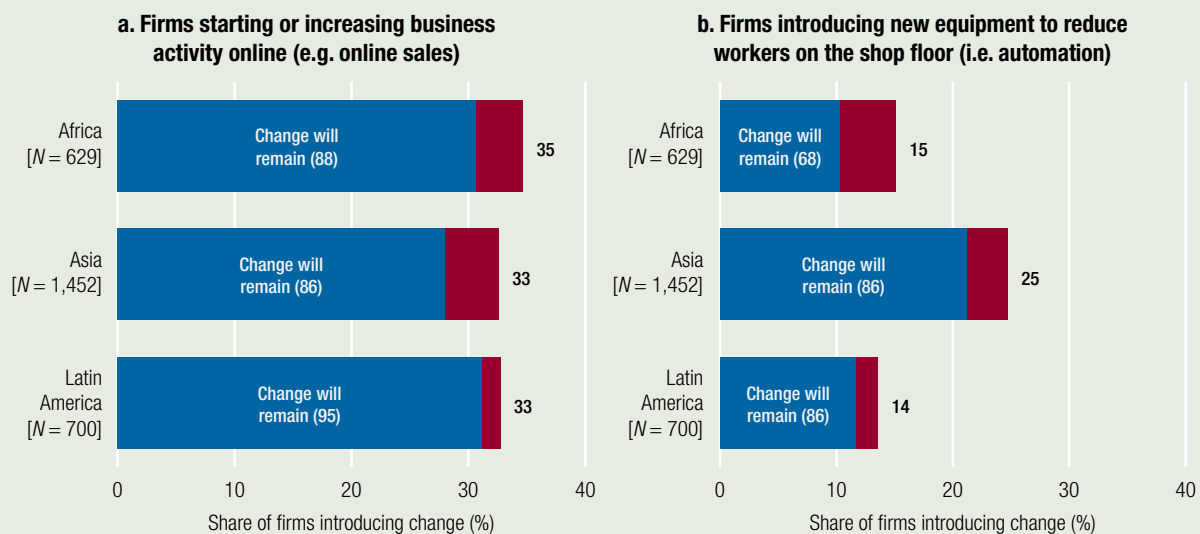
Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: Regions are ordered according to the shares of manufacturing firms currently adopting the most advanced generations of digital technologies (generations 3.0 and 4.0). The sample covers 26 DEIEs. Only manufacturing firms have been considered (N = 2,698). See Annex A for more detailed information on the sample composition and the methodology of the UNIDO COVID-19 firm-level survey. ADP=advanced digital production; DEIEs = developing and emerging industrial economies.

ADP technologies; lead firms that are already adopting these technologies find it difficult to establish backward and forward linkages with domestic firms and nurture their supply chain. When the digital capability gap is extreme, as it is in DEIEs in these regions, the diffusion of ADP technologies is thus very limited due to both technological and structural constraints.

At the same time, there are strong indications that the pandemic has actually boosted digitalization, even in developing countries.³ As can be seen in Figure 3.3, about one-third of firms surveyed in UNIDO’s COVID-19 firm-level survey reported they have introduced or increased online activity, including e-commerce, due to the pandemic (left panel). Moreover, the vast majority of those who introduced or increased online activity (from 86 percent in Asia to 95 percent in Latin America) indicated they expect this change to remain in the future. The pandemic has also forced many manufacturing firms to make decisions on automation (right panel). This is particularly

Figure 3.3
Digitalization among manufacturing firms due to the pandemic in selected DEIEs, by region, 2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm-level survey (2021).

Note: The figures show the share of manufacturing firms indicating that they have adopted the corresponding change in response to the pandemic. The colours within bars show the percentage of firms that also indicated this change will remain in the future. See Annex A for more detailed information on the sample composition and the methodology of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

“ A new centre of economic gravity is in the making

important in Asia (25 percent of firms) but also non-negligible in Africa and Latin America, where about 15 percent of firms indicated introducing this change in response to the pandemic. Here, too, the majority expect to keep the change introduced.

Despite this—albeit small—acceleration of ADP diffusion, the risk of having a growing digital divide between countries remains, and may particularly affect LDCs. There is also a concern that the development and diffusion of digital technologies remains limited to a rather small number of large companies, both in developed and developing countries. Since digitally advanced firms have been able to cope with and respond to the pandemic more successfully (see Chapter 2), narrowing the digital divide and gap both across and within countries will be an important agenda for the global community as all countries strive to build back better and prepare for the future. As will be discussed in the next chapter, dealing with these concerns requires coordinated policy actions and support from the international community.

Global changes in industrial production organization and the shift towards Asia

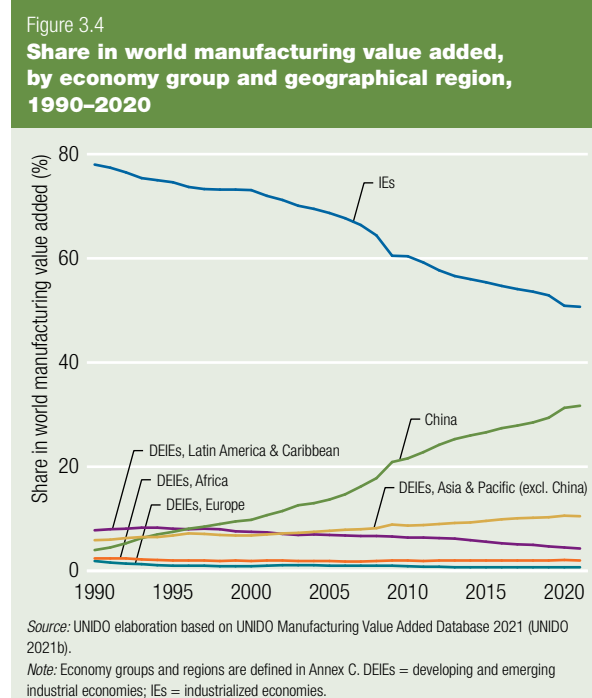
Several macroeconomic indicators show that a new centre of economic gravity is in the making. Indeed, one of the most significant socioeconomic transformations over the last decade has been the increasing weight of Asia in the global economy. The Asian contribution to global GDP has been growing rapidly over the last decades, which has been boosted by China’s spectacular performance. Additionally, current projections indicate that Asia’s current share of global GDP will double by 2050, reaching 52 percent, whereas the share of all other world regions is set to decline (ADB 2020).

The trend is also observable when analysing the power shifts in the global manufacturing sector specifically. Until the early 1990s, the main manufacturing powers were located in North America and Western Europe, with IEs representing almost 80 percent of global manufacturing value added. Since then, however, there has been a steady redistribution of

manufacturing towards developing countries. The latest available estimates indicate that DEIEs are now responsible for 49.1 percent of worldwide manufacturing value added. This is, to a large extent, a result of the expansion of manufacturing activities in Asia (see Figure 3.4).

China has been at the forefront of this development: its share of global manufacturing value added jumped from 4 percent in 1990 to 31.3 percent by 2020, making it the world’s largest manufacturer. Other developing economies in Asia and the Pacific region have also expanded their share but at a more gradual rate. Conversely, the weight of Latin America declined from 7.8 percent in 1990 to only 4.7 percent in 2020, while the share of developing economies in Europe also shrank, from 1.9 percent to 0.7 percent over the same period. Africa’s share remained almost constant, contributing to about 2 percent of total global manufacturing output throughout these years.

This emergence of a new economic centre of gravity has been accompanied by changes in the international division of labour. Since the 2000s, DEIEs in



COVID-19 may have accelerated this shift towards Asia

3

COVID-19 AND THE MEGATRENDS SHAPING THE FUTURE OF INDUSTRIAL DEVELOPMENT

Asia have been upgrading their manufacturing skills, and this has translated into gains in productivity above that of IEs—resulting in a narrowing of the productivity gap with the most advanced economies, which is in stark contrast with the trend observed for other regions, where this gap has actually been growing (see Figure 3.5). Once again, the trend in Asia seems to be driven mostly by the dynamism observed in China. Ultimately, continuous gains in productivity, accompanied by enormous rises in wages and expansions in research and development (R&D) capabilities, may be followed by a gradual transition from factor-cost to knowledge-based economies, as countries move to higher income status.

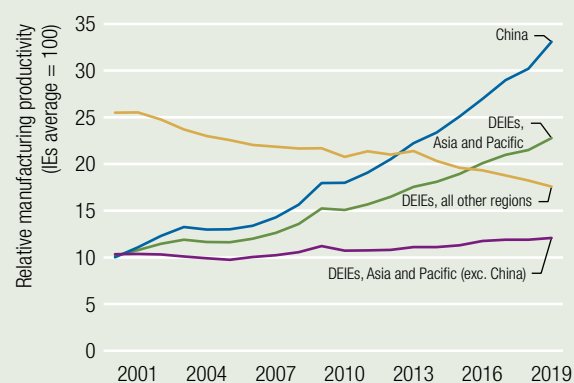
In addition to Asia's growing share of global production, a shift in supplier distribution towards this region can also be observed. For the largest 750 world manufacturing public companies—in terms of sales, assets, profits and market value—the share of Asian suppliers increased from 18 percent in 2013 to 42 percent in 2019—an increase of 24 percentage points. Interestingly, this increase is equally distributed between Asian IEs (an increase of 12 points) and Asian DEIEs (also an increase of 12 points). Over the same period, suppliers from non-Asian IEs lost

significant share (falling from 77 to 55 percent) and so did non-Asian DEIEs (also falling from 5 to 3 percent) (Figure 3.6).

This shift towards the use of Asian suppliers has been even more pronounced in medium-high and high-tech industries—such as transport equipment and machinery and computers—but also in some low-tech industries and natural resources intensive industries—such as textiles, leather and apparel; and plastics and mineral products. As shown in Figure 3.7, these industries have shown above-average increases in the share of Asian suppliers. Overall, the increase in Asian suppliers is observed across all manufacturing industries.

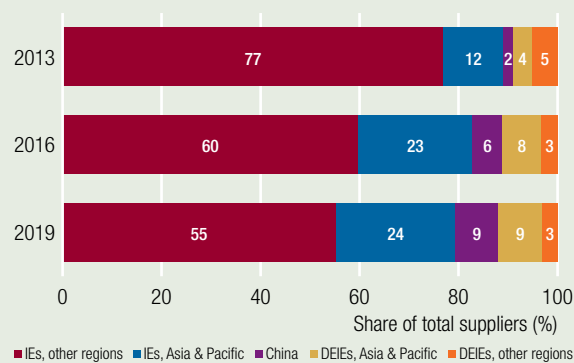
Available evidence suggests that the pandemic may have actually accelerated this megatrend of a shift towards Asia. Despite being deeply impacted at the beginning of the pandemic, China's manufacturing sector was able to return quickly to its pre-pandemic growth rates, partly due to very strong containment measures taken by the government. Conversely, the fall in production in industrialized countries tended to be more prolonged. As a result, the shares of China and other Asian DEIEs in world manufacturing production continued to grow even in 2020 and 2021.

Figure 3.5
Manufacturing labour productivity of DEIEs relative to IEs, selected regions, 2000–2019



Source: UNIDO elaboration based on UNIDO Manufacturing Value Added Database 2021 (UNIDO 2021b) and ILO (2021c).
Note: Labour productivity is calculated as the value added per worker in constant \$ 2010. Economy and regional groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

Figure 3.6
Share of suppliers for all G750 manufacturing companies, by region of origin, 2013–2019

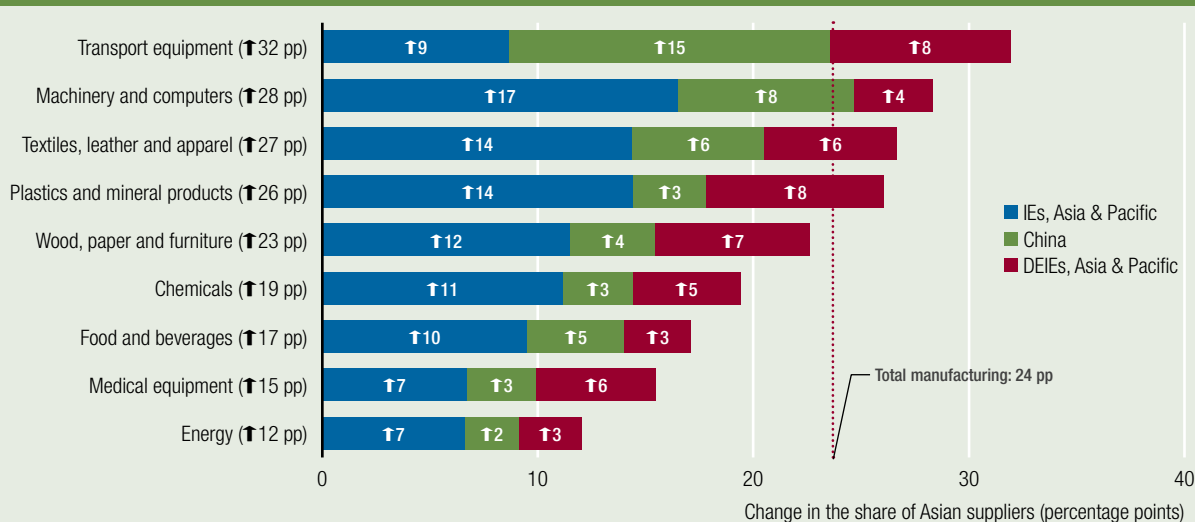


Source: UNIDO's elaboration based on the background paper prepared by Falk et al. (2021) and Accenture Research using FactSet financial data and analytics.
Note: Number of suppliers of the G750 (750 largest public manufacturing companies) were identified by looking at buyer-supplier relationships in the FactSet data. Economy and regional groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

“ The share of Asian suppliers to the largest global manufacturing firms increased in 2020

Figure 3.7

Change in Asian share of total suppliers for all G750 manufacturing companies, by industry, 2013–2019



Source: UNIDO's elaboration based on the background paper prepared by Falk et al. (2021) and Accenture Research using FactSet financial data and analytics.

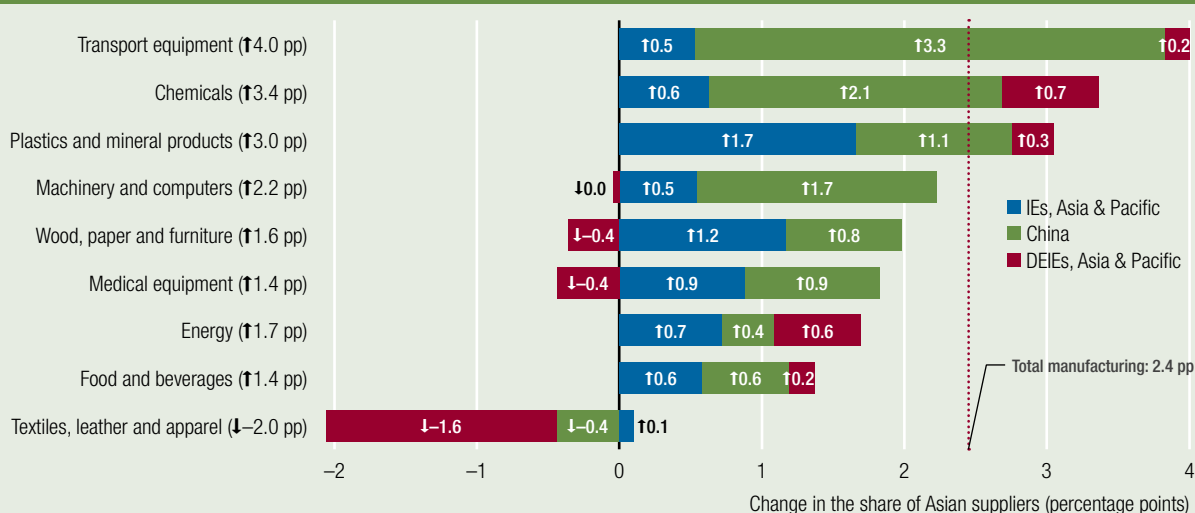
Note: Each bar in the figure shows the change in Asian suppliers' share in the total number of suppliers to the G750 manufacturing companies operating in the corresponding industry, broken down by sub-group. Number of suppliers of the G750 (world's 750 largest public) manufacturing companies have been identified by looking at buyer-supplier relationships in the FactSet data. Economy and regional groups are defined in Annex C. pp = percentage points; DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

The same is true for the suppliers to the largest 750 global manufacturing companies: the share of Asian suppliers continued to grow in 2020 (see Figure 3.8). When considering all manufacturing firms together, the share of Asian suppliers increased from 41.7 in

2019 to 44.2 percent in 2020, an increase of 2.4 percentage points in only one year. Transport equipment, chemicals and plastics, and mineral products lead the increase in Asian suppliers. Contrasting with the trends observed earlier in this chapter, the share

Figure 3.8

Change in Asian share of total suppliers for all G750 manufacturing companies, by industry, 2019–2020



Source: UNIDO's elaboration based on the background paper prepared by Falk et al. (2021) and Accenture Research using FactSet financial data and analytics.

Note: Each bar in the figure shows the change in Asian suppliers' share in the total number of suppliers to the G750 manufacturing companies operating in the corresponding industry, broken down by sub-group. Number of suppliers of the G750 (world's 750 largest public) manufacturing companies identified by looking at buyer-supplier relationships in the FactSet data. Economy and regional groups are defined in Annex C. pp = percentage points; DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

“Lead firms are switching from “just-in-time” to “just-in-case” management

3

COVID-19 AND THE MEGATRENDS SHAPING THE FUTURE OF INDUSTRIAL DEVELOPMENT

of Asian suppliers to the textiles, leather and apparel industry declined, in line with the particular impact that the COVID-19 crisis had on this industry in Asia.

Aggregate data on manufacturing value added, productivity and suppliers is also supported by firm-level evidence collected by UNIDO’s survey on the impact of COVID-19 on manufacturing firms around the world. Survey results show that, despite the effects of the pandemic on the global economy, during the first half of 2021, 52 percent of Asian firms expected to increase investments in new equipment and 54 percent predicted increases of investments in new software (see Figure 3.9). These responses contrast with those of other regions, where the majority of firms expect to reduce or merely maintain those levels of investments—particularly Africa, which shows the largest expected declines in investment. If these trends continue, the rebalancing towards Asia might accelerate further in the years to come.⁴

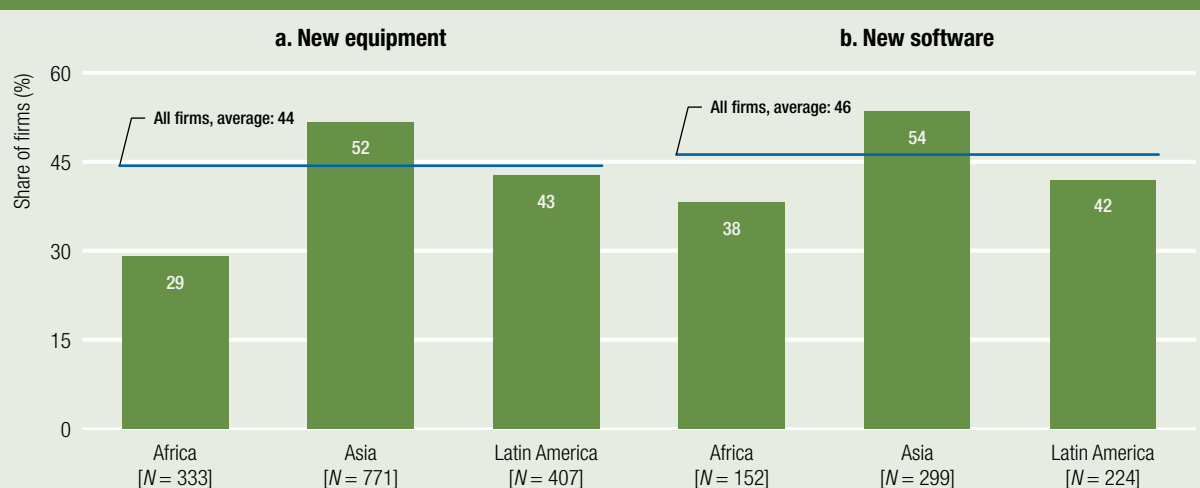
Not only is COVID-19 expected to affect the geography of global industrial production—by accelerating a movement towards East Asia and South-East Asia—but also the way it is organized across borders through GVCs. Even before the pandemic, both the

import content of global production and foreign value added in exports were stagnating, with GVCs becoming less fragmented—entailing fewer and different cross-border production stages—and more regionalized (Miroudot 2020). Indeed, the trend was one of increasing domestic (and regional) value added relative to the share of an extra-regional component.

While it is too early to grasp the full implications of the COVID-19 crisis for GVCs, business decisions are already perceived as shifting. “Lead” firms—large multinational enterprises (MNEs), which coordinate innovation and production activities across borders—are being forced to adopt more sophisticated risk management practices, a move that can be described as switching from “just-in-time” to “just-in-case” management. The pandemic has also exposed the vulnerabilities of complex supply chains (see the Global integration, domestic markets and socioeconomic resilience section in Chapter 1), which typically involve multiple tasks being handled in different countries, to exogenous shocks. Faced with the bottlenecks and shortages generated by the pandemic, lead firms have found themselves with little in the way of business contingency plans to correct the impacts of

Figure 3.9

Manufacturing firms expecting to increase investments in selected DEIEs post-pandemic, by region, 2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm level survey (2021).

Note: The figure shows the share of firms indicating that they will increase investments compared to their pre-pandemic levels. The sample includes only manufacturing firms that made investments in new equipment (N = 1,511) and in new software (N = 675) during 2018 and 2019. The sample considers 26 DEIEs. See Annex A for more detailed information on the sample composition and the methodology of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

Greening of manufacturing is likely to shape the future of industrialization

just-in-time planning (Mikic 2021). Indeed, the “just-in-time” model might no longer be sustainable. Future shocks arising, for instance, from climate change may cause closures of production and connectivity capacities, engendering entire supply chains.

New business models are therefore likely to emerge in response. To ensure continuity in output delivery, larger stocks of inputs and final products might be required in lieu of today’s lean inventories—as well as a process of diversification in the sourcing of materials and intermediates.⁵ A combination of larger stocks and the diversification of input sourcing—two critical components of a “just-in-case” business model—are likely to ensure a greater degree of resilience vis-à-vis future supply chain disruptions. However, changes in business planning are not the whole story. A widespread concern is that the vulnerabilities exposed by the pandemic might nudge some firms to consider either shortening their value chain⁶ or bringing it closer to the end consumer (“reshoring”). Political pressure, particularly in IEs, might also factor into these decisions. What is essential for firms to pay attention to, however, are trends in the cost arbitrage between the offshore locations and their alternatives (Anukoonwattaka and Mikic 2020).

Moreover, the cost advantage of DEIEs might be eroded by the adoption of ADP technologies by producers in IEs. The diffusion of ADP technologies carries a double risk for firms in DEIEs. The growing digitalization of supply chains, including through the use of real-time logistics management, might exclude SMEs in developing economies from participation in globalization. Moreover, there is a risk that production might gradually shift back towards the countries where MNEs are headquartered—particularly in those industries characterized by fast-paced changes in demand—driven by consumers in the “home” market.

At the same time, however, the growth prospects of many DEIEs—particularly, but not only, in East Asia—are likely to act as a counterweight, with MNEs possibly shifting from efficiency- to market-seeking modes of engagement with DEIEs. At least for the time being, the diversification of suppliers might

prove to be a more resilient and cost-efficient choice for lead firms, relative to the domestication of entire supply chains. In addition, insofar as ADP technologies enable MNEs to outsource services in addition to physical production, there might be opportunities for firms in DEIEs to engage in the global economy via, for instance, teleworking (Baldwin and Forslid 2020).

Climate change and greening of economies

Moving in parallel with advanced digitalization and changes in the global structure of production, the increasing greening of manufacturing industries is the third megatrend likely to shape the future of industrialization. This trend is due to the growing recognition of the impact of human activity on the environment and the increasing awareness that environmental externalities should be taken into consideration by the manufacturing sector, which should continue moving towards cleaner, more resource-efficient processes.

Three major economic blocs have placed the greening of their economies at the top of their political agendas. In 2019, the European Commission introduced the European Green Deal, which aims to reach climate neutrality by 2050 within the European Union (EU) (European Commission 2019). In 2021, the United States rejoined the Paris Agreement on climate change and committed to reduce its emissions by about 25 percent by 2025 compared to 2005 levels. Finally, China’s current Five-Year Plan foresees decarbonization and investment in green solutions and emphasizes China’s goal for global leadership in green technologies (Holzmann and Grünberg 2021).

While decisions made by a few IEs may have established key technological and institutional standards so far, developing countries are increasingly committed to environmental issues. Since 2015, they have been investing more in green energy than developed countries, both in absolute and relative terms (Frankfurt School-UNEP Centre/BNEF 2020). Moreover, analysis conducted on the 2019/20 round of the World Bank Enterprise Surveys revealed that almost 70 percent of firms operating in Eastern Europe, Central Asia

“ Manufacturing in all country groups has become more energy-efficient

and North Africa have adopted at least one green innovation within the last three years (Falk et al. 2021).

Sustainability issues have also gained prominence in the corporate world. A recent survey conducted by Accenture showed that 43 percent of the interviewed large organizations have a Chief Sustainability Officer role who leads the sustainability agenda in their company. A majority of executives (67 percent) also reported that their enterprise has sustainability action plans across the organization (Accenture 2020).

Although much still needs to be done to scale up and accelerate the transition to a low-carbon economy, efforts to reduce greenhouse gas (GHG) emissions finally seem to be gathering momentum. The speed of growth in global fossil GHG emissions has slowed in the last decade, yet there has not yet been a sustained decrease in absolute terms (Le Quéré et al. 2020). However, when analysed in relative terms—as the amount of manufacturing-related carbon dioxide (CO₂) emissions per unit of manufacturing value added—it’s clear that manufacturing in all country groups has become more energy-efficient, with fewer emissions emitted per unit of manufacturing activity.

Aided by the rapid fall in the costs of renewable energy devices, such as wind turbines, solar photovoltaic (PV) cells and batteries, decarbonization is gaining momentum.⁷ The trend has been especially remarkable in China, while relatively more gradual in other DEIEs (Figure 3.10). Yet, despite these efficiency improvements, CO₂ emissions from the manufacturing industry remain high and much still needs to be done in this sector to meet international agreements to combat climate change.

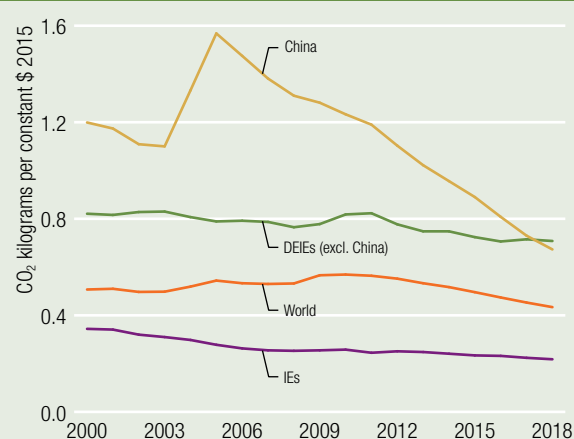
Here, too, the COVID-19 crisis has affected this megatrend and has had mixed effects on the environment. In the short term, as the pandemic advanced and governments implemented policies such as lockdowns, GHG emissions fell quickly and abruptly; CO₂ emissions, in particular, hit bottom in early April 2020 when the hardest restrictions were imposed in many countries: a reduction of 19 percent per day across key industries relative to the mean level of 2019 could be observed (Figure 3.11).

Disaggregated data presented in Figure 3.11 indicates the most substantial drop occurred in the transport sector. For 2020 as a whole (from January 2020 to January 2021), estimated CO₂ emissions fell 7 percent.

While industry-related GHG emissions decreased during the COVID-19 pandemic, an increase in other kinds of pollution has been observed. In many countries, for instance, there has been an increase in human waste, that shifted from productive sectors towards residential production due to the decrease in manufacturing activities and changes in consumption priorities, such as a rise in online shopping. In addition, global e-commerce sales is estimated to hit more than \$4 trillion in 2021 (Verdon 2021).

Although the level of GHG emissions rebounded as much of industrial operations resumed, there are signs that at least part of the changes to a greener global economy came to stay. Firms may be slow in adopting environmental strategies as market imperfections such as asymmetric information or path dependency play a role in slowing down the adoption of environmental friendly practices. However, there are signs that the pandemic may accelerate these processes, inducing

Figure 3.10
Manufacturing CO₂ emissions per unit of value added, by economy group, 2000–2018

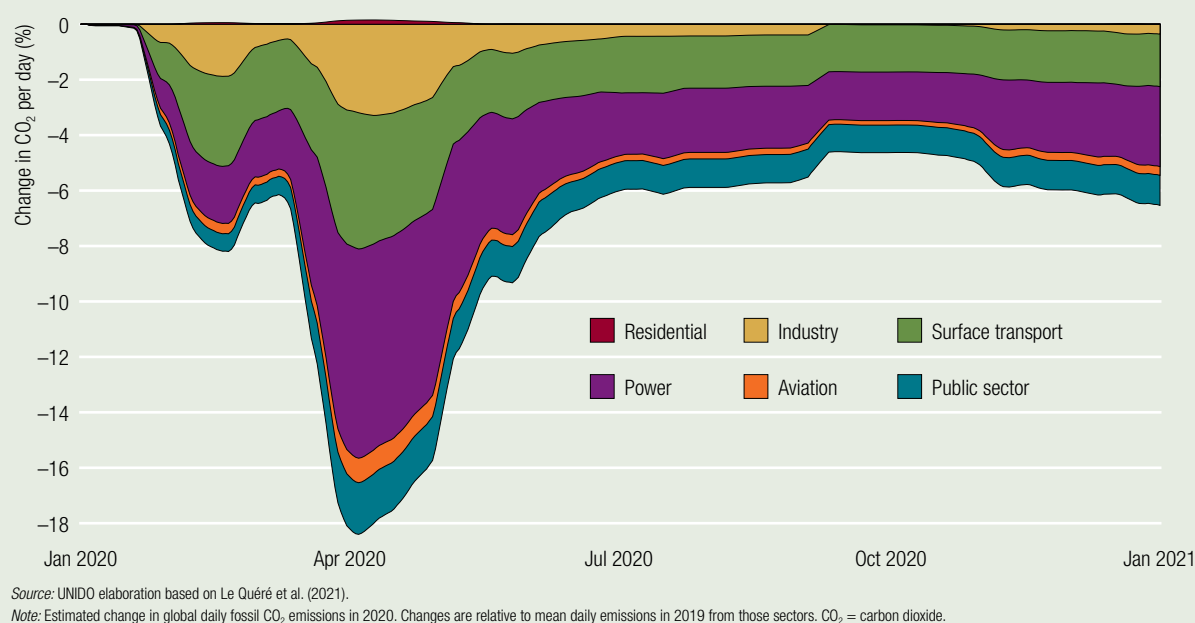


Source: UNIDO elaboration based on IEA (2021) and UNIDO Manufacturing Value Added Database 2021 (UNIDO 2021b).

Note: Economy groups are defined in Annex C. CO₂ = carbon dioxide; DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

“ Firms increasingly target economic and environmental goals simultaneously

Figure 3.11
Estimated 2020 daily change in global CO₂ emissions relative to 2019 mean level, by sector



firms to increasingly adopt win-win strategies that simultaneously target economic and environmental goals. As Figure 3.12 illustrates, manufacturing firms in developing countries expect the pandemic to trigger the adoption of environmentally friendly practices. This trend is more noticeable in Africa and less so in

Latin America, but positive expectations on this matter can be seen across the three regions where data have been collected.

What could be the reasons behind this incipient change in behaviour? Firms are increasingly adopting environmentally friendly practices, encouraged by the growing proposals and implementation of green policy packages by governments—such as the European Green Deal—and the rising demand of donors and investors to incorporate environmental factors into firms’ operations.

As reported by Karapinar (2021), the volume of global impact investment increased from \$502 billion in 2019 to \$715 billion in 2020. *Impact investments* are defined as the investments made to generate positive social and environmental impacts alongside a financial return. The finding borrows from a survey conducted by the Global Impact Investment Network of 294 respondents representing investments organizations, such as asset managers, funds managers and development finance institutions, based in 46 countries. Fifty-seven percent of the respondents claimed that they targeted investments concerning SDG 7 (Affordable

Figure 3.12
Adoption of environmentally friendly practices due to COVID-19 in selected DEIEs, by region, 2021



Source: UNIDO elaboration based on data collected by the UNIDO COVID-19 firm level survey (2021).
Note: The figure shows the share of manufacturing firms indicating that the pandemic will trigger the adoption of new environmentally friendly practices to a great, moderate or no extent. The sample considers 26 DEIEs. Only manufacturing firms have been considered. See Annex A for more detailed information on the sample composition and the methodology of the UNIDO COVID-19 firm-level survey. DEIEs = developing and emerging industrial economies.

“ The three megatrends are highly interdependent and mutually reinforcing

and Clean Energy), 55 percent targeted SDG 11 (Sustainable Cities and Communities) and 54 percent targeted SDG 13 (Climate Action).

Consistent with these findings, another study demonstrated that stock prices of companies with strong environmental, social and governance (ESG) records have performed better during both the deterioration and recovery periods of the pandemic in 2020 (Johnstone-Louis et al. 2020).⁸ Investors have stronger trust in the operations and governance of ESG firms. The trust that is built through firms’ investments in environmental and social protection in normal times pays off during a crisis.

Firms are also adopting this type of practice due to the growing awareness of the positive economic benefits of environmental protection. When it comes to climate change, improved efficiency producing value added by reducing emissions can go hand in hand with competitiveness and making countries and firms more resilient to shocks (Cantore and Cheng 2021; Karapinar 2021).

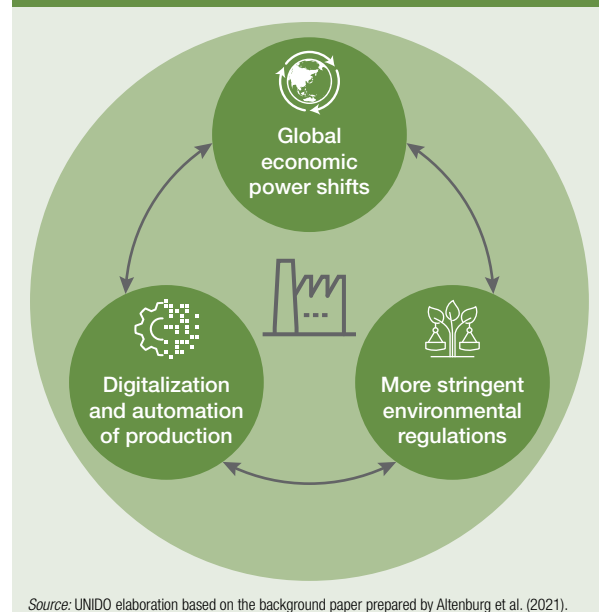
It is clear that the megatrend towards greening of the economy has had a wide range of effects on the manufacturing sector. First, mainstreaming of green principles in established industries might shift the competitive advantage within industries to firms with greener business models, products and processes. For instance, the energy required to make one ton of crude steel is 40 percent lower than it was three decades ago due to energy-efficiency improvements (Koch Blank 2020). Second, entirely new markets and industries were created, including solar photovoltaics, lithium batteries, green hydrogen, electric vehicles and related minerals. Despite the pandemic, the amount of added renewable energy capacity globally in 2020 exceeded the record in 2019 by nearly 50 percent (IRENA 2021). Third, while the changing incentives mentioned earlier in this section are driving up competitive advantages in many parts of the economy, they are eroding existing advantages in other industries, such as in oil- and gas-related industries, as well as in sectors and energy-intensive industries such as steel, cement and aluminium (IEA 2020).

Interrelationship between the three megatrends

The previous analysis has shown how the three megatrends (digitalization and automation, global economic power shifts and greener economies) affect industrial development, creating risks and opportunities for countries at different stages of industrialization. These changes are highly interdependent and mutually reinforcing (Figure 3.13).

Changes in the current distribution of global economic production are affected by digitalization. While some innovations, such as mobile money and distributed ledger encryption (blockchain) technologies,⁹ may be easily accessible by and beneficial for low-income economies, automation tends to devalue labour cost advantages and reduce the incentive for leading firms operating in IEs to outsource to DEIEs and lower-income economies. Increasing “digital content” across all industries also further raises entry barriers as it requires systemic integration, advanced skills, additional capital investment, and in some cases significant economies of scale.

Figure 3.13
Interrelationship between industrialization megatrends



“ No programme of socioeconomic rebirth can be sustained without industrial capabilities

This process tends to reinforce existing power and economic imbalances and raises the concern that opportunities for less developed economies to be integrated with international production systems will decline. Accordingly, whether digitalization and other technologies associated with the 4IR will represent a new window of opportunity for structural change or a source of further risks for DEIEs will depend on those countries' responses and readiness (that is, industrial policy, digital literacy, the skill and education level compared to wage rates, domestic market size and position in GVCs).

The rise of new digital technologies and the greening of the economy are also deeply related. First, economic greening can only be possible through a shift in the technological paradigm—by helping to develop new ways of reducing energy and material consumption in physical facilities and buildings (for example, smart lighting and heating), transport (for example, avoidance of congestion), industry (for example, increased accuracy and reduction of scrap) and energy production (for example, smart grids).

Yet, increasing the use of digital technologies will also raise the demand for energy necessary to run these technologies. As a result, digital technologies are also likely to stimulate economic growth, which in turn will increase resource consumption and pollution. For example, growing online trade will increase the demand for packaging material (Lange et al. 2020), and blockchains are found to consume an exorbitant amount of energy because of the algorithm followed for its creation (Ghosh and Das 2020).

Finally, the global manufacturing power shift towards Asia also intersects with the greening of economies in many ways. High economic growth in the emerging Asian economies combined with the consequential rise of consuming middle classes increases environmental pressures associated with substantial rises in car ownership, meat consumption and long-distance travel, among other trends. And the greening of economies also offers different opportunities for IEs and DEIEs. While IEs account for the vast majority of green technological innovation (Auktor et al. 2020),

the latter may benefit from the increasing demand for renewable energy, bio-economy products and low-carbon agriculture in different ways (Lema et al. 2020; Pegels and Altenburg 2020).

Key drivers of post-pandemic industrialization

The three megatrends reviewed in the previous section were already in full swing before the COVID-19 outbreak and are expected to continue to shape the future of industrialization moving forward. The pandemic has only reinforced them: advanced digitalization, shifts in global production and industrial greening will continue to be key drivers of structural change in the years to come. The COVID-19 crisis also underscored the strategic importance of some segments of the industrial sector that have the potential to shield countries and communities against future health crises and events of this nature.

Post-pandemic, ISID will be central to achieving the SDGs. As industrial policy returns into fashion, firms and countries should adapt to the megatrends—by, for instance, keeping up investments in energy efficiency and renewable energy generation—while also accumulating those industrial capabilities which have proven to be successful in managing the pandemic. These capabilities include production capabilities in general, capabilities in the production of essential products and digital solutions—from test-and-trace systems to plant-level automation—without which the health and economic crises unleashed by COVID-19 could not have been even addressed.

Achieving ISID and the SDGs in a post-pandemic world will require substantial government-led capital investments and the accumulation of human resources in science and technology (S&T), but also enterprise-level skills and capabilities in manufacturing production and innovation. No programme of socioeconomic rebirth can be sustained without industrial capabilities that are fit for purpose. Finally, countries will also need to consider how to strategically engage with a changing global economy, while also ensuring equitable access to essential goods domestically.

Strengthening public health systems across the globe is a key priority for recovery

Synergies between industrialization and public health

As highlighted in Chapter 1, a country's ability to cope with the COVID-19 health emergency has contributed much to explaining differences in the socio-economic impact of the pandemic across the globe. Countries with well-functioning test-and-tracing systems, well-resourced health facilities, ample access to personal protective equipment (PPE) and effective use of isolation measures have managed to weather the economic impacts associated with the COVID-19 shock better relative to their peers. Strengthening public health systems across the globe is thus a key priority for a post-pandemic economy.

There are varied institutional forms for organizing and governing health systems across and within countries, as well as their ramifications towards the rest of the economy (Srinivas 2021). Despite this institutional variety, one factor that resilient public health systems have in common is strong manufacturing capabilities and reliable domestic supply chains. In many parts of the world, the outbreak of the COVID-19 pandemic was followed by panic-driven buying and shortages of medical goods, including protective masks, gloves and personal hygiene products. Trade in medical goods was also impacted, with supply shortages emerging in response to soaring global demand. Countries such as LDCs, which rely heavily on imported medical products to meet their healthcare demands, were particularly hard hit (Hakobyan and Cherif 2021).

By contrast, in countries with strong industrial capabilities—as defined in Chapter 1—the supply of essential medical goods rebounded rapidly. Domestic suppliers were by and large able to address initial shortages and ensure equitable access to masks, personal hygiene products and ventilators. As documented in Chapter 2, the strategic use of industrial policy tools, including public procurement, has been critical in ensuring steady access to medical supplies during the pandemic. The Republic of Korea is a key example of an economy that managed this successfully (see Box 3.1), and one where clear synergies exist between industrial and health policy (Mackintosh and Tibandebage 2016; Shadlen and Fonseca 2013)—a theme which connects the contribution of industrialization to the achievement of the SDGs discussed in Chapter 1.

Over the short term, ensuring access to a stable and reliable supply of vaccines is perhaps the most urgent of priorities—particularly in DEIEs and LDCs. As the COVID-19 pandemic continues, inequality in vaccination coverage between countries and regions represents a serious threat to the recovery prospects of the global economy (UN 2021).¹⁰ International coordination will be required to address emerging supply shortages in key inputs—such as active ingredients used to manufacture the vaccines—and to allow vaccine manufacturing to ramp up globally (WTO 2021). Other essential goods whose production and distribution should be prioritized in the context of the immediate

Box 3.1

Public procurement in the Republic of Korea during the COVID-19 pandemic

In the Republic of Korea, the shortage of protective face masks began in January 2020, before COVID-19 became widespread throughout the country. The panic buying of masks started when the first case of COVID-19 was identified. To address shortages, the central government directly intervened in the market for protective face masks and enforced mandatory public procurement measures. All overseas exports of masks were temporarily banned, and 80 percent of domestic production was subject to public procurement. The remaining 20 percent of mask sales had to be

reported to the Ministry of Food and Drug Safety of Korea. In addition, the procurement of all masks was solely managed by a single government entity, the Public Procurement Service. The Republic of Korea thus effectively nationalized the entire upstream and downstream process of mask production and distribution and, by March 2020, was able to supply 10 million protective masks daily to citizens and medical professionals—a ten-fold increase relative to just one month earlier.

Source: UNIDO elaboration based on the background note prepared by Lee (2021).

Capabilities in pharma and medical supplies are crucial to cope with future pandemics

post-pandemic recovery include immunobiological drugs, equipment for intensive care and services for testing and monitoring viral mutations.

Developing capabilities in the pharmaceutical and medical supply industries is also crucial over the long term to cope with the effects of future pandemic and epidemic events. This is particularly the case in countries where healthcare needs have remained, so far, under-serviced by both the private and public sectors, making them vulnerable to new epidemic outbreaks. The current under-servicing of health markets in DEIEs and aging populations in IEs are two trends that are likely to ensure demand growth in the medical device industry, even in the absence of epidemic and pandemic events (Altenburg et al. 2021).

Vaccines, immunobiological drugs and medical devices present different levels of technological complexity and involve a broad range of science fields, industries and technologies (Srinivas 2021). Medical devices, for instance, range from relatively low-complexity products—disposable protective equipment such as masks and gloves—to products requiring more sophisticated capabilities to produce, such as surgical instruments, therapeutics and diagnostic equipment. Even in the case of disposables, however, the technology to manufacture such products at

scale, speed and reliability can be extremely complex (Andreoni 2021).

Leapfrogging in the medical device industry is therefore challenging. For those firms in DEIEs that should engage in this sector, however, learning opportunities abound. For example, the case of Costa Rica (see Box 3.2) highlights how DEIEs can leverage foreign and domestic investment to upgrade technologies, skills and infrastructure in the medical device industry and tap into growing world demand for medical products. Multiplier effects from this strategy are not negligible. Backward linkages can be established with several industries, such as the chemical, rubber and textile sectors, while the demand for machinery can stimulate industries such as machine tools and electronics (Andreoni 2021).

Diagnostics is another industry in which developing countries face challenges but also find opportunities for building up domestic manufacturing capacity. The shortages of diagnostic kits experienced during the pandemic led many countries to turn to local production to achieve accessible and affordable solutions. Some countries opted to increase local manufacturing incrementally; others have relied on existing local manufacturing (Srinivas 2021). It is expected that COVID-19 diagnostic kits will continue to enjoy an

Box 3.2

Development of a medical devices industry in Costa Rica

Costa Rica emerged as a global medical device centre in the 1980s, with over 70 specialist firms, including leading multinationals, such as Baxter and Medtronic. The medical device industry has expanded, diversified and upgraded substantially since then, transitioning from a focus on Class I medical devices (such as disposables) to Class III medical devices (such as surgical instruments). Costa Rica has thus moved from a low-tech manufacturing hub to an R&D and advanced manufacturing ecosystem. In fact, between 2007 and 2018 medical device exports tripled to become Costa Rica's largest export.

Industrial policy has played an important role in shaping this sector: since the late 1980s, the government of Costa Rica has explicitly targeted foreign direct investment (FDI) in

high-tech industries. The medical equipment firm Baxter set up a plant in Costa Rica in 1987 and Intel chose Costa Rica as one of three locations to manufacture microprocessors. Shortly afterwards, the government and the investment promotion agency (CINDE) decided to move away from electronics, given the volatility of the industry and the potential for low margins for assemblers. The medical device industry was targeted and, building on the experience with Baxter and Intel, the government developed an incentive policy and combined this with targeted investments in the development of capabilities. Over the years, the government's emphasis on investment in technological upgrading has established the country as a leading research centre in this sector.

Source: UNIDO elaboration based on the background paper prepared by Andreoni (2021).

“ Development of health-related industries needs infrastructure improvements

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important, yet lower, demand after the pandemic. In this context, the question, particularly for DEIEs and LDCs, is how to extend the successful experiences of COVID-19 diagnostics to develop products and solutions for use across multiple diseases and involving multi-modal deployment, biohazard waste processing and recycled materials. Strengthening manufacturing capabilities—in conjunction with quality infrastructure and regulation, logistics and procurement coordination—will be crucial if countries are to reap the health and economic benefits of effective production of diagnostics.

Frontier pharmaceutical drugs and more sophisticated medical devices and equipment require capabilities in a broader range of science fields—ranging from physics to chemistry and life sciences—as well as industries and technologies that might currently be out of reach for some developing economies and LDCs. For emerging industrial economies, however, the need for a broad range of capabilities makes the pharmaceutical and medical devices industries challenging but at the same time appealing. Potential linkages to other activities—ranging from public services such as nursing to higher-tech activities such as life science research—can also be developed through a combination of demand and supply effects (Andreoni 2021; Mackintosh and Tibandebage 2016).

As countries seek to advance their industrialization processes, the development of health-related industrial and supply chain capabilities needs to be accompanied by improvements in infrastructure. The case of oxygen production for medical use in India illustrates this well. During the COVID-19 pandemic, the country successfully managed a very rapid, 2- to 3-week ramping up of industrial oxygen production (Srinivas 2021). This agility required coordinated effort of multiple private sector and public sector industrial sites, facilities, administration and public sector railways to enable delivery across the country. Industrial policy was once again a key factor, making possible the shutting down of industrial use of oxygen and the re-steering and ramping up of industrial oxygen to include medical use and liquid storage and transport.

However, while industrial production was able to deliver efficiently, bottlenecks in last-mile infrastructure complicated the meeting of rising demand at critical moments during the pandemic. More industrial diversification and skilled personnel or investments in decentralized infrastructure could facilitate the long-term deepening of the industrial base.

ADP technologies: Accelerating the pace of adoption, addressing divides

In most IEs and some DEIEs, the pandemic resulted in a shift to remote work, a boom in the use of online services and the normalization of e-commerce—a sudden acceleration for which not all firms were ready. Even in countries where the adoption of ADP technologies had stagnated prior to the COVID-19 crisis, however, evidence suggests that the adoption of digital solutions is picking up pace. Crucial in helping mitigate the socioeconomic impacts of the pandemic, ADP technologies are likely to become a key enabling factor for countries to achieve ISID and the SDGs.

Yet, translating the digitalization opportunity into reality is challenging. The interdependence of different technologies—which characterizes many ADP technologies—means that their adoption is hardly a seamless process. As seen in Chapter 2, UNIDO's micro-level evidence corroborates this observation and suggests that the digital gap between countries of different regions and economic groups discussed earlier arises from multiple, mutually reinforcing sources. Among firms, differences in size, capabilities and the availability (or lack thereof) of a supporting innovation system account for a large share of today's digital divide.

Particularly in DEIEs, SMEs tend to lag behind relative to their larger peers. Yet even larger firms might be held back by fragile science and technology (S&T) capabilities at the country level—even in high-tech areas. To compound this issue, technology-intensive firms are often too few—and with limited links to domestic specialized suppliers—to have the critical mass to push forward on their own (Coutinho 2020).

“ Provision of digital infrastructure must take into account digital divides

Digital gaps are gendered, too. This is particularly the case in LDCs and other developing economies, where women—as entrepreneurs and workers but also as household members—may be more likely than men to be excluded from internet access and the use of digital solutions. The picture is not necessarily brighter in IEs and emerging industrial economies, where the shift to remote work has had a disproportionate impact on women, as household and childcare responsibilities often remained distributed unequally within families (Sorgner 2021).

Against this backdrop, fostering the diffusion of ADP technologies is an important priority. In DEIEs, ADP technologies are often applied through retrofitting: by, for instance, adding sensors to machines, factories and products (Andreoni and Anzolin 2019; UNIDO 2019b). Basic, enterprise-level capabilities in manufacturing production and innovation are therefore key to diffusion. At the same time, the provision of digital infrastructure must take into account digital divides and the needs of vulnerable and disadvantaged groups (Altenburg et al. 2021; Sorgner 2021).

The good news is that the evolutionary nature of ADP technologies means firms in lower-income economies have ample opportunity to learn and develop these technologies. Many “traditional” sectors are already being reshaped by ADP technologies, including textiles and apparel—with the use of CAD/CAM laser-cutting technologies, 3D printing for prototypes and functional fabrics—and agriculture, with the rise of precision farming. Cutting across sectors, the growth of digital platforms and e-commerce—even if not always home-grown—can help local producers launch their products on the global stage (Altenburg et al. 2021).

For DEIEs, other opportunities open up. There are digital applications in many sectors that can be used as leapfrogging avenues. The automotive sector, for instance, is where firms from DEIEs—ranging from South Africa to Poland—increasingly participate owing to their involvement in GVCs. Here, basic ADP capabilities can be built into the digitalization of monitoring and tracing processes, predictive maintenance

and production optimization—all supported by sensors and IoT. For all countries, regardless of their income level, policies are needed to steer and maximize technology deployment while reducing the costs and risks associated with adoption (see Chapter 4).

Industrial greening: Achieving a sustainable future

While the pandemic resulted in reduced material consumption and GHG emissions, these effects are mostly the result of temporary confinement measures, which lead to a stark decline in mobility, including air and ground transport. At the time of writing, energy consumption and emissions seemed to be experiencing a rebound—as they had in the aftermath of the Great Recession (Li and Li 2021).

Investments in energy efficiency and in the diversification of energy sources are critical to avoiding a post-pandemic rebound in emissions. Energy efficiency is consistently cited as a key driver behind the reduction in CO₂ emissions in industrialized economies (Li and Li 2021; Wang and Wang 2020) as well as in developing and emerging economies (Avenyo and Tregenna 2021). Deployment of renewables is also critical. The expansion of power generation from renewables remains a key contributor to lowering emissions from electricity generation.¹¹

Other short-term goals include the modernization of electricity grids and of insulation, heating and domestic energy storage systems (Hepburn et al. 2020). Regulation promoting sustainable industrial water management practices in the manufacturing sector—particularly in LDCs and other developing economies—to mitigate water risks and avoid pollution is another objective (Paccagnan 2021). Several industrialized economies are already leveraging their fiscal stimulus packages in the wake of the COVID-19 pandemic to act on these priorities—a point to which we return in Chapter 4.

Industrial greening is a societal imperative. Greening is particularly relevant where economic activities are vulnerable to climate change.¹² Agricultural productivity, for instance, is vulnerable to fluctuations in

“ Firms in DEIEs need to anticipate green regulations to retain access to exporting markets

temperature and precipitation.¹³ In addition, over two-thirds of DEIEs (and almost 90 percent of LDCs) are dependent on natural resources such as oil and natural gas (UNCTAD 2019)—often yet to be extracted and commercialized. In resource-rich sub-Saharan African economies, natural resources provide a vital source of revenue (Kayizzi-Mugerwa 2021). These resources are at risk of becoming stranded assets as industrialized economies begin to decarbonize, making industry diversification in that region an even more urgent imperative than before (Rempel and Gupta 2021).¹⁴

Moreover, firms in DEIEs increasingly have to adapt to changing consumer demand for more sustainable products—including through the mainstreaming of circular economy business models—in key consumer markets (see Box 3.3). Existing “Green Deal” proposals in the United States and the European Union strongly imply a change in regulations and market demand towards more sustainable products

(Altenburg et al. 2021). Firms in DEIEs thus need to anticipate and adapt to green trade regulations if they are to retain access to exporting to the largest consumer markets.¹⁵

Industrial greening, however, also represents an important economic opportunity. Consider, for instance, employment. Circular economy business models and renewable energy generation tend to be labour-intensive activities with the potential of generating jobs in rural areas (Mathews 2020). According to IRENA (2020a) data, there has been a substantial increase in the number of jobs created across the renewables sector, reaching approximately 12 million jobs in 2019, globally. Other studies suggest that a clean energy economy will be a positive source of net job creation—even considering the job losses generated by polluting industry retrenchments—because of the higher labour intensity in clean energy and because of the domestic content of spending, which tends to

Box 3.3

Industrial greening in the fashion industry

The COVID-19 pandemic has created unprecedented challenges for the global fashion industry, including declining consumer spending and disrupted supply chains. Observers are increasingly asking whether the crisis will catalyse a shift to greener, more sustainable business models. Fashion, one of the world’s largest consumer goods industries, is key to income and employment generation. An estimated 60 million people work in textile and garment production worldwide. Yet, it is also a substantial polluter. Fashion uses 93 billion cubic meters of water annually and emits more CO₂ than all flights and maritime shipping combined.

Part of this footprint is attributable to “fast fashion.” Spurred by growing consumer awareness, global fashion brands are seeking better alternatives. These include using renewable and recycled fibres, instituting cleaner production processes, and adopting circular business models. As part of the EU-funded SwitchMed Programme, UNIDO brings together global brands, governments and experts to explore and mainstream these alternatives. The programme aims at laying down the foundations for circular business models in participating countries (Egypt, Morocco and Tunisia), and to accelerate the textile finishing industries’ shift towards adopting safer chemical protocols.

Thanks to support from the programme, global fashion brands together with local stakeholders are demonstrating circular economy practices in their textile supply chains. Under the lead of UNIDO, global brands and local suppliers explore opportunities for recycling the waste that results from clothing production into yarns, fabrics and fibres for textiles and non-woven applications.

Local firms are also accelerating the adoption of safe chemicals and water pollution controls in the finishing process. Overall the work of UNIDO is showing how achieving higher levels of circularity along local value chains can create income and employment opportunities and prepare local suppliers and clusters to meet future global market requirements for sustainably produced textile and garment products.

The first phase of SwitchMed implemented the MED TEST component of UNIDO in eight countries (Algeria, Egypt, Jordan, Israel, Lebanon, Morocco, Palestine and Tunisia). It identified over 1,800 resource-efficiency measures, resulting in savings of water, energy and raw materials of up to \$42 million annually. The programme is now in its second phase and continues to promote the adoption of resource efficiency and circular economy practices in the region.

Source: UNIDO elaboration.

“ A greener future needs capabilities to design, manufacture and deploy renewable infrastructure

increase when retrofitting existing building stocks (Garrett-Peltier 2017; Pollin 2015). The shift towards industrial greening is also likely to boost manufacturing and generate substantial learning opportunities for firms in DEIEs. To date, most DEIEs—with some notable exceptions, such as Brazil and China—have remained consumers rather than producers of renewable energy technologies. Meanwhile, the design and manufacturing of the bulk of renewable energy equipment, along with high-value service inputs, remains concentrated in a handful of IEs.¹⁶ Being cut off from the design, production and R&D sections of the value chain severely limits employment and learning opportunities to activities such as construction, operations and maintenance.

Devices to generate and store energy from renewable sources, such as wind turbines, solar PV cells, and batteries are manufacturing products—subject to cost reductions achieved through learning (Mathews 2020). As the cost of producing renewable devices diminishes, markets expand. As demand for renewable energy generation equipment increases, opportunities might arise for developing country firms to integrate higher value-added segments of renewable value chains. The production of turbines and batteries, for instance, has large economic multipliers—in terms of wage and income gains and skill-building opportunities—and cross-linkages to other sectors.

Navigating this complex and rapidly changing landscape is likely to require considerable investments in capability-building—particularly among DEIEs. For a green industrialization process to materialize in DEIEs, firms in these countries will therefore need to continue attracting FDI in strategic sectors while also simultaneously strengthening their manufacturing capabilities (Lebdioui 2021). Over time, building up capabilities in industrial design and R&D will also prove crucial to take advantage of the opportunities associated with the industrial greening megatrend.¹⁷

Investment in education and training to address the possible employment fallout from the structural shift towards decarbonization and circular economy models should be another long-term priority for DEIEs, as are

the natural capital investment for ecosystem resilience and regeneration, including restoration of carbon-rich habitats and climate-friendly agriculture (Hepburn et al. 2020). In lower-income economies and LDCs, adaptation strategies could include supporting rural systems as they cope with climate change—including, for example, sustainable agriculture—as well as in accelerating the installation of clean energy infrastructure designed and developed elsewhere (Hepburn et al. 2020). Chapter 4 returns to these issues.

Industrial capabilities: Key to resilience in a post-pandemic world

This chapter has discussed three global megatrends—the digitalization of industrial production, the shifts in the global organization of industrial production and the greening and decarbonization of manufacturing. The megatrends are likely to radically alter the industrial landscape in the years to come. The interaction between these trends and the ongoing COVID-19 pandemic is complex. Yet, as countries gradually recover from both the sanitary and economic crises, the megatrends will remain and possibly accelerate, in both pace and intensity.

Should the megatrends intensify, countries will need to adapt and develop strategies to address them. The importance of industrial capabilities for long-term resilience—which was clearly evident throughout the pandemic, as diversified industrial sectors helped weather the twin sanitary and socioeconomic crises (Chapter 1)—suggests that it is only by gearing industrial policies towards the accumulation of production capabilities within the framework of a diversifying manufacturing sector that countries will be able to continue coping with and taking advantage of the megatrends.

Crucially, the future of ISID depends on the accumulation of manufacturing capabilities. Just as it is difficult to imagine a resilient public health system without an industrial infrastructure to supply it, so it is hard to plan for a greener future without the capabilities to design, manufacture and deploy renewable infrastructure. Similarly, the evolutionary nature

“ Capability accumulation depends on the sectoral structure of industrial production

of ADP technologies means that leapfrogging into a digital economy is likely impossible without a solid foundation of firm-level skills in production and innovation on which to build.

Naturally, no firm or country can develop the whole range of existing industrial capabilities. The capability development pathway that countries should follow to achieve ISID in the post-pandemic world varies widely across industries and countries. It is important to note, however, that it hinges on pre-existing

capabilities: the path to capability accumulation depends not only on a country’s level of economic development, but also on the sectoral structure of their industrial production (Cimoli et al. 2009). Yet, as evidenced in Chapters 1 and 2, all countries engaging in capability building can afford the opportunity to learn and diversify one’s industrial structures—two pillars of resilience that have proven critical during the pandemic and will likely remain so in the future of industrial development.

Notes

1. In some countries, the COVID-19 pandemic has also heightened gender and racial forms of bias. In the United States, for instance, Black women have been more exposed to health risks relative to other groups, due to their overrepresentation in low-paid, essential service jobs (Sorgner 2021).
2. These economies are: China; France; Germany; Japan; Republic of Korea; Netherlands; Switzerland; Tawian Province of China; United Kingdom and United States.
3. In the particular set of LDCs, the use of digital solutions has also occurred “under the radar” (Fu 2020). Across sub-Saharan Africa, as mobility restrictions forced formal firms online, informal sector actors have become central to supply and distribution chains. In Uganda, for instance, GetBoda, an online transport platform using informal motorcycle riders, reported a steep increase in demand to address the growing need for home deliveries (Gatune 2021).
4. It should be noted that Asia is also an heterogeneous region. As shown in Chapter 1, some sub-regions (most notably South Asia, but also West Asia) have been severely hit by the pandemic and are still struggling to recover. The trends presented in this section refer primarily to East Asia and South-East Asia.
5. Improving one’s supply resilience, however, is not costless. In instances where firms account only for *private* and not for *social* costs and benefits, governments might have to step in. Indeed, the pandemic has heightened the need for government intervention in those markets that are essential for public health, safety and security. Public-private cooperation should therefore aim to ensure that sufficient stocks of essential medicines and equipment are accessible at all times.
6. That is, reducing the stages of production located overseas or the shares of foreign value added integrated into their production.
7. Costs of solar PV have been falling by 28.5 percent for every doubling of production, which has occurred every two to three years (Mathews 2020).
8. Here, performance is measured based on changes in the share prices of 1,827 companies listed on the New York Stock Exchange and Nasdaq from February to April 2020.
9. Distributed ledger encryption (blockchain) provides a suitably acceptable ecosystem for record-keeping of contracts (fix the terms in perpetuity for future record review, record who viewed and accepted the terms, etc.), electronic signatures and digital contracts provide an intermediate step which can achieve similar purposes as those of a physical contract (ICC 2020).
10. In many countries, differences in coverage also exist among age groups and genders. Delays in vaccination rollouts represent a particular threat for women, as women are over-represented among the most vulnerable groups, including among the pregnant and the elderly (UN 2021).

11. Currently, 29 percent of global electricity generation stems from renewables, up from 27 percent in 2019 (IEA 2021).
12. The benefits of environmental sustainability extend well beyond the economy. Cleaner air, through cleaner energy, has been found to contribute to the reduction of COVID-19-related deaths (Wu et al. 2020). Environmental degradation and climate change contribute to the spread of zoonotic diseases, such as the coronavirus (UNEP 2020). Building long-term resilience to pandemics will thus require stricter environmental measures and a more significant sustainability push in industrial processes.
13. For instance, climate change may pose a serious risk to salmon farming in Chile (Soto et al. 2019) or coffee beans production in Viet Nam (Conway 2020).
14. Additional examples of stranded assets in natural resource-rich economies include extractive infrastructures being decommissioned prematurely, lost revenues from extraction activities ceasing to be profitable, as well as job losses from decarbonization (Rempel and Gupta 2021).
15. Brandi et al. (2020) find that by 2018, each new Preferential Trade Agreement contained, on average, approximately 73 different environmental provisions—up from approximately five in 1990.
16. In 2014 only four countries in the world—China, Germany, Japan and the United States—accounted for over three-quarters of patents filed in renewable energy technologies (Lebdioui 2021).
17. The case of the Chinese wind energy sector provides very clear evidence of the success of such policies. When China began to develop its wind energy capacity, its policy approach shifted from a fast-track development approach (which implies the installation of the greatest number of turbines in the shortest possible time through the imports of wholly assembled wind turbines) to a slow-track development approach, which seeks to develop a domestic manufacturing capability base for wind turbines (Lema and Ruby 2006).

Chapter 4

Building back better: The need to improve industrial policies and enhance international coordination

Key messages

- The COVID-19 pandemic has posed new challenges for industrial policies; they should continue to support industrial capabilities as an engine of growth, while bolstering manufacturing's ability to help improve resilience against global crises.
- It remains a priority for industrial policies to support global containment efforts, ensuring coordinated multi-agent efforts both to fight the pandemic and to foster a recovery that leaves no one behind.
- Industrial policy should be part of strategies to build back better, setting the stage to address future development challenges such as those established by the Sustainable Development Goals (SDGs).
- Stronger international coordination and collaboration around industrial policy could improve the world's collective ability to manage and more fairly distribute the cost of global disasters.

Introduction

Post-pandemic recovery offers opportunities to explore new routes towards more inclusive and sustainable development.¹ The notion of “building back better” summarizes this aspiration. Simply restoring to what was before the pandemic is insufficient to redress the fragilities and inequalities of the global economy. The world needs to find new ways to tackle those dynamics if it is to navigate a sustainable way out of the crisis, be better prepared for the next one and make progress towards achieving the Sustainable Development Goals (SDGs).

Industrial policy is emerging as a key factor to building back better. By promoting industrialization in sectors relevant to fighting the pandemic—notably healthcare-related products—several countries expect to bolster industrialization and resilience. However, the healthcare industry is not the only one to offer advancement opportunities in a COVID-19 and post-pandemic world, particularly for countries where populations face limited or no access to adequate safety nets. Diverse areas of social and economic activity offer opportunities to bridge capability gaps and to turn the current crisis into windows of opportunity for growth and prosperity. The threats of mounting food insecurity, environmental degradation or overexposure to global value chains (GVCs) are examples of particularly sensitive areas for developing countries (Santiago et al. 2020). This is consistent with proposals to

leverage industrial policies to address global challenges like climate change, and to build a culture of resilience against global disasters,² thereby making industrial development and industrial resilience complementary policy areas.

This chapter proposes some general guidelines for post-pandemic industrial policies. To do so, the first section of the chapter examines how industrial policy can contribute to building back better, with emphasis on long-term industrial development post-pandemic. Next, the chapter argues that global disasters demand enhanced solidarity and concomitant coordinated responses at the international level, as these have been insufficient in the fight against COVID-19. By overcoming this, the international community can increase its chances to build back better, while leaving no one behind. Building on these discussions, the chapter concludes with a call for action for the international community to engage actively in building a better post-pandemic future for all.

Building back better: A path towards SDG-friendly industrial policies post-pandemic

Popularized as a concept in the aftermath of the 2004 Asian tsunami, the term *building back better* summarizes the intention to coordinate efforts at the local and global levels towards achieving a new level of recovery after a major disaster (Clinton 2006). Beyond

Enhanced resilience enables economies to overcome structural vulnerabilities

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BUILDING BACK BETTER: THE NEED TO IMPROVE INDUSTRIAL POLICIES AND ENHANCE INTERNATIONAL COORDINATION

restoration to what existed previously, this recovery should enable a promising and safer development path for affected communities.

The term became part of international guidelines on disaster management in 2015 under the Sendai Framework for Disaster Risk Reduction 2015–2030 (Sendai Framework) (UNDRR 2015). The Sendai Framework postulates that prevention is better than cure; society should invest up-front rather than pay a heavier price later when a disaster strikes. The estimated cost of fighting the COVID-19 pandemic is a reminder of this. Despite the expected economic rebound favoured by the rolling out of COVID-19 vaccines, for 2020/21 alone, the forgone output globally would amount to about \$10.3 trillion, a figure comparable only to the gross domestic products (GDPs) of China or the United States (The Economist 2021b).

Box 4.1 summarizes recommendations that emerge from the building back better narrative to inform approaches to industrial policy design post-pandemic. Next, we discuss some central features of what this entails.

First, a distinction between policies addressing short-term emergencies and those targeting long-term effects of a disaster is necessary because of differences in a country's or industry's ability to manage shocks and respond to the turbulence of change.³ Moreover, constraints to structural change, sustainability

and resilience vary across countries. This combined approach is a major lesson learned from the 2008/09 financial crisis, when short-term policies prevailed (Kozul-Wright 2020). Arguably, resilience is the outcome of a successful development process, following which economies are better able to overcome structural vulnerabilities (see Chapter 2). Building back better is an opportunity to trigger behavioural changes—for example, encouraging economic diversification, flexible supply chains and innovation—while also minimizing the environmental impacts of production. The latter can be accomplished by decoupling industrial development from resource use and enhancing industry's disaster preparedness and resilience in the longer term.

Second, given the overwhelming socioeconomic impacts of the pandemic, any policy response requires solid engagement from all parties, with increased levels of dialogue and cooperation among government, business, academia and civil sectors to sustain industrial policies over time. Policy coherence and consistency at different levels of the policymaking process are key to the success of a more broad-based industrial policy (Aiginger and Rodrik 2020; Ferrannini et al. 2021). Public institutions need to be empowered to manage the challenges that such enhanced interaction processes could create. Thus, nurturing public sector capabilities to respond appropriately to such dynamics is crucial (Mazzucato and Kattel 2020; Ohno 2012).

Box 4.1

Recommendations for SDG-oriented industrial policy approaches post-pandemic

- Distinguish between short-term and long-term effects of a disaster. Emergency interventions should accompany other solutions that address more structural challenges and that contribute to enhancing industry's resilience against future disasters.
- Include multistakeholder approaches to policymaking, with greater levels of dialogue and cooperation from all parties. Private sector involvement in short-term recovery, and in fostering long-term industrial development and resilience, should be part of any recovery and long-term development strategy.
- Address the risks and opportunities opened by megatrends expected to shape industrialization in the future.
- Target systemic, structural change by enhancing local manufacturing capacities and other industrial commons, including research and development (R&D), manufacturing infrastructure and expertise.
- Contribute to strengthened multilateralism and international coordination around industrial policy issues, resilience and global disaster risk management.

Source: UNIDO elaboration.

Industrial policy can contribute to building more inclusive societies

Policy actors should also leverage the business sector as a key contributor to industrial development and resilience (Bakker and Elkington 2020) and in its ability to create social value (Sinkovics and Archie-Acheampong 2020), including at the time of global disasters. Businesses could contribute to short-term recovery, but also to initiatives to overcome long-term development bottlenecks. The policy challenge is to encourage investment decisions inclined towards the achievement of more socially conscious development paradigms (Schwab 2020; Schwab and Malleret 2020), steering the market towards fairer outcomes and the global provision of public goods (Mazzucato and Ryan-Collins 2019).

Third, efforts towards recovery must take account of the megatrends discussed in Chapter 3. Industrial policymakers have a significant role to play in identifying and transforming those megatrends into new development opportunities, and in assisting the transition from receding activities to others that are more dynamic (either with higher productivity potential or that offer greater social value). In addition to policies for upskilling and reskilling, efforts should enable the introduction of novel institutional and governance frameworks. They should also facilitate the necessary changes in competitive market conditions, investments in infrastructure, and the promotion of science, technology and innovation, among other areas.

A structural challenge for the recovery is to steer additional efforts towards the green transformation of low-carbon economies and high-quality jobs as well as cleaner products and production processes. This will depend strongly on policy interventions that either help or hinder the zero-carbon transition. It will be challenging, because in general, emerging economies still need to achieve the necessary readiness for a zero-carbon recovery relative to the more industrialized nations (Fankhauser et al. 2020).

Fourth, overcoming the COVID-19 crisis is no guarantee of recovery if industrial capabilities and other fundamental factors hindering structural transformation of developing countries remain unattended (UNIDO 2021e). To cope with the effects of future

pandemics, there is an urgent need to develop pharmaceutical and medical supply industries in countries that have been, so far, under-serviced and therefore vulnerable. The current under-servicing of health markets in developing and industrialized countries, and the aging populations in industrialized countries, are two trends that are likely to ensure demand growth even in the absence of future epidemic and pandemic events. However, the heterogeneous nature of disasters suggests that health is not the only sector offering scope to further industrialization.

While renewing emphasis on nurturing local manufacturing capacities, especially in hard-hit, low- and middle-income countries, industrial policy also can contribute to building more inclusive societies, broadening its scope to include social welfare as a relevant outcome (Aiginger and Rodrik 2020). The recovery must also enhance industrial commons such as R&D, manufacturing infrastructure and know-how (Pisano and Shih 2009). That, along with economic diversification and addressing inequalities, including the divide in digital skills and technology—especially with regard to women and other vulnerable groups—would put less-resourced countries in a better position to deal with the possible shortening of global supply chains post-pandemic (see Box 4.2).

Fifth, because disasters such as the COVID-19 pandemic exceed the capacity of communities to cope using their own resources, no single country, acting in isolation, can fight a pandemic and similar disasters (UNDRR 2020). Due to the transnational nature of disaster risk, the multidimensional nature of resilience and the multistakeholder approaches to disaster risk management, the best strategy is to pool resources across jurisdictions. Strengthening multilateralism, international coordination and collaboration around industrial policy issues is crucial to building back better, as well as ensuring that tackling global disasters in the future avoids the pitfalls observed in the management of the current crisis (Osterholm and Olshaker 2021). Improved collaboration would reaffirm commitments made around the Decade of Action to Deliver the SDGs (UNSDG 2020).

Resilience building requires strengthening national development banks

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Box 4.2

UNIDO's COVID-19 Industrial Recovery Programme

As firms and countries begin to recover from the ongoing COVID-19 pandemic, Sustainable Development Goal (SDG)-oriented industrial policies must focus on strengthening manufacturing capabilities—particularly in least developed countries (LDCs) and developing and emerging industrial economies (DEIEs). UNIDO has recently developed a new approach to provide targeted support to national governments to plan and implement post-pandemic industrial recovery programmes, with the aim of transforming and adapting to the changing realities with the goal of meeting national, regional and international needs.

UNIDO's COVID-19 Industrial Recovery Programme (CIRP) provides a phased approach to industrial recovery that is primarily focused on supporting LDCs as well as low-income and lower middle-income DEIEs in achieving post-pandemic resilience. The five phases of CIRP are: (1) sectoral

analysis of the impact of the COVID-19 pandemic on national economies, (2) consensus building among private and public stakeholders, (3) the design of a national industrial recovery plan, (4) piloting national industrial sector recovery, and finally (5) replicating and scaling up successful pilots.

Depending on an initial assessment of the pandemic's impact on the industrial sector and, at the same time, of the country's positioning within local, regional, and global value chains (GVCs), the CIRP programme will examine the extent to which advanced digital production (ADP) technologies can be leveraged to reconfigure existing manufacturing processes of domestic enterprises. Moreover, the national industrial recovery plans that will result from the implementation of the CIRP programme will consider the regional dimension of international trade and economic relations.

Source: UNIDO elaboration.

In what follows, we elaborate further on some of these elements; to the extent possible, we provide examples based on concrete country experiences. The intention is to inform efforts towards strengthening policy space by overcoming some public finance challenges and improving government capabilities more generally. Likewise, we discuss relevant interventions that address some of the megatrends shaping the future of industrialization, and considerations around risk and risk management as part of industrial policy.

Strengthen policy space towards addressing national priorities

To support the achievement of inclusive and sustainable industrial development (ISID) and the SDGs, policymakers can influence the direction of growth towards more inclusive and sustainable development outcomes (Aiginger and Rodrik 2020). In the context of the pandemic, limited fiscal space affecting several developing countries obliges governments to make—often painful—choices regarding where and how much to allocate of their scarce resources, whether into recovery programmes, or into interventions targeting structural challenges. In addressing these bottlenecks, issues of conditionality of public support and the

strengthening of development finance are core to the discussion (UNIDO 2021e).

Introducing conditional programmes may help governments steer recovery and promote private sector investments in desired directions. Governments can adopt performance-based incentives, attaching conditions to public finance that build in reciprocity—in exchange for public support, firms contribute to the achievement of national priorities. Hence, governments can support restructuring firms in backward sectors, minimizing the risk of bailing out otherwise unviable firms. The periodic monitoring and evaluation of these incentives should be part of the institutional structure supporting disaster prevention and response. This can help minimize potential policy capture, bind governments' engagement in time and increase the chances that public interventions follow a cumulative policy-learning path.

Long-term recovery and resilience building require rethinking and strengthening the role of national development banks (NLDBs). NLDBs can play a key role in implementing and channelling support to other economic agents, thereby ensuring continuity of their operations even at times of economic turbulence (Griffith-Jones and Ocampo 2018); their functions can range from counter-cyclical investments to

Improved government capabilities can reduce reconstruction and rehabilitation costs

Table 4.1

National development banks: The multiple functions that they can serve in post-pandemic recovery

Function	Description
Counter-cyclical	Ensuring investment flows despite the economic downturn spurred by the pandemic
Resilience-building	Enabling increased capitalization and flexible lending conditions to support resilience-building projects and the formalization of business continuity planning
Developmental	Providing long-term capital to stimulate investment in strategic infrastructure and industries, especially in industrializing countries
Entrepreneurial	Supporting high-risk R&D-intensive start-ups and innovative projects, thereby contributing to spur innovation and new firm growth
Challenge-led	Funding projects that address societal challenges such as climate change, thereby contributing to industrialization and the building of resilience

Source: UNIDO elaboration based on Griffith-Jones and Ocampo (2018) and Mazzucato and Penna (2016).

Note: R&D = research and development.

challenge-led projects (see Table 4.1). The relative importance of these functions in individual contexts will depend on the government priorities and a country's stage of development.

There is scope to revitalize NLDBs and their ability to support productive sectors, and to provide infrastructure, technical and managerial assistance (Guadagno 2016). However, preparing NLDBs for their different tasks is not trivial. It involves, in addition to recapitalization and organizational restructuring, learning by trial and error for both governments and managers, as well as continuous investment in staff training and development of professional managerial skills (Guadagno 2016).

Invest in government capabilities

The COVID-19 pandemic has shown the importance of prevention and preparedness in managing complex emergencies. Chapters 1 and 2 documented how

industrial capabilities influence countries' resilience; they are critical to both withstand shocks and steer industrial recovery towards a better future. However, industrial capabilities work best in crisis response if complementary government capabilities are present, including robustness and readiness. As discussed in Chapter 1, such capabilities enable governments to act swiftly and effectively, but they need to develop and accumulate over time along a complex, path-dependent process (Andreoni 2021).

Supporting the creation and strengthening of government capabilities is challenging in resource-constrained developing countries. Nevertheless, these capabilities can pay off significantly by reducing the cost of reconstruction and rehabilitation of economies and societies. Considering the specific context of the pandemic, investments can target public health facilities and related infrastructure responsible for prevention. They can also target testing and containment of a health crisis and the institutions that provide critical public goods, such as quality infrastructure to ensure that products and services are fit-for-purpose (Box 4.3).

Improving government readiness helps promote the structural transformations necessary to build back better. Because desired changes require system-level reconfigurations and integrated packages of policies, limiting the state's role to correcting market or coordination failures is insufficient (Mazzucato et al. 2021; Mazzucato and Kattel 2020). Rather, governments ought to build on dynamic policy capabilities that enable a vision of the future, which provides alignment and coordination functions and creates a strong ability to steer strategic sectors in desired directions (Mazzucato et al. 2021). In this sense, the accumulation of the skills, technology and knowledge required to ignite and sustain growth is a systematic policy learning process (Ohno 2012). The development of these capabilities necessitates nationally integrated approaches to complex challenges instead of separate ministerial actions. Key to progress is to establish fruitful partnerships with other socioeconomic agents, particularly from the business sector.⁴

“Unlocking digital transformation needs active policy shaping consumption patterns

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Box 4.3

Developing laboratory infrastructure: Helping to ensure efficient, resilient and sustainable production in Colombia

Quality and standard requirements increasingly govern participation in trade and global value chains (GVCs). To succeed in export markets, firms in developing and emerging industrial economies (DEIEs) must demonstrate compliance with global quality infrastructure requirements that facilitates interoperability and integration. This often represents a challenge, particularly for small and medium-sized enterprises (SMEs). Quality infrastructure is a crucial element in promoting cross-border trade, industrial transformation and sustainable development. Such a system relies on metrology, standardization, accreditation, conformity assessment and market surveillance. Laboratories are a key component of a country's quality infrastructure.

Laboratories provide data and information that are essential for transparent and trustworthy decision-making, particularly regarding inspection and certification activities. In Colombia, with support from UNIDO's Global Standard and Quality Programme (GSQP) (funded by the government of Switzerland through its State Secretariat for Economic Affairs), the government has developed a Laboratory Policy and is tapping into artificial intelligence (AI) to support the development of a dedicated search engine to gather laboratory data. This initiative aims to foster a national laboratory network, facilitate registration of medicines and close information/market gaps between supply of conformity assessment bodies and SME demand for laboratory services in the country.

Source: UNIDO elaboration.

Design policy that reflects a rapidly changing global industrial landscape

Chapter 3 highlighted digitalization and the greening of industry as key trends that create challenges and opportunities for all countries. Countries' ability to deal with these issues will largely depend on the effectiveness of industrial policies, which will need to be consistent with the specificities and challenges in each context. Moreover, industrial policy should contribute to the building of more inclusive societies, with emphasis on bridging inequalities around gender, region or firm size.

Regarding digitalization, countries have and will continue to advance at different speeds depending on how rapidly industrial capabilities can be developed

(see Chapter 3). In middle-income countries with some of the basic industrial capabilities in place, the goal would be to explore ways to adopt digital applications across those sectors seeking potential avenues for leapfrogging. That involves both sectors that are mainly users of digital technologies—such as agroindustry, consumer goods, chemicals and pharmaceuticals—and sectors that are suppliers, such as capital goods and information and communication technology (ICT). Industrial policy must exploit such “pull” and “push” pressures strategically.

Generally, advancing towards digital transformation requires a flexible and comprehensive policy approach. Governments will need to target education and skills—including re-training and changes to academic curricula to strengthen science, technology, engineering and mathematics (STEM). Workers who cannot be retrained or who lose their jobs should be guaranteed social protection.⁵ Similarly, it is also pertinent to provide and safeguard inclusive access to digital infrastructure, which will enable workforces to use digital technologies, especially in disadvantaged communities and countries with limited access to the internet and other digital technologies. In addition, governments need to better articulate innovation and industrial policies. Such policies would serve to (1) advance the adoption of digital technologies in production, (2) foster investments in R&D and (3) promote productive diversification. This will boost the ability to respond to demands for new design and product development as well as incentivize and shape the capabilities of designers and producers in order to meet customized demands (UNIDO 2019b).⁶

Unlocking the opportunities for digital transformation calls for active policy shaping of consumption patterns and other behavioural changes. For example, policymakers can support sustainable consumption decisions by requiring firms to disclose information about their production processes as well as the environmental and social impacts of their products, and by promoting consistent and reliable labelling processes. In this way and many others, the COVID-19 crisis is an opportunity to rethink the importance of

COVID-19 is an opportunity to rethink the importance of digitalization and sustainability

digitalization and sustainability as part of industrial development strategies.

As documented in the *Industrial Development Report 2020* (IDR 2020) (UNIDO 2019b), the preceding discussion implies three areas where industrial strategies and policy efforts need to focus attention, namely (1) improving framework conditions for digitalization, (2) fostering demand for advanced digital production (ADP) technologies and (3) strengthening capabilities for digitalization. This is illustrated by the recent efforts to foster the transition towards a sustainable and digital industrial development in Turkey (Box 4.4).

Green recovery programmes will play a central role in the structural transformation towards a low-carbon future, while tackling several interrelated socioeconomic objectives: economic development, job creation, public health and resilience to pandemics (IRENA 2020b). The megatrend towards industrial greening should impact the balance of competitive

advantages for firms in established industries. But it also entirely alters countries' comparative advantages by stimulating completely new industries (Altenburg et al. 2021). Navigating this complex and rapidly changing landscape will require considerable investments in capability-building—and in adaptation.

Green industrial policies will be particularly important for commodity-dependent countries whose production structure are greatly exposed to the impacts of climate change. They can also help countries adapt to changing consumer demand for more sustainable products in key consumer markets. While concrete actions will depend on the specificities of production systems in individual countries, different policy objectives can be set for the short and long term—together with tools to achieve them (Table 4.2).

In the short term, the greening of industry needs to be at the centre of post-COVID-19 recovery programmes. This can be achieved by adopting sustainability standards for the production of industrial goods,

Box 4.4

Fostering the transition towards a sustainable and digital industrial development: The case of Turkey

Despite the challenges posed by the pandemic and its effects on the industrial sector, Turkey continues its efforts to improve framework conditions for digitalization of the local manufacturing industry. In particular, the country continues to push forward the 2023 Industry and Technology Strategy, which consists of five main components: High Technology and Innovation, Digital Transformation and Industry Move, Entrepreneurship, Human Capital and Infrastructure. Digitalization in industrial production receives special attention, as a tool to promote an environmentally friendly, efficient and flexible manufacturing ecosystem. Likewise important is to address small and medium-sized enterprises (SMEs)' needs to adapt and transform for a new, green, sustainable and digital era. Some ongoing initiatives include:

- Regarding capability building, the Capability and Digital Transformation Centre (Model Factory) Project, launched in 2015, aims at supporting digitalization and optimization of industrial processes. Model Factories, which provide applied training services especially for SMEs, operate in critical industrial cities, and the number of these training centres is expected to increase in the future.
- The National Life Cycle Assessment Database Development Project will create the technical and statistical data

infrastructure to inform initiatives to increase energy and resource efficiency in industry and to reduce greenhouse gases and other emissions. With this project, Turkey joins the existing Life Cycle Assessment database networks in the world, which support the achievement of UN Sustainable Development Goals (SDGs) related to resource efficiency, climate change, emission reduction. First data sets will be released at the end of 2021.

- A roadmap for the digital transformation of the manufacturing industry is being prepared through multistakeholder contributions. Specific programmes to support the digital transformation of manufacturing are being implemented by institutions related to the Ministry of Industry and Technology, such as Small and Medium Enterprises Development Organization of Turkey (KOSGEB) and the Scientific and Technological Research Council of Turkey (TÜBİTAK).

Additional incentive programmes are implemented to support localization and enhanced cooperation among private sector organizations.

Source: UNIDO elaboration based on inputs provided by the Ministry of Industry and Technology of the Republic of Turkey.

Policy focus should shift towards strengthening capabilities related to green industries

Table 4.2

Priority areas and tools for industrial policies that promote the post-pandemic greening of industry

Area	Short term (post-COVID-19 recovery)		Long term	
	Policy tools	Examples	Policy tools	Examples
Decarbonization	Adopt decarbonization goals at the core of recovery programmes	Net-zero carbon pledges	Adopt objectives for manufacturing and export of low-carbon products/ technologies	Hydrogen production objectives
Structural change	Reorient <i>existing</i> productive capabilities to integrate green industrial value chains (<i>following comparative advantage</i>)	Leverage domestic steel manufacturing for the construction of renewable energy plants	Promote <i>new</i> productive and innovative capabilities (<i>defying existing comparative advantage</i>)	Support for value addition in critical minerals sectors; development of complex low-carbon industrial ecosystem
Global integration	Foreign direct investment (FDI) promotion in green industries	Fiscal incentives for investments in solar energy plants	Supplier development programmes and promotion of knowledge and technology transfer to trigger innovation and spillover effects	Incentives for local content for renewable energy projects; transfer of retrofitting/ solar cell production technology
Standards and innovation	Foster awareness of sustainability standards to boost the demand for green goods	Government regulations to phase-in resource efficient solutions such as LED lighting	Scale up of low-carbon R&D support	Provision of patient capital and non-repayable funding for low-carbon innovation
Green skills	Establish national competency frameworks for the re-training/repurposing of skills from “dirty” to “clean” manufacturing	Retrain programmes for jobs at risk due to the global energy transition	Expansion of education and training certification programmes related to sustainable manufacturing	Expansion of energy efficiency and low-carbon engineering graduate programmes

Source: UNIDO elaboration based on the background paper prepared by Lebdioui (2021).

Note: FDI = foreign direct investment; LED = light-emitting diode; R&D = research and development.

introducing low-carbon technologies and implementing, more broadly, policies to stimulate the demand for low-carbon technologies and “green skills.” Policy efforts should also prioritize specialization within green industrial sectors based on existing comparative advantage. Colombia, for example, is providing \$4.3 million funding for 27 strategic renewable energy and transmissions projects, including wind, solar, geothermal and hydrogenation; it is also offering \$8 million credit to SMEs to promote reduction in greenhouse gas emissions by scaling up financing to SMEs’ investments in energy-efficient projects. Similarly, Viet Nam is supporting the development of solar energy projects by enabling corporate Power Purchase Agreements (PPAs) for rooftop solar projects, as well as instituting a feed-in-tariff (PAGE 2021).

In the longer term, however, the policy focus should shift to the strengthening of new productive and innovative capabilities related to green industries that promote a transition from “low-quality” activities to “high-quality” activities. The scope for such a green policy can be illustrated by distinguishing three dimensions: behaviour of consumers, production processes of firms and innovation processes of firms. Table 4.3 describes each policy dimension and uses examples to illustrate how post-pandemic green industrial policy can address those dimensions. It also highlights the importance of policies to promote the circular economy in manufacturing processes and supply chains (see the column labelled “Second dimension—Production processes of firms” of Table 4.3), so that a more efficient and sustainable use of resources

Industrial policies should prioritize and improve the situation of the most vulnerable

Table 4.3

Three dimensions for policy action to support industrial greening

Green industrial policy	First dimension— Behaviour of consumers	Second dimension— Production processes of firms	Third dimension— Innovation processes of firms
Definition	Policies that seek to influence consumer behaviour	Incentives for firms to improve resource efficiency in their production processes and supply chains	Policies promoting innovation and the development of low-carbon industries
Key actors	Consumers	Firms	Firms
Objectives	Shift consumers' behaviour mainly through demand-side policies	Improvement of firms' production efficiency and their resource use through circular economy processes	Shift of the economy towards low-carbon sector
Time horizon	Short term	Medium to long term	Long term
Country examples	Incentives for car sharing; subsidies for electric and efficient vehicles (EEVs); bans on incandescent bulbs; green mortgages that involve lower interest rates for energy-efficient housing	Goals for greenhouse gases emission; incentives for adopting circular economy models; incentives for automotive producers to adopt more efficient exhaust pipes; carbon taxes; limiting the transport of materials in production processes	Combine demand- and supply-side policies: R&D support; subsidized credits for EEV producers and/or solar panel producers; strategic adoption of feed-in-tariffs
Benefits	Changing consumer behaviour can have an impact on production through the power of consumers on the governance of buyer-driven value chains	Can help deliver the same final goods with less CO ₂ emissions/waste and better production efficiency, thereby entailing some changes in production systems without having to change consumer preferences	Considers the production-side of climate change mitigation, thereby making the production structure more compatible with sustainability
Limitations	Consumer behaviour is unlikely to change if consumers have imperfect information or if the cost of changing consumption towards a greener one is too high when alternatives are lacking	Such policies have a clear limit without complementary investments in R&D for technology to improve resource efficiency	Difficult to achieve in many developing countries that lack the technological and institutional capacity to coordinate innovation in new green technology sectors

Source: UNIDO elaboration.

Note: CO₂ = carbon dioxide; EEVs = electric and efficient vehicles; R&D = research and development.

can ensue and contribute to resilience (Albaladejo et al. 2021; Domenech and Fokeer 2020).

Developing economies increasingly realize the consequences of years of disinvestment in vital capabilities and absence of preparedness. Chapter 2, for instance, documented the risks that shocks such as those associated with the pandemic imply for the most vulnerable groups of society, thereby supporting advocacy for human-centred recovery initiatives (ILO 2021b). Industrial policies could contribute at various levels to these initiatives by targeting, prioritizing and improving the situation of the most vulnerable actors,

as identified throughout the report. Table 4.4 presents examples of initiatives distinguishing, at the industry level, vulnerable industries; at the level of firms, MSMEs; and, at the level of workers, women, youth and informal workers.

Human-centred recovery underscores the consequences of a lack of universal protection, especially with regard to health, which contribute to undermining resilience against future shocks. Comprehensive approaches that address these gaps may foster recovery while favouring industries that serve the health system, as well as tap into potential spillover into

“ Post-COVID 19 world offers strategic opportunity for gender-inclusive industrialization

Table 4.4

Priority areas and tools for industrial policies that promote post-pandemic development in a socially inclusive manner

	Short term		Long term	
	Policy goals	Potential policy tool	Policy goals	Potential policy tool
Industries	Support continued operations of the most affected and essential industries through targeted support packages	<ul style="list-style-type: none"> Financial and fiscal support to mitigate liquidity stress targeted at the most affected industries Targeted job retention schemes Strengthening direct support measures to reduce the destruction of industrial capabilities 	<ul style="list-style-type: none"> Foster the recovery, reorientation and strengthened resilience of most affected industries 	<ul style="list-style-type: none"> Targeted financial and non-financial support for industry diversification, R&D and innovation Support for digitalization and automation Gradual phase out of incentives for repurposed production Foster continued market access to expanded production capacity by linking to other development needs at home and abroad
	Enable the repurposing of production to address contingent situations in vulnerable and essential sectors	<ul style="list-style-type: none"> Incentives and technical support for industries willing to repurpose Secure demand for repurposed production, for example, through government procurement guarantees 		
	Ensure SMEs survival through targeted support	<ul style="list-style-type: none"> Access to finance and financial products tailored to SMEs Incentives for the formalization of informal businesses 	<ul style="list-style-type: none"> Facilitate the uptake of new technologies (especially ADP technologies) in SMEs Build capacity in SMEs to better incorporate risk management Promote market diversification 	<ul style="list-style-type: none"> Develop awareness centres and organise events to expand SMEs' knowledge of new technologies, risk management and business continuity planning Targeted financial and technical support for SMEs' digitalization (training, readiness assessment, grants, credit, etc.) Advisory services and funding for business continuity planning and insurance targeted at SMEs Targeted financial and non-financial support for diversification, R&D and innovation
Firms				
Workers	Enhance safety net provision for vulnerable segments of the population	<ul style="list-style-type: none"> Guarantee aid for vulnerable workers, with wide coverage and extended duration Introduce temporary initiatives to contain layoffs or wage cuts 	<ul style="list-style-type: none"> Support employability of vulnerable workers 	<ul style="list-style-type: none"> Strengthen public and private investments in skills development and lifelong learning (universal and effective access to quality education and training) Enhanced targeted programmes to enable job transition, rehabilitation and job accommodation, and career reorientations

Source: UNIDO elaboration based on ILO (2020), López-Gómez et al. (2021), UNDRR (2020), and UNIDO (2019b).

Note: ADP = advanced digital production; CO₂ = carbon dioxide; R&D = research and development; SMEs = small and medium-sized enterprises.

non-health industrial and service sectors (Mackintosh and Tibandebage 2016). In the longer term, however, industrial policies should address the risk of reversing progress made on several social and inclusiveness indicators, turning negative short-term effects of the pandemic into long-term consequences. In

this regard, the post-COVID-19 scenario offers strategic opportunities to advance industrial development that is both gender-inclusive and sustainable (Braustein 2021). This can be achieved based on three guiding principles for industrial policies (Braustein 2021):

“ Planning for strengthening resilience can avoid losing years of industrial efforts in one major shock

- **Bring a gender-aware perspective to the employment challenges of increasing technological intensity and automation in industry.** Policy design should ensure that women workers participate in the gains brought about by technological change, thereby helping to reverse the trend of women’s exclusion from the benefits that higher productivity and better-paying industrial jobs create.
- **Increase women’s access to industrial sector work, particularly in the context of targeted growth of green jobs.** Policies fostering a greener industrialization offer scope to apply a gender-aware lens to job creation, bridge existing gender gaps in industry and tap into women’s potential to become key agents of change (Ugaz et al. 2020) and drivers of a green transition.
- **Identify social infrastructure and investments in the care economy as part of industrial policy.** Industrial policy can acknowledge and reward the investment that represents the care work that it takes to educate children; care for the sick, elderly and disabled; and maintain the able-bodied workforce on a daily basis. Public investments in the care sector can stimulate aggregate demand and job creation, resulting in an increased participation of women, and generate more significant tax revenues than similar public investments in physical infrastructure sectors like construction (De Henau and Himmelweit 2021).

Industrial policies informed by these principles may seek to expand and protect women’s involvement in paid work and, if possible, in the sectors and activities offering the best employment conditions. Future initiatives can learn from those implemented during the pandemic, including tax cuts, financial support for SMEs, and subsidized credit to hard-hit industries with a strong presence of women.⁷ Box 4.5 summarizes policy recommendations for gendered industrial policies in three areas, each corresponding to one of the aforementioned guiding principles.

Box 4.5

Recommendations for gendered industrial policies

- **Gender-aware skill development and training.** Offer women opportunities to upgrade existing skills or retrain on a regular basis.
- **Gender statistics to inform targeting efforts.** Improve support of women-led innovation and entrepreneurship.
- **Gender-aware upgrading of social infrastructure.** Invest in basic social services and infrastructures such as health and care systems, to ensure support of women working in the informal sector.

Source: UNIDO elaboration based on Oyón (2020) and UNIDO (2019a).

Include disaster risk management considerations in industrial policy design

The pandemic has demonstrated that the manufacturing sector is vulnerable to global disasters, allowing the distinction between more vulnerable and robust industries (see Chapter 1). Understanding manufacturing as a sector exposed to varying degrees of risk makes the case for integrating planning for resilience and risk management into industrial policy. The biggest risk is losing years of industrialization efforts to one major external shock.

Table 4.5 summarizes some relevant industrial policy goals that promote industrialization and industrial resilience focusing on issues of prevention and preparedness against emerging disasters.

The diversity of responses to the COVID-19 outbreak illustrates the uneven levels of preparedness against emerging global disasters across firms and countries. The crisis pinpoints areas requiring improvement if those countries are to boost preparedness for future disasters (Osterholm and Olshaker 2021). This will largely depend on a network of actors—including local authorities and governments, non-governmental organizations (NGOs), finance institutions, international donor agencies, the private sector and academia—being able to plan responses, mobilize and adequately channel the full range of resources available.

Setting up institutional mechanisms for implementing emergency plans requires intense stakeholder

“ International coordination should strike a balance between national and global interests

4

BUILDING BACK BETTER: THE NEED TO IMPROVE INDUSTRIAL POLICIES AND ENHANCE INTERNATIONAL COORDINATION

Table 4.5

Policy targets for disaster risk management-friendly industrial policies

Risk management	Goals	Suggested policies
Prevention	<ul style="list-style-type: none"> Implementation of actions to minimize exposure and to reduce the vulnerability of manufacturing industries to existing and emerging risks 	<ul style="list-style-type: none"> Sponsor training, events and consultations to build awareness and facilitate knowledge exchanges Map local capabilities and supply chain risks and vulnerabilities Support R&D, technology transfer and local production of critical and strategic goods that are prone to shortages during a global emergency Minimize vulnerability of industrial assets
Preparedness	<ul style="list-style-type: none"> Development of emergency plans for delivering manufacturing goods and capabilities as needed in the event of disasters 	<ul style="list-style-type: none"> Create emergency task forces to address disasters Identify and stock resources needed to face potential risks and disasters Support development and enforcement of business continuity planning and management in manufacturing with emphasis on SMEs Foster hazard monitoring and early warning systems in manufacturing

Source: UNIDO elaboration based on the background papers prepared by López-Gómez et al. (2021) and Santiago and Laplane (2021).
Note: R&D = research and development; SMEs = small and medium-sized enterprises.

engagement throughout the process—from devising the plan and required implementation processes to its actual execution. The pandemic response in several heavily impacted developing regions has suffered because of deficient coordination and contested leadership. This is particularly the case for SMEs, since the diversity of their needs implies that there may be multiple entry points to support their development and resilience building efforts (UNDRR 2020). In practice, most support for SMEs has consisted of labour policies, deferral policies and financial instruments, while structural policies—those contributing to building resilience and future growth—have tended to be less frequent (Zodrow et al. 2020).

Maintaining open platforms dedicated to fostering innovation—including funding and incentives that encourage R&D tailored to emerging disasters needs—may contribute to longer-term preparedness initiatives (Rovenskaya et al. 2021). While the nature of disasters varies depending on the source of risk, introducing special arrangements to help companies protect their workforce (through non-medical protection and operation automation) could help reduce the burden on workers during and after a disaster. Likewise, adoption of transparent emergency public

procurement regulations that can enable fast-tracking public purchases is useful, signaling sufficient demand exists for those companies seeking to repurpose their operations due to an emerging disaster.

Enhancing industrial policy coordination across national boundaries

The global nature of the crisis resulting from the pandemic highlights that without renewed commitments to strengthen multilateralism, national efforts to build back better will be insufficient and may make recovery fragile, uneven and uncertain (The Economist 2021a). In the fight against COVID-19, international policy coordination has been insufficient on many fronts, from the initial response in the face of shortages of essential health supplies and equipment to the ongoing COVID-19 vaccine rollout. Restrictive trade measures to safeguard domestic supplies of COVID-19-related necessities have created tensions among countries and disrupted the scope of coordinated interventions across countries. Some sort of international coordination would be required for future approaches to industrial policies that are capable of striking a balance between national and global interests, thereby

“ Poor finance constrains governments fight against COVID-19 and preparedness for crises

avoiding misguided protectionist and interventionist industrial policies from the past (Aiginger and Rodrik 2020).

The COVID-19 experience stresses the importance of multilateral platforms such as the United Nations (UN) system and the G20 to tighten collaboration with international financial organizations and regional development banks (RDBs), and to coordinate with philanthropic organizations to provide necessary support for manufacturing in developing countries (UNIDO 2021e). These entities should provide policy advice and help developing countries improve crisis management capabilities as well as ensure their manufacturing capacities remain operational. These functions supplement more traditional roles of development partners in assisting countries with the identification of prioritized industries, the design of measures to remove bottlenecks to their development, and the formulation of policies to bolster domestic investment and attract foreign direct investment (FDI) to achieve ISID (UNIDO 2021e).

Intensified international coordination of industrial policy matters should help to boost a fast and sustainable recovery that leaves no one behind. This requires improved access to: (1) finance and technology, (2) enhanced governance mechanisms to secure uninterrupted flows of essential goods and a fairer distribution of the cost of disruptions in GVCs and (3) selective policies and performance criteria to encourage innovation and create synergies. What will be essential to building back better post-pandemic is improved international frameworks for transboundary disaster risk management and placing environmental sustainability at the forefront of recovery efforts (UNIDO 2021e).

Provide access to finance to support recovery and build resilience

The need for fresh and readily available resources remains significant. Access to finance is a key constraint for many governments in the face of the COVID-19 pandemic and future crises. Initiatives to improve access to global development finance vary widely.

Several of them bolster and commit major international financial institutions (IFIs) through initiatives to increase systemic liquidity, for example, through comprehensive reform of special drawing rights (SDRs)⁸ and other mechanisms to recapitalize regional and multilateral development banks. IFIs make contributions to cope with COVID-19, including through debt rescheduling and the COVAX Facility (co-led by the World Health Organization, or WHO; Gavi, the Global Vaccine Alliance; and the Coalition for Epidemic Preparedness Innovations, or CEPI). However, the balance between funding for productive development projects and those resources channelled to humanitarian assistance could also be improved (UNIDO 2021e). Implementation of international banking regulations, the so-called Basel III measures, could accommodate emerging, short-term needs for corporate restructuring, such as those recorded in the wake of COVID-19, and their associated impact on risk on banks' balance sheets (Campa 2021).

Limited fiscal space and indebtedness have severely constrained, even delayed, the ability of developing countries' governments to adopt economic emergency plans and impacted their effectiveness. RDBs can help augment the fiscal space available to developing country governments in ways similar to the expected role of NLDBs in securing and mobilizing additional resources to enhance national-level capabilities to respond to disasters (Arezki and Bolton 2021). Lessons can be gleaned from their contribution towards mitigating the bottlenecks faced by developing countries during the pandemic. Table 4.6 shows different initiatives by which RDBs have provided contingent financial support and technical assistance to contain the health emergency. They are mobilizing or supporting investment in digital infrastructure and green restructuring, fostering innovation and the emergence of new business models, promoting the collection and access to data for social impact and helping to ease liquidity and working capital constraints of firms, particularly SMEs.

As documented in Chapter 2, debt relief and other debt restructuring packages could further enhance

Investments in prevention could reduce the burden of recovery programmes

Table 4.6

Regional development banks: Support of developing country responses to COVID-19

Focus	Examples of different types of support
Emergency	<ul style="list-style-type: none"> The Asia Development Bank (ADB) announced a \$20 billion package to help developing member countries fight COVID-19. This includes \$2.5 billion in concessional and grant resources and \$2 billion to support private sector recovery. In 2020, ADB supported various projects in medical-related industries. In 2021, focus has been on vaccine development and delivery under ADB's Asia-Pacific Vaccine Access Facility. In 2020, the African Development Bank (AfDB) raised an exceptional \$3 billion through a three-year Social Bond to help alleviate the impacts of the COVID-19 pandemic and support Africa's emergency response and recovery. This emission is the largest dollar-denominated Social Bond ever issued in international capital markets to date, and it is the largest US dollar benchmark ever issued by the AfDB. In 2020, the Islamic Development Bank Group (IsDB) Strategic Preparedness and Response Programme for the COVID-19 Pandemic allocated \$2.3 billion to help Member Countries address the sanitary emergency while setting the basis for socioeconomic recovery post-pandemic. The programme proposed a 3-R approach—Respond, Restore and Restart—with advanced technology playing a central role at each stage.
Recovery	<ul style="list-style-type: none"> ADB made longer-term investments related to vaccine manufacturing and general strengthening of health care systems. For 2021, the New Development Bank (NDB) of the BRICS (Brazil, Russia, India, China and South Africa) approved \$1.1 billion in loans to support China's economic recovery from COVID-19. The NDB investment priorities include: (1) restoration of production in key sectors hit hard by the pandemic; and (2) supporting economic recovery. The Inter-American Development Bank is mobilizing its CivicLytics initiative which implements the use of AI to capture citizens' needs and concerns in the pandemic. The data are expected to inform public and private sector response to local and regional level priorities.
Structural transformation	<ul style="list-style-type: none"> The Development Bank of Latin America (CAF) closed 2020 with an all-time high loan approval of more than \$14 billion. Two main tranches stand out: (1) resources to address effects of the pandemic on the economy and healthcare systems (roughly \$4.5 billion); and (2) loans to revamp digital, ground and energy infrastructure (more than \$2 billion). Through local development banks, CAF supports micro, small and medium-sized enterprises (MSMEs) with up to \$1.6 billion to boost internationalization, innovation and productive integration and help create formal jobs, foster economic recovery and support structural transformation in the region. In 2021, the AfDB announced financing agreements for a \$20 million concessional investment from the Sustainable Energy Fund for Africa (SEFA) for the COVID-19 Off-Grid Recovery Platform (CRP). This is part of a five-year, \$50 million blended finance initiative to provide liquidity support to firms operating in the market for renewable energy access solutions through and beyond the pandemic.

Source: UNIDO elaboration based on information gathered from ADB (www.adb.org/what-we-do/covid19-coronavirus), CAF (www.caf.com/en/currently/news/2021/01/caf-closes-2020-with-all-time-loan-approval-high?parent=6574), NDB (www.ndb.int/press_release/ndb-board-directors-approves-rmb-7-billion-emergency-program-loan-supporting-chinas-economic-recovery-covid-19/), African Development Bank (2020; 2021), Goldin (2020), Inter-American Development Bank (2021), IsDB (2020).

Note: ADB = Asia Development Bank; AfDB = Africa Development Bank; BRICS = Brazil, Russia, India, China and South Africa; CAF = Development Bank of Latin America; CRP = COVID-19 Off-Grid Recovery Platform; IsDB = Islamic Development Bank Group; MSMEs = micro, small and medium-sized enterprises; NDB = New Development Bank; SEFA = Sustainable Energy Fund for Africa.

the fiscal space required to support financial stimulus packages with an emphasis on supporting SMEs. From a resilience and disaster management perspective, pertinent proposals include the creation of contingency funds and investments in prevention mechanisms to reduce the burden of recovery programmes. One such mechanism is the creation of an International Pandemic Financing Facility to overhaul the global pandemic preparedness and response system through individual annual contributions, while taking into account differences in development and financial

capacities across countries (Cardenas 2021). Innovative financial instruments, such as hurricane clauses,⁹ can be customized to support industries that are more exposed and vulnerable to natural hazards and help countries ensure the resources needed to build industrial resilience.

Support from international organizations to facilitate DEIEs' access to international finance already integrates the megatrends discussed in Chapter 3, targeting future enhancement of digital capabilities and greening of industrial production. However,

“ Bridging digital divides could support ADP technology engagement and drive industrial development

strengthened development finance could further boost investment in productive infrastructure, including digital and digitally enabled infrastructure, while contributing to greening the economy, job creation, resilience and improved governance (Box 4.6).

Provide access to knowledge, learning and adaptation

Misinformation and poor information sharing across countries and regions at the outset of the pandemic, together with uncoordinated global action, have contributed to worsening its impact. Building back better initiatives advocate better mechanisms for governing knowledge creation and sharing; this can enable swift validation of emerging evidence that can be acted upon rapidly. These initiatives include improvements in global science systems—comprising peer-review and dissemination—or upgrading science-policy interfaces that inform resilience building and disaster response at different levels (IATT 2020). There is potential to bolster coordinated initiatives to facilitate knowledge sharing and support technology transfer under the framework of the United Nations, for example,

through the WHO’s COVID-19 Technology Access Pool (www.who.int/initiatives/covid-19-technology-access-pool), the UN Technology Bank for Least Developed Countries (www.un.org/technology-bank/) and UNIDO’s Knowledge Hub (<https://ti.unido.org/>).

Initiatives to bridge global digital and production divides could support developing countries’ engagement with ADP technologies, as drivers of industrial development post-pandemic. Actions could target the development and use of online digital platforms for international knowledge transfer and diffusion of ADP technologies and other technologies relevant to developing countries. Likewise, it would be useful to set up a global system or programme to govern digital data and digital standards. To improve industry disaster preparedness UNIDO (2019c) proposes the creation of a platform to collect and analyse risk data, map hazardous areas, develop core indicators and use advanced digital technologies. This platform could draw on existing initiatives at the regional level and facilitate knowledge sharing and communication among countries.

Box 4.6

Development finance to address economic, environmental and resilience outcomes in developing countries

The government of Bangladesh is implementing projects to underpin recovery from the COVID-19 pandemic, with a view towards longer-term recovery. Job creation efforts specifically target women workers and entrepreneurs. An example is the Private Investment and Digital Entrepreneurship (PRIDE) project, which seeks to strengthen social and environmental standards in selected economic zones and software technology parks. An investment of \$500 million financed by the World Bank expects to leverage \$2 billion in additional private investments, helping create 150,000 jobs, with an emphasis on female workers. The project will invest in dedicated greening and resilience infrastructure—including road networks with stormwater drainage, solar-powered streetlights, climate-resilient water, sanitation and power networks—for the Bangabandhu Sheikh Mujib Shilpa Nagar II in Mirsarai-Feni park, and Dhaka’s first digital entrepreneurship hub in the Janata Software Technology Park.

The Central Bank of Kenya and the E4 Impact Foundation—an initiative to support the development of impact

entrepreneurship in Africa—adopted a Memorandum of Understanding to support Kenyan financial technology (fintech) start-ups and enterprises through customized capacity building and connect them to investors, markets and ecosystem partners in Kenya, elsewhere in Africa and globally.

Regarding greening initiatives, an illustrative case is the collaboration between the European Union and the Ethiopian Chamber of Commerce and Sectoral Associations (ECCSA) through the Greening Ethiopian Manufacturing Project (<http://ethiopianchamber.com/gem/about-us/>). This project targets Ethiopian micro- and small-scale manufacturing firms—including in the informal sector—in light industries interested in sustainable consumption and green growth opportunities. The project seeks to capture activities shifting away from China because of rising production costs. The participating firms will benefit from a pilot programme of green manufacturing clusters, training and technical support in design for sustainability, improved resource usage and waste management.

Source: UNIDO elaboration based on Haraguchi and Wenyuan (2021) and López-Gómez et al. (2021).

Promote knowledge sharing around industrial policy through novel international mechanisms

4

BUILDING BACK BETTER: THE NEED TO IMPROVE INDUSTRIAL POLICIES AND ENHANCE INTERNATIONAL COORDINATION

In a broader sense, there is support to establish a novel international mechanism to promote knowledge creation and sharing around relevant industrial policy issues for the current pandemic and beyond (UNIDO 2021e). Such a mechanism would, among other things, help countries identify demand opportunities at the domestic, regional and global levels that trigger and/or strengthen the development of local industrial capabilities and growth prospects. While acknowledging differences in industrial policy approaches across countries, the mechanism could facilitate mutual learning on a wide range of issues, including trade and investment rules, property rights, social standards and the promotion of energy efficiency and renewable energy. This supports Aiginger and Rodrik's 2020 proposal for an annual International Forum for Industrial Policy Shaping Responsible Globalization that would enable political leaders, civic organizations and firms to discuss industrial policy issues of global concern. The forum would enhance coordination on sensitive issues such as national strategies around subsidies for fossil energy and large-scale agriculture and assist countries failing to meet the challenges of globalization and rapid technological change.

Exploring South-South collaboration to foster knowledge sharing and policy coordination would also benefit countries that share certain characteristics. In devising suitable South-South collaboration mechanisms, it can be useful to critically assess ongoing initiatives around industrial policy—such as those established by the BRICS countries (Box 4.7)—in their contribution to enriching policy space and coordination. These mechanisms could be expanded to help manufacturing activities in the countries involved be better prepared for future emergencies.

Upgrade international frameworks for trans-boundary disaster risk management

In an interconnected world, disasters occurring in one part of the world can affect distant locations. The adoption of global standards and protocols to guide regional and national responses, while acknowledging national differences in terms of acceptance and

Box 4.7

A forum to enable industrial policy coordination among BRICS

BRICS countries (Brazil, Russia, India, China and South Africa) are exploring cross-border collaboration around industrial development and related policy matters to enable them to respond to emerging development challenges and opportunities. The BRICS Industry Ministers Meeting is the formal mechanism governing this collaboration. These meetings serve to discuss joint strategies to boost trade and sustainable economic growth, strengthen industrial ties, promote technology transfer and innovation and improve investment climates and job creation. The shared agenda comprises a proposal for joint training and skill development programmes, collaborative research and development and business development opportunities.

The scope of collaboration has evolved gradually. It currently involves a shared Action Plan, which acknowledges the emergence of the fourth industrial revolution (4IR) and the increasing interdependence of manufacturing and manufacturing-related services. It also addresses their influence on existing production arrangements and business model innovations with potential to create new industries. The Action Plan reaffirms BRICS's commitment to enhance collaboration in industrial capacity building and industrial policy coordination, with potential implications for each individual BRICS and other countries.

Source: UNIDO elaboration based on Santiago (2020).

interpretation of risk, could help coordinate prevention and preparedness against disaster risks (Djalante et al. 2020). More importantly, it would enable better coordinated responses and more equitable sharing of costs globally. This includes building coordinated actions that leverage best practices and technologies to foster industrial safety and reduce disaster-related damage (Haraguchi and Wenyan 2021; UNIDO 2019c) and securing mechanisms to facilitate access to essential goods at times of crises.

Of concern is how to distribute more evenly the burden of value chain disruption among participating actors. Sudden gaps between demand and supply are frequent after natural disasters, and these can be seriously disruptive for the local populations (WTO 2019). International or multilateral arrangements can contribute to securing the orderly distribution of essential manufacturing products during crises. Possible

International arrangements can contribute to securing distribution of essential products

initiatives include trade-facilitation mechanisms that can mitigate trade disruption, especially involving products essential on health grounds, or to manage disasters such as the ongoing pandemic (Table 4.7).

International collaboration in trade facilitation can help overcome domestic productive capability and quality gaps while securing the necessary products to address surges in domestic demand. In particular, bridging cross-country discrepancies in standards and regulatory regimes for goods and professional certifications is critical at times of disasters. For example, by arranging “green lanes,” the European Union and the Central European Free Trade Area made it possible to speed up trade in prioritized goods—including medical goods and food products—in the context of increased demand for such products and shortages in domestic production capacities during the lockdown

(UNECE 2020). UNIDO (2017) documents how multi-country pooling of strategic public procurement can improve access to essential medicines in Latin America. A similar initiative is the Africa Medical Supplies Platform (AMSP), an innovative multi-lateral platform that provides immediate access to an African and global base of screened manufacturers and procurement collaborators (Box 4.8).

Improved industrial policy coordination could target orderly responses to emerging crises while protecting those countries or firms exhibiting the greatest potential for damage in the wake of a supply chain disruption. A revision of contracts between international lead firms and supplier firms in GVCs could lead to a fairer burden sharing, protecting people’s welfare. Corporate governance reforms geared towards increasing productive investments—for example, prohibiting

Table 4.7

Trade facilitation measures that can smooth supply of manufacturing goods during crises

Proposed measure	Description
Establish special regimes for expedited clearance of essential medical goods and food products	<ul style="list-style-type: none"> • Anticipate sudden, radical increases of demands of essential goods. • Establish special programmes to expedite clearance of essential goods that are experiencing shortages in domestic markets.
Set up pre-arrival processing and release	<ul style="list-style-type: none"> • Implement simplified procedures before the goods arrive at the port of entry.
Effective risk management	<ul style="list-style-type: none"> • Prioritize goods based on degrees of risk. Conduct documentary checks and inspections performed on high-risk goods. Consider waivers on inspections of certain low-risk goods. • Implement post-clearance audits.
Expanded use of integrated risk management	<ul style="list-style-type: none"> • Include health-related criteria in customs risk management systems in order to identify shipments posing significant risk to human health. • Invest in skills and hardware to integrate risk management.
Enhanced coordination between different border authorities	<ul style="list-style-type: none"> • Share data and information among different border authorities. • Have regular communication between health authorities and border and immigration agencies to guarantee that essential medical goods can be imported immediately, or cross border entry by experts.
Authorized operator or trusted trader schemes	<ul style="list-style-type: none"> • Increase the use of authorized economic operator (AEO) or trusted trader (TT) schemes to engage more companies in sourcing, manufacturing or transporting essential goods.
Emergency mutual recognition arrangements for priority goods	<ul style="list-style-type: none"> • Avoid discrepancies among countries in standards and regulatory regimes for the treatment of goods and professional certifications. • Promote the use of consistent health and safety requirements and assessment procedures.
Use new technologies at borders	<ul style="list-style-type: none"> • Enable system-to-system electronic data interchange. • Implement a National Single Window for international trade.

Source: UNIDO elaboration based on the background paper prepared by Haraguchi and Wenyan (2021).

Note: AEO = authorized economic operator; TT = trusted trader.

Box 4.8

**Regional cooperation to fight the pandemic:
The Africa Medical Supply Platform**

The African Union (AU) launched the Africa Medical Supply Platform (AMSP) as an immediate, integrated and practical response to the COVID-19 pandemic. This not-for-profit initiative functions as an e-commerce platform to connect medical suppliers with government health agencies, non-governmental organizations (NGOs) and donor agencies while eliminating middlemen. It contributes to the affordable, equitable provision of essential medical equipment, test kits and other supplies to the AU Member States. The World Health Organization (WHO) or the Africa Centres for Disease Control certify the products traded through the AMSP according to quotas for individual countries.

The platform expects to secure the supply and administration of the COVID-19 vaccines for 55 AU Member States. At the time of this writing, it was open for COVID-19 vaccines pre-orders, including vaccine accessories such as needles, syringes and extremely low-temperature freezers. The AMSP demonstrates potential from a regional industrial policy perspective, as it supports engagement of local medical manufacturers as suppliers. An example is Volkswagen's South African plant, which has now started manufacturing COVID-19-related medical products such as face shields and ventilators.

The AMSP allows AU governments to aggregate purchase volume from critical suppliers, manage their quotas, facilitate payment and manage logistics. In addition to maintaining transparency as a single-source platform, it grants Member States greater bargaining power to stabilize prices. For instance, by securing large volumes of N95 masks, it reduced unit prices from \$30 to about \$2.

Partnership building contributes to success. For instance, participation of the African Export-Import Bank enables access to dedicated finance to support countries facing cash shortages. Commercial partnerships with the private sector include major African airlines and international courier services to better support smooth logistics of medical supplies. Collaboration with Royal Philips, a multinational manufacturer of health technology, is helping to strengthen healthcare infrastructure by improving access to a variety of medical equipment, including state-of-the-art ventilators and other medical devices needed to fight the pandemic.

The AMSP is helping to connect Africa with other developing regions. Fifteen Caribbean Community (CARICOM) member countries established a partnership with the AMSP in 2020; several Latin American countries and the Pacific Islands are considering adoption of similar models.

Source: UNIDO elaboration based on Africa Medical Supplies Platform (2021) and the background paper prepared by Haraguchi and Wenyan (2021).

“Any viable post-pandemic recovery plan must simultaneously be a climate change plan

share buy-backs or setting conditionality of reinvestment—can help in countering the vicious cycle caused by financialization of corporations (UNIDO 2021e).

Place environmental sustainability at the forefront of global recovery

Building back better stresses that any viable post-pandemic recovery plan must simultaneously be a climate change plan. Translating such ambition into action requires renewed cooperation and a shared sense of urgency among all countries. Otherwise, the world risks missing a unique opportunity to leverage the post-pandemic recovery into a launch of the transition towards climate neutrality by 2050. It is necessary to significantly raise global awareness about the challenges imposed by climate change, including the risk of more frequent and more intense pandemics (Osterholm and Olshaker 2021). The European COVID-19 recovery plan could illustrate long-term strategies towards sustainable development. It combines an ambition to accelerate the transition towards climate-neutrality (while creating jobs and social inclusiveness), with targets and an action plan to support industry transition (European Commission 2021). This and other similar initiatives can inform incentives to upscale green initiatives in developing regions where they can have the greatest impact.

Additional actions could include facilitating cross-country exchange of experiences with sustainable industrialization, along the lines discussed in the section entitled “Design policy that reflects a rapidly changing global industrial landscape,” or such actions could facilitate global access to green technologies by equating these technologies to those needed to address COVID-19 and supporting every mechanism available to ensure that they can be used in developing countries (UNIDO 2021e). Similar efforts could facilitate learning from—and whenever possible, replicating and adapting—the successful examples of partnerships created to deal with the current pandemic. The latter involved consortia to innovate products and services to fight the medical emergency and develop vaccines, and so on.

“ The international community should actively contribute to a better post-COVID-19 future

The creation of new green development banks and the financing of international cooperation for sustainable development, including the creation of industrial energy transformation funds, could learn from ongoing experiences such as Mission Innovation, which is a global initiative launched in 2015 to catalyse action and investments in different areas related to affordable, attractive and accessible clean energy (Box 4.9). There are also interesting examples from UN agencies working together to support countries' green recovery efforts.¹⁰ Funding for these novel financing mechanisms would benefit from progress towards the introduction of new global taxes on pollution, corporate incomes, offshore accounts, international financial transactions and net wealth of very rich individuals. The priorities include scaling up multilateral investments in greening of the economy.

Fostering private sector-led international initiatives could also speed progress towards meeting climate change-related targets. The 1.5°C Supply Chain Leaders initiative of the International Chamber of Commerce (ICC) is an example of concrete commitments by large multinational firms to introduce climate action across their supply chains, with emphasis on supporting SMEs, including a recently launched SME Climate Hub (Exponential Roadmap Initiative

2020). This intends to facilitate knowledge sharing and encourage participating SMEs to commit to halve greenhouse gas emissions before 2030 and reach net-zero emissions before 2050. In return, SMEs will gain access to tools and resources to help them reduce emissions and build business resilience. More importantly, they may tap into new business opportunities to unlock direct commercial incentives.

A call for action to the international community

This section calls on the international community to actively engage in building a better post-COVID-19 future. Already provided were some strategic guidelines for industrial policy design and coordination, and previously discussed were policy options for achieving an inclusive and sustainable industrial recovery. The proposals below articulate concrete steps in this direction. We distinguish between actions to be taken in the short term to alleviate the economic and social effects of the pandemic, and actions to be taken over the longer term, which are geared to building back better through inclusive and sustainable development. They are inspired both by the analysis of the data presented throughout the report, and by the discussions held at UNIDO's High-Level Expert Group Consultation

Box 4.9

Mission Innovation to foster environmental sustainability

Mission Innovation is a global initiative launched alongside the Paris Agreement in 2015 that brings together 24 countries* and the European Union to reinvigorate and accelerate global clean energy innovation and make clean energy widely affordable. Members represent over 90 percent of global public investments in clean energy innovation. During its first phase, 2015–2020, 20 founding countries committed to double their respective clean energy R&D investment over five years. Although falling short of this target, the initiative promoted additional annual investments in the order of \$5.8 billion since 2015. Of this, \$1.6 billion was leveraged to support 157 new international collaborations and nearly 1,500 innovations. The cumulative increase in clean energy innovation investments adds up to \$18 billion.

A second phase, Mission Innovation 2.0, announced earlier in 2021, renews commitments to step up investment in clean energy innovation by targeting three main missions: green power future, clean hydrogen and zero-emissions shipping. Each of these addresses specific challenges and entails specific goals. This second phase will continue to enable the pooling of investments in renewable energy generation and serve as a platform to share experiences at the regional and multilateral level.

*Australia, Austria, Brazil, Canada, Chile, China, Denmark, Finland, France, Germany, India, Italy, Japan, Morocco, the Netherlands, Norway, Republic of Korea, Saudi Arabia, Sweden, the United Arab Emirates, the United Kingdom and the United States.
Source: UNIDO elaboration based on Mission Innovation (2021).

Support global efforts to contain COVID-19 and ensure that recovery leaves no one behind

4

BUILDING BACK BETTER: THE NEED TO IMPROVE INDUSTRIAL POLICIES AND ENHANCE INTERNATIONAL COORDINATION

held in May 2021. With this urgent appeal, the report hopes to contribute to mobilizing the necessary efforts for the achievement of the 2030 Agenda for Sustainable Development.

The international community is hereby called upon to (1) in the short term, support global efforts to contain COVID-19 and ensure that both the fight

against the pandemic and the efforts to foster subsequent recovery leave no one behind, and (2) in the medium to long term, coordinate global efforts to address future development challenges and ensure that the world builds back better through inclusive and sustainable means (see Table 4.8).

Table 4.8

Building back better: A call for action to the international community

	Intended goals	Proposed actions
Short term	Address vaccine rollout and access, ensuring global protection against COVID-19	<ul style="list-style-type: none"> Accelerate production and deployment of COVID-19 vaccines, especially to developing countries Eliminate export restrictions on ingredients essential to COVID-19 in vaccines and medications Expand technology transfer commitments to increase the global manufacturing capacity of COVID-19 vaccines and treatments
	Expand the policy space available to developing countries for inclusive and sustainable recovery and for continued progress towards achieving the SDGs	<ul style="list-style-type: none"> Promote recapitalization of development banks at the national, regional and multilateral levels Facilitate and support developing countries' efforts to expand fiscal space needed to strengthen health systems and introduce post-pandemic economic recovery packages
	Strengthen government capabilities for the design and implementation of industrial policies post-pandemic	<ul style="list-style-type: none"> Assist governments in design of SDG-oriented industrial policies, by leveraging the state's ability to introduce conditionalities that encourage private sector investments that advance national development priorities Support revitalization of synergistic partnerships with the private sector as well as other social and economic actors that can provide concrete solutions to specific development problems Support sustained long-term investments in public sector institutions
Medium to long term	Tackle digital divides, supporting developing countries' engagement with ADP technologies	<ul style="list-style-type: none"> Support establishment of an international programme to promote knowledge creation, knowledge sharing, including ADP technologies and other technologies relevant to developing countries' industrial development Scale investments and strengthen domestic capacities in digital infrastructure, education, skills and R&D related to manufacturing production
	Foster a post-pandemic green transition to achieve climate neutrality by 2050 and to mitigate the global warming trend	<ul style="list-style-type: none"> Scale multilateral and national investments in greening the economy, including industrial decarbonization, energy switching, deployment of new green technologies and application of circular economy principles Facilitate global access to green technologies by treating them similarly as the technologies needed to address COVID-19 Foster partnerships created to fight COVID-19 and raise global awareness of the urgency of climate
	Promote local industrial capabilities that are consistent with future socioeconomic and environmental resilience	<ul style="list-style-type: none"> Foster opportunities for local production capabilities in health-related strategic goods and devices Integrate more systematically elements of socioeconomic resilience and risk management into industrial policy practices—including contingency funds and investments in prevention mechanisms that reduce the burden of recovery programmes

Source: UNIDO elaboration building on High-level Expert Group Consultation held in May 2021 (UNIDO 2021e).

Note: ADP = advanced digital production; R&D = research and development; SDG = Sustainable Development Goal.

Notes

1. This chapter builds on a UNIDO consultation with senior experts in the field of industrial development, which included the production of short written submissions and their discussion in an online meeting (UNIDO 2021e), as well as various background papers.
2. According to the UN Office for Disaster Risk Reduction (UNDRR), a disaster denotes “A serious disruption of the functioning of a community or a society at any scale due to hazardous events interacting with conditions of exposure, vulnerability and capacity, leading to one or more of the following: human, material, economic and environmental losses and impacts” (UNDRR 2020).
3. This short-term focus requires robustness capabilities in both firms and governments discussed in Chapter 1, while the longer-term focus requires what were termed *readiness capabilities*.
4. India, for example, which before the pandemic depended on imports of personal protective equipment, has managed to switch to domestic production early after the outbreak, becoming the second largest manufacturer in the world. This has been possible thanks to the coordinated action of key players in government and the textile industry. In Senegal, meanwhile, the government’s successful response to COVID-19 involved the effective mobilization of a broad set of actors, including researchers, scientists, start-ups and citizens. With a common goal of tackling the virus, it was possible to create new collaborations around the healthcare system and spur innovation (Mazzucato et al. 2021).
5. The provision of basic income in developing countries is an interesting option (UNCTAD 2021c), but a still largely unexplored, potentially problematic one in fiscally constrained countries (World Bank 2019).
6. Mexico, for example, has targeted sectors where smart manufacturing already exists, and encouraged the formation of smart suppliers. In Viet Nam, several policies, plans and legislation around information technologies, intellectual property rights, e-transactions, and cybersecurity are in place, hopefully providing a solid basis for investments in smart manufacturing (UNIDO 2019a).
7. In China, for example, tax cuts and financial support for SMEs in response to the pandemic seem to be easing cost pressures in services and manufacturing, important sectors for women. In Bangladesh, interest-free loans supported export-oriented garment industries, a sector in which women prevail (Braustein 2021).
8. In August 2021, the International Monetary Fund (IMF) announced the approval of the largest SDR allocation in the history of the Fund, about SDR 456 billion, equivalent to \$650 billion, to boost global liquidity and target in particular the most vulnerable economies in context of the COVID-19 pandemic (IMF 2021a).
9. Such clauses enable the deferral of principal and interest debt service payments or the possibility of fast-tracking debt restructuring operations in the event of a hurricane (ECLAC 2021).
10. The Partnership for Action in Green Economy (PAGE) integrated by five UN agencies is supporting several developing countries mainstream and support green economic opportunities in key economic sectors to mitigate the socioeconomic impacts of the pandemic (South Africa), including by tapping the potential of nature-based solutions and economic diversification through the community-based eco-tourism sector (Mongolia), or by assisting in the design and implementation of fiscal measures for promoting sustainable recovery of the tourism sector (Burkina Faso) (PAGE 2021).

Part B

The impact of the pandemic on industrial development indicators

Chapter 5

What statistical indicators reveal about manufacturing during the pandemic

Key messages

- The COVID-19 crisis has had a severe impact on the global manufacturing sector, causing the largest decline in world manufacturing production since the financial crisis of 2008/09. However, the impact was not equally distributed in terms of timing and severity.
- The impact has also varied across industries. Sectors producing essential goods, such as food and pharmaceutical industries, benefitted from a sustained demand and were less impacted during the crisis. Products with higher technological content have also recovered faster and have driven the recovery.
- Countries with more competitive industries could afford imposing strict containment measures with only a limited impact on their production levels. Countries with less competitive economies suffered a stronger collapse in production, even with relatively softer lockdowns.
- A flexible, innovative and well-resourced statistical system should be at the centre of the recovery efforts, making sure that reliable, precise and timely information is available to support the post-pandemic economy and increase resilience to future shocks.

A detailed look at how the global manufacturing sector weathered the COVID-19 crisis

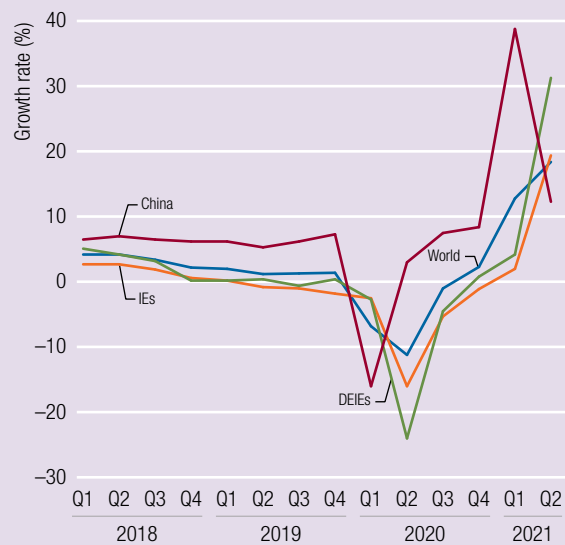
Since early 2020, the world has been affected by successive waves of the coronavirus pandemic, challenging not only national health sectors but also the global economy and its manufacturing production. To slow the spread of the virus, many countries introduced restrictive measures, effectively halting business activity and closing international borders, which led to severe impacts on both demand for, and supply of, products and services, consequently damaging employment and income prospects. The crisis arrived at a moment when manufacturing production and international trade were already suffering from a slowdown, triggered mainly by trade and tariff uncertainties in commodity trading among China, the European Union and the United States, as well as other factors.

The biggest economic disruptions were recorded in the first half of 2020, due to introduction of strict, blanket containment measures in many parts of the world. Further waves of coronavirus cases since the autumn of 2020 forced governments around the world to maintain different levels of restrictions to economic and social life at least until the third quarter of 2021. Even though most of the national lockdowns starting

in the third quarter of 2020 lasted considerably longer than during the first wave, the impact on manufacturing production was less severe (see Figure 5.1). This can be explained by more targeted measures, which allowed many businesses to continue operating under strict hygiene rules and a close monitoring of the pandemic. Widespread vaccination campaigns put a preliminary end to national containment measures in some countries. However, it remains unclear whether this will contribute to stabilizing the global pandemic in the long run, considering the emergence of virus mutations and the recurring COVID-19 outbreaks in some parts of the world, as well as the lack of a comprehensive and fair distribution of vaccines around the world.

Figure 5.1 provides an overview of the impacts of the pandemic on manufacturing. Global manufacturing output fell by 11.4 percent during the second quarter of 2020, compared to the same quarter of 2019, and only returned to growth by the end of the fourth quarter of 2020. China,¹ the world's largest manufacturer, suffered the impact of the pandemic first, in the first quarter of 2020, but reported positive year-over-year growth rates by the second quarter of 2020. This swift recovery, and the comparatively low baseline of 2020, translated into a growth rate of almost 40 percent in

Figure 5.1
**Industrial production by economy group:
 Quarterly growth rates compared to prior year,
 2018 Q1–2021 Q2**



Source: UNIDO elaboration based on Quarterly Index of Industrial Production Database (UNIDO 2021d).

Note: Seasonally adjusted quarterly growth rates. Averages values weighted by economies' shares on each group's manufacturing value added. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

the first quarter of 2021 compared to the first quarter of 2020 and 12.1 percent in the second quarter of 2021 compared to the second quarter of 2020. Manufacturing in industrialized economies (IEs) finally moved past its pre-pandemic production level in the first quarter of 2021 and then reached a growth rate of 19.2 percent in the second quarter of 2021, compared to the pandemic related drop of 16.2 percent in the second quarter of 2020. Developing and emerging industrial economies (DEIEs) (excluding China) also registered an increase in manufacturing output of more than 30 percent in the second quarter of 2021, compared to a decline of 24.2 percent in the second quarter of 2020. These figures indicate that DEIEs experienced a higher contraction in production in the second quarter of 2020 compared to IEs, but also recovered sooner. IEs, on the other hand, showed considerable output decreases until the end of 2020, then noticeable increases for the first half of 2021.

As shown in Figure 5.1, the effects of the COVID-19 pandemic did not affect the manufacturing sector in

COVID-19 did not affect the manufacturing sector in a synchronized manner around the world

a synchronized manner around the world. To facilitate the comparison of pandemic-related impacts in terms of severity as well as the shape of the recovery, Figure 5.2 aligns the trends of each region's manufacturing output relative to the onset of the COVID-19 impact. Monthly country-level indices of industrial production are used in order to provide a greater level of detail, rebased to take a value of 100 at the month before the first pandemic-related fall was registered.

- **China.** China recorded an immediate drop but soon returned to a recovery path and had already surpassed its pre-crisis level six months after the first effects were registered. Twelve months after the onset of the crisis in this country, their manufacturing production was already 8 percent higher than their pre-crisis level.
- **IEs.** The collapse brought about by the pandemic in IEs was less pronounced for the first month, with a relatively subdued start, with large drops in the following two months. But the recovery in this group of economies was also more gradual than in China, sustainably surpassing the pre-crisis level 13 months after they were first affected by the pandemic.
- **DEIEs.** For DEIEs (excluding China), the drop in production was greater than in either China or IEs, reaching its lowest point two months after the start of the crisis. However, the recovery was slightly faster than IEs as DEIEs exceeded their pre-crisis output level ten months after the start of the pandemic. However, they were later affected by subsequent waves of the pandemic and could not sustain this recovery. Fifteen months after the start of the pandemic, DEIEs again dropped below their pre-crisis output.

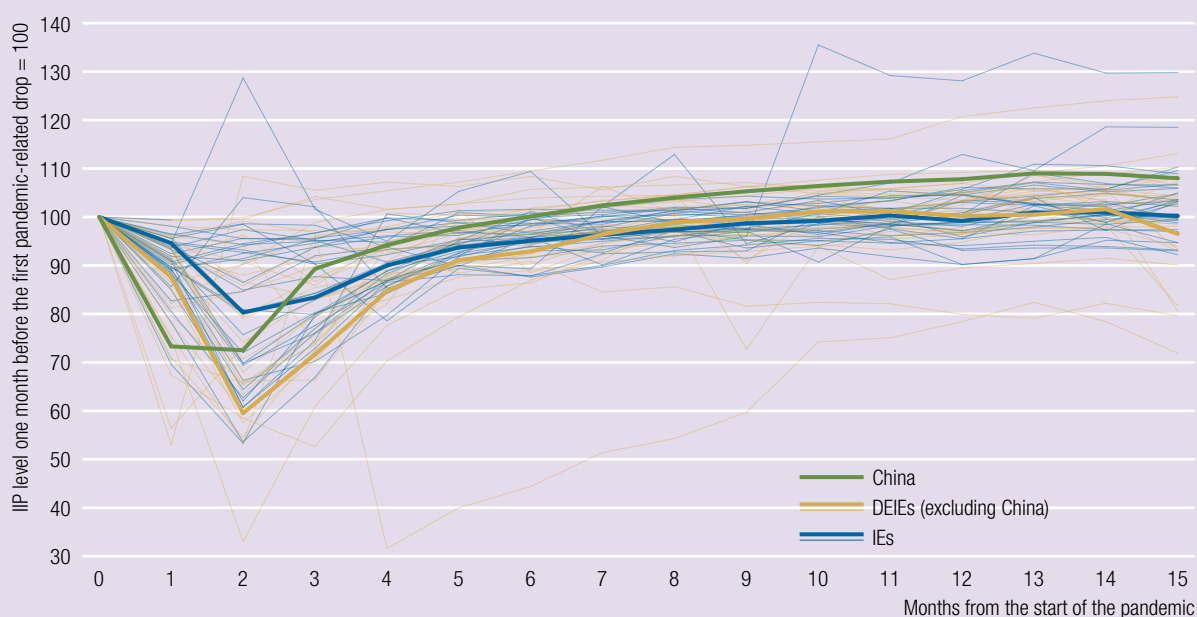
Figure 5.2 also shows the trends of individual countries (indicated by the fainter lines), illustrating the high variability observed at the country level, with some countries registering strong swings, and others yet to return to their pre-crisis levels.

Recent trade and employment data confirm the trends described above for manufacturing industries. Exports of manufactured goods from China

For DEIEs (excluding China) the drop in industrial production was greater than in IEs

Figure 5.2

Monthly evolution of industrial production since the first pandemic-related drop, by economy group



Source: UNIDO elaboration based on Monthly Index of Industrial Production Database (UNIDO 2021c).

Note: Seasonally adjusted IIP. The thinner lines represent country-level data, while the thicker lines correspond to China and economy groups weighted averages. Averages values weighted by economies' shares on each group's manufacturing value added. First pandemic drop is the first month in which the IIP level declines after December 2019. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies; IIP = Index of Industrial Production.

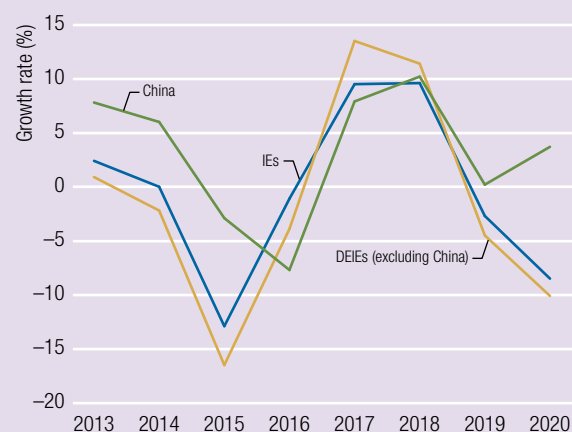
weathered the crisis with relatively high growth rates, reflecting a continued demand for its products. On the other hand, other developing and emerging economies as well as IEs suffered a collapse of their manufacturing exports in 2020 (Figure 5.3). Furthermore, detailed annual export data on manufacturing products (see Figure 5.4) reveal different impacts across sectors. As shown in panels a and d, exports of essential consumer goods, such as food or pharmaceuticals, were less affected by the pandemic, while the export of road vehicles (as shown in panel f) sharply declined in 2020. Panel e of Figure 5.4 indicates that the data for office machines also show a positive impact from remote working and entertainment during the periods with economic and social restrictions. With the exception of food products, all manufacturing sectors in China recorded growth in 2020.

On the other hand, data for employment in the manufacturing sector (Figure 5.5) highlight the comparably lower drop in employment in IEs relative to DEIEs (excluding China). This could be the result of a

relatively less harmful impact of the pandemic on the sector, in addition to the various subsidies and support measures implemented by IEs to sustain employment

Figure 5.3

Annual growth rates of total manufacturing exports, by economy groups, 2013-2020



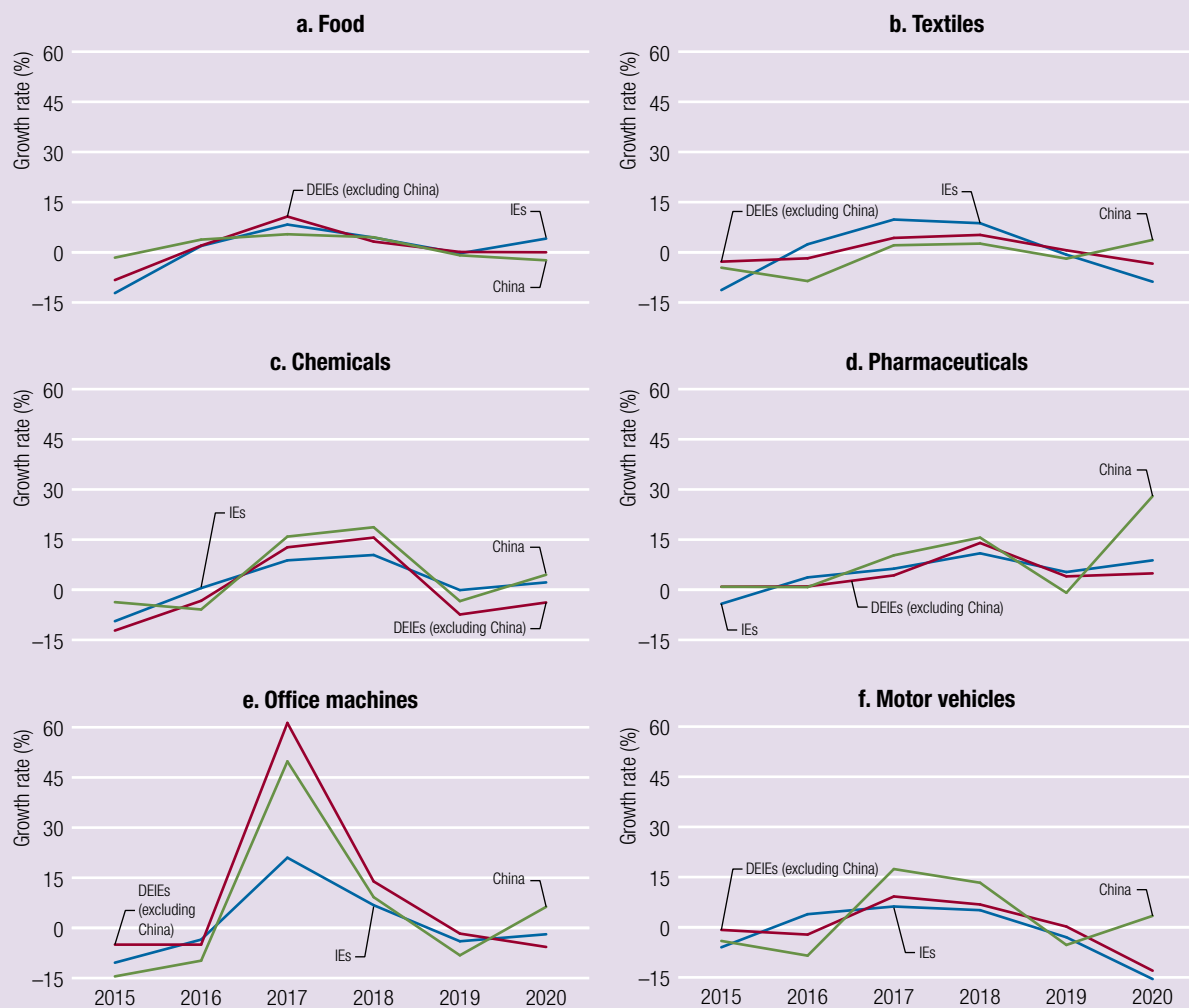
Source: UNIDO elaboration based on data from UNCTAD (2021a).

Note: Averages growth rates weighted by economies' shares on each group's total merchandise exports. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

Exports of essential goods, such as food or pharmaceuticals, were less affected by the pandemic

Figure 5.4

Annual growth rates of merchandise exports by economy groups for selected products, 2015-2020



Source: UNIDO elaboration based on data from UNCTAD (2021a).

Note: Averages growth rates weighted by economies' shares on each group's total merchandise exports. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

levels during the crisis. The large drop for DEIEs (excluding China) indicates a strong potential for poverty rates to increase, negating the gains that have been achieved over the last decades through development policies.

A closer look at manufacturing in different regions (Figure 5.6) reveals the different regional impacts of the pandemic on manufacturing production. The majority of the regions faced a considerable production plunge in the second quarter of 2020 as well as further output reductions during the rest of the year.

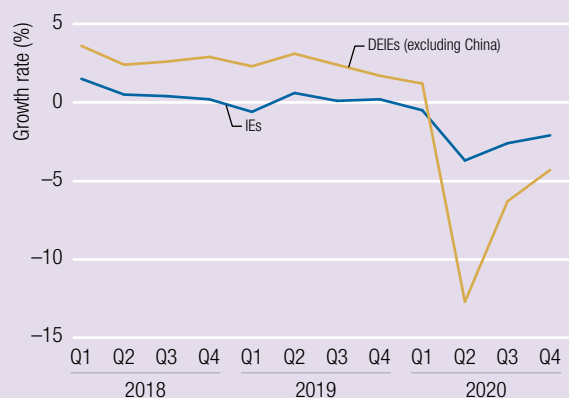
By the second quarter of 2021, all regions experienced growth in production of at least 10 percent; however, as shown in panel d, China was already registering exceptionally high growth after the first quarter of 2020.

While COVID-19 had a strong influence on overall manufacturing production in 2020, the severity of the impact was different across industrial sectors. Production data grouped according to technological intensity (Figure 5.7) provide further insights. Medium-high- and high-technology industries have

“ The drop of employment in DEIEs indicates a strong potential for poverty rates to increase

Figure 5.5

MANUFACTURING EMPLOYMENT BY ECONOMY GROUP: Quarterly growth compared to prior year, 2018 Q1–2020 Q4



Source: UNIDO elaboration based on data from ILO (2021a).
 Note: Averages growth rates weighted by economies' shares on each group's total manufacturing employment. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

been driving the manufacturing recovery; furthermore, this group of industries now accounts for almost 50 percent of total manufacturing production. These trends can be verified in all regions presented in the graph, with higher-technology sectors outperforming lower-technology industries.

Figure 5.8 presents the top 10 industries according to their share in global manufacturing production, with a combined weight of approximately 75 percent of total output. Six out of these 10 industries are classified as medium-high and high-technological intensity.² One can see that the production of essential consumer goods, such as food products (panel a) and pharmaceuticals (panel c), experienced less severe contractions in the second quarter of 2020. The production of certain categories, including electrical equipment (panel h), chemicals (panel b), and pharmaceutical products (panel c) as well as computer, electronic and optical products (panel g) has been growing considerably since the second half of 2020. The pharmaceutical sector played a major role in the response to the health crisis and never recorded negative growth. Computer, electronic and optical products suffered only limited declines followed by explosive growth, particularly in IEs, due to the demand for equipment for working and

studying from home, as well as increasing home-based digital entertainment, during the lockdowns.

A historical comparison of the different stages of the crisis and recovery versus the last global economic crisis reveals further insights. Figure 5.9 highlights the evolution of manufacturing production since 2006. It is evident that the duration and severity of the COVID-19 crisis did not reach the levels experienced during the global financial crisis of 2008/09. The latest manufacturing export data (Figure 5.10) also indicate that trade was impacted by the crisis, although less severely than in previous downturns. However, the ongoing contraction in employment (Figure 5.11) indicates that the decline and recovery are following similar trends in comparison to the previous crisis. Taking into consideration the hesitancy of businesses facing a subdued demand and the gradual decline of governmental support, the impacts of the COVID-19 crisis could have more severe and long-lasting effects on employment.

Is there a link between industrial competitiveness and the severity of COVID-19 impacts?

While it is too early to establish causal links between the characteristics of manufacturing, the impact of COVID-19, and the ensuing recovery, this section will study whether countries with different levels of industrial competitiveness had a different policy response during the pandemic and, if that is the case, this led to different outcomes in industrial performance during the crisis. The Competitive Industrial Performance (CIP) Index measures how successful a country's industries are at producing and selling their goods in domestic and foreign markets while moving along the technological ladder. A higher score in the CIP Index indicates that a country's industries are more competitive.³ The CIP Index is used to assess and benchmark the industrial competitiveness of 152 economies in 2019, the year before the start of the COVID-19 crisis.

To facilitate the analysis, all countries will be ranked and grouped into five quintiles according to their level of competitiveness. For example, Germany, China,

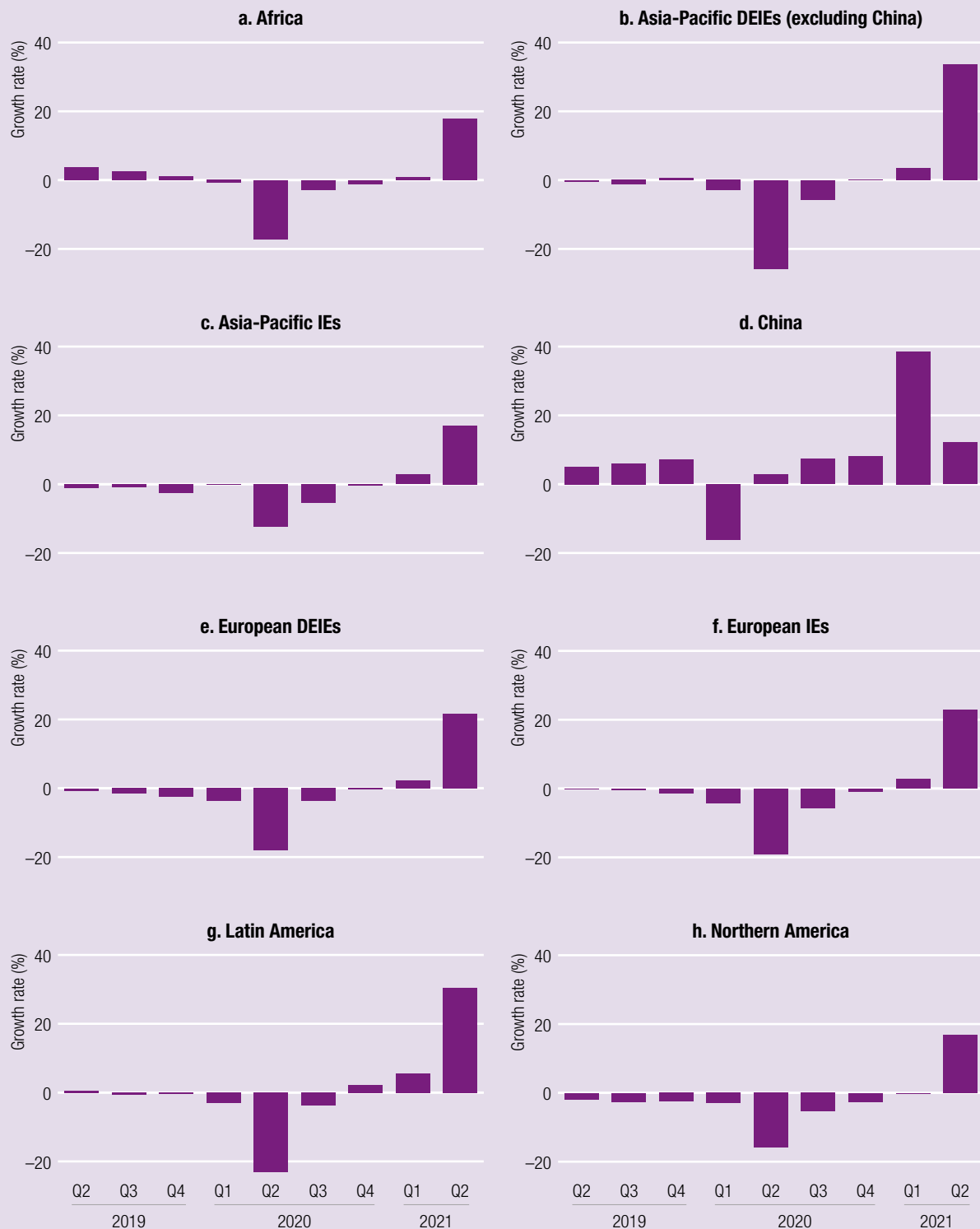
“ Most regions faced a considerable production plunge in the second quarter of 2020

5

WHAT STATISTICAL INDICATORS REVEAL ABOUT MANUFACTURING DURING THE PANDEMIC

Figure 5.6

Industrial production by region: Quarterly growth rates compared to prior year, 2019 Q1–2021 Q2



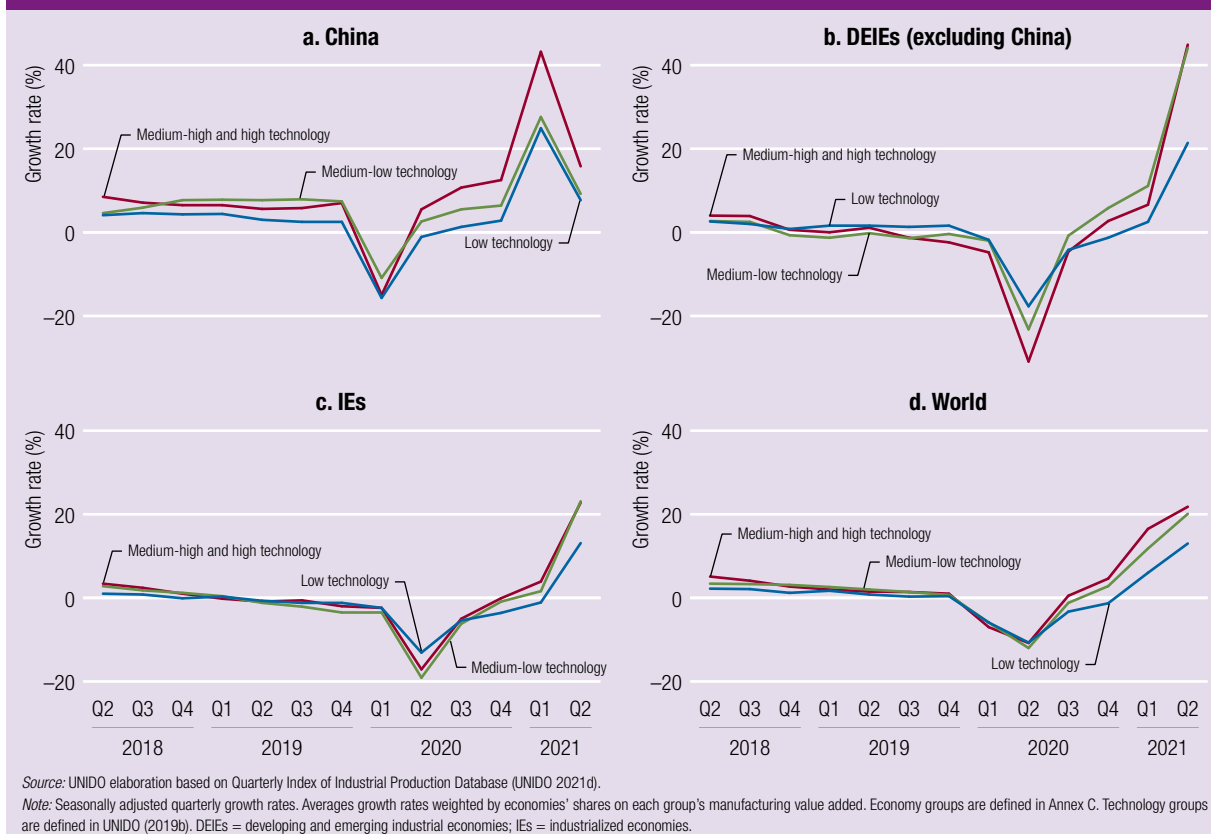
Source: UNDO elaboration based on Quarterly Index of Industrial Production Database (UNIDO 2021d).

Note: Seasonally adjusted quarterly growth rates. Averages growth rates weighted by economies' shares on each group's manufacturing value added. Economy groups are defined in Annex C. DEIEs = developing and emerging industrial economies; IEs = industrialized economies.

Medium-high- and high-technology industries have driven the manufacturing recovery

Figure 5.7

Industrial production according to technological intensity by economy group: Quarterly growth rates compared to prior year, 2018 Q2–2021 Q2



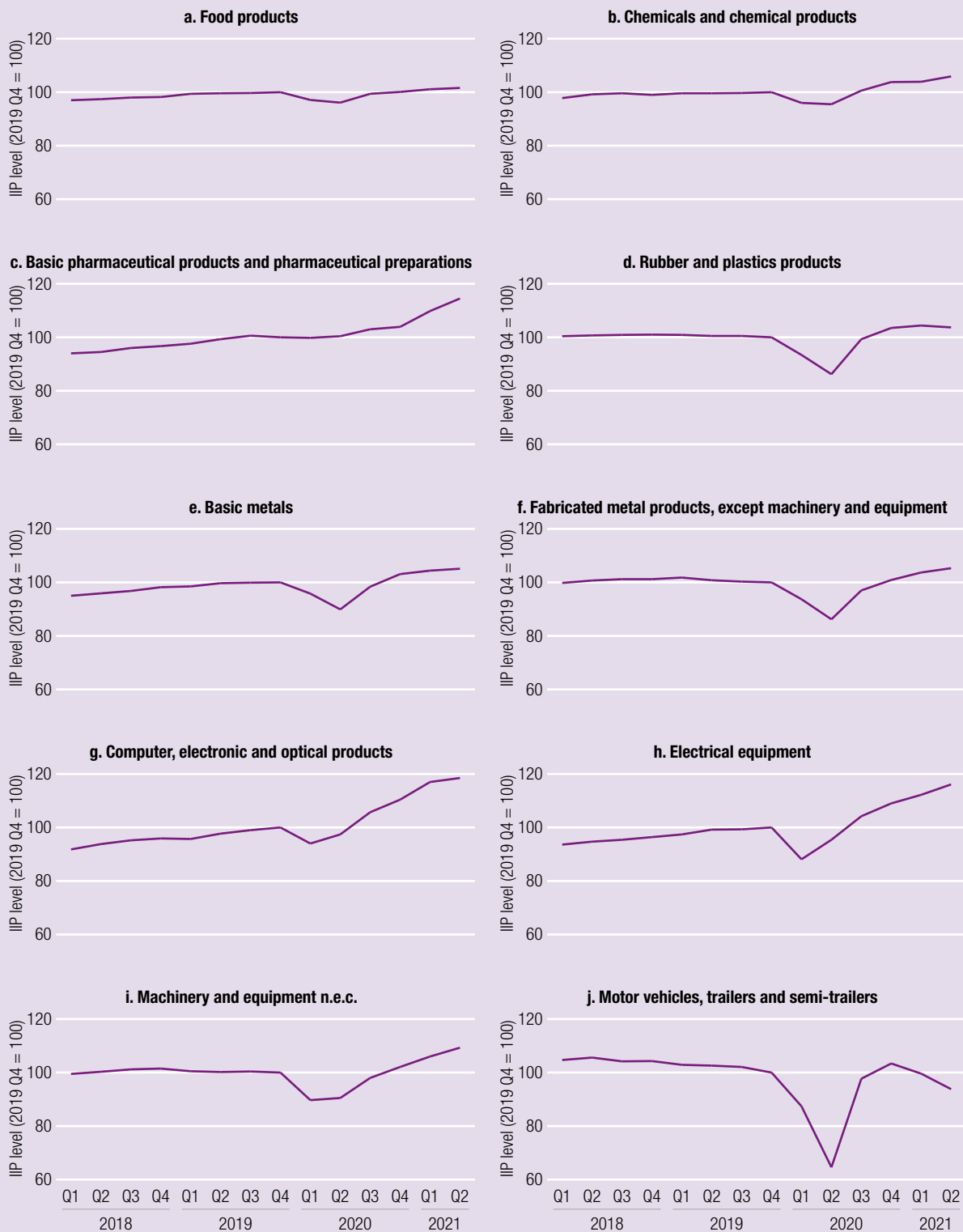
United States, Japan and the Republic of Korea as the top five most competitive economies in the world (in this order) according to the CIP Index, become part of the top quintile, along with the other economies with a score in the top 20 percent of the index. In this section, these five quintiles of industrial competitiveness will be used to analyse trends in policy response and industrial production.⁴

This section also relies on the Oxford COVID-19 Government Response Tracker introduced in Chapter 1, a data source providing consistent information on public policy measures implemented as a reaction to the pandemic. This tool presents data collected from public sources on 23 indicators of government response, ranging from health system policies to economic policies (Hale et al. 2020). The analysis of most components of the Tracker goes beyond the objectives

of this section, since they reflect actions implemented in specific sectors, such as schooling or public health programmes, or target individuals instead of firms. However, one of the indicators is well suited for the analysis, with a clear and direct link on the performance of productive units: workplace closing. This indicator records whether governments introduced COVID-19 restrictions that required employees to work remotely or stop working until businesses could be opened again. This remains a controversial policy response because, while potentially effective to reduce people movement and contain the spread of the virus, it could also bring significantly damaging effects to the productive system. The index of workplace closing ranks between zero and 100 and combines the strictness of the measure with the geographical coverage in its implementation. Thus, a score of zero indicates

“ The pharmaceutical sector played a major role in pandemic response and did not record negative growth

Figure 5.8 Evolution of world industrial production in selected industries, 2018 Q1–2021 Q2



Source: UNIDO elaboration based on Quarterly Index of Industrial Production Database (UNIDO 2021d).
 Note: Seasonally adjusted IIP. IIP = Index of Industrial Production.

“ The impacts of the COVID-19 crisis can have severe and long-lasting effects on employment

Figure 5.9
World industrial production: Quarterly growth rates compared to prior year, 2006 Q1–2020 Q4



Source: UNIDO elaboration based on Quarterly Index of Industrial Production Database (UNIDO 2021d).
Note: Seasonally adjusted IIP. IIP = Index of Industrial Production.

Figure 5.11
World manufacturing employment: Quarterly growth rates compared to prior year, 2006 Q1–2020 Q4



Source: UNIDO elaboration based on data from ILO (2021a).

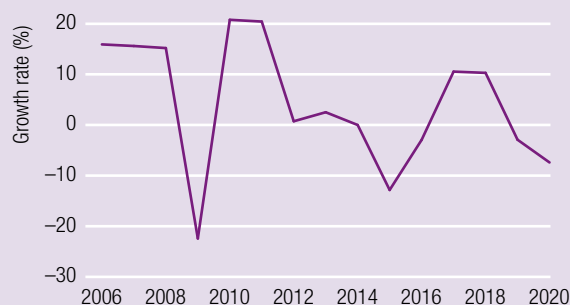
that no measures were implemented, while a score of 100 indicates that there was a national requirement for workplace closing or work from home for all-but-essential workplaces. In between are the cases in which countries recommended closing or work from home (at the regional or national level) or required closing or work from home for some sectors or categories of workers (at the regional or national level).⁵

Figure 5.12 depicts the evolution over time in the application of workplace closing for countries grouped according to industrial competitiveness quintiles. The figure suggests that all country groups, independently of their level of industrial competitiveness, moved in tandem at the onset of the pandemic, rolling out this containment measure to prevent the spreading of the

virus. However, the strictness in its implementation changed across country groups and over time. Data show that the strictest implementation took place in the second quarter of 2020, with the bottom quintile recording a softer implementation than the other country groups.

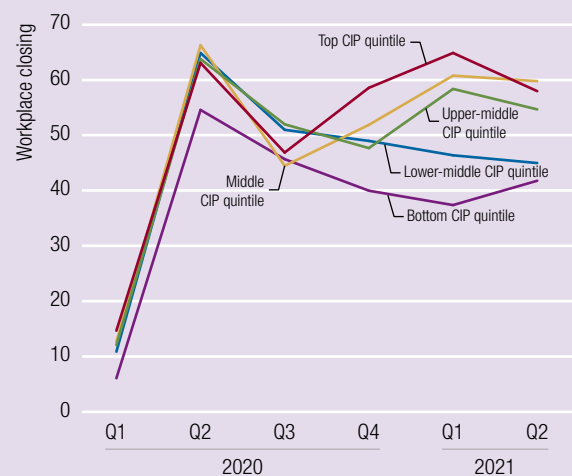
Measures were loosened up by the third quarter of 2020, but new waves of contagions forced countries to

Figure 5.10
World manufacturing exports: Annual growth rates compared to prior year, 2006–2020



Source: UNIDO elaboration based on data from UNCTAD (2021a).

Figure 5.12
Workplace closing by quintile of industrial competitiveness, 2020 Q1–2021 Q2



Source: UNIDO elaboration based on data from Oxford COVID-19 Government Response Tracker (Hale et al. 2021) and the UNIDO CIP 2021 database (UNIDO 2021a).

Note: Seasonally adjusted data. The CIP Index expresses the industrial competitiveness of countries. Workplace closing expresses how restrictive were government measures about closing of businesses. CIP quintile values and the levels of workplace closing are calculated by simple average of the economies with available data. CIP = Competitive Industrial Performance.

Economies in lowest CIP quintile suffered a stronger impact on industrial production

restore some of the restrictions in the following periods. As of the second quarter of 2021, the latest period with available data, workplace closing remained relevant as a policy measure and its implementation varied across country groups in a way that resembles their level of industrial competitiveness. However, countries in the upper quintiles, composed mostly of high- and middle-income countries, started to curb some of the restrictions given the success of containment measures and vaccination campaigns, while countries in the bottom quintile were instead forced to increase restrictions.

With such a diverse policy response in more recent periods, it would be interesting to further examine the evolution of industrial production according to this sector's competitiveness, particularly at the end of 2020, when some countries were re-introducing the workplace closing policy while others were leaving it behind.

Figure 5.12 shows that economies in the bottom quintile took a relatively softer approach to the implementation of this measure when compared to other country groups. With such a heterogeneous response across country groups, it would be interesting to further examine whether the dissimilar policy response led to significant disparities in industrial production. Moreover, it would be interesting to compare industrial performance not only among country groups, but also in its evolution over time, as many countries changed their policy from one quarter to the next according to their own economic and health priorities. Similar to Figure 5.1 in the previous section, Figure 5.13 depicts the recent evolution of industrial production indices, but this time with economies grouped according to CIP quintiles.

Figure 5.13 also shows how all country groups by CIP quintile fell simultaneously during the first half of 2020, although with different degrees of severity. Most country groups have now returned or surpassed the pre-crisis production level, with the exception of economies in the bottom quintile. The chart shows that top competitive economies, which were still implementing the most stringent workforce closing policy towards

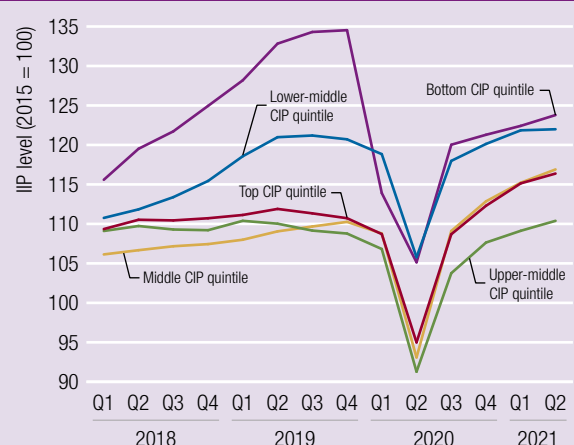
the end of 2020, were performing similarly to other groups. On the other hand, the less competitive economies, which were implementing a significantly softer version of this policy, suffered the strongest impact and were the only group where industrial production had not yet recovered its pre-pandemic level.

This finding suggests that industrial leaders were able to recover and maintain a growth similar to other economies that applied far less restrictive policy measures. In contrast, the less competitive countries were unable to recover to their pre-pandemic levels of industrial production even with more lax policies for the productive system. It is important to note that this finding aligns with the economic analysis presented in Chapter 1, which showed that the level of industrial capabilities had a negative marginal effect on the estimated gross domestic product (GDP) growth loss for 2020. In other words, higher industrial capabilities seem to help contain the negative effects of the pandemic on GDP growth.

This relationship between workplace-related policy measures and their potential links to industrial production is further explored in Figure 5.14. In the

Figure 5.13

Industrial production by quintile of industrial competitiveness, 2018 Q1–2021 Q2



Source: UNIDO elaboration based on the Quarterly Index of Industrial Production Database (UNIDO 2021 d) and the UNIDO CIP 2021 database (UNIDO 2021a).

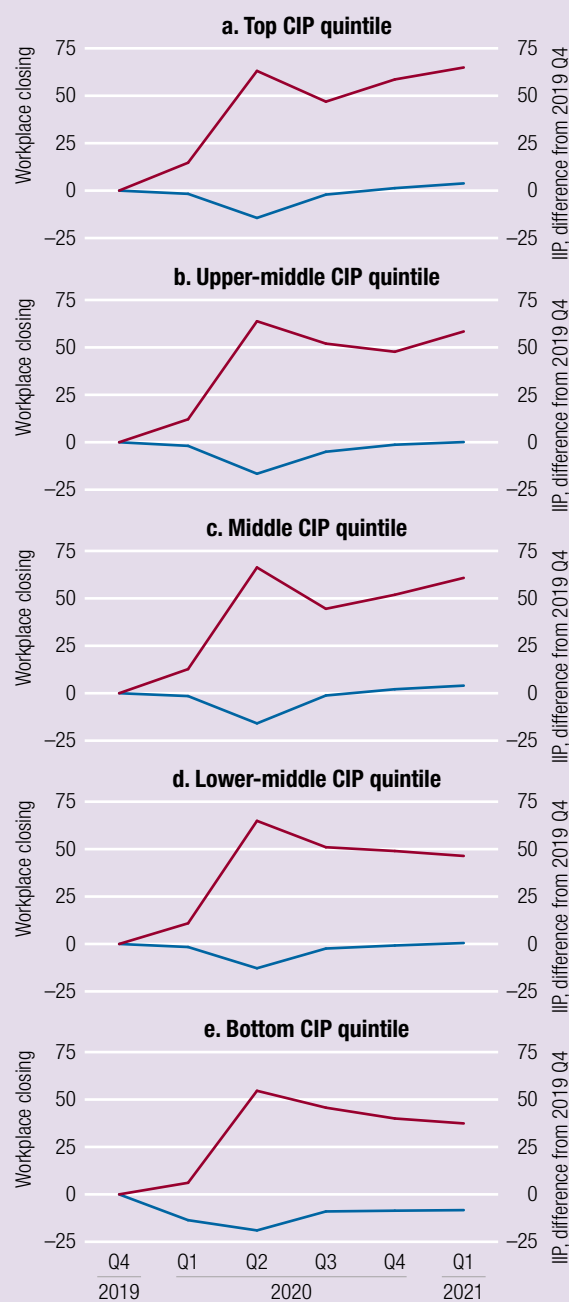
Note: Seasonally adjusted IIP. The CIP expresses the industrial competitiveness of countries.

CIP quintile values are calculated by simple average of the economies with available data.

CIP = Competitive Industrial Performance; IIP = Index of Industrial Production.

Higher industrial capabilities helped contain the negative effects of the pandemic on the economy

Figure 5.14
Industrial production and workplace closing by quintile of industrial competitiveness, 2019 Q4–2021 Q1



Source: UNIDO elaboration based on data from Oxford COVID-19 Government Response Tracker (Hale et al. 2021), the UNIDO CIP 2021 Database (UNIDO 2021a) and the Quarterly Index of Industrial Production Database (UNIDO 2021d).

Note: The red lines show the index of workplace closing (left axis), while the blue lines represent the absolute difference between the current level of IIP and the level in the last quarter of 2019 (2019 Q4 = 100). CIP quintile values and the levels of workplace closing are calculated by simple average of the economies with available data. Seasonally adjusted data. The CIP Index expresses the industrial competitiveness of countries. Workplace closing expresses how restrictive were government measures about closing of businesses. CIP = Competitive Industrial Performance; IIP = Index of Industrial Production.

figure, workplace closing policy is represented by the red lines, which are identical to those depicted in Figure 5.12. The blue lines show the difference between the industrial production at any given quarter and the industrial production in the last quarter of 2019, just before the beginning of the COVID-19 crisis. Both lines start at zero in the fourth quarter of 2019, since there were still no COVID-19-related restrictions at that time, and this is the base of comparison for production levels. Each panel of the figure shows a country group quintile according to the CIP Index.

Panels a, b, and c show the three groups with the highest score in industrial competitiveness, and one can see how industrial output collapsed in these economies at the beginning of the pandemic, when the most severe lockdown policies were put in place. However, production quickly returned to growth and approached or surpassed pre-crisis levels by early 2021. These countries managed this while restrictions were maintained or even strengthened again towards the end of 2020. This shows that governments were implementing more targeted and effective policies but could also highlight that more competitive industries provided the adaptability and resilience required to weather the crisis. Additional data are still required to further study this hypothesis.

Panel d of Figure 5.14 illustrates that countries in the lower-middle quintile managed to maintain their level of industrial production, but only by lifting workplace-related restrictions that were introduced in the second quarter of 2020. Only time will tell if this will have an impact on the further evolution of the pandemic and industrial activity in these countries.

Countries in the bottom quintile, shown in panel e, followed different trends. Despite the relatively lax workplace closing policy, their industrial production did not manage to return to previous levels and so far has lost more than 7 percent of pre-crisis output levels. In addition, note that the largest fall in the less competitive quintile took place during the first quarter of 2020, prior to the first wave of COVID-19 cases in their own countries (and elsewhere), and only China was yet struggling against the virus. This

“ Statistical activities were not spared from the impacts of the COVID-19 pandemic

5

WHAT STATISTICAL INDICATORS REVEAL ABOUT MANUFACTURING DURING THE PANDEMIC

suggests that the first and biggest economic shock was not the arrival of the virus itself, with the subsequent increase in confirmed cases, but the fall in foreign demand together with negative business environment, low confidence and few growth prospects. This considerable fall without a significant recovery highlights the fragility of this group of countries, which tend to rely on foreign demand to export predominantly primary products and low-technology goods (Boly 2012; UNIDO 2021a). The recent increase in workplace restrictions in the second quarter of 2021, enforced to contain the spread of new variants, could further affect manufacturing production in this group of economies.

While it is certainly possible that this heterogeneous impact of the COVID-19 crisis on the industrial sector is due to differing capacities to adapt manufacturing production to the specific challenges raised during the pandemic, it should be considered that many other factors could also be at play. Indeed, the relationship between the level of competitiveness and industrial production is the result of multiple factors (such as foreign demand, sector specialization, technological development and many others) and not only due to different policy responses introduced in each of these country groups, even at the time of a pandemic.

Yet despite these considerations, the available evidence suggests that top competitive economies—either because they needed more restrictive measures or simply because they could afford them—were more inclined to apply workplace closures than economies with less competitive industries. Additionally, available data confirm that countries with less competitive industries were those that had the biggest fall during the pandemic and those that have not yet recovered to their previous levels of industrial production.

Therefore, the available data seem to indicate that—at least for the most competitive countries—industrial competitiveness mattered because it gave countries more flexibility to implement stricter policies to contain the spread of the virus. Moreover, it seems the penalty on their industrial output for applying these measures has been relatively low in compared

to other country groups, as shown in Figure 5.13 and Figure 5.14. Finally, the data show that industries in less competitive economies remain fragile and require more time and support to recover when faced with a shock like the COVID-19 crisis.

Will COVID-19 lead to a significant shift in statistical activities related to manufacturing?

The COVID-19 pandemic disrupted many aspects of life and statistical activities were not spared. Movement restrictions, business closures and other measures affected the ability to collect information from households and firms. This had an impact in the production of consistent and timely statistics, in some cases leading to discontinuities in data and even a temporary delay or permanent cancellation of some statistical series. While the impact was felt all over the world, developing economies were particularly affected.

According to the findings of a survey of country-level statistical activities through the COVID-19 emergency shown in Figure 5.15, 9 in 10 national statistical offices (NSOs) in low- and lower-middle income countries stated that the pandemic affected their ability to meet international reporting requirements. This survey, jointly implemented by the UN Department of Economic and Social Affairs and the World Bank, was conducted over three rounds in May, July and October 2020 (UN DESA and World Bank, 2020a, 2020b and 2020c). It focused on measuring the impact of the pandemic on statistical activities, identifying the most affected areas from the operational and methodological point of view and the specific actions undertaken by NSOs to uphold their activities as well as provide new information about its prevalence and impacts.

The first round of the survey revealed that the production of monthly or quarterly statistics had been negatively impacted by COVID-19 in 88 percent of reporting low- and lower-middle-income countries. Seventy-six percent of NSOs in this group of countries had to adapt their publication and dissemination

“ Timely and reliable information is needed to respond to the socioeconomic impact of the pandemic

Figure 5.15
Proportion of national statistical offices reporting impacts from COVID-19 on their regular activities, first round of survey



calendar because of unavoidable postponement or cessation of underlying data collection activities. Subsequent survey rounds confirmed that the impact of the pandemic was persistent and that the most affected statistical activities were household and labour market surveys, followed by collection related to production and turnover, which comprise the main source of information for industrial statistics.

The COVID-19 pandemic affected the production of statistics in many ways. First, and possibly the most palpable channel, was that the measures to contain the virus meant that face-to-face interviews could not take place. Field work for many surveys had to be suspended, with 96 percent of all NSOs reporting that they at least partially stopped face-to-face data collection (first round of the survey). By the second round of the survey, this percentage had decreased to 72 percent, although it did increase to 74 percent by the survey's third round. Substantial uncertainty remained about when face-to-face data collection could be resumed, with less than half of NSOs able to provide a clear timeline. In many cases, field work had to switch to alternative modes such as telephone or online interviews, or rely on complementary data sources, such as

administrative data, possibly introducing bias or comparability issues into the series.

Also, as in many other sectors, staff from the national statistical system faced mobility restrictions and office closures and had to switch to remote work. At least initially, this created technical and operational difficulties, especially given the sensitive work of many statistical activities dealing with individual- or firm-level data.

This was particularly challenging given that the pandemic hit in 2020, a year when 150 countries were scheduled to conduct census preparation enumeration. Many countries had to extend deadlines, reprogram fieldwork or postpone the entire census. Even if this concerns mostly population censuses, many countries were also preparing a business census in 2020. According to the first round of the survey of the countries responding that were preparing this activity, 57 percent saw an impact on preparatory activities, and 64 percent had to postpone fieldwork, mostly because of minimized face-to-face interviews, mobility and transport restrictions and funding constraints. This will surely have an impact on the future availability of industrial and other business statistics.

“ Statistical activities were also affected by diminishing resources and growing demands to combat the health emergency

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WHAT STATISTICAL INDICATORS REVEAL ABOUT MANUFACTURING DURING THE PANDEMIC

However, the impact of COVID-19-related measures extended beyond survey field work. For instance, in some situations, it became problematic to collect information for sectors that were temporarily not operational. How to calculate a consumer price index when there are no transactions in significant products and services of the consumption basket, in sectors such as tourism or transportation? How to estimate a producer price index when many products were not traded in the period due to lockdowns?

Additionally, with many firms suspending activities temporarily or indefinitely, or changing their business models to adapt to the new conditions, existing business registers are at risk of quickly becoming obsolete. As the foundation of many firm-level data collection activities, this could have a long-lasting effect on future business statistics.

As a related issue, economic statistics from national accounts to price statistics rely on the structure observed in a base year, providing weights and baskets for the calculation of indicators. With all the changes brought about by the pandemic, either transitory or permanent, those structures may not reflect the current economic reality, possibly affecting the validity of statistics. Also, existing statistical methodologies for imputation, forecasting, seasonal adjustment and other purposes were not calibrated to accommodate the abnormally large fluctuations caused by the pandemic, possibly leading to unreliable results.

Finally, statistical activities were also affected by diminishing resources and growing demands to combat the health emergency and support the economy. Eight out of 10 NSOs from low- and lower-middle-income countries mentioned operational difficulties during the pandemic because of funding constraints. In contrast, only 26 percent of NSOs in high-income countries mentioned that their funding has been affected.

These disruptions arrive at a time when, more than ever, timely and reliable information is needed to understand, navigate and respond to the pandemic and its impacts on society and the economy. This pandemic was extensively monitored, by those needing

this information demanding a constant stream of real-time data, not only on the number of cases and deaths, but also on the impacts on businesses, industries, individuals and the government. For the area of industrial statistics, the obstacles and constraints mentioned above put at risk the quality and timeliness of available disaggregated information. This could lead to an incomplete picture of how the crisis unfolded across industries and how the different actors (investors, business owners, employees) were affected. This could put at risk the monitoring of industrialization and progress towards Sustainable Development Goal (SDG) 9.

NSOs have responded to the challenges by exploring new ways to continue regular data collection, either by developing new fieldwork protocols to mitigate the risks of COVID-19 in face-to-face collection, or by using alternative data collection modes (such as online or hybrid interviews). They have also increasingly complemented traditional data sources with administrative records or big data solutions, and they have established partnerships with the private sector, academia, international organizations and other actors to bridge data gaps. They also have explored methodological solutions to reduce the bias introduced by changes in survey mode or data sources.

The pandemic-induced shifts to teleworking, electronic commerce, distance education and digital activities translated into new areas that suddenly required closer monitoring. Many statistical offices responded by collecting specific information to monitor the pandemic and assess its impact, either by adding questions to existing instruments or by designing new, purpose-built surveys. As revealed by the aforementioned survey of NSOs undertaken by the UN Department of Economic and Social Affairs and the World Bank, most of the new COVID-19-specific data collection efforts focused on understanding the impact of the pandemic on households and firms. Other instruments focused on identifying at-risk populations, measuring access to health services, determining the impacts on physical and mental health and examining access to COVID-19 testing, treatment and vaccination campaigns.

“ A flexible, innovative and well-resourced statistical system should be at the centre of recovery efforts

The COVID-19 pandemic demonstrates how a global shock can halt economic activity across the world and introduce large uncertainties in short- and long-term economic decisions. It also shows how the impacts on different countries, industries, firms and individuals can be unequal. Although traditional data collection methods for industrial statistics were

disrupted, the information they provide is essential for policymakers and other stakeholders to navigate and respond to the crisis. A flexible, innovative and well-resourced statistical system should be at the centre of such efforts, making sure that reliable, precise and timely information is available to support the recovery and increase future resilience.

Notes

1. China is presented separately in this chapter because of its size and rapid transformation to an economy with the characteristics of an industrial economy.
2. Of the remaining four, two are classified as low technology (food products and fabricated metal products) and two as medium-low technology (basic metals and rubber and plastics products).
3. For more details on the methodology of the CIP Index, see UNIDO (2017). The most recent CIP Index database can be found available in the UNIDO Statistics data portal (<https://stat.unido.org/cip>).
4. The country classification by industrial competitiveness quintile is included in the Annex B.
5. The index of workplace closing was calculated using the Oxford methodology available at: https://github.com/OxCGRT/covid-policy-tracker/blob/master/documentation/index_methodology.md.

Annexes

Annex A.1

UNIDO COVID-19 firm-level survey

A survey on the impact of the COVID-19 pandemic on manufacturing firms across world regions

Although several surveys were conducted by national and international organizations, institutions and agencies after the immediate outbreak of the COVID-19 pandemic, harmonized and comparable information on the consequences of the pandemic for manufacturing firms in different developing and emerging industrial economies (DEIEs) remained scarce and scattered. In particular, data on the conditions and expectations of manufacturing actors during later stages of the COVID-19 pandemic—between 9 and 12 months after it had begun—were rarely available.

To fill this gap, UNIDO conducted a firm-level survey in several countries in Africa, Asia and Latin America between November 2020 and June 2021. Born as an initiative to collect primary data to support the production of the *Industrial Development Report 2022* (IDR 2022), the UNIDO COVID-19 firm-level survey looks beyond the immediate short-term impact of the COVID-19 outbreak and offers novel insights on the response strategies undertaken by manufacturing firms to cope with the crisis as well as on the policy support received.¹

The UNIDO COVID-19 firm-level survey aims to shed new light on the features and drivers of firm-level resilience in DEIEs by providing a better understanding of the expected and mid- and longer-term implications of the COVID-19 pandemic on the manufacturing sector as well as the responses to deal with it. Moreover, by exploring the channels and mechanisms through which the crisis affected manufacturing firms, the results of the survey can inform and guide industrial policymaking towards the design and implementation of measures for the post-pandemic recovery and resilience of the industrial sector.

The survey is the result of a close collaboration between UNIDO and a large number of local partners in each of the countries where the survey was conducted. These partners include national and local government agencies and institutions, industry associations, business chambers, universities and non-governmental organizations (see Table A1.1). In the case of Africa in particular, the survey was conducted in collaboration with the African Development Bank (AfDB) and constituted a key input for a UNIDO-AfDB joint research project on the impact of COVID-19 on the African manufacturing sector.

Table A1.1

Partners of the UNIDO COVID-19 firm-level survey

Country	Partners
Africa	
Congo, Democratic Republic of the	Congolese Enterprise Federation (FEC)
Côte d'Ivoire	National Institute of Statistics of Côte d'Ivoire
Kenya	Kenya Association of Manufacturers (KAM); Kenya National Chamber of Commerce & Industries (KNCCI); Kenya investment authority (Keninvest)
Mauritius	University of Mauritius
Rwanda	Rwanda Association of Manufacturers (RAM)
South Africa	Department of Trade, Industry and Competition (DTIC); Business Unity South Africa (BUSA)
Tunisia	Agency for the promotion of Industry and Innovation (APII); Ministry of Industry and of SMEs; Chambre Nationale des Femmes Chefs d'Entreprise - Union Tunisienne de l'Industrie, du Commerce et de l'Artisanat (CNFCE-UTICA)
Zambia	Ministry of Commerce, Trade and Industry; Northwestern Chamber of Commerce and Industry; Kabwe Chamber of Commerce and Industry (KCCI); Livingstone Chamber of Commerce and Industry
Asia	
Afghanistan	Ministry of Industry and Commerce (MoIC); Afghanistan Chamber of industries and Mines (ACIM); Afghanistan Women Chamber of Commerce and Industry (AWCCI)
Bangladesh	Business Initiative Leading Development (BUILD)
China	China Centre for Promotion of SME Development
India	India SME Forum
Indonesia	Ministry of Industry of Indonesia; Indonesian Chamber of Commerce and Industry (KADIN)
Lao, People's Democratic Republic	Ministry of Industry and Commerce; Department of Industry and Handicraft; Department of SME promotion; Lao National Chamber of Commerce and Industry (LNCCI)
Malaysia	Ministry of International Trade and Industry (MITI); Federation of Malaysian Manufacturers
Mongolia	Ulaanbaatar SME Industry and Service Center; SME Association of Mongolia; the Delegation of the European Union in Mongolia; European Bank for Reconstruction and Development, Mongolia
Pakistan	Ministry of Industries and Production (MoIP) of Pakistan
Thailand	Ministry of Industry; Small and Medium Industrial Institute under the Federation of Thai Industries
Viet Nam	Vietnam Industry Agency (VIA), Ministry of Industry and Trade; Agro Processing and Market Development Authority (AgroTrade), Ministry of Agriculture and Rural Development
Latin America	
Argentina	Industrial Organization of Argentina (UIA)
Bolivia, Plurinational State of	Chamber of Industry, Commerce, Services and Tourism of Santa Cruz (CAINCO); Bolivia's National Chamber of Industry (CNI); National Chamber of Commerce (CNC-Bolivia); Autonomous University Gabriel René Moreno
Brazil	National Federation of Industries (CNI); Ministry of the Environment (MMA); Ministry of Science, Technology and Innovation (MCTI)
Ecuador	National Federation of Chambers of Industries of Ecuador; Chamber of Industries and Production of Quito (CIP); Chamber of Industries, Production and Employment of Cuenca (CIPEM); Chamber of Industries and Production of Tungurahua (CIPT); Chamber of SMEs of Pichincha (CAPEPI)
Mexico	UN Global Compact Mexico; National Chamber of Pharmaceutical Industry (CANIFARMA); National Chamber of the Footwear Industry (CANAICAL); Chamber of Footwear Industry of the State of Guanajuato (CICEG)
Peru	National Society of Industry (SNI); Peru SME Association; Sustainable Peru (Network Peru 2021)
Uruguay	Chamber of Industries of Uruguay (CIU)

Source: UNIDO elaboration.

Note: Names of institutions and organizations are the English translation provided by their official websites. SMEs = small and medium-sized enterprises.

Data collection and sample composition

The UNIDO COVID-19 firm-level survey was collected in 26 DEIEs between November 2020 and June 2021, gathering information from more than

3,700 firms.² All analyses presented in Chapters 1, 2 and 3 of this report have been produced based on the whole sample displayed in Table A1.2, unless stated otherwise.

Table A1.2

UNIDO COVID-19 firm-level survey sample composition, by country and sector

Country	Collection period	Total	Manufacturing		Non-manufacturing
			Robust industries	Vulnerable industries	
Africa					
Congo, Democratic Republic of the	November 2020–January 2021	27	9	7	11
Côte d'Ivoire	November 2020–January 2021	99	32	56	11
Kenya	November 2020–March 2021	111	55	36	20
Mauritius	December 2020–February 2021	139	74	60	5
Rwanda	November 2020–March 2021	54	31	22	1
South Africa	December 2020–March 2021	80	61	13	6
Tunisia	November 2020–March 2021	144	102	33	9
Zambia	November 2020–February 2021	105	50	45	10
Asia					
Afghanistan	March–May 2021	114	47	44	23
Bangladesh	March–June 2021	124	69	39	16
China	March–May 2021	606	227	326	53
India	March–June 2021	440	184	154	102
Indonesia	March–June 2021	75	33	28	14
Lao, People's Democratic Republic	February–April 2021	115	70	37	8
Malaysia	April–May 2021	48	20	14	14
Mongolia	February–April 2021	158	69	54	35
Pakistan	March–May 2021	169	118	32	19
Thailand	April–June 2021	65	32	26	7
Viet Nam	March–May 2021	111	62	33	16
Latin America					
Argentina	March–May 2021	250	131	83	36
Bolivia, Plurinational State of	March–June 2021	138	57	52	29
Brazil	June–July 2021	379	160	151	68
Ecuador	February–April 2021	43	27	11	5
Mexico	May–June 2021	50	33	13	4
Peru	February–April 2021	61	27	22	12
Uruguay	April–May 2021	52	22	29	1
Total		3,757	1,802	1,420	535

Source: UNIDO COVID-19 firm-level survey (2021).

Note: The reported observations correspond to unique individual firms that were in operation at the time of the survey and provided valid information on the sector. Robust and vulnerable industries are classified based on Chapter 1, Table 1.2. Non-manufacturing sectors include agriculture, mining, utilities, construction and services. No specific threshold in terms of number of employees was required of respondents.

The universe of reference of the survey corresponded to the population of firms operating in the manufacturing sector, defined as all activities belonging to the International Standard Industrial Classification (ISIC) Rev.4. codes 10 to 33. Although they were not the main target of the survey, several respondents from non-manufacturing sectors were also included to allow for comparisons between manufacturing industries and the rest of the economy.

The survey questionnaire was applied online, through the interface of a survey manager platform. In some countries, many responses were also collected through telephone interviews. In all cases, responses were recorded in real time on the survey manager platform. The support of local partners such as chambers of industry and business associations provided access to firm registries and databases containing individual firm characteristics and contacts, through which firms could be contacted to participate in the survey.

Topics addressed

The survey questionnaire entailed 35 to 50 questions,³ organized according to five main modules:⁴

- Observed impact on firms' activities since the start of the pandemic, including main problems faced and changes in capacity utilization, monthly sales, yearly profits and employment;
- Expected impact on firms' activities in the months and years to come, in terms of investment decisions, environmental sustainability and cross-border operations;
- Response actions taken by firms to cope with the crisis, in terms of changes introduced into their regular operations,⁵ and responses given to deal with cash-flow and input shortages;

- Government support measures received and needed by firms to facilitate their recovery; and
- General characteristics of the firms, including ownership type, firm size, sector, international operations, innovation activity and digitalization level.

The survey instrument also included a separate module for firms that reported they had closed operations at the time of the survey. Besides collecting general information on the firm (such as size and sector before closing operations), this module asks about the reasons for closing and whether it is expected to be temporary or permanent. An additional 245 firms responded to this module, but given the online nature of the survey, this number is likely a significant underestimation and should not be taken as indicative of the share of firms that closed operations due to the pandemic.

A digitalization profile for manufacturing firms

Among the many characteristics of the firms collected in the last module of the UNIDO COVID-19 firm-level survey, one particularly important result of the analysis undertaken in this report is the level of digitalization. As information on the technological digital level of manufacturing firms in DEIEs is rather rare, the collected data represent a unique source of information about the industrial application of digital technologies. The UNIDO survey asked firms to select one of five options to identify the set of production technologies used. The options range from the simplest analog processes to the most cutting-edge digital technologies, passing through technologies employed in rigid, lean and integrated modes of production (see Table A1.3).

Table A1.3

UNIDO COVID-19 firm-level survey: Definitions of technological generations

Technological generation	Definition
G 0.0 – Zero generation: analog production	No digital technologies are used during any stage of the production process (e.g. in-person contact with suppliers or via phone; use of machinery that is not micro-electronic based)
G 1.0 – First generation: rigid production	The use of digital technologies is limited to a specific purpose in a specific function and activity (e.g. use of CAD only in product development; use of non-integrated machines operating in isolation)
G 2.0 – Second generation: lean production	Digital technologies involve and connect different functions and activities within the firm (e.g. use of CAD/CAM linking up product development and production processes; basic automation)
G 3.0 – Third generation: integrated production	Digital technologies are integrated across different activities and functions, allowing for the interconnection of the whole production process (e.g. use of ERP systems; fully “paperless” electronic production control systems; industrial and service robots)
G 4.0 – Fourth generation: smart production	Digital technologies allow for fully integrated, connected and smart production processes, where information flows across operations and generates real-time feedback to support decision-making processes (e.g. digital twins; real-time sensors and machine-to-machine communication; collaborative robots (cobots); management decision making supported by big data and artificial intelligence support)

Source: UNIDO (2019b).

Note: CAD = computer-aided design; CAM = computer-aided manufacturing; ERP = enterprise resource planning.

Generation 0.0 refers to a pre-digital production system: it includes all types of analog technologies possibly used in different stages and function of manufacturing production. The other technological generations—generations 1.0 to 4.0—correspond to digital production technologies employed in manufacturing. Generations 1.0 and 2.0 have been around for as long as numerical control programming systems have existed (late 1950s), although the evolution of devices such as computer-aided design has been exponential in recent years thanks to parametric engines. Generation 3.0 represents a further level of digital complexity by enabling the integration of production processes, and generation 4.0 entails the “smartness” of real-time interaction and data exchange, allowing for the

exploitation of the full potential of digital technologies in terms of connectivity and flexibility by relying on the most advanced application of robotization, sensorization, big data, artificial intelligence and communication devices, among others (UNIDO 2019b). In this report, advanced digital production (ADP) technologies are associated with the use of generations 3.0 and/or 4.0 in this classification.

In practice, the UNIDO COVID-19 firm-level survey asked firms to select the technological generations they employ in two areas of firm operations: production processes and customer relations. Table A1.4 presents the two questions and the sets of technologies associated with each of the five technological levels.

Table A1.4

UNIDO COVID-19 firm-level survey: Defining the digitalization profile for manufacturing firms

Technological generation	Question one: Which of the following set of technologies is currently used by the firm to support the production processes?	Question two: Which of the following technologies use the firm to support the relationship with customers?
Analog	Analog systems: use of machinery that is not micro-electronic based	Analog systems: use of phone, fax, or personal contacts
Rigid	Simple and rigid automation systems: use of non-integrated CNC (computer numerical control) machines and/or other non-connected, stand-alone, non-integrated machines operating in isolation	Manual electronic handling of accounts and contacts: by electronic means but in an unstructured electronic format (with e-mail and e-mail attachments). Clients' registration and transaction information are dispersed
Lean	Full or partial automation systems: manufacturing processes controlled by PLC (programmable logic controller); use of robots	Sales force automation: use of CRM (customer relationship management) solutions, existence of a client electronic database with account and contact records
Integrated	Computerized manufacturing execution systems: use of MES (manufacturing execution system), AGV (automated guided vehicle), product identification solutions (i.e. RFID or QR code), fully electronic production control systems, mobile production control solutions (i.e. monitor production with mobile devices)	Web-based integrated support systems: use of CRM (customer relationship management) solutions with multichannel integration; mobile solutions and salesforce support with mobile apps; web-based Internet sale system; social media integration; customer data analytics
Smart	Smart production systems: use of machine-to-machine communication or other systems based on data exchange between machines and components; use of digital twin technology to model individual products; use of real-time sensors for data acquisition and adjustment; use of co-bots, augmented reality, additive manufacturing, real-time production management, artificial intelligence and/or big data analytics to support the management of production	Client lifecycle management and control: use of connected devices for gathering and monitoring product usage data throughout lifecycle (i.e. sensors embedded in products); offer of services based on customer usage patterns (i.e. maintenance); artificial intelligence in customer service (i.e. automatic response); analysis and offer of services with support of artificial intelligence and/or big data analytics

Source: UNIDO COVID-19 firm-level survey (2021).

Note: QR = quick response; RFID = radio-frequency identification.

This approach makes it possible to match each individual firm with a unique digital generation, which serves as a proxy for firms' digital level. This allows the definition of an indicative digital profile for each firm as well as the obtainment of a better idea of the digital gap existing between firms and within countries and/or regions. In the analyses presented in Chapters 2 and 3 of this report, the categorical variable

to proxy for firms' technological level was generated as the simple average of the two technological generations selected by the firm in response to the questions displayed in Table A1.4. Therefore, ADP technologies adopter firms (also defined as digitally advanced firms) are the ones associated with an average technological generation of 3.0 or 4.0.⁶

The World Bank COVID-19 Follow-up Enterprise Survey: Complementing the analysis

Over many years, the World Bank has conducted enterprise surveys in several economies in all regions of the world, gathering extended firm-level information and offering a wide array of indicators to capture enterprises' economic outcomes and operational conditions. At the outbreak of the COVID-19 pandemic, the World Bank started implementing a new data collection to assess the impact of COVID-19 on firms: the World Bank COVID-19 Follow-up Enterprise Survey. These surveys were designed as a short follow-up module of the standard enterprise surveys collected in several economies between 2016 and 2019.⁷ The advantage of this approach is that it allows one to look at the effects of a shock such as the COVID-19 pandemic by measuring the impact of the crisis in terms of firm survival rate and changes in firm-level outcomes, using as a baseline the existing data from the previously collected survey. The ability to look after the shock at

the same sample of firms used in the baseline survey allows obtainment of reliable information regarding firm survival.

For this reason, when meaningful and desirable for the purpose of the debate, the analysis presented in Chapter 2 of this report incorporated some information collected by the World Bank COVID-19 Follow-up Enterprise Survey in several DEIEs. Table A1.5 displays the sample from the World Bank follow-up survey from which Figures 2.2 and 2.7 in Chapter 2 were generated. Acknowledging the caution needed when comparing data and indicators between surveys with different coverage and methodologies,⁸ the presented analysis considered 28 DEIEs. The difference in the sets of countries used in Figures 2.2 and 2.7 is due to (1) the period of data collection (in Figure 2.2, 18 DEIEs were considered where the follow-up survey was collected before end of July 2020) and (2) country coverage of other indicators (in Figure 2.7, 23 DEIEs were considered) with available information on their level of UNIDO CIP Index 2019.

Table A1.5

World Bank COVID-19 Follow-up Enterprise Survey sample composition, by country and sector

Country	Collection period	Total	Manufacturing		Non-manufacturing	Included in Figure 2.2	Included in Figure 2.7
			Robust industries	Vulnerable industries			
Albania	June 2020	646	77	336	233	☑	☑
Bosnia and Herzegovina	February–March 2021	635	120	287	228	☒	☑
Bulgaria	July–September 2020	1,500	513	646	341	☑	☑
Chad	June 2020	272	39	144	89	☑	☒
Croatia	September 2020	649	150	249	250	☒	☑
Cyprus	June 2020	333	71	107	155	☑	☑
El Salvador	June–August 2020	1,495	332	842	321	☑	☑
Georgia	June 2020	839	188	275	376	☑	☑
Greece	June–July 2020	988	266	442	280	☑	☑
Guatemala	June–August 2020	595	140	249	206	☑	☑
Guinea	June 2020	187	22	41	124	☑	☒
Honduras	June–August 2020	516	97	181	238	☑	☑
Jordan	July–August 2020	893	224	361	308	☑	☑
Kazakhstan	January–March 2021	2,648	736	1,407	505	☒	☑
Lebanon	November–December 2020	938	291	384	263	☒	☑
Moldova	May 2020	589	130	243	216	☑	☑
Mongolia	Aug 2020	452	69	151	232	☒	☑
Morocco	July–August 2020	1,612	292	696	624	☑	☑
Mozambique	July–December 2020	1,099	228	559	312	☒	☑
Nicaragua	June–August 2020	508	99	184	225	☑	☒
Niger	June 2020	201	27	64	110	☑	☑
North Macedonia	October–November 2020	549	99	228	222	☒	☑
Romania	August–September 2020	1,652	486	874	292	☒	☑
Serbia	February 2021	587	161	198	228	☒	☑
Togo	June 2020	230	45	85	100	☑	☒
Zambia	June–July 2020	833	145	272	416	☑	☑
Zimbabwe	June–July 2020	981	229	433	319	☑	☑
Total		22,427	5,276	9,938	7,213		

Source: UNIDO elaboration based on the World Bank COVID-19 Follow-up Enterprise Survey (first round, 2020/21).

Note: Robust and vulnerable industries classified based on Chapter 1, Table 1.2. Non-manufacturing sectors include: construction; wholesale, retail trade and repair services; hotels and restaurants; transport, storage and communications; and the subsector of computer and related activities. Agriculture, extracting and financial intermediation activities and government-owned firms are excluded. Only firms with five or more employees are considered.

Annex A.2

UNIDO COVID-19 policy-level survey

A survey on industrial policymaking during the COVID-19 pandemic

Many governments in industrialized economies (IEs) adopted a wide array of policies to mitigate the impact of the COVID-19 pandemic crisis on firms, including exchange rate adjustments and balance of payments measures, as well as monetary and fiscal policies mobilizing a large amount of resources. Still, the policy response of governments in developing and emerging industrial (DEIEs) has been less investigated, leaving unanswered questions about whether these governments have emulated policies and actions introduced in IEs, or whether they have developed their own policy responses and policy mixes, according to their stage of economic development and environment (Hartwich and Isaksson 2020).

To answer these questions, UNIDO conducted a survey targeting policymakers in ministries of

industry in several countries across all world regions.⁹ The UNIDO COVID-19 policy-level survey complements the organization's longstanding industrial policy packages, allowing governments to pursue industrial development goals while simultaneously crafting ad hoc policy measures to mitigate the COVID-19 impacts on their industries.

Data collection and sample composition

The UNIDO COVID-19 policy-level survey was collected in 44 DEIEs, gathering information from 51 policymakers.¹⁰ The target respondents were officials of the ministry of industry (or of an institution with equivalent functions). Table A2.1 displays the sample considered in the analysis presented in Chapter 2 of this report. For the purpose of the presented analysis, 44 DEIEs were considered.

Table A2.1

UNIDO COVID-19 policy-level survey sample composition, by country

Region	Countries considered	Collection period
Africa	Burkina Faso; Cameroon; Côte d'Ivoire; Egypt; Ethiopia; Ghana; Guinea; Kenya; Lesotho; Madagascar; Mali; Mauritius; Sierra Leone; Somalia; South Africa; Sudan; Tunisia; Zambia; Zimbabwe	March 2021
Asia	Afghanistan; Azerbaijan; Cambodia; China; Indonesia; Iran, Islamic Republic of; Kyrgyzstan; Lao, People's Democratic Republic; Lebanon; Malaysia; Mongolia; Pakistan; Philippines; Syrian Arab Republic; Thailand; Turkey; Viet Nam	April–May 2021
Latin America	Argentina; Brazil; Colombia; Ecuador; Mexico; Peru; Uruguay; Venezuela	April–May 2021

Source: UNIDO COVID-19 policy-level survey (2020/21).

Note: One policymaker per country responded to the survey, with the exception of Burkina Faso, Brazil, Cambodia, Kenya, Mexico, Peru, and Uruguay, where two policymakers' responses were collected.

The UNIDO COVID-19 policy-level survey is the result of a close collaboration with UNIDO's Regional Programmes and Field Offices, where the former were instrumental in organizing the field work, while the latter were asked to reach out to the ministries and follow up with respondents in case clarifications were needed. The survey questionnaire was applied online, through the interface of a survey manager platform. Responses were collected and registered in real time through the survey manager platform.

Topics addressed

The survey questionnaire entailed 16 questions, ranging from how the government's policymaking process had been impacted (if at all) to descriptions of policies put in place in response to the pandemic and its perceived impact. The survey also inquired about how the government views the industrial sector's own response and actions, and whether these have been sufficient. The final section of the survey asks policymakers about the role of international organizations such as UNIDO in supporting industrial recovery.

Notes

1. More information about the UNIDO COVID-19 firm-level survey is available at the dedicated website (https://www.unido.org/covid19_surveys).
2. The firm is the unit of analysis of the survey. This has been preferred to using the "establishment" as the unit of analysis, in view of the modality in which the survey was administered (online).
3. The actual length of the questionnaire can differ from firm to firm because it contains logical jumps (questions that are asked only for certain answers to the previous questions).
4. In some countries, the original survey questionnaire was extended to meet countries' requests to collect additional information on issues of special interest to them.
5. The survey explores the following possible transformational changes in response to the COVID-19 pandemic: change in business activity online; change in delivery or carry-out of goods or services; change in remote work arrangement; introduction of new equipment; repurposing; release of new products; introduction of organizational changes. In the analyses presented in Chapter 2, some of these changes have been considered together due to the convergence of the operations and business functions involved.
6. To correct for possible bias in responses, firms that selected generation 4.0 but did not report investing in new software during the last two years were downgraded to generation 3.0. See Calza et al. (2021) for more details about the procedures used to analyse ADP technology adoption.
7. More information about the World Bank COVID-19 Follow-up Enterprise Survey is available at the dedicated website (<https://www.enterprisesurveys.org/en/covid-19>).
8. The universe of the World Bank Enterprise Survey is defined as the non-agricultural, non-extractive, formal, private sector with five or more employees. More information on the Enterprise Surveys methodology is available at: <http://www.enterprisesurveys.org/Methodology/>.
9. More information about the UNIDO COVID-19 policy-level survey can be found in Hartwich and Isaksson (2020).
10. The original survey sample entails responses from 70 policymakers in 60 countries across all economy groups. To maintain consistency with the focus of the *Industrial Development Report 2022* (IDR 2022), only developing and emerging industrial economies (DEIEs) were considered.

Annex B

Countries and economies by level of industrial competitiveness

Table B.1
CIP Index ranking for 2019 and quintiles of industrial competitiveness

Top quintile		Upper-middle quintile		Middle quintile		Lower-middle quintile		Bottom quintile	
Economy	CIP rank	Economy	CIP rank	Economy	CIP rank	Economy	CIP rank	Economy	CIP rank
Germany	1	Australia	32	Morocco	62	Nigeria	92	Cameroon	122
China	2	Romania	33	Serbia	63	Botswana	93	Kyrgyzstan	123
United States	3	Portugal	34	Egypt	64	Uzbekistan	94	Congo	124
Japan	4	Russian Federation	35	Kazakhstan	65	Cyprus	95	Libya	125
Korea, Republic of	5	Viet Nam	36	Costa Rica	66	Lebanon	96	Zambia	126
Ireland	6	Norway	37	Bangladesh	67	Côte d'Ivoire	97	Montenegro	127
Switzerland	7	India	38	Tunisia	68	Namibia	98	Suriname	128
Taiwan Province of China	8	Saudi Arabia	39	Ukraine	69	Armenia	99	Tajikistan	129
Singapore	9	Indonesia	40	Malta	70	Algeria	100	Papua New Guinea	130
Netherlands	10	Lithuania	41	Colombia	71	Bolivia, Plurinational State of	101	Uganda	131
Italy	11	Brazil	42	Panama	72	Mongolia	102	Belize	132
Belgium	12	Philippines	43	Iceland	73	Senegal	103	Madagascar	133
France	13	New Zealand	44	Sri Lanka	74	Georgia	104	Mozambique	134
United Kingdom	14	Luxembourg	45	Jordan	75	Jamaica	105	Saint Lucia	135
Austria	15	Belarus	46	North Macedonia	76	Honduras	106	Nepal	136
Czechia	16	Estonia	47	Venezuela, Bolivarian Republic of	77	Angola	107	Niger	137
Sweden	17	Qatar	48	Uruguay	78	Moldova, Republic of	108	Bermuda	138
Canada	18	Chile	49	Guatemala	79	Lao, People's Democratic Republic	109	Cabo Verde	139
Denmark	19	Bahrain	50	Brunei Darussalam	80	Gabon	110	Rwanda	140
Mexico	20	Greece	51	El Salvador	81	State of Palestine	111	Haiti	141
Spain	21	South Africa	52	Bosnia and Herzegovina	82	Kenya	112	Macao SAR, China	142
Malaysia	22	Bulgaria	53	Myanmar	83	Bahamas	113	Malawi	143
Poland	23	Croatia	54	Eswatini	84	Zimbabwe	114	Maldives	144
Finland	24	Argentina	55	Pakistan	85	Barbados	115	Ethiopia	145
Thailand	25	Iran, Islamic Republic of	56	Cambodia	86	Tanzania, United Republic of	116	Burundi	146
Hungary	26	Latvia	57	Ecuador	87	Ghana	117	Eritrea	147
Slovakia	27	Kuwait	58	Paraguay	88	Azerbaijan	118	Afghanistan	148
Turkey	28	Trinidad and Tobago	59	Hong Kong SAR, China	89	Fiji	119	Gambia	149
Israel	29	Oman	60	Mauritius	90	Syrian Arab Republic	120	Iraq	150
United Arab Emirates	30	Peru	61	Cuba	91	Albania	121	Tonga	151
Slovenia	31							Yemen	152

Source: UNIDO elaboration based on UNIDO (2021a).
Note: CIP = Competitive Industrial Performance.

Annex C

Country and economy groups

Table C.1

Countries and economies by industrialization level and geographical region

INDUSTRIALIZED ECONOMIES (IEs)				
ASIA				
Eastern Asia				
Hong Kong SAR, China	Japan	Macao SAR, China ^a	Korea, Republic of	Taiwan Province of China
South-East Asia				
Malaysia	Singapore			
West Asia				
Bahrain	Israel	Kuwait	Qatar	United Arab Emirates
EUROPE				
Eastern Europe				
Belarus	Czechia ^a	Hungary ^a	Poland ^a	Russian Federation
Slovakia ^a				
Northern Europe				
Denmark ^a	Estonia ^a	Finland ^a	Iceland	Ireland ^a
Latvia ^a	Lithuania ^a	Norway	Sweden ^a	United Kingdom
Southern Europe				
Andorra ^e	Italy ^a	Malta ^a	Portugal ^a	San Marino ^e
Slovenia ^a	Spain ^a			
Western Europe				
Austria ^a	Belgium ^a	France ^a	Germany ^a	Liechtenstein ^e
Luxembourg ^a	Monaco ^e	Netherlands ^a	Switzerland	
LATIN AMERICA AND THE CARIBBEAN				
Aruba ^e	British Virgin Islands ^e	Cayman Islands ^e	Chile ^d	Curaçao ^e
French Guiana ^e	Puerto Rico ^e	Trinidad and Tobago ^d	Turks and Caicos Islands ^e	United States Virgin Islands ^e
NORTH AMERICA				
Bermuda ^e	Canada	Greenland ^e	United States	
PACIFIC				
Australia	French Polynesia ^a	Guam ^e	New Caledonia ^e	New Zealand
DEVELOPING AND EMERGING INDUSTRIAL ECONOMIES (DEIEs)				
AFRICA				
Northern Africa				
Algeria	Egypt	Libya ^e	Morocco	Sudan ^{c,e}
Tunisia				
Sub-Saharan Africa				
Angola ^c	Benin ^{c,e}	Botswana	Burkina Faso ^{c,e}	Burundi ^c
Cabo Verde ^b	Cameroon	Central African Republic ^{c,e}	Chad ^{c,e}	Comoros ^{b,c,e}
Congo, Republic of the	Congo, Democratic Republic of the ^{c,e}	Côte d'Ivoire	Djibouti ^{c,e}	Equatorial Guinea ^e
Eritrea ^c	Eswatini, Kingdom of	Ethiopia ^c	Gabon	Gambia ^c
Ghana	Guinea ^{c,e}	Guinea-Bissau ^{b,c,e}	Kenya	Lesotho ^{c,e}
Liberia ^{c,e}	Madagascar ^c	Malawi ^c	Mali ^{c,e}	Mauritania ^{c,e}
Mauritius ^b	Mozambique ^c	Namibia	Niger ^c	Nigeria
Réunion ^e	Rwanda ^c	São Tomé and Príncipe ^{b,c,e}	Senegal ^c	Seychelles ^{b,e}
Sierra Leone ^{c,e}	Somalia ^{c,e}	South Africa	South Sudan ^{c,e}	Tanzania, United Republic of ^e
Togo ^{c,e}	Uganda ^c	Zambia ^c	Zimbabwe	

Table C.1 (continued)

Countries and economies by industrialization level and geographical region

DEVELOPING AND EMERGING INDUSTRIAL ECONOMIES (DEIEs) (continued)				
ASIA				
Central Asia				
Kazakhstan	Kyrgyzstan	Tajikistan	Turkmenistan ^e	Uzbekistan
East Asia				
China	Korea, Democratic People's Republic of ^e	Mongolia		
South-East Asia				
Brunei Darussalam	Cambodia ^c	Indonesia	Lao People's Democratic Republic ^c	Myanmar ^{c,e}
Philippines	Thailand	Timor-Leste ^{b,c,e}	Viet Nam	
South Asia				
Afghanistan ^{c,e}	Bangladesh ^c	Bhutan ^{c,e}	India	Iran, Islamic Republic of
Maldives ^{b,e}	Nepal ^c	Pakistan	Sri Lanka	
West Asia				
Armenia ^e	Azerbaijan	Cyprus ^a	Georgia	Iraq
Jordan	Lebanon ^e	Oman	Saudi Arabia	Palestine, State of ^e
Syrian Arab Republic ^e	Turkey	Yemen ^{c,e}		
EUROPE				
Eastern Europe				
Bulgaria ^a	Republic of Moldova	Romania ^a	Ukraine	
Southern Europe				
Albania	Bosnia and Herzegovina	Croatia ^a	Greece ^a	Montenegro ^e
North Macedonia ^e	Serbia			
LATIN AMERICA AND THE CARIBBEAN				
Anguilla ^e	Antigua and Barbuda ^{b,e}	Argentina	Bahamas ^b	Barbados ^b
Belize ^b	Bolivia, Plurinational State of	Brazil	Colombia	Costa Rica
Cuba ^{b,e}	Dominica ^{b,e}	Dominican Republic ^{b,e}	Ecuador	El Salvador
Grenada ^{b,e}	Guadeloupe ^e	Guatemala	Guyana ^{b,e}	Haiti ^{b,c}
Honduras	Jamaica ^b	Martinique ^e	Mexico	Montserrat ^e
Nicaragua ^e	Panama	Paraguay	Peru	Saint Kitts and Nevis ^{b,e}
Saint Lucia ^{b,e}	Saint Vincent and the Grenadines ^{b,e}	Suriname ^b	Uruguay	Venezuela, Bolivarian Republic of ^e
PACIFIC				
Cook Islands ^e	Fiji ^b	Kiribati ^{b,c,e}	Marshall Islands ^{b,e}	Micronesia, Federated States of ^{b,e}
Palau ^{b,e}	Papua New Guinea ^b	Samoa ^{b,e}	Solomon Islands ^{b,c,e}	Tonga ^b
Tuvalu ^{b,c,e}	Vanuatu ^{b,e}			

Source: UNIDO elaboration.

Note: a. EU; b. SIDS; c. LDCs; d. Included together with Latin American DEIEs in the analysis of Chapter 1; e. Excluded from the analysis of Chapter 1 due to lack of information on relevant indicators. IEs include economies with adjusted manufacturing value added (MVA) per capita higher than \$2,500 (PPP international dollars) or a gross domestic product per capita higher than \$20,000 (international PPP); DEIEs include the rest. DEIEs = developing and emerging industrial economies; EU = European Union; IEs = industrialized economies; LDCs = least developed countries; PPP = purchasing power parity; SIDS = Small Island Developing States.

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“This report provides a comprehensive analysis and valuable new evidence on the impact of the COVID-19 pandemic and the importance of industrial capabilities and digitalization in mitigating the negative impact of the pandemic and in strengthening resilience for post-pandemic recovery. It highlights the role of digital transformation, international coordination and global cooperation of industrial policy for building back better for all. The report is an important, timely and visionary guide for governments and policymakers at various levels to develop an effective solution for a more inclusive, resilient and sustainable development in the post-pandemic world.”

Xiaolan Fu, University of Oxford

“UNIDO brilliantly underpins policy responses and the contributions of the industrial sector in overcoming the challenges of the COVID-19 crisis. An endemic SARS CoV-2 can lead to recurrent aggressive variants, particularly if less developed countries do not receive massive immunization assistance. Long-term economic growth is also threatened by the jump in poverty and underemployment, foreshadowing a deepening of the social, industrial and digital divide between developed and developing societies. More than ever, international cooperation for both a broad, post-pandemic recovery of investments in sustainable energy and infrastructure as well as increased digitalized industrial development is essential to socially equitable and sustainable global growth.”

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