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COMPETITIVE INDUSTRIAL PERFORMANCE REPORT 2018

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1.1 Introduction

1.1.1 Competitiveness and industrial development

The 2018 CIP Report assesses and benchmarks industrial competitiveness across economies, providing valuable information on the strengths and of weaknesses in national manufacturing sectors. This information is crucial to policymakers, as competitive industries drive the process of structural change, which development depends on. By promoting competitiveness, it is possible to maximize economic efficiency in the allocation of scarce resources while generating greater prosperity for the population.

Yet recent political and social developments seem to contradict the foundations on which industrial competitiveness is built. For example, global trade liberalization has historically contributed to an increase in the mobility of goods and services among countries, with international competition being a main source of greater economic efficiency. In recent years, however, trade frictions have emerged in North America, Europe and Asia, with major economic powers trying to boost their domestic industries and getting an edge on their direct competitors with protectionist policies. The established global trade order is being questioned, which has put the debate on competiveness and industrial development on the agenda again.

Despite its widespread use, the term competitiveness still causes some confusion. The term competitiveness is used in very different contexts, ranging from political campaigns, industrial policy plans, academic discussions to economic debates. This has resulted in a blurring of the term competitiveness over time.

The term competitiveness seems to be straightforward, yet it is difficult to explicitly define. One important reason lies in the fact that competitiveness has different meanings at the firm and at the country level. At the firm level, competitiveness refers to the ability of firms to compete, i.e. their capacity to sell their products in domestic or global markets. The implication is that one firm's gain comes at its competitor's loss. However, competition between countries in international markets is not a zero-sum game: all countries can compete and at the same time—as alleged by David Ricardo around 200 years ago (Ricardo, 1817)—benefit from international trade.

The concept of competitiveness at the country level seems to be associated with the following three elements: international trade, economic performance and overall prosperity. One of the most widely recognized definitions of competitiveness is that developed by the World Economic Forum (WEF). It defines competitiveness "as the set of institutions, policies, and factors that determine the level of productivity of an economy, which in turn sets the level of prosperity that the economy can achieve" (WEF, 2017, page 11).

This definition emphasizes the clear link between economic performance (measured in this case as productivity) and overall prosperity, but does not mention international trade. Etymologically, competitiveness derives from "compete", and there is no competition between countries without international trade. In this context, Paul Krugman claims that the use of the term competitiveness without including international trade makes very little sense because prosperity—that is, the rise in living standards—would be almost entirely determined by the rate of productivity growth. According to Krugman: "for an economy with very little international trade, 'competitiveness' would turn out to be a funny way of saying 'productivity' and would have nothing to do with international competition" (Krugman, 1994, page 32).

When shifting the scope of analysis to industrial competitiveness—which is the focus of this report—we redirect our attention to a country's capacity to increase its presence in international and domestic markets whilst developing industrial sectors and activities with a higher value added and technological content, the purpose being the improvement of the population's overall prosperity (UNIDO, 2013).[1]

When we shift our scope of analysis to industrial competitiveness, we must also change our focus from economic performance and international trade flows to industrial performance and manufacturing trade. Manufactured goods represent around 75 per cent of total merchandise trade (UNCTAD, 2018), with the other 25 per cent composed of primary products or commodities. The main distinction between these two groups of goods is that the determinants for competition tend to differ. For example, while commodities tend to face strong price competition, its role tends to be much weaker for manufactured goods, where technology plays a more dominant role.

Malik and Temple assert that manufactured goods are less likely to be affected by price fluctuations than commodities, and as a result of their higher value added, often yield more benefits for those that produce them (Malik and Temple, 2009). Based on this notion, an increase in industrial competitiveness implies that the country is exporting manufactured goods—as opposed to commodities—and consequently has a wider margin of benefits, which in turn has a higher impact on the country's overall economic performance and prosperity.

An increase in industrial competitiveness can contribute to a country's overall prosperity in many different ways. For example, it can encourage more investment from national and international firms. It increases a sector's resilience to external shocks, including surges in commodity prices or economy-wide recessions WEF, 2017). Competitiveness is decisive if a country's industrial sector is to flourish, and it determines the pace and quality of the country's structural change as its economy develops as well as the extent to which these changes will contribute to society's wellbeing. The industrial sector's contribution to prosperity depends on its capacity to produce manufactured goods, to exchange those goods in global markets and to specialize in complex production processes.

Yet the benefits of greater competitiveness in manufacturing are not limited to the development of the country's industrial sector or its economic growth. Greater industrial competitiveness translates into economic, social and environmental benefits, in addition to technological progress. For example, changes in the structure of a country's economy towards a stronger man-

[1]The term prosperity here is defined as in the Sustainable Development Goals publication; it is the extent to which "all human beings can enjoy prosperous and fulfilling lives and that economic, social and technological progress occurs in harmony with nature" (United Nations, 2015, page 5). Thus, it entails all three dimensions of sustainable development: the economic, social and environmental. In other words, overall prosperity is much more than the rise in living standards, measured by the rate of productivity growth or income per capita.

ufacturing sector have historically been accompanied by social progress. This includes greater gender equality, higher levels of education, reduced poverty and better health (UNIDO, 2014). The environmental impact of industrialization significantly affects a society's living standards and should therefore be considered in all strategies and polices aimed at increasing a country's overall prosperity.

While the aforementioned benefits are not components of economic growth or productivity measures per se, they contribute to an improved and more sustainable future. There is a strong link between industrial competitiveness and the Sustainable Development Goals (SDGs). Greater industrial competitiveness raises an economy's likelihood of succeeding in achieving the SDG targets, particularly SDG 9 to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation".[2]

Box: 1.1 Competitiveness, Inclusive and Sustainable Industrialization and the SDGs

UNIDO's mandate is to promote and accelerate Inclusive and Sustainable Industrial Development (ISID). The underlying objective is to improve the living standards of the entire population in every country through industrial progress, while protecting the environment. ISID implies that no one is left behind and that all parts of society are to benefit from industrial progress, thus providing countries the means to tackle critical social and humanitarian needs.

Industrial sector development drives both competitiveness and ISID, its impact reaching far beyond manufacturing to stimulate economic, social and environmental progress. The relevance of ISID and industrial competitiveness are explicitly recognized in SDG 9, which aims to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation".

While the link between ISID and SDG 9 is expressly outlined in its title, industrial competitiveness and SDG 9 merge at a deeper level. Countries must keep track of the progress they make in each SDG, which requires the setting of targets and identification of indicators for each SDG. Six targets and their corresponding indicators have been proposed for SDG 9 to measure the progress made in different components of SDG 9. Three of these indicators are included in the CIP Index and focus on a country's 1) production capabilities, 2) technological deepening and 3) environmental damage from industrial production. The link between SDG 9 and the CIP Index is discussed in more detail in Section 1.3: "Sustainable Development Goals".

[2] Section 1.3 demonstrates that many SDG9 targets overlap with the indicators used to create the CIP Index.

1.1.2 International embeddedness

International trade is a key element of industrial competitiveness. As the capacity of countries to increase their presence in international markets rises, the potential impact on their industrial development and prosperity also grows.

Economic history has shown how countries — at different paces — have opened up their economies to exchange their goods based on the notion that selling goods they can produce (efficiently) and buying those they cannot produce (efficiently) generates economic benefits for their economy. This notion is not new – it is based on the principle of comparative advantages developed by David Ricardo in 1817 to explain why countries benefit from international trade.

Although countries have been exchanging goods for centuries, trade flows have intensified in recent decades. Figure 1.1 presents the global trend since 1990. It shows the surge of manufacturing exports, particularly after 2001, and compares it with the development of manufacturing value added. The gap between these two trends demonstrates how profound the integration process has been during this period; it has been characterized by disruptive technological shocks that have changed the manufacturing business model from huge industrial plants able to work independently and built for mass production to the fragmentation of the production process into several units that work together and are integrated in a global production chain.

Global manufacturing value added (MVA) was 2.5 greater in 2015 than in 1990, yet the value of manufacturing exports increased by a factor of 4.5 over the same period.[3] The growth rate of manufacturing exports was particularly high between 2000 until the onset of the financial crisis in 2008. Manufacturing exports were affected considerably more than overall MVA throughout the financial crisis. The period from 1990 to 2015 was generally characterized by a rapid increase in the globalization of markets: frictions such as industrial tariffs and other barriers to trade declined, while technological progress facilitated international goods trade (McMillan and Rodrik, 2011).

Opening up to new markets and consumers allowed firms to realize economies of scale. Economies of scale increased the benefits of producing greater quantities due to falling average costs or increasing bargaining power. However, opening up the economy also meant increased competition from abroad, forcing manufacturing firms to innovate and specialize in niches in which they had a comparative advantage (OECD, 2008). Firms that could not adequately respond to these challenges faced serious difficulties staying in business.

While it is widely agreed that international trade has contributed positively to industrial development, some industries have had negative experiences, i.e. although international competition has boosted some local industries, it harmed others. It is, however, unquestionable that the integration of global markets has had a profound impact on countries' economic system.

The data presented in Figure 1.2 suggest that countries with the highest MVA growth rates tend to also register the highest increase in their manufacturing exports. Countries with a weak manufacturing export performance are also likely to show poor industrial performance.

[3] MVA growth is usually calculated in real prices. Current USD prices were used here to make a comparison of manufactured exports possible, as exports are valued in current USD prices. Please note that even if both series are at current prices, their comparability is still ambiguous as manufactured exports prices (Free On Board (FOB), according to UN Trade Statistics) should include the transaction value of goods and the value of services rendered to deliver the goods to the border of the exporting country, while manufacturing value added should include the value of materials and supplies for production and the cost of services received. Therefore, the value of exports does not reflect the value added in a particular country. Simply spreading individual production across value chains in multiple countries—while keeping total production constant—would therefore also lead to an increase in the value of exports. Additionally, heterogeneity in country sizes may produce confusing data. Countries with large domestic markets are likely to have a lower export share as they are less focused on foreign demand (UNIDO, 2018b).

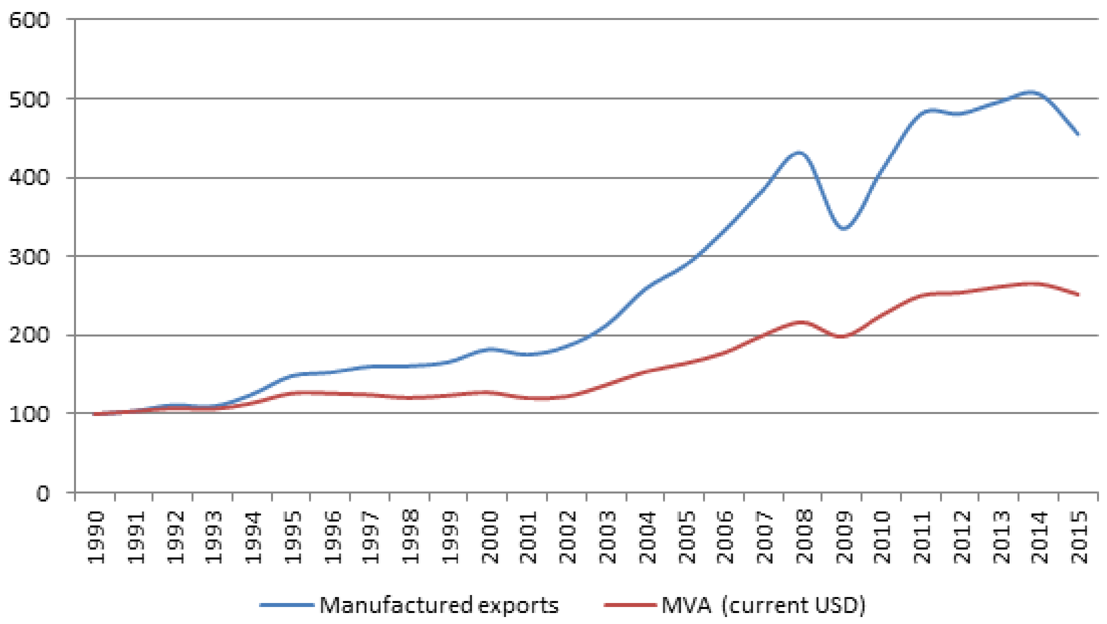

Figure 1.1: World manufacturing exports and MVA, 1990-2015 (Index, 1990=100)

Source: UNIDO, 2018a

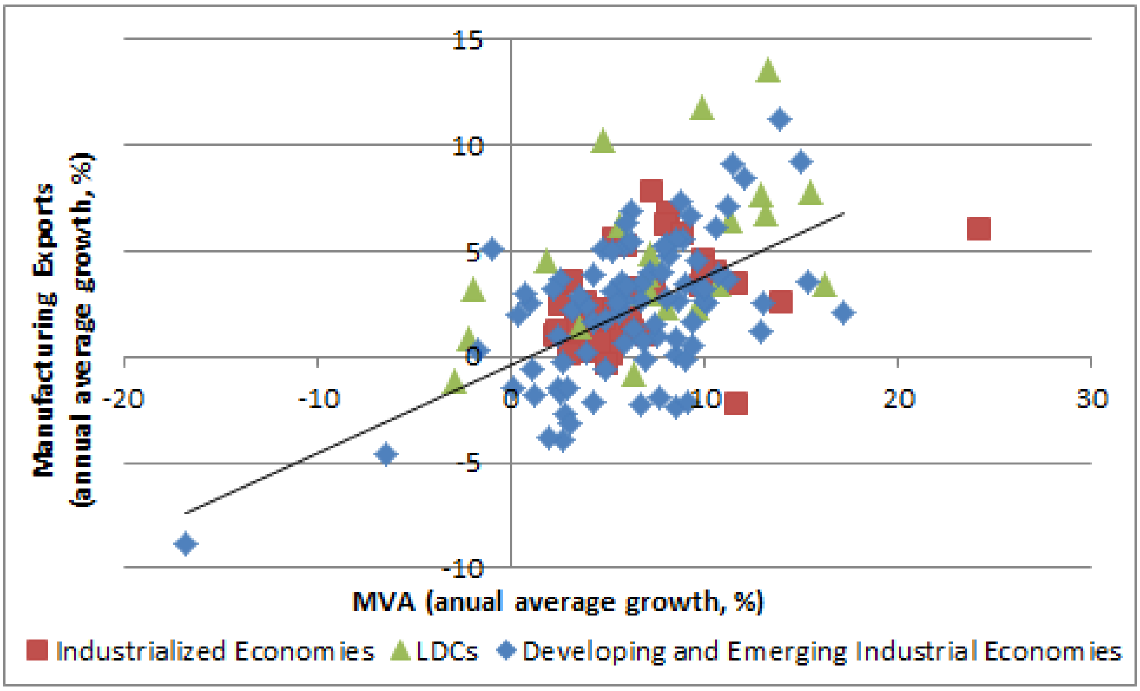

Figure 1.2: Annual growth rates of MVA and manufacturing exports, 1990-2016 (%)

Note: 148 countries used in the sample, with two countries removed as they presented outlying values. Source: UNIDO, 2018a

The increase of international trade flows reaches beyond the growth of the manufacturing sector. Opening up to international trade often translates into stronger integration of manufacturing firms in global value chains, which in turn leads to an inflow of foreign direct investment and know-how. Knowledge transfers and spillover effects are the result of greater interaction with foreign firms. These effects are not exclusive to the manufacturing sector and can occur as technologies are diffused, workers move between firms or production processes are imitated.

Consequently, some economists claim that today's economic and industrial development depends much more on a country's ability to export goods abroad while importing capital, technology and know-how than it does on local industrial and economic policies designed in autarky.[4] There is a clear trend showing that those economies that have registered long episodes of economic growth over the world average tend to also report total export and manufactured export growth that are higher than the world average. This trend is presented in Figure 1.3.

Figure 1.3 presents the average annual growth rates of both total exports and manufacturing exports for the world's fastest growing economies from 1990 to 2016. High economic growth rates are, on the whole, accompanied by annual increases in manufacturing exports that lie well above the global average. For example, in China, Myanmar, Mozambique, Viet Nam and Uganda, the average annual growth rate in manufacturing exports was above 13 per cent – more than twice the world average. While total exports in these countries also grew much more rapidly than the world average, the difference is not as significant as it is for manufacturing exports. The only exceptions are Qatar, where manufacturing exports grew roughly proportionally with GDP, and Laos, where GDP grew more than manufacturing exports.

Economic growth is linked to export-orientation in the manufacturing sector, particularly in fast-growing countries. This link was crucial to the industrialization of East Asian countries and regions such as Hong Kong SAR, Taiwan ROC, Singapore and the Republic of Korea. In these countries and regions, domestic firms initially received state support to operate in global markets until they became competitive (McMillan and Rodrik, 2011). As projected by development economists a long time ago, large-scale diversification of the economy from agricultural production and commodities to manufacturing entailed considerable productivity increases as the workforce shifted to the manufacturing sector (Lewis, 1954; Kaldor, 1966).

1.1.3 Technological absorption

The link between manufacturing export performance and economic growth reaches beyond the statistical correlation. A positive correlation usually reflects countries that have succeeded in increasing their exports considerably by taking advantage of the economies of scale in key manufacturing industries, particularly technology-intensive industries with high value added. Thus, successful industrialization processes are not only characterized by the expansion of manufactured exports but also by profound structural change towards technology-intensive industries. At the same time, production diversifies away from agriculture and commodities to manufacturing activities and services (Haraguchi and Rezonja, 2011).

This has been the case for China and other successful East Asian countries. Figure 1.4 presents the share of medium- and high-tech (MHT) manufacturing exports in total manufacturing exports for selected countries. In the Asian countries and regions previously men-

[4] Industrial and competitiveness policies continue to be crucial for industrial development, as they redefine the country's comparative advantage and its attractiveness in terms of foreign direct investment (FDI). Education and infrastructure are key to attracting FDI, for transferring technology and knowledge and having an export-friendly environment.

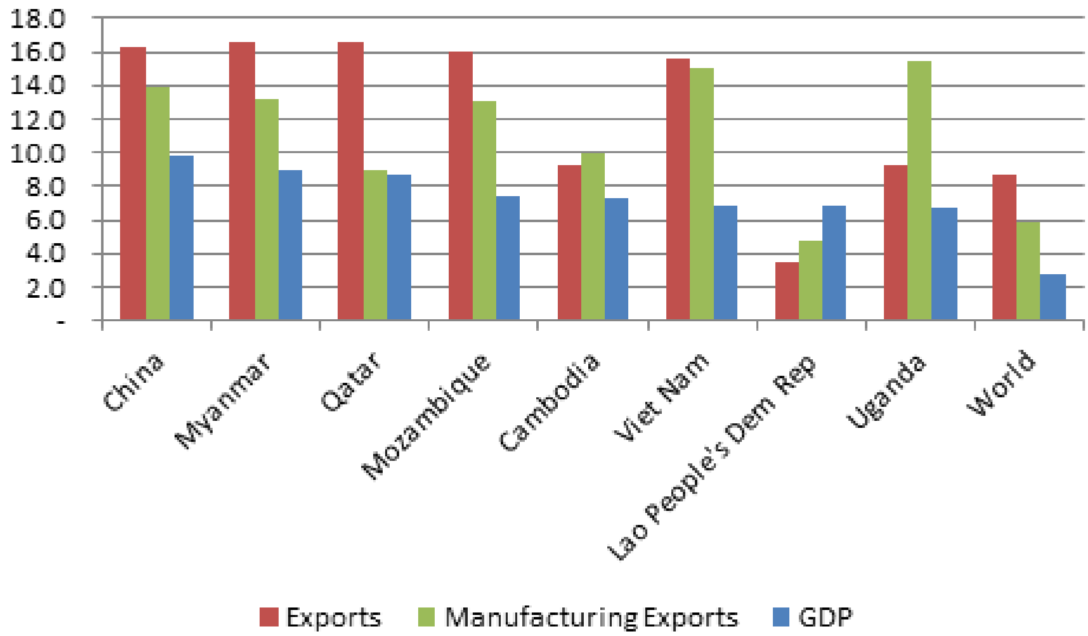

Figure 1.3: Average annual growth rates of GDP, total exports and manufacturing exports, 8 fastest growing economies in terms of GDP, 1990-2016 (%)

Source: UNIDO, 2018a

tioned, the share of MHT manufacturing exports was considerably higher in 2016 than in 1990, ranging from 37 per cent in Hong Kong SAR to nearly 78 per cent in Singapore. A number of factors determine a country's ability to absorb advanced technologies and innovations, and thus increases its competitiveness and export performance. Factors of production must be available, for example, through sufficient capital on efficient capital markets or mobile labour that can transition to innovative firms. Government policies also play an important role in improving an economy's capacity to transition to MHT industries. The quality of the education and training system determines whether workers are able to contribute to technologically advanced production processes. Likewise, infrastructure must be in place to enable the introduction of MHT technology.

Openness to trade and the resulting diffusion of new technologies thus contribute to development differently, depending on each country's characteristics. Moreover, there might be (short-term) trade-offs to this form of technology acquisition, particularly when foreign technology replaces local knowledge in the form of embodied knowledge in capital goods. For example, when workers are replaced with machines and other forms of capital, this may reduce the domestic comparative advantage in labour-intensive industries, thereby reducing the potential for trade with other countries (Rodrik, 2018). Additionally, development experts have argued that when countries are not prepared to absorb and retain a skilled workforce, to create new knowledge and achieve technological catch up with more advanced countries, openness to trade may result in a locked-in situation in which the developing country ends up being no more than a source of low-wage labour and production for more advanced economies Dosi, Pavitt, and Soete, 1990).

1.2 Measuring competitiveness

1.2.1 Composition of the CIP Index

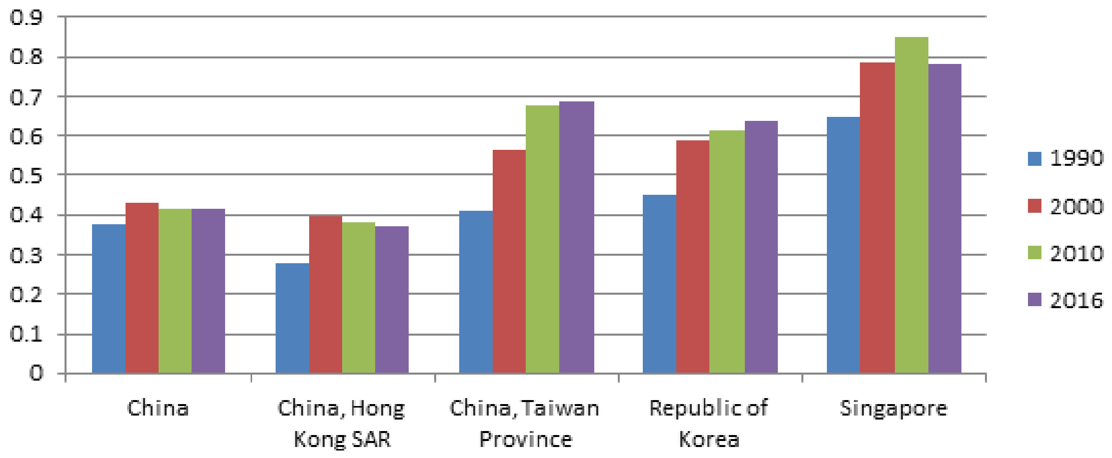

Figure 1.4: Medium- and high-tech manufacturing exports, selected countries, 1990-2016

Source: UNIDO, 2018a

The 2018 CIP Index assesses and benchmarks the industrial competitiveness of 150 countries. It provides an indication whether a country's manufacturing sector contributes to its development. The CIP Index measures how successful a country's industries are at producing and selling their goods on domestic and foreign markets, and consequently how much they contribute to structural change and development.

The CIP Index covers three main dimensions, each consisting of two indicators. These dimensions are: i) the capacity to produce and export manufactured goods, ii) technological deepening and upgrading, and iii) world impact. The higher the scores in any of the three dimensions, the higher the country's industrial competitiveness and its CIP Index. Figure 1.5 illustrates the configuration of the CIP Index.[5]

1.2.2 Capacity to produce and export

The CIP Index's first dimension provides a comparable measure of countries' manufacturing production, either for local or for foreign consumption. Manufacturing value added per capita, MVA_{pc}, allows for country comparisons independent of their size. This indicator is closely linked to a country's stage of development and is expected to change throughout the process of structural change.

In a globalized economy, a country's capacity for production must be accompanied by an ability to export manufactured goods. Manufacturing industries unable to specialize and integrate in global value chains are unlikely to be competitive and will face limitations in terms of demand for their products which is in direct relation to the size of their economies. Manufacturing exports per capita, MX_{pc}, is an additional indicator reflecting the ability to realize comparative advantage in specific industries. Per capita manufacturing exports allows country comparisons irrespective of country size. However, this is just a simple indicator that does not fully capture all important elements in a country's export performance.

1.2.3 Technological deepening and upgrading

[5] Definitions and conceptual descriptions in this chapter are elaborations based on the Industrial Development Report 2012/13 and subsequent CIP reports (UNIDO, 2013).

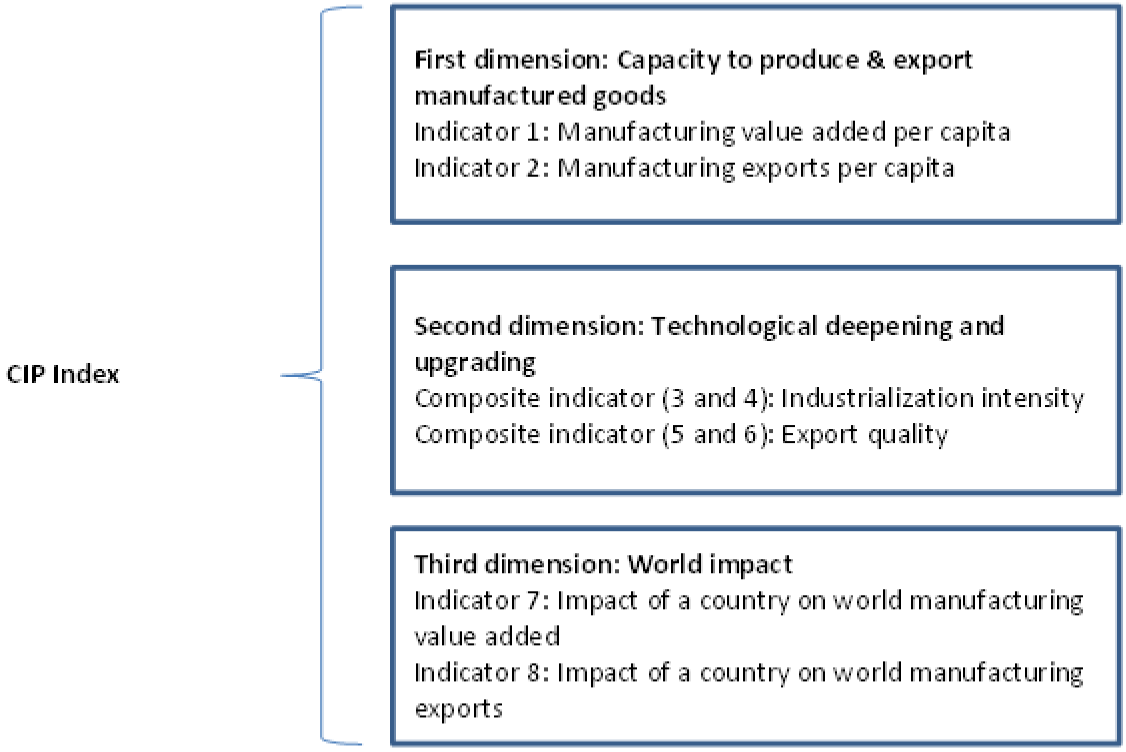

Figure 1.5: Composition of the CIP Index

Source: UNIDO, 2013

The types of goods a country's manufacturing sector produces are also relevant to measure competitiveness. Technological spillovers and low vulnerability to price shocks implies that the more technology-intensive the goods being produced are, the higher the expected benefits from producing (and further exporting) them.

The CIP Index accounts for technological deepening and upgrading with two composite indices. First, the degree of industrialization intensity, $INDint$, serves to estimate the complexity of production processes. This consists of the share of medium- and high-tech (MHT) MVA in total MVA ($MHVA_{sh}$) and the share of MVA in total MVA, the GDP (MVA_{sh}). And second, the export quality, $MQual$, which measure the quality of the integration process in the country's manufacturing sector.

A greater share of MHT production in total manufacturing production denotes an economy with a high level of productivity, innovative activity and technological progress. In turn, the greater the complexity of the manufacturing processes in certain industries, the higher the likelihood of knowledge spillovers across industries and sectors. In this respect, successful structural change entails a transition from low-technology, labour-intensive activities to MHT activities, as was the case of the four East Asian countries and regions mentioned in the previous section.

It is important to distinguish between the composition of a country's total manufacturing production and of its manufacturing exports. MHT goods face competition from foreign markets, in particular, and the characteristics of exports are thus a further indication of industries' competitiveness. The export quality, $MQual$, is therefore estimated on the basis of the share of MHT manufacturing exports in total manufacturing exports, (MHX_{sh}), and the share of manufacturing exports in total exports (MX_{sh}).

1.2.4 World impact

Finally, the CIP Index considers a country's position in the global market in terms of its manufactured goods. This indicator consists of the country' shares in world MVA ($ImWMVA$) and in the world trade of manufactured goods ($ImWMT$). The higher the values of these shares, the higher the country's ability to benefit from agglomeration, scope and scale effects. These benefits may include sharing investments in infrastructure and greater negotiating power in trade agreements.

All indicators of the CIP Index are used to compute the final CIP values. Appendix A provides definitions, data sources and further information for each of the components, as well as a detailed description of the methodology used to deal with missing values and to calculate the CIP Index.

1.3 Sustainable Development Goal 9

1.3.1 Measuring SDG progress

The 2030 Agenda for Sustainable Development emphasizes the importance of inclusive and sustainable industrial development. The Sustainable Development Goal 9 (SDG 9) aims to "Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation".

All SDGs have specific targets and indicators that allow countries to measure the progress in achieving global development. Targets specify the specific goals and indicators represent the metrics by which the world aims to track whether these targets are being achieved.

In particular, SDG 9 has 8 targets and 12 indicators that cover the economic, social and environmental dimensions of ISID. From these 12 indicators, 6 indicators are directly linked to UNIDO's mandate, among which three are directly included in the CIP. These 6 indicators will be mention in the sections below.

1.3.2 SDG 9.2.1 Manufacturing value added as a proportion of GDP and per capita

The level of industrialization is central to SDG 9. It is often measured as the share of MVA in GDP and MVA per capita because it reflects a country's manufacturing production capabilities. SDG Target 9.2 aims to "significantly increase" the level of industrialization in developing countries. In LDCs, the target is even more ambitious, namely doubling the share of manufacturing in GDP; Box 1.2 discusses the prospects of achieving this target.

Manufacturing value added as a share of GDP and MVA per capita are included in the first and second dimensions of the CIP Index as the capacity to produce manufactured goods is also a key aspect of competitiveness.

1.3.3 SDG 9.2.2 Manufacturing employment as a proportion of total employment

Although not covered in the CIP Index, the share of manufacturing employment as a share of total employment provides an indication of structural change within the economy as countries move from labour- to capital-intensive modes of production. It also reflects the share of the population that directly benefits from the country's industrial sector. Figure 1.6 shows that the share of the workforce employed in manufacturing in industrialized economies fell by more than one-third from 1990 to 2016, from 21 per cent to 13 per cent. Similarly, there was a slight reduction in the share of manufacturing employment in emerging industrial economies and other developing countries. Although an increase in manufacturing employment share was registered in LDCs between 1990 and 2016, it remained very low: the share of the labour force engaged in the manufacturing sector increased from 6.0 per cent to 7.2 per cent in the world's poorest countries.

Openness to trade and participation in global

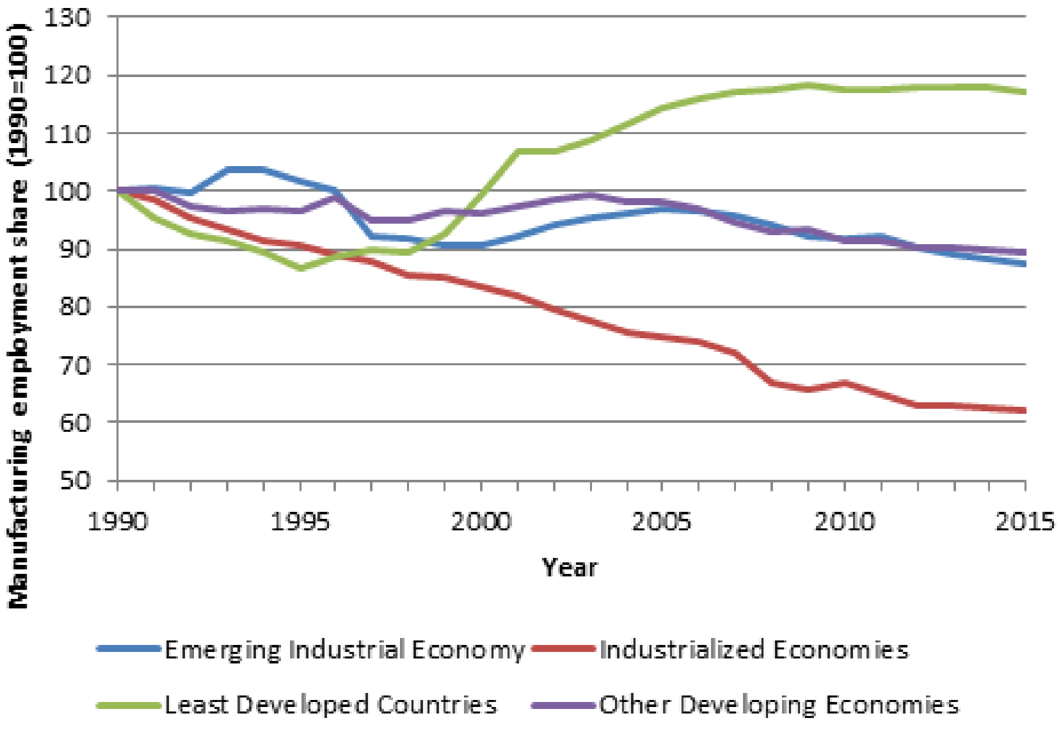

Figure 1.6: Manufacturing employment as a share of total employment by country group, 1990-2015

Source: ILO, 2018

value chains leads to specialization of production in specific goods that countries have a comparative advantage in. As discussed above, this stimulates competitiveness and increases net welfare. However, the effects are not homogeneous across the labour force. Foreign competition forces workers in uncompetitive industries to reallocate to high-productivity sectors. Their ability to do so depends on whether they are able to acquire the specific skills necessary to be competitive in a different sector.

As a result, there might be "losers" from trade within an economy. They are likely to be firms and workers who are unable to compete in global markets and have difficulties transitioning to industries with high levels of productivity. Economic policies are central in fostering the transmission of new skills and technologies in order for workers to be able to enter into more productive sectors or industries. This facilitates the successful reallocation of the labour force to other jobs. However, this may be a long-term transition and require several years.

1.3.4 SDG 9.3.1 Proportion of small-scale industries in total industry value added

Small-scale industries can act as important drivers of competitiveness, in particular in developing and emerging economies. Micro, small and medium enterprises are important sources of value added and jobs. They are therefore key to poverty alleviation and the provision of incomes. Moreover, small-scale industries can easily participate in local markets, do not require huge investments or advanced technology and build on local know-how to respond flexibly to changing market conditions. However, small firms are often characterized by lower levels of productivity and wages due to internal inefficiencies and an unsupportive business environment. Effective policies are therefore necessary to support small-scale industries in accessing finance, interacting with suppliers and customers and benefiting from an effective regulatory environment. This will allow them to be drivers of innovation in specific niches that directly benefit the population.

1.3.5 SDG 9.3.2 Proportion of small-scale industries with a loan or line of credit

Despite the comparatively low capital necessary to set up small-scale industries, they often lack access to financing to realize their productive potential. This may be attributable to lack of financial infrastructure in the given country. Moreover, banks are less likely to provide credit for individuals who lack collateral, financial literacy and even bank accounts – these factors add up and make small-scale industries more likely to default on their debt. As a result, these firms often only have access to informal credit systems, which can be considerably more expensive than those offered in the formal banking sector. Policies can support the provision of credit with schemes by backing communities in the credit market, ensuring that women can also access credit and providing the necessary infrastructure and skills to promote credit market activity. This encourages entrepreneurship and innovative activity to exploit market opportunities. Consequently, access to loans and credit can increase the competitiveness of small-scale firms, thereby enabling their integration in local and global value chains.

1.3.6 SDG 9.4.1 CO_2 emissions per unit of value added

The manufacturing sector is responsible for around one-third of global CO_2 emissions. Industrialization must therefore be adapted to be compatible with the realization of environmental targets. This includes limiting greenhouse gas emissions by upgrading infrastructure and adopting more efficient technologies. SDG 9 highlights the need to reduce the emission intensity of production and the emissions per unit of MVA.

The CO_2-adjusted CIP Index, presented in Chapter 3, takes into consideration the environmental damage from industrial production. This index provides an alternative perspective of the CIP Index, whereby the adoption of the most efficient technologies, the production of less emissions-intensive goods and investments in pollution abatement positively affect a country's level of competiveness.

1.3.7 SDG 9.B.1 Proportion of MHT industry value added in total value added

SDG 9.B.1 assesses the technological deepening of a country's industrial sector based on the share of medium and high-tech (MHT) industry value added in GDP. This reflects a country's capability to innovate and absorb new technologies, and hence its level of competitiveness in niches in global value chains. The ability of the economy to generate a large share of value added in medium- and high-tech industries is pivotal to long-term competitiveness and welfare.

SDG 9.B.1 is captured in the second dimension of the CIP Index. As discussed above, a greater share of MHT industry in total production generates higher levels of productivity in the use of machinery, as well as in production processes and structures. Moreover, the potential for knowledge spillovers across industries and sectors increases.

The diffusion of technological advances depends on both firm-level characteristics and the external economic environment. Firms must invest in specific technologies that alter the productivity of machinery, the way knowledge is managed and the organization of the firm. At the same time, interaction with other firms, research institutions, workers and further external bodies in domestic and foreign markets allows new technologies to spread throughout the economy. Whether the firm's environment is conducive to growth depends on a number of factors, such as openness to trade, institutions and policies. Applying more advanced technologies leads to radi-

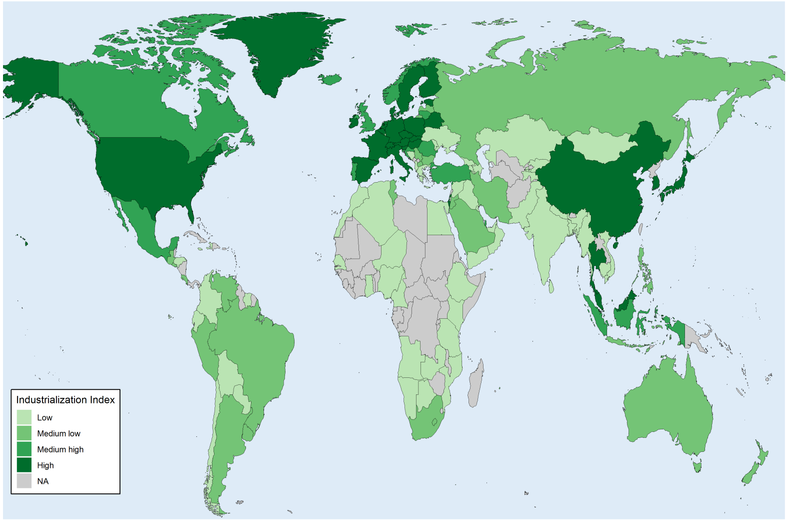

Figure 1.7: Countries' progress in achieving SDG 9, 2015

Source: UNIDO, 2018d

cal changes in the manufacturing sector's modes of production. Currently, a trend towards advanced modes of production with systems based on cloud-computing, artificial intelligence and cyber physical systems in the framework of the fourth industrial revolution is emerging (UNIDO, 2017b).

1.3.8 Countries' progress in achieving SDG 9

Applying the same methodology as that used in the CIP Index, UNIDO calculates a composite index to measure a country's performance in reaching the SDG 9 targets. The composite index covers four indicators (included in the SDG 9 targets) that are related to industrial development and for which there is reasonable country coverage: share of MVA in GDP and MVA per capita; manufacturing employment as a share of total employment; CO2 emissions per unit of value added; and the share of medium- and high-tech industry value added in total value added. The data used by UNIDO as the custodian agency of SDG 9 to monitor the indicators were used to calculate the resulting SDG 9 performance index.

Figure 1.7 presents the results of the composite analysis for 2015, ranking 122 countries based on their performance in achieving inclusive and sustainable industrialization. The five countries that performed best on the composite SDG 9 progress index were: Germany, Republic of Korea, Switzerland, Czechia and Japan.

1.4 How to use the CIP Index

1.4.1 The CIP index as analytical tool

The 2018 CIP Index assesses and benchmarks the industrial competitiveness of 150 countries. Each country's outcome is a reflection of its performance across the three dimensions of the CIP Index: (1) The capacity to produce and export manufactured goods; (2) Technological deepening and upgrading, and (3) World impact. The CIP Index enables cross-country comparisons of industrial competitiveness. Box 1.3 presents the functions of the CIP Index as an analytical tool in three steps.

First, the index allows countries to identify comparator countries. To provide a differentiated representation of competitiveness, the CIP report presents outcomes by different categories depending on the stage of industrialization, geographical region and indicator. Comparator countries can include neighbours, immediate competitors, potential competitors or role models. They may be comparable due to similarities in geography, availability of production factors, or types of goods produced.

Second, countries that perform best across the three dimensions of the CIP Index can serve as a benchmark for their comparators, given their specific circumstances. By highlighting areas in which other countries achieve higher CIP scores, the Index can support and guide policies for future industrial development. For example, the manufacturing sectors of countries that perform poorly in the CIP Index are characterized by inefficiencies in the allocation of factors of production, such as labour and capital.

Third, the CIP Index serves as a guideline, with an intuitive starting point to more detailed analyses for identifying and tackling these inefficiencies, thereby contributing to widespread productivity growth and structural change by using feasible targets that depend on the countries' circumstances. As structural change is a long-term process, changes in the CIP Index are likely to be reflected several years after policies aimed at increasing competitiveness have been implemented.

Box 1.2: LDCs' prospects of achieving SDG 9.2

Progress on SDG 9.2 on inclusive and sustainable industrial development consists of two major targets to be reached by 2030 in LDCs: first, doubling the share of manufacturing value added (MVA) both as a percentage of GDP and in per capita terms and second, doubling manufacturing employment as a percentage of total employment (UNIDO, 2017). Determining whether LDCs' industrial sectors are on the growth trajectories necessary to achieve these targets is crucial for developing industrial policies that can contribute to structural change and development. Forecasts based on previous trends indicate that doubling the 2015 share of MVA in GDP by 2030 is highly unlikely in LDCs as a whole. On average, reaching the required annual growth rate of 4.7 per cent seems improbable based on the projected value of only 0.8 per cent – even when considering the high level of uncertainty associated with forecasting.

The results also point to considerable regional heterogeneity. Even if this is insufficient for reaching the ambitious target, LDCs in South-East Asia, such as Cambodia, Myanmar and Lao People's Democratic Republic, will likely register high growth rates of their share of MVA in GDP by 2030. Figure below presents the forecast for LDCs in the Asia-Pacific region. The model projects a share of MVA in GDP of around 24 per cent by 2030, still some way off the MVA in GDP target share of 32 per cent. A high level of uncertainty surrounds this estimate, leading to a large bandwidth of the 95 per cent confidence interval. The target growth trajectory of 4.7 per cent per year is far greater than the forecasted annual growth rate of 2.6 per cent, but falls within this confidence interval.

By contrast, some sub-Saharan African economies have actually experienced deindustrialization. This implies that their share of MVA in GDP has fallen since 1990. Thus, the industrial sectors of countries such as Burundi, Chad or Malawi are moving in the opposite direction of that intended by SDG Target 9.2. Considering the evidence of the positive effects of industrialization in eradicating poverty, this development is of particular concern. Understanding the fundamental causes behind these divergent trends and developing effective industrial policies that promote sustainable industrialization is therefore imperative.

Moreover, while positive interlinkages between industrialization and fighting poverty are clear, it is also important to understand how the future growth of industrial sectors in the global South relates to other SDG targets, such as those concerning the environment or natural resources. At the same time, potential synergies may emerge through improved institutions, better infrastructure and greater welfare. This can provide additional momentum for the growth of manufacturing in LDCs.

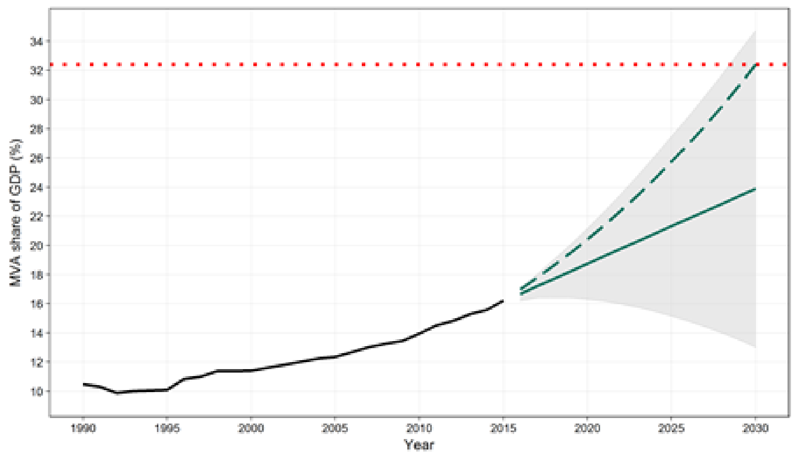

Figure: Forecast for reaching SDG 9.2 target in LDCs in the Asia-Pacific region by 2030

Source: Nice, 2018 . Note: The dotted red line depicts the targeted MVA share in GDP; the dashed green line denotes the required growth trajectory; the solid green line represents the growth model forecast and the shaded area is the 95 per cent confidence interval.

Box 1.3: The CIP Index as an analytical tool

1. Identify comparators	
Identify neighbours Identify immediate competitors Identify potential competitors Identify role models	Which comparators can provide useful information? For which activities are the comparators useful? What is a manageable number of comparators?
2. Benchmark performance	
Compare overall industrial performance Compare basic indicators of industrial performance Trace competitive strengths and weaknesses with respect to different sets of comparators	How has the country performed over time in global or regional rankings? Is the industrial structure suited to growth and make the best use of local resources and capabilities? How far from or close to the selected benchmarks is the country? In which aspect of performance does the country lead or lag? Does the performance of comparators suggest cause for concern about any aspect of performance? Is there a need for more detailed technical benchmarking of particular industries, clusters or technologies?
3. Benchmark drivers	
Compare individual elements of drivers	What are the relative strengths and weaknesses in the capabilities of the selected country?
Trace competitive strengths and weaknesses with respect to different sets of comparators Assess which drivers are most important for improved performance Add new data and analysis as necessary	Do the general indicators capture the underlying drivers at work? If not, how can they be refined? Which drivers constitute the most critical constraints to industrial growth and competitiveness? Is there enough information to evaluate non-quantifiable variables such as linkages, institutions and governance? If not, how can more information be obtained?

Source: UNIDO, 2002 and UNIDO, 2017a, page 15

CIP report 2018: Chapter 2

2. Highlights of the CIP report 2018

2.1 Basic facts about the CIP 2018 edition

2.1.1 Country coverage

The 2018 edition of the CIP Index assesses 150 economies, six more than in the previous edition. In total, US$ 12.3 trillion of value added was generated by the manufacturing sectors of these economies in 2016, corresponding to 15.6 per cent of global GDP. Chapter 2 provides an overview of the CIP rankings and presents more detailed results by development group, geographical region and CIP dimension.

Economies are thus able to identify comparators and benchmark their performance within their specific group. This approach furthermore exposes the extent of global inequalities in manufacturing performance. Long-term trends that contribute to competitiveness within a country or region are discussed, and selected cases of economies with dynamic manufacturing sectors and noteworthy results are examined in detail. This chapter focuses on highlights of the CIP Index and paints a picture of the global manufacturing sector.

2.1.2 Data sources and compilation

All the data used in this report are available in the UNIDO Statistics Data Portal. The website provides online access to different sets of data compiled by UNIDO Statistics, including the data set for the CIP.

The database is updated annually and is primarily based on the UN Statistical Division's National Accounts Main Aggregates database, the World Bank's World Development Indicator database, OECD STAN Structural Analysis database and the UN Comtrade database. Other supplementary sources include databases maintained by regional agencies such as the Asian Development Bank, the African Development Bank, the Economic Commission for Latin America and the Caribbean and databases of national statistical offices. Occasionally, non-official data sources are used to cross-check the consistency of the data. Population data are provided by the UN Population Division.

Appendix A.1 provides a brief summary of more extensive methodological notes included in the previous editions of the CIP reports. For further details, including the treatment of missing values and outliers and the normalization procedure, please refer to UNIDO, 2013 and UNIDO, 2017a.

2.1.3 The CIP ranking

Table 2.1 presents the complete results of the 2018 CIP Index, with each economy ranked according to its composite score. Economies are grouped into quintiles of the CIP Index—top, upper middle, lower middle and bottom—which are highlighted in the table. Appendix C.1 provides detailed results of the CIP Index for each economy in each of the three dimensions.

The colour of the rank depicts the economy's stage of development, differentiating between least developed countries, other developing economies, emerging industrial economies and industrialized economies. There is a correlation between stage of development and competitiveness. The top quintile of the CIP Index consists almost entirely of industrialized economies, while the majority of LDCs are concentrated in the bottom quintile. There are some exceptions, however. For example, the Philippines and Viet Nam are both classified as other developing economies; yet in the CIP Index, they perform better than a number of industrialized economies and emerging industrial economies and are ranked in the upper middle quintile of the CIP.

Industrialized economies
Emerging industrialized economies
Other developing economies
Least developed countries

Quintile	Rank 2016	Country	Score 2016	Rank 2015
Top quintile	1	Germany	0.5234	1
	2	Japan	0.3998	2
	3	China	0.3764	4
	4	United States of America	0.3726	3
	5	Republic of Korea	0.3667	5
	6	Switzerland	0.3207	6
	7	Ireland	0.3172	7
	8	Belgium	0.2807	8
	9	Italy	0.2733	9
	10	Netherlands	0.2707	10
	11	France	0.2679	11
	12	Singapore	0.2573	12
	13	China, Taiwan Province	0.2547	13
	14	Austria	0.2389	14
	15	Sweden	0.2254	16
	16	United Kingdom	0.2191	15
	17	Czechia	0.2148	18
	18	Canada	0.2074	17
	19	Spain	0.2044	19
	20	Mexico	0.1786	20
	21	Denmark	0.1715	21
	22	Malaysia	0.1662	22

Table 2.1 continued from previous page

Quintile	Rank 2016	Country	Score 2016	Rank 2015
	23	Poland	0.1651	23
	24	Slovakia	0.1604	24
	25	Thailand	0.1536	25
	26	Hungary	0.1493	26
	27	Finland	0.1457	27
	28	Israel	0.1318	28
	29	Turkey	0.1242	29
	30	Australia	0.1199	30
Upper middle quintile	31	Slovenia	0.1109	34
	32	Russian Federation	0.1047	31
	33	Norway	0.1042	32
	34	Portugal	0.1026	37
	35	Brazil	0.1019	33
	36	Saudi Arabia	0.1018	35
	37	Romania	0.1015	36
	38	Indonesia	0.0907	38
	39	India	0.0830	40
	40	Lithuania	0.0818	39
	41	United Arab Emirates	0.0735	41
	42	Luxembourg	0.0728	42
	43	Philippines	0.0725	43
	44	Viet Nam	0.0724	46
	45	South Africa	0.0694	44
	46	New Zealand	0.0659	45
	47	Belarus	0.0657	49
	48	Estonia	0.0647	48
	49	Argentina	0.0633	50
	50	Qatar	0.0631	47
	51	Chile	0.0606	51
	52	Greece	0.0591	52
	53	Croatia	0.0552	54
	54	Bulgaria	0.0524	57
	55	Bahrain	0.0515	55
	56	Trinidad and Tobago	0.0499	56
	57	Kuwait	0.0491	59
	58	Iran (Islamic Republic of)	0.0482	53
	59	Latvia	0.0474	58
	60	Peru	0.0426	62
Middle quintile	61	Tunisia	0.0418	63
	62	Serbia	0.0416	65
	63	Morocco	0.0415	66
	64	Ukraine	0.0407	64
	65	Malta	0.0398	70
	66	Oman	0.0392	60
	67	Costa Rica	0.0389	68
	68	Venezuela (Bolivarian Republic of)	0.0382	61
	69	Kazakhstan	0.0372	67

Table 2.1 continued from previous page

Quintile	Rank 2016	Country	Score 2016	Rank 2015
	70	Colombia	0.0369	69
	71	Iceland	0.0345	71
	72	Bangladesh	0.0340	72
	73	Egypt	0.0331	74
	74	Guatemala	0.0309	73
	75	Panama	0.0308	75
	76	El Salvador	0.0303	77
	77	Sri Lanka	0.0298	79
	78	The f. Yugosl. Rep of Macedonia	0.0291	78
	79	Uruguay	0.0281	76
	80	Jordan	0.0267	80
	81	Bosnia and Herzegovina	0.0257	86
	82	Pakistan	0.0245	82
	83	Brunei Darussalam	0.0245	83
	84	Swaziland	0.0243	85
	85	Botswana	0.0238	88
	86	Mauritius	0.0222	84
	87	China, Hong Kong SAR	0.0220	87
	88	Cambodia	0.0212	91
	89	Ecuador	0.0196	90
	90	Lebanon	0.0188	89
Lower middle	91	Myanmar	0.0186	97
	92	Honduras	0.0159	92
	93	Cyprus	0.0159	94
	94	Algeria	0.0149	95
	95	Namibia	0.0147	93
	96	Paraguay	0.0136	96
	97	Georgia	0.0135	98
	98	Bolivia (Plurinational State of)	0.0134	99
	99	Armenia	0.0128	103
	100	Jamaica	0.0121	101
	101	Lao People's Dem Rep	0.0115	104
	102	Mongolia	0.0109	107
	103	Kenya	0.0108	105
	104	Barbados	0.0107	102
	105	Côte d'Ivoire	0.0106	108
	106	Albania	0.0105	100
	107	Azerbaijan	0.0101	115
	108	Senegal	0.0101	109
	109	Gabon	0.0097	112
	110	Republic of Moldova	0.0097	111
	111	State of Palestine	0.0096	110
	112	Syrian Arab Republic	0.0093	81
	113	Congo	0.0093	113
	114	Suriname	0.0092	106
	115	Nigeria	0.0092	114
	116	Fiji	0.0091	116

Table 2.1 continued from previous page

Quintile	Rank 2016	Country	Score 2016	Rank 2015
	117	Cameroon	0.0087	117
	118	Bahamas	0.0080	119
	119	Zambia	0.0080	118
	120	Papua New Guinea	0.0066	121
Bottom quintile	121	Kyrgyzstan	0.0066	124
	122	Montenegro	0.0066	123
	123	Ghana	0.0064	125
	124	Zimbabwe	0.0061	122
	125	Mozambique	0.0055	129
	126	Madagascar	0.0054	120
	127	United Republic of Tanzania	0.0053	126
	128	Belize	0.0049	127
	129	Uganda	0.0045	128
	130	Angola	0.0039	134
	131	Nepal	0.0037	133
	132	Central African Republic	0.0035	131
	133	Tajikistan	0.0035	132
	134	Malawi	0.0034	135
	135	Saint Lucia	0.0034	137
	136	Cabo Verde	0.0030	136
	137	Haiti	0.0030	138
	138	Bermuda	0.0027	140
	139	Yemen	0.0026	139
	140	Niger	0.0022	143
	141	Rwanda	0.0021	141
	142	Maldives	0.0018	144
	143	Ethiopia	0.0015	148
	144	Afghanistan	0.0013	142
	145	Gambia	0.0011	149
	146	Iraq	0.0009	130
	147	China, Macao SAR	0.0008	145
	148	Burundi	0.0000	146
	149	Eritrea	0.0000	147
	150	Tonga	0.0000	150

Source: UNIDO, 2018a

Table 2.1: 2018 CIP Index results

Figure 2.1 presents the scores and ranks of the top performing countries in the 2018 CIP Index. Germany achieved the highest composite score and thus tops the CIP rank – as it has for all but one year since 1990. It is followed by Japan in 2nd place and China in 3rd place. China's competitiveness has continued to surge, rising from rank 5 in 2014 and 22 in 2000. China's climb in the CIP ranks ejected the United States of America from the top 3 to rank 4 and the Republic of Korea down to 5th place. Figure 2.1 also provides an overview of those countries setting the competitiveness benchmark in seven geographic regions and in four development groups.

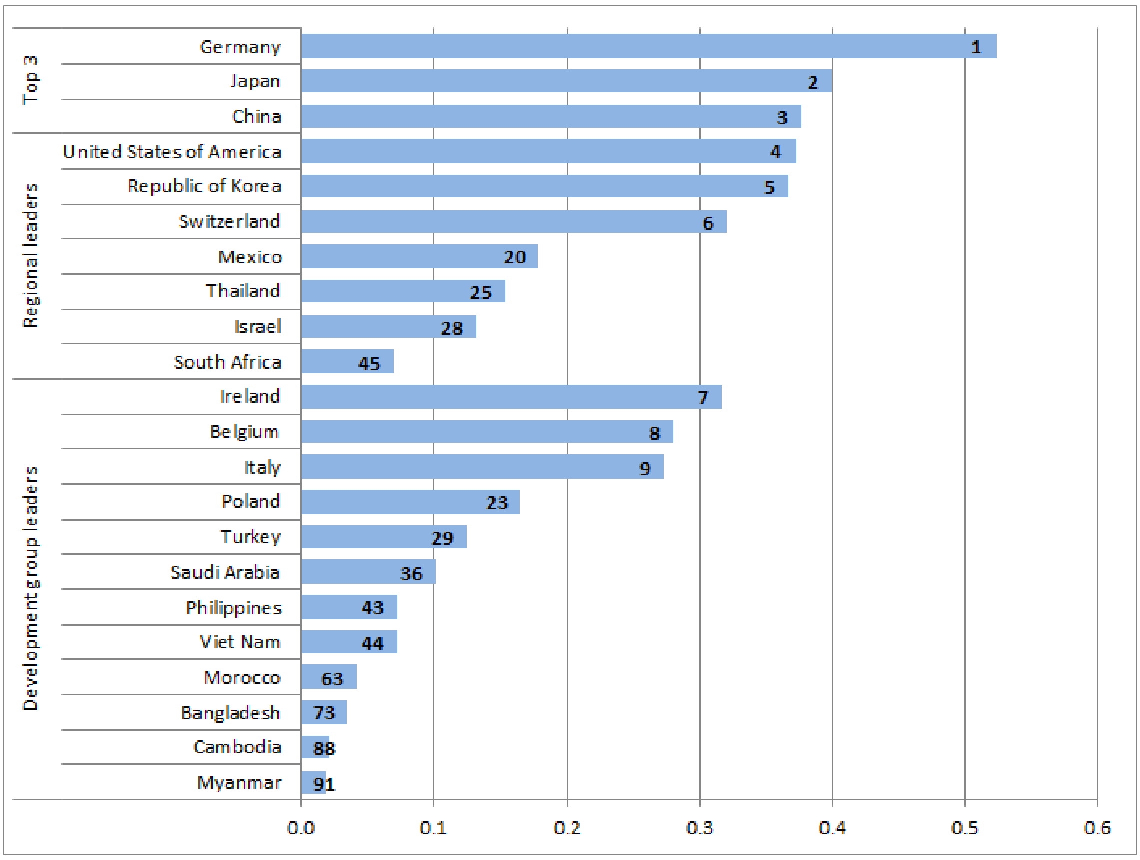

Figure 2.1: Scores and ranks of the top performing countries in the 2018 CIP Index

Source: UNIDO, 2018a. Note: If a country is already listed in the top three, the runner-up is highlighted in the group of regional leaders. Similarly, if a country is included in the group of regional leader, the runner-up will come in first among the development group leaders. See Appendix B for country classifications.

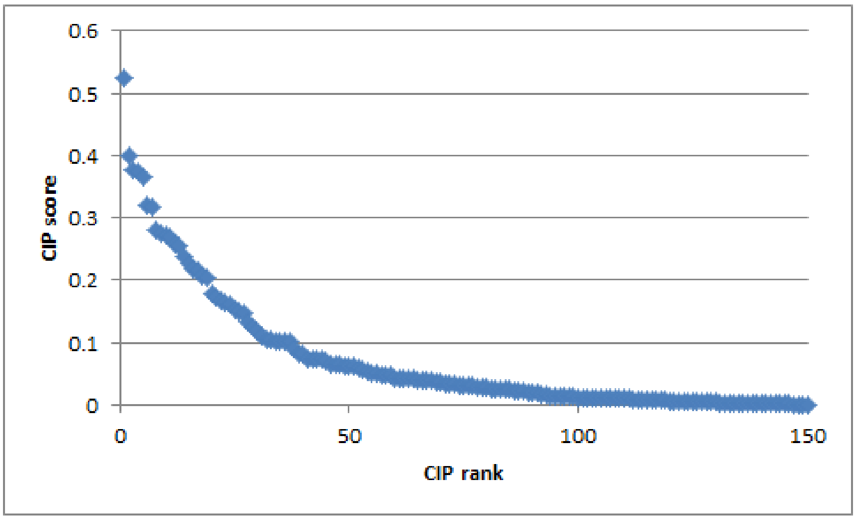

Figure 2.2: Relationship between CIP scores and ranks

Source: UNIDO, 2018a.

Overall, the CIP Index can range between 0 and 1. Yet the highest score (achieved by Germany) is only 0.52. This reflects the fact that no country leads in all eight CIP indicators. At the same time, the CIP scores are distributed very unequally. Few countries achieve high scores and thus do not substantially outrival others in terms of industrial competitiveness; low CIP scores below 0.1 are far more frequent.

Figure 2.2 depicts the non-linear relationship between countries' scores and their ranks in the 2018 CIP Index. For example, the gap between the CIP scores of Germany in 1st place and the country in 12th place, Singapore, is around 0.26 and thereby just as large as the distance between the CIP scores of Singapore and the countries ranked 150th, Burundi, Eritrea and Tonga. As lower CIP scores are more congested, minor increases in competitiveness result in large shifts in those countries' ranking. There is thus more competition among countries that rank lower in terms of competitiveness. For example, Albania's CIP rank improved by nine positions year-over-year, with an absolute increase in its CIP score of less than 0.001. Such countries are likely to replicate technologies in a bid to "catch-up" with innovative countries at the frontier, as they lack the capabilities to act as pioneers themselves. This also implies that a positive change in a country's CIP score is not the same as a change in its CIP rank – both values are important to obtain an accurate picture of a country's overall performance.

One example of a country that has witnessed a considerable improvement in its rank and score in the top quintile of the CIP Index is China – this is discussed in detail below. Yet while China attained the highest absolute increase in terms of CIP score in recent years, other countries achieved even larger relative increases in their CIP ranking between 2000 and 2016. Countries that were able to increase their CIP score most relative to their direct competitors include Myanmar, which moved up 39 places in the CIP rank, Kazakhstan, which moved up 37 places and Viet Nam, which moved up 35 places.

2.2 By development stage

2.2.1 Main findings by development country group

There are major differences in competitiveness between countries at different stages of development. The CIP Index only evaluates outcomes in a given year; a more dynamic perspective, however, is necessary to assess long-term processes of structural change. Box 2.1 presents trends in the dimensions of competitiveness of countries at different development stages over the past quarter century.

Figure 2.3 presents the median CIP ranks of the four development groups used in this analysis for the period 1990 and 2016. There was little change during this 26-year period. One slight exception is the small increase in the median ranks of industrialized economies and emerging industrial economies. This slight increase in the median of the CIP rankings reflects the fact that few countries were able to displace others at the top of the competitiveness rankings. Although Box 2.1 indicates that industrialization occurred in emerging industrial economies during this period, it did not suffice for a systematic increase in the competitiveness of the entire group. The positive upward shift of a few countries with exceptionally high growth rates, as China, India, Oman and Poland, could not sustain the median as it was counterbalanced with the loss in competitiveness in more countries, among them: Suriname, Cyprus, Ukraine and Venezuela. Thus, the overall mean of the group experienced a decrease in competitiveness.[1]

Countries are assigned to development groups ex-post (see Appendix B.1 for country classifications), and transitions between development stages are therefore not considered. This could have an effect on the median CIP rank if increases in competitiveness—and thus of industrialization—led to transitions of countries between groups. Let us take a country that jumped from rank 100 to 50, in the CIP ranking, for example. If that country was grouped in the "Other Developing Economies" in 1990 and continues to be in the same category in 2016, the median of the group "Other Developing Economies" will most likely improve.

However, when as a result of the increase in its industrial competitiveness it also moves from its previous category to the group "Emerging Industrial Economies", then its shift to the new category will imply that the improvement in the "Other Developing Economies" group will be removed, as the country belongs to another group.

Figure 2.4 differentiates the rankings based on the three dimensions of the CIP Index. This highlights areas in which a country group is particularly (un)competitive. It indicates, for example, that industrialized economies are more competitive in the first dimension of the CIP Index, which measures countries' capacity to produce and export manufactured goods, than they are in others. By contrast, least developed countries' performance in the first dimension, which is most closely linked to profound processes of structural change, was very poor. The world's poorest country group is also uncompetitive in terms of its world impact.

Inequality in competitiveness is least pronounced (albeit still strong) in the dimension of technological deepening and upgrading. This is an indication that although the diffusion of advanced technologies can support an increase in competitiveness, it does not suffice to drive higher competitiveness across all relevant dimensions. For technological diffusion to truly contribute to greater competitiveness in manufacturing, the country's institutions, infrastructure, human capital, business environment and other factors must also be conducive to structural change (Rodrik, 2018).

Figure 2.4 also shows that emerging industrialized economies have shown a systemic improvement in technological deepening, shortening considerably the distance with industrialized economies.

[1] Interestingly enough, the average rank of the emerging industrial economies has sligtly improved during this period, from 57 in 1990 to 56 in 2016. Thus, while most of the countries in this group have suffered some loss in competitiveness, in average, the high performers have gained more competitiveness than what the low performers have lost.

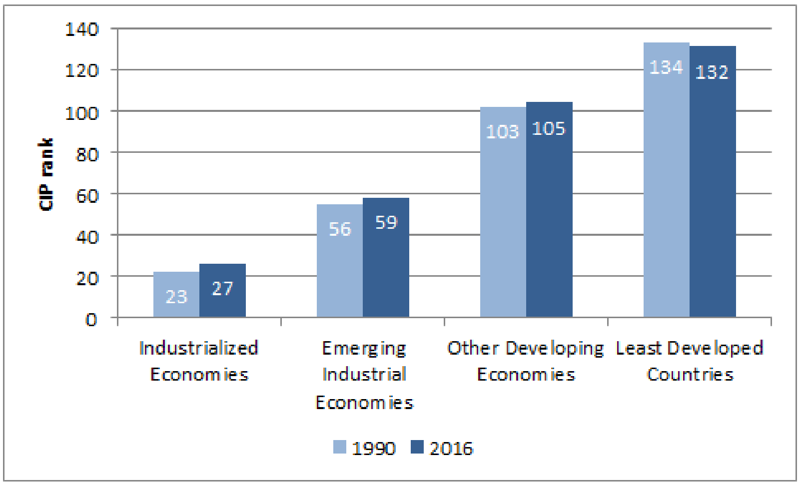

Figure 2.3: Median CIP ranks by country group, 1990 and 2016

Source: UNIDO, 2018a

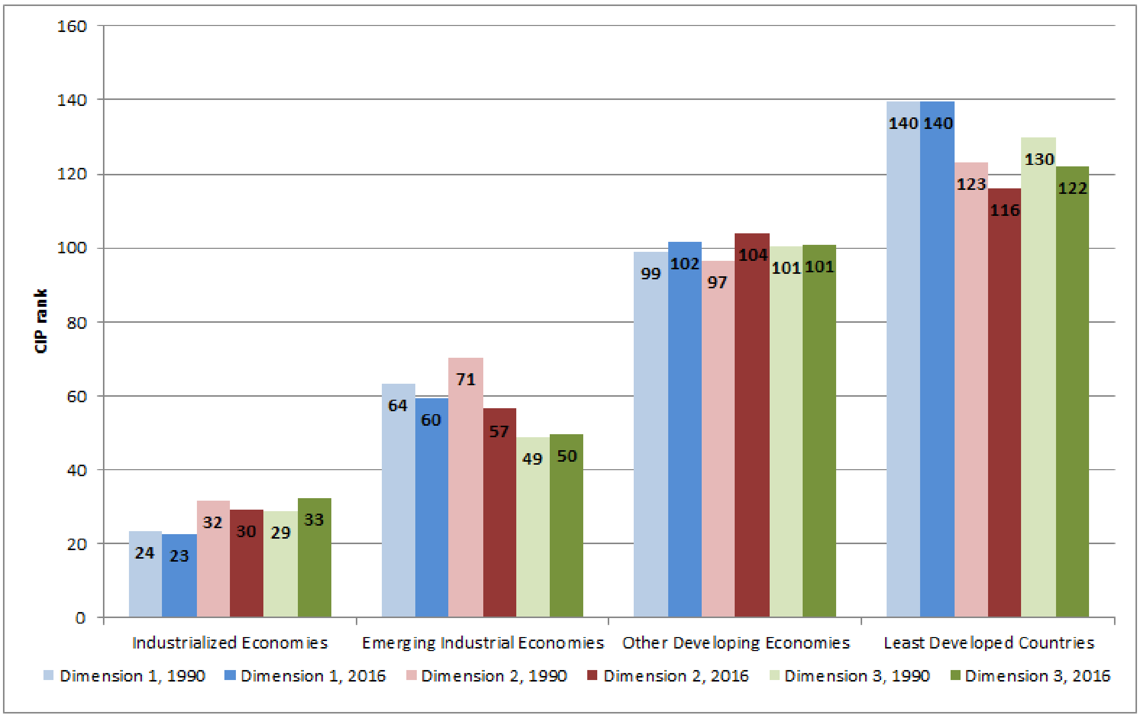

Figure 2.4: Median CIP rank in CIP dimensions by country group, 1990 and 2016

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

Box 2.1: Trends in global manufacturing production and exports, by development stage

Globally, industrial output increased rapidly and—with the exception of the financial crisis—steadily from US$ 5.8 trillion to US$ 12.6 trillion (at 2010 prices) from 1990 until 2016. This MVA was, however, generated very unequally between country groups. Figure below illustrates that in 2016, 56 per cent of global MVA was produced in industrialized economies, which are home to just 15 per cent of the world's population. The share of global MVA produced in industrialized economies fell by over 22 percentage points between 1990 and 2016. Over the same period, the share of manufacturing net output from emerging industrialized economies increased substantially. In 2016, these countries produced 40 per cent of global MVA, more than double the share in 1990. This industrial growth was largely driven by India, China, Brazil, Indonesia and Mexico (UNIDO, 2014). In these countries, the share of MVA in GDP has increased considerably in recent years to reach around 24 per cent.

The share of global MVA of LDCs was a mere 0.8 per cent in 2016, although these countries are home to over one-tenth of the world's population. This is a slight increase from the 0.5 per cent share of global MVA of LDCs in 1990, but manufacturing growth in these countries lagged far behind that in emerging industrial economies. The share of LDCs' MVA in GDP was around 12 per cent in 2016. In comparison, the agricultural sector and extractive industries contributed around one-third of LDCs' GDP, while in emerging industrial economies, structural change led to a reversal of these shares (UNIDO, 2018b). These results are an indication of an inverted U-shaped relationship between the share of MVA in GDP and GDP per capita, as empirically demonstrated by Haraguchi, Cheng, and Smeets, 2017. Very broadly speaking, this denotes that the share of developing countries' MVA in GDP is low; transition economies have undergone a process of structural change, with factors of production shifting to manufacturing; and industrialized economies have deindustrialized and shifted to services-based economies. However, there is only limited evidence supporting the theory of unconditional convergence (McMillan and Rodrik, 2011; Rodrik, 2012 and Rodrik, 2011), according to which countries with the smallest relative manufacturing sector should exhibit the highest growth rates in the sector – instead, least developed countries have had relatively limited manufacturing growth in recent decades. This generalization does not, however, apply to all least developed countries. These countries represent a heterogeneous category with varying degrees of structural change, as discussed in Box 1.2.

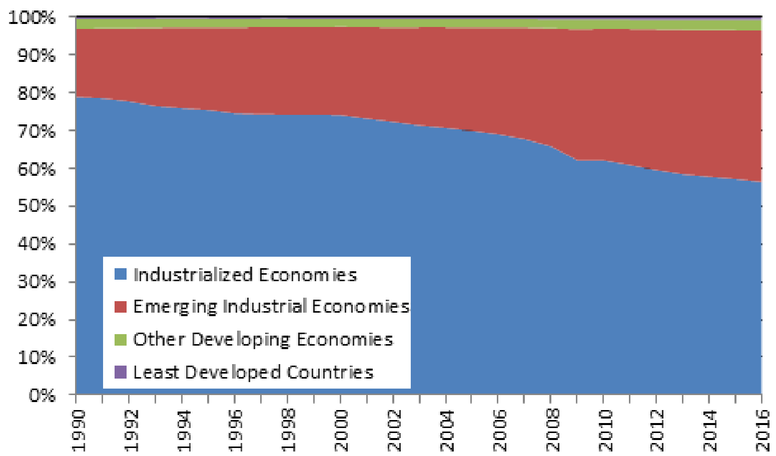

Figure: Share of global MVA by country group, 1990-2016.

Source: UNIDO, 2018a

2.3 By geographical region

2.3.1 Main findings by geographical region

Assessing competitiveness by geographical region facilitates comparisons with neighbouring countries which may have several common socio-economic and geographical characteristics. Countries within the same region are likely to have similar features, such as institutional legacies, endowments with natural capital and cultures. Commonalities may extend to free trade areas, such as under NAFTA, in the EU or ASEAN and even to common currencies, such as the euro or the franc-CFA in West and Central Africa.

Beyond these shared features, the competitiveness of a neighbouring country is likely to affect domestic competitiveness through spatial spillovers. Proximity to competitive countries increases the likelihood of high levels of domestic competitiveness, as it is easier to trade with countries that are in close proximity. As discussed previously in this report, greater trade is closely linked to higher levels of productivity: greater demand means that the country can sell more goods and exploit economies of scale; if the country faces greater competition from abroad, its firms are forced to innovate and to become more competitive to survive on the market; if there is trade between neighbouring countries, it is also likely that there is a greater flow of capital and workers, thus supporting the diffusion of knowledge. This corresponds to the gravity model of international trade that is used to explain flows of goods, investments and people. The gravity model deems that trade flows depend on both the size of the economies (and thus on one of the dimensions of their competitiveness) and the proximity between the two countries.

Figure 2.5 shows the geographic distribution of countries in different CIP Index quintiles across the world. The figure provides evidence that countries with high levels of competitiveness are likely to be grouped within the same regions. Clusters of highly competitive countries are concentrated in North America, Western Europe and East Asia. By contrast, the majority of countries with the lowest levels of competitiveness are located in sub-Saharan Africa.

The remainder of this sub-section assesses the CIP Index results for seven regions: East Asia, Europe, Latin America, the Middle East and North Africa, South and South East Asia, sub-Saharan Africa and Other Asia and Pacific.[2] The following tables present the regional and global rankings of the countries within each geographical region, as well as the changes they underwent over time. In addition to each table, a figure illustrates the regional score distribution within the region.

2.3.2 East Asia

Overall, East Asian economies rank high in the CIP Index. Three countries from the region are in the top 5 of the global ranking: Japan, China and the Republic of Korea. Table 2.2 shows that 5 of the top-6 countries in the ranking improved their positions in the CIP ranking relative to 1990. China's jump of 29 places in the CIP ranking is particularly remarkable; Box 2.2 assesses the drivers of this increase in competitiveness in detail.

Both Australia and New Zealand, despite being high income countries, have comparatively low levels of manufacturing competitiveness. This follows decades of contraction in the manufacturing sectors of both countries, accompanied by a drop in the CIP ranks as they deindustrialize.

Figure 2.6 shows the distribution of scores in each of the three dimensions of the CIP Index, with the median depicted by the colour change in each bar. There is a high level of heterogeneity in the scores of East Asian countries. China dominates the *World Impact* dimension, with the highest share of both world MVA and world

[2] See Appendix B.1 for a detailed classification of countries based on geographical regions.

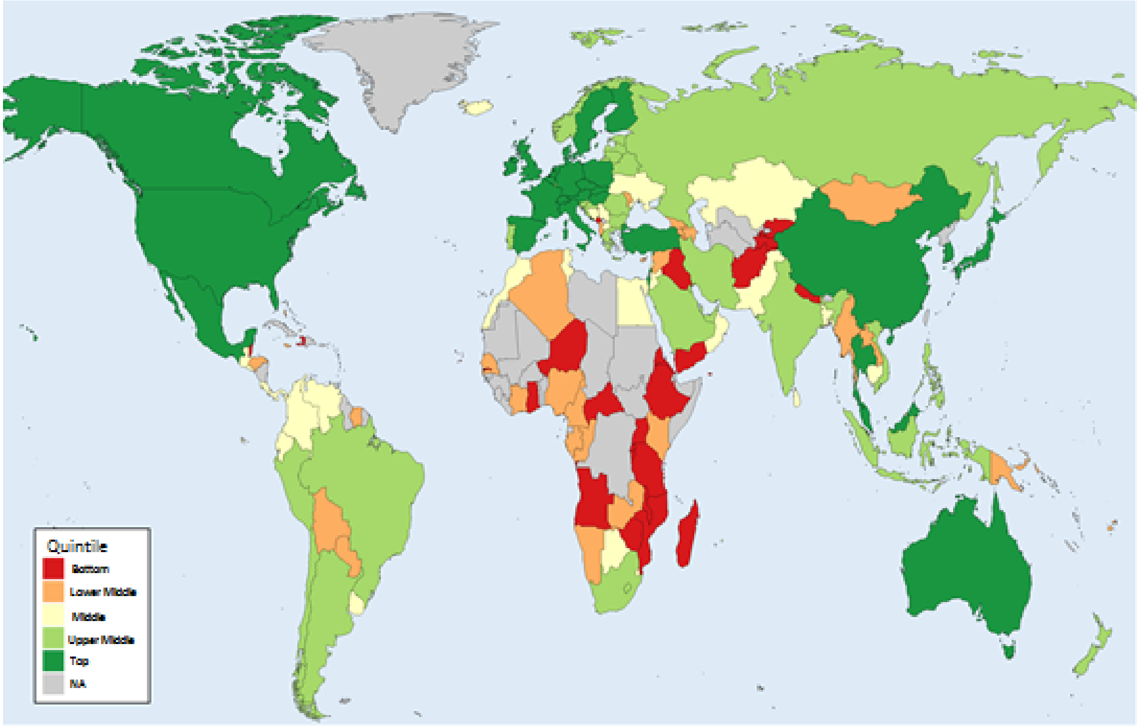

Figure 2.5: Map of CIP performance (quintiles), 2016

Source: UNIDO, 2018a.

trade in manufactured goods. At the same time, the Republic of Korea and Singapore have very high scores in the second dimension, *Technological Deepening and Upgrading*.

These countries can act as role models for achieving high rates of structural change over the past 60 years, and for having successfully transitioned to high-technology, high value-added forms of production. With the exception of Singapore, the performance of East Asian economies is comparatively weaker in the first dimension of the CIP Index, which measures the capacity to produce and export.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Japan	2	0	0
2	China	3	-3	-29
3	Republic of Korea	5	1	-12
4	Singapore	12	5	-1
5	China, Taiwan Province	13	1	-1
6	Malaysia	22	0	-6
7	Australia	30	2	8
8	New Zealand	46	0	8
9	China, Hong Kong SAR	87	14	66
10	China, Macao SAR	147	13	102

Table 2.2: Regional and global 2018 CIP rank, East Asia
Source: UNIDO, 2018a.

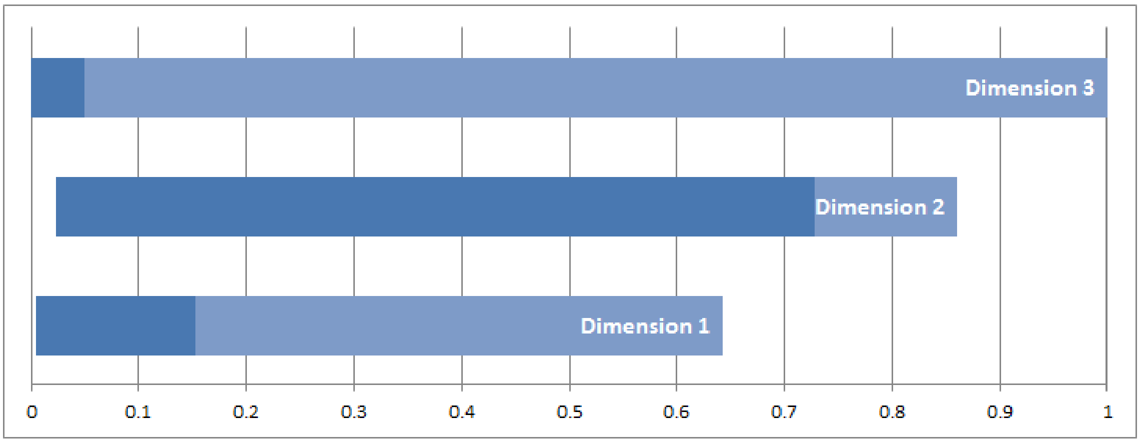

Figure 2.6: Score distribution, East Asia

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

Box 2.2: China's increasing competitiveness

China has entered the top three in the CIP ranking. This follows a considerable increase in the country's position from 29^{th} in 1990 to 19^{th} in 2000. Between 1990 and 2016, China's CIP Index score increased from 0.09 to 0.37 – by far the greatest absolute increase in the CIP score of any country. Figure A presents the change in rank and score over this period.

Figure B presents the normalized results of the six indicators used to calculate the CIP scores for China in 1990, 2000, 2010 and 2016. The largest contributor to China's high CIP score—particularly between 2000 and 2010—was the increase in the world impact of both MVA and manufacturing exports. In 2016, China accounted for 24 per cent of global MVA (up from 3 per cent in 1990) and 17 per cent of world trade in manufactured goods (up from 3 per cent in 1990).

Multiple factors have played a role in China's rise to becoming the global leader in both the production and export of manufactured goods. One of these factors includes China's low labour cost, providing it with a comparative advantage in low-technology industries such as textiles; it has furthermore made large-scale investments in transport infrastructure for shipping goods abroad and introduced effective industrial policies to boost industries with high potentials and the adoption of efficient technologies.

Compared to other large, resource-rich countries, where exports are typically less important due to the size of the domestic market, exports play quite a remarkable role for China's manufacturing sector. For example, from 1990 to 2016, manufacturing exports growth in the United States was 4.3 per cent, whereas it was 13.8 per cent in China. Exports of tradable goods have been the main contributor to China's recent economic growth (Guo and N'Diaye, 2009).

In China, MVA contributes around 32 per cent of total value added and may therefore have already peaked. This means that in future, structural change will likely lead to a further deindustrialization of the economy (Haraguchi, Cheng, and Smeets, 2017). The quality of Chinese manufacturing exports also increased considerably between 1990 and 2016. Export quality in the CIP Index is measured as the mean of the share of MHT manufacturing exports in total exports and the share of manufacturing exports in total exports. One potential problem of China's export orientation is the resulting vulnerability to demand shocks abroad. If there is a recession in other countries, as was the case during the financial crisis of 2007/08, it can have considerable knock-on effects on domestic production and consequently competitiveness.

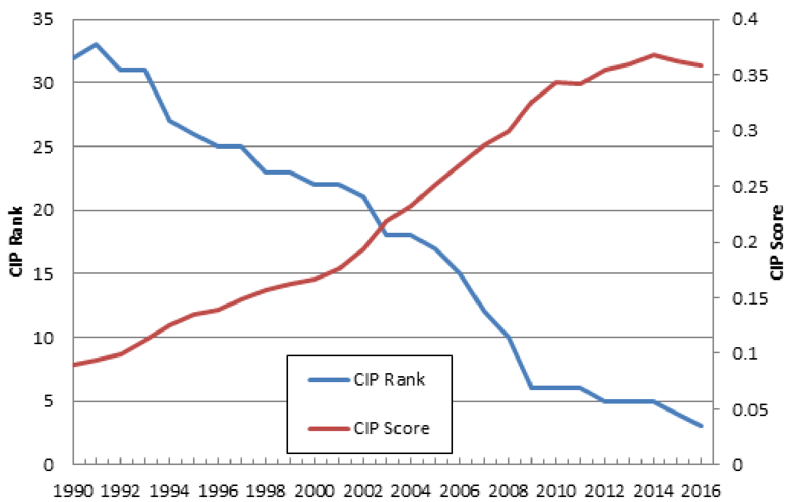

Figure A: China's CIP rank and score, 1990-2016
Source:UNIDO, 2018ae

Moreover, as wages in the manufacturing sector increase, China's comparative advantage in labour-intensive production has fallen. To remain competitive and achieve higher levels of industrialization, the manufacturing sector has to adapt (Labaye et al., 2013). This means continuing to increase productivity levels. Further investments in the quality of exports is crucial to continue the transition to industries further up the value chain and to increase value added. Such a development is essential for China to avoid the "middle-income trap" – this situation arises when productivity levels are insufficient for industries to compete in high-tech goods markets with highly competitive economies, while labour-intensive production processes are relocated to other emerging industrial economies with lower wage levels (Eichengreen, Park, and Shin, 2013).

Productivity-enhancing policies, such as research and development, education and high-tech infrastructure are therefore key if countries are to avoid the middle-income trap. The comparatively high share of MHT technology products in exports is an indication that China's industrial sector is adapting and may have the potential to overcome the middle-income trap.

Figure B highlights areas in which future increases in competitiveness could be achieved. Compared to leading industrialized economies, China performs poorly in the first CIP dimension measured as the country's capacity to produce and export manufactured goods per capita. Thus, despite China's tremendous impact on world manufacturing, there is still considerable room for improvements in inclusive and sustainable industrialization and to provide the workforce with high incomes.

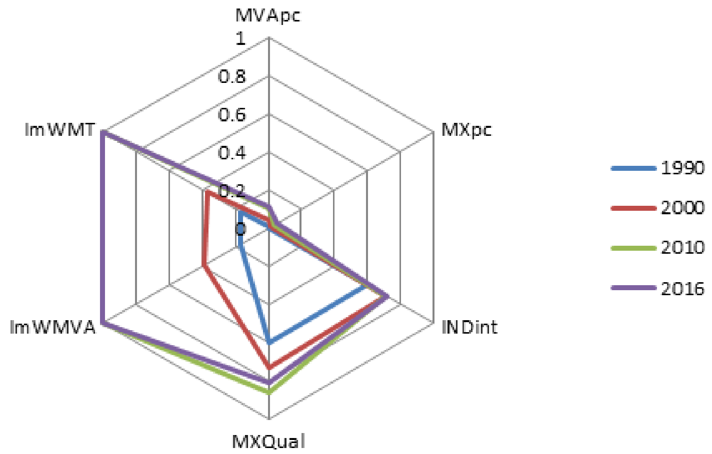

Figure B: China's indicator scores, 1990-2016

Source:UNIDO, 2018a

2.3.3 Europe

European countries have maintained their strong position in the CIP rankings, occupying six places in the global top 10. Most notably, Ireland's rank improved considerably relative to the 2014 CIP Index. It moved up 7 positions, mainly due to a large increase in the net-output of its manufacturing sector (see table 2.3). The reasons for this are discussed in detail in Box 2.3.

Yet while the group of European economies hosts some of the world's most competitive economies, competitiveness has not spread to all countries. This is supported by Figure 2.7: there is a large dispersion in European country scores within each of the CIP Index's three dimensions. While Germany, Switzerland, Ireland and other countries in the top quintile of the CIP Index performed well, particularly in Dimensions 1 and 2, this is not the case for a number of Eastern European countries. In countries such as Albania, Moldova and Montenegro, integration with Western Europe since their transition from centralized to market-based economies has only partially resulted in structural change. Despite minor increases in their CIP rank in recent years, these countries' performance in production capacity and manufacturing exports is fairly poor.

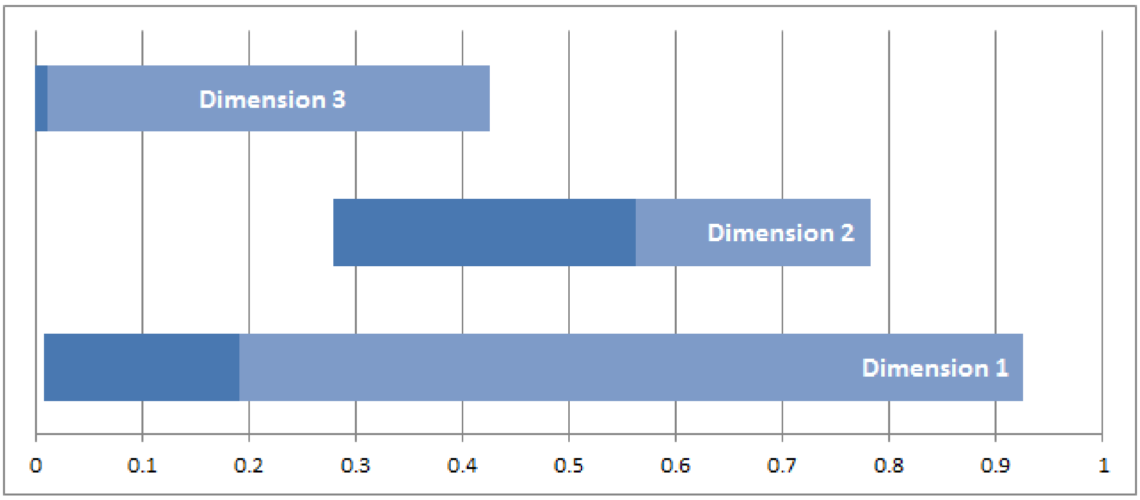

Figure 2.7: Score distribution, Europe

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Germany	1	0	0
2	Switzerland	6	1	1
3	Ireland	7	-7	-12
4	Belgium	8	-2	-2
5	Italy	9	1	5
6	Netherlands	10	-1	1
7	France	11	2	5
8	Austria	14	-2	2
9	Sweden	15	2	4
10	United Kingdom	16	1	9
11	Czechia	17	-2	-12
12	Spain	19	1	4
13	Denmark	21	0	5
14	Poland	23	-3	-30
15	Slovakia	24	-5	-15
16	Hungary	26	-1	-9
17	Finland	27	7	9
18	Slovenia	31	-3	1
19	Russian Federation	32	-1	8
20	Norway	33	3	13
21	Portugal	34	-1	9
22	Romania	37	1	0
23	Lithuania	40	-3	-22
24	Luxembourg	42	-2	15
25	Belarus	47	5	-1
26	Estonia	48	-3	-11
27	Greece	52	5	16
28	Croatia	53	-2	19
29	Bulgaria	54	-5	0
30	Latvia	59	-3	4
31	Serbia	62	-10	6
32	Ukraine	64	7	23
33	Malta	65	2	16
34	Iceland	71	0	10
35	The f. Yugosl. Rep of Macedonia	78	-11	5
36	Bosnia and Herzegovina	81	-3	-26
37	Cyprus	93	1	22
38	Georgia	97	-3	-4
39	Albania	106	-1	-9
40	Republic of Moldova	110	-9	30
41	Montenegro	122	-1	12

Table 2.3: Regional and global 2018 CIP rank, Europe

Source: UNIDO, 2018a.

Box 2.3: Ireland's jump in MVA

Between 2014 and 2015, Ireland's share of MVA in GDP increased from 17.7 per cent to 29.9 per cent as MVA per capita more than doubled. This large jump is mostly the result of the country's economic situation and the taxation policies, which have been considered very favorable to businesses and corporations (European Commission Eurostat, 2016; OECD, 2016). Following these incentives, many multinational firms with very high revenues -especially those engaged in R&D and innovation – were registered here. With this movement, many highly valuable intangible assets owned by these companies were registered in Ireland's accounts. Examples of these assests are intellectual property rights in the pharmaceutical industry, which are worth large sums of money. The relocation of these firms thus had a large effect on the comparatively small Irish manufacturing sector.

The jump in Irish MVA highlights the importance of considering countries' relative positions in global value chains. In globalized production networks, multinational companies often move their headquarters to countries in which they can reduce their tax obligations. This can lead to very large shifts in countries' MVA levels because, from the perspective of national accounting, the location of the headquarters is often where the greatest value is added to the production process, even if physical manufacturing does not take place in that country. Equally, comparatively few individuals may benefit from this value added in the form of higher wages or consumption. Therefore, MVA per capita is just one dimension of inclusive and sustainable industrialization: and unfortunately, large increases in value do not necessarily translate into greater well-being of the population if it does not lead to additional jobs or higher incomes.

The figure below shows normalized MVA for a group of European countries, after Ireland's jump in MVA (that is, from 2015 to 2018): Ireland, the United Kingdom, the three countries with the greatest MVA in the EU – Germany, France and Italy, all other EU countries and the EU overall. The figure shows that even after the very large increase in MVA mentioned earlier, MVA in Ireland continued to grow at a considerably faster rate than in other European countries – increasing by 18 per cent over the three observed years compared to 8 per cent in the rest of the EU. At the same time, MVA in the United Kingdom contracted slightly. This may indicate that firms chose to not expand manufacturing production in the United Kingdom in the face of economic and political uncertainty linked to the United Kingdom's plan to leave the EU in 2019. Indeed, according to the Bank of England, it is expected that the reduction in trade openness between UK and EU will reduce the UK's productive capacity and economic growth (Bank of England, 2018).

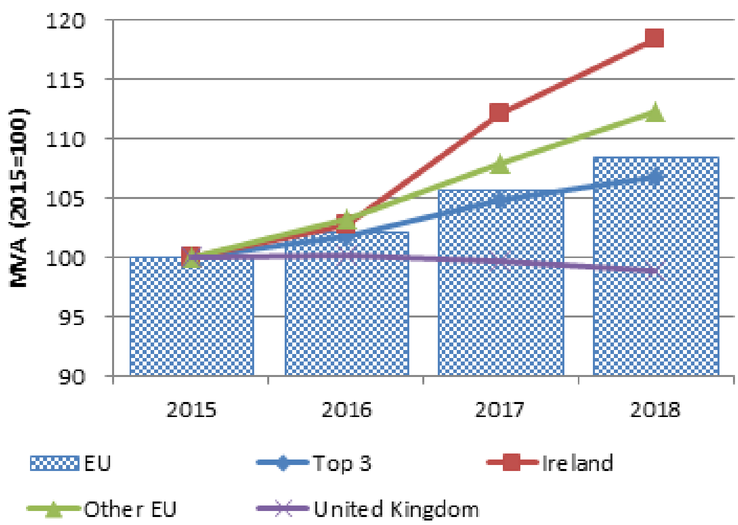

Figure: Index numbers of MVA in selected European countries, 2015-2018
Source:UNIDO, 2018a

2.3.4 Latin America

The manufacturing sectors in Mexico, Brazil and Argentina continue to be the most competitive in Latin America, while the majority of Caribbean countries are positioned in the lowest quintiles of the CIP Index. Table 2.4 presents the CIP ranks for Latin America.

There have been diverging trends even within the group of most competitive Latin American countries. While Mexico continued its upward trajectory, Brazil and Argentina have not been able to prevent their slide down in the global CIP ranks. Figure 2.8 depicts the three countries' indicator scores compared to 1990. Each of the three countries experienced minor and even negative growth rates across the CIP Index's dimensions towards the end of the 1990s – particularly during Argentina's Great Depression and a recession in Mexico. Yet on the whole, Mexico performed far better in each of the three dimensions of the CIP Index, particularly in its capacity to produce and export manufactured goods and its world impact. Additionally, Mexico has the third highest share of MHT exports worldwide. This is a result of the establishment of NAFTA in 1994, facilitating manufacturing exports to the large markets in the United States and Canada as well as a flow of FDI into Mexico.

Brazil's CIP scores dropped in all three dimensions and Argentina's CIP scores also dropped in its capacity to produce and export manufactured goods and its world impact, while barely improving in its technological deepening and upgrading. These two countries have witnessed a significant slump since the global financial crisis of 2007/08. Furthermore, the present economic conditions in these countries are not yet robust enough to recover and for their manufacturing sectors to enter into a solid growth path (Padilla, 2018).

Figure 2.9 shows that Latin American countries performed particularly poorly in the first and third dimension of the CIP Index, largely due to the lack of integration in global value chains. Similarly, Latin American countries performed considerably worse in the second dimension than other emerging industrial economies, most notably from Asia. Mexico is the only country in the region that has closed the gap to the technological frontier, attributable largely to very high levels of FDI.

Box 2.4: Panama's rise in competitiveness

Panama achieved the greatest improvements in competitiveness of any Latin American country in recent years. This development has not been a continuous upward trend. Between 1990 and 2009, Panama's CIP rank dropped from 104^{th} to 120^{th}. Panama witnessed a considerable increase in its rank between 2010 and 2016, moving up to rank 74. This is partly a reflection of the clustering of a large number of countries with low levels of competitiveness at low CIP values. All the same, important policy implications can be derived from Panama's increase in competitiveness.

Panama's strong manufacturing growth is mainly attributed to spillovers from a boom in large-scale investment projects. This occurred in industries related to construction, particularly those involved in the expansion of the Panama Canal, which was completed in 2016. A number of other infrastructure projects were carried out over the same period, such as motorway and underground expansions. Beyond large government and private investment, the business environment also supported growth in manufacturing productivity. The overall quality of transport, energy and communications infrastructure is very high for the region, which further supports investment and economic growth (Beaton and Hadzi-Vaskov, 2017).

Improving the quality of education and the efficiency of institutions is central to guaranteeing that future increases in competitiveness can be achieved, as Panama still lags far behind the regional and global frontiers. At the same time, effective policies will be necessary to guarantee that high growth rates are sustainable once large infrastructure projects are completed and that workers can be effectively transferred from construction to other manufacturing sectors (Hausmann, Espinoza, and Santos, 2016).

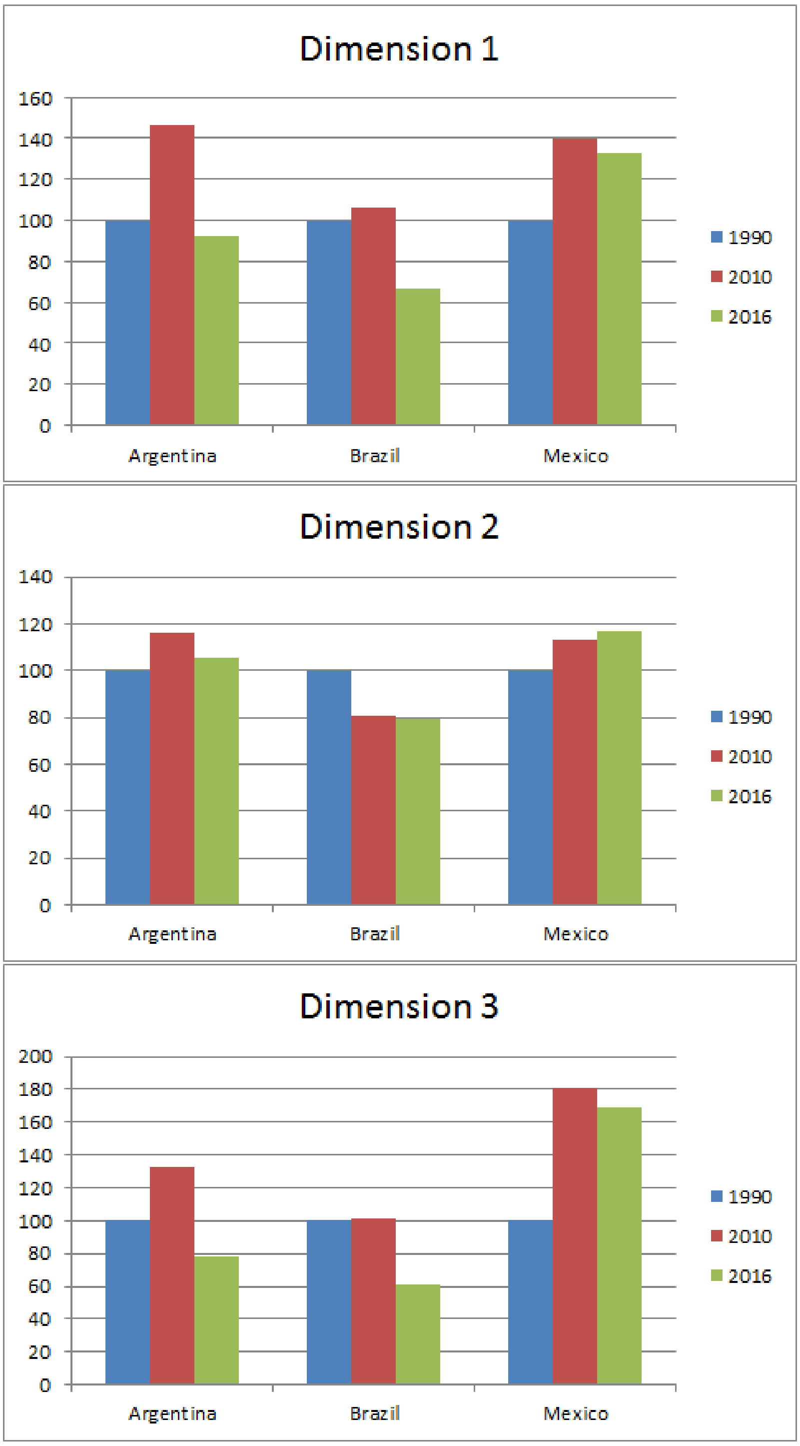

Figure 2.8: Performance in the three CIP dimensions, Brazil, Argentina and Mexico, 1990-2016 (1990=100)

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Mexico	20	-3	-11
2	Brazil	35	4	9
3	Argentina	49	10	3
4	Chile	51	2	-7
5	Trinidad and Tobago	56	6	-12
6	Peru	60	-1	-15
7	Costa Rica	67	1	-7
8	Venezuela (Bolivarian Republic of)	68	16	18
9	Colombia	70	5	13
10	Guatemala	74	-1	-3
11	Panama	75	-43	-29
12	El Salvador	76	-1	-11
13	Uruguay	79	3	14
14	Ecuador	89	4	-13
15	Honduras	92	-2	-24
16	Paraguay	96	-9	-13
17	Bolivia (Plurinational State of)	98	1	-10
18	Jamaica	100	4	31
19	Barbados	104	2	15
20	Suriname	114	16	38
21	Bahamas	118	10	-15
22	Belize	128	2	8
23	Saint Lucia	135	-1	3
24	Haiti	137	0	23

Table 2.4: Regional and global 2018 CIP rank, Latin America

Source: UNIDO, 2018a.

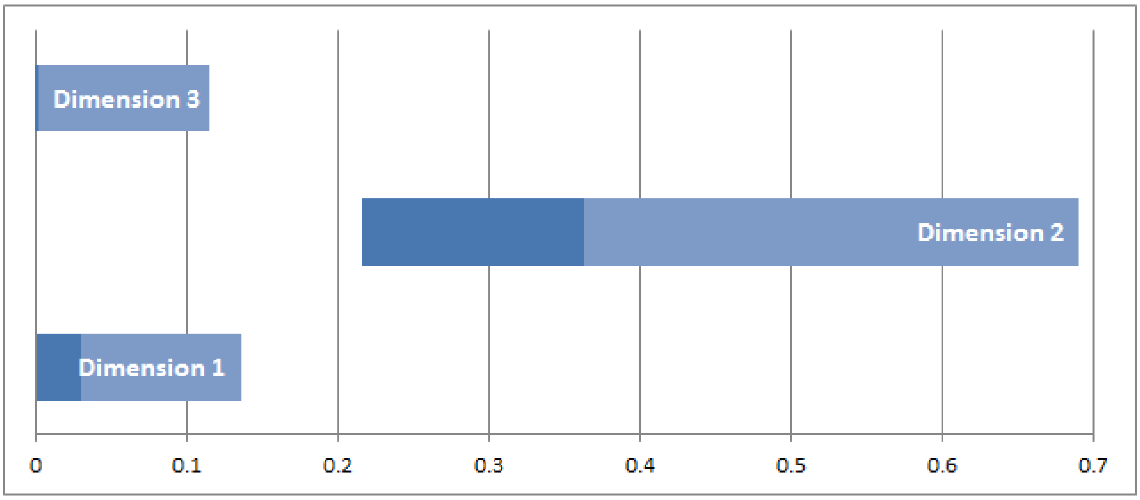

Figure 2.9: Score distribution, Latin America

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

2.3.5 Middle East and North Africa

Israel, Turkey and Saudi Arabia continue to lead the CIP rankings in the MENA region. The most noticeable change in manufacturing in the region over the past decades has been the large increase in the industrial competitiveness of oil-exporting countries, such as Saudi Arabia, the United Arab Emirates and Oman. At the same time, political and social unrest in a number of countries in the MENA region have contributed to reduced competitiveness – for example, in the Syrian Arab Republic and Yemen (see Table 2.5).

Figure 2.10 presents the average scores of the MENA region in the three CIP dimensions in comparison with two regions at similar levels of competitiveness, Latin America and South and South East Asia. The composition of the CIP score in the three regions is similar: all achieve strong scores for technological deepening and upgrading and the weakest ones in world impact. Although all MENA countries have low levels in the world impact, the MENA region is more competitive than the other two regions in this dimension, but has a slighly weaker technological deepening than South and South East Asia and smaller production and export of manufactured goods than Latin America.

Figure 2.11 shows that—as is the case in other regions—there are major differences in the performance of countries from the MENA region in the dimensions of the CIP Index. The manufacturing sector plays the most important role for the economy in oil-importing countries such as Turkey and Egypt. Yet these countries produce comparatively low-technology, labour-intensive goods with low margins. As a result, they are unable to contribute with a large share of the value added in global value chains.

By contrast, Israel's competitiveness is largely based on its adoption of advanced technologies in manufacturing, and it is therefore the regional leader in Dimension 2 of the CIP Index. This is closely linked to Israel's high levels of investment in education, research and development and targeted support of information and communication technologies (The Economist Intelligence Unit, 2018a; The Economist Intelligence Unit, 2018b).

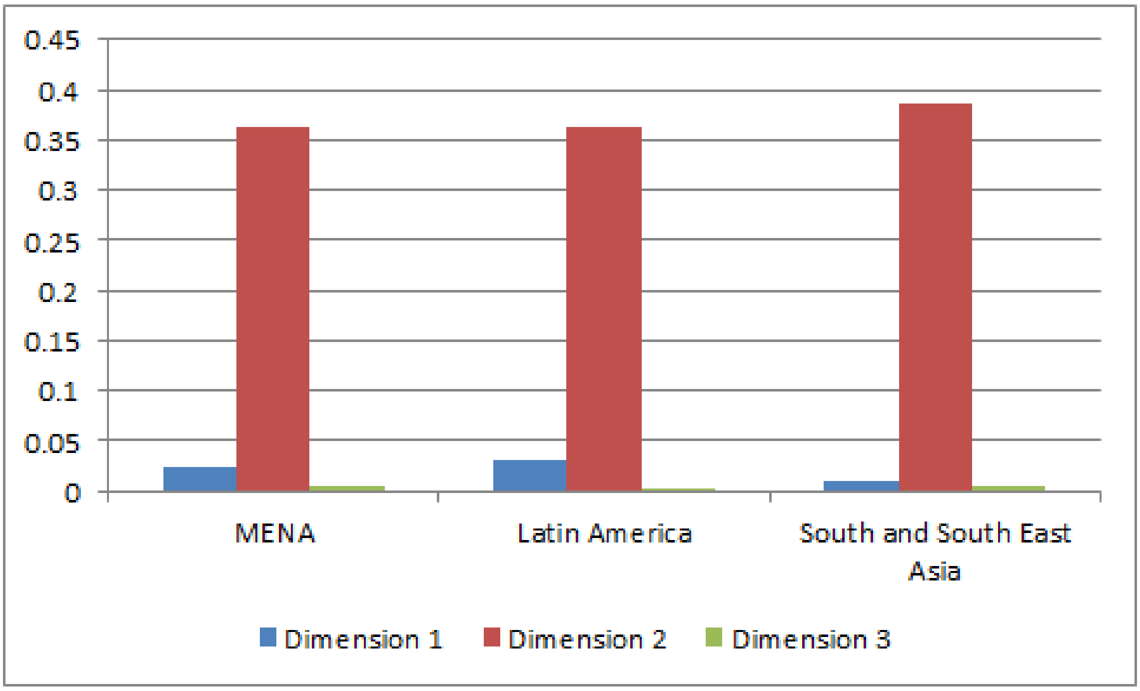

Figure 2.10: Mean CIP dimension scores in MENA, Latin America and South and South East Asia, 2016

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

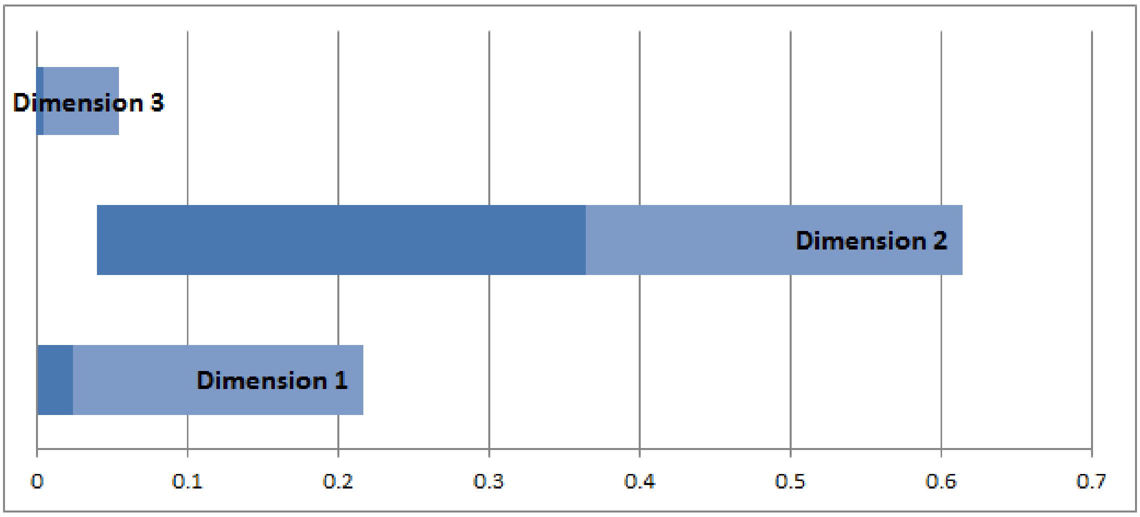

Figure 2.11: Score distribution, MENA

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Israel	28	3	5
2	Turkey	29	-3	-11
3	Saudi Arabia	36	-1	-6
4	United Arab Emirates	41	-13	-43
5	Qatar	50	-6	6
6	Bahrain	55	10	3
7	Kuwait	57	9	-15
8	Iran (Islamic Republic of)	58	0	-27
9	Tunisia	61	1	-2
10	Morocco	63	-6	-4
11	Oman	66	-2	-34
12	Egypt	73	3	-5
13	Jordan	80	6	-11
14	Lebanon	90	9	-8
15	Algeria	94	3	13
16	State of Palestine	111	-4	0
17	Syrian Arab Republic	112	17	15
18	Yemen	139	11	0
19	Iraq	146	-3	24

Table 2.5: Regional and global 2018 CIP rank, MENA
Source: UNIDO, 2018a.

2.3.6 North America

Table 2.6 shows that the leading industrialized economies in North America, i.e. the United States and Canada, have continued to experience reductions in their levels of industrial competitiveness. Both dropped further in the global rankings, overtaken by China and Czechia, respectively. Compared with other economies in the top quintile of the CIP Index, the United States and Canada have not been able to keep up with other countries' increases in manufacturing competitiveness in the top quintile of the CIP Index.

Figure 2.12 shows the performance of Bermuda, Canada and United States. While the result of the comparison between these three countries is quite obvious - as Bermuda has consistently been at the bottom quintile of the CIP Index; its manufacturing sector is very small, with most of the country's high GDP per capita being generated in the financial and insurance sectors by offshore firms - interesting insights can be drawn from the analysis of the countries' trends over time.

In the first dimension, Canada performs slightly better than United States and much better than Bermuda. Yet, all three countries suffered a drop in their capacity to produce and export manfuactured goods. The poor performance of the United States is directly due to a considerable lack of growth in MVA per capita and manufacturing exports per capita. The United States' low export activity is mainly attributable to the size of its domestic market and the importance of services for the economy, which are less tradable internationally. The low growth in manufacturing net output is part of a general trend towards deindustrialization in the United States and Canada, which is also reflected in a falling share of MVA in GDP in both countries.

This also has an impact on Dimension 2 of the CIP Index, which measures technological deepening and upgrading. Although manufacturing firms in the United States and Canada have historically been close to the technological frontier, they are facing increasing competition from abroad, in particular from East Asia, and have been unable to keep up with increases in competitiveness. It is also remarkable to witness the improvement shown in the Bermuda's CIP score in this dimension.

Finally, although the United States still has a very large impact on world manufacturing due to the size of its economy, its score in the third dimension of the CIP Index has also fallen dramatically due to the growth of China's manufacturing sector. Moreover, it is clear that the heterogeneity of these countries is much more profound here than in the other dimensions of the CIP.

Figure 2.13 shows that this region still performs best in technological upgrading, and that this is an area in which there is potential to overcome the current trends in the contraction of their manufacturing sectors. This could, in particular, occur through spillovers from high-tech firms into the manufacturing sector.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	United States of America	4	1	1
2	Canada	18	1	10
3	Bermuda	138	3	-9

Table 2.6: Regional and global 2018 CIP rank, North America
Source: UNIDO, 2018a.

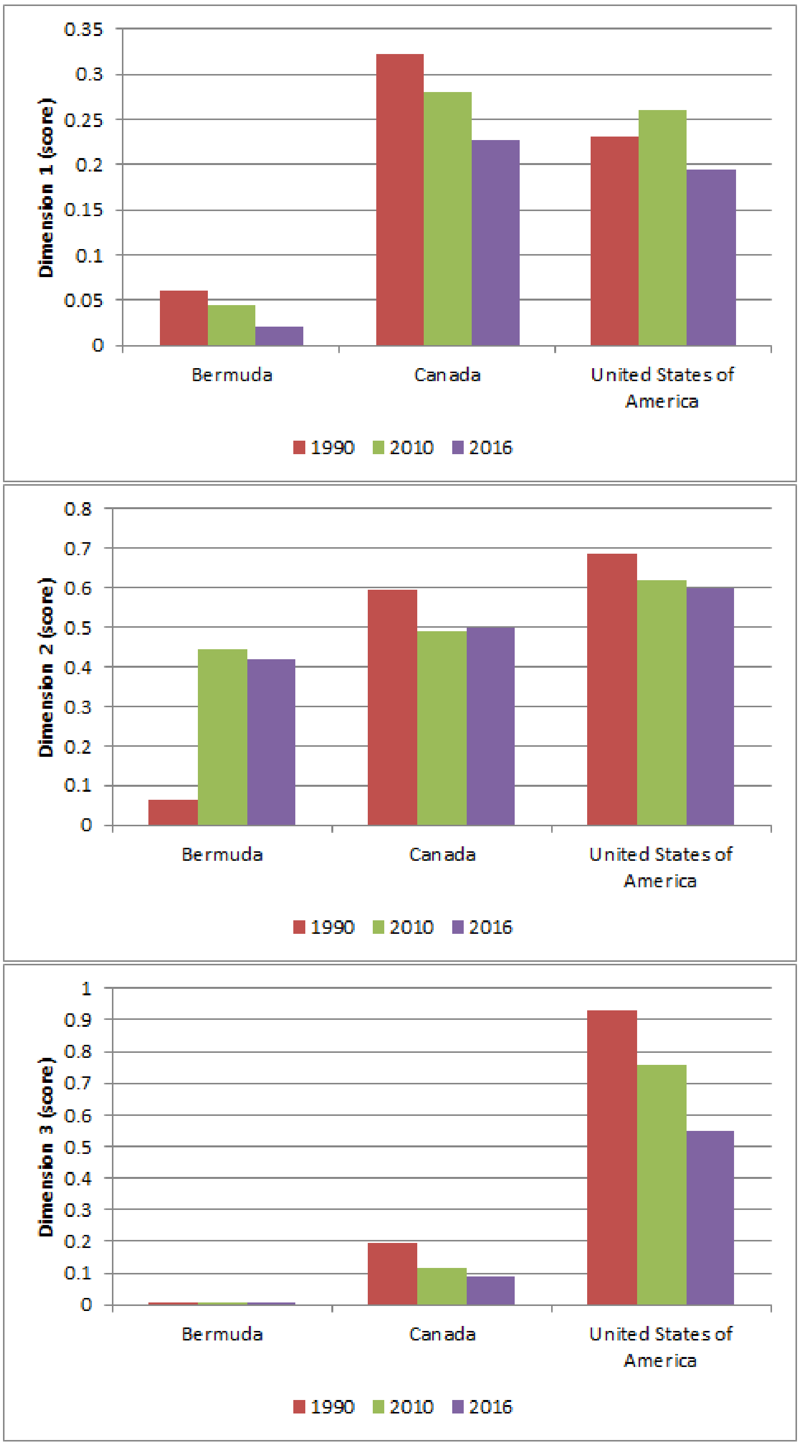

Figure 2.12: Scores in the three CIP dimensions, Bermuda, Canada and USA

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

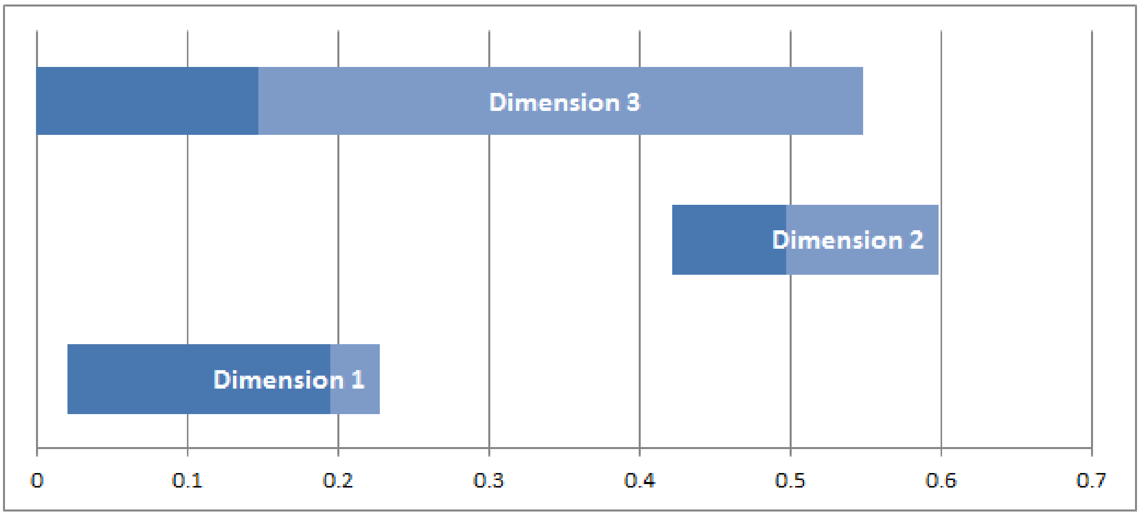

Figure 2.13: Score distribution, North America

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

2.3.7 South and South East Asia

Table 2.7 shows that countries in South and South East Asia represent multiple groups. The first, consisting of the top five countries in the regional rank, are found in the upper quintiles of the CIP Index. Led by Thailand, the region has experienced the strongest growth in manufacturing exports per capita of any region, as shown in Figure 2.14. From 2010 to 2016, the value of manufacturing exports in South and South East Asia nearly tripled.

Figure 2.14 also shows that while global trade was strongly affected by the financial crisis of 2007-2009, South and South East Asia recovered quickly in comparison to other regions, achieving average annual growth rates in manufacturing exports of 5.9 per cent between 2010 and 2016. As a result, most countries in South and South East Asia have been able to move up the CIP ranks since 1990. The major challenge remains the integration of those economies that have not experienced increased competitiveness in global value chains, to follow the paths of other South and South East Asian countries such as Thailand and Indonesia.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Thailand	25	1	-8
2	Indonesia	38	0	-13
3	India	39	-2	-21
4	Philippines	43	-10	-4
5	Viet Nam	44	-23	-50
6	Bangladesh	72	-8	-34
7	Sri Lanka	77	-1	-13
8	Pakistan	82	3	3
9	Brunei Darussalam	83	0	-13
10	Cambodia	88	-13	-38
11	Myanmar	91	-8	-47
12	Lao People's Dem Rep	101	-19	-27
13	Nepal	131	1	2
14	Maldives	142	-1	2
15	Afghanistan	144	4	20

Table 2.7: Regional and global 2018 CIP rank, South and South East Asia
Source: UNIDO, 2018a.

The most competitive countries in South and South East Asia improved their performance in Dimension 3 of the CIP Index considerably between 2010 and 2016. That said, the region still has a relatively small impact on global production and trade in manufactured goods.

Despite the size of its economy and recent growth, India's case is somewhat unusual in that the country's structural change moved the economy away from agriculture but it has not necessarily been accompanied by high productivity growth in manufacturing. Instead, its services sector has registered strong increases in productivity (Goel and Restrepo-Echavarria, 2015). The share of MVA in GDP has increased comparatively little in recent decades and for its size, India has little impact on global production and manufacturing exports. However, India's policies are now increasingly focusing on the promotion of the manufacturing sector (The Economist, 2014).

Further improvements in competitiveness in

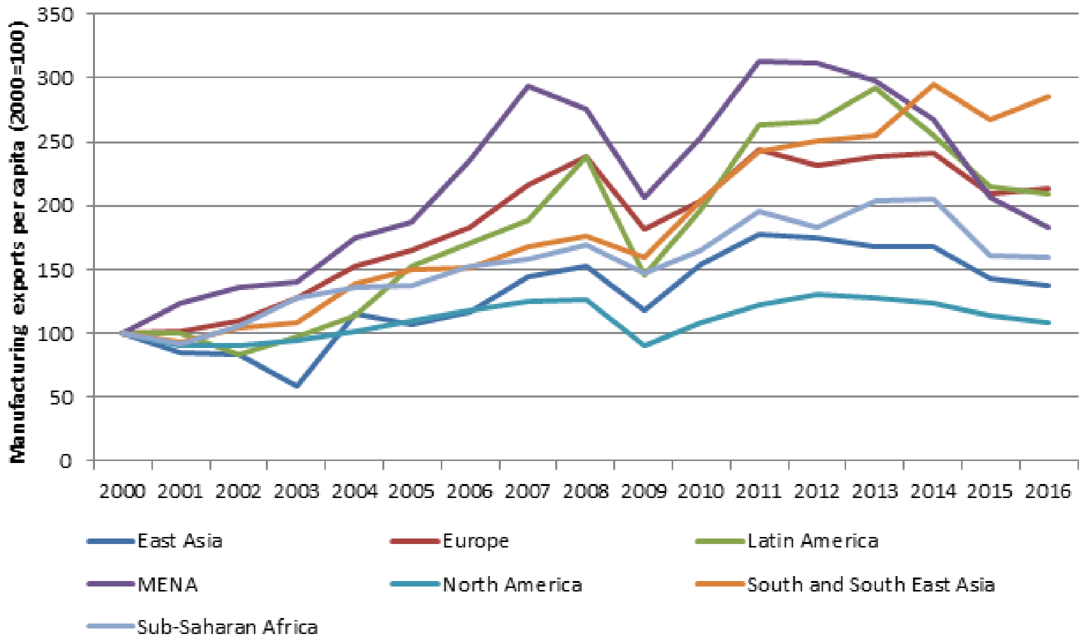

Figure 2.14: Manufacturing exports per capita by geographic region, 2000-2016

Source: UNIDO, 2018a.

the region depend on whether manufacturing in labour-intensive industries continues to shift from China to countries such as Viet Nam and Bangladesh, particularly in the apparel industry (Lopez-Acevedo and Robertson, 2016). Although this is at comparatively low stages of global value chains, it could be a first step towards increasing both MVA per capita and manufacturing exports per capita. Figure 2.15 shows that the region's performance is particularly poor in this regard (see dimension1). The majority of countries in South and South East Asia have invested heavily in transport infrastructure and education in recent years (World Economic Forum, 2016). This increases the likelihood that the growth of manufacturing production and exports will continue with greater capabilities to absorb new firms and investments.

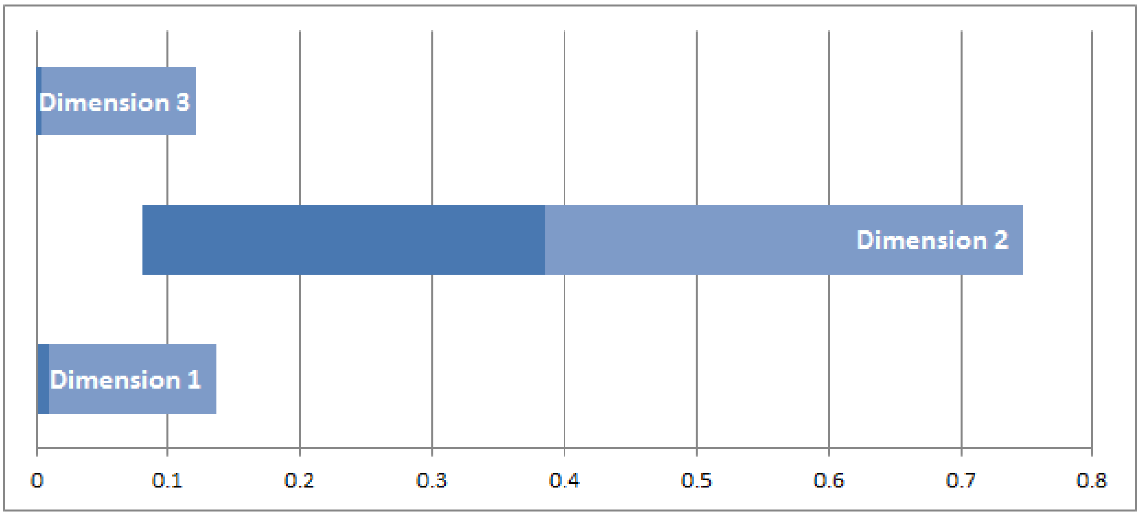

Figure 2.15: Score distribution, South and South East Asia

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

2.3.8 Sub-Saharan Africa

The manufacturing sectors of some countries in sub-Saharan Africa (SSA) have witnessed strong growth rates in recent years. The countries with the greatest expansion of their manufacturing sectors and the highest increases in competitiveness between 1990 and 2016 include Botswana, Ethiopia, Kenya, Mozambique and Rwanda. Their development is illustrated in Figure 2.16. Maintaining consistently high MVA growth rates poses a considerable challenge, even for the most successful countries in sub-Saharan Africa.

A large gap in industrial competitiveness between sub-Saharan Africa and other regions is still evident: with the exception of the top performers South Africa, Swaziland, Botswana and Mauritius, countries in sub-Saharan Africa are found in the bottom quintiles of the CIP Index (see Table 2.8). What is more, the majority of LDCs (14 out of 22 in the CIP Index) are in sub-Saharan Africa and all, with the exception of Senegal, are positioned in the lowest quintile of the CIP Index. Many of these countries have undergone a process of deindustrialization since 1990, as described in Box 1.2. This highlights the strong need for increases in competitiveness to drive structural change in Africa, thereby generating economic growth and providing jobs (Fox, Thomas, and Haines, 2017).

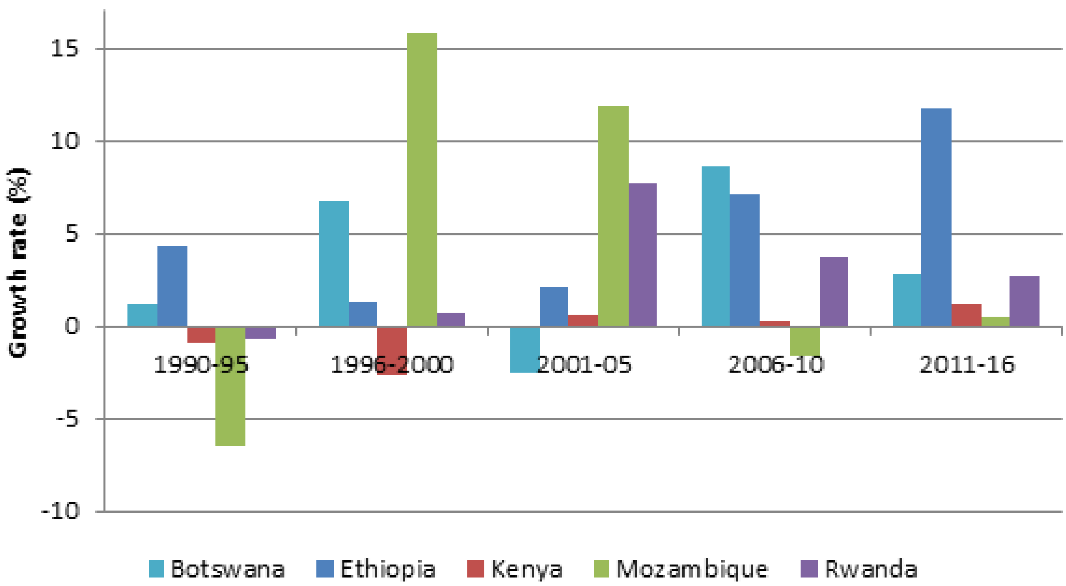

Figure 2.16: Average annual growth rates of MVA per capita, selected countries in SSA

Source: UNIDO, 2018a.

Figure 2.17 shows that the performance of sub-Saharan African countries in CIP Dimensions 1 and 3 is particularly poor. Yet some countries have made some advances in technological deepening and upgrading. This result is driven by comparatively sophisticated manufacturing production systems in Swaziland and South Africa.

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	South Africa	45	5	2
2	Swaziland	84	2	14
3	Botswana	85	-5	3
4	Mauritius	86	0	20
5	Namibia	95	8	9
6	Kenya	103	-1	0
7	Côte d'Ivoire	105	12	6
8	Senegal	108	2	-4
9	Gabon	109	-2	-12
10	Congo	113	1	-21
11	Nigeria	115	27	-8
12	Cameroon	117	8	12
13	Zambia	119	2	-6
14	Ghana	123	-4	4
15	Zimbabwe	124	8	31
16	Mozambique	125	-14	-17
17	Madagascar	126	1	-1
18	United Republic of Tanzania	127	6	-10
19	Uganda	129	-2	-15
20	Angola	130	-2	-11
21	Central African Republic	132	-10	2
22	Malawi	134	1	-2
23	Cabo Verde	136	-2	1
24	Niger	140	-1	9
25	Rwanda	141	-3	-8
26	Ethiopia	143	-4	-5
27	Gambia	145	-1	0
28	Burundi	148	3	5
29	Eritrea	149	1	3

Table 2.8: Regional and global 2018 CIP rank, sub-Saharan Africa

Source: UNIDO, 2018a.

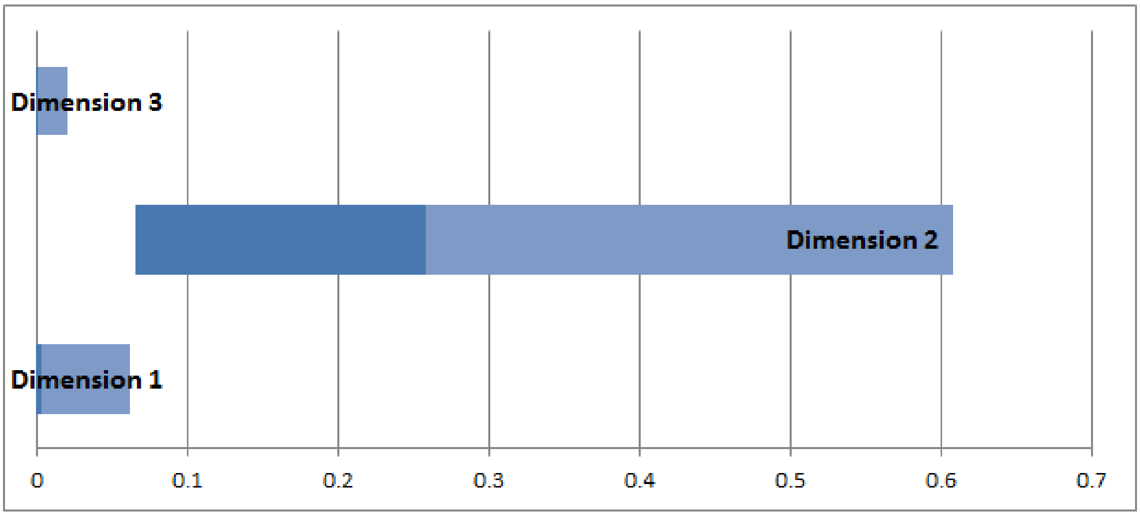

Figure 2.17: Score distribution, sub-Saharan Africa

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

2.3.9 Other Asia and Pacific

Table 2.9 shows that the region of other Asia and Pacific is composed by a heterogeneous group of countries that still shares similar weaknesses in industrial competitiveness. With the exception of Kazakhstan, all countries of this region rank in the bottom or lower middle quintile of the ranking. Yet, Armenia and Mongolia have shown some major improvements in their industrial competitiveness during the current decade, 2010-2016.

A closer look into the different dimensions of competitiveness shows that this group of countries faces major difficulties at producing and exporting their manufactured goods and their challenge in even bigger in international market as they have almost no impact. Moreover, despite having a limited technological deepening, these countries seem to perform much better in this dimension than in the other two (see Figure 2.18).

			Absolute change in rank	
Regional rank	Country	Global rank	2010-2016	1990-2016
1	Kazakhstan	69	5	5
2	Armenia	99	-11	11
3	Mongolia	102	-11	-16
4	Azerbaijan	107	4	24
5	Fiji	116	2	21
6	Papua New Guinea	120	-2	3
7	Kyrgyzstan	121	-3	29
8	Tajikistan	133	4	20
9	Tonga	150	0	0

Table 2.9: Regional and global 2018 CIP rank, North America

Source: UNIDO, 2018a.

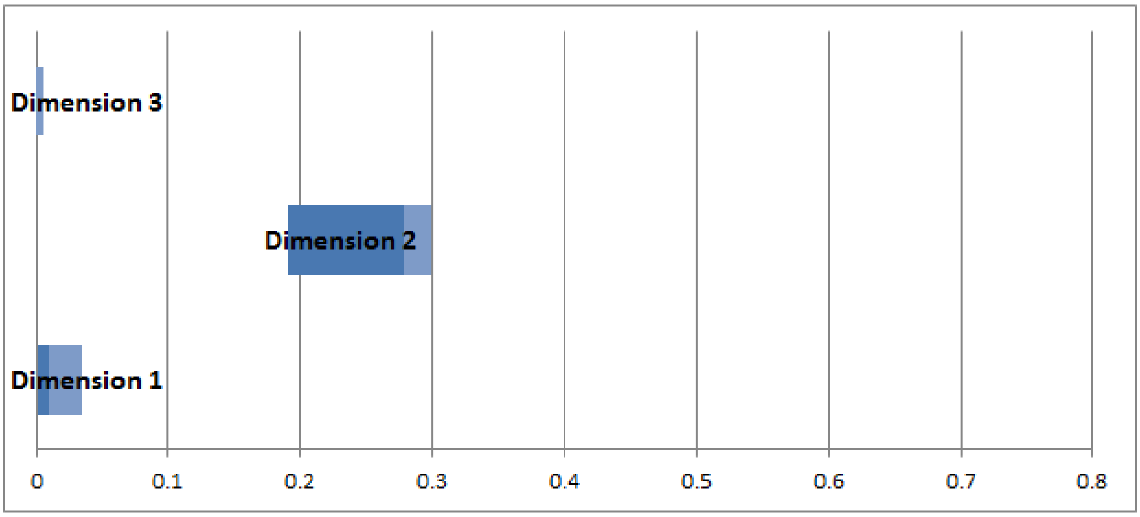

Figure 2.18: Score distribution, Other Asia and Pacific

Source: UNIDO, 2018a. Note: Dimension 1: Capacity to produce and export; Dimension 2: Technological deepening and upgrading; Dimension 3: World impact.

2.4 By indicator

2.4.1 Main findings by indicator

The following subsection assesses aggregate results in each of the three dimensions of the CIP Index as well as the indicators they cover. It also presents longer-term trends to determine how competitiveness is changing at the global level, as well as the drivers of those changes and their policy implications.

Table 2.10 presents a summary of the mean ranks within each CIP indicator for a combination of the development groups and geographic regions considered in the previous sections of the CIP report. The vertical lines separate the three dimensions of the CIP Index. The following subsection discusses each dimension and the corresponding indicators in detail, with reference to Table 2.10.

2.4.2 Dimension 1: Capacity to produce and export manufactured goods

The lower the mean CIP rank within a specific subgroup in Table 2.10, the greater the average level of its countries' competitiveness. The table reveals a number of important findings from the CIP Index. First, the average gap in competitiveness between industrialized economies and the rest of the world is particularly large for both indicators measuring the capacity to produce and export manufactured goods. The distance between a few countries in the top quintile and the rest is visible in Figure 2.19. The figure plots the relationship between CIP Indicators 1 and 2, MVA_{pc} and MX_{px}, and demonstrates that few countries dominate both indicators. The frontier in Dimension 1 consists of Ireland, Switzerland, Singapore and Belgium.

Only LDCs were able to partially reduce the average gap in the rankings of at least one of the two indicators of the first CIP dimension between 2010 and 2016: manufacturing exports per capita. This was mainly due to the remarkable export performance of Bangladesh and Myanmar. Emerging industrial economies, by contrast, fell behind in the rankings of the first indicator due to the drop in export performance which was particularly high across some countries from Latin America and from the Middle East. This dynamic was not the same across regions, however. For example, the positions of European industrialized economies, emerging industrial economies and other developing economies in the first two indicators improved. At the same time, emerging industrial economies from East Asia (mainly driven by China) made substantial gains in the ranking.

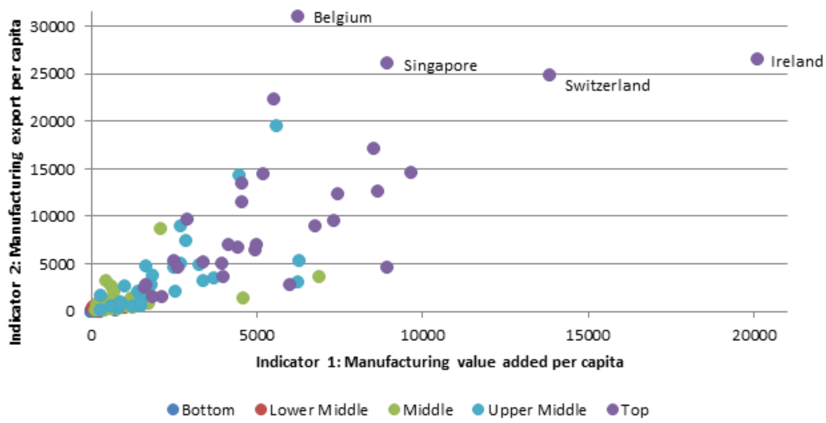

Figure 2.19: Indicator 1 and 2 performance, 2016

Source: UNIDO, 2018a.

Country group	Manufacturing value added per capita (MVApc)	Manufacturing export per capita (MX_{pc})	Industrialization intensity (INDint)	Medium and high-tech value added share in total MVA ($MHVA_{sh}$)	Share of MVA in GDP (MVA_{sh})	Export quality ($MXQual$)	Medium and high-tech export share in total exports (MHX_{sh})	Share of manufacturing exports in total exports (MX_{sh})	Impact on world manufacturing ($ImWMVA$)	Impact on world manufacturing exports ($ImWMT$)
Industrialized Economies	**27**	**28**	**42**	**34**	**61**	**47**	**45**	**56**	**46**	**40**
East Asia	38	41	50	39	65	57	52	63	43	42
Europe	22	19	34	30	50	34	34	44	41	34
Latin America	40	32	27	33	33	68	74	79	86	78
MENA	29	33	58	45	91	101	84	99	58	57
North America	36	60	71	39	107	43	43	51	55	55
Emerging Industrial Economies	**60**	**66**	**58**	**63**	**57**	**67**	**63**	**74**	**53**	**56**
East Asia	41	57	5	27	2	13	28	6	1	1
Europe	61	51	61	57	67	43	51	49	70	59
Latin America	58	75	64	71	62	92	80	98	51	60
MENA	62	72	51	53	58	80	64	88	42	50
South and South East Asia	59	77	39	61	23	53	45	75	34	46
Sub-Saharan Africa	62	63	78	89	58	65	91	47	70	71
Other Asia and Pacific	62	80	101	98	90	102	59	124	53	67
Other Developing Economies	**102**	**99**	**102**	**101**	**94**	**94**	**99**	**86**	**102**	**101**
Europe	99	90	106	101	101	78	95	73	120	109
Latin America	90	88	93	89	91	84	94	70	106	104
MENA	107	105	104	97	101	90	95	89	86	91
South and South East Asia	99	96	68	77	56	70	90	61	67	66
Sub-Saharan Africa	108	105	105	111	99	112	110	103	99	106
Other Asia and Pacific	112	108	126	125	107	107	98	105	126	117
Least Developed Countries	**136**	**131**	**110**	**119**	**90**	**103**	**103**	**93**	**111**	**118**
Latin America	133	144	122	131	89	88	140	53	125	136
MENA	141	145	128	145	104	104	73	116	108	138
South and South East Asia	124	116	92	119	58	94	122	69	88	93
Sub-Saharan Africa	140	136	115	116	102	108	95	105	120	125

Table 2.10: Changes in mean indicator ranks between 2010 and 2016, by development stage and geographic region

Source: UNIDO, 2018a. Note: Red denotes a downward shift (deterioration) in the mean rank greater than one place, and green an upward shift (improvement) greater than one place. For a detailed description on the headers of each column, please see Appendix A.1

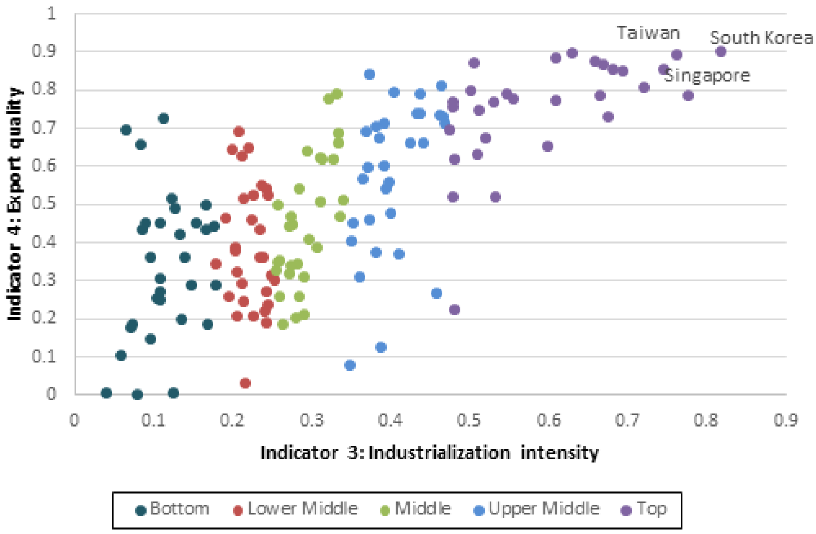

Figure 2.20: Indicator 3 and 4 performance, 2016

Source: UNIDO, 2018a.

2.4.3 Dimension 2: Technological deepening and upgrading

East Asian economies, with their successful industrial policies of export-orientation and technological adoption—discussed in previous sections of the report—are at the frontier of Dimension 2, which measures technological deepening and upgrading. However, East Asia was unable to increase its average competitiveness in this dimension between 2010 and 2016 and they even dropped some positions in the export quality ranking. Figure 2.20 shows that the countries at the frontier of the two indicators of Dimension 2 are all from the East Asia region, with the Republic of Korea, Taiwan ROC and Singapore leading the ranks in technological deepening and upgrading.

Table 2.10 indicates that despite the clear dominance of emerging industrial East Asian countries, there is considerably less inequality between groups at different development stages in the second dimension of the CIP Index than in the first one. This is particularly valid when looking at the export quality indicator (and its subindicator of share of manufacturing exports in total export), as it was also characterized by greater convergence between 2010 and 2016. The average rank of industrialized economies in this indicator worsened. The opposite took place in LDCs, and therefore, the distance in export quality between the most developed and less developed countries was considerably reduced.

The industrialization intensity indicator shows mixed results. Indeed, while industrialized economies improved their industrialization intensity between 2010 and 2016, other developing economies worsened due to the fall in performance of Latin American and MENA countries. Despite the improvement of Haiti and other LDCs in the South and South East Asian region, the group of LDCs was not able to move up in its ranks in this indicator.

2.4.4 Dimension 3: World impact

Finally, rankings in Dimension 3 of the CIP Index, *World Impact*, are highly correlated with a country's level of industrialization as well as the size of its economy. Figure 2.21 shows that the five most competitive countries according to the 2018 CIP rankings—Germany, Japan, China, the United States and the Republic of Korea—dominate share of world MVA and share of world manufacturing exports.

Those five countries are responsible for 58 per cent of global MVA and 44 per cent of global trade in manufactured goods (China alone accounted for 24 per cent and 17 per cent, respectively). The top quintile dominates both indicators in general, with 81 per cent of world MVA and 87 per cent of world manufacturing trade. There is a continuing concentration of global MVA and trade in manufactured goods among East Asian countries. While the Republic of Korea kept its share constant and China increased its share considerably between 2010 and 2016, the other three countries witnessed reductions in both indicators. Few other countries were able to increase their shares and thus "keep up" with increases in competitiveness in China. These include India, Ireland (see Box 1.3), Indonesia and Poland – countries with particularly strong manufacturing growth between 2010 and 2016.

Countries in the bottom quintile of the CIP Index are responsible for less than 1 per cent of global MVA and trade in manufactured goods. Moreover, Table 2.10 shows that the competitiveness of LDCs in the indicators measuring world impact shows an small improvement. This, however, is the result of the improvement of few countries (mainly from South and South East Asia) rather than a systemic movement of the entire LDCs. As a result, manufacturing production and trade continue to be very much concentrated in industrialized countries.

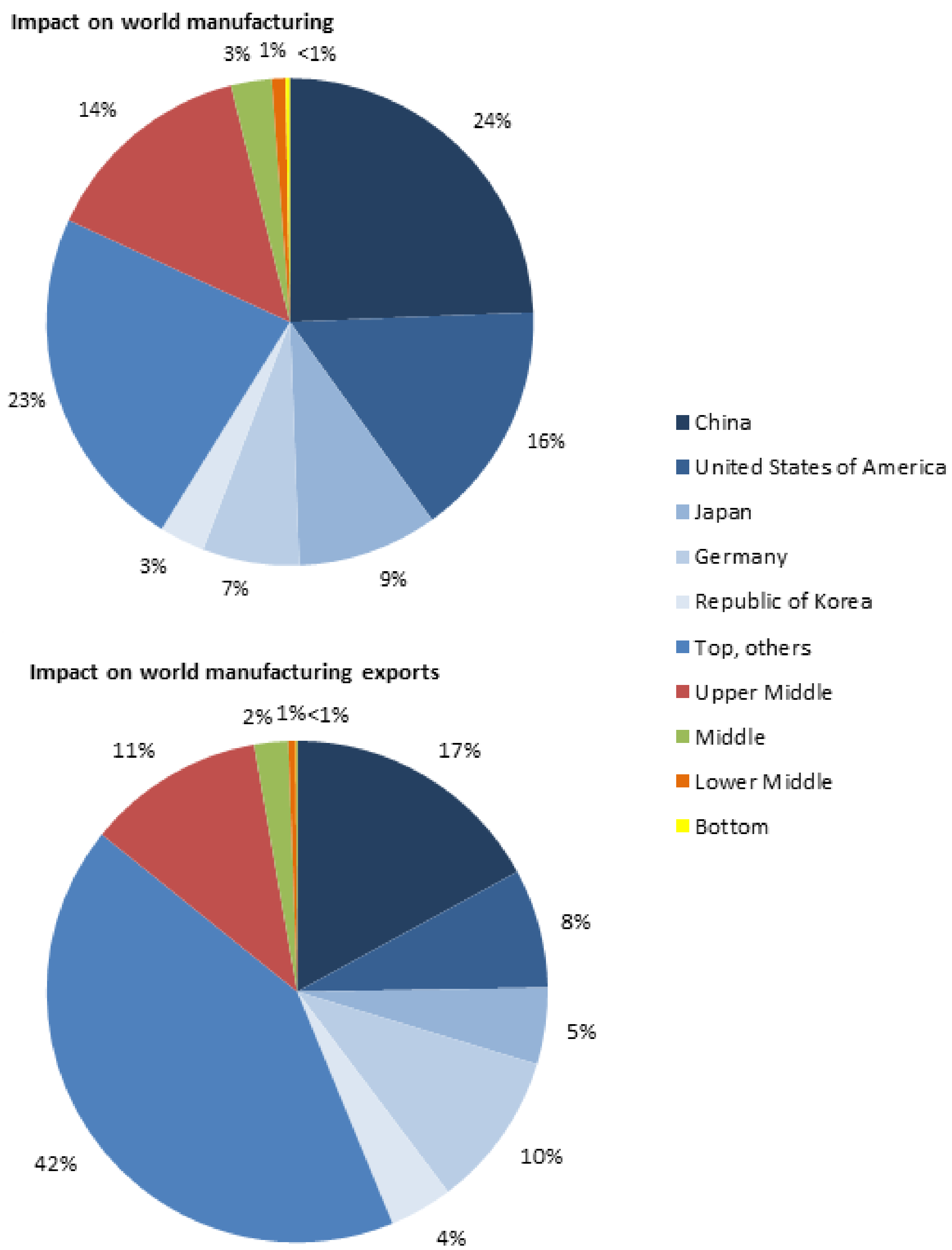

Figure 2.21: Shares of world MVA and world manufacturing trade, 2016

Source: UNIDO, 2018a.

CIP report 2018: Chapter 3

3. CO_2-adjusted CIP Index

3.1 Introduction to the CO_2-adjusted CIP Index

3.1.1 General considerations

Industrialization is a key driver of structural change, increased incomes and greater welfare. Yet manufacturing production also contributes to the degradation of local and global ecosystems through resource use and pollution (United Nations Environment Programme, 2011). The previous chapter of the CIP report approximated the relative success of a country's manufacturing sector on the basis of its manufacturing net output, value of exports and other economic measures. These are important indicators of a country's success in increasing economic prosperity; but the economic value of production does not fully reflect the contribution of a sector to overall prosperity. Moreover, MVA does not account for the external, uncompensated environmental effects of manufacturing. These effects can damage ecosystems, put their essential services at risk and thus decrease human welfare.

Industrial production can have numerous negative environmental effects, with impacts ranging from the local to the global scale. Manufacturing may contribute to the overstepping of planetary boundaries (Rockström et al., 2009). For example, when natural habitats vanish to be replaced by infrastructure for production or natural resource extraction, biodiversity is jeopardized. Similarly, an over-extraction of natural resources such as water or timber for production puts pressure on natural systems. The manufacturing material footprint, which measures the sector's total material requirements, is thus an important indicator for assessing the natural resources used in production across value chains. Beyond the inflow of natural resources for production, the outflow of waste products from production can pollute soil and water sources with chemicals or increase the concentration of greenhouse gases in the atmosphere.

Degradation of "natural capital" has high social and economic costs (Nordhaus, 2017). These are difficult to measure and vary depending on the sector of the economy, the location and the time scale (Tol, 2018). For example, global warming can negatively impact industrial competitiveness[1] and production capabili-

[1] Although some industries may benefit from climate change, the adjusted CIP Index assumes that the long-term macroeconomic effect on industrial competitiveness is negative (Tol, 2018).

ties through frequent climate catastrophes, which lead to the destruction of infrastructure and other physical capital. Equally, the social, economic and political uncertainty resulting from climate change may divert investment away from productivity-enhancing innovations. It is important to note, however, that manufacturing is less vulnerable to climate change than agriculture.

The present chapter focuses on the relationship between industrial competitiveness and CO_2 emissions, the main cause of anthropogenic global warming. The adjustment extends the CIP Index as a measure to also incorporate the negative environmental effects of manufacturing. To this end, it incorporates CO_2 emissions data for the manufacturing sector collected by the International Energy Agency (IEA). The adjustment accounts for the damage caused to ecosystems by large, emissions-intensive industries by reducing the CIP scores accordingly.[2]

The adjustment of the CIP Index on the basis of CO_2 emissions rearranges the CIP rankings to the benefit of countries that effectively protect natural capital by realizing measures for pollution abatement in manufacturing. Conversely, countries in which manufacturing is particularly harmful to the environment receive lower scores in the adjusted CIP Index and move down the rankings. There is a lot of potential—and an environmental need—to reduce emissions from manufacturing industries in these countries. The adjusted CIP Index serves as an additional instrument in cross-country comparisons of competitiveness by taking environmental externalities into account.

This reflects the notion that there might be a trade-off between MVA growth and emissions reductions, for example, when countries introduce stringent environmental policies or carbon taxes (Cifci and Oliver, 2018). These countries may, as a result, have smaller manufacturing sectors, and may appear less competitive in the unadjusted CIP Index compared to countries with high levels of pollution. Yet by acknowledging and compensating for the environmental costs of production, countries that invest in pollution abatement mitigate pressure on ecosystems, the value of which is not otherwise accounted for.

The premise of the adjusted CIP Index is that greater competitiveness can be achieved by improving emission efficiency[3], i.e. reducing emissions per unit of MVA. Efficiency gains can be achieved with technological innovations, new forms of cooperation or improvements in institutions and management. Greater efficiency, in turn, can reduce the quantity of carbon-based resources as inputs in production – the primary path to lower CO_2 emissions from manufacturing (United Nations Environment Programme, 2011).[4] At the same time, promoting a circular economy that retains value within production processes by reusing, repairing and refurbishing existing manufactured goods can reduce dependency on the production of emissions-intensive materials without negatively impacting welfare (Nasr et al., 2018).

In addition to production's emission intensity, the adjustment of the CIP Index is also based on countries' manufacturing carbon footprints. This reflects the notion that the responsibility for reducing emissions is not the same globally. Some countries contribute a far greater share to overall global natural capital depletion and thus play a key role in the global effort to reduce manufacturing emissions. Economic measures are less suited to adequately evaluate the contribution of manufacturing to welfare in countries that cause greater environmental harm.

The section 3.2 of this chapter presents an overview of trends in emission efficiency and

[2]Limiting the analysis to CO_2 emissions only exposes one dimension of the relationship between competitiveness and the negative environmental externalities of manufacturing. This is problematic because the results may differ for other types of emissions, such as Sulphur oxides, nitrogen oxides or particulate matter (Naqvi and Zwickl, 2017; OECD, 2002). Brinkley and Less, 2010, for example, finds that CO_2 emissions reduction in the manufacturing sectors of Denmark and the Netherlands was the result of substituting coal and oil for natural gas. Although natural gas emits less CO_2, it also releases large amounts of methane, another greenhouse gas linked to global warming. However, due to a lack of data on other environmental externalities from the manufacturing sector, our analysis is limited to CO_2 emissions.

[3]Emission efficiency is defined as the inverse of emission intensity – countries with low CO_2 emissions per unit of MVA have low emission intensity and high emission efficiency.

[4]UNIDO's 2011 Industrial Development Report focuses on the importance of energy efficiency for sustainable industrial development in detail UNIDO, 2011.

total emissions from manufacturing across quintiles of the CIP Index. It thereby extends the analysis of previous sections of the CIP report by focusing on the two dimensions that determine country-specific impacts of manufacturing, i.e. CO_2 emissions on the environment. The section 3.3 describes the method and reasoning used to adjust the CIP Index on the basis of CO_2 emissions. And the section 3.4 discusses the results of the adjustment and their implications.

Box 3.1: The CO_2-adjusted CIP Index in the context of the SDGs

Reconciling industrial development and emissions reductions is key to achieving the 17 SDGs. As discussed in Chapter 1, SDG Target 9.2 aims to "significantly raise industry's share of employment and national product" by 2030. In least developed countries, the goal is to double the share of MVA in GDP and the share of manufacturing employment in total employment. At the same time, environmental targets are embedded in the SDGs, for example, in SDGs 12 (*Responsible Consumption and Production*), 13 (*Climate Action*) and 15 (*Life on Land*).

The need to limit global warming by reducing CO_2 emissions is reiterated in numerous international treaties. In the 2015 Paris Agreement, for example, 175 countries have committed to limiting global warming to below 2^oC above pre-industrial levels. A recent Intergovernmental Panel on Climate Change (IPCC) report goes even further: it argues that a temperature rise of 1.5^oC above pre-industrial levels in the coming decades already poses considerable climate risks for humans and ecosystems. This is a highly likely scenario unless emissions reductions can be achieved. By 2017, human activity had already caused average global temperatures to increase by approximately 1^oC relative to pre-industrial levels (Masson-Delmotte et al., 2018). There are complex feedback processes between human and natural systems. Global natural capital depletion through emissions threatens the social foundation industrialization seeks to improve. For example, if climate change reduces crop yields, leads to the destruction of physical capital and threatens livelihoods, the purpose of structural change and increased manufacturing competitiveness is undermined. In short, *sustainable development* implies that environmental goals cannot be separated from greater human welfare (through industrialization) (Robert, Parris, and Leiserowitz, 2005). This is of particular significance because climate risks are not distributed equally: the most vulnerable population groups are also those in LDCs who have most to gain from poverty reduction, from increased gender equality and other benefits of industrialization (Tol, 2018).

The CO_2-adjusted CIP Index facilitates the integration of environmental considerations in industrial policy design. It serves to compare countries' relative success in achieving emission-efficient industrialization and synergies in the SDGs. Yet achieving these goals simultaneously is extremely challenging. Reducing CO_2 emissions can be thought of as contributing to the global public good of a "clean" atmosphere with a limited amount of greenhouse gases (Samuelson, 1954). This means that individual countries do not reap the full benefits of their own investment in pollution abatement and there is an incentive for countries to not reduce their emissions. It is therefore important to highlight those countries that set the benchmark in achieving industrialization with minimal environmental damage.

3.2 Emission efficiency and carbon footprint

3.2.1 The global distribution of production and emissions

A disproportionate share of global CO_2 emissions comes from industrial production: in 2015, manufacturing contributed around 16 per cent of global total value added, but 36 per cent of CO_2 emissions (IEA, 2018). CO_2 is released through two channels in industrial production. Most manufacturing emissions are the result of energy generation – either directly from combustion of fossil fuels, such as oil, coal and gas or indirectly by purchasing electricity. Chemical processes in various forms of production, for example, in the cement, chemical and metal industries, also cause considerable CO_2 emissions (Andrew, 2018).

The production of manufactured goods is central to industrialization and structural change. Yet the type of goods being produced, as well as their production processes, can vary considerably between countries and across time. As a result, there are large variations in the extent to which manufacturing negatively impacts ecosystems. The following section presents a descriptive analysis of the two dimensions used to adjust the CIP Index: emission intensity, measuring both the efficiency of the technologies used to generate value added and the energy requirements of goods; and the carbon footprint, measuring each country's per capita impact on global environmental degradation.

3.2.2 Emission intensity

Emission intensity measures the quantity of CO_2 emitted per unit of MVA. Figure 3.1 depicts the relationship between countries' emission intensity and MVA per capita. There is a negative correlation: on average, countries with the lowest levels of industrialization and the least competitive industries are those with the highest emission intensities. For example, countries in the bottom quintile of the CIP Index emit, on average, around one metric tonne of CO_2 per unit of MVA. The average emission intensity is less than one-quarter of that in countries that are in the top quintile of the CIP Index. The emission intensity of production decreases when moving from less competitive countries with low levels of industrialization to more competitive, highly industrialized countries.

This relationship is determined by changes in *sector specialization* and *technology adoption* that accompany structural change: a country's emission intensity thus depends on the features of its production (Borghesi, Cainelli, and Mazzanti, 2015; Balibey, 2015). Both of these dimensions determine the relationship between industrialization and emission efficiency. Manufacturing in low-income countries is largely concentrated in the food and beverages, textiles and apparel industries. These industries are at the bottom of global value chains, with little value being added to production (UNIDO, 2018b). These industries do not have particularly large levels of overall emissions (as discussed in the following sub-section), yet the particularly low value added means that production is comparatively emissions-intensive.

In countries in the middle and upper middle quintiles of the CIP, MVA per capita is considerably higher. Manufacturing production shifts to medium-technology goods, for example, metals, cement and chemicals. These industries have high levels of overall emissions, but also contribute with comparatively high levels of value added to the economy. As a result, the emission efficiency remains fairly constant in the CIP Index's bottom four quintiles.

As countries reach high levels of competitiveness, their products, processes and organizational structures become more efficient through ecological innovations. This leads to reductions in emission intensity. Moreover, an additional "natural" structural change in manufacturing production evolves as countries industrialize. Industrialized countries with greater (human) capital availability specialize in more high-technology, capital-intensive goods, such as electronics. The emission level of high-technology industries is

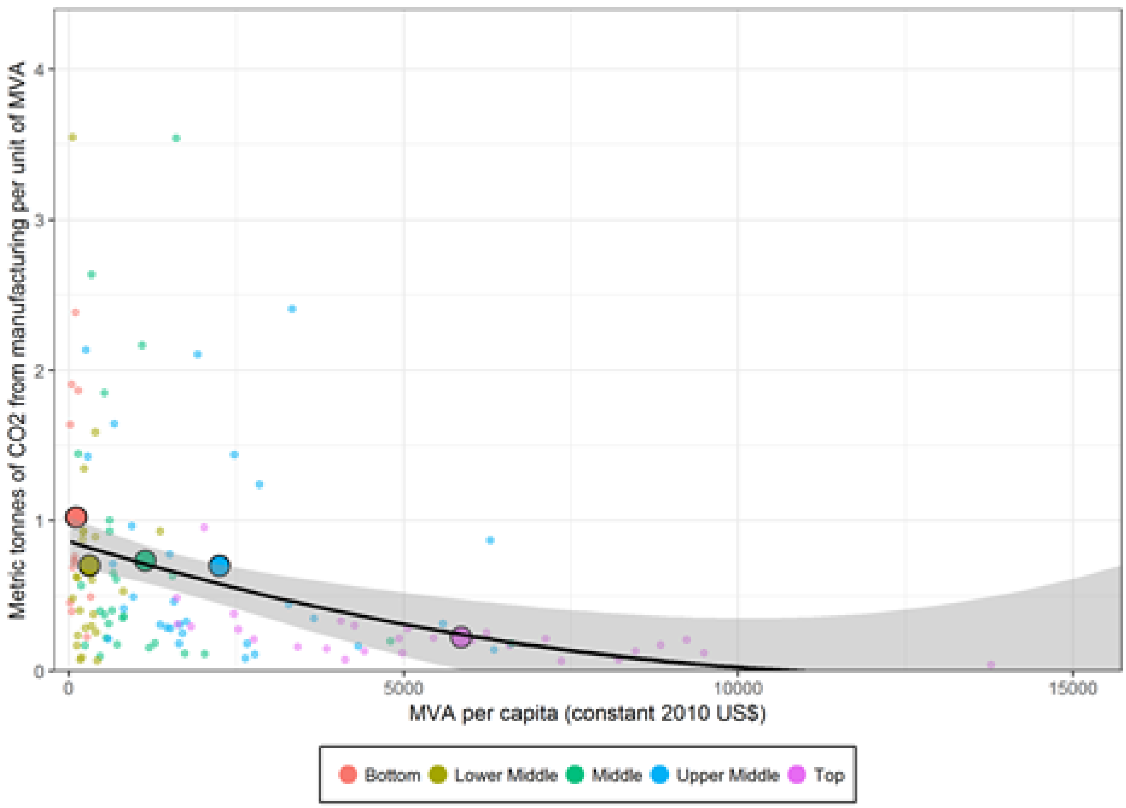

Figure 3.1: MVA per capita and CO_2 emissions from manufacturing per unit of MVA, 2000-2015

Source: UNIDO, 2018a and UNIDO, 2018d. Note: Larger circles correspond to quintile means.

low while their MVA is high. Hence, the emission intensity of manufacturing is low. The three countries with the greatest emission efficiency in 2015 were European countries in the top CIP quintile: Ireland, Switzerland and Denmark.

3.2.3 The manufacturing carbon footprint

Total annual CO_2 emissions from manufacturing correspond to the manufacturing sector's carbon footprint. Both the scale and efficiency of production determine the size of the manufacturing carbon footprint: the net output of manufacturing goods requires a specific amount of energy, most often through combustion of CO_2 emitting resources, while emission intensity determines the quantity of CO_2 emitted per unit of MVA (Nordhaus, 2017).

In 2015, 5.8 billion tonnes of CO_2 were emitted in global manufacturing production to generate US$ 11.8 trillion of MVA. The manufacturing sector thus contributed over one-third to total global CO_2 emissions, when accounting for indirect emissions from electricity and heating (IEA, 2018). Figure 3.2 shows that total CO_2 emissions from manufacturing increased by 59 per cent between 2000 and 2015.

Carbon footprints and emission intensity are distributed highly unequally between country groups (Piketty and Chancel, 2015). Figure 3.2 shows the level of variation in total manufacturing emissions between the CIP Index's quintiles. Countries in the top quintile were responsible for 70 per cent of global CO_2 emissions from manufacturing in 2015. In absolute terms, the CO_2 emissions of the top CIP quintile increased

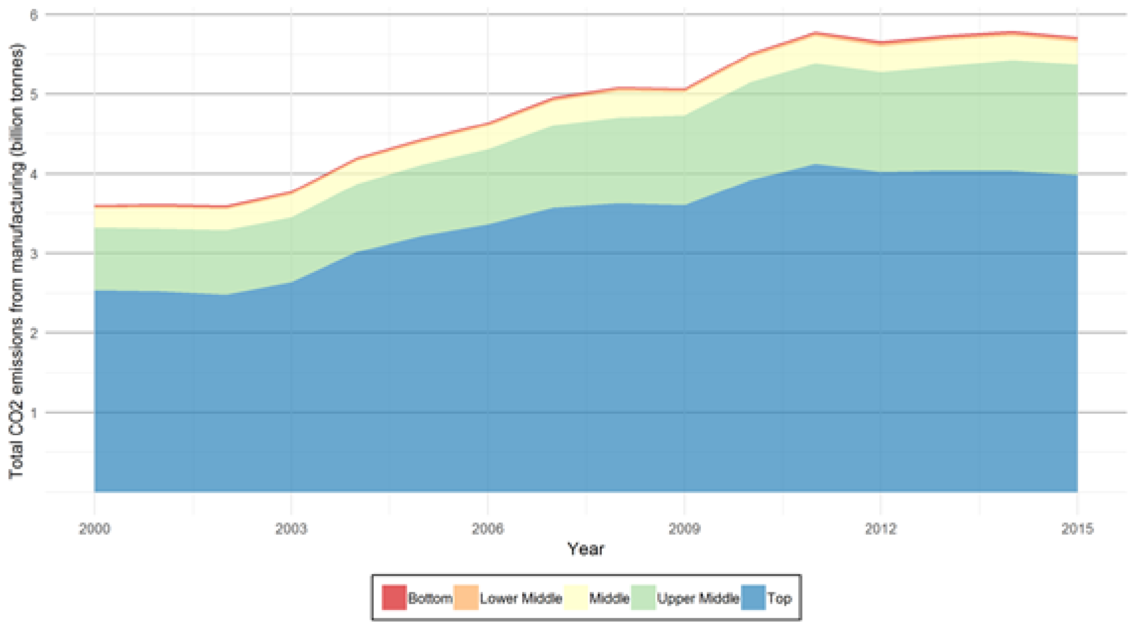

Figure 3.2: Total CO_2 emissions from manufacturing by CIP Index quintile, 2000-20155
Source: UNIDO, 2018a and UNIDO, 2018d.

from 2.5 billion tonnes to 4.0 billion tonnes between 2000 and 2015. Yet, as already mentioned, these countries also had the greatest emission efficiency, producing 83 per cent of global MVA in 2015. At the same time, Figure 3.2 shows that the average growth rate of CO_2 emissions in countries found in the CIP Index's upper quintile has not been constant over time. While emissions rose considerably between 2000 and 2010—driven mainly by manufacturing growth in China—the annual emissions in the top CIP quintile essentially stagnated between 2010 and 2015.

The manufacturing sector of the countries in the CIP Index's upper middle quintile were responsible for over one-third of global manufacturing CO_2 emissions and one-quarter of global MVA. From 2000 to 2015, their share of the world's manufacturing CO_2 emissions increased by five percentage points. By contrast, the countries in the bottom CIP quintile, consisting mostly of countries with the least competitive industries (the majority of which are in sub-Saharan Africa) were responsible for just 0.3 per cent of global CO_2 emissions and 0.2 per cent of MVA in 2015. There was little change in either share between 2000 and 2015.

In addition to an increase of one-third in total manufacturing output, other factors are also linked to the rise in the carbon footprints of emerging industrial economies, including India, Mexico, Indonesia and China (which is in the upper quintile of the CIP Index). Rapid urbanization has taken place in developing and transition economies, particularly China. This has led to a doubling of the highly emissions-intensive production of cement, as demand for construction materials has increased (IPCC, 2014; Andrew, 2018). The cement industry alone is responsible for 5 per cent of global CO_2 emissions (IEA, 2018). Thus, while structural change has contributed to large-scale poverty reduction in emerging industrial economies over the past 50 years, it has also been accompanied by an increase in both the scale and emission intensity of industrial production in those countries (IPCC, 2014; UNIDO, 2018b).

Box 3.2: Comparing annual and historical emissions in the adjusted CIP Index

The adjusted CIP Index only accounts for CO_2 emissions within a given year. As such, it does not consider the historical responsibility of countries to emissions abatement – for example, the majority of industrialized economies have emitted CO_2 for up to 150 years, while emerging industrial economies have only contributed several decades of manufacturing emissions. Before achieving high levels of emission efficiency, most countries underwent a process of structural change that involved the production of emissions-intensive goods. As the stock of CO_2 particles in the atmosphere has caused the rise in the level of anthropogenic warming, these countries can be considered to have contributed proportionately more to climate change than less developed countries. The main purpose of the CO_2-adjusted CIP Index, however, is to supplement the ranking of countries' competitive industrial performance in a given year. Countries that have achieved high levels of emission efficiency should serve as benchmarks to others. It is therefore important to consider countries' performance in a given year to also be able to track improvements through environmental policies.

Figure 3.3 illustrates that CO_2 emissions per capita and MVA per capita follow a shallow inverted-U shape. This implies that the process of industrialization is initially accompanied by an increase in the manufacturing sector's carbon footprint. However, the curve flattens at a per capita MVA of around US$ 2,000 in (constant 2010 prices). This corresponds to the average MVA per capita of countries in the upper middle quintile of the CIP Index. Beyond this level of industrialization, the curve measuring the average manufacturing carbon footprint flattens out, and even falls in countries with a per capita MVA of above US$ 10,000.

The manufacturing sectors of most countries with emission-efficient industries in the CIP Index's top quintile still have higher emissions per capita than those of the least competitive, low-technology countries due to a greater scale of industrial production. Therefore, the initial increase and subsequent drop in emission intensity with industrial development does not mean that simply encouraging the diffusion of more efficient technologies leads to a reduction in total emissions. Instead, it is important to consider that emissions rise if the scale effect of increased production through greater incomes dominates efficiency gains, particularly if there is no change in the type of goods being produced.

The shallow inverted-U shape depicting the relationship between MVA per capita and CO_2 emissions corresponds roughly to that of the environmental Kuznets curve (Dasgupta et al., 2002). Although production in low-income countries is comparatively inefficient, as shown in Figure 3.3, the very low level of output dominates, meaning that the least industrialized countries have the lowest carbon footprints. The environmental Kuznets curve predicts that as low-income countries with small manufacturing sectors industrialize, per capita emissions increase.

Structural change leads to greater output in the manufacturing sector as productivity increases. In addition to increased production, a transition in the type of goods produced takes place towards products with higher emission intensity, as discussed above. At the same time, manufacturing firms in less competitive countries are likely to have low levels of productivity; therefore, they may not have the means to invest in pollution abatement and more efficient technologies. Equally, governments may not have the institutional capabilities or incentives to introduce and enforce environmental policies, especially if accompanied by reductions in economic growth. As countries industrialize, this lack of regulation may also contribute to increasing emissions.

According to the environmental Kuznets curve, the marginal increase in CO_2 emissions from manufacturing falls as countries move to high levels of industrial output. At higher MVA levels, the composition of the economy changes and a country's manufacturing sector is likely to become highly productive and specialized in less emissions-intensive goods. Finally, the economic significance of manufacturing overall declines as structural change leads to an expansion

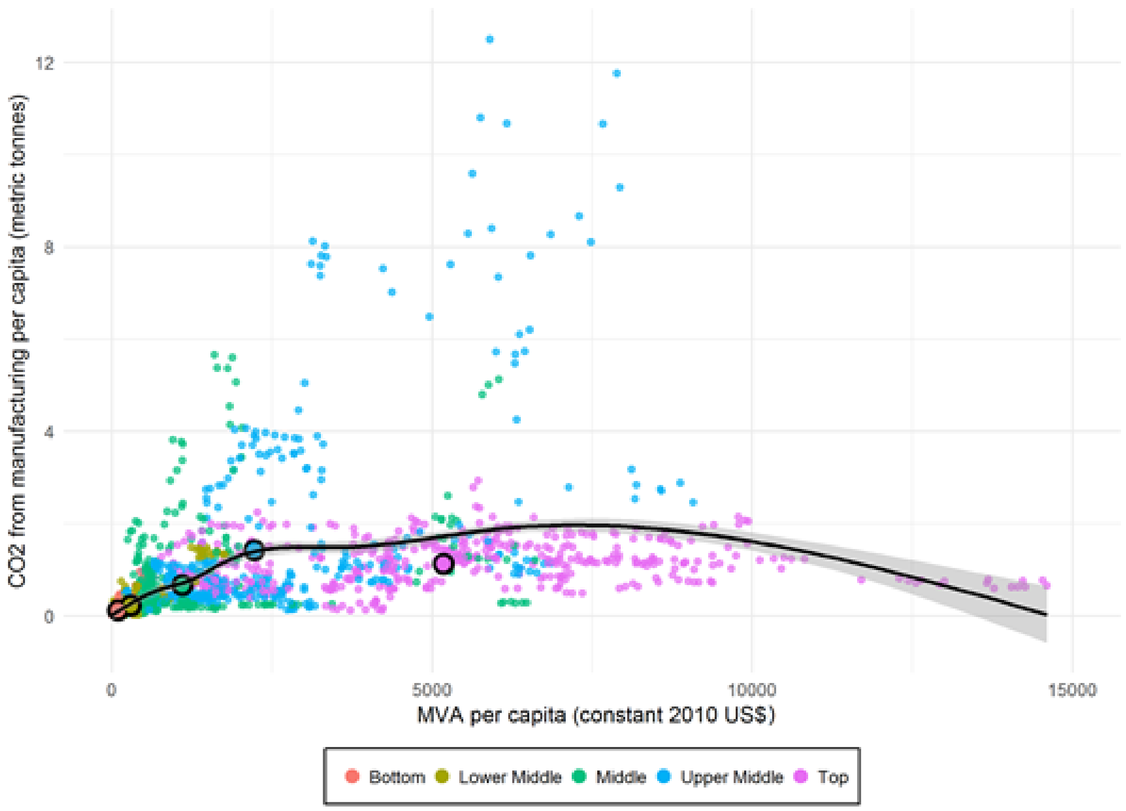

Figure 3.3: MVA per capita and CO_2 emissions from manufacturing per capita, 2000-2015

Source: UNIDO, 2018a and UNIDO, 2018d. Note: Larger circles correspond to quintile means.

of the services sector and to deindustrialization. Consequently, governments may be more willing to support emissions reductions by imposing environmental regulations on the heaviest polluters. Overall, both efficiency and scale effects contribute to the decrease in the carbon footprint of industrialized economies.

3.2.4 Linking emission efficiency and the carbon footprint

The previous sections have shown that a country's per capita manufacturing carbon footprint is defined as the product of emissions per unit of MVA and MVA per capita. Both of these dimensions are combined in Figure 3.4 to assess the different groups described in the second part of this report. The horizontal axis in the figures denotes MVA per capita and the vertical axis signifies the emission intensity of production. The per capita carbon footprint from manufacturing (in kilogrammes of CO_2) is thus the product of the two, represented as the area of the circles. The figures provide a number of important findings and highlight the significance of considering both emission intensity and the carbon footprint when evaluating a country's environmental impact (Ritchie, 2018).

When differentiating countries by stage of development, we find that industrialized economies have by far the highest per capita manufacturing carbon footprint. The comparatively high level of emission efficiency does not suffice to compensate for the volume of production. Industrialized economies therefore bear a large responsibility for further investments in pollution abatement to reduce the environmental impact of production. Yet at the same time, a further expansion of manufacturing industries in industrialized economies would have a comparatively small effect on global CO_2 emissions due to their high level of emission efficiency. By contrast, emission intensity is highest in other developing countries and emerging industrial economies: greater manufacturing output in those groups of the same goods and using the same technologies to produce them would have the largest negative environmental impact. It is therefore particularly important for the projected growth in the manufacturing industries of those economies to occur with less emissions-intensive goods and production processes.

Determining countries' carbon footprint is also important in the context of global value chains. As goods production at the lower end of the value chain has shifted from industrialized to transition economies, production emissions have increased. This is because the "outsourcing" of production entails the use of less efficient technologies and energy is more likely to come from more emissions-intensive fuels, such as coal, than is the case in economies that use more advanced technologies (Liu et al., 2016). Further deindustrialization in industrialized economies and industrialization elsewhere must therefore be accompanied by the diffusion of cleaner technologies and higher environmental standards; otherwise, the global manufacturing carbon footprint will expand.

The graph at the bottom of Figure 3.4 distinguishes seven geographic regions. Countries in the Middle East and North Africa have the highest emission intensity and the second highest carbon footprint of any region – mostly attributable to oil exporting countries such as the United Arab Emirates, Saudi Arabia and Oman. Further growth in countries' manufacturing sectors will be particularly problematic with regard to greenhouse gas emissions, unless gains in emission efficiency can be achieved.

The manufacturing industries of South and South East Asia have the second highest emission intensity, but a comparatively small carbon footprint due to the low level of value added. However, strong manufacturing growth in the region may change this, depending on whether a shift to more high-technology production processes and goods takes place as the region industrializes, thereby reducing emission intensity. The lowest emission intensity was registered in North America, even though the region has the largest carbon footprint. This again indicates the significance of distinguishing between the scale and the emission efficiency of production when measuring environmental impacts.

3.2.5 Changes in emission efficiency and carbon footprint over time

To determine whether countries' manufacturing sectors are moving towards greater levels of environmental sustainability, changes in net manufacturing output and CO_2 emissions from manufacturing over time must be assessed. Globally, the amount of required energy per unit of manufacturing value added fell by 20 per cent between 1990 and 2015, particularly in industrialized economies (IEA, 2018). Yet the IPCC estimates that the current energy intensity of manufacturing could be reduced by a further 25 per cent if the most efficient innovations were universally implemented (IPCC, 2014). Moreover, advances in technology and renewable substitutes, new forms of sharing infrastructure between industries and changing demand for "green" products could also contribute to greater emission efficiency in industrial production.

Figure 3.5 presents the trends of MVA and CO_2 emissions from manufacturing within different CIP quintiles between 2000 and 2015. In countries belonging to the top quintile of the CIP Index, excluding China, MVA increased by nearly one quarter. Over the same period, CO_2 emissions from manufacturing *shrank* by a similar share. Yet in all other groups, manufacturing emissions increased over the observed time period. This is particularly the case in China, where MVA was over four times greater in 2015 than in 2000, and the level of emissions was over three times higher. Figure 3.5 also shows that China's emission efficiency climbed considerably from

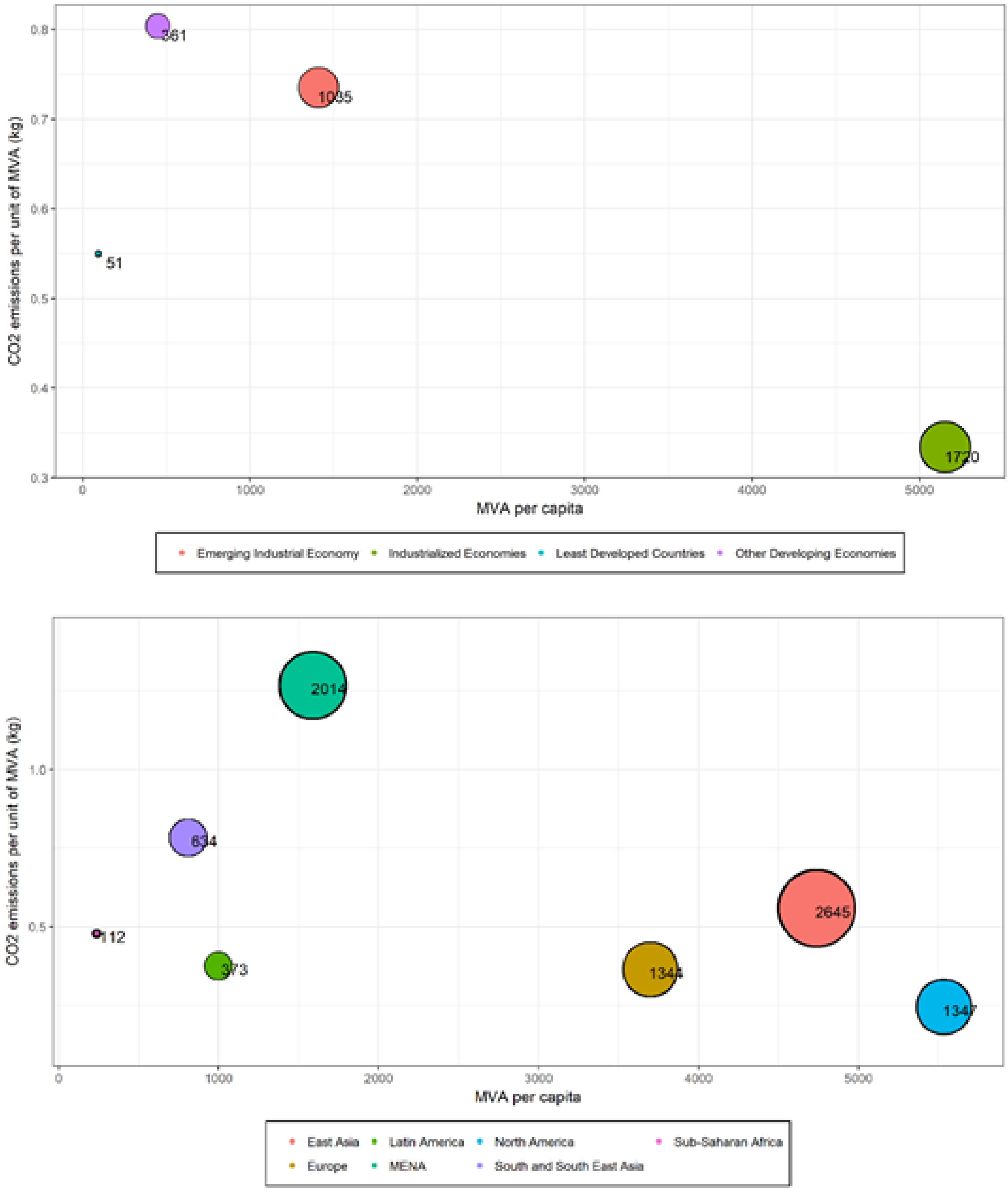

Figure 3.4: MVA per capita and CO_2 emissions from manufacturing per capita by development stage (top) and region (bottom), 2015

Source: UNIDO, 2018a and UNIDO, 2018d. Note: The area of the circles and the number within the circles represent the carbon footprint, CO_2 emissions from manufacturing per capita in kg.

2010: in the preceding decade, the rise in emissions was higher than MVA, but then slowed down while net manufacturing output continued to increase.

In the upper middle quintile, MVA and CO_2 emissions from manufacturing both increased by approximately a factor of 1.8 between 2000 and 2015, implying that there was no change in the emission intensity of production over that period. In lower quintiles, CO_2 emissions from manufacturing increased by around one quarter, which, however, was considerably lower than the increase in MVA.

If MVA growth is higher than the increase of manufacturing emissions over a given period, manufacturing's emission intensity decreases and a decoupling takes place in this sector. Decoupling is defined by the OECD, 2002, page 4 as "breaking the link between 'environmental bads' and 'economic goods'". In this context, decoupling occurs when the manufacturing sector's net output grows at a greater rate than its CO_2 emissions.

Two different cases of decoupling can be distinguished. If manufacturing emissions indicate negative or no growth while MVA shows a positive growth—as in the case of the CIP Index's top quintile (excluding China)— *absolute* decoupling takes place. This means that an increase in industrial production is not linked to increases in environmental pressures through CO_2 emissions. If relative decoupling occurs, emissions increase, albeit at a slower rate than MVA – as in the case of all other quintiles of the CIP Index and China. This reflects increased emission efficiency, but may still be considered problematic for the environment if the growth in production cancels out the efficiency gains. In this case, the carbon footprint would continue to rise.

Whether greater emission efficiency actually leads to a reduced carbon footprint depends thus on the size of the seemingly paradoxical *rebound effect*. The rebound effect applies when greater resource efficiency leads to economic responses that effectively increase net manufacturing output, thereby leading to an increase in resource demand. This is the case when more efficient production means that goods become cheaper, incomes increase, machines can be used more intensively or technology becomes more widely available and production increases (**??**). Hence, if the scale effect is larger than the realized efficiency gains, there is greater resource demand in manufacturing and the carbon footprint increases. This implies that a reduction in emission intensity is dominated by rising MVA per capita, thereby increasing the per capita carbon footprint (i.e. the area of the circles in Figure 3.4). Overall, increased industrial production can only be considered to not contribute to greater CO_2 emissions in the presence of absolute decoupling.

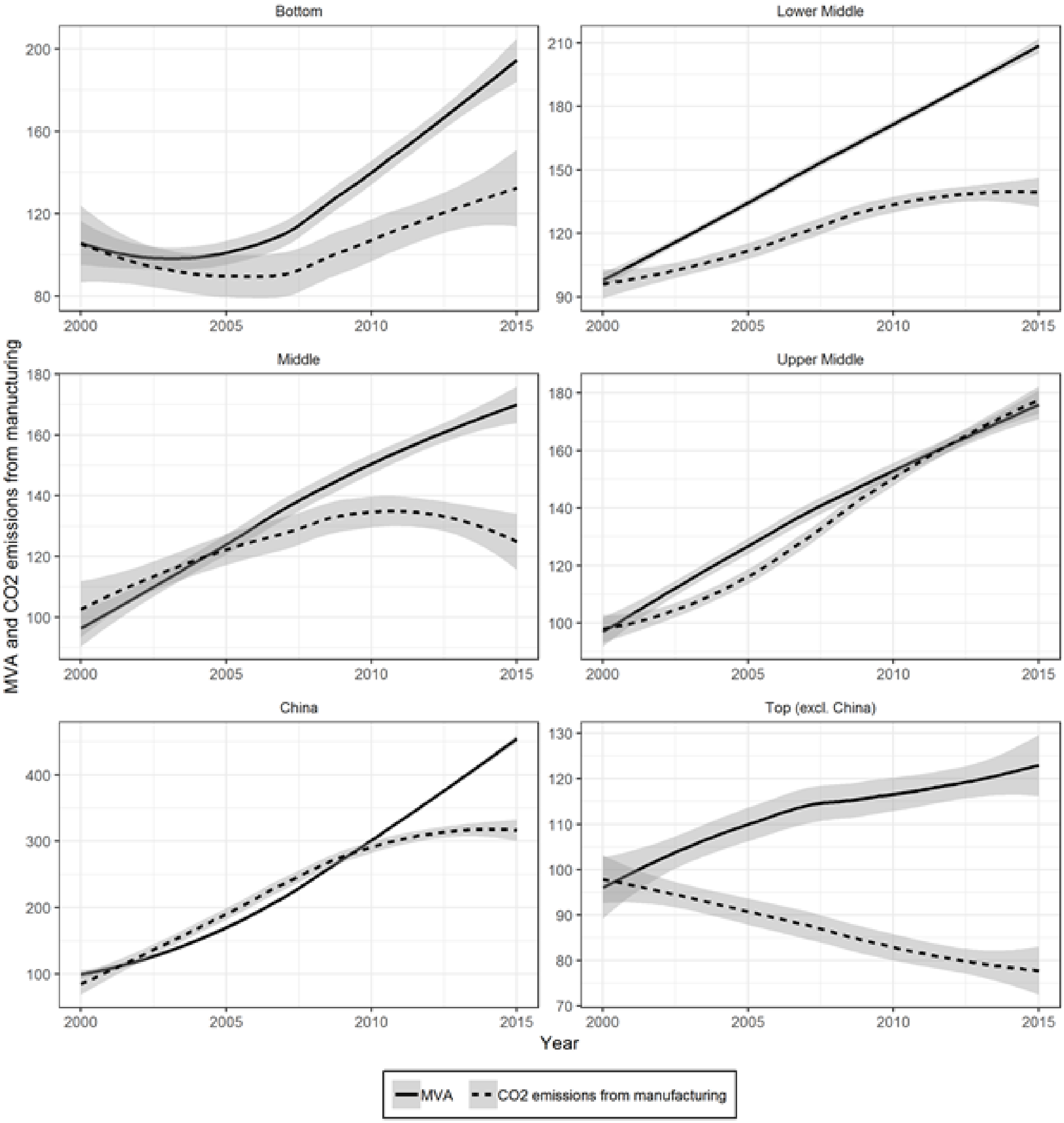

Figure 3.5: MVA and CO_2 emissions from manufacturing by country group, 2000-2015

Source: UNIDO, 2018a and UNIDO, 2018d. Note: MVA in 2010 USD and CO_2 emissions from manufacturing relative to the respective values in 2000, (index numbers, year 2000 =100).

Box 3.3: Measuring countries' rates of decoupling

The Figure below presents the rate of decoupling in each country for which data is available from 2010 to 2015. The quadrants correspond to different states of decoupling over the five-year period. In the bottom-right quadrant, MVA growth is positive and CO_2 growth is non-positive – this denotes cases of absolute decoupling. In other words, increased manufacturing output did not lead to greater CO_2 emissions over the observed period. The majority of countries in which absolute decoupling took place are found in the top quintiles of the CIP Index. There was comparatively positive MVA growth and negative emissions growth in Spain and Denmark, for example.

Both MVA and CO_2 emissions increased between 2000 and 2015 in countries in the top-right quadrant of the Figure below. Below the dotted identity line, relative decoupling occurred, as the MVA growth rate is higher than the CO_2 growth rate. This means that emission intensity fell, as the MVA growth rate was greater than that of emissions. The majority of countries that achieved a relative decoupling of CO_2 emissions from MVA were those in the upper quintiles of the CIP Index. However, some countries classified as having low levels of competitiveness also achieved high MVA growth rates and thus relative decoupling. For example, in Angola, total CO_2 emissions from manufacturing rose considerably between 2010 and 2015, and yet efficiency gains grew even more. This reflects the significance of distinguishing between relative and absolute decoupling.

Countries in which *coupling* took place are found above the dotted line. In those countries, the emission intensity of manufacturing increased between 2010 and 2015. This was the case in the majority countries in the middle, lower middle and bottom quintiles of the CIP Index, for example, in Bangladesh, Ethiopia and Zambia. Yet the greatest increase in emissions with relatively low MVA growth was registered in Bahrain. The emission intensity of manufacturing also increased in other industrialized, oil exporting countries, such as Kuwait and the United Arab Emirates. It is thus important to consider heterogeneity when determining the decoupling rates of countries at different levels of industrialization. Countries in which *negative coupling* occurred are located in the bottom-left quadrant, i.e. both emissions and MVA decreased – this, however, is only the case in very few countries in exceptional circumstances, such as the Syrian Arab Republic.

The countries that achieved the highest rates of decoupling were Central and Eastern European countries: Czechia, Poland and Slovakia. This follows the methodology used by the OECD's (2002) indicator to measure decoupling. The unadjusted CIP Index is an "outcome indicator" whereas decoupling measures "progress"; hence the decoupling indicator is not suitable to adjust the CIP Index. It does, however, give an indication of how the adjusted CIP Index is likely to develop: countries with high rates of decoupling are expected to increase their adjusted competitiveness as the emission intensity of production falls.

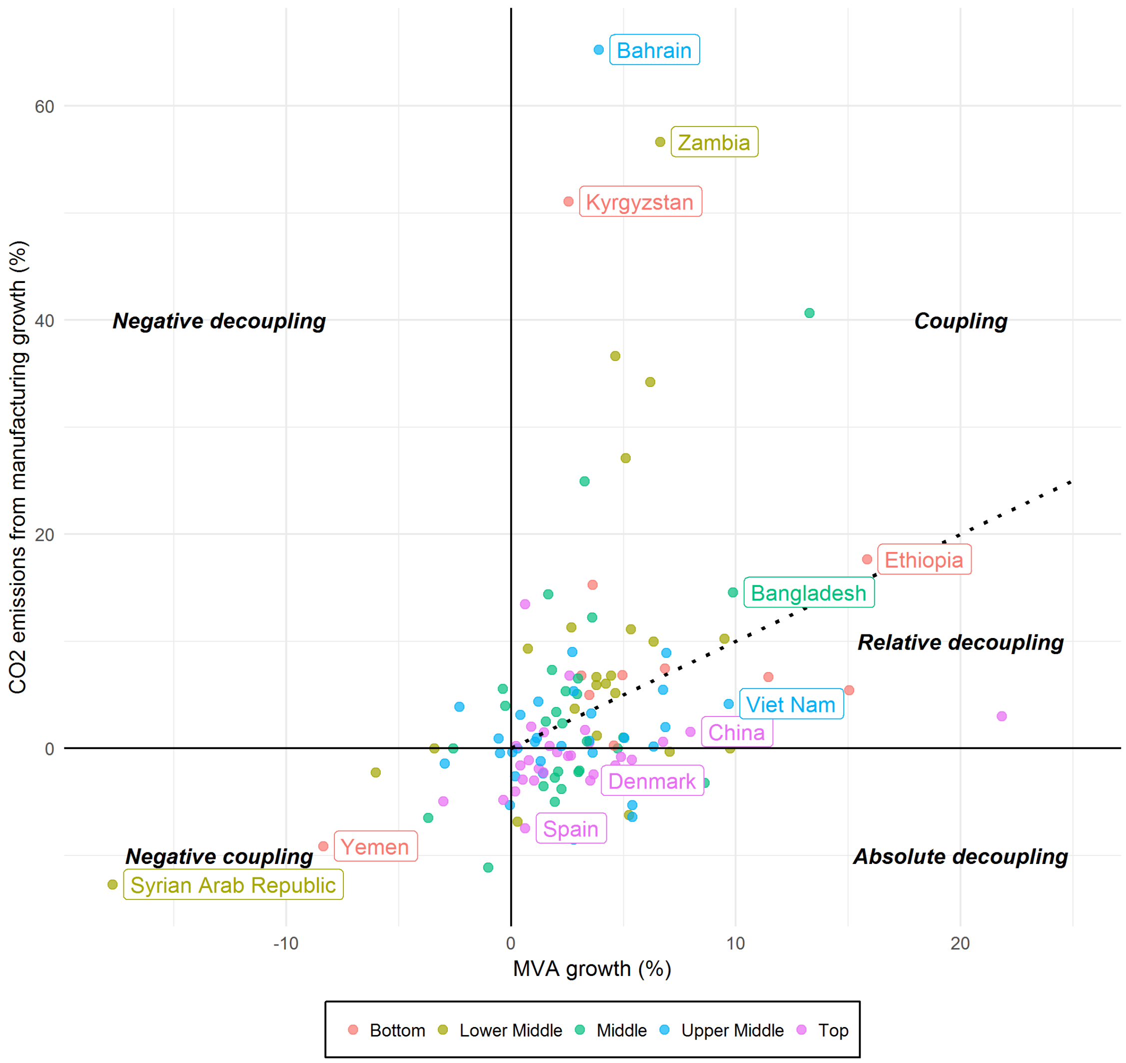

Figure: MVA and CO_2 emissions growth rates, 2010-2015

Source: UNIDO, 2018a and UNIDO, 2018d. Note: Based on Naqvi and Zwickl, 2017.

3.3 Calculating the CO_2-adjusted CIP Index

3.3.1 A non-linear adjustment

The impact of industrialization on ecosystems—along with the essential services they provide—depends on multiple factors (United Nations Environment Programme, 2011). The previous section discussed the relationship between the emission intensity of manufacturing, emissions per capita and the level of manufacturing net output. The main adjustment of country-specific values of the CIP Index is based on emission intensity. A new CIP Index value is thereby calculated for each country for which emissions data is available.[5]

Industrial development that minimizes environmental externalities depends on the ability of a country to achieve low levels of emission intensity. The first indicator for adjusting the CIP

[5] See Appendix A.2 for a detailed discussion on the methodology used to calculate the adjusted CIP Index.

Index is therefore emissions per unit of MVA, normalized so all countries can be ranked relative to the most efficient country, which takes a value of 1. Countries that experience a substantial change from the unadjusted to the adjusted CIP Index can thus be considered to be further away from the frontier of emission efficiency in industrial production. As discussed above, there are two main reasons for variations in emission intensity: the use of different technologies and the production of different goods.

Moreover, for a given level of emission intensity, the adjustment of the CIP Index varies depending on the country's carbon footprint. The carbon footprint serves as a scaling factor in the adjustment of the CIP Index. The countries with the lowest per capita manufacturing emissions are Niger, Cambodia and Cameroon – countries with very low levels of production, and hence the scale effect dominates the efficiency effect in the calculation of the carbon footprint. The countries with the greatest scaling factor due to their high levels of per capita CO_2 emissions are Qatar, Oman and the United Arab Emirates. A high scaling factor therefore reflects the need to move to more emission-efficient modes of production in manufacturing industries that are responsible for the greatest per capita environmental externalities. Efficiency gains in these countries are key to reducing global manufacturing emissions.

The carbon footprints of countries presented in the adjusted CIP Index reveal which of these countries' manufacturing sectors have the highest negative per capita impact on the environment. The Index also reflects the fact that the environmental impact of a country's given emission intensity depends on the ecosystem's ability to absorb emissions in carbon sinks and thereby limit the negative externalities of manufacturing on the natural environment. The carrying capacity of carbon sinks refers to the amount of CO_2 emissions that forests, the ocean, soils and other carbon "reservoirs" can capture. This sequestration of greenhouse gases slows atmospheric warming. Accounting for the carrying capacity of carbon sinks is therefore an important dimension for estimating the negative impact of manufacturing emissions (Nordhaus, 2017).

The interrelationship of carbon sinks and CO_2 emissions is highly complex: the adjustment factor is merely a stylized representation of this relationship. The final adjustment factor is non-linear, with an initially increasing marginal penalty for greater emissions. Due to positive feedback loops, evidence suggests that climate change does not have a constant effect on the ability of carbon sinks to capture emissions (Rockström et al., 2009). For example, as the ocean becomes more acidic through carbon absorption, its ability to sequestrate additional CO_2 is reduced. Similarly, with more frequent wildfires on account of global warming, the stock of carbon stored as biomass in plants and trees enters the atmosphere. This increases the CO_2 particles in the atmosphere and leads to a reduction in the availability of carbon sinks (Ciais et al., 2013).

The non-linearity of the adjustment factor means that initially, an increase in emission intensity only leads to minor increases in the adjustment of MVA per capita. If production is highly efficient, carbon sinks may be able to compensate for a reasonable share of manufacturing emissions. The marginal penalty from an increase in emission intensity expands to reflect the increasing negative environmental impact of lagging further behind the efficiency frontier.

At the same time, the country's carbon footprint determines an emissions threshold. The marginal negative adjustment is greatest at this threshold. This reflects the fact that at a given "tipping point", which is highly dependent on the amount of emitted CO_2, i.e. the carbon footprint, the marginal cost of an increase in emissions per unit of MVA is highest. For countries above this specific emission intensity threshold, the marginal penalty decreases again, i.e. each increase in the percentage of emission intensity has less effect on the adjustment of the CIP value than the previous increase in intensity percentage. This reflects the results of Figure 3.1. For least competitive countries—whose manufacturing sectors are characterized by high emission intensity—efficiency improvements through investments in pollution abatement or by shifting to other product types are assumed to be cheap. Thus, large emission reductions and an improvement in efficiency are comparatively easy to achieve for least efficient manufacturers. However, the efficiency gains from each unit of investment in pollution abatement are decreasing, which implies that as emission intensity declines, greater marginal investments are necessary to further reduce the manufacturing sector's emission intensity. This is visible in countries in the CIP Index's middle quintile, where the manufacturing sector's emission intensity grew at the same rate as manufacturing output between 2000 and 2015. Each marginal reduction in emissions above the emission intensity tipping point results in a lower marginal negative impact on competitiveness. It is assumed that this can be easily changed. For countries with a medium-high emission intensity, however, large investments are necessary to further reduce emission intensity.

The initially increasing and then decreasing marginal adjustment factor beyond the tipping point also has methodological reasons. It imposes a lower bound of 0 and an upper bound of 1 on the adjustment factor as emission intensity becomes infinitely large or converges to 0. As the unadjusted CIP score is multiplied with the adjustment factor to compute the adjusted CIP score, imposing those bounds means that the adjusted CIP value cannot be larger than the unadjusted CIP value, but can also not be smaller than 0.

It is necessary to adjust the final CIP indexes, rather than, for example, specific indicators prior to normalization. Adjustment prior to normalization would change the index value for all countries if the maximum or minimum value were changed. For example, if there is a large downward adjustment for a country with the highest per capita MVA, the index value would increase for other countries as their relative distance to the country with the highest MVA per capita falls, even if they also have a high emission intensity. This is not an intuitive result, and hence the final indexes are multiplied by the adjustment factor. Figure 3.6 presents the ratio of the adjusted and unadjusted CIP Index values according to a ranking of the adjustment factors (i.e. the country with the smallest downward adjustment in its CIP score ranks first, while countries with least emission-efficient industries have the highest downward adjustment). The figure presents the described non-linear relationship: at the efficiency frontier, there is little downward adjustment in CIP scores. The marginal adjustment increases up to around the 25th country in the ranking. Beyond this tipping point, the marginal adjustment decreases. This highlights the fact that very few countries are at the efficiency frontier and have a comparatively small carbon footprint.

Box 3.4: The sustainable modernization indicator

The UNIDO Industrial Development Report 2016 developed an alternative measure of industrialization's environmental compatibility: the sustainable modernization indicator. This entails two factors – the emission efficiency gap relative to a "benchmark" country and the extent of structural change, measured as the share of employees in the non-agricultural sector.

3.4 CIP adjustment

3.4.1 Adjustment in ranks and scores

Table 3.1 presents the CO_2-adjusted CIP ranking. The percentage change from the unadjusted to the adjusted CIP Index is shown in the table's fourth column. The countries with the largest relative adjustment to MVA per capita on the basis of emission intensity are Oman, the United Arab Emirates and Ukraine. These countries have both high emission intensities and large carbon footprints. Efficiency increases could thus have a considerable effect on reductions in environmental harm caused by those countries' manufacturing sectors. China's CIP value also decreased significantly, resulting in a drop in its CIP rank of 16 places, from 4^{th} to 20^{th}, the largest shift in the CIP Index's top quintile.

Figure 3.7 illustrates the ranks in the adjusted

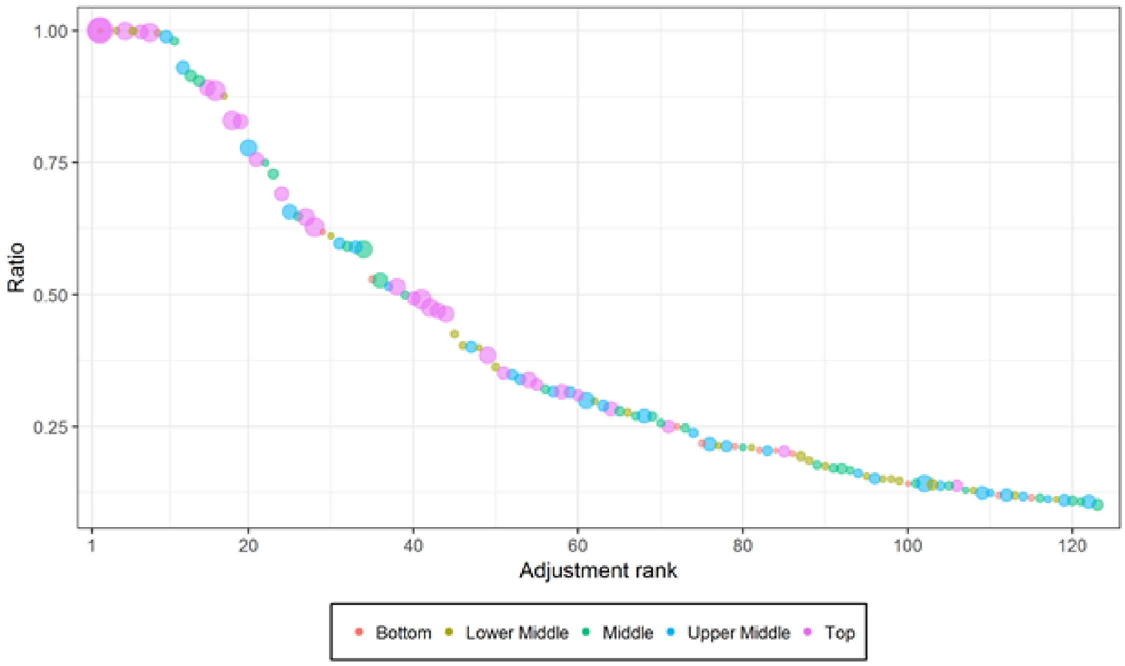

Figure 3.6: Ratio of adjusted and unadjusted CIP Index at different CO_2 emission levels

Source: UNIDO, 2018a and UNIDO, 2018d. Note: Larger circles correspond to quintile means.

and unadjusted CIP Indexes by stage of development. The majority of countries that experienced a downward shift in the CIP rank belonged to the group of other developing economies and LDCs. Consequently, emerging industrial economies is the only group to clearly experience a worsening of their mean rank, moving from an average position of 56^{th} to 61^{st}.

The countries with the smallest adjustment of their CIP scores are all in the top quintile of the CIP Index. This indicates that they have a low emission intensity and comparatively low per capita CO_2 emissions from manufacturing. The most competitive country according to the adjusted CIP ranking remains unchanged: Germany. Its CIP value decreases by around 11 per cent, nonetheless. Due to the German manufacturing sector's large lead in CIP scores, however, there is no drop in its ranking. Overall, those countries with the highest energy efficiency—and thus the smallest change in unadjusted to adjusted MVA per capita—are some of the most competitive countries according to the CIP Index. This reflects evidence of the distribution of emission intensities (Figure 3.3).

The top 3 of the adjusted CIP Index are Germany, Switzerland and Ireland. Both Switzerland and Ireland are closest to the emission efficiency frontier and their CIP scores were therefore not adjusted downward. The countries above them in the unadjusted CIP ranking, namely Japan, the United States, China and the Republic of Korea, all experienced a considerable downward adjustment of at least one-third and therefore moved down the ranks. This allowed Switzerland and Ireland to enter the top 3.

Figure 3.7 reveals that the mean CIP rank of industrialized economies barely changes when adjusting for CO_2 emissions. This is partly because industrialized economies occupy the majority of the top positions in the ranking, hence minor shifts among countries within the same group do not lead to changes in the average rank. At the same time, it is also a reflection of heterogeneity within the group of industrialized economies as regards their emission efficiency and carbon footprint: while there was very little adjustment in some countries, other large polluters such as the United Arab Emirates, Kuwait and Qatar experienced major downward shifts in their CIP scores.

The largest average shift in the rankings is observed in LDCs, with their mean CIP position increasing from 119^{th} to 96^{th}. The group closed the gap to other developing countries, for which the mean rank increased from 94^{th} to 88^{th}. The move of the poorest—and least competitive—countries up the CIP ranks following adjustment is in part due to the clustering of small CIP scores described in Chapter 1 of the CIP report. Minor changes in the scores lead to large volatility in the CIP ranks. Overall, the CO_2 adjustment reduces the inequality in CIP scores across country groups.

Rank adj. CIP	Country	Adjusted CIP	Unadjusted CIP	Change (%)	Change in rank
1	Germany	0.4628	0.5196	-10.93	0
2	Switzerland	0.3181	0.3181	0	-4
3	Ireland	0.3049	0.3049	0	-4
4	Japan	0.2776	0.3939	-29.53	2
5	Italy	0.2433	0.2720	-10.56	-4
6	United States of America	0.2373	0.3815	-37.81	3
7	France	0.2272	0.2685	-15.38	-4
8	Republic of Korea	0.2205	0.3725	-40.8	3
9	Sweden	0.2201	0.2217	-0.68	-7
10	Austria	0.1929	0.2275	-15.22	-4
11	Denmark	0.1701	0.1704	-0.13	-10
12	United Kingdom	0.1678	0.2242	-25.16	-3
13	Singapore	0.1606	0.2654	-39.5	1
14	Spain	0.1600	0.2016	-20.63	-5
15	Netherlands	0.1578	0.2709	-41.76	5
16	Belgium	0.1453	0.2797	-48.05	8
17	Israel	0.1339	0.1345	-0.5	-11
18	Czechia	0.1215	0.2070	-41.31	0
19	Finland	0.1047	0.1459	-28.25	-7
20	China	0.1010	0.3803	-73.45	16
21	Canada	0.1007	0.2105	-52.15	4
22	Norway	0.0917	0.1132	-18.96	-9
23	Hungary	0.0879	0.1454	-39.55	-4
24	Mexico	0.0807	0.1790	-54.92	4
25	Poland	0.0791	0.1618	-51.13	2
26	Lithuania	0.0748	0.0808	-7.49	-13
27	Slovenia	0.0741	0.1023	-27.54	-8
28	Slovakia	0.0708	0.1545	-54.15	4
29	Portugal	0.0692	0.1024	-32.44	-5
30	Malaysia	0.0657	0.1666	-60.57	8
31	Estonia	0.0629	0.0640	-1.75	-18
32	Turkey	0.0583	0.1243	-53.10	3
33	Thailand	0.0525	0.1524	-65.56	8
34	Australia	0.0519	0.1212	-57.19	4
35	Brazil	0.0476	0.1042	-54.38	2
36	Philippines	0.0442	0.0722	-38.81	-7
37	Romania	0.0427	0.0986	-56.71	1

Table 3.1 continued from previous page

Rank adj. CIP	Country	Adjusted CIP	Unadjusted CIP	Change (%)	Change in rank
38	Malta	0.0345	0.0379	-8.92	-31
39	Indonesia	0.0335	0.0883	-62.07	1
40	Belarus	0.0330	0.0691	-52.32	-4
41	Latvia	0.0323	0.0475	-32.08	-17
42	Luxembourg	0.0322	0.0727	-55.68	0
43	Russian Federation	0.0319	0.1127	-71.66	11
44	Chile	0.0299	0.0616	-51.5	-7
45	Costa Rica	0.0298	0.0387	-22.92	-22
46	Croatia	0.0285	0.0538	-47.02	-9
47	Greece	0.0275	0.0605	-54.45	-5
48	Uruguay	0.0273	0.0302	-9.66	-28
49	New Zealand	0.0269	0.0650	-58.54	1
50	Saudi Arabia	0.0234	0.0967	-75.84	13
51	Iceland	0.0233	0.0346	-32.59	-20
52	Argentina	0.0233	0.0657	-64.57	5
53	Botswana	0.0217	0.0224	-3.14	-34
54	El Salvador	0.0214	0.0302	-28.99	-23
55	India	0.0199	0.0808	-75.39	15
56	Bahrain	0.0195	0.0543	-64.02	2
57	Cambodia	0.0194	0.0194	-0.13	-34
58	Guatemala	0.0186	0.0311	-40.09	-17
59	Nigeria	0.0186	0.0244	-23.73	-25
60	South Africa	0.0183	0.0688	-73.41	15
61	Bulgaria	0.0175	0.0509	-65.64	4
62	Qatar	0.0172	0.0634	-72.82	12
63	Peru	0.0171	0.0409	-58.09	1
64	United Arab Emirates	0.0163	0.0728	-77.61	23
65	Morocco	0.0159	0.0404	-60.57	0
66	Viet Nam	0.0156	0.0677	-76.98	20
67	Mauritius	0.0154	0.0229	-32.57	-19
68	Colombia	0.0153	0.0373	-58.99	-2
69	Brunei Darussalam	0.0141	0.0223	-36.94	-19
70	Paraguay	0.0137	0.0137	-0.2	-27
71	Trinidad and Tobago	0.0131	0.0526	-75.13	15
72	Kuwait	0.0127	0.0558	-77.23	19
73	Venezuela (Bolivarian Rep. of)	0.0125	0.0410	-69.42	12
74	Serbia	0.0125	0.0400	-68.72	8
75	Tunisia	0.0121	0.0412	-70.58	15
76	Jordan	0.0113	0.0276	-59.14	-4
77	Bangladesh	0.0112	0.0330	-66.04	4
78	Iran (Islamic Republic of)	0.0109	0.0457	-76.28	19
79	Egypt	0.0101	0.0339	-70.15	7
80	Lebanon	0.0093	0.0205	-54.49	-9
81	Ukraine	0.0090	0.0404	-77.65	17
82	Oman	0.0088	0.0405	-78.38	19

Table 3.1 continued from previous page

Rank adj. CIP	Country	Adjusted CIP	Unadjusted CIP	Change (%)	Change in rank
83	Cameroon	0.0087	0.0089	-1.36	-34
84	Kazakhstan	0.0087	0.0384	-77.28	16
85	The f. Yugosl. Rep of Macedonia	0.0086	0.0282	-69.52	6
86	Panama	0.0085	0.0322	-73.56	12
87	Congo	0.0080	0.0096	-16.7	-25
88	Ecuador	0.0078	0.0201	-61.27	-2
89	Honduras	0.0077	0.0160	-51.45	-4
90	Myanmar	0.0071	0.0138	-48.73	-6
91	Bosnia and Herzegovina	0.0067	0.0250	-73.01	10
92	Pakistan	0.0062	0.0246	-74.99	10
93	Armenia	0.0062	0.0114	-46.19	-10
94	China, Hong Kong SAR	0.0056	0.0239	-76.68	9
95	Cyprus	0.0052	0.0156	-66.76	0
96	Jamaica	0.0051	0.0125	-58.84	-4
97	Zambia	0.0051	0.0080	-35.8	-22
98	Algeria	0.0044	0.0157	-71.73	4
99	Côte d'Ivoire	0.0044	0.0106	-58.22	-8
100	Bolivia (Plurinational State of)	0.0038	0.0125	-69.35	1
101	Azerbaijan	0.0038	0.0120	-68.09	-1
102	Georgia	0.0037	0.0135	-72.47	4
103	Kenya	0.0036	0.0108	-66.31	-2
104	Senegal	0.0034	0.0102	-66.49	-5
105	United Republic of Tanzania	0.0033	0.0071	-54.1	-15
106	Mongolia	0.0030	0.0120	-74.96	5
107	Suriname	0.0029	0.0107	-73.21	1
108	Republic of Moldova	0.0027	0.0098	-72.3	-3
109	Albania	0.0026	0.0094	-72.37	-6
110	Mozambique	0.0024	0.0041	-41.48	-19
111	Gabon	0.0023	0.0096	-76.02	-2
112	Montenegro	0.0023	0.0065	-64.64	-11
113	Angola	0.0022	0.0037	-39.16	-20
114	Syrian Arab Republic	0.0021	0.0094	-77.49	0
115	Zimbabwe	0.0021	0.0065	-67.58	-9
116	Ghana	0.0021	0.0064	-68.13	-9
117	Niger	0.0020	0.0020	0	-26
118	Kyrgyzstan	0.0016	0.0066	-76.17	-3
119	Haiti	0.0010	0.0030	-67.08	-18
120	Nepal	0.0010	0.0038	-74.38	-10
121	Yemen	0.0010	0.0027	-64.47	-18
122	Iraq	0.0009	0.0037	-76.86	-9
123	Ethiopia	0.0000	0.0000	0	-25

Table 3.1: Adjusted and unadjusted CIP Index ranks and scores

Source: UNIDO, 2018a and UNIDO, 2018d

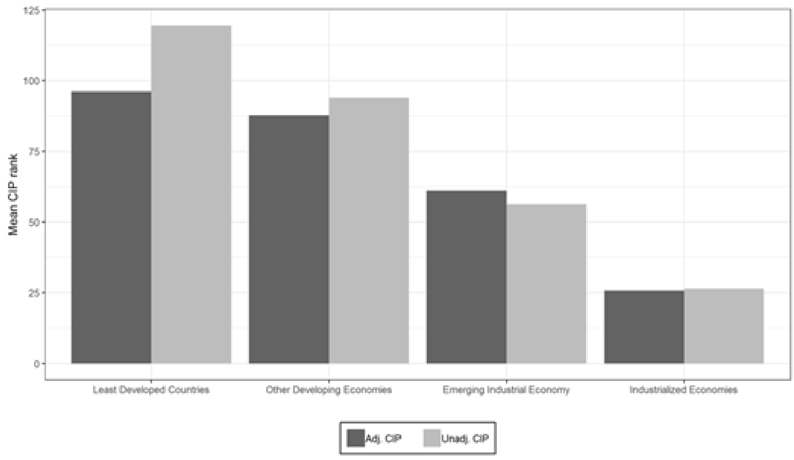

Figure 3.7: Ranks in the adjusted and unadjusted CIP Indexes by development stage

Source: UNIDO, 2018a and UNIDO, 2018d

Figure 3.8 depicts the ratio of the adjusted and unadjusted CIP Index scores at different levels of MVA per capita, as well as the CIP quintile means. If the ratio is closer to 1, then the downward adjustment is comparatively small; the country is close to the emission efficiency frontier and has a small carbon footprint. Moving from countries in the bottom to those in the CIP Index's middle quintile, the average ratio of the adjusted and unadjusted CIP scores decreases. Although there is little change in emission efficiency between these groups, the manufacturing sectors of the countries in the bottom quintile have a lower emissions impact due to their level of net output.

The fitted trend line, which depicts the ratio of the adjusted and unadjusted CIP values, increases beyond the MVA per capita threshold of the countries in the middle quintile. At greater levels of MVA per capita, it approaches a value of 1—meaning the countries with the highest levels of industrialization, i.e. those that have specialized in the production of high-technology goods at the highest node of global value chains—also have the highest emission efficiency levels.

The ratio of the adjusted and unadjusted MVA per capita values corresponds to the inverse of the stylized inverted-U shape of the environmental Kuznets curve. Countries with the greatest environmental impact, i.e. those close to the maximum point of the environmental Kuznets curve, experience the highest downward shift in CIP values.

As discussed above, the adjustment of the CIP Index is solely based on annual emissions – it does not consider the historical costs of emissions in different countries. The 1992 United Nations Framework Convention on Climate Change states that countries have a "common but differentiated responsibility" to combat climate change. While the indicator measuring the carbon footprint captures differences in countries' contributions to natural capital depletion through manufacturing emissions, it is questionable whether the same adjustment factor should be applied to both LDCs and industrialized economies which have emitted CO_2 related to manufacturing production over the past 150 years. The adjusted CIP Index therefore merely serves as a benchmark and performance measure. It should not be interpreted as a reason for countries with the most emission-efficient industries to reduce their commitment to decrease the environmental impact of their manufacturing sectors.

3.4.2 By regions

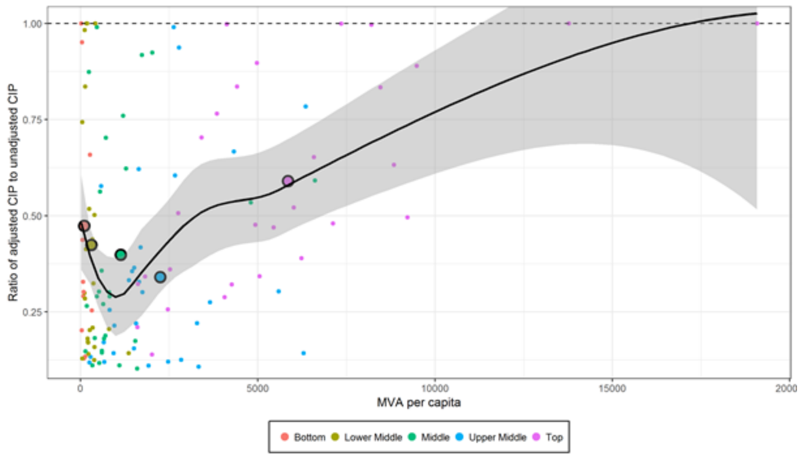

Figure 3.8: Ranks in the adjusted and unadjusted CIP Indexes by development stage

Source: UNIDO, 2018a and UNIDO, 2018d. Note: The further the distance from the dashed line, the greater the relative change from the unadjusted to the adjusted CIP Index.

Figure 3.9 shows that countries with similar adjustment factors are clustered together. Globally, the countries that experienced the greatest adjustment in their CIP values were oil-exporting countries in the Middle East, such as Saudi Arabia, the United Arab Emirates, Oman and Kuwait. These countries have both high emission intensities and large carbon footprints. This is partly due to the industries these countries specialize in. Oil refinery is particularly emissions intensive due to the energy requirements and chemical processes during the transformation of crude oil into petroleum exchanged on international markets (Concawe, 2008). At the same time, if fossil fuels are very cheap, countries may be less likely to invest in pollution abatement and improvements in emission efficiency as there is less monetary incentive to reduce dependence on fuels that emit large amounts of CO_2.

In Asia, Viet Nam, India, China and many others registered a large downward adjustment of their CIP Index scores. These are all transition economies that have experienced major increases in manufacturing net output which have not been compensated through gains in emission efficiency. The adjustment of CIP scores on the basis of emission intensity and the carbon footprint highlights the potential of these economies to catch up with the technological frontier.

In Europe, Ukraine, Bosnia and Herzegovina, Russia and other countries in the East witnessed the greatest adjustment to their CIP values. Yet there are also tremendous differences among highly-industrialized economies in Western Europe. For example, Luxembourg, Belgium and the Netherlands face considerably higher penalties than the more efficient industries of, for example, the Scandinavian countries. Similarly, the United States and Canada have significantly lower levels of emission efficiency relative to countries at comparable levels of industrialization.

With the exception of oil exporting countries such as Gabon, there is comparatively little downward adjustment of the CIP Index's values in sub-Saharan Africa. This, in part, is due to low total manufacturing production and the resulting small carbon footprint in the majority of countries. The adjusted CIP Index shows that sub-Saharan countries at a low level of industrialization, producing low-technology, low-emissions goods, should aim to find alternative modes of industrialization that do not necessarily follow the path taken by the countries of East and South Asia. One possibility for countries with low levels of industrialization and low emissions is leapfrogging, i.e. adopting advanced, low-emissions technologies from highly competitive countries in a process of radical change. For example, decentralized energy generation can make small-scale firms independent of a potentially unreliable, emissions-intensive, cen-

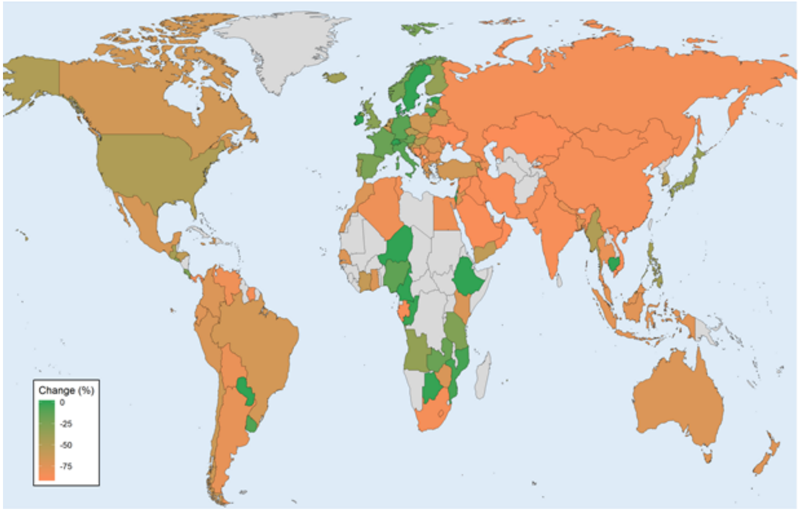

Figure 3.9: Ranks in the adjusted and unadjusted CIP Indexes by development stage

Source: UNIDO, 2018a and UNIDO, 2018d.

tralized energy generating infrastructure (Bank, 2017). Such innovations may allow developing countries to industrialize without necessitating large investments in heavily polluting, fossil fuel-based energy systems. However, if existing development problems such as the lack of access to education, poor quality of infrastructure, ineffective institutions, etc. continue, then it is unclear to what extent leapfrogging can be considered to contribute to large-scale industrialization and structural change with limited negative environmental effects.

In Latin America, Trinidad and Tobago experienced the largest downward shift in its CIP score when adjusting for environmental externalities. It is considered a regional leader in manufacturing competitiveness (see Chapter 2.3 of this report), yet its industries are built on cheap natural resources – as such, there is considerable potential for investments in pollution abatement. Other countries that performed poorly in the adjusted CIP Index include Panama and Venezuela: Box 2.4 explained that Panama's industrial growth is closely linked to the emissions-intensive construction industry, while Venezuela is an oil exporting economy. By contrast, Paraguay and Uruguay witnessed the smallest adjustment of their CIP scores in the region.

IV

Concluding remarks

Concluding remarks

Inclusive and sustainable industrial development (ISID) encompasses the economic, social and environmental dimensions on which overall prosperity depends. The CIP Index measures a central component of ISID, namely the economic efficiency of processes related to industrial development. It is constructed in such a way as to reflect the multiple dimensions of competitiveness, incorporating the capacity of economies to produce and sell their goods domestically and internationally, to adopt advanced technologies and to generate a greater share of value added.

In general, economies with high levels of competitiveness tend to perform well in each of the three key dimensions of competitiveness. Yet the gap between the most competitive economies and those trying to catch up is not the same across those dimensions. There are major inequalities in economies' capacities to produce and export manufactured goods and in their world impact. Both dimensions indicate a large gap between a few highly competitive economies that dominate globally integrated markets for manufactured goods and a majority of less competitive countries.

Performance in technological deepening and upgrading is less uneven. This implies that while there is diffusion of technologies to less competitive economies, it is not necessarily accompanied by an improvement in other aspects of those economies' competitiveness. Building the capacities required to convert technological deepening and upgrading into greater overall industrial competitiveness - for example, through improvements in infrastructure, greater human capital or more effective institutions - is a key challenge to achieving structural change and ISID, particularly in LCDs. Industrialization in LDCs is fundamental to SDG Target 9.2, namely the doubling of the shares of both MVA in GDP and of manufacturing employment in total employment by 2030. This objective can be fostered through investments and capacity building from abroad; yet more needs to be done to increase LDCs' potential to achieve the target.

It is thus possible to broadly distinguish between two groups of economies based on their performance in developing competitive industries. First, a group of global leaders that competes to innovate and thereby generates the largest share of value added at the top of global value chains. Second, economies within the group of technological adopters specialize in lower-technology intermediate manufactured goods, generating smaller amounts of value added, and thus compete to position themselves at higher stages of global value chains. The majority of economies fall within the second group, yet there is little dispersion in their levels of competitiveness. Minor improvements may therefore suffice for countries to leapfrog others in the year-over-year competitiveness rankings. On the whole, however, very few countries have been able to transition from the group of technological adopters to innovators.

Long-term trends in CIP scores serve to identify those countries that have been particularly successful in improving the competitiveness of their manufacturing sectors. It is thus important to go beyond a static analysis within a given year to identify successful comparators and role models. Over the past 25 years, China has achieved the highest absolute increase in both CIP score and rank of any country. This increase is attributable to the progress made in the dimensions measuring world impact and technological deepening and upgrading, both of which are linked to its strong export orientation and integration in global value chains.

Yet China's improvement in industrial competitiveness is only a reflection of the economic dimension of industrialization. A more complete evaluation of ISID requires a perspective that takes into account environmental sustainability as well as socio-economic considerations. Therefore, the 2018 edition of the CIP report extends the Index to adjust for environmental damages resulting from manufacturing, approximated by CO_2 emissions. The CO_2-adjusted CIP Index can support industrial policies that promote forms of production that are more compatible with the preservation of natural capital.

For example, as China industrializes, the CO_2 emissions and environmental impact of its manufacturing sector have increased considerably – much like in other industrialized and transition economies as their manufacturing output increases. There is an urgent global need to promote industrial development while reducing greenhouse gas emissions. This can be achieved through the use of more efficient technologies or alternative energy sources or the change of the specialization pattern towards the production of more environmentally-friendly goods, all of which can reduce the damage manufacturing causes to the world's natural capital. Otherwise, long-term productivity and welfare are at risk.

Accordingly, the CO_2-adjusted CIP Index defines industrial competitiveness not just on the basis of economic measures, but also with regard to the environmental sustainability of manufacturing production. The adjusted Index identifies countries near the frontier of emission efficiency that can serve as a benchmark for others. Through technological progress and further structural change, this frontier can shift further towards green forms of production that minimize industrialization's environmental externalities, while contributing to greater welfare.

Preservation of natural systems, which is a global public good on which the welfare of every country depends, is imperative. As in many other cases with public goods, the free market allocation will be socially inefficient and therefore, developed countries should have incentives to help developing and transition economies, particularly LDCs, to follow a more environmentally friendly path of industrialization than they themselves did. Thus, global cooperation and integration are central to achieving sustainable industrialization. Global policies in support of environmentally sustainable manufacturing can lead to a form of structural change that does not put excessive stress on natural systems, and thereby does not undermine the benefits of competitive industries for economic growth and social inclusion.

Appendix

Appendix A

A.1 Methodology of the CIP Index

The CIP index is constructed as a weighted geometric average of six indicators, using the following formula:

$$CIP_jt = (\prod_{i=1}^{6} I_{ijt})^{(1/6)} \tag{3.1}$$

where I_{ijt} is the value of the indicator i for country j and year t. The CIP_{jt} values range from 0 to 1. The six indicators are included in the dimensions of the CIP Index, mentioned in Chapter 1, Section 2. They are the following:

Dimension 1: Capacity to produce and export manufactured goods

Indicator 1: Manufacturing value added per capita (MVA_{pc}) is the relative value of total net manufacturing output to a country's population (POP):

$$MVA_{pc} = MVA/POP \tag{3.2}$$

Indicator 2: Manufacturing exports per capita (MX_{pc}) is the value of manufacturing exports relative to the population:

$$MX_{pc} = MX/POP \tag{3.3}$$

Dimension 2: Technological deepening and upgrading

Indicator 3: Industrialization intensity (IND_{int}) is a composite indicator calculated as the arithmetic average of two other indicators, namely manufacturing value added share in total GDP

(MVA_{sh} = MVA/GDP) and the medium- and high-tech manufacturing value added share in total manufacturing value added ($MHVA_{sh}$ = MHVA/MVA_{total}):

$$IND_{int} = (MVA_{sh} + MHVA_{sh})/2 \tag{3.4}$$

Indicator 4: Export quality (MX_{Qual}) is also a composite indicator. It is calculated as the arithmetic average of two further indicators measuring the share of manufacturing exports in total exports (MX_{sh}= MX/X_{total}) and the share of medium- and high-tech manufacturing exports in total manufacturing exports (MHX_{sh}=MHX/MX):

$$MX_{Qual} = (MX_{sh} + MHX_{sh})/2 \tag{3.5}$$

Dimension 3: World impact

Indicator 5: Impact of an economy on world manufacturing value added (ImWMVA) is the share of an economy in global manufacturing value added:

$$ImWMVA = MVA/MVA_{world} \tag{3.6}$$

Indicator 6: Impact of a country on world trade (ImWMT) is the share of an economy in global manufacturing trade:

$$ImWMT = MX/MX_{world} \tag{3.7}$$

A.2 Methodology of the CO_2-adjusted CIP Index

As presented in the text, two dimensions are used to adjust the CIP Index on the basis of emissions. The first dimension covers the emission intensity of manufacturing, measured as CO_2 emissions per unit of MVA per capita in country i. It is calculated as:

$$EI_i = E_i/MVA_i \tag{3.8}$$

with E denoting CO_2 emissions from manufacturing in a given year. Countries with a small index value in the first dimension of the adjustment function can be considered to use more efficient technologies and produce "greener" goods. The second dimension of the adjustment function is calculated as CO_2 emissions per capita and thus represents the per capita manufacturing carbon footprint of country i:

$$CF_i = E_i/Pop_i \tag{3.9}$$

The second dimension thereby measures the negative impact of a given country's manufacturing sector on the global stock of natural capital. This reflects the notion that countries with a larger per capita manufacturing carbon footprint, for example, because the manufacturing sector produces goods that are particularly emissions intensive but important for the economy, assume a greater responsibility to invest in pollution abatement. Each country's adjustment factor is calculated as follows. Both emission indicators are normalized according to the distance-to-reference method (Joint Research Centre-European Commission, 2008). The country with the lowest emission intensity at the emissions frontier serves as the reference for other countries:

$$I_{IE_i} = 1 - (EI_{min}/EI_i) \tag{3.10}$$

Similarly, for the carbon footprint:

$$I_{CF_i} = 1 - (CF_{min}/CF_i) \tag{3.11}$$

Both emission indicators are thus considered to measure the “bads” of manufacturing rather than the “goods” as in the other CIP indicators. The final adjustment factor is calculated according to the following formula that contains the product of the two indexes:

$$Adj_i = 1 - \frac{I_{EI_i}}{1 + \alpha I_{CF_i} (I_{EI_i})^{\beta}} \tag{3.12}$$

α and β are values selected to determine the scale of the adjustment. In the analysis above, both parameters are arbitrarily set to a value of 2. Starting from this value, a marginal increase (reduction) of β, would change the relative weight of I_{IE_i} respect to I_{CF_i} , increasing (reducing) thus the penalty for emissions intensity; while a marginal increase (reduction) of α would increase (reduce) the adjustment factor for each polluting country.

The precise shape of the adjustment factor curve is mainly determined by a country’s emission intensity. If the emission intensity is small, then there is a larger bandwidth of “acceptable” carbon footprint at which the adjustment factor remains small. If, in contrast, the country has a large emission intensity, the marginal penalty increases quickly. Increasing the carbon footprint thereby leads to a very small adjusted CIP score sooner. In other words, being further away from the emission efficiency frontier is penalized more severely. This reflects the aim of the adjusted CIP to point out the potential for emissions reductions relative to the technologies available in the leading countries.

The CO_2 adjusted CIP Index is calculated as:

$$CIP_{Adj_i} = Adj_i \cdot CIP_i \tag{3.13}$$

with the unadjusted CIP Index calculated as in Appendix A.1. If a country has both a low emission intensity and carbon footprint value, its adjustment factor is close to 1 and there is therefore little change between the adjusted and the unadjusted CIP scores. If, however, a country is further from the efficiency frontier and has a large carbon footprint, the adjustment factor approaches 0 and the adjusted CIP score is therefore a smaller proportion of the unadjusted score. The adjusted CIP Index is thus also within the range [0; 1] and is necessarily no larger than the unadjusted CIP Index. The relative downward shift in the adjusted CIP Index value is a reflection of the state of environmental damages and efficiency potential within a country.

Appendix B

B.1 Country classifications

Countries by development stage

Industrialized Economies		
Australia	Austria	Bahrain
Belarus	Belgium	Bermuda
Canada	China, Hong Kong SAR	China, Macao SAR
China, Taiwan Province	Czechia	Denmark
Estonia	Finland	France
Germany	Hungary	Iceland
Ireland	Israel	Italy
Japan	Kuwait	Lithuania
Luxembourg	Malaysia	Malta
Netherlands	New Zealand	Norway
Portugal	Qatar	Republic of Korea
Russian Federation	Singapore	Slovakia
Slovenia	Spain	Sweden
Switzerland	Trinidad and Tobago	United Arab Emirates
United Kingdom	United States of America	
Emerging Industrial Economies		
Argentina	Brazil	Brunei Darussalam
Bulgaria	Chile	China
Colombia	Costa Rica	Croatia
Cyprus	Egypt	Greece
India	Indonesia	Iran (Islamic Republic of)
Kazakhstan	Latvia	Mauritius
Mexico	Oman	Peru
Poland	Romania	Saudi Arabia
Serbia	South Africa	Suriname
Thailand	FYR Macedonia	Tunisia
Turkey	Ukraine	Uruguay
Venezuela		
Other Developing Economies		
Albania	Algeria	Angola
Armenia	Azerbaijan	Bahamas
Barbados	Belize	Bolivia
Bosnia and Herzegovina	Botswana	Cabo Verde
Cameroon	Congo	Côte d'Ivoire
Ecuador	El Salvador	Fiji
Gabon	Georgia	Ghana
Guatemala	Honduras	Iraq
Jamaica	Jordan	Kenya
Kyrgyzstan	Lebanon	Maldives
Mongolia	Montenegro	Morocco
Namibia	Nigeria	Pakistan
Panama	Papua New Guinea	Paraguay

Philippines	Republic of Moldova	Saint Lucia
Sri Lanka	State of Palestine	Swaziland
Syrian Arab Republic	Tajikistan	Tonga
Viet Nam	Zimbabwe	
Least Developed Countries		
Afghanistan	Bangladesh	Burundi
Cambodia	Central African Republic	Eritrea
Ethiopia	Gambia	Haiti
Lao People's Dem. Rep.	Madagascar	Malawi
Mozambique	Myanmar	Nepal
Niger	Rwanda	Senegal
Uganda	United Republic of Tanzania	Yemen
Zambia		

Source: UNIDO, 2017a, UNIDO, 2018c, UNIDO, 2019.

Countries by geographic region

Europe		
Albania	Austria	Belarus
Belgium	Bosnia and Herzegovina	Bulgaria
Croatia	Cyprus	Czechia
Denmark	Estonia	Finland
France	Georgia	Germany
Greece	Hungary	Iceland
Ireland	Italy	Latvia
Lithuania	Luxembourg	Malta
Montenegro	Netherlands	Norway
Poland	Portugal	Republic of Moldova
Romania	Russian Federation	Serbia
Slovakia	Slovenia	Spain
Sweden	Switzerland	FYR Macedonia
Ukraine	United Kingdom	
Latin America		
Argentina	Bahamas	Barbados
Belize	Bolivia (Plurinational State of)	Brazil
Chile	Colombia	Costa Rica
Ecuador	El Salvador	Guatemala
Haiti	Honduras	Jamaica
Mexico	Panama	Paraguay
Peru	Saint Lucia	Suriname
Trinidad and Tobago	Uruguay	Venezuela (Bolivarian Rep. of)
MENA		
Algeria	Bahrain	Egypt
Iran (Islamic Republic of)	Iraq	Israel
Jordan	Kuwait	Lebanon
Morocco	Oman	Qatar
Saudi Arabia	State of Palestine	Syrian Arab Republic

Tunisia	Turkey	United Arab Emirates
Yemen		
North America		
Bermuda	Canada	United States of America
South and South East Asia		
Afghanistan	Bangladesh	Brunei Darussalam
Cambodia	India	Indonesia
Lao People's Dem Rep	Maldives	Myanmar
Nepal	Pakistan	Philippines
Sri Lanka	Thailand	Viet Nam
Sub-Saharan Africa		
Angola	Botswana	Burundi
Cabo Verde	Cameroon	Central African Republic
Congo	Côte d'Ivoire	Eritrea
Ethiopia	Gabon	Gambia
Ghana	Kenya	Madagascar
Malawi	Mauritius	Mozambique
Namibia	Niger	Nigeria
Rwanda	Senegal	South Africa
Swaziland	Uganda	United Republic of Tanzania
Zambia	Zimbabwe	
Other Asia and Pacific		
Armenia	Azerbaijan	Fiji
Kazakhstan	Kyrgyzstan	Mongolia
Papua New Guinea	Tajikistan	Tonga

Source: UNIDO, 2017a, UNIDO, 2019.

B.1 Country classifications

Technology classification of exports

Type of export	SITC Rev. 3
Resource-based	016, 017, 023, 024, 035, 037, 046, 047, 048, 056, 058, 059, 061, 062, 073, 098, 111, 112, 122, 232, 247, 248, 251, 264, 265, 281, 282, 283, 284, 285, 286, 287, 288, 289, 322, 334, 335, 342, 344, 345, 411, 421, 422, 431, 511, 514, 515, 516, 522, 523, 524, 531, 532, 551, 592, 621, 625, 629, 633, 634, 635, 641, 661, 662, 663, 664, 667, 689
Low technology	611, 612, 613, 642, 651, 652, 654, 655, 656, 657, 658, 659, 665, 666, 673, 674, 675, 676, 677, 679, 691, 392, 693, 694, 695, 696, 697, 699, 821, 831, 841, 842, 843, 844, 845, 846, 848, 851, 893, 894, 895, 897, 898, 899
Medium technology	266, 267, 512, 513, 533, 553, 554, 562, 571, 572, 573, 574, 575, 579, 581, 582, 583, 591, 593, 597, 598, 653, 671, 672, 678, 711, 712, 713, 714, 721, 722, 723, 724, 725, 726, 727, 728, 731, 733, 735, 737, 741, 742, 743, 744, 745, 746, 747, 748, 749, 761, 762, 763, 772, 773, 775, 778, 781, 782, 783, 784, 785, 786, 791, 793, 811, 812, 813, 872, 873, 882, 884, 885
High technology	525, 541 542, 716, 718, 751, 752, 759, 764, 771, 774, 776, 792, 871, 874, 881, 891

Source: UNIDO, 2017a, page 90.

Medium high- and high-technology (MHT) manufacturing categories

Description	ISIC Rev. 3
Manufacture of chemicals and chemical products	24
Manufacture of machinery and equipment	29
Manufacture of office, accounting and computing machinery	30
Manufacture of electrical machinery and apparatus	31
Manufacture of radio, television, and communication equipment and apparatus	32
Manufacture of medical, precision and optical instruments, matches and clocks	33
Manufacture of motor vehicles, trailers and semi-trailers	34
Manufacture of other transport equipment, excluding:	35
–ISIC revision 3:	
Building and repairing of ships and boats = 351	
–ISIC revision 4:	
Building of ships and floating structures = 3011	
Building of pleasure and sporting boats = 3012	
Repair of transport equipment, except motor vehicles = 3315	

Source: OECD, 2003, UNIDO, 2010 and UNIDO, 2017a, page 90.

Appendix C

C.1 CIP Index 2018, detailed tables

Regional scores and ranks

Table 3.5: *East Asia*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Japan	1	2	0.3998	17	10	4
China	2	3	0.3764	48	9	1
Republic of Korea	3	5	0.3667	13	1	5
Singapore	4	12	0.2573	4	3	28
China, Taiwan Province	5	13	0.2547	16	2	15
Malaysia	6	22	0.1662	35	14	23
Australia	7	30	0.1199	33	98	30
New Zealand	8	46	0.0659	35	99	58
China, Hong Kong SAR	9	87	0.0220	82	111	84
China, Macao SAR	10	147	0.0008	124	150	147

Source: UNIDO, 2018a.

Table 3.6: *Europe*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Germany	1	1	0.5234	7	5	3
Switzerland	2	6	0.3207	2	13	17
Ireland	3	7	0.3172	1	4	26
Belgium	4	8	0.2807	3	21	12
Italy	5	9	0.2733	19	23	7
Netherlands	6	10	0.2707	5	30	11
France	7	11	0.2679	23	20	6
Austria	8	14	0.2389	6	16	24
Sweden	9	15	0.2254	9	17	27
United Kingdom	10	16	0.2191	31	27	9
Czechia	11	17	0.2148	11	7	25
Spain	12	19	0.2044	30	33	13
Denmark	13	21	0.1715	10	29	33
Poland	14	23	0.1651	37	24	21
Slovakia	15	24	0.1604	14	6	35
Hungary	16	26	0.1493	22	8	32
Finland	17	27	0.1457	15	34	39
Slovenia	18	31	0.1109	12	19	52
Russian Federation	19	32	0.1047	61	76	18
Norway	20	33	0.1042	18	69	45
Portugal	21	34	0.1026	36	46	40
Romania	22	37	0.1015	44	18	38
Lithuania	23	40	0.0818	29	37	59
Luxembourg	24	42	0.0728	8	58	72
Belarus	25	47	0.0657	51	22	57
Estonia	26	48	0.0647	25	38	70
Greece	27	52	0.0591	49	70	54
Croatia	28	53	0.0552	45	43	65
Bulgaria	29	54	0.0524	53	50	60
Latvia	30	59	0.0474	41	54	75
Serbia	31	62	0.0416	64	44	66
Ukraine	32	64	0.0407	92	57	51
Malta	33	65	0.0398	28	39	93
Iceland	34	71	0.0345	20	94	104
The f. Yugosl. Rep of Macedonia	35	78	0.0291	59	36	90
Bosnia and Herzegovina	36	81	0.0257	69	66	89
Cyprus	37	93	0.0159	74	63	125
Georgia	38	97	0.0135	96	81	112
Albania	39	106	0.0105	101	110	115
Republic of Moldova	40	110	0.0097	113	83	126
Montenegro	41	122	0.0066	102	100	138

Source: UNIDO, 2018a.

Table 3.7: *Latin America*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Mexico	1	20	0.1786	47	15	10
Brazil	2	35	0.1019	65	53	16
Argentina	3	49	0.0633	63	65	41
Chile	4	51	0.0606	54	107	46
Trinidad and Tobago	5	56	0.0499	39	47	80
Peru	6	60	0.0426	76	102	50
Costa Rica	7	67	0.0389	58	56	77
Venezuela (Bolivarian Republic of)	8	68	0.0382	66	120	48
Colombia	9	70	0.0369	80	85	49
Guatemala	10	74	0.0309	84	59	71
Panama	11	75	0.0308	56	64	74
El Salvador	12	76	0.0303	75	51	81
Uruguay	13	79	0.0281	57	106	85
Ecuador	14	89	0.0196	91	134	78
Honduras	15	92	0.0159	105	79	95
Paraguay	16	96	0.0136	99	122	98
Bolivia (Plurinational State of)	17	98	0.0134	107	133	92
Jamaica	18	100	0.0121	97	88	121
Barbados	19	104	0.0107	71	55	137
Suriname	20	114	0.0092	73	131	135
Bahamas	21	118	0.0080	83	60	139
Belize	22	128	0.0049	104	121	141
Saint Lucia	23	135	0.0034	98	80	143
Haiti	24	137	0.0030	137	95	132

Source: UNIDO, 2018a.

Table 3.8: *Middle East and North Africa*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Israel	1	28	0.1318	24	25	37
Turkey	2	29	0.1242	50	41	22
Saudi Arabia	3	36	0.1018	43	72	31
United Arab Emirates	4	41	0.0735	38	124	44
Qatar	5	50	0.0631	26	86	63
Bahrain	6	55	0.0515	32	77	79
Kuwait	7	57	0.0491	42	118	62
Iran (Islamic Republic of)	8	58	0.0482	78	82	42
Tunisia	9	61	0.0418	70	32	64
Morocco	10	63	0.0415	88	42	56
Oman	11	66	0.0392	52	97	73
Egypt	12	73	0.0331	103	67	47
Jordan	13	80	0.0267	86	49	82
Lebanon	14	90	0.0188	89	71	94
Algeria	15	94	0.0149	112	143	68
State of Palestine	16	111	0.0096	110	91	123
Syrian Arab Republic	17	112	0.0093	125	116	87
Yemen	18	139	0.0026	143	123	128
Iraq	19	146	0.0009	133	149	102

Source: UNIDO, 2018a.

Table 3.9: *North America*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
United States of America	1	4	0.3726	27	28	2
Canada	2	18	0.2074	21	48	14
Bermuda	3	138	0.0027	87	62	149

Source: UNIDO, 2018a.

Table 3.10: *South and South East Asia*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Thailand	1	25	0.1536	46	12	19
Indonesia	2	38	0.0907	77	45	20
India	3	39	0.0830	108	40	8
Philippines	4	43	0.0725	81	11	34
Viet Nam	5	44	0.0724	72	31	29
Bangladesh	6	72	0.0340	114	61	43
Sri Lanka	7	77	0.0298	85	84	67
Pakistan	8	82	0.0245	126	68	53
Brunei Darussalam	9	83	0.0245	40	78	117
Cambodia	10	88	0.0212	100	73	76
Myanmar	11	91	0.0186	115	90	69
Lao People's Dem Rep	12	101	0.0115	111	89	105
Nepal	13	131	0.0037	144	96	127
Maldives	14	142	0.0018	117	147	146
Afghanistan	15	144	0.0013	140	145	124

Source: UNIDO, 2018a

Table 3.11: *Sub-Saharan Africa*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
South Africa	1	45	0.0694	67	52	36
Swaziland	2	84	0.0243	62	35	111
Botswana	3	85	0.0238	55	93	83
Mauritius	4	86	0.0222	60	75	107
Namibia	5	95	0.0147	79	126	109
Kenya	6	103	0.0108	130	101	86
Côte d'Ivoire	7	105	0.0106	122	127	91
Senegal	8	108	0.0101	127	87	101
Gabon	9	109	0.0097	90	146	119
Congo	10	113	0.0093	106	74	106
Nigeria	11	115	0.0092	121	135	55
Cameroon	12	117	0.0087	123	119	96
Zambia	13	119	0.0080	129	125	108
Ghana	14	123	0.0064	131	144	97
Zimbabwe	15	124	0.0061	132	113	122
Mozambique	16	125	0.0055	139	92	116
Madagascar	17	126	0.0054	136	128	118
United Republic of Tanzania	18	127	0.0053	138	142	99
Uganda	19	129	0.0045	141	130	113
Angola	20	130	0.0039	116	148	88
Central African Republic	21	132	0.0035	135	26	140
Malawi	22	134	0.0034	142	115	131
Cabo Verde	23	136	0.0030	120	109	145
Niger	24	140	0.0022	145	117	130
Rwanda	25	141	0.0021	146	139	136
Ethiopia	26	143	0.0015	149	141	120
Gambia	27	145	0.0011	147	114	148
Burundi	28	148	0.0000	150	132	142
Eritrea	29	149	0.0000	148	140	144

Source: UNIDO, 2018a.

Table 3.12: *Other Asia and Pacific*

Country	Group rank	Global rank	Index score	Dimension 1	Dimension 2	Dimension 3
Kazakhstan	1	69	0.037172835	68	104	61
Armenia	2	99	0.012790185	95	103	114
Mongolia	3	102	0.010934582	94	138	103
Azerbaijan	4	107	0.010140587	109	137	100
Fiji	5	116	0.00907017	93	105	134
Papua New Guinea	6	120	0.006566948	118	136	110
Kyrgyzstan	7	121	0.00656189	128	108	129
Tajikistan	8	133	0.003536148	134	112	133
Tonga	9	150	0	119	129	150

Source: UNIDO, 2018a.

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