INDUSTRIALIZATION AS THE DRIVER OF SUSTAINED PROSPERITY

Editorial Supervision by

LI Yong
Director General, UNIDO

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Foreword

With ten years to go to achieve the 2030 Agenda, the world faces the tremendous challenge of delivering on the Sustainable Development Goals (SDGs) adopted in 2015. This book is a timely contribution to uncovering the key drivers of sustained and inclusive prosperity.

Historically, industrialization has been the main driver of economic growth and is the underlying core of the economic success of high-income countries in Europe and North America. Relying on the expansion of their manufacturing sector, many East and South East Asian economies have similarly transitioned from low income to middle income countries over the last 50 years, which considerably improved the living standards of their citizens.

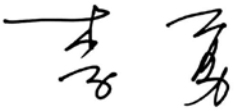
This book substantiates that industrialization does not only contribute to economic growth and infrastructure upgrading, but can also directly and indirectly support the achievement of the SDGs' socio-economic and environmental objectives through the creation of jobs, improvements in working conditions, innovation, and the development of new and greener production technologies.

There is growing recognition that market forces alone rarely initiate industrialization processes similar to those of early industrializers like Germany, Japan or the United States. Policymakers are increasingly turning their attention to industrial policies aimed at promoting specific manufacturing industries and the allocation of resources towards these industries. This publication shows that industries countries ultimately focus on is dependent on country-specific context, and this book comprehensively analyses this aspect.

There has been renewed interest in industrial policies in recent years. Despite this, there is a lack of practical information for governments and policymakers on feasible industrial policy options and how to promote such policy. This book aims to close this gap by looking at individual country experiences at different points in time, selected case studies from various manufacturing industries, and examples of successful industrial policy governance packages. This book provides new, timely and relevant insights into this important topic.

Although industrial policies have played a key role in economic development, their formulation is far from straightforward and requires a deep understanding of at least three important dimensions: 1) their selectivity, 2) their feasibility, and

3) their orientation. Even when these policies are well formulated, implementing them remains a major challenge. At the end of the day, successful industrialization is not simply about choosing the right policy instruments and institutions, but also about learning how to effectively build, use and coordinate them. Taking all these elements into consideration, this book offers useful guidance for governments of developing countries and for international organizations alike on the fundamental features of the industrial policy formulation and implementation process. I look forward to seeing this book serve as a reference document in the study of the leading role industrial development plays in the achievement of the 2030 Agenda for Sustainable Development.



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Abbreviations

4IR: Fourth Industrial Revolution
CIP: Competitive Industrial Performance
EPZ: Export Processing Zone
FDI: Foreign Direct Investment
GATT: General Agreement on Tariffs and Trade
GDP: Gross Domestic Product
GVCs: Global Value Chains
IMF: International Monetary Fund
ISIC: International Standard Industrial Classification
ISID: Inclusive and Sustainable Development
LDCs: Least Developed Countries
MVA: Manufacturing Value Added
OEM: Original Equipment Manufacturer
PCP: Programme for Country Partnership
R&D: Research and Development
ROK: Republic of Korea
SDGs: Sustainable Development Goals
SEZ: Special Economic Zone
SITC: Standard International Trade Classification
SMEs: Small and Medium-Size Enterprises
SOEs: State-Owned Enterprises
UNIDO: United Nations Industrial Development Organization
UNSD: United Nations Statistics Division
VA: Value Added
WDI: World Development Indicators
WTO: World Trade Organization

1 ACHIEVING SUSTAINABLE DEVELOPMENT

New empirical evidence on the impact of industrialization on social and environmental sustainability goals

1.1. Putting industrialization back on the international agenda

Considerable progress has been made in terms of understanding growth and development. First, there is growing consensus that a one-size-fits-all development model does not exist. Second, an appropriate policy framework and institutions are indispensable for initiating a sustained growth process, even if there is considerable disagreement over what these highly context-specific policies should be. Third, there is a rediscovery of the insights from economists of the past, such as Albert Hirschman, Paul Rosenstein-Rodan and Arthur Lewis, who argued that a crucial element in spurring development is to transform a predominantly rural and highly informal economy into a 'modern' economy with a thriving industrial sector at its core. Finally, it is widely acknowledged in the meantime that economic growth, with its associated increase in *average* income levels, does not guarantee development. Although the UN acknowledges that *"there is no established convention for the designation of "developed" and "developing" countries"*[1], few would doubt that the notion of development goes beyond material standards of living and includes non-income dimensions of well-being such as life expectancy, health, education, and a clean and liveable environment. This broad-based and comprehensive view of development is enshrined in the UN Sustainable Development Goals (SDGs), a collection of 17 objectives (Figure 1.1) that form part of the 2030 Agenda adopted in 2015.[2]

The SDGs were created as *"a blueprint for shared prosperity in a sustainable world—a world where all people can live productive, vibrant and peaceful lives on*

1 See United Nations at https://unstats.un.org/unsd/mi/worldmillennium.htm, note b.

2 The SDGs were adopted as part of Resolution 70/1 of the United Nations General Assembly.

Figure 1.1: The Sustainable Development Goals

Source: https://sustainabledevelopment.un.org/sdgs.

a healthy planet".[3] Importantly, and in contrast to the Millennium Development Goals (MDGs), which were often criticized as being too selective and not sufficiently comprehensive, industrialization figures prominently among the SDGs comprized in Goal 9. Cambridge economist Ha-Joon Chang described the MDGs as a development discourse without development—comparing it to Shakespeare's Hamlet without the Prince of Denmark—precisely because industry and structural change were absent. The SDGs reintroduced the notion of development as a process of change in the productive structure of an economy, so that, in Chang's terms, the Prince of Denmark is back.

Considerable progress has been made in key aspects of economic development over the past 25 years. Over one billion people have managed to escape extreme poverty, and maternal and child mortality rates have dropped significantly (United Nations, 2019). Nevertheless, the fact that 10 per cent of the global population still live in extreme poverty[4], with more than half of that population living in Africa, and that the number of people suffering from hunger seems to be on the rise again (United Nations, 2019), indicates that the 'holy grail' of economic development

3 Foreword to the Sustainable Development Goals Report 2019 (United Nations, 2019).

4 As of 2015. People with incomes of less than US dollars 1.90 per day are considered to live in extreme poverty.

has yet to be found. In its latest *Sustainable Development Goals Report*, the United Nations summarises the current situation, stating that *"while advances have been made in some areas, monumental challenges remain"* (United Nations, 2019). The progress made in achieving SDGs can therefore be given a negative or a positive interpretation. What seems clear, however, is that the positive momentum needs to accelerate; at the current pace of progress, the world is not on track to end extreme poverty by 2030.

Against this background, the first chapter of this book investigates the role of industrialization, itself one of the SDGs that is far from being an accomplished mission, for the achievement of other SDGs. For this purpose, the SDGs are divided into socio-economic goals and environment related goals. The evidence presented is based primarily on empirical regularities identified in past development. Although highly informative, such empirical patterns should not be considered natural laws. On the contrary, as emphasized in Chapter 2, the potential and paths for countries to industrialize, as well as the subsequent consequences for other social and economic outcomes, are highly context-specific and strongly influenced by policy choices. Hence, the empirical patterns serve as useful guidance to learn from past experiences but should by no means be considered deterministic. In fact, UNIDO's promotion of inclusive and sustainable industrial development (ISID) shows that industrialization processes need to be managed (and most likely initiated) by governments to make sure that no country and no parts of society within a country are left behind and that industrial activities are decoupled from an excessive use of natural resources and environmental degradation.[5]

1.2. An overview of industrialization, productive transformation and development

Historically, the phenomenon of industrialization, featuring the establishment of a thriving manufacturing sector nurtured by innovation and a supportive infrastructure, has gone hand in hand with economic development. This is true for pioneering countries (such as England or the Netherlands) as well as 'latecomers' (and 'late latecomers') eager to catch up with countries at the technological frontier.

Against this background, the re-introduction of *Industry, Innovation and Infrastructure* as a development goal (SDG 9) was overdue. Many economists assign great importance to this component, as the entire process of development is rooted in the transformation of the productive structure and its underlying capabilities (see e.g. Chang, 2010). Traditionally, the transformation of the productive structure was associated with industrialization, implying the shift of production factors (mainly labour) from (subsistence) agriculture to manufacturing and other 'modern' industries characterized by high levels of productivity (Cimoli et al., 2009; Reinert, 2007). This shift in the production structure directly contributes to countries' growth and is known as a 'structural change bonus' (Timmer and Szirmai, 2000).

5 See: https://www.unido.org/inclusive-and-sustainable-industrial-development

The manufacturing sector enjoys a productivity advantage over the economy as a whole in developing countries (Figure 1.2, panel a). This advantage was most pronounced in low income countries over the period 1991-2017, amounting to 55 per cent. In general, the productivity advantage is particularly high vis-à-vis the agriculture sector, substantiating the tremendous potential of the aforementioned 'structural change bonus'. The manufacturing sector's observed productivity advantage results from its many special features (see Box 1.1)[6] and has turned it into the key driver of economic development in the majority of 'economic miracles' cases, including those of the East Asian economies since the 1960s.

Box 1.1: Why manufacturing is special

It is a well-established empirical fact that the amount of output produced with a given amount of inputs, i.e. productivity, tends, on average, to be higher in manufacturing than in agriculture and in the services sector due in part to higher levels of capital per workers. In addition, however, there is also evidence that the growth of productivity has been higher in manufacturing than in agriculture and in many, but not all, parts of services. The growth of productivity that has made manufacturing an engine of growth arises from several sources. First are *economies of scale*. In the presence of up-front investments (fixed costs), capital deepening facilitates mass production and reduces the costs per unit produced as output increases. Equally important are dynamic economies of scale which arise from learning-by-doing as more pieces of the same product, e.g. aircraft, are produced. Increasing returns to scale are one of the key features that distinguish manufactured goods from simple commodities and also from most service activities. For this reason, manufacturing industries characterized by high fixed costs, such as *pharmaceuticals* or *aerospace*, have been the usual targets of strategic trade policies (Brander and Spencer, 1985; Krugman, 1986) aimed at 'rent-shifting', that is, attempting to attract domestic production in industries with abnormally high profits at the expense of foreign rivals. Moreover, traditional infant-industry protection is based on the notion of dynamic economies of scale as the idea of such a tariff is to protect an industry from foreign competition until it has moved down the learning curve and become internationally competitive.

A second key feature of manufacturing is found in its *strong linkages to other parts of the economy*. Linkages are important because they imply that the growth of an industry automatically creates additional demand or new supplies and opportunities for other industries. Linkages across industries therefore ensure that economic dynamism in one sector spreads to other areas. For many economists, the reinforcing nature of linkages lies at the core of economic development. This is why the creation of clusters and ecosystems, which are both characterized by a set of tightly interwoven activities, has become a cornerstone in many countries' industrial and development policies.

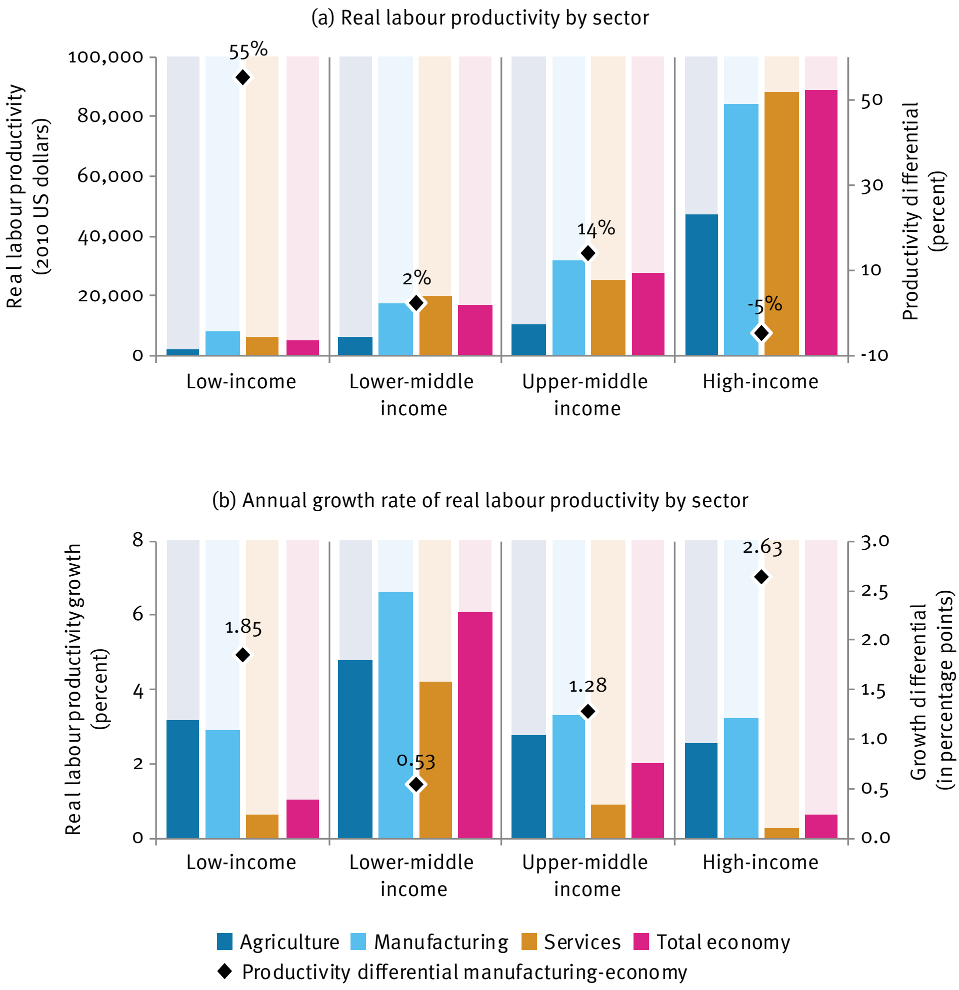
Third, the manufacturing sector is the *source of most innovations and advances in technology*. Manufacturing feeds into the growth process beyond the sector itself as other parts of the economy make use of the newly developed technologies.

Further characteristics that heighten the sector's relevance for the economy far beyond its share in value added and employment are discussed below in the context of industrialization and individual SDGs.

6 For further details, see also Szirmai, 2012; Rodrik, 2008 and 2013; Szirmai and Verspagen, 2015; Haraguchi et al., 2017.

It is due to this superior productivity performance that manufacturing is widely considered to be an economy's 'engine of growth', especially in developing countries. It is only at the high income level that this productivity advantage disappears, when countries turn into service-driven economies. Productivity growth is, on average,

Figure 1.2: Real labour productivity by broad sectors across income groups, 1991-2017



Notes: Based on all available economies for the period 1991-2017. The World Bank's country classification by income as of 1991. Productivities are weighted by countries' sector-specific shares in the real value added of their income group. Excluding outliers defined as countries with sector-specific real labour productivity that is higher or lower than the mean real labour productivity of the respective income group +/- 4 times the standard deviation in any year. The sectors mining and utilities (electricity, gas and water) are not shown but included in "Total economy".

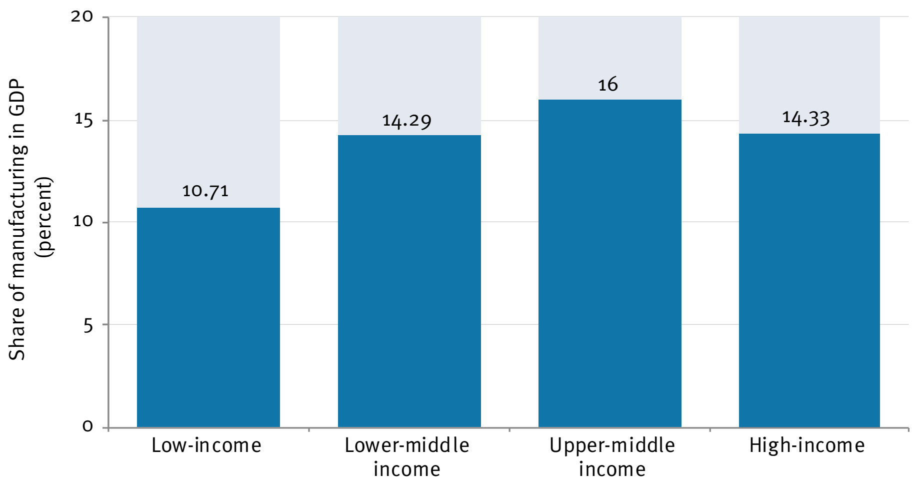
Source: UNIDO elaboration based on UNSD National Accounts Estimates of Main Aggregates, ILO World Employment and Social Outlook database.

higher in the manufacturing sector than it is in the rest of the (services-dominated) economy, even for high income countries (Figure 1.2, panel b).

The claim that manufacturing nurtures growth and development is also supported by the fact that its share in GDP increases across income groups in a long-term perspective until the upper middle income level is reached (Figure 1.3).

Reflecting the increasing shift towards service-driven economies at the high income stage (which is also related to the high income elasticity of many services), the share of manufacturing value added in GDP is, on average, lower in high income countries than in upper middle income countries. Historically, only when economies have matured to become advanced economies has the share of manufacturing in GDP receded, with the production structure tending to shift towards services (Figure 1.3). More recently, the lower manufacturing share of high income countries (compared to upper middle income countries) is also partly driven by the offshoring activities of multinational enterprises, with the relocation of production activities to lower wage destinations. Part of the value added is thereby shifted out of developed countries, leaving what can be referred to as 'high powered' manufacturing consisting of research and development (R&D),

Figure 1.3: The role of manufacturing in the economy across income groups; value added shares, 1970-2017



Notes: Based on all available countries for the period 1970-2017. The World Bank's country classification by income as of 1970 or first available year. Income group classification based on the historic World Bank income group classification, which was extended backwards in time on the basis of the threshold values for its lending operations (following the GNI per capita thresholds in US dollars (Atlas methodology) series). The series are available from the 1970s onwards and (in an adapted manner) serve as the basis for the World Bank's country classification by income.

Sources: UNIDO elaboration based on UNSD, National Accounts Estimates of Main Aggregates.

design, marketing and other high-value added activities, still located there. In addition, manufacturing shares have peaked more recently at lower income levels than in the past, leading to concerns in these countries about the phenomenon of *premature deindustrialization* (Rodrik, 2016).[7]

Importantly, the transformation of productive structures as part of the process of development is not confined to the economic sphere. There is a large body of historical evidence that new productive structures can in turn transform the social fabric leading to urbanization, changes in gender relationships, the rise of labour movements and the advent of the welfare state. Industry and innovation are therefore not only the cornerstone of SDG 9 but potentially support and reinforce the achievement of other SDGs. This is true above all for economic growth (SDG 8), but there are also links to ending poverty (SDG 1), good health and well-being (SDG 3), education (SDG 4) and reducing inequalities (SDG 10). As already noted, not all of the links follow a particular pattern as experiences are often country-specific, underlining the role of policies and institutions.

1.3. Industrialization as a driver of the Sustainable Development Goals

1.3.1. Industrialization and the overall achievement of SDGs

The 17 SDGs are structured into 169 targets featuring an even greater number of indicators. They range from ending extreme poverty to enhancing inclusive and sustainable urbanization and from promoting the rule of law to ending epidemics such as AIDS, tuberculosis or malaria. The diversity and comprehensiveness of the targets derive from the complexity of development processes that go far beyond income levels and material well-being. Given the extensive scope of goals, targets and indicators, it is useful to take a bird's eye view of the SDG-Industrialization link, using aggregate scores for countries that measure their progress in reaching the SDGs, overall or individually for each SDG. Although such a broad-brush approach does not pay due attention to the multi-faceted nature of the SDGs, it gives a preliminary insight into the question at hand, which is whether industrialization can contribute to progress in other, interdependent SDGs.[8]

7 Premature deindustrialization refers to the decline in the share of manufacturing at a lower income level than that observed in today's industrialized economies. According to Rodrik (2016), this not only entails the risk of slowing down the growth process, but may foreclose the development of a labour movement, and habits of compromise and moderation arising out of industrial struggles over pay and working conditions, all of which are supportive of strong democratic institutions. However, the share of global manufacturing value added over global GDP in developing countries has not changed for the last 40 years. Thus, the phenomenon of premature deindustrialization implies an increase in the concentration of manufacturing activities in a few successful countries (Haraguchi, et al., 2017).

8 The overall SDG index used here is available from the Sustainable Development Report 2019 compiled jointly by the Bertelsmann Stiftung and the Sustainable Development Solutions Network (see Sachs et al., 2019). The indicators used in the compilation of this SDG index overlap largely with the official indicators, but are not identical. For details, see Sachs et al. (2019) and https://sdgindex.org/reports/sustainable-development-report-2019/.

A first important observation in this context is that the overall SDG scores of countries are significantly associated with their income level (Figure 1.4, panel a). This positive relationship is attributable to the fact that many SDGs are related to socio-economic challenges that are obviously more pressing in less developed economies. Incidence of poverty, undernourishment, access to sanitary facilities or of infectious disease are prime examples of problems that, while not absent in developed countries, are clearly more acute in poorer countries.[9] The positive relationship between GDP per capita and the SDG index, which is present at all income levels, is therefore not surprising.

A second observation is that the higher SDG scores are also positively correlated with manufacturing intensity, defined as manufacturing value added (MVA) per capita[10] (Figure 1.4, panel b). This suggests that, overall, industrialization and the development of a sizeable and productive manufacturing sector is associated with countries' progress in achieving their SDGs.

This result is in line with the historical evidence, which shows that economic development is typically spurred by industrialization. As manufacturing intensity reflects the importance of both the sector in the economy and its productivity level, the established positive relationship between the overall SDG score and industrialization can be driven entirely by a general productivity effect. In other words, as countries become richer and more productive, SDG scores improve, as does manufacturing intensity.

The relationship between industrialization and the overall progress made in achieving the SDG objectives as presented in Figure 1.4 calls for a further investigation of the interdependencies between industrialization and individual goals and targets. This is the focus of the next sections, dividing the SDGs into two sets of indicators: socio-economic indicators, which capture *inter alia* the inclusiveness dimension of ISID; and indicators related to environmental transformation, capturing the sustainability dimension.

1.3.2. An in-depth analysis of industrialization and SDGs

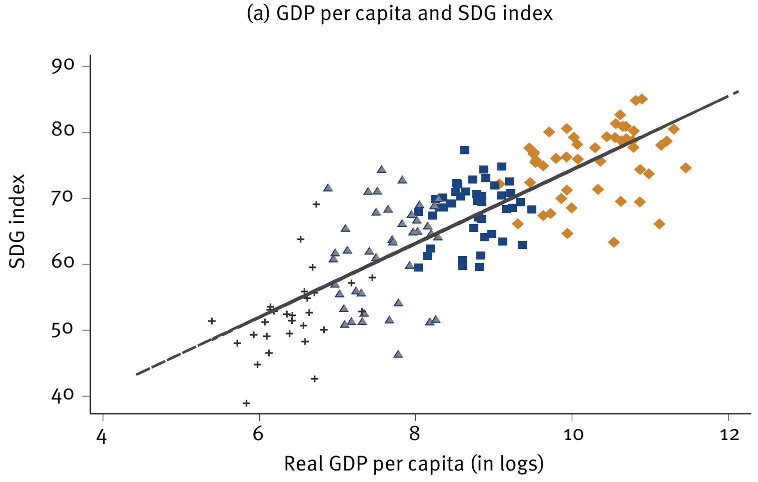
With a view to refining and verifying the insights obtained from the preliminary analysis, empirical regularities between industrialization and individual SDG targets[11] are examined. For this, a number of targets and indicators have been selected (see Appendix 1 for details), with the choice of indicator based on a combination of a priori reasoning and data availability.

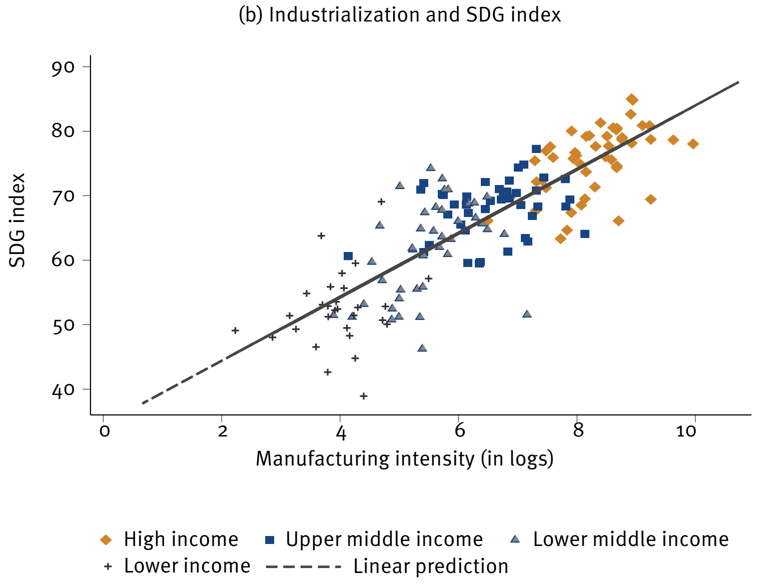
9 There are, however, also socio-economic SDG targets that represent challenges mainly for high income countries and the newly emerging middle classes of middle income countries, such as obesity.

10 Although there is no perfect measure to capture the complex phenomenon of industrialization, MVA per capita serves the purpose as an informative and readily available indicator for industrialization. It also figures among the set of indicators for SDG 9 on industrialization, innovation and infrastructure and is intended, in particular, to measure progress in achieving target 9.2, which calls for inclusive and sustainable industrialization. The second indicator listed in target 9.2, which measures the share of manufacturing value added in GDP, is also included. This is another important indicator as it allows for the analysis of the effect of manufacturing expansion (retraction), i.e. an increase (decrease) in the MVA-to-GDP share, and how this is associated with changes in the metrics of SDGs.

11 More precisely, individual indicators assigned to targets are investigated.

Figure 1.4: A positive relationship between GDP per capita, industrialization and SDG achievements





Notes: Manufacturing intensity is defined as MVA per capita. SDG index is taken from the Sustainable Development Report 2019 (Sachs et al., 2019) and the accompanying database, which used indicators that do not fully coincide with official SDG indicators.

Source: UNIDO elaboration based on UNSD, National Accounts Estimates of Main Aggregates, World Bank's WDI (for population), Sachs et al. (2019).

With 17 global goals and 169 highly ambitious targets, the aim and scope of the SDG agenda offers a very granular and detailed outlook on desired global development patterns. A quantitative analysis of all SDG targets goes beyond the scope of this chapter as (a) the relationship between some of the targets and manufacturing development is unclear from a conceptual point of view;[12] (b) data coverage relying on official data does not merit an empirically-driven analysis and hence a qualitative analysis is preferred;[13] and (c) analysing targets that are highly correlated with each other adds little to the discussion.

With

17 *and* **169**

global goals — highly ambitious targets

the aim and scope of the **SDG agenda** *offers a* **very granular** *and* **detailed outlook** *on desired global development patterns.*

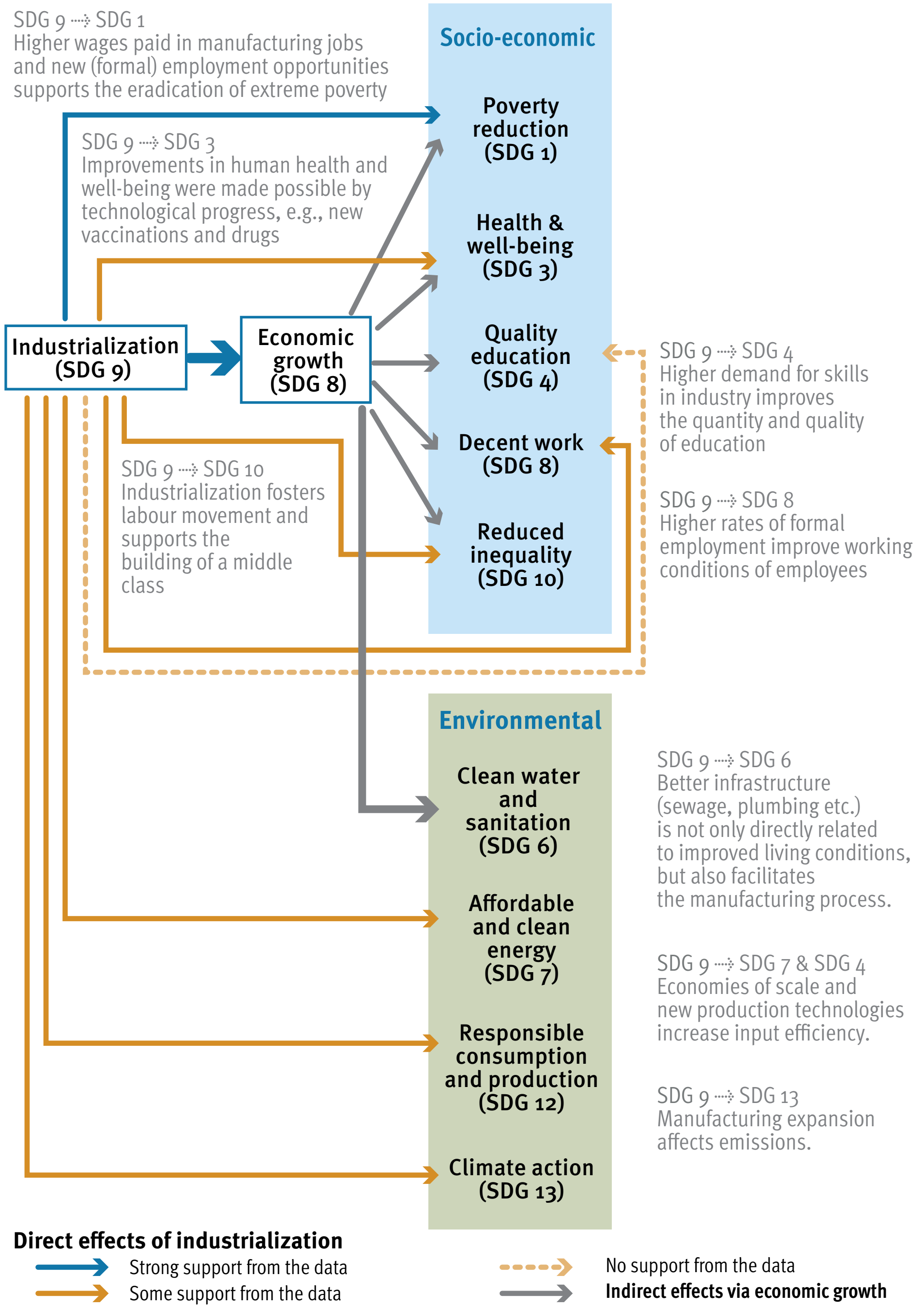
The expectation is that industrialization primarily affects SDGs via economic growth. We refer to this as 'indirect effects' because the supportive impact of industrialization on socio-economic development arises indirectly from its role as an engine of growth (Figure 1.5). Nevertheless, there are also a number of specific characteristics of manufacturing that induce direct effects on SDGs (for example, a higher rate of formal employment).

The remainder of this chapter offers a detailed analysis of the selected set of SDG indicators governing both the socio-economic as well as the environmental domain.

12 Consider, for example, Goal 10—Reduced Inequalities; target 10.6.1: 'Proportion of voting rights of developing countries in international organisation' or Goal 5—Gender Equality; target 5.5.1: 'Number of seats in national parliaments'.

13 Consider, for example, Goal 12—Responsible Consumption and Production; indicator 12.4.1: 'Compliance with the Montreal Protocol on hazardous waste and other chemicals', which reports full compliance for all recorded countries as provided by SDG (2019).

Figure 1.5: Industrialization, economic growth and the SDGs: Synthesis framework



Source: UNIDO elaboration.

1.4. Industrialization and the socio-economic SDGs

The role of industrialization in stimulating economic growth is central to the Synthesis Framework set out in Figure 1.5. A successful development process requires high growth rates to be sustained over a long period of time. A sustained catching-up trajectory was estimated to require average GDP growth rates of 5 per cent annually or more for at least two decades (Szirmai, 2012; UNIDO, 2015), with a volatility of growth as low as possible (Pritchett, 2000). The historical record of such growth take-offs in Europe and, more recently, in East Asia suggests a close relationship between industrialization and economic growth. Apart from the historical evidence at hand, the data examined for this book clearly suggest that a growing share of manufacturing in GDP is positively associated with economic growth (Figure 1.6).

This positive relationship with GDP growth is much stronger for manufacturing than for services. For the agriculture sector, the relationship is negative. As discussed above, this pattern is in line with the idea of industrialization as a process of productive transformation characterized by increasing returns to scale, strong linkages and high tradability of output.

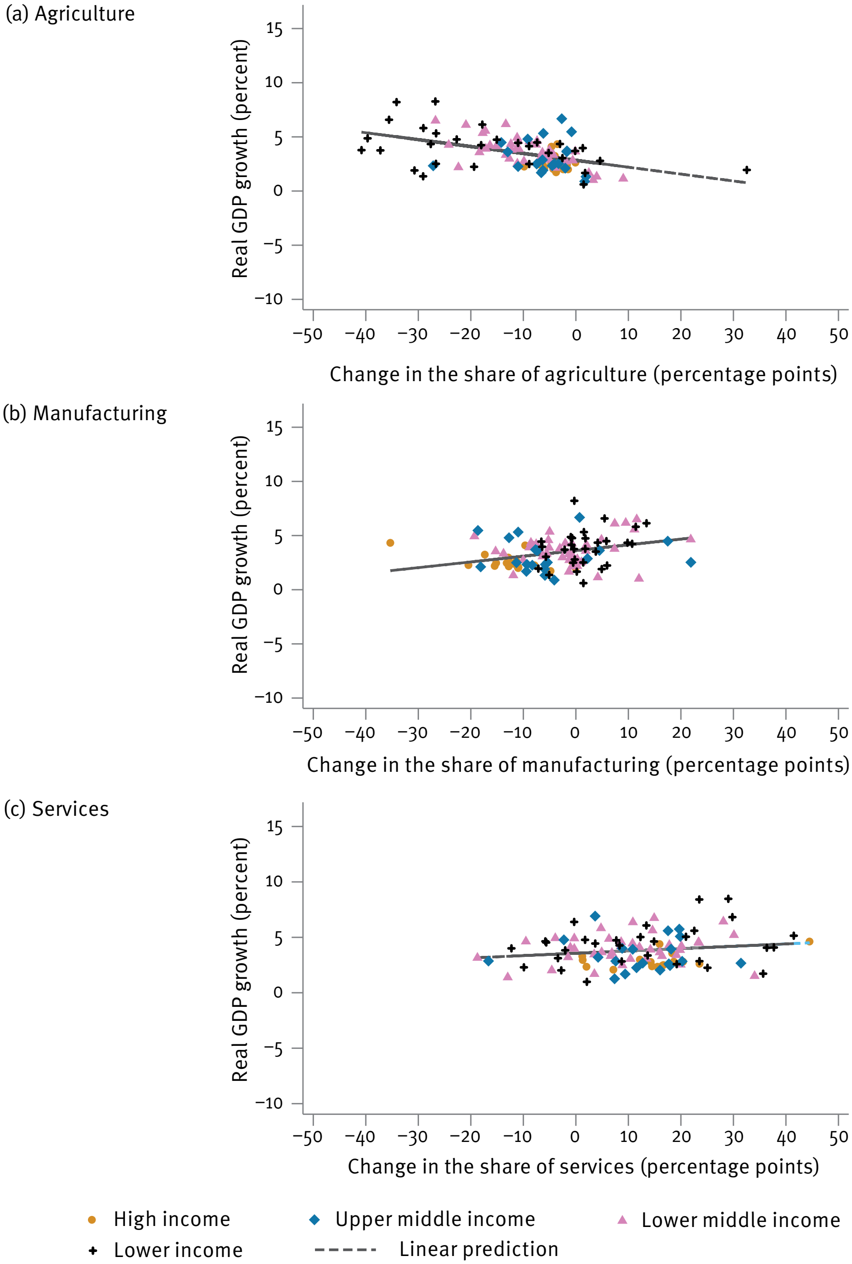
Not only are larger industrial sectors associated with economic growth, fast-industrializing countries[14], on average, tend to grow more rapidly than other economies (Figure 1.7, panel a). The distribution of growth rates clearly shows that fast industrializers, which include China, Turkey, the Republic of Korea (ROK) and Viet Nam, registered an average growth of 3.2 per cent, which is almost twice as high as the average growth rate of the other countries in the sample.[15] There is a great deal of variation, however. This can be seen by the wide overlap in the blue and the yellow curves, which implies that over the period from 1970 to 2017, there were several episodes where individual fast industrializers grew slowly (the left 'tail' of the yellow curve) and episodes where some non-fast industrializers had strong growth (the right 'tail' of the blue curve). This implies that industrialization is not the only factor that influences a country's growth performance. Country-specific characteristics that can play a significant role are likely to include political factors, geography, institutional features, including labour markets and income and asset inequality. Focussing on averages, the growth advantage enjoyed by fast industrializing economies is present throughout the entire period from 1970 to 2017 (Figure 1.7, panel b).

The robust finding that fast industrializers tend to grow faster is one of the channels through which industrialization affects other socio-economic goals. At the same time, it also establishes a direct link between SDG 9 and SDG 8.

14 For the definition of fast-industrializing countries and the list of countries, see Appendix 2. Broadly speaking, fast industrializing countries are countries which not only grew fast in the last 50 years but also increased their manufacturing share in GDP.

15 A simple t-test shows that the differences in the growth rates of the two groups of countries are statistically significant.

Figure 1.6: Relationship between changes in sectoral shares and economic growth, 1970-2017

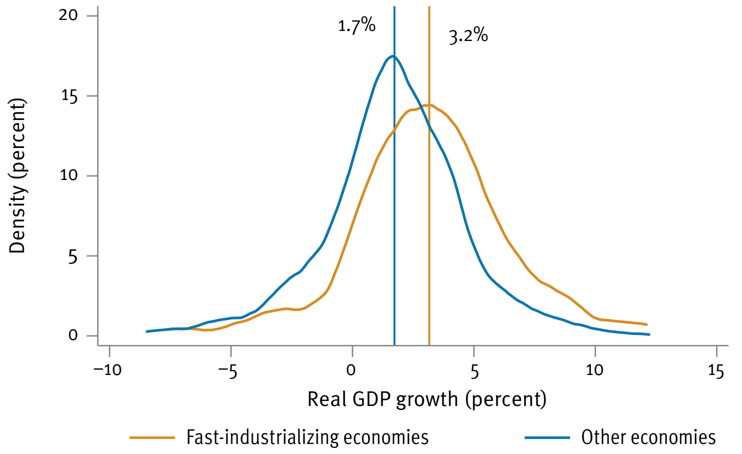


Notes: Includes economies with more than 1 million inhabitants. Income groups categorization as in the initial year of categorization.

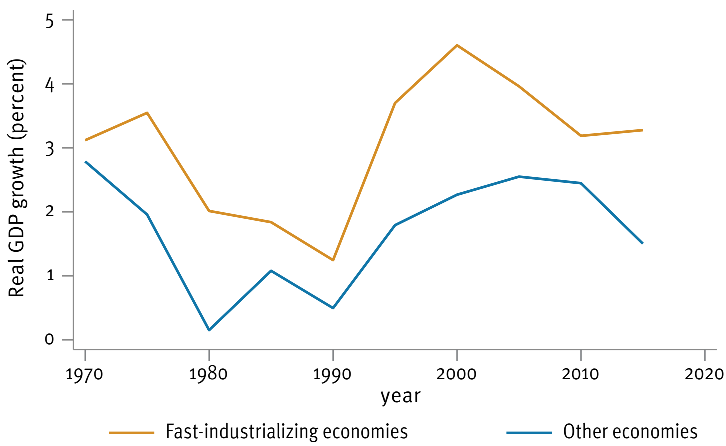
Sources: UNIDO elaboration based on UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI (for population).

Figure 1.7: Fast-industrializing economies are growing faster than others, 1970-2017

(a) Distribution of growth rates—fast-industrializing economies versus other economies



(b) Average growth rates of fast industrializers and other economies, 1970-2017



Notes: Based on average five-year growth rates. Includes countries with a population of 1 million or more. First and last percentile of the data are excluded to control for outliers. Averages are unweighted averages over countries and periods. Fast industrializers are defined by the following criteria: (i) long-term growth of real MVA is greater than long-term growth of real GDP; (ii) the initial share of manufacturing is at least 15 percent of GDP or growing by at least 5 percentage points over the period; and (iii) real GDP growth is always non-negative (for a list of countries under this definition, see Appendix 2).

Sources: UNIDO elaboration based on World Bank, WDI.

Having established a direct link between industrialization and overall economic growth, an attempt is made to isolate 'direct effects' of industrialization on SDG goals due to the specific characteristics of the manufacturing sector, from the indirect effects that arise via economic growth. A direct relationship between industrialization, proxied by the share of manufacturing in GDP, and the respective goal is said to exist if such relationships hold even when the effect of income per capita is controlled for.[16]

1.4.1. Industrialization and health

The SDGs cover not only economic growth, as discussed above, but also the important issue of human health and well-being, as covered by SDG 3. Health is primary a matter of state capacity and policy choices. The effectiveness of the provision of the most basic health services is strongly influenced by the organizational capacity of the state and, given sufficient state capacity, of political priorities. The experience of Kerala, which is not the richest state in India by far, serves as an example that countries or regions can— with the corresponding policy priorities—install and maintain a high standard health sector with strong benefits for the local population.

Technological progress provides a strong link between industrialization and health improvement, as the application of technological advances in medication (e.g. antibiotics), medical apparatus (e.g. X-rays) and operation techniques (e.g. keyhole surgery) takes place in manufacturing (especially the pharmaceutical industries). Together with a greater focus on hygiene, these technological advances have helped improve the health situation of people worldwide, leading to increases in life expectancy, lower infant and maternal mortality rates and has drastically reduced deaths from infectious disease such as tuberculosis.[17] Further historical aspects of the relationship between industrialization and health conditions are presented in Box 1.2.

Focussing on more recent experience, there is a clear link between value added per capita created in the main sectors of the economy and a decline in infant mortality across countries. Infant mortality rates are taken as an example but the patterns are very similar for related indicators of SDG 3, such as maternal mortality.[18] Higher sectoral value added per capita (at least partly) reflects advances in sector-specific productivity that nurture economic growth and hence strengthens the capacity of states to provide all kinds of services, including basic health services. Interestingly, this negative association also holds when controlling for GDP per capita (Figure 1.8, panel a), pointing to effects that go beyond growth in general (which is the 'indirect effect' depicted by the grey arrows pointing from economic growth to all other SDGs

16 Ideally, one would want to test such relationships in a dynamic form using changes, as was done for the industrialization-growth nexus. Data limitations prevent such an approach, however, which is why the analyses are in levels, controlling for past economic growth by using GDP per capita.

17 Despite this undeniable progress, many developing countries still suffer from massive shortcomings in basic health coverage. For example, about 90 per cent of women who die from complications relating to pregnancy and childbirth live in low and middle income countries.

18 No such relationship was found, however, for incidences of tuberculosis.

Box 1.2: A healthy industrialization process?

Source: World History Archive / Alamy Stock Photo

Some economic historians, mainly using evidence from the first industrial revolution, have disputed the relationship between industrialization and human health. In particular, there is disagreement about the channels through which successful industrialization improves health conditions and the relative strength of counterforces such as sanitary problems in densely populated urban areas.

Starting with the channels, there are two predominant views. In the first, associated with British physician and epidemiologist Thomas McKeown, industrialization improves health conditions primarily via rising living conditions and, linked to these, a higher per capita nutritional intake. This constitutes a classic 'indirect effect', where supportive effects of industrialization on other SDGs play out through economic growth, in this case via consequent improved nutrition, thereby also creating a link to SDG 2—eliminating world hunger.

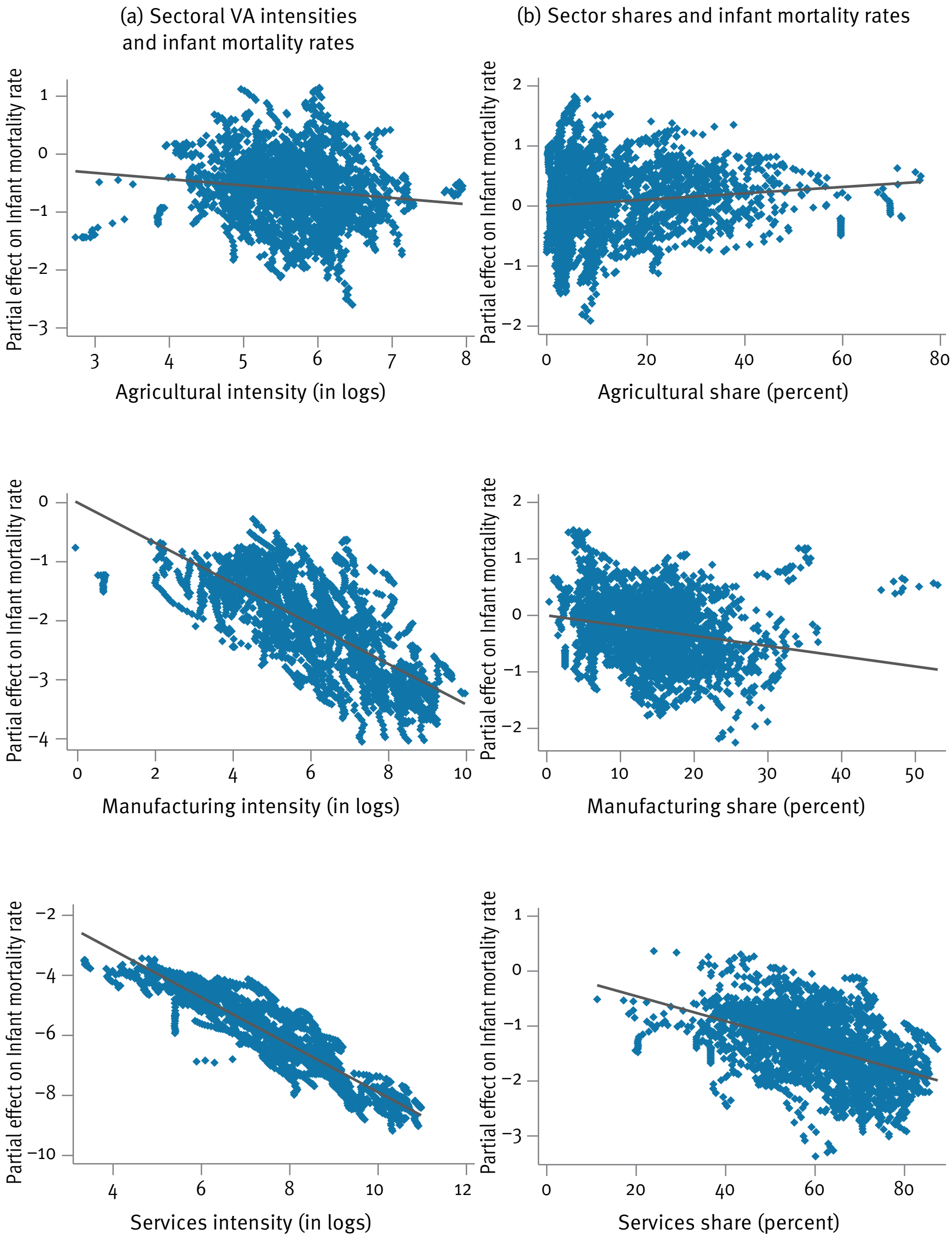
In contrast to this view is the claim that industrialization improves health conditions more directly by way of investments in health-promoting technologies, products and services. Advocates of this view sought to refute the nutrition-based argument (which was supported by detailed epidemiological data for England and Wales since the mid-19th century as well as by data on the height of United States' military recruits) by pointing out that the history of the first industrial revolution in England does not fit the pattern expected by this hypothesis. In particular, life expectancy rose during the 18th century, despite no significant increase in real wages. By 1811, the increase in life expectancy had come to a halt, precisely at the time when real wages, until then stagnant, started their upward trend. Historical research has shown that these developments can be traced back to deteriorating health conditions in industrializing towns and cities throughout England. The trend was finally reversed, but it took until the 1870s for the health levels of the early 19th century to be reached.

This illustrates that in addition to the positive effects, industrialization, urbanization and long-distance trade can also inflict harm and pose risks for human health. History shows that dense settlements are prone to the transmission of epidemics. Moreover, social interactions between populations previously not exposed to each other creates risk of exchange not only of new goods and ideas, but also of potentially fatal diseases.

What these historical considerations show is that industrialization affects human health in many ways, some of which are beneficial, while others entail risks. This makes a general assessment of the industrialization-health nexus extremely difficult and emphasizes the importance of adequate place, context and specific policies (see Chapter 2). Hence, it is fair to say that industrialization is a necessary condition for sustained improvements in health conditions, but is by no means a sufficient condition in itself.

Based on Szreter (2004).

Figure 1.8: Industrialization and infant mortality rates



Notes: VA = value added. The unit of the infant mortality rate is deaths (counts) per 1,000 live births. The regressions use the logs of the death rates. The graphs show the partial effects of the variable on the horizontal axis on infant mortality.

Sources: UNIDO elaboration based on Global SDG Indicators Database; UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI.

in Figure 1.5). Considering sector shares in GDP, the correlations between infant mortality rates and sector shares (again controlling for income levels) are not as uniform, and those for the agricultural share are clearly positive (Figure 1.8, panel b) while the corresponding correlations for the manufacturing sector and the services sector are negative. The interpretation of these patterns is that the structural transformation from a predominantly agrarian (and potentially subsistence) economy to one dominated by modern industries, including manufacturing and services industries, also induces the provision of basic health care, thereby bringing down infant mortality rates.

1.4.2. Industrialization and working conditions

There are several reasons why over time industrialization should improve working conditions. Key is the significantly higher share of formal labour in manufacturing and the provision of jobs, including for young people. Youth often find it difficult to find employment; which is why across countries and income levels, youth unemployment rates exceed those of the overall population. Youth unemployment is a major concern because there are few developments that are as detrimental to the economic future as a frustrated and disillusioned young generation who feel left behind by the state and society. When countries' economies can neither offer young people jobs nor education, there is a significant risk of social unrest.[19]

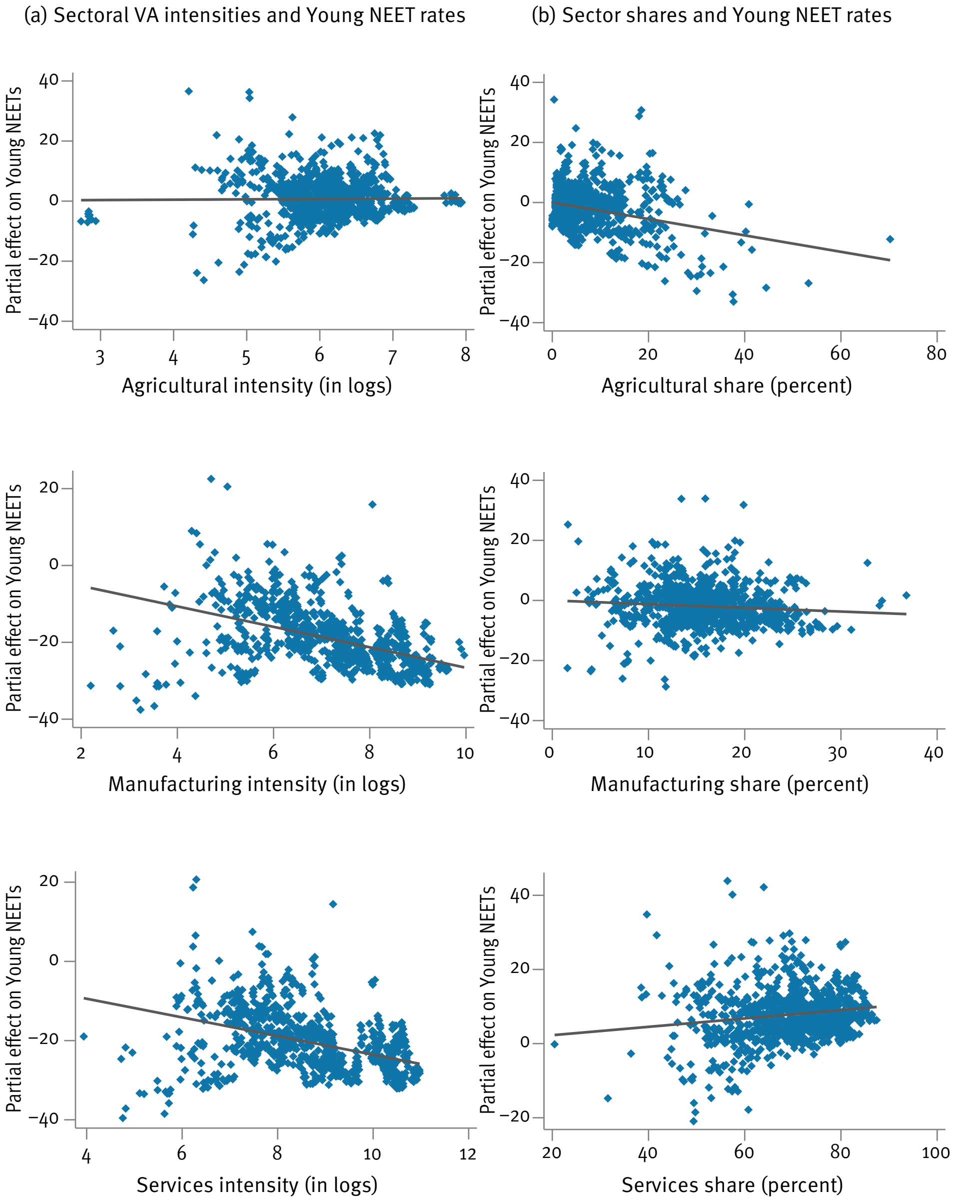
The proportion of young people who are neither in employment nor in education or training, the so-called NEETs, is a good measure of the economic prospects of the young. The analysis of sectoral developments akin to that of mortality rates for the NEETs rate illustrates that in manufacturing, there is clearly a negative relationship between sector intensity and the NEET rate, controlling for income (Figure 1.9, panel a), although the negative relationship is much weaker for sector share, where the line is nearly flat (Figure 1.9, panel b).

Manufacturing has the potential to create jobs for young workers, even if it must be acknowledged that many developing countries still struggle to create a sufficient number of manufacturing jobs, including for the young.

Another aspect of decent working conditions is the issue of informal employment. This is important not only from a productivity perspective, but also with regard to the safety of workers and their social protection, including in case of illness, accidents or old age. Although significant evidence suggests that a structural shift towards 'modern sectors' of the economy will help reduce the size of the informal economy, no systematic association between the manufacturing share in GDP and a decline in the informal employment rates (in the non-agricultural parts of the economy) is found. The reason for this disconnection between manufacturing and informality is not entirely clear. It may be due to the fact that although the potential for creating formal jobs is large, actual employment growth in the manufacturing sector has been modest in many developing countries. Box 1.3 discusses the problem of informality and its relation to manufacturing in Morocco.

19 This was demonstrated by the Arab Spring in 2011.

Figure 1.9: Industrialization and young persons neither employed, nor in education or training (NEETs)



Notes: VA = value added. The NEETs include persons in the age bracket 15 to 24 years. The graphs show the partial effects of the variable on the horizontal axis on the share of young NEETs.

Sources: UNIDO elaboration based on Global SDG Indicators Database; UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI.

Box 1.3: Manufacturing as the most promising path for structural transformation in Morocco

The UNIDO PCP Report on Morocco looked at relative labour productivities across several sectors and the relationship with formal and informal employment. The Moroccan labour market has significant informal employment. Although the overall unemployment rate has remained stable at around 9-10 per cent in recent years, the low participation rates in the labour market and the extent of the informal sector conceal substantial levels of unemployment and underemployment.

Formal jobs in Morocco are rare, especially in the private sector. In 2015 80 per cent of all employees belonged to the informal sector, leaving only 20 per cent formally employed (a person is considered to be formally employed when registered in the social security system). In the private sector, the rate of informality is even higher (86 per cent) (HCP and World Bank, 2017). This implies that out of an active population of 11.8 million (2015), only 1.17 million—or 11 per cent of those employed—held a formal position in the private sector.

One implication of the high prevalence of informality in the Moroccan economy is a wide dispersion of labour productivities across sectors. This is a common feature of developing economies and evidence of a 'dual economy' (Lewis, 1954). In a dual economy, traditional sectors such as agriculture with scarce modern agricultural equipment, co-exist with modern sectors that have embraced capitalist modes of production.

The case of Morocco can be described as a 'double dual' economy as there is also a duality in the labour market: an expansive informal labour market and a comparatively limited formal sector, so that informality is one of the key obstacles to higher productivity growth.

The manufacturing sector features a labour productivity that is about twice that of the Moroccan economy, on average (Figure B.1.3). This is based on both formal and informal employment, which together amount to 1.1 million (2015). The national structural business survey (ENSI) comes to a similar conclusion, although this survey is based on formally registered firms only (HCP, 2017). In 2014 manufacturing employment in formal enterprises amounted to 625,000 employees, which implies that about half of manufacturing employment is formal. This share is much higher than the rest of the economy.

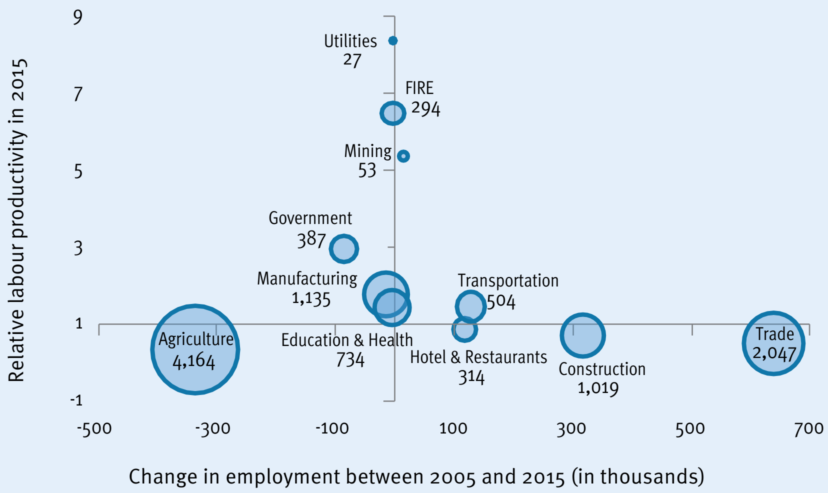
1.4.3. Industrialization and education

Over time, whilst there have been major improvements in education indicators like years of schooling and literacy rates, the economic impact has sometimes been difficult to establish. The productivity and wage premiums in manufacturing vis-à-vis the agriculture sector are due to the manufacturing sector's higher capital and skill requirements. Therefore, industrialization and its demand for skills should also support educational objectives (SDG 4), including raising the participation rate in education and training, whether formal or informal.[20] Moreover, although manufacturing intensity (again controlling for income) is positively associated with education and training rates, this is not the case for the sector's share in GDP

20 The indicator is assigned to target 4.1., which calls for equal access for all women and men to affordable and quality technical, vocational and tertiary education by 2030.

Box 1.3 (continued)

Figure B.1.3: Labour productivity and structural change in the Moroccan economy, 2005-2015



Note: The size of the bubbles indicates the size of the industry in terms of employment (in thousands). FIRE = Finance, insurance and real estate. Utilities = Water, gas and electricity.

Source: UNIDO, Programme for Country Partnership Report Morocco, based on ILOSTAT and HCP data; includes extrapolations for 2015. Value Added from UN SNA database (real 2007 values in national currency).

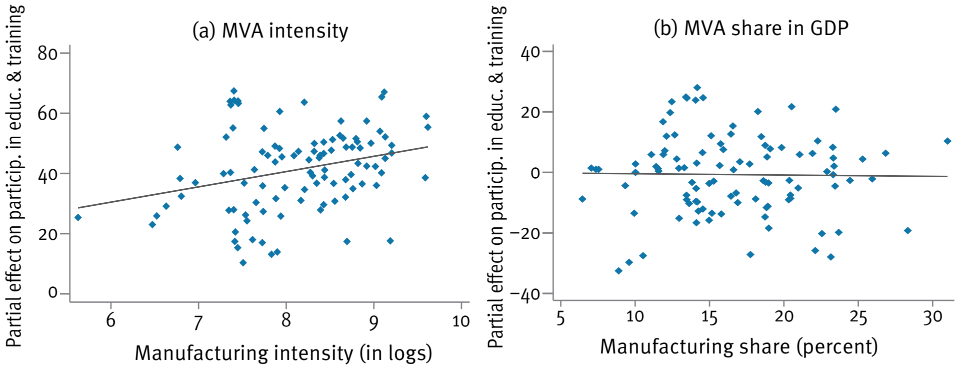
(Figure 1.10). The latter relationship results in a ‘flat line’, indicating that there is essentially no link between the two. The same is also true for the other two sectors, agriculture and services.

Hence, the transformational process from agriculture to manufacturing (or to services) as yet does not necessarily raise participation rates in formal or informal education and training. This finding should be taken with some caution as it is based predominantly on information for high income countries, given the lack of comparable data for most developing countries. Nevertheless, one explanation may be that the coverage and focus of education and training is determined principally by policy priorities rather than by demands arising from growth and structural change. However, an alternative explanation could simply be data limitations, which unlike the case of the other SDG indicators restricts the analysis to predominantly high income countries.

1.4.4. Industrialization and poverty

The ending of extreme poverty is one of the SDG targets where considerable progress has been achieved. However, the pace of progress has slowed in recent years,

Figure 1.10: Industrialization and the participation rate in formal and non-formal education



Notes: Participation rate of youth and adults in formal and non-formal education and training in the previous 12 months.

Sources: Global SDG Indicators Database; UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI; authors' calculations.

jeopardising the objective of eradicating extreme poverty by 2030 (United Nations, 2019). In general, poverty rates fall as growth picks up (Figure 1.11).

Importantly, the speed of poverty reduction accelerates at growth rates beyond 5 per cent (in terms of GDP per capita). This positive relationship between economic growth and the reduction in poverty rates is weak, in the sense that the average trend does *not* predict well the country-specific experiences. In Figure 1.11 this can be seen from the length of the vertical distances from the red line depicting the predicted rate of poverty reduction for the different country observations. There are instances, such as Romania and Rwanda where quite high growth rates did not translate into strong reductions in poverty.

Can something be said about the reasons for the huge variance in the nexus between growth and poverty reduction? The growth profiles of countries obtained through a decomposition of overall GDP growth provide some insights.

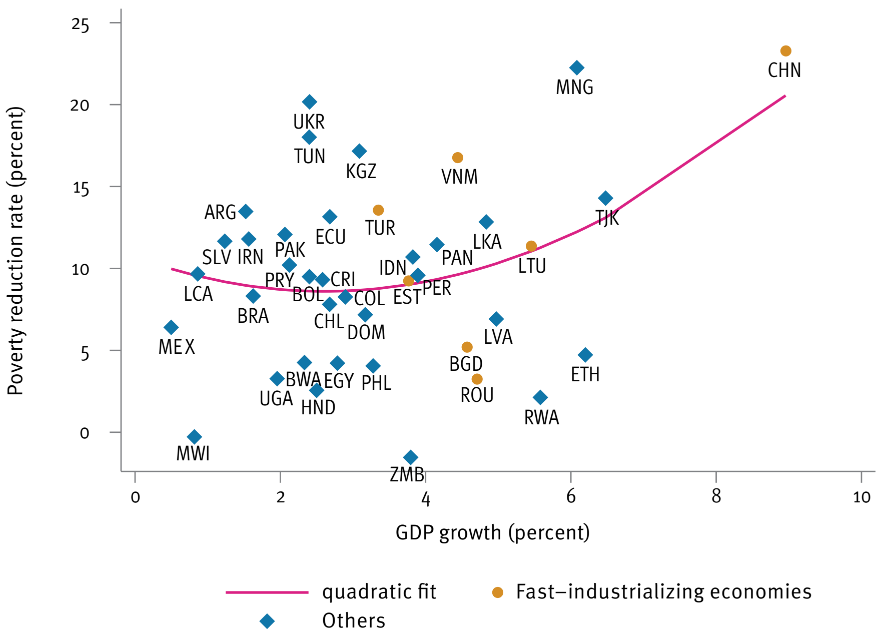
The key insight is that countries with growth processes that are driven by the industrial sector tend to experience higher reductions in their poverty rates. As shown in Figure 1.12, the estimated impact of value added growth in industry (represented by the yellow diamond in the line industry in panel a) is positive and significant. This would suggest that industry-driven growth tends to be 'pro-poor', particularly when the industry-driven growth component is productivity-intensive as opposed to employment-intensive.[21] This is in line with the fact that four of the

21 Employment-intensive is in relation to the share in total working population. It does not reflect factor intensity in production.

six fast industrializers in Figure 1.11 are found above the regression line, which indicates that their poverty reduction rates were higher than predicted by their growth rate.

The decomposition of growth rates into employment and productivity effects at the sector level (as shown in Figure 1.12, panel b), provides further insights into the analysis of industrialization and poverty reduction. At the sectoral level, agriculture and industry are identified as the two sectors that contributed to the reduction of poverty over the period 2000-2015. The detailed decomposition of these sectoral effects shows that poverty reductions are achieved primarily via advances in productivity. Most striking is the fact that employment generation in the agriculture sector per se is unlikely to bring down the poverty rate. On the contrary, unless accompanied by productivity growth, the expansion of the agriculture sector tends to increase the incidence of poverty. This feature is not

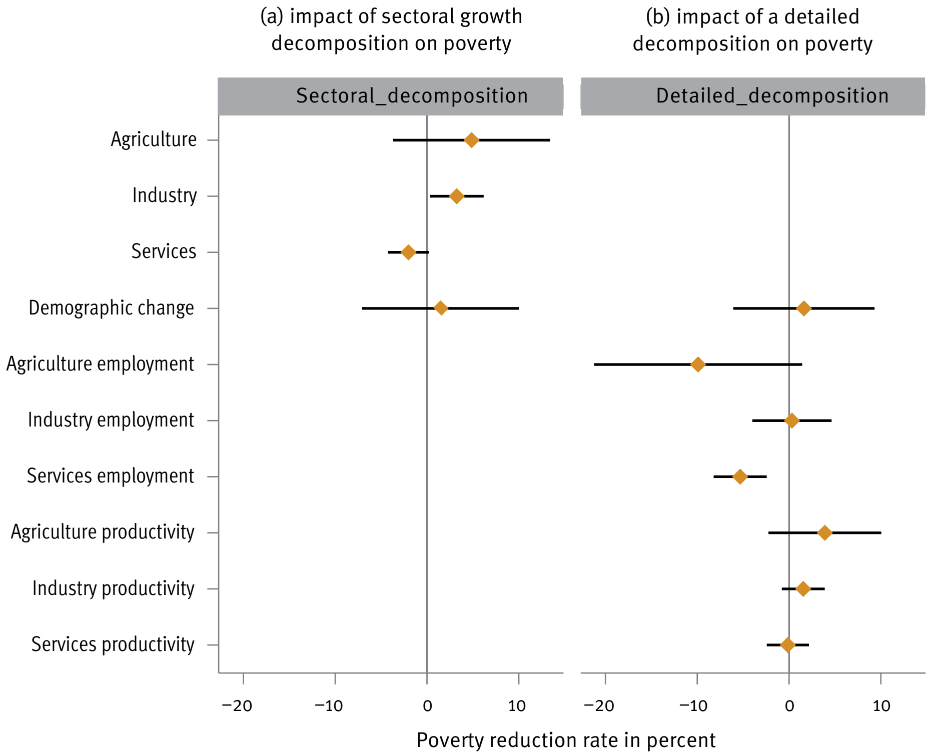
Figure 1.11: A positive but heterogeneous effect of economic growth on poverty reduction, 2000-2015



Notes: The growth rate is the compound annual growth rate of GDP per capita. The line is the result of a quadratic regression of the poverty reduction rate (the negative of the growth in the poverty headcount as a percentage of total population) on GDP growth per capita. The sample consists of 40 countries for which data on poverty rates for the period 2000-2015 are available.

Sources: UNIDO elaboration based on World Bank, WDI.

Figure 1.12: Contributions to growth and the impact on poverty reduction rates, 2000-2015



Notes: Employment effect captures changes in the employment rate (sectoral employment over working-age population); productivity effect captures changes in labour productivity; and demographic change is the change in the ratio of working-age population to total population. Growth decomposition following Gutierrez et al. (2007). The yellow diamonds represent the coefficient of the decomposition regression, the lines indicate the 95 percent confidence intervals.

Sources: UNIDO elaboration based on UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI.

present in the case of employment growth in the industrial sector. Although there is no sizeable effect from increasing employment rates on poverty eradication, at least there are no signs of employment intensity systematically increasing poverty. What this means is that a structural transformation, in the sense of a shift of labour resources out of agriculture and towards industry, tends to have a poverty-reducing impact that is separate from additional productivity effects that are positive in both sectors. Note that in this analysis, the service economy does not appear to be the most effective vehicle for fighting poverty. Meanwhile, the variation in the success of reducing poverty (even for countries with similar growth rates) and the fact that the latter sectoral results reflect cross-country averages means that the situation may be very different from one country to another. Therefore, there is also a view that the sector that drives the growth process is less important than the requirement that employment growth should be accompanied by productivity growth in order to achieve substantial improvements in poverty rates (see Hull, 2009). Nevertheless, the combination of the evidence on poverty reduction in fast industrializing economies versus other economies and the sectoral decomposition exercise support the view that industrialization provides support for eliminating poverty.[22]

1.4.5. Industrialization and inequality

The reduction of incidences of extreme poverty also contributes to reducing inequality within a society, which is the subject of SDG 10.

Inequality has many dimensions and is therefore difficult to quantify. Among the official SDG indicators, the within-country dimension of inequality dominates (as opposed to the between-country dimension). Even when focussing on the within-country dimension, the phenomenon remains multi-faceted as people may be concerned about inequality in opportunities, as well as inequality in outcomes, such as income, or wages or wealth.

Despite the popular view that a certain level of inequality in outcomes is required for providing incentives to invest in human capital and innovation, it is equally acknowledged that inequality can cause negative effects on social stability and economic growth (Dabla-Norris et al., 2015; OECD, 2014, 2017b).

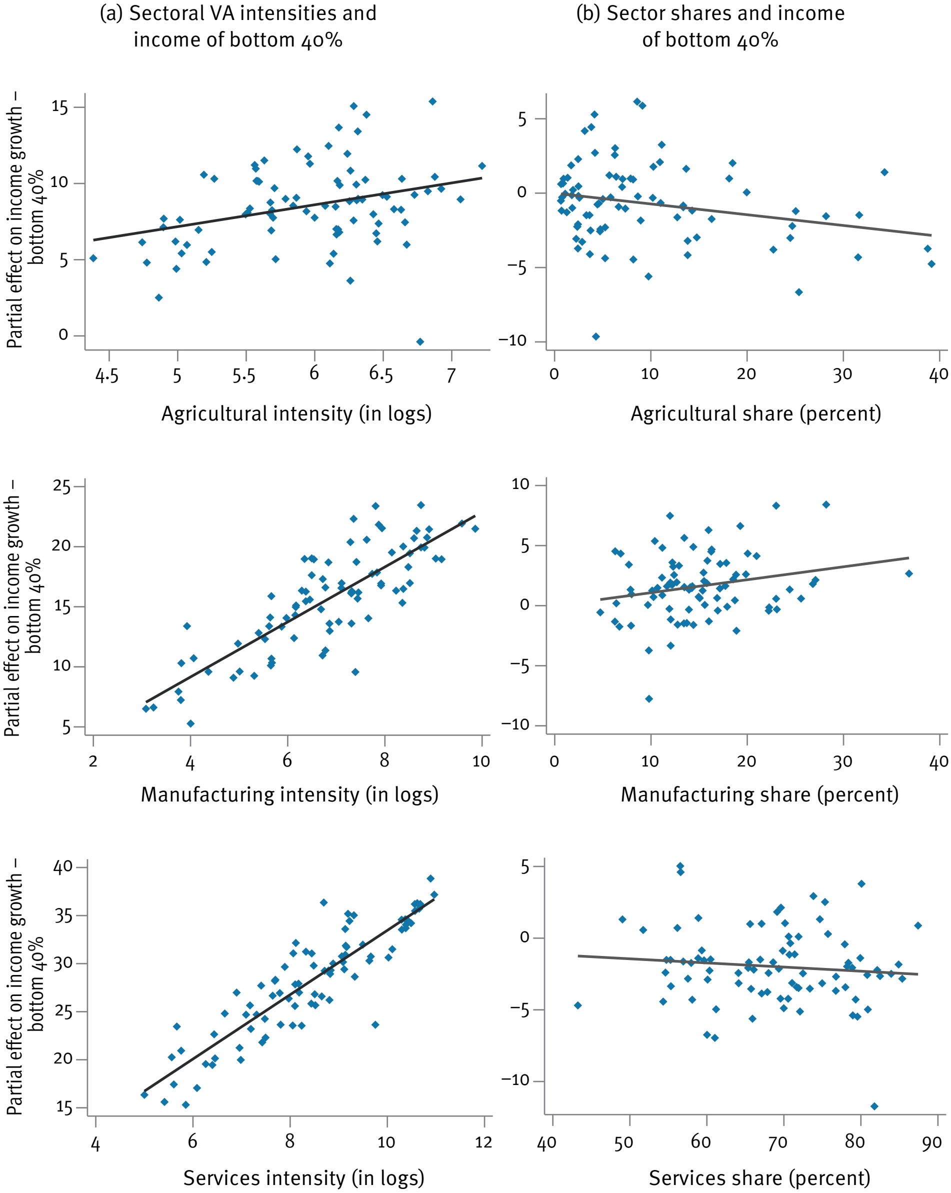
One way to reduce intra-country inequalities is to ensure that the poorer parts of society can reap some benefits from economic development. It is therefore informative to look at the consumption and income of the bottom 40 per cent of the household income distribution. With regard to sectors, it is only in manufacturing that sector share in GDP is positively associated with a higher growth in consumption (and income) of the bottom 40 per cent of households (Figure 1.13, panel b). The manufacturing sector has an equalising and stabilising effect because it offers relatively well-paid jobs for low- and medium-skilled workers. This indicator supports the idea that industrialization paves the way for a more equal economic development process.

Another important result is that a structural shift towards manufacturing and services away from agriculture tends to increase the wage share in national income. A larger wage share tends to reduce inequalities because wages are less unequally distributed than capital and wealth. Moreover, in most countries wages are the primary source of income for households. Therefore a larger share of national income earned by labour has a levelling effect. Hence, in relation to the impact of industrialization, both the income and consumption growth of the bottom 40 per cent and the wage share suggest some direct positive effects that can contribute to meeting to SDG 10 on reducing inequality.

Overall, the discussion of individual targets and indicators confirms the positive association between industrialization and the achievement of the SDGs presented

22 The sector analysis based on the manufacturing share in GDP employed for many of the other socio-economic indicators is also fully in line with this conclusion.

Figure 1.13: Industrialization and consumption (or income) growth of the bottom 40 percent of households



Notes: VA = value added. The indicator is the growth of income or consumption of the bottom 40 percent households. Observations used depend on data availability by country. The graphs show the partial effects of the variable on the horizontal axis on this growth rate.

Sources: UNIDO elaboration based on Global SDG Indicators Database; UNSD, National Accounts Estimates of Main Aggregates; World Bank, WDI.

in Figure 1.4. The existing discrepancies between the two perspectives, however, highlight that any assessment of either progress in or the relationship between SDG goals is necessarily influenced by the targets and indicators considered. What could be identified in both perspectives is that indirect effects of industrialization working via economic growth are essential in basically all socio-economic aspects. In addition, the individual analysis was able to identify several specific direct effects on SDGs targets from industrialization. Given the richer data available, very strong links could be established between industrialization and economic growth (SDG 8) and industrialization and poverty (SDG 1). Moreover, some evidence could be found in favour of industrialization directly supporting some targets of health and well-being (SDG 2); decent work (SDG 8) and reducing inequality (SDG 10). Also for SDG 4, which deals with education quality, the indicator available provided some quantitative support for the direct effects, though only in terms of manufacturing intensity. These findings are summarized in the synthesis framework presented in Figure 1.5.

1.5. Industrialization and the environmental SDGs

Given that the issue of sustainability is a relatively new challenge—at least compared to the social question, which has been around for centuries—environmental issues figure prominently among the SDGs. They range from clean energies to life under water and, as in the socio-economic domain, no position is taken on the feasibility of meeting all SDGs simultaneously (UNGA, 2014), nor on priorities among them. This holds true irrespective of the fact that only a selected number of environment-related SDGs and their links to industrialization are studied in depth.

Some of the SDGs, such as climate action (SDG 13) are defined not in terms of outcomes but in terms of policy action. Among these policy actions, the issue of adaptation plays a crucial role. Broadly speaking, adaptation can be defined as purposeful adjustments to reduce a society's vulnerability to environmental changes. Adaptation efforts are reflected in various indicators that measure the progress made in achieving the SDGs. For example, to measure progress or efforts in combating climate change and its impacts (SDG 13), indicator 13.1.3 captures the '*proportion of local governments that adopt and implement local disaster risk reduction strategies in line with national strategies'*. Such policy measures can hardly, of course, be attributed directly to a thriving manufacturing sector alone. Even so, a large body of literature reports a strong association between successful adaptation and economic development.[23] Therefore, there are potentially positive indirect effects of industrialization and adaptation. In other words, manufacturing matters for reducing the negative effect of environmental changes on a society through its impetus for economic growth.

Another focus point of the environmental dimension in the SDGs is mitigation, meaning any action intended to remedy, reduce or offset known negative impacts

23 See, among others, Klien, Schipper and Dessai (2005); Pouliotte, Smit and Westerhoff (2009); Jerneck and Olsson (2008); Schipper and Pelling (2006).

on the environment, including the impacts induced by human actions on the use of energy, water and emissions, etc. Although none of the SDGs deals exclusively with greenhouse gas emissions, a number of targets are directly related to climate objectives, namely those targeting renewable energy, energy efficiency or clean energy research, to name just a few. There might also be an implicit trade-off between socio-economic development goals, above all, economic growth and industrialization, on the one hand, and environmental goals, on the other. With regard to the use of energy (and hence emissions), for example, it is recognized in the literature that climate change mitigation in emerging and developing countries might pose a challenge from a development perspective if it requires more costly, low carbon energy sources (Jakob and Steckel, 2014).

Manufacturing development does not necessarily have to pose environmental concerns. New technologies and modernized production processes can allow for a less resource-intensive utilisation of inputs (sometimes referred to as the 'decoupling hypothesis'), although it must be emphasized that considerable uncertainty remains regarding the technological limitations and cost of low carbon or mitigation technologies such as carbon capture and storage (Bullis, 2014).

Box 1.4: Challenges of an empirical analysis—two viewpoints to consider

First, a pure 'betting on technology' approach may be insufficient to allay any environmental concerns. There is always a great deal of uncertainty about the potential and limitations of new technologies, together with economic and socio-political constraints as well as cost uncertainty regarding their deployment. This is true for both production as well as mitigation technologies, such as low carbon technologies or carbon capture and storage, nuclear power and renewables (Bullis, 2014). As far as mitigation technologies are concerned, the Intergovernmental Panel on Climate Change's report on mitigation of climate change (IPCC, 2014) acknowledges constraints in terms of finance, technology but also the high environmental cost of delaying the installation of new energy capacity. There is also a growing literature showing the substantial understatement of the magnitude of technological challenges when it comes to the integration of new technologies (see Fisher-Vanden et al., 2012; Myhrvold and Caldeira, 2012; Schilling and Esmundo, 2009).

Second, a certain degree of 'fragmentation' in policy actions outside the United Nations Framework Convention on Climate Change process is observable (IPCC, 2014). This fragmentation may be related to countries' stages of economic development. In a cross-country analysis such as the one provided here, this will inevitably lead to a skewed view as developing and developed countries may be subject to different (self-imposed) rules and hence held to different standards. Another issue that the literature points to—see for example Davis and Caldeira (2010) and Peters et al. (2011)—is a growing transfer of, for example, carbon emissions from developed countries to emerging economies. This may either be the unintended side effect of outsourcing activities to developing countries of those parts of the production process that happen to be the more polluting ones; or it may be directly related to the different environmental standards between developing and developed countries (carbon leakage). Considered jointly, both effects might overemphazise the outcome of technology-led differences across developing and developed economies.

In developed economies, a notable decoupling of inputs in production processes is observable, lending support to the notion of an 'environmental Kuznets curve'.[24]

One aspect of decoupling is increased input efficacy, which implies less need for resources. In this vein, Figure 1.14 presents the relationship between manufacturing shares and various indicators of input efficiency.[25] The scatter points are coloured to distinguish the income group each country is associated with. A clear positive relationship between economic development (GDP per capita) and water efficiency (SDG 6) is shown in the left plot of panel a. In addition, the increase in the slope of the line for the respective income groups highlights that this relationship strengthens with higher incomes. In other words, as economies grow richer, they become more efficient in their use of water. By contrast, there is no corresponding relationship between manufacturing share and water use efficiency (the right plot of panel a). This is because the share of manufacturing in GDP does not increase monotonically with income, so the more advanced economies are typically not those with the highest share of manufacturing in GDP.[26]

The empirical evidence in Figure 1.14 indicates that the countries with the highest efficiency (equivalent to the lowest intensity) are typically the more developed or higher income economies. Furthermore, an expansion of manufacturing for either income country group (visualized by the regression lines for all three variables in Figure 1.14, panel b) show an improvement in energy intensity (SDG 7) across income groups.

As far as material use is concerned (SDG 12), an overall negative relationship between material consumption and income emerges. This negative relationship is found to be stronger for higher income countries (Figure 1.14, panel c, right plot). The strongly negative association with GDP can be interpreted as evidence for relative decoupling: An increase of GDP is associated with a decrease of material consumption per unit of output in value terms, that is, the material consumption needed to produce one US dollars' worth of output. The reason for this is that the change in material consumption is smaller than the change in GDP.

The relationship between material consumption and manufacturing appears to be very complex (Figure 1.14, panel c, left plot): On the one hand, domestic material

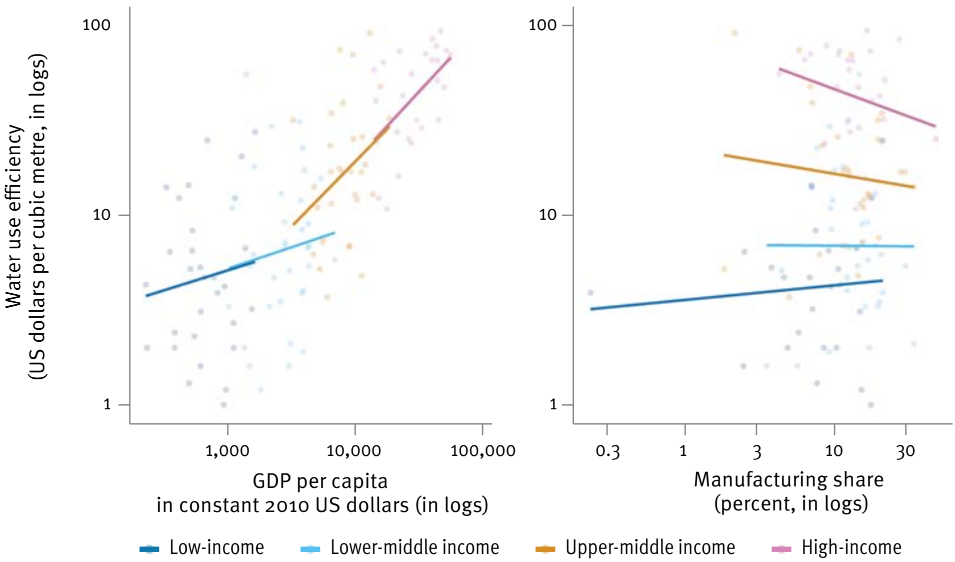
24 The original Kuznets curve visualizes the hypothesis that as an economy develops, market forces first lead to an increase and then a decrease in inequality. While this pattern was first described by Kuznets in 1955 to illustrate more general economic development patterns, environmental health indicators such as water and air pollution and/or resource footprint indicators show a similar empirical regularity: as per capita income increases, environmental stress first increases and then decreases (Grossman and Krueger, 1995).

25 The empirical results described in this section follow the same methodological approach as in section 1.4 based on the partial effect of manufacturing expansion after controlling for GDP per capita levels. However, because of the condensed nature of this section, the empirical evidence presented in what follows utilises a scatter plot analysis of the effect of manufacturing expansion broken down by country income groups. The discussion reflects the visual evidence presented and is furthermore grounded in the same empirical models of section 1.4.

26 The second reason is that the share of MVA in GDP is bounded and cannot, conceptually, exceed 100 percent.

Figure 1.14: Industrialization and input uses

(a) Water use efficiency (US dollars per cubic metre) vs GDP per capita and manufacturing share



(b) Energy intensity level of primary energy (megajoules per constant 2011 PPP GDP) vs GDP per capita and manufacturing share

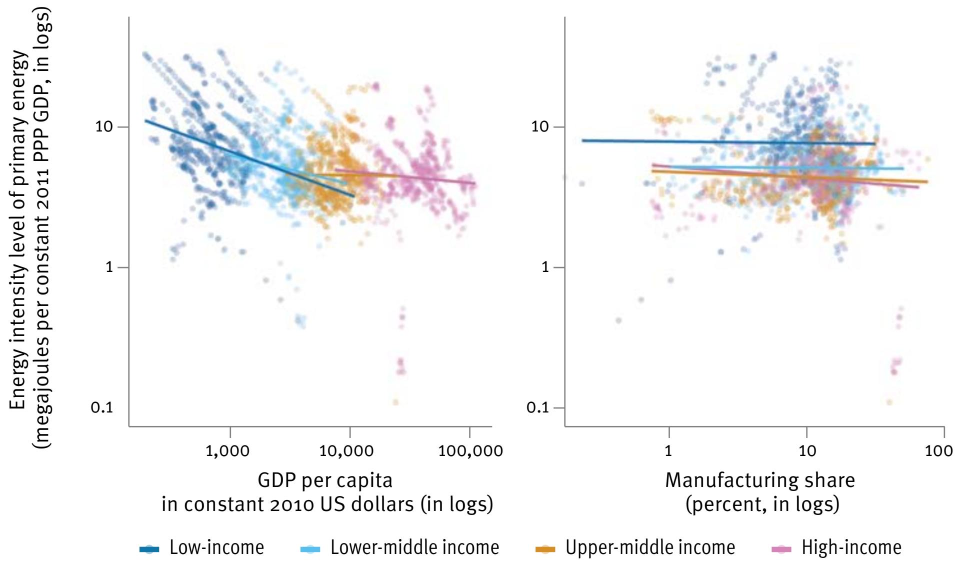
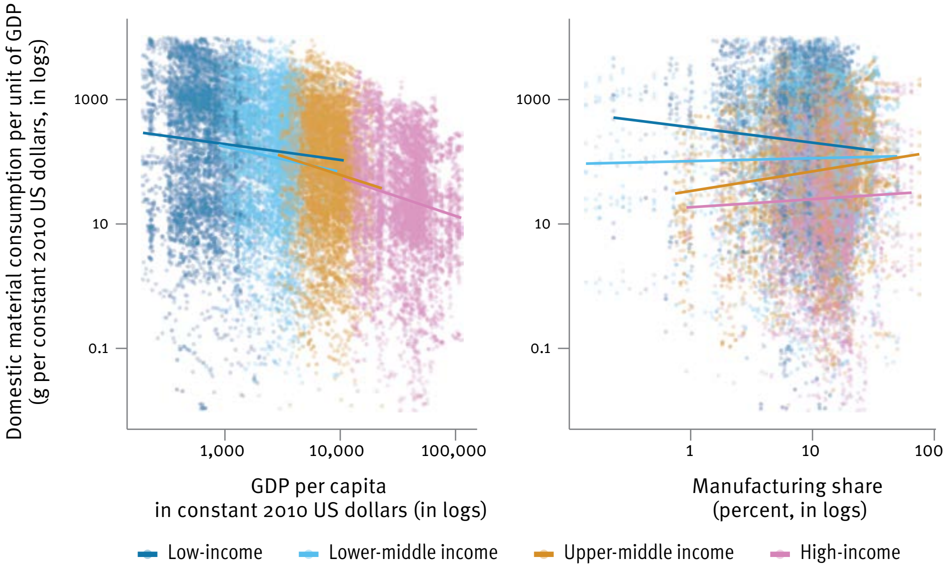


Figure 1.14 (cont.): Industrialization and input uses

(c) Domestic material consumption per unit of GDP by type of raw material (kg per constant 2010 US dollars) vs GDP per capita and manufacturing share



Note: Data covers the period 2000-2017 (or closest years).

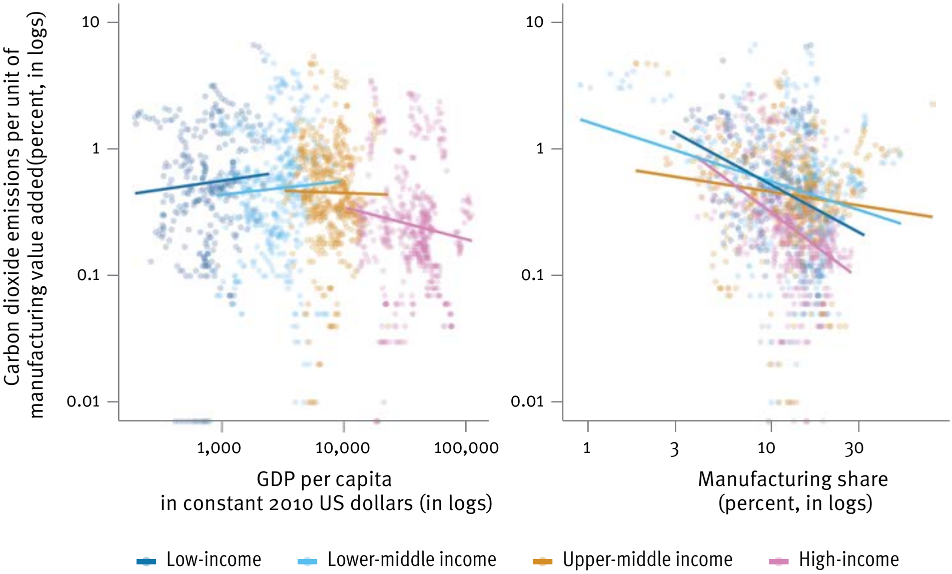
Sources: UNIDO elaboration based on Global SDG Indicators Database and World Bank, WDI.

consumption per unit of output is lower, on average, the richer an economy is. On the other hand, increases in the share of manufacturing are found to reduce material consumption most strongly for low income countries. This indicates that while low income countries are, on average, found to have the highest domestic material consumption intensity of all country income groups, manufacturing expansion leads to a disproportionate decrease in consumption compared to all other income groups.

More recently, environmental concerns have focussed on carbon emissions (SDG 9).[27] Figure 1.15 indicates that carbon dioxide emissions per unit of MVA are strongly associated with the level of economic development. On average, higher per capita GDP is negatively associated with carbon emissions per unit of MVA, although this result needs to be interpreted with caution: it may be due in part to 'emission outsourcing' to lower income countries and need not all be the result

27 While this chapter does not seek to discuss emission reduction or mitigation possibilities within manufacturing, it attempts to assess the effect of carbon dioxide emissions per unit of MVA. This metric appears sensible as it directly links carbon emission to the production capacity of manufacturing.

Figure 1.15: Industrialization and carbon dioxide emissions



Note: Carbon dioxide emissions per unit of manufacturing value added measured in kilogrammes of CO_2 per constant 2010 US dollars. Data covers the period 2000-2016.

Sources: UNIDO elaboration based on Global SDG Indicators Database and World Bank, WDI.

of technological progress or changing behaviour in more advanced economies.[28] The decrease of manufacturing's contribution to GDP at higher incomes related to deindustrialization tendencies may also be (at least partly) responsible for this result.

An increase in the share of manufacturing in GDP is negatively related to relative carbon dioxide emission per unit of manufacturing value added for all country groups, with the most strongly pronounced negative association observed for high income countries. Hence, if the manufacturing-induced reduction in emission intensity is strong enough, CO_2 emissions could indeed decline.

The results derived in this section are of particular interest in policy terms with regard to developing economies and to the accomplishment of SDGs. The environment-related SDGs have a strong focus on issues of adaptation and mitigation (notably, improvements in input efficiency and emission intensity). While the former can be indirectly linked to manufacturing development through the academic literature

28 It is also important to note that these are reductions in CO_2 per unit of MVA, not total emissions from manufacturing.

and the results presented on socio-economic indicators discussed in this chapter, the latter is found to be linked more directly to manufacturing expansion. On the one hand, the association between manufacturing expansion and input intensity suggests the potential to achieve environmental SDG goals through efficiency gains. These effects are found to be particularly favourable for countries on the lower income spectrum. On the other hand, the results presented here indicate that manufacturing expansion does not necessarily have to come at the expense of increasing carbon dioxide emissions, if appropriate mitigation measures to reduce emission intensities are implemented.

1.6. Key lessons: The interlinkages between industrialization and the SDGs

This introductory chapter endeavoured to investigate the multi-faceted interlinkages between industrialization—itself a highly complex process—and both socio-economic and environment-related SDGs, which are equally complex. Without any claim of causality or universal validity, a number of conclusions on the nexus between industrialization, which is associated with growing manufacturing intensities and manufacturing shares, and a number of other SDGs has emerged from the analysis, which can be summarized in the following messages.

- The SDG drafters' emphasis that the set of goals is best perceived as an entity with numerous linkages between them, which more often than not run in both directions, is fully justified and confirmed by the abundance of interlinkages between industrialization (enshrined in SDG 9) and other goals.
- The empirical analysis in this chapter shows that there is a very close and robust relationship between industrialization and economic growth (SDG 8). Countries that recorded stronger growth in the share of manufacturing in their economies also experienced higher economic growth. This view also supported by both theoretical arguments and historical evidence
- Industrialization promotes advancement in a large number of other socio-economic goals. The impact of industrialization on other SDGs may be direct, but in some cases is limited to indirect effects that materialize through economic growth.
- In the realm of socio-economic SDGs, direct effects have primarily been identified in terms of poverty reduction (SDG 1), leading to the conclusion that industry-led growth is pro-poor. Weaker but still identifiable direct effects were found for health (SDG 3), decent work (SDG 8) and reduction of inequality (SDG 10).
- Mixed results emerged in the contentious domain of inequality. Industrialization seems to support growth in income and consumption among the poorer segments of a country's population, but no such impacts are detected for a broader set of inequality indicators.
- Industrialization and the associated structural changes, such as urbanization and a trend towards formal economic activities, are important, but so are many other factors. The policy choices by governments are of particular importance. Many socio-economic aspects covered by the SDGs are shaped and influenced more

strongly by these policy choices and institutions than by industrialization itself, although all of these are, of course, also intertwined (for example, as discussed in the following chapters policy can have major impact on industrialization).

- Arguably, the role of policy is even more pronounced when it comes to environment-related SDGs. This is because there are clear trade-offs between economic development and most environmental SDGs. Therefore, the chapter explored the issue by examining whether industrialization affects mitigation measures, which can potentially resolve or at least mitigate the existing trade-offs.
- Manufacturing development reduces energy intensity and material consumption inputs, which amounts to a direct positive effect of industrialization on clean energy (SDG 7) and responsible consumption and production (SDG 12). The efficiency gains in the use of inputs associated with industrialization are more pronounced in low income countries. This is an additional argument for not leaving any country behind in the shift towards a more sustainable economy.
- An expansion of the manufacturing sector does not have to come at the expense of increasing carbon dioxide emissions, because emission intensity typically decreases as countries industrialize. This is evidence, at least, of a relative emission decoupling, that is a delinking of economic development from CO_2 emissions.

2 STEPPING UP THE INDUSTRIALIZATION LADDER

Industrial policy success experiences across early, recent and emerging industrializers

2.1. Moving up the industrialization ladder

Industrialization is a transformative process shaping countries' economic structure, as well as impacting on their social and institutional fabric. Evidence presented in Chapter 1 established the existence of a direct and positive relationship between industrialization and different clusters of SDGs. In particular, industrialization was found to have a clear positive impact on all those Goals associated with poverty reduction, education, jobs creation, technological and infrastructural upgrading, and broader economic development. With respect to other sustainability dimensions, industrialization can contribute *indirectly* to SDGs. For example, by spurring green innovation and technological change, industrialization is essential in addressing the most pressing social and environmental sustainability challenges (Andreoni and Chang, 2017).

Governing industrialization towards an inclusive and sustainable transformation of the global economy is thus central for implementing and pursuing the SDGs Agenda. Over the last three centuries, countries have followed very different industrialization trajectories. Despite that, they all have something in common, that is, the central role that *industrial policies* have played in their transformation. Industrial policies have been a major driver of industrialization in all successful industrialization experiences, both across Europe and North America as well as recent and emerging cases across Eastern and Southeastern Asia, Latin America, and Africa. Industrial policy has been used to develop social capability, to direct market forces, to spur technological and organizational innovation, and to create new markets and institutions (Chang, 2002; Reinert, 2008; Cimoli et al., 2009; Stiglitz and Lin, 2013; Noman and Stiglitz, 2016; Andreoni and Chang, 2019).

From the early industrialization experiences of the eighteenth and nineteenth centuries, up to the most recent and emerging cases, a variety of industrial policy instruments and institutions have been deployed to drive structural transformation. A number of key policies have remained almost unchanged over time, as they perform critical *industrialization functions*. However, their *institutional and policy forms* have changed over time and space. There are several reasons for that. First, policies and institutions have to adapt to context and time-specific country conditions—including a country's endowment structure, political economy and government capabilities. Second, some policies which were feasible in the past might become unfeasible given a reduction in countries' *policy space*. Third, policy instruments or institutions which were effective under a certain industrial and technological landscape, may have to be adapted to the evolving industrial and technological environment.

Thus, for all these reasons, there is no one size fits all industrial policy. Instead countries can rely on a variety of instruments and institutions performing different functions more or less effectively given the context (Andreoni, Chang and Scazzieri, 2019). From past experience countries have learnt many lessons on how to drive and govern industrialization. There is evidence on what tends to work under certain global settings, and why certain institutional forms might be more or less suitable to achieve certain results. Some countries have learnt and experimented more than others, but even the most successful industrialization experiences are always a mix of successes and failures.

This chapter documents the experience of some successful economies and tries to distil the main lessons in terms of the instruments of industrial policy used, their effectiveness under different industrial paradigms and their replicability in view of today's policy space. Collecting evidence on some of these experiences and distilling some of these lessons can inform policymakers across countries. Even more critically, it is a way of *learning to learn* how to drive industrialization, how to achieve inclusive and sustainable development and, finally, how to govern a complex transformative process which require complex packages of interacting policies. By learning how to address these challenges, governments can use industrial policy more effectively. Specifically, they can identify among different policy instruments and institutions available, those that can have a higher enabling impact on various SDGs. Second, they can manage both static and dynamic trade-offs affecting interdependent social, economic and environmental goals (Andreoni and Chang, 2017).

The analysis of this chapter is complemented in Chapter 4 with a more focussed discussion on the governance of interacting packages of industrial policy instruments, including the importance of selectivity and alignment in industrial policy making.

2.1.1. Early, recent and emerging industrializers

To identify the factors which have made countries successful in industrialization the analysis focusses on a group of nine countries to review their different experiences with industrial policy. Among the countries selected are three cases of *'early industrializers'*—Germany, United States and Japan—three cases of *'recent industrializers'*—China, Brazil and Malaysia—and three cases of *'emerging industrializers'*—Indonesia, Viet Nam and Ethiopia.

The *early industrializers*—Germany, Japan and the United States—have all reached a high-income status and in 2017 ranked first, second and fourth in the UNIDO Competitive Industrial Performance (CIP) ranking, respectively. They are also among the top five countries for global market share of exports in manufacturing. Their industrialization pathway can be traced back to the middle of the nineteenth century, and they have been using industrial policy more or less consistently since then. Their journey along the industrialization ladder has thus started long ago, when both the global policy context and industrial environment were different from more recent industrialization experiences.

The *recent industrializers* selected—Brazil, China and Malaysia—include countries which started a sustained industrialization journey only during the second half of the twentieth century. However, while Brazil made use of industrial policy discontinuously since then, both China and Malaysia have continuously experimented, implemented and upgraded their industrial policies since the 1980s. China is however the only recent industrializer which has managed to get closer to the early industrializers in terms of industrial competitiveness. China is ranked third in the UNIDO Competitive Industrial Performance Index, with Taiwan Province of China ranked 13th. The other two countries which experienced the same phenomenal industrialization performance are the Republic of Korea (ROK) (5th) and Singapore (12th). As a case-study the experience of the ROK in the development of the electronics industry is discussed in Chapter 3.

This group of recent industrializing countries developed during the last phase of the global policy regime established after 1945—the General Agreement on Tariffs and Trade (GATT). The earliest developer in this group of recent industrializers was Brazil. Despite being the best performer among recent industrializers until the 1970s, Brazil experienced severe macroeconomic crises in the 1980s and 1990s and resumed its industrialization efforts only in the 2000s, after a long Structural Adjustment Programme. On the contrary, starting in the 1980s and with a significant acceleration in the 1990s and 2000s, China sustained its industrialization efforts and became integrated into the global economy and World Trade Organization (WTO) regime (China joined in 2001). Malaysia's growth trajectory, instead, started slowing after joining the WTO in 1995, and the country became one of those cited as falling into the 'middle-income trap'.

The *emerging industrializers* selected include two lower-middle income countries–Indonesia and Viet Nam—and a low-income country—Ethiopia. These are ranked 38th, 44th and 143rd in the UNIDO Competitive Industrial Performance Index. The start of a successful industrialization journey for these countries can be traced back to the mid-1980s for Indonesia and Viet Nam and to the 1990s for Ethiopia. The global policy and industrial space in which emerging industrializers developed show similarities with the conditions facing recent industrializers, although the latter are confronting increasing global competition and concentration in several industrial sectors, as they attempt to develop competitive global industries.

2.1.2. The industrialization ladders

The industrialization journey of these three group of countries—early, recent and emerging industrializers—presents multiple differences *across* groups, but also a number of similarities *within* groups. Differences arose because depending on when countries started their industrialization journey, early, recent and emerging industrializers faced a different *policy space*—so governments could implement a different version of industrial policy. They also faced a different industrial paradigm or environment– that is, the dominant technologies, organizational modes of production, and global demand conditions were different.

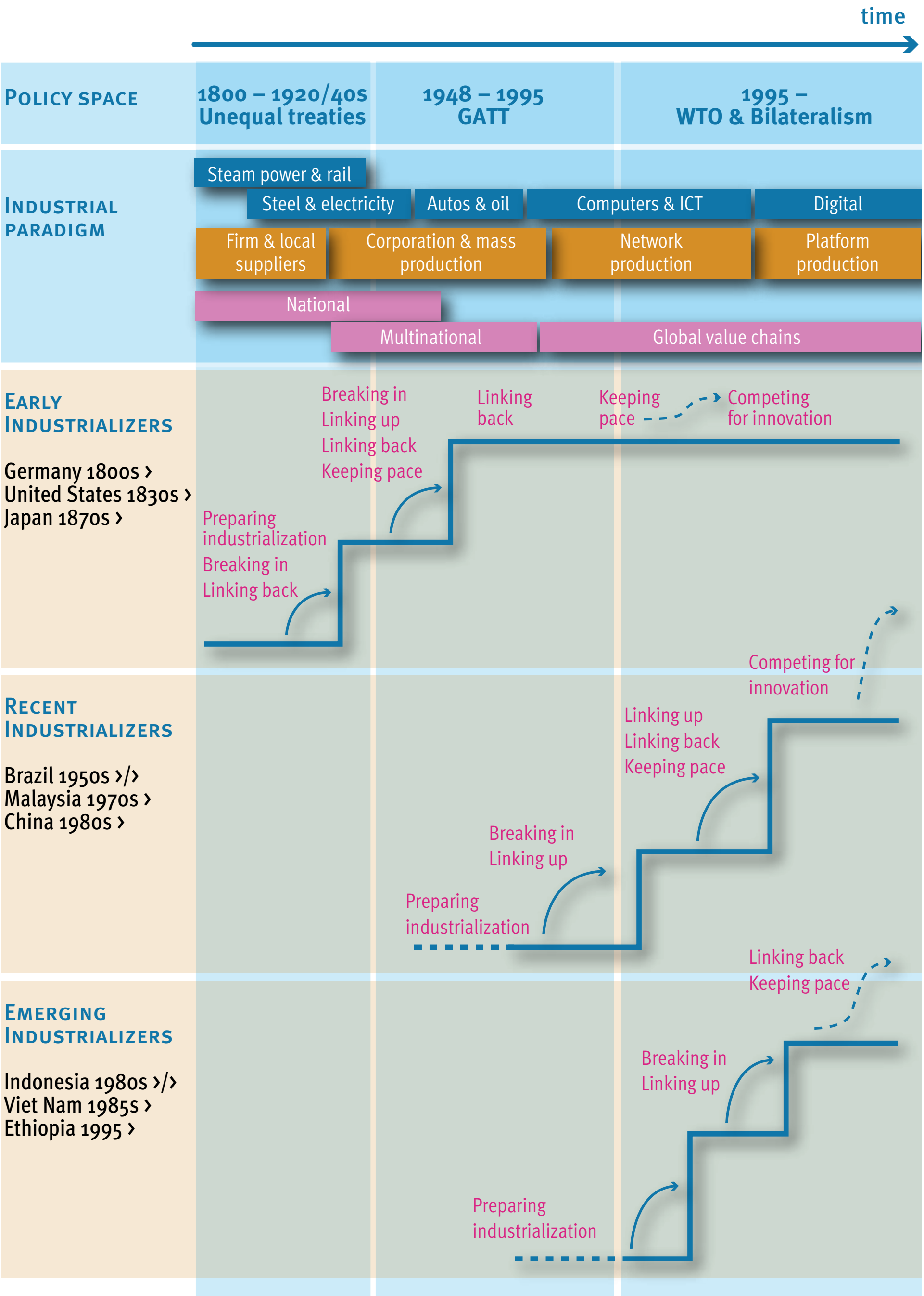
Similarities were due to the fact that countries within each group had to go through a similar sequence of steps and faced similar challenges in transforming their economies through industrialization. First, all countries went through initial pre-industrial phases in which state building, resource mobilization and macroeconomic stabilization were critical in preparing for industrialization. Second, despite differences in natural endowments, geography and other historical legacies, all countries needed to develop and accumulate capabilities and make strategic use of their strengths through industrial policy. Third, given their distinct governmental capabilities and political economy conditions, they all faced similar types of policy governance challenges in driving industrialization at early, intermediate and more advanced stages of development. As discussed in Chapter 4, a number of governance models developed by early industrializers were later re-deployed by recent and emerging industrializers to design, implement and enforce industrial policy.

A way to take into account both these differences across country groups and similarities within country groups is to consider what can be termed an *industrialization ladder*. If countries follow similar steps and face similar challenges in their industrialization journey, they face a single industrialization ladder. However, the ladder may change over time depending on the policy space and industrial paradigm under which the process of industrialization is taking place. The three country groups can be considered to be facing three distinct industrialization ladders, one for each group. Figure 2.1 provides a graphical representation of these industrialization ladders.

Starting from the global policy regime of the 'unequal treaties' during the colonial era, followed by the GATT and the establishment of the WTO, the policy space layer of the framework points to the policies which were or were not feasible when countries started their industrialization. One key dimension is trade policy—that is, the freedom to use tariffs strategically to support domestic production and under specific conditions and complementary policies stimulate industrial learning (Chang, 1994; Amsden, 1989 and 2001; Wade, 1990; Andreoni, Chang and Estevez, 2019).

Since the Uruguay Round started in 1986 under GATT and then the WTO new trade regime, the effectively applied tariff protection in world trade has declined significantly (Figure 2.2). The global policy space has been also shrinking as a result of bilateral trade agreements and the introduction of a more comprehensive set of regulations on investment, intellectual property rights and sectors of the economy which were not previously covered by international agreements. While the formal policy space is important, how countries engage with global regulations is also significant. In some cases, countries chose a very rapid integration into the global

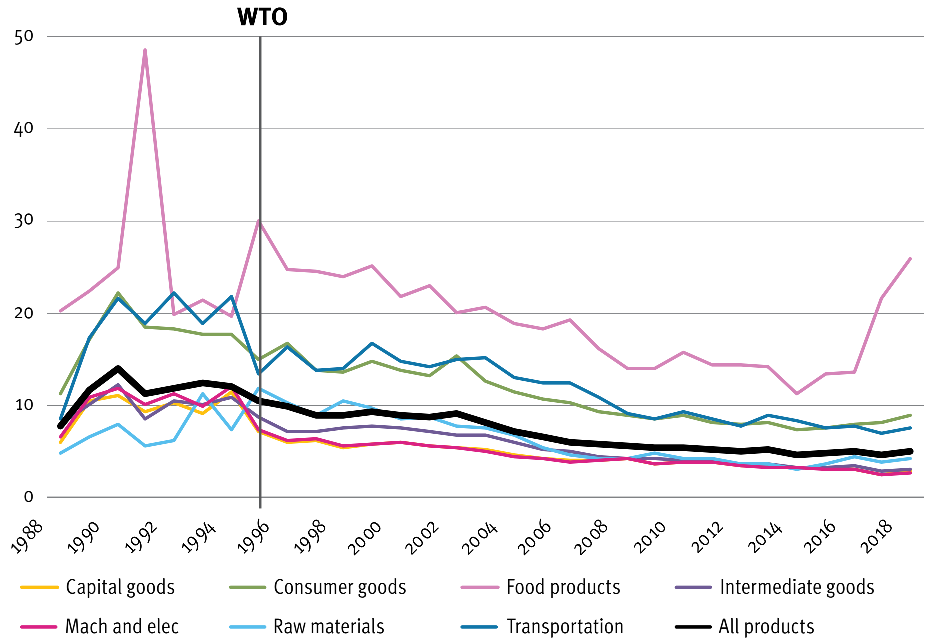
Figure 2.1: The industrialization ladders



Note: Years after country names indicate periods when industrialization started.

Source: UNIDO elaboration.

Figure 2.2: Effectively applied weighted average tariff, World 1988-2018



Source: UNIDO elaboration based on World Bank World Integrated Trade Solution (WITS).

economy, while in others governments have used the available industrial policy instruments and institutions to ensure a much more gradual approach, even where use of such measures was not formally feasible from a policy space perspective.

The second layer of the framework is the dominant *industrial paradigm* countries faced when they took their first steps on the industrialization ladder.[29] Here industrial paradigm refers to three main aspects of the operating environment facing firms—the dominant techno-economic paradigm, the main organizational model of production and firms' main geographic scope. Since the first industrial revolution, different historical periods have been dominated by different technologies—from steam power in the nineteenth century to digital technologies today. In addition, different organizational models of production have developed, from the managerial firm of early industrializers, to mass production and platform production. Finally, the geographic scope of production has moved from the national to the global, and is increasingly structured around global value chains (GVCs). Table 2.1 presents a schematic representation of changing industrial paradigms since the 1860s.

29 This discussion builds on the seminal work of Joseph Schumpeter (1934) and several evolutionary economists (Dosi et al., 1988; Perez, 2002; Lee, 2013).

Table 2.1: Industrial paradigms from 1860 to present

Industrial paradigms	1861 - 1913	1896 - 1945	1955 - 1992	1991 - 2005	2008 - present
Technological paradigm	Steam power & rail	Steel & electricity	Autos & oil	Computers and ICTs	Digital
Organizational model of production	Managerial firms & local suppliers	Corporation & mass production	Multinational corporation & mass production	Network production	Platform production
Geographic scope	National	National multinational	Multinational	Global value chains	

Source: UNIDO elaboration adapted from Sturgeon and Whittaker (2019).

Thus, depending on when countries start their industrialization, they face a different industrial paradigm, and therefore different opportunities and challenges.[30] Different international conditions create a different policy space and policies effective in one era may not be effective in another.

2.1.3. Industrialization challenges

Three different types of industrialization challenges calling for different types of industrial policy and institutions can be identified. These challenges are mapped in Figure 2.1 against the industrialization ladders and with specific reference to the three country groups selected.

A. Breaking into the global economy

Access to external demand and development of an export-oriented sector have been central in all countries' industrialization experience since the first industrial revolution. By breaking into the global economy countries can accelerate domestic processes of accumulation, especially in initial phases of development when they lack effective domestic demand to support efficient scale industrial production. By exporting they can gain access to the foreign exchange needed for technology transfer. They can also 'learn by exporting', that is, they can use the export market as a benchmark to improve the quality of their industrial products and the efficiency of their production. Thus, breaking into the global economy is a way of accumulating both industrial capital and productive capabilities (Cimoli et al., 2009; Chang and Andreoni, 2020).

However, breaking into the global economy and gaining world market shares in manufacturing, has become increasingly challenging. In their analysis of the

30 Sturgeon and Whittaker (2019), for example, define the experience of countries who industrialized after the 1970s in a 'network development era' dominated by GVCs as a 'compressed development' experience. Compressed developers such as our recent and emerging industrializers—they argue—faced an industrial landscape which is fundamentally different from the one faced by early industrializers such as Germany, Japan and the United States. In the industrial ladder framework, this means that the steps of the ladder have become steeper and even to remain on the same step countries have to run faster.

shifting patterns of manufacturing internationally, Haraguchi et al. (2017) found that manufacturing activities have become increasingly concentrated in a small number of populous developing countries. This persistent concentration and compression in global manufacturing—both at the country and sectoral levels—has made it very difficult for emerging and recent industrializers to break into low, medium- and high-tech activities respectively. Early and recent industrializers have erected several entry barriers, including developing global-scale economies, institutions and capabilities for technological development and innovation. The emergence of major national champions and multinational companies operating globally has also introduced new forms of direct and indirect competition from GVCs in middle-income countries' domestic markets (Andreoni and Tregenna, 2020). These challenges are highlighted in Chapter 3 where sector-specific industrialization experiences are analysed.

Currently success in international markets is closely associated with access to GVCs, in a process of 'linking up'. Starting from the 1950s, multinational corporations developed in a number of early industrializer countries and these were the driving force for the initial development of GVCs. The attraction of GVCs is that firms have the opportunity to move to more profitable and/or technologically sophisticated capital and skills-intensive economic activities with higher value-creation potential. Companies can specialize in specific production tasks or components, preferably high-value niches, while avoiding the building up of entire vertically integrated industrial sectors or blocks of industries (Gereffi, 2013). The selective specialization in tasks, driven by capturing value opportunities, encourages companies to upgrade incrementally to activities such as R&D, design and after-sale services.

First-tier suppliers and original equipment manufacturer (OEM) companies in low and middle-income countries, however, face multiple challenges in linking up to GVCs, especially moving into their more technologically sophisticated segments. First, focussing only on the production of low-value-added parts and components does not automatically lead to the upgrading of domestic technological capabilities, especially given the asymmetries characterising GVCs (Milberg and Winkler, 2013; Andreoni, 2019; Ponte et al., 2019). Second, in a number of cases, countries that have attempted to link up globally have also ended up 'de-linking domestically' and hollowing out the domestic manufacturing sector (Kaplinsky and Morris, 2015). Thus, linking up in GVCs is necessary, but not sufficient, for sustained industrialization.

B. Linking back in the domestic production system

Even a successful engagement with GVCs does not remove the need to 'link back' to local producers and local supply chains. With the development of linkages in the local production system, domestic companies can add more value, intensify their linkages and learn from exporting (Hirschman, 1958 and 1977; Andreoni, 2019). Early industrializers have again an advantage in this area, as their industrialization started when companies had a national geographic scope and developed local chains of suppliers. From the 1970s recent industrializers had to confront the 'linking back' industrialization challenge. The ROK and Taiwan Province of China first, and China later, all started their industrialization by linking backwards, whilst operating in global supply chains, and adding value through forward linkages in electronics and other industries, starting in particular from those characterized by short technology cycles (Lee, 2013). With the expansion of their local production systems, more opportunities for backward integration also opened up, as domestic companies started importing more intermediate goods while diversifying their export baskets.[31]

Over the last two decades, only a very small number of countries have been successful in linking back as part of GVCs. That is, only a few have managed to involve their OEMs, and first-, second- and third-tier domestically located companies in the value addition process of GVCs. The capabilities and institutions needed for this step have proved difficult to attain.

C. Keeping pace with technical change

In order to link up and back successfully, countries that are approaching or have already reached a middle-income status have to address a fundamental problem of technological upgrading.[32] Sectoral value chains are based on specific combinations of complementary technological capabilities—technology platforms—required to execute tasks in the different stages of the chain (Andreoni, 2014, 2018 and 2020; Lee, 2013; Tassey, 2007). Technology platforms underpin the production processes of closely related industrial sectors, as well as different product-value segments within the same industrial sector.

Keeping pace with technical change in these platforms effectively can be constrained by investment gaps at different stages of industrial or technological development. For example, firms in lower and middle-income countries might not be able to leverage a well-funded and diversified domestic science base that provides access to generic technologies. Companies might be also unable or unwilling to make significant investments in basic research, as the long-term capital commitment is either prohibitively high or judged too risky. The fact that the industrial base in these countries has limited technological depth also means that the scaling up of the new product or technology has to rely on external inputs. As discussed in Chapter 4, lack of policy coordination might also be a constraining factor.

Those countries which have managed to reach a sufficient level of global integration and build a domestic production system with firms capable of absorbing and investing in technologies still face a challenging global economic environment. Currently competing for innovation at the global frontier is particularly challenging, under the most recent industrial paradigm of the digital economy (UNIDO 2019b). The ‘digital capability threshold’ that companies have to reach to engage in digital innovations and apply them is particularly high, especially in technology domains such as artificial intelligence, data science, and robotization (Andreoni and

31 Lee et al. (2017) describe the successful catching-up process of countries like the ROK and China as an ‘in-out-in-again’ integration into GVCs. Chapters 3 analyses these two countries experiences in the electronics and machinery sectors respectively.

32 They have to do so fast enough to overcome the so called ‘Red Queen Effect’—that is, the fact that “middle income countries have to move to innovation-based growth more quickly, just to stay in the same place, let alone move up” (Kang and Paus, 2019:3).

Anzolin, 2019), Moreover, industrializing countries face new entry barriers due to network economies—especially in digital platforms—and asymmetries in accessing technology, skills and finance, along value chains (Sturgeon, 2017).[33]

2.1.4. What can we learn from contextualized industrialization experiences?

A variety of policy instruments and institutions can be used to address the challenges raised above, provided that there is enough policy space to implement them and that they are effectively calibrated to address the specific challenges under the current industrial paradigm. Effectiveness will also depend on the way policy and institutions are governed, given the policy constraints that countries at different stages of development face. In taking their first steps on the industrialization ladder, countries tend to be constrained by political economy factors and challenges in the governance of policies—especially, their enforcement—as much as by production-related issues. The political economy of industrialization—the way in which industrial policy creates a system of incentives and compulsion for increasing productivity—is also critical in explaining the success of the early stages of industrialization.

As noted above, while the form of these policies and institutions are often different, reflecting the specific features of countries and their political economy, these different policies and institutions tend to perform similar functions in driving industrialization. The same institutions can also perform more than one function at the same time. Against this variety of industrial policy forms and functions across and within the groups of country cases—the discussion below aims to identify the successful policies which have driven the industrialization of early, recent and emerging industrializers, how the evolution of the policy space and industrial paradigm affected countries' use of different industrial policy instruments and the lessons that can be drawn for today's developing countries.

In the following sections the discussion is organized around the industrial policies and institutions used by the three country groups in response to the three key challenges noted above.

2.2. Early industrializers: Policy factors and lessons

Britain was the first early industrializer in the late eighteenth century (Gerschenkron, 1962). In a few decades, Britain had acquired a dominant position, and the limitations imposed on the policy space of other nations through unequal treaties (Chang, 2002). From the mid-nineteenth century, however, Germany, France and the United States joined Britain among the earlier industrializers with a series of technological and industrial innovations—for example in heavy industries such as chemicals—but also the development of new institutions in areas like banking. In 1853 Japan was

33 As the case of Costa Rica shows, industrial policy can play an effective role in filling the digital capability gap and developing technologies for high-tech sectors like medical device (see Chapter 3).

forced to open its economy and, as a result, its feudal political system collapsed. The so-called Meiji Restoration of 1868 started a modernization phase for the country, followed by a fast process of early industrialization, which made Japan one of the so called 'Big Five' nations by the end of the World War I (Ohno, 2013). Differently from the other early industrializers, however, Japan regained its policy space only in 1911 with the end of the unequal treaties.

2.2.1. Breaking into the global economy

As illustrated in Figure 2.3, since the mid-nineteenth century, early industrializers have experimented with different sets of industrial policies, however trade policy played a key role, especially as a form of 'infant protection' (Chang, 2002 and 2007; Reinert, 2007).[34] To become industrially competitive, firms need time to 'learn in production', that is, to develop and accumulate sufficient productive capabilities (Hirschman, 1958; Andreoni, 2014; Chang and Andreoni, 2020). Between 1816 and the end of World War II, the United States had one of the highest average tariff rates on manufacturing imports in the world reaching average tariff peaks between 40 and 50 percent in 1875. Given that the country also enjoyed an exceptionally high degree of natural protection due to high transportation costs at least until the 1870s, US industries were the most protected in the world until 1945 (Chang, 2002).

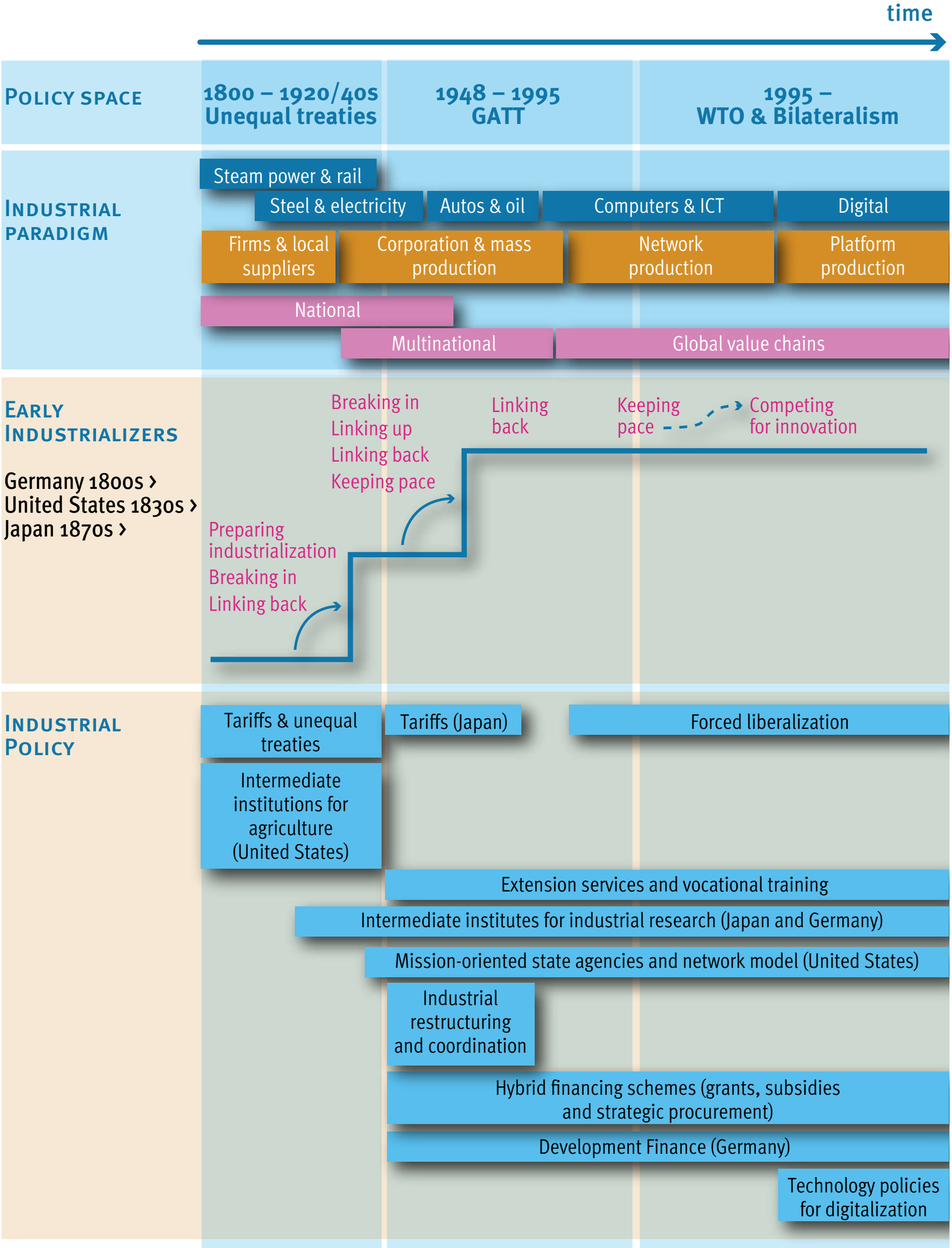
Although a German customs union under Prussian leadership was already established in 1834, Germany did not use tariffs as a form of 'infant industry protection' as widely as Britain and the United States until 1879. However, over the last two decades of the nineteenth century Germany witnessed a significant tariff increase as well as the development of a more targeted system of tariffs to promote specific industries and build a coalition of interests supporting industrialization. Under Otto von Bismarck, Chancellor of Germany, tariffs were used successfully and in a selective manner to support heavy industries such as steel and iron. Steel was emerging as the key material of the new industrial paradigm and a key input to develop the machinery industries. Selective tariffs were also used in Germany as a way of allocating rents to different powerful groups in society and cementing a political coalition between landlords and industrialists.[35]

Japan could not use tariff protection over 5 percent until 1911, when the so-called unequal treaties, signed in 1858, expired. Given its limited policy space, the Japanese government had to experiment and develop new industrial policy instruments which were feasible at the time and which would replicate some of the functions performed by trade policies. For example, state-owned model

34 The infant industry argument was invented by the first American finance minister (Treasury Secretary), Alexander Hamilton, in his 1791 Report on the subject of Manufactures by the Treasury Secretary. The Report argued for the importance of guaranteeing domestic industries some form of trade protection to support their acquisition of productive capabilities.

35 German experience thus points to the fact that trade policies can be about much more than allocation of tariff protection, but can be a key instrument to shape the development of the industrial system and guarantee sustained support for industrial policy and its enforcement. This political dimension is crucial for effective policy governance. Chapter 4 highlights how the government plays a key role in building coalitions of interests and in managing conflicts between different constituencies.

Figure 2.3: Successful policy factors for early industrializers



Note: Years after country names indicate periods when industrialization started.

Source: UNIDO elaboration.

factories were established in a number of industries—notably in shipbuilding, mining, textile, and military industries—to protect the domestic learning process and the accumulation of technological capabilities. Although most of these were privatized by the 1870s, the government continued to subsidize the privatized firms, especially in shipbuilding. Subsequently, Japan established the first modern steel mill, and developed railways and the telegraph (Chang, 2002). The Japanese experience points to the fact that even with limited policy space in the area of trade policies, other policies and institutional tools can be used to perform the same institutional functions by supporting learning in production. However, policies are not always substitutable and in many cases retaining policy space is critical to craft an appropriate package of complementary trade, industrial and technology policies.

With the end of the unequal treaties in 1911, Japan started using a range of tariffs to implement infant industry protection strategies. The country had arguably the world's toughest regulations on Foreign Direct Investment (FDI) and on technology imports (to make sure that imported technologies were not overly outdated and the royalties paid were reasonable). Tariffs were also used to make access to raw materials cheaper relative to other imports, and a control on luxury consumption was introduced, a measure later used by the ROK and other Eastern Asian countries (Chang, 1997). Trade policies can be used not only to protect infant industries, but also to focus national resources towards imports of productive assets and technologies. Japan used control on luxury consumption—effectively a trade policy—as part of its broader technology transfer policy.

With the end of World War II, early industrializers shifted their industrial policies from trade protection to other areas of intervention aimed at adapting their industrial system to the evolving industrial paradigm. As discussed below, industrial restructuring, mission-oriented innovation, applied industrial research, development finance, and hybrid finance solutions including subsidies, grants and strategic procurement became the main industrial policy instruments of early industrializers. While for them trade policies no longer performed an 'infant protection' function, early industrializers embraced a multilateral approach to trade liberalization under the GATT/WTO, which promoted access of early industrializers to developing countries' markets.

More recently early industrializers have shifted their policy focus more towards technology policies aimed at competing for innovation, especially in areas like digital policies. Whilst tariffs have been reduced dramatically, new instruments in the form of Non-Tariff Barriers (NTBs) have been used to protect their industries—both with respect to other global leaders and recent industrializers. While these NTBs can be introduced to pursue standards, they can be also used to regain policy space in trade policy.

2.2.2. Linking back in the domestic production system

Early industrializers learnt quickly that trade and infant protection was not sufficient in driving productivity increases and technological progress. They realized that industrial competitiveness could not be achieved and sustained without industrial policies supporting the technological capabilities and skills of the workforce.

Both the United States and German experiences show how during this period trade policies were also effective tools for developing domestic companies which later would constitute the supply chain of big national firms ('linking back'). As documented by Alfred Marshall, Britain was among the first to develop industrial districts, a dense network of small and medium-size enterprises (SMEs) supplying both the national and—through bigger companies—the global market (Andreoni and Lazonick, 2020). The majority of these firms—especially in the United States—could benefit from a protected domestic market to scale up their operations and adjust to sector specific conditions, with the more successful breaking into export markets.

In each country transformation of the agricultural sector was a milestone in the development of early industrializers, and an opportunity for industrial development (Andreoni, 2011). In the United States one of the early policies to complement trade protection was the development of extension services to improve productivity in agriculture. In the late nineteenth century, the United States was still a relatively agrarian economy and in 1890, agricultural products accounted for almost 75 percent of total U.S. exports (Ferleger and Lazonick, 1993). To help diversify the export basket the government promoted transformation in agriculture through the grant of government land to agricultural colleges and the establishment of government research institutes. However, continued productivity growth also required scientific and managerial advances. Through the United States Department of Agriculture (USDA) and State experimental stations, the government developed and transferred capabilities in the use of seeds, fertilizers, and disease control, as well initiating the development of new products. Extension services, agricultural research in major crops and technology diffusion through networks of public technology intermediaries were critical in the industrialization of the United States. Increasing productivity in agriculture made it possible to develop a number of related industries such as food and beverages, and also triggered processes of inter-sectoral learning which saw the emergence of giant agro-machinery companies such as McCormick and John Deere—still today leaders in the sector. It also freed labour for work in manufacturing and created a market for new national manufacturing producers.

Finance is critical for industrialization and industrial finance institutions and various financing schemes can play a very important role, particularly in relation to long-term finance. The early industrializers developed very different industrial finance institutions and models. Germany and Japan based their policies on a strong network of public saving banks, credit cooperatives, and development banks each with corporate governance regulations favouring a long-term perspective. In Germany the Bank for Reconstruction (KfW), founded in 1947, played a central role in the post-war reconstruction era and was used as an institutional arm of the government in the implementation of industrial policy. During the 1960s and 1970s, KfW operated as a traditional development bank under the ownership of and with funding from the Federal government. KfW provided credit on preferential terms and managed subsidized direct credit programmes targeting the domestic industrial sector. It provided increasingly competitive German companies specialized support in the form of export finance, as well as subsidized project finance for outward foreign direct investment.

Since 1990 KfW has also been the main institution responsible for German success in the renewable energy industry. In the early stage of its development renewable energy was expensive and the market was not willing to channel significant resources into the sector. KfW was used to provide subsidized long-term finance to fund investment in the industry, and later to promote exports (Mazzucato and Penna, 2016). It is estimated that, if co-finance projects are included, about 80 percent of wind energy plant investment and 40 percent of the total renewable energy development in Germany has been financed by KfW. By 2014, three out of the top ten wind turbine manufacturers (Enercon, Siemens and Nordex) were German companies, with a combined world market share of 21.5 percent (Naqvi et al., 2018).

About

80%

of wind energy
plant investment and

40%

of the total renewable energy
development in Germany has
been financed by KfW

Japan also relied on similar institution such as the Japanese Development Bank (JDB), the Long-Term Credit Bank of Japan and the Industrial Bank of Japan. However, what is distinctive about the Japanese experience is that between the mid-1960s and the late 1990s, companies insulated themselves from short-term pressures through cross-shareholding among 'friendly' or interrelated enterprises, which accounted for 35 to 50 percent of all Japanese shares during this period. Banks were closely involved with enterprises and provided not only long-term capital, but also de facto management consultancy for smaller firms, which could not afford these services at commercial rates.

Being a stock market based financial system, the United States relied less on finance from specialist development banks. Public industrial financing has taken the form of R&D grants, and deferral of tax liability and tax exemptions. Two programs run by the Small Business Administration (SBA), namely the Small Business Investment Company (SBIC) and the Small Business Innovation Research and Technology Transfer (SBIR/STTR), have been particularly successful. These programmes combine loans, R&D grants, and pre-commercial public procurement to support small businesses, Original Equipment Manufacturers (OEMs), and specialist manufacturing contractors engaged in the development and scale-up of technological systems or components.

Over time governments of the United States have expanded the operational and financial capacity of the SBIR programme in recognition of its success. The programme combines different financing instruments to channel financial resources to targeted companies to reduce risk and support the development of new markets. The amount of resources provided for R&D often exceeds that from private sources and is aligned with resources channeled by other public agencies. Funds from SBIR and 'mission-oriented' public agencies have been found to crowd-in or stimulate additional private investment more effectively than tax incentives (Mazzucato, 2013; Andreoni, 2016).

These different approaches to government support for financial intermediation have each been broadly successful. The German model has proven to be very effective in supporting the traditional industrial sectors, as well as in developing new green technologies. The US model—epitomized by the SBIR programme—was particularly effective in supporting innovation in advanced technologies. The Japanese model insulated companies from short-termism and gave a competitive edge to major conglomerates in the electronics, automotive and machinery industries.

Early industrializers have had to alter their policies towards their industrial sectors in response to transformations in the industrial paradigm, during the course of the twentieth century. The emerging industrial paradigm which centred on mass-production, science-based industrialization and increasing multinational orientation, called for significant industrial restructuring, which industrial policy was used to support with a view to creating the 'optimal level of competition' (Amsden and Singh, 1994). The experiences of early industrializers with industrial restructuring and investment coordination highlights how governments can play an important role in creating an industrial structure that is competitive both domestically and internationally. Competition policy is thus integral part of industrial policy and needs to be applied in a coordinated manner especially in early stages of industrialization (Roberts, 2013). The trade-off is that increasing scale can bring more efficiency in many sectors, but also a potential reduction in competition, while cartels can bring coordination in investment, but also risk blocking productivity and technical change.

Japan was the first to proceed far with industrial rationalization. During the 1920s, the government sanctioned cartel arrangements and encouraged mergers to reduce 'excessive' competition and achieve scale economies, standardization, and organizational innovations, such as the introduction of scientific management. In the 1950s, laws were introduced to prevent large firms from abusing their market dominance particularly in relation to their suppliers. These laws pushed large firms to invest in enhancing the capabilities of their suppliers (such as through equity participation or secondment of technicians), rather than pressurising their profit margins and depriving them of the resources needed to invest in capability enhancement. Cartels were allowed only under clear conditions in terms of their aims (such as avoiding duplicate investments, upgrading technology, avoiding price wars in the export market, and orderly phasing-out of declining industries) and life spans.

In Germany in the early post 1945 period, industrial policy also focussed on industrial restructuring and public ownership. After the war, the giant chemical company, I.G. Farben, was broken up into Bayer, Hoechst (now part of Aventis), Agfa, and BASF. These companies allowed Germany to regain a world leading position in the modern science-based chemical industry. In electrical engineering Siemens quickly became a European leader in power engineering, telecommunications and other electronics. When the Federal government decided to privatize national companies—starting in the 1960s with Volkswagen and VEBA– the Länder (State) governments often maintained shares in these companies.

Even the United States which pioneered anti-trust regulations, used industrial and investment coordination in combination with its mission-oriented innovation policies. Semiconductors, for example, were first developed through funding from the US Defence research programme. When the two main firms—Fairchild and Texas Instruments—were subsequently involved in costly patent suits, the United States Department of Defence intervened to resolve the situation by imposing a patent pool between the two companies (Perelman, 2003, 56).[36]

2.2.3. Keeping pace with technical change

Encouraging and supporting technical change is central to industrial policy. The experience of early industrializers suggests that a network of industrial institutes focussing on technology absorption, adaptation, and diffusion can play a critical role in the early stages of industrial development.

In the early twentieth century, firms started transforming into mass production enterprises with a unitary, centralized organizational structure run with scientific methods and new managerial processes—the so called 'Fordist Corporation'. The government of the United States responded to this new emerging industrial paradigm and the increasing competition for technologies and innovation with the establishment of the Office of Scientific Research and Development. Under the lead of Vannevar Bush, the Office became the critical node of a networked inter-organizational system for science and technology R&D (Best, 2019). This network included industries, universities, national laboratories and other research

36 In 1987, the government of the United States gave the industry a further boost by setting up SEMATECH, a joint venture of 12 firms with ARPA funding, as a means to fight off the Japanese technological challenge (Block and Keller, 2011; Mazzucato, 2013).

institutes and state agencies such as ARPA (Advanced Projects Research Agency) of the Pentagon, the NIHs (National Institutes of Health), the NSF (National Science Foundation), the National Institute for Standards and Technology (NIST), the Departments of Energy and Agriculture, and NASA (National Aeronautics and Space Administration). Between the 1950s and 1980s, the share of government funding in total R&D in the United States accounted for, depending on the year, between 47 and 65 percent, as against around 20 percent in Japan and the ROK and less than 40 percent in several European countries (for example, Belgium, Finland, Germany, Sweden).

These public R&D investments were pivotal in the development of key ‘general purpose’ technologies especially in defence (computers, semiconductors, aircraft, internet) and health (drugs, genetic engineering). They also supported the integration of mass production and technological innovation and steered the economy of the United States into new sectors, while creating new markets (Mazzucato, 2013). During the 1950s and 1960s, many of these institutions were strongly focussed on translating cutting-edge technological research, much of which was generated through major public funding of R&D into commercial use.

Germany became a champion of intermediate technology institutes starting from 1959, and with a significant expansion from the mid-1970s. The government developed its industrial research and science infrastructure around two publicly funded networks of institutes, the Fraunhofer Society and the Max Planck Society. Fraunhofer institutes were explicitly aimed at filling the gap between basic science and company-based industrial research and at overcoming the disadvantages and scale bottlenecks faced by *Mittlestand* companies (firms with between 100 and 500 employees). Fraunhofer institutes are specialized in joint pre-competitive research, prototyping and manufacturing scale-up, as well as in the commercialization of new products, bilateral applied research with individual firms and technology transfer schemes. The majority of these institutes are focussed on specific technology domains and collaborate with companies from different sectors including healthcare, security, ICT, energy and the environment. While the government provides seed funding and supports part of the regular budget of these institutes, Fraunhofer institutes have a strong incentive to develop their own sources of funding by developing collaboration with industry and business associations. The German experience highlights how public-private collaboration under good governance and appropriate incentives is critical if public research support is to deliver results (Andreoni, 2016).

Given its limited policy space, and backwardness relative to the other early industrializers Japan invested significant resources in technology transfer throughout its modernisation phase pre-1945. Keeping pace with technological change involved the creation of sector-specific technology centres—especially in shipbuilding—but also the attraction of foreign engineers and the promotion of turnkey projects in targeted industries. Building on the model adopted in the United States of a network of agricultural extension and engineering experimentation stations, in 1902 Japan built what remains today its main network of industrial research institutes known as *Kohsetsushi Centres* (O'Sullivan et al., 2013). Established in 1902, these centres were located in regional prefectures to support local SMEs with a variety of quasi-public good technologies for testing, trial production, and scale-up, as well as training services. This network of centres currently has 262 offices and is complemented by cutting-edge research institutes, such as the *National Institute of Advanced Industrial Science and Technology* (AIST) (O'Sullivan, 2011).

More recently, as part of the shifting industrial paradigm over the last two decades, early industrializers have each invested heavily in the development of digital-based technologies and have redesigned their overall industrial policy frameworks to address this challenge. For example, from mid-2000 Germany's industrial and innovation policy vision has been framed within a Federal plan, called the "High-Tech Strategy" (HTS) (first adopted in 2006 and expanded in 2010). This is an overarching national innovation strategy aimed at coordinating (and exploiting complementarities across) the full spectrum of technology, innovation and manufacturing policies and regulations. Similarly, in 2010 Japan set out an "Industrial Structure Vision 2010" and a "New Growth Strategy" aimed at diversifying the Japanese industrial structure and capturing many of the opportunities offered by new frontier technologies in life science, biotechnologies and artificial intelligence. The United States has also engaged in a number of 'mission-oriented' initiatives—like the robotics and the genome ones—to allow their firms to compete in the new digitalisation era.

While building on the same technology infrastructure and networks developed over the last century, early industrializers are now increasingly relying on mission-oriented initiatives aimed at addressing major challenges, including climate change, and disruptive technologies, such as artificial intelligence. Technology policies in the digitalization era have started changing to reflect the new technological realities and the blurring of sectoral boundaries. For example, sector-specific technology institutes are becoming increasingly focussed on cross-sectoral and cross-cutting technological opportunities and challenges (Andreoni, 2020).

In a number of technology areas, early industrializers, are also facing the technological innovation challenge of recent industrializers, in particular China and the ROK. The competitive challenge at the frontier posed by these countries is making early industrializers increasingly aware of the importance of rebuilding their industrial production capabilities, alongside their R&D and innovation capability (Berger, 2013). Because of the link between innovation and industrial production some of the institutions and policies, which were useful under previous industrial paradigms are now being rediscovered as ways to support industrialization in the current era. The United States, for example, has rediscovered the importance of developing production linkages in the domestic economy. The Manufacturing Extension Partnership (MEP) launched in the 1980s under the increasing competitive pressure of Japan has been revamped. A new network of regional institutes working on the development and adoption of advanced manufacturing technologies, the National Network for Manufacturing Innovation (NNMI) was also established to respond to the competition from Germany, Japan, China and the ROK (O'Sullivan et al., 2013).

2.3. Recent industrializers: Policy factors and lessons

The group of recent industrializers include a quite large and diverse number of countries who started their industrialization in the second half (in some cases even the last quarter) of the twentieth century and reached middle-income status only over the last two decades. In the nineteenth and early twentieth century, this group of countries were subjected to various forms of unequal treaties under which they were deprived of the right to set their own tariffs (Andreoni, Chang and Estevez, 2019). Only a low (3 to 5 percent) and uniform rate of tariff for revenue purpose was allowed, thus making impossible to use trade policies for infant industry protection. These treaties also introduced the concept of 'most favoured nation' (MFN), which enabled all the countries that signed (an unequal) treaty with a weaker country to get a more favourable treatment, if any one of them managed to extract an extra concession. The impact of colonialism and of unequal treaties started to recede slowly from the 1920s, with the expiry of the unequal treaties for Japan in 1911, Turkey in 1923 and China in 1929. Starting from the mid-1940s former colonies also started gaining independence and developing countries regained some policy space.

The new global regime that emerged after 1945, represented by the GATT, put only mild restrictions on trade and industrial policies. Many of today's industrialized nations in the meanwhile started reducing their trade barriers and promoted the opening up of international trade relations. In the first GATT rounds, tariffs were cut on a selective product-by-product basis. This approach was later replaced with the use of formulae to cut tariffs across-the-board, while retaining some exceptions.[37]

The policy space for developing countries started shrinking again from the 1980s. First, with the introduction of Structural Adjustment Programs by the IMF (International Monetary Fund) and the World Bank, which put conditionalities on their loans that demanded dismantling of interventionist policies. Second, during the Uruguay Round, and later with the establishment of the WTO in 1995, new 'tariff bindings' were used, especially for industrial products or manufactured goods. Under the binding mechanisms, WTO members agreed to a Schedule of Commitments whereby tariff upper bounds were set for a large number of products and sectors. Since then, a number of developing countries have undergone processes of unilateral liberalization and have applied tariffs at a much lower level than the ones allowed within their own Schedule of Commitments (Baldwin, 2010).[38]

Moreover, new multilateral arrangements, agreed as part of the WTO, such as the SCM (Agreement on Subsidies and Countervailing Measures), the TRIMS (Trade Related Investment Measures), the GATS (General Agreement on Trade and Services), and the TRIPS (Trade Related Aspects of Intellectual Property Rights) started covering and shrinking important areas of industrial policy space, which

37 While the formula approach is more efficient in terms of negotiations from an industrialized nation perspective, it limits space for selective infant industry protection.

38 For a review of bound and applied tariffs, see UNECA (2016).

were almost completely unregulated for early industrializers. Also as noted above, the dominant industrial paradigm also evolved dramatically over the last half of the twentieth century raising new challenges and opportunities. By the 1970s, early industrializers had restructured and advanced their domestic industrial and technological systems. Major corporations from early industrializing countries had developed mass production capabilities and had started establishing global supply chains in a few developing countries.

This was the background against which the recent industrializers started moving up the industrialization ladder. Brazil already had an industrial base in the 1950s and benefitted from the industrial policy space available at the time. However, in 1970s and 1980s progress on industrialization there was interrupted by mounting macroeconomic imbalances and the Structural Adjustment Programmes to address these limited the available industrial policy space. Among the other recent industrializers, China and Malaysia proved more effective than Brazil in using their shrinking policy space and gaining industrial competitiveness. While Malaysia managed to break into a number of global industries such as palm oil and later on linking into electronics value chains, it has only partially managed to address the other industrialization challenges of linking back and keeping pace with technological change. On the other hand, from the 1990s China gained increasing world market shares in a range of manufactures, and also managed relatively effectively to both link back into the domestic production system and keep pace with global technological change.

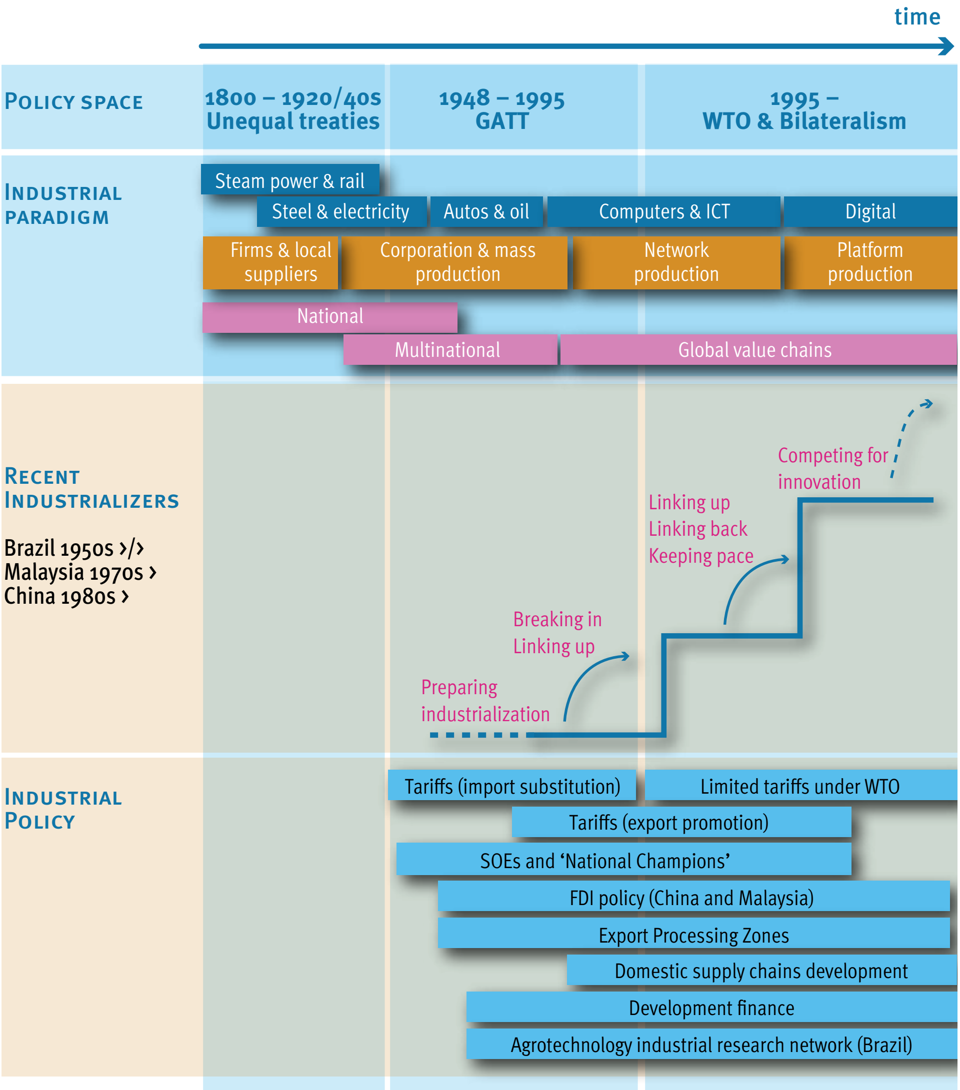
The industrial policy experiences of recent industrializers have been diverse, and all countries have had both success and failures. While as noted a number of policies and institutions, which were feasible under the earlier global policy space, are no longer available options, nonetheless other policy instruments can be still used and have proved to be effective, especially when aligned within coordinated industrial policy packages. Figure 2.4 provides a summary of the policies which proved to be successful in the selected group of recent industrializers—Brazil, China and Malaysia.

2.3.1. Breaking into the global economy

Between 1950s and 1970s, Brazil used trade policies simply as an instrument to promote import substitution, while paying only limited attention to the opportunities offered by exporting. The Brazilian protectionist regime was structured around *ad valorem* tariffs—the Law of Similarities (*Lei do Similar Nacional*)—according to which a product could only be imported if it could be proved that a similar product was not produced in Brazil. These measures were intensified during the period from 1960 to 1980, when the country entered into a macroeconomic crisis. Import substitution delivered some domestic diversification, however without the competitive pressure of exporting, companies lagged behind in industrial competitiveness.

When Malaysia gained independence in 1957, its industrial policies were also mainly based on import substitution. During the second half of the 1960s, import

Figure 2.4: Successful policy factors for recent industrializers



Note: Years after country names indicate periods when industrialization started.

Source: UNIDO elaboration.

substitution policies were complemented by a broader package of interventions with a strong export-orientation. Starting with the *Investment Incentives Act in 1968* a number of policies were introduced to promote linking up with GVCs and later—some form of linking back into the domestic economy and keeping pace with global technological change. The Second Malaysia Plan (SMP), 1971-75, was centred around export promotion through regulated FDI in a number of strategic manufacturing sub-sectors. The fact that by that time Singapore was building on its capabilities in semiconductor assembly to move up the value chain in more complex tasks and products, opened a window of opportunity for Malaysia. With a focus on semiconductors and other electronic components assembling, the electronics industry was highly labour intensive and allowed for short-learning cycles in related electrical products, such as audio electric systems. A number of multinational corporations based in the United States were offered a comprehensive package of incentives, including tax holidays and profit repatriation guarantees. Many of these incentives were tied to investments in training, export performance, and R&D activities. Incentive packages favoured export-oriented firms in particular. For example, the government supported duty drawback schemes along with export incentives offering double deduction benefits on corporate tax (Lall, 2001a). In exchange for these incentives, Technology Transfer Agreements (TTAs) were signed to enable domestic firms to obtain the necessary technologies to meet international quality and process standards. These agreements are usually seen as key factors in the success of the firms concerned.

China's experience with trade policies followed a similar pattern. Between the 1950s and early 1980s, China mainly relied on import substitution with limited results. However, in 1978, China started experimenting with a series of new policy instruments including the setting up of export processing zones to link into the global value chains and access foreign technologies. At the same time the opening of the economy and the shift towards export promotion did not stop the government from developing infant industries and domestic productive capabilities. Import substitution strategies such as local content requirements were integrated into other policy instruments—such as FDI policies and Export Processing Zones (EPZs). This allowed China to achieve a strategic integration and alignment between export promotion and import substitution policies. Moreover, state-owned enterprises (SOEs) were also promoted as a way of building national champions capable of breaking into the global market.

Starting in the 1980s and increasingly in the 1990s, FDI policies in China were also used strategically by the government to link into GVCs, while also creating the conditions for the development of domestic production linkages (Andreoni and Tregenna, 2020). The June 1995 *Provisional Regulations of Guidance on Foreign Direct Investment* mapped out guidelines for targeting FDI in priority high-technology sectors, and a list of encouraged, restricted or prohibited foreign investments was set out in the *Foreign Investment Industrial Guidance Catalogue*. Targeted industries typically involved high-end manufacturing and new advanced technologies. Sectors such as automobile and semiconductor industries were guaranteed incentives and market protection in exchange for technology transfer. Specifically, foreign investors benefitted from tax exemptions and subsidized land. However, they were also highly regulated, with local content requirements and joint venture rules involving indigenous firms (foreign shareholding was capped at 50 percent). Examples of early joint ventures include BAIC and American Motors Company, and SAIC and Volkswagen. Import tariffs and quotas were imposed using an infant industry strategy, with import tariffs as high as 200 to 300 percent in the 1980s, and 100 to 200 percent in the early 1990s. It was only in the late 1990s that the government loosened entry restrictions on foreign automobile manufacturers.

The experiences of both Malaysia and China point to the importance of strategic targeting in FDI policies and the need for creating a system of 'carrots and sticks' whereby allocated rents—through, for example, fiscal incentives, domestic market protection, or the grant of land—result in the development of productive capabilities. Malaysia's targeting of a sector with relatively short-learning cycles is another important lesson, also common to other East Asian Tigers such as the ROK (Lee, 2013). Targeting those sectors in which previously accumulated industrial capabilities were relatively less important to become competitive, made it possible for Malaysia to learn and link up relatively rapidly.

Export promotion zones (EPZs) are an institutional invention of recent industrializers (Oqubay and Lin, 2020). Early industrializers took their first steps on the industrialization ladder at a time when companies were nationally oriented and relied on local supply chains. This allowed the emergence of industrial districts and clusters and created the benefits of economies of agglomeration several centuries ago. Since the 1970s recent industrializers have attempted to achieve the same results by promoting the establishment of EPZs and industrial zones, often in conjunction with their FDI policies. These zones also became institutional tools for coordinating complementary policies such as for training and management of customs. In 1971 in Penang—the Bayan Lepas Export Processing Zone—was the home of the first electronic industry in Malaysia. Many companies relocated their electronics plants in the following decade, leading to the establishment of a local production system around semiconductors and electronic components (Rasiah, 2010). A number of these companies developed productive capabilities in higher-technology and higher value-added products through continuous investment in skills, and R&D. In 1990 Malaysia became the world's largest exporter of semiconductors, and among the largest exporters of disk drives, telecommunications apparatus, audio equipment, room air-conditioners, calculators, colour televisions, and various household electrical appliances. Significantly, by 1992, almost 90 percent of the manufacturing of electronic products was being conducted by affiliates of transnational corporations (TNCs).

These results were achieved at the same time as the strategic enforcement of local content policies, even after Malaysia joined the WTO. While imposing local content requirements has been formally ruled out under the WTO, governments have various instruments to encourage foreign companies to support local supply chains. In the first Trade Policy Review of Malaysia at the WTO, it was revealed that: "Malaysia has no local content laws or regulations. However, the Government encourages the use of local materials in the manufacturing sector and the use of local content is taken into account in the granting of investment incentives provided by the Government".[39]

39 WTO document G/TRIMS/N/1/MYS/1, dated 12 April 1995

To support and induce multinational corporations in EPZs to upgrade their operations and move to higher value tasks, Malaysia also invested heavily in technical training. For example, in 1989, the government established the Penang Skills Development Corporation (PSDC). The steering committee was headed by three leading companies—Motorola, Hewlett-Packard and Intel—and included another 24 founder firms providing equipment, production technologies and highly-skilled engineers and managers to teach at the newly established campus funded by the state of Penang.[40]

China also used EPZs extensively starting with the establishment of the Shenzen Special Economic Zone (SEZ) in 1983. In 1985 alone, FDI contracts amounted to over 1 billion US dollars from more than five hundred investors focussing on garments, metal and plastic products for export. In the 1990s new locations emerged as major sites for FDI—such as around the Yangtze River Delta—and new SEZs were established. FDI policies were not the only framework within which these SEZ operated. To promote technology transfer, in 1986, the National High-Tech Development Plan (also known as the 863 Plan) introduced the first articulated national technology strategy targeting clusters around biotechnology, space, information technology, laser technology, automation, energy and new materials. The Torch Programme was initiated in 1988 to promote hi-tech cluster development and innovation, so that SEZ, clustering policies and technology policies were aligned and integrated with a view to delivering productive capabilities and economies of agglomeration (Andreoni and Tregenna, 2020).

2.3.2. Linking back in the domestic production system

Similar to early industrializers, recent industrializers have also invested significant resources in developing national champions and SOEs in strategic sectors, especially heavy industry and infrastructure. In Brazil, for example, key large companies were Petrobras (founded in 1953) in the oil industry, Eletrobras (1962) in the energy generation sector and Embraer (1969) in aviation. In 1970 also Malaysia established SOEs as part of the New Economic Policy (NEP) and as a way of addressing the mounting socio-economic crisis and related racial conflicts. The number of SOEs grew from 10 in 1957, to 82 in 1974, alongside 185 joint ventures with the private sector. The newly formed SOEs were later privatized and ownership was given to indigenous Malays.

While the experience with SOEs in Brazil and Malaysia is mixed, the country which arguably managed to use SOEs most effectively is China. The government did not use SOEs simply as a way of promoting one industry, but also as a way of coordinating processes of industrial upgrading and restructuring. In some cases, SOEs were used to limit domestic competition and achieve economies of scale. In others, with the development of a national team of state enterprises, SOEs were used to break into global markets and link into value chains. More recently, they were used to

40 In 1996 the PSDC was ranked among the top ten workforce development institutions in the world. In the 2000s, to keep pace with this technological upgrading, the PSDC founded an intermediate institution, the Micro-Electronic Center of Excellence.

launch merger and acquisition programmes (Nolan, 2001).[41] Within the WTO regime however, the use of SOEs has become increasingly contested and their feasibility as an industrial policy tool has been reduced.

In terms of access to finance, learning from early industrializers, all recent industrializers introduced development finance institutions—such as development banks and sector-specific industrial banks—as well as introducing various financing schemes such as subsidized loans, research grants, matching grants, tax allowances and incentives to channel funds to priority areas. While all these policy instruments and institutions may look similar, they have been designed, implemented and enforced differently across countries. Selectivity in financing provision, sector-specific financing instruments reflecting specific company needs, and the establishment of an enforceable set of conditionalities, which reduce the risk of rent-seeking are the key design features in successful cases.

Brazil established the Brazilian Development Bank (BNDES) in 1952. Since then, BNDES has been the main provider of long-term finance in the country, and one of the biggest in the world measured by assets, equity and disbursement (Ferraz and Coutinho, 2019). China also made extensive use of development banks. However, in the case of China only firms from priority industries benefitted from subsidized loans, and their financing was provided by specialized banks such as the Export-Import (Exim) Bank of China—mainly focussing on export finance, the Agricultural Development Bank of China (ADBC)—mainly focussing on the primary sector, and the China Development Bank (CDB)—mainly focussing on manufacturing. The overall financial infrastructure was also given a pro-industrial development orientation by law.[42]

Both China and Malaysia also adopted financing models combining different financing instruments to support technological innovation. What makes these models particularly innovative and successful is the fact that they integrate several streams of financing, each with strong policy direction. The case of the InnoFund sheds some lights on the Chinese approach to funding innovation. InnoFund was set up in 1999 as a special government R&D programme to support investment in early stages of technology development. It has precisely-defined eligibility criteria, and provides different types of financial support targeting different types of companies at different stages of development, from loan interest subsidies to equity investment (Guo et al., 2016). Strict eligibility criteria are critical in bringing selectivity and direction to the policy scheme.

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41 However, in China SOEs benefitted from incentives and preferential loan terms, which some argue put serious financial pressure on the banking sector. Between 1998 and 2003, SOEs received 65 percent of all commercial bank loans, despite accounting for only a quarter of China's economy. Imputed interest rates on debts offered to SOEs were 20 to 25 percent lower than those offered to private enterprises between 1999 and 2003 (Ferri and Liu, 2010).

42 For instance, Chapter IV, Article 34 of the 1995 *Law of the People's Republic of China on Commercial Banks* highlights that "[a] commercial bank shall conduct its loan business in accordance with the need for the development of the national economy and social progress and under the guidance of the state industrial policy" (see Andreoni, 2016).

Similarly, Malaysia introduced a matching grant scheme to accelerate the shift of Malaysian-owned companies to targeted high value added, high-technology, innovation-based industries. The scheme, the Domestic Investment Strategic Fund (DISF) matches companies' investments with a 50 percent grant for specific activities.[43] These matching grants are also aligned with the sectoral industrial strategy, and thus prioritize technological investment in renewable energy, advanced microelectronics, machinery and equipment, medical devices, pharmaceuticals and aerospace.

2.3.3. Keeping pace with technical change

The promotion of technological capabilities can rely on financing schemes—such as those discussed above—or technology services to support the transfer, adoption, adaptation and diffusion of more advanced technical solutions and managerial practices. In a country where policy enforcement is difficult, and financing schemes are vulnerable to exploitation and the capture of rents, the setting up of intermediate institutions providing technology services is potentially a better option. Financing incentives risking attract all types of firms—including those simply interested in rents—while technology service provision tends to attract only those firms interested in innovation and commercial success.

Many of the successful recent industrializers have relied on some form of these intermediate technology institutes.[44] Historically intermediate institutions have developed different forms characterized by different combinations of supportive technology functions. Starting from the 1970s, Brazil managed to establish one of todays' most extensive networks of technology intermediaries focussed on agro-industrialization. For example, established in 1972 as a public corporation under the Ministry of Agriculture, Livestock, and Food Supply (MAPA), Embrapa (Empresa Brasileira de Pesquisa Agropecuária) is the national agricultural research agency of Brazil. During its first decade, Embrapa created its network of national commodity centres and regional centres that focussed on major cropping and animal production systems as well as on eco-regional and national themes. Over the years, agricultural research became more closely linked with research in advanced manufacturing. An example of this is the satellite monitoring services for the acquisition and processing of remote sensor images and field data. The Satellite Monitoring Centre was created in 1989 in an area of 20,000 sqm in Campinas (Sao Paulo state) assigned by the Brazilian army to Embrapa for the development of a special unit focussed on territorial management systems and electronic networks for modern agriculture.[45]

At a more advanced level the Chinese government has recently focussed on an ambitious technology policy to start competing in innovation with early

43 These cover training and R&D, outsourcing activities, complying with international standards and the licencing or purchase of technology.

44 These institutions are called intermediate as they play a critical intermediary role between R&D, education, markets and sectoral production. They should not be confused with institutions from the 1970s, which promoted an intermediate low scale technology.

45 According to information provided by the Brazilian government, Embrapa has generated and recommended more than nine thousand technologies for Brazilian farmers since its inception in 1973 (Andreoni and Tregenna, 2020).

industrializers. In 2015 the *Made in China (MIC) 2025* plan was launched as a ten-year strategy aimed at transforming the economy along the pathway started in the 1990s to becoming a high-technology industry powerhouse. Several demand and supply side interventions, including public R&D, and preferential finance and fiscal incentives have been deployed to implement the MIC. The programme has a broad sectoral and technological focus, including renewables, alternative fuels, artificial intelligence, cybersecurity services, integrated circuits, network equipment and software, biotechnology, energy-efficient and environmental technologies, and high-end manufacturing. The main challenges identified in the implementation of the strategy in these areas include lower product quality, less established and less well-known trademarks, a high dependency on foreign technology and a low energy efficiency. These illustrate the difficulties that the digitalization era poses to middle-income countries, even the most successful one, in competing with early industrializers (Andreoni and Tregenna, 2020).

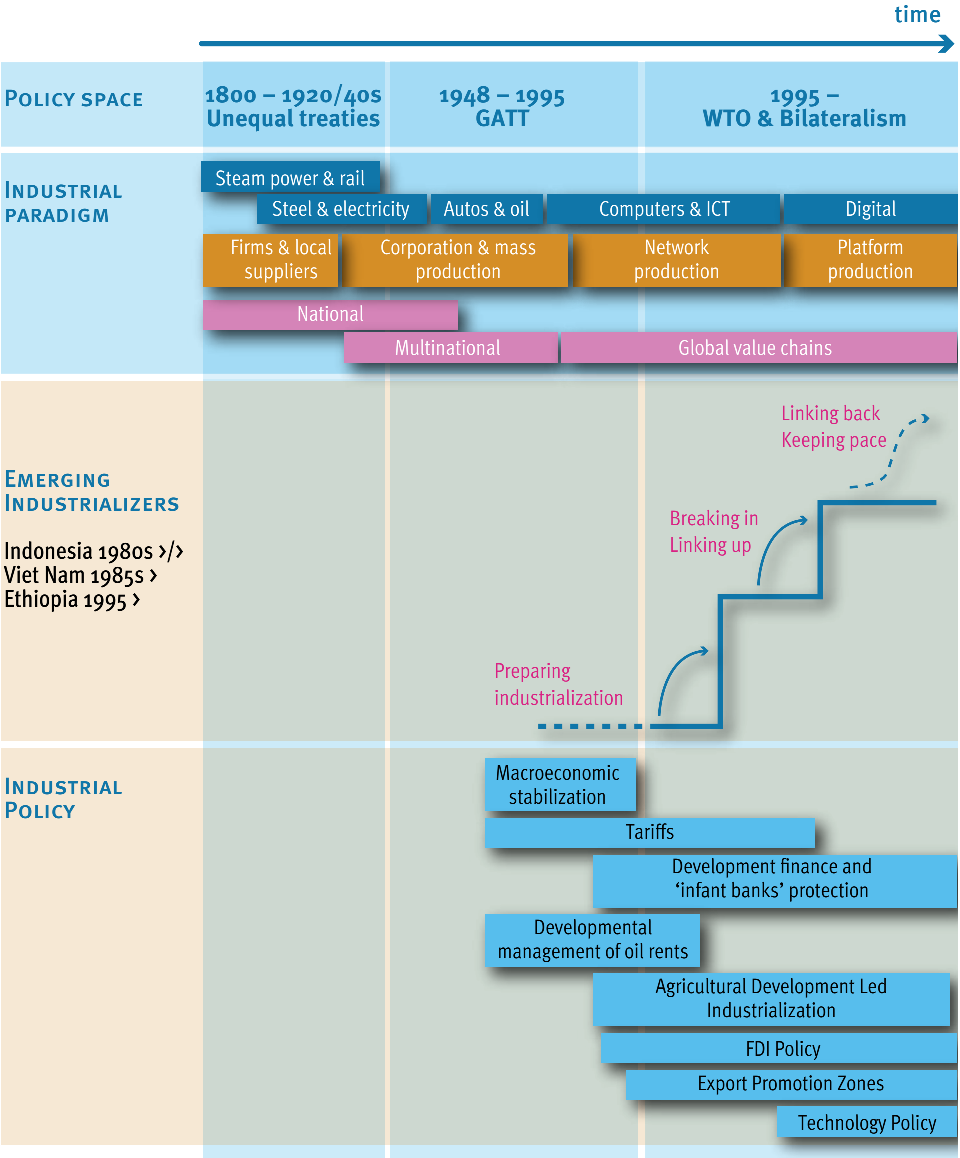
2.4. Emerging industrializers: Policy factors and lessons

The group of emerging industrializers include countries that started promoting industrialization seriously only after the 1980s and—in a sustained form—only in the following two decades. Throughout the 1980s and early 1990s, some of the emerging industrializers went through major institutional transitions and macro-economic reforms. As the selected cases—Indonesia, Viet Nam and Ethiopia—show, industrial policy played a central role in this transition and the subsequent manufacturing development, allowing them to defy comparative advantage in a number of sectors, as well as linking up with GVCs. Today's emerging industrializers are struggling to find space in an increasingly crowded industrial landscape, in which the pace of change makes it difficult to progress relatively to those countries which are already industrialized. Despite that, a number of countries have learnt how to craft the space for policy intervention and have applied a number of industrial policies that have proved to be successful. Figure 2.5 provides a schematic representation of the most successful policy factors for emerging industrializers.

2.4.1. Breaking into the global economy

The emerging industrializers first needed to meet a number of preconditions before embarking on sustained industrialization and export success. In some countries severe macro-economic imbalances had to be addressed. A common source of macroeconomic instability among emerging industrializers has been limited access to foreign currency, which typically results, in one form or another, in multiple exchange rates. Foreign currency is needed for imports of key technologies and products which are not available or produced domestically. However, multiple exchange rate systems can create serious distortions in prices, give powerful groups the opportunity for unproductive rent-seeking and discouraging productive investment. Indonesia in the 1980s is a successful case of a country that managed to achieve macroeconomic stability by abandoning its multiple exchange rate system

Figure 2.5: Successful policy factors for emerging industrializers



Note: Years after country names indicate periods when industrialization started.

Source: UNIDO elaboration.

and lifting various import and export controls to liberalize foreign trade. These reforms allowed Indonesia to access concessionary loans from the IMF and World Bank to invest in infrastructure. In this case liberalization did not mean abandoning macroeconomic sovereignty. A number of targeted trade policies and monetary policies remained under the control of the government and tariffs and non-tariff barriers were used selectively to replace some imported goods with locally made products (Thee, 2002).

Indonesia also succeeded in avoiding the worst effects of natural resource abundance associated with the so-called Dutch Disease, whereby a booming natural resource sector can distort incentives and by appreciating the real exchange rate can make it more difficult for manufacturing exports to be competitive. Throughout the 1970s, the government used the accumulated oil revenues to shift from a modest import substitution programme to a more ambitious plan for industrialization. Under the lead of the Department of Industry, this plan centred on deepening the domestic industrial structure, promoting upstream industries—especially basic resource processing such as steel, aluminium, fertilizers and petrochemicals—and developing industries making parts and components for the downstream assembly industry via local content programmes. Tax and other incentives were also offered to diversify the economy and exports, and to attract foreign investment in non-oil sectors (Resosudarmo and Irhamni, 2008). In November 1978 the government devaluated the currency by 50 percent to reduce the purchasing power of the Indonesian rupiah against the US dollar and managed to shelter the infant manufacturing sector from the cheaper import competition (Thorbecke, 1995).

Macroeconomic stabilization also requires institutional reforms in the fiscal and tax system. Countries that implemented these reforms successfully applied a gradualist approach. In this regard Viet Nam was particularly successful in two main respects. First, the government implemented a successful process of fiscal decentralization which resulted over time in an increase in on-budget revenues and in more locally targeted investment. Fiscal decentralization was not only beneficial in allowing targeted industrial policies, but also implied the involvement of several actors in the budgeting process. Budgeting structures can be critical in the governance of industrial policy as they provide an institutionalized process through which different groups develop coalitions. In Viet Nam, the distribution of power within the local levels of the ruling coalition played a very important role in shaping its political economy and helped in building fiscal capacity (Gray, 2018).

Second, Viet Nam was also particularly successful in managing SOEs reforms. In 1986 the Doi Moi renovation programme was launched at a time of macroeconomic imbalances and fiscal deficit. SOEs had traditionally benefitted from preferential fiscal treatment, as well as access to foreign exchange and credit at less than market rates. In an attempt to reduce the fiscal transfer from the government budget to SOEs and to make them more productive, SOEs were given increasing autonomy and flexibility in decision-making and planning, while subsidies were gradually reduced. Although a number of SOEs went into liquidation, those that survived, remained important productive assets for the country and in many cases managed to link up with GVCs.

Emerging industrializers have learnt extensively from recent industrializers, especially in policy areas related to attraction of FDI and integration in GVCs. A number of industrial policies adopted by countries like China and Malaysia in these areas were also appropriate for recent industrializers, as they were originally designed against the same global policy and industrial context. However, attracting FDI and linking into GVCs is challenging for emerging industrializers, where competitor countries benefit from an incumbent advantage. Linking with GVCs involves reform and institution-building in areas such as custom agencies, export promotion zones and investment promotion agencies. These authorities are in charge of allocating critical fiscal rents—such as tax allowances, fiscal exemptions, import licenses—and there is always a risk of poor governance leading to institutional capture.

A number of countries, including Indonesia adopted a liberalization approach which attempted to reduce as much as possible policy interference in these institutions. For example, custom reforms were at the core of the first Law on Industrial Policy passed in Indonesia in 1984. To promote a more outward-oriented model of industrialization the government removed a number of constraints affecting clearing time at customs and import costs. For example, complex trade licensing schemes were replaced by unconditional ex-ante tax exemption and duty drawback facilities, tariff exemptions replaced the export subsidy scheme and procedures for FDI were simplified.[46]

2.4.2. Linking back in the domestic production system

While the reforms introduced by Indonesia were successful in attracting FDI and linking with GVCs, they were less successful in linking back multinational companies with the local production system. Both Viet Nam and Ethiopia attempted to address this challenge by using FDI and EPZ schemes in a more strategic manner. In the case of Viet Nam, policies were strategically targeted both by sector and spatially, as part of its regional industrial policy. In the case of Ethiopia, the government has been strategic in targeting export markets and building different types of industrial parks providing a range of government services.

In Viet Nam the success in linking with GVCs was due to the effective promotion of various types of development zones—including industrial zones, economic zones, EPZs and high-tech zones. Ho Chi Minh City promoted the establishment of the first EPZ in Viet Nam in 1991and the Policy for Industrial Zones passed in 1994 allowed production for both domestic and international markets within zones based on

46 Between 1985 and 1992, the percentage of imports covered by quantitative restrictions went from 43 to only 3 percent and the average nominal tariff declined from 22 to 9 percent. In the 1990s FDI restrictions were lifted and foreign companies were given the option of either forming a joint venture with up to 95 percent majority equity ownership with no further divestment required, or forming a fully owned subsidiary with the requirement of divestment to a local partner of 5 percent of their shares within 15 years (Resosudarmo and Irhamni, 2008).

access to subsidized land, infrastructure and fiscal incentives. In 2007 with the increasing proliferation of these special economic zones, the management of these zones was passed from the Prime Minister's Office to the provincial level where Provincial Industrial Zones Management Boards were established. By 2015 there were 313 economic zones in Viet Nam which contributed 40 percent of total exports. As part of the fiscal decentralization, since the 1990s, provincial and local governments were given the freedom to establish off-budget financing mechanisms for capital projects and to tailor fiscal and non-fiscal policies, including allocation of land, to attract FDI (Gray, 2018).

By

2015

there were

313

economic zones in Viet Nam

which contributed

40%

of total exports.

Ethiopia started developing EPZs in 2004 and the first industrial park was the Eastern Industrial Park in Dukem, near Addis Ababa. There are ambitious plans to establish a number of different types of park, some of which will be foreign-owned (UNIDO, 2018). These different types of industrial parks can play an important role both in terms of building more efficient domestic supply chains, and also concentrating the provision of export promotion incentives. Ethiopia has used multiple export promotion schemes, including duty-drawbacks, voucher schemes, and bonded warehouses, and under these schemes the export sector is exempt from customs duties and indirect taxes such as VAT. The implementation and enforcement of these schemes is however extremely challenging from a governance point of view to avoid unproductive use of rents. A key factor is if companies genuinely have access to foreign markets, since if they do, there is limited incentive in using the preferential fiscal and custom regime to abuse the system (Oqubay, 2016).[47]

47 For example, they would not need to use the bonded warehouses system to smuggle products into the country.

Similar to recent industrializers, emerging industrializers have relied on development banks and other specialist financial institutions as the commercial banking system was not able to provide the long-term credit needed for industrial investment. Ethiopia adopted an alternative approach to other countries in what could be termed an 'infant banks protection' model. The government kept the domestic banking sector closed, not allowing foreign banks to operate in the country. This was meant to give national banks the space to develop the financial, technological and organizational capabilities required to compete with global financial institutions (Oqubay, 2016). The government used state-owned policy banks to support industrial investment. State-owned banks such as the Development Bank of Ethiopia (DBE) and the Construction and Business Bank (CBB) control roughly half of the market and more than half of the capital base. They specialize in long term financing to priority sectors at subsidized rates, while financial institutions such as the Commercial Bank of Ethiopia (CBE) focus on shorter-term finance to support working capital, as well as providing international banking services. This system resembles that of early industrializers in the first half of the last century, more recently that of China.

As was the case of both of the other groups of industrializers the development of agriculture has been important as a support to industrialization in emerging industrializers. Increasing productivity and generating a surplus in the agricultural sector is a critical step for preparing a sustained industrialization process. The generated surplus can help in mobilizing both material and human resources to invest in industries which, in turn, can feedback to the agricultural sector with both agricultural inputs, machinery and consumer goods (Andreoni, 2011).

The emerging industrializers dealt with this challenge in different ways with varying success. In Indonesia the government attempted to support the agricultural sector and stabilize crop prices over several decades (Timmer, 2019). In 1968, when Indonesia was largely a rural economy, the food logistics agency *Bulog* was used in stabilizing the price of the main crops, such as rice, and also for the allocation of lucrative import licences for rice, wheat, sugar and soybeans. A comprehensive package of support and services, including irrigation rehabilitation, imported fertilizer and its distribution, better rice varieties, and extension and farm credit, were also made available to increase yields and productivity.

Similarly, in Viet Nam the government also implemented several policies in support of the agricultural sector. Land reform and the redistribution of land to peasants, was followed by an incremental liberalization of prices, particularly of rice, and crop production experienced a very rapid growth turning Viet Nam into a net exporter of rice and other agricultural products (Tarp, 2018).

However, the country that more than others has centred its industrialization strategy on the agricultural sector is Ethiopia. During the 1990s and 2000s, national plans were based on the concept of Agricultural Development Led Industrialization (ADLI) and the importance of developing domestic productive capabilities with a focus on technical skills, technology transfer, absorption and diffusion, extension services and SMEs. A key factor is that ADLI was implemented as an evolving strategy open to policy experimentation, adaptation and continuous revision and was in line with the political economy of the country in that growth was targeted at smallholders in rural areas, who formed of the political base of the ruling party.[48]

The approach in the ADLI allowed the government to focus both national resources and international aid towards agricultural development and poverty reduction. The main instruments used included: (i) upgrading and expanding agricultural extension services; (ii) training of extension agents at vocational training institutions; (iii) training of farmers at farmers training centres; (iv) supporting access to inputs and credit; (v) restructuring peasant cooperatives and linking farmers to markets. Particular emphasis in the strategy was given to the development of cross-sectoral domestic linkages, which could make farmers part of the industrialization process. For example, in the case of the leather sector the idea was that domestic animal hides and skins would provide the raw material to be transformed by tanneries and finally used for manufacturing leather products (Oqubay, 2016).

For improving productivity and quality in the leather industry, a sector specific intermediate institute was established—the Leather Industry Development Institute. The Institute provided technical training, access to testing and quality standard facilities, and coordination of technology transfer with partnerships from India. Access to markets was also developed with business-matching initiatives linking domestic leather shoe producers to European companies and buyers. Other key inputs like preferential land, credit and foreign-currency were made available, although, at the same time, there was a ban on the export of raw leather. In addition, a high domestic tax on semi-finished leather products was introduced to guarantee companies access to the domestic market, while they were learning to export. To monitor and adapt the strategy to the evolving needs of producers, monthly meetings between the government and companies were held and the information collected there used to inform planning decisions. Over time, more emphasis was given to the commercialization of agriculture, and broader private sector development, so that support was extended to large-scale commercial agriculture and tradable activities more generally, including manufacturing.

2.4.3. Keeping pace with technical change

Over the last decade, a number of emerging industrializers have started approaching or have reached lower middle-income status. This means that countries like Indonesia, Ethiopia and Viet Nam, which were among the poorest in the world in the second half of the twentieth century, are now facing the new challenge of keeping pace with technological change and avoiding what some have called the ‘middle income trap’ of slowing growth once the advantages of low labour costs are less evident.

48 Ohno (2013:286) argued that the ADLI vision was not simply an economic policy but also a "political statement of assurance that the interests of the farmers and rural communities will not be sacrificed or forgotten no matter what industrial strategy may be adopted by the government".

Of the three the Viet Namese government has been the most proactive in this respect, although actual progress appears modest. The First Law on Science and Technology was passed in 2000 and led to the establishment of a network of national laboratories. However, the first overarching Science and Technology Development Strategy was launched only in the 2011-2015 and 2016-2020 period. Despite ambitious plans—such as the training of '80,000 engineers, technicians and managers who are employed in SMEs', the launch of the Silicon Valley Project in 2013 and fiscal incentives for R&D—the overall budget allocation to science and technology has remained limited (Klingler-Vidra and Wade, 2019).

2.5. Key lessons: Ten policy instruments that effectively drive industrialization

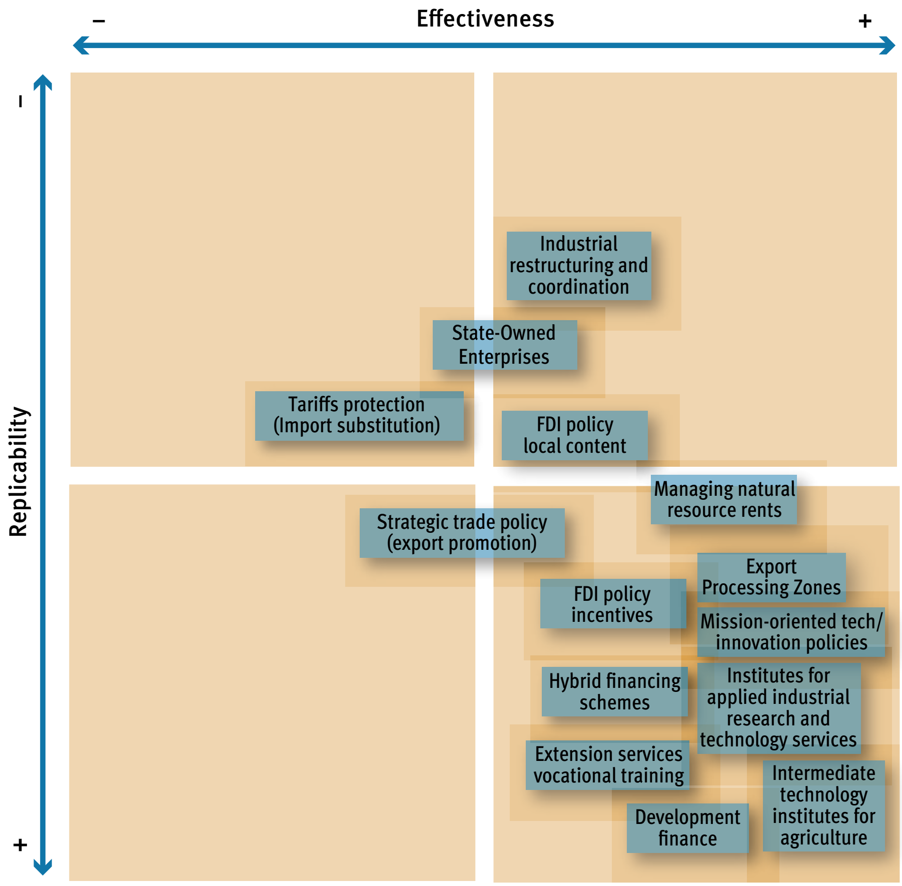
The comparative industrial policy analysis for each group of early industrializers (section 2.2), recent industrializers (section 2.3) and emerging industrializers (section 2.4) has pointed to three important results.

First, country industrialization experiences present several similarities, especially when countries are compared within the same 'early', 'recent' and 'emerging' country groups. Similarities could be found both in terms of their industrialization challenges, and the policy space and industrial regime they faced. All successful economies used trade policy either to restrict imports or support exports (or both at the same time), all had to find ways of channeling long-term finance to firms, all needed a growing agriculture to support industrialization and all are grappling with ways of keeping pace with technical change. In each case policy interventions rather than simple market solutions were used to overcome the various constraints on industrialization. However, country-specific history and different institutional and policy forms also emerged from within country groups comparisons. Not all countries within the same groups relied on the same institutions and policies, and even when they did so their implementation was context-specific.

Second, country industrialization experiences present significant differences across country groups. This is mainly because early, recent and emerging industrializers started their industrialization under different global policy and industrial regimes. Since the time of the early industrializers, countries' policy space has been shrinking and the industrial dominant paradigm has become increasingly challenging. New opportunities are also emerging calling for an even more strategic industrial policy approach.

Third, the comparative analysis revealed a number of industrial policies which were used across time and space. The discussion below focusses on a selection of ten industrial policies of this type and for each makes a judgement on the extent to which they are replicable in other countries and have proved effective in driving industrialization. Figure 2.6 maps these industrial policy instruments against two parameters: 'replicability'—how difficult it is to replicate them today; and, 'effectiveness'—how effective they have been in the selected countries.

Figure 2.6: The effectiveness-replicability quadrant



Source: UNIDO elaboration.

Policy instrument 1: Intermediate technology institutes for improving productivity in agriculture (Best practices: Brazil, Ethiopia, Malaysia and the United States)

Policy instrument 2: Extension service and vocational training to improve technology absorption, diffusion and adaptation (Best practices: China, Germany and Japan)

Policy instrument 3: Institutes for applied industrial research and provision of technology services (Best practices: China, Germany and Japan)

Policy instrument 4: FDI Policy incentives and conditionalities to attract foreign direct investments and favour technology transfer (Best practices: China, Japan and Viet Nam)

Policy instrument 5: Export Processing Zones to promote export capabilities and domestic linkages (Best practices: China, Ethiopia and Viet Nam)

Policy instrument 6: Development banks and other banking sector regulation favouring specialized and long-term credit for investment (Best practices: Brazil, China, Germany and Ethiopia)

Policy instrument 7: Incentives and hybrid financing schemes including grants, matching investment schemes, subsidies and procurement policies supporting investments in research and development, technological upgrading and production capacity expansion (Best practices: China, Japan, Malaysia and the United States)

Policy instrument 8: Mission-oriented innovation policies creating new markets and addressing major societal challenges (Best practices: China, Germany and the United States)

Policy instrument 9: Strategic trade policies supporting export promotion (Best practices: China, Ethiopia, Indonesia, Malaysia and Viet Nam)

Policy instrument 10: Management of natural resource rents to divert resources in productive development policies (Best practices: Indonesia and Malaysia)

The effectiveness of these industrial policy instruments will depend on the specific country context, the effectiveness of its governance and the package of interdependent policies that countries implement to move up their industrialization ladder. Hence there can be no guarantee that the success achieved in the best practice experiences can be automatically replicated. Based on international experience the list here can be best seen as a starting point for the measures that governments can consider. Chapter 4 addresses the governance issue in the context of packages of interacting policies.

Governments across recent and emerging industrializers have seen their policy space being reduced significantly, especially after the Uruguay Round under the GATT and later on the WTO. Under the WTO, countries' policy space has been further compressed by additional agreements (so called- WTO+), such as bilateral investment treaties (BITs), 'free trade' agreements (FTAs), economic partnership agreements (EPAs), preferential trading agreements (PTAs) and mega-regional agreements (*e.g.* the Transpacific Partnership-TPP). These agreements have proliferated in the past two decades, partly in response to the stagnation of the Doha Round of WTO negotiations in the mid-2000s, which in turn was largely the result of strong resistance from developing countries to further curtailment of their policy autonomy.

As a result of these developments, for some of the policy instruments listed above governments across recent and emerging industrializers have limited policy space today. However, having said that, a number of governments have chosen too early and too rapid liberalization, and are not fully exploiting their policy space to implement industrial policies (Andreoni et al, 2019). Although it is safe to assume that any WTO+ agreement can only be expected to impose additional restrictions to those agreed upon within WTO, some agreements allow for greater flexibility than others. For example, even though performance requirements on foreign investors are tightly restricted in the WTO's Agreement on Trade-Related Investment Measures (TRIMS), it is possible to circumvent some of these restrictions in the services sector under the WTO's General Agreement on the Trade of Services (GATS), as most developing countries have made few commitments in relation to the (restraints on) regulation of FDI. Table 2.2 details the impact of global rules on the policy space of today's developing countries with reference to nine industrial policy instruments that early, recent and emerging industrializers have used to industrialize.

As a general rule, unless developing countries have signed bilateral agreements with advanced countries or are part of stringent regional agreements, they still enjoy a certain amount of policy space to implement industrial policies. Moreover, a range of governments have found ways of circumventing formal restrictions. For example, despite the draconian restrictions on local content requirements, many countries still use them today and have yet to be challenged in the WTO. Subsidies for research and development, regional balances, and environmentally friendly technologies are in theory challengeable, but they have seldom been disputed. Even tariff and quota restrictions can be partly circumvented with the strategic deployment of measures such as technical regulations and rules of origin, which can function as non-tariff barriers to imports.

To conclude, a meta-lesson across countries is that governments must be willing to use their policy space and keep pushing the boundaries of what is allowed. Chapter 4 discusses how willingness to use the policy space is determined by the domestic political economy, that is, the way in which the government can create and is part of coalitions of productive interests supporting industrialization. It also points out how the effectiveness of industrial policy instruments depends on the packages of interdependent policies that countries implement and the effectiveness of governance that is applied to these instruments.

Table 2.2: Impacts of global rules on policy space

Policies for industrial development	Global rules that affect policies
1. Targeted investments in infrastructure, training, education, R&D	Not directly affected by WTO or WTO+ agreements
2. Coordinated investments and government-mediated mergers	Not directly affected by WTO or WTO+ agreements
3. Subsidies for key industrial sectors	The WTO's Agreement on Subsidies and Countervailing Measures (SCM) considers subsidies trade distorting measures and prohibits any sector-specific subsidies, as well as those for export promotion and for enforcing the use of local contents in manufacturing. It also prohibits indirect subsidies through intra-private sector transfers brought about by government regulation. In practice, however, subsidies can be used until they are challenged or countervailed. Subsidies for R&D, regional balances, and environmentally friendly technologies are 'actionable' but have seldom been disputed, in part because developed countries often use them. LDCs are permitted to use export subsidies under certain conditions, but are not exempted from countervailing measures from trading partners.
4. Creation of state-owned enterprises (SOEs)	The use of SOEs is not directly affected by WTO agreements. However, tariff cuts in the General Agreement on Tariffs and Trade (GATT) and market-access and national treatment requirements in the General Agreement on the Trade of Services (GATS) - Mode 3 (commercial presence) can be fatal for SOEs, limiting the potential to use them as industrial policy tools (e.g., a state-owned telecom company buying from local handset makers), or to supply services to locally-owned industries at a subsidized rate (e.g., state-owned electricity companies giving concessional rates to designated industries or 'industrial zones'). Service sector commitments apply only to the sectors that countries agree to include, but developing countries are being pressured to expand and deepen their commitments in the Doha Round of WTO negotiations. WTO+ agreements are effectively used to achieve these aims despite the stagnation of the WTO's Doha Round or negotiation.
5. Infant industry protections (e.g. tariffs, quotas, and market reservations for domestic industrial producers)	WTO member countries are all required to bind at least some of their tariffs at an upper limit. In the Doha Round of Non-Agricultural Market Access negotiations, industrialized countries are pushing to bind and slash all unbound tariffs. The GATT (Art. XVIII) allows developing countries with low standards of living to temporarily raise tariffs to promote the establishment of a particular industry, but this requires difficult negotiations, approval of WTO members, and compensation through other tariff reductions. Furthermore, the time frame allowed is very short relative to historically effective time frames for infant-industry protections (8 years) (Chang, 2003: 268). The GATT (Art. XXVIII) allows quantitative restrictions to address balance of payments difficulties, but the procedures to implement them have become more difficult. WTO+ agreements increase these restrictions on policy space.
6. Capital controls and capital outflow taxes	Under the GATS and TRIMS regulations, restrictions on capital controls exist, but violations of the rules can only be challenged in a dispute if a member country initiates state-state arbitration. WTO+ agreements are much more restrictive. US Bilateral Investment Treaties, for example, require that US firms are allowed to freely transfer payments in and out of host countries without delay.

Table 2.2 continued: Impacts of global rules on policy space

Policies for industrial development	Global rules that affect policies
7. Government allocation of foreign exchange, giving top priority to capital goods imports and the bottom priority to luxury consumption good imports	Not directly affected by WTO or WTO+ agreements (or IMF).
8. Performance requirements (e.g. requirements on foreign investors to incorporate of local content/workers) or engage in joint-ventures, technology transfer	The WTO's TRIMS Agreement constrains local content requirements, but not conditions for joint venture and transfer of technology. The activities covered by the GATS- Mode 3 (services delivered through commercial presence) are subject to fewer restrictions than those covered by the TRIMS. WTO+ agreements, however, increase restrictions on performance requirements (e.g., US FTAs; US BITs strictly prohibit all performance requirements. US BIT signatories in Sub-Saharan Africa include Cameroon, Congo, DRC, Mozambique, Rwanda and Senegal).
9. Procurement policy through preferential treatment of domestic firms or of foreign providers willing to transfer technology or accept high (and rising) levels of local contents	The WTO Agreement on Government Procurement places restrictions on these measures, but most developing countries are not signatories to this agreement. Some WTO+ trade and investment agreements, however restrict these measures (e.g., EU-EPAs categorically prohibit them). Cameroon, Côte d'Ivoire, Mauritius, Seychelles, and Zimbabwe are among the Sub-Saharan African countries that have in force EU-EPAs or are working toward them.

Source: Andreoni, Chang and Estevez (2019).

3 WHAT YOU PRODUCE MATTERS

Industrial policy success experiences across different manufacturing sectors

3.1. Sectoral heterogeneity, conditions for success and industrial policy

Industrialization is a structural transformation process involving changes in the sectoral composition of the economy (Kuznets, 1965). A country's economy is composed of different sectors, each of them including several sub-sectors. Sectors (and sub-sectors as their components) are linked to each other by a set of interdependent input-output relationships determining a country's unique economic structure.[49] Other types of structural interdependencies such as technological linkages also link different sectors and sub-sectors of the economy.[50] Industrialization is thus about a change in the sectoral composition of the economy—measured in terms of value addition or employment—but it is also about evolving changes in the structural interdependencies linking sectors of the economy (Andreoni and Chang, 2017 and 2019).

Chapter 2 established the centrality of industrial policy in driving industrialization. It also pointed to the existence of differences in the long-term industrialization experiences of three country groups—early industrializers, recent industrializers and emerging industrializers. While all countries had to face similar industrialization challenges in stepping up their industrialization ladder, they had different policy space and developed under different industrial paradigms. As a result, recent and emerging industrializers could not use the same industrial policy instruments used by early industrializers. Moreover, under different industrial paradigms, certain policy instruments turn to be more (or less) effective than others.

49 There is a vast literature on input-output approaches and economic structure; see for example Leontief (1953); Pasinetti (1981); Andreoni and Scazzieri (2014) and Cantore et al. (2017).

50 See for example, Hirschman (1977); Naude et al. (2015) and Andreoni (2020).

While overall country-level conditions are important for sustained industrialization in general, in addition there are sector-specific factors and conditions, which are essential for the success of individual sectors. In some cases, sub-sectoral heterogeneity is also extremely important. Sectors and sub-sectors are populated by different business enterprises producing goods under production, technological, organizational and market conditions which are sector-specific. For example, certain sectors (and their companies) might depend on a specific natural resource. One sector might be more or less energy-intensive than others. In other sectors, the efficient scale of production or the degree of vertical integration might be significantly higher than others.

Technology complexity might be also different, with some sectors relying on more sophisticated technology platforms and more R&D investment than others. As a result of these sector-specific conditions, certain sectors will tend to be populated by relatively fewer and bigger firms with almost no space for small companies; while other sectors might be populated by a relatively larger number of small and medium size companies, alongside a few big ones. Thus, the degree of competition across companies differs across sectors. Sectors also tend to have different geographical scope, depending on whether they are based on national, regional or global value chains and how far they are located in industrial clusters. The extent and type of markets—that is the scale, distribution, composition and elasticity of demand—also matter in shaping sectoral differences. Finally, some sectors are more internationally tradable than others. Historically, manufacturing has always been and remains the most tradable sector, so a country's strength in manufacturing gives more opportunity for generating export revenue.

Countries and international organizations have developed different sectoral and sub-sectoral classifications in order to capture such sectoral and sub-sectoral heterogeneity. Within the secondary industry sector, manufacturing has the highest degree of sub-sectoral heterogeneity. This is why sub-sectors of manufacturing are often clustered according to their level of technological intensity.[51] Table 3.1 presents manufacturing sub-sectors according to the International Standard Industrial Classification (ISIC) revision 3 and technological classification adopted by UNIDO (see Lall, 2001b and 2001; UNIDO, 2002).

Thus, sectoral differences matter in achieving inclusive and sustainable industrialization. For industrial policy to be effective in driving structural change, these sector-specific conditions (as well as potential sub-sectoral differences) must be acknowledged and factored into the policy design, implementation and enforcement processes. For example, as discussed in Chapter 4, intra-sectoral heterogeneity matters in targeting industrial policy instruments so they can better reflect business enterprises' specific needs. Sectoral differences also matter because different sectors tend to have a different political economy—that is, a different distribution of power among organizations. As a result of this different distribution

51 For a discussion of the UNIDO classification, also in relation to the OECD R&D-based expenditure classification, see: https://stat.unido.org/content/focus/classification-of-manufacturing-sectors-by-technological-intensity%2528isic-revision-4%2529;jsessionid=4DB1A3A5812144CACC956F4B8137C1CF

Table 3.1: Manufacturing industries by technological groups

Technological groups					
Low technology		**Medium-low technology**		**Medium-high and high technology (MHT)**	
Division 15	Manufacture of food products and beverages	Division 23	Manufacture of coke, refined petroleum products and nuclear fuel	Division 24	Manufacture of chemicals and chemical products
Division 16	Manufacture of tobacco products	Division 25	Manufacture of rubber and plastics products	Division 29	Manufacture of machinery and equipment n.e.c.
Division 17	Manufacture of textiles	Division 26	Manufacture of other non-metallic mineral products	Division 30	Manufacture of office, accounting and computing machinery
Division 18	Manufacture of wearing apparel; dressing and dyeing of fur	Division 27	Manufacture of basic metals	Division 31	Manufacture of electrical machinery and apparatus n.e.c.
Division 19	Tanning and dressing of leather; manufacture of luggage, handbags, saddlery, harness and footwear	Division 28	Manufacture of fabricated metal products, except machinery and equipment	Division 32	Manufacture of radio, television and communication equipment and apparatus
Division 20	Manufacture of wood and of wood products			Division 33	Manufacture of medical, precision and optical instruments
Division 21	Manufacture of paper and paper products			Division 34	Manufacture of motor vehicles, trailers and semi-trailers
Division 22	Publishing, printing and reproduction of recorded media			Division 35	Manufacture of other transport equipment
Division 36	Manufacture of furniture; manufacturing n.e.c.				
Division 37	Recycling				

Source: UNIDO (2010).

of power, government-business relationships will develop along different pathways both across and within sectors.

Three main issues must be taken into consideration when sectoral heterogeneity is factored in the industrial policy making process.

First, different groups of countries tend to follow a 'normal' pattern of structural change, that is, they tend to have a similar sectoral composition at different stages of economic development (Haraguchi, 2016).

Second, sectoral heterogeneity results from differences in a set of 'industrial parameters', with some of these critical in determining success for a specific type of activity. Given the high degree of sectoral heterogeneity and its importance for industrial policy making, this Chapter investigates differences in industrial parameters across six major manufacturing industries. These are: Food and beverages, Garments, Automotives, Machinery and equipment, Electronics and Fourth Industrial Revolution (4IR) technology applications with a focus on medical devices.

Third, industrial policy is both about building capabilities to meet these industrial parameters, but also changing these parameters (Lin and Chang, 2009; Chang and Andreoni, 2020). Technological change affects these industrial parameters and traditional sectoral boundaries are constantly redesigned. Focussing on sector-specific factors while understanding how to trigger these sectoral changes is critical for effective industrial policy making. Each industry case focusses on a successful experience in a selected country. These are Chile for food and beverages; Bangladesh for garments; Thailand for automotives; China for machinery and equipment; the Republic of Korea (ROK) for electronics and Costa Rica for medical devices. In conclusion, the sector-specific policies governments have deployed effectively to develop the specific sector are highlighted.

3.1.1. Normal patterns of structural change

Countries moving up the industrialization ladder tend to follow normal patterns of structural change, that is, certain sectors (and manufacturing sub-sectors) tend to reach a peak in value addition and employment at certain stages of economic development, then see a decline in these shares (Chenery and Taylor, 1968). Other sectors, instead, tend to continue contributing value addition and employment even at advanced stages of development (Andreoni and Tregenna, 2019). These normal patterns of structural change are important benchmarks in terms of placing countries along the industrialization ladder discussed in Chapter 2.

Haraguchi (2016) illustrates normal patterns of structural change for two groups of countries—small and large countries. A population threshold of 12.5 million is derived econometrically to divide countries into ‘small’ and ‘large’ country groups. This country grouping allows an analysis of an important country-specific factor—country size—alongside sector-specific dynamics. For each country group, Figure 3.1 presents the normal patterns of structural change to be expected in ten major manufacturing sub-sectors (also termed industries). These are: food and beverages, textiles, wearing apparel, rubber and plastics, chemicals, basic metals, fabricated metals, machinery and equipment, electrical machinery and apparatus, and motor vehicles. These sub-sectors are taken to be representative of the different characteristics of the manufacturing sector in terms of their periods of emergence in a country’s general and technological development.

The food and beverages industry textiles and wearing apparel are typically the first to take off. However, food and beverages tend to remain a major sector (especially among large countries), while textiles and wearing apparel tend to decline after reaching a peak at around 8,000 US dollars per capita (constant 2005 PPP). Other industries like chemicals undergo a profound transformation and see increasing internal heterogeneity. Chemicals emerge quite early in the form of basic chemicals such as dyeing materials or fertilizers (especially in large countries), the sector keeps growing over a long income range to become the major source of advanced products like pharmaceuticals in the advanced stages of development.

The electrical machinery and apparatus, motor vehicle, fabricated metal, and basic metal industries start their development later and can sustain their growth rates longer than the early industries. Among these, in motor vehicles economies of scale tend to play the most dramatic role. As a result, larger countries have a comparative advantage in this industry, amongst others. The electrical machinery and apparatus industry is the most sustainable in the sense that it can maintain a fast growth rate for a long time.

While the slope of these sector-specific trajectories matters, it also matters how long it takes for countries to develop these sectors and, thus, move along the normal trajectories presented in Figure 3.1. The speed at which structural change happens is reflected by the relationship between the growth rate of value added per capita (measured as value added in a sector divided by a country's population) and that of labour productivity in a sector. Haraguchi (2016) finds that productivity plays an important and positive role, that is, the higher the growth of labour productivity, the faster a country moves in the development trajectories of the eight industries, as measured by changes in value added per capita. This correlation is higher for more capital- and technology-intensive industries and lower for labour-intensive ones.

Productivity can be determined by two types of country-specific conditions. Haraguchi (2016) distinguishes between:

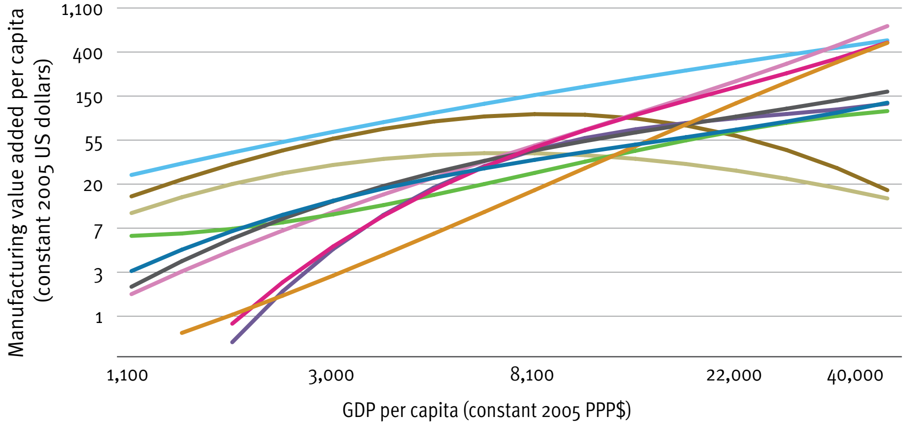
i. 'country-specific conditions that are ubiquitous and have similar patterns of impact on industries across countries, though the degree or intensity of these conditions differs from country to country';
ii. 'country-specific conditions [that] are not easily discernible and remain a country-specific advantage or disadvantage for manufacturing development even after controlling for all conditions which belong to the first type'.

While the first group of conditions—such as factor endowments—might play a role in industrialization, the second group of conditions—such as specific institutional, political and social capability—are even more critical. This is because these deeper determinants tend to affect the extent to which general country-specific factor endowments are used to drive industrial development. What a country can make of its endowments is what really matters. Paradoxically, as the experience of countries like the ROK has shown, the lack of a certain factor endowment—such as iron ore—does not preclude the development of a certain industry—such as steel.[52] In several cases, industrial policy has helped in turning the lack of a certain factor into an opportunity to innovate and revolutionize an industry.

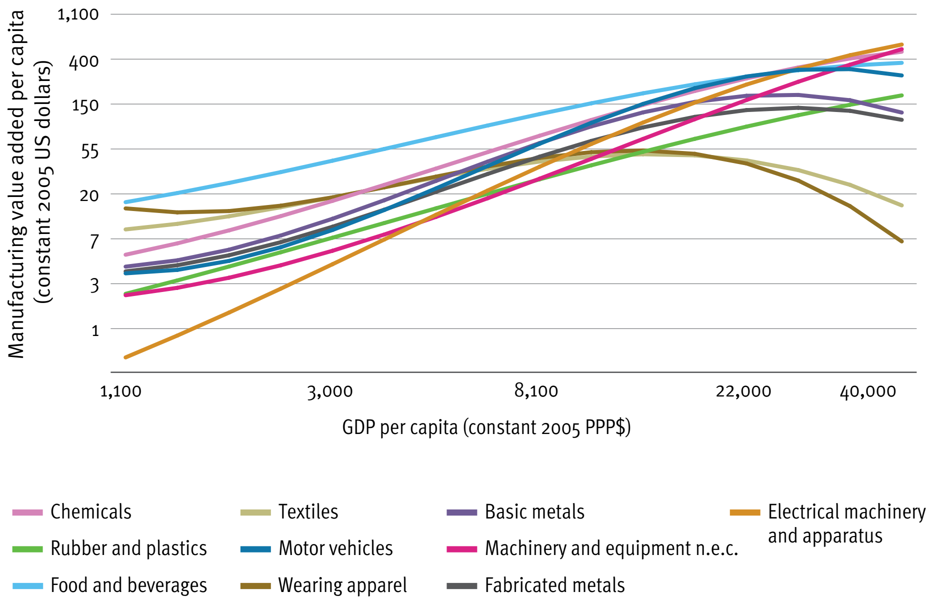
52 See the discussion in, amongst others, Amsden (1989), Chang (1993) and Lee (2013).

Figure 3.1: Normal patterns of structural change within manufacturing (ten sub-sectors) and across small and large economies

(a) Small economies



(b) Large economies



Note: All values are for the period 1963-2010. GDP is gross domestic product, PPP is purchasing power parity and n.e.c. is not elsewhere classified. Large economies are defined as those with 12.5 million inhabitants or more and small economies as those below this threshold.

Source: UNIDO (2017).

3.1.2. Success conditions: Industrial parameters for productivity and competitiveness

Each sector (and sub-sector) is characterized by a number of *industrial parameters* determining production, organizational, technological and market conditions which are specific to that sector (or sub-sector). While all these parameters are important for achieving high levels of productivity and industrial competitiveness, in a specific sector some might be more critical than others—what can be termed 'binding' or 'critical' parameters. These parameters either individually or in combination determine the success conditions of that specific activity. For example, for an industry like automotives to be industrially competitive its firms must operate at a minimum level of scale. Even if the companies in the industry manage to outperform under other industrial parameters, if industrial policy does not address the sector-specific binding parameter—in this example scale efficiency—then productivity and industrial competitiveness will be very difficult to achieve.

Table 3.2 presents a taxonomy of key industrial parameters clustered around production, organizational, technological and market conditions. The taxonomy is not aimed at determining a unique formula for productivity and industrial competitiveness for all companies in a sector (or sub-sector). Even within the same industry, certain industrial parameters might matter more for certain firms than for others. For example, the operational scale efficiency would be different among companies operating at different stages of a vertically disintegrated sector or a global value chain.

The industrial parameters taxonomy in Table 3.2 provides a framework to analyse sectoral heterogeneity with reference to three main issues. First, it suggests a way to map out the sector-specific parameters that might matter for productivity and industrial competitiveness. In the following sections, six different sectors will be analysed against this taxonomic framework in search for the binding parameters that policymakers should keep in mind when they design sector-specific industrial policy. Being aware of these industrial parameters is also a way of improving government-business interactions, since in the design, implementation and enforcement of sector-specific policies these industrial parameters are critical in designing the system of incentives and compulsions. Collecting data on these parameters will be necessary to support a meaningful dialogue between government and business enterprises and in designing sector-specific policies.

Second, once a list of sector-specific industrial parameters has been identified, this taxonomy helps in focussing government's efforts on those sub-set of industrial parameters that are binding for the development of the sector/industry. The taxonomy is therefore also a focussing device to prioritize sector-specific interventions. Without this prioritization, industrial policy interventions risk being ineffective. Instead, by focussing first on the sector-specific binding parameters, the government can help enterprises meet the necessary conditions for competitiveness. What is a necessary condition is also a moving target as the industrial parameters become increasingly stringent the more a sector develops. Currently even traditionally low technology

Table 3.2: Industrial parameters taxonomy

Success conditions dimensions	Industrial parameters
Production	
	Reliance on a specific and non-reproducible natural resource
	Energy intensity and quality
	Capital intensity and type
	Production time and cycle
	Scale economies and minimum scale efficiency
	Labour intensity
	Skills intensity
	Scope for automation and robotization
	Capital / Labour substitutability
	Process standardization
Organizational	
	Degree of vertically (dis-)integration
	Degree of administrative hierarchic (de-)centralization
	Process modularization scope
	Geographical spread and distribution
	Supply chain management capabilities (just-in-time)
	Logistics (time to the market)
	Organizational integration capabilities
	Scope for organizational diversification
Technological	
	Basic science dependence
	Technology intensity
	Standardization
	Learning cycles (how long it takes to learn)
	Product customization
	Product reliability (critical product systems)
	Scope for technological diversification
Market	
	Extent (size of the market)
	Type (segmentation and structure)
	Demand elasticity (income and price)
	Degree of tradability
	Proximity to markets advantage
	Accessibility (transportation costs)
	Protection (tariff and non-tariff barriers)
	Competition
	Regulations and standards

Source: UNIDO elaboration.

sectors like textiles or food have become relatively more advanced and more industrial parameters have become binding.

Third, each sector (and sub-sector) is generally defined on the basis of a set of products which are relatively similar to each other and which meet similar consumption needs. Sectors, however, can also be defined by all or a sub-set of the industrial parameters listed in Table 3.2. This is helpful because standard sectoral classifications might miss the evolving nature of sectors and their changing boundaries due to technical change (Andreoni, 2020).

In the industrial sector (and across manufacturing sub-sectors), sectoral heterogeneity is thus the result of differences across several industrial parameters, beyond the simple fact that sectors produce different products. These industrial parameters evolve over time as a result of changes in the industrial landscape and global markets. Within these broad parameters, enterprises will compete within (and across) sectors to gain a competitive edge. They can do that in two main ways. First, by meeting specific standards or industrial parameters—such as quality, reliability or scale—that are binding parameters for that specific sector. Second, by innovating their production processes, organizational models, and technologies, as well as shaping markets.[53] In some cases, innovation is also a way of bypassing binding parameters. For example, companies within a certain sector might overcome scale operational efficiency by using their global supply chain to expand and diversify across several sectors and product segments of the market.

3.2. Food and beverages industry

3.2.1. Industry overview: Global parameters and segmentation

The Food and Beverages (F&B) industry is one of the largest global manufacturing sectors worth over 8 trillion US dollars in 2018, approximately 10 percent of the world's GDP. It is also a dynamic sector with an expected annual growth of 11.4 percent which would bring worldwide revenues from 90 billion in 2018 to 139 billion US dollars by 2022 (Statista Market Forecast, 2019). According to the European Food and Drink Industry, the EU is the region capturing 44 percent of the global industry turnover, followed by the United States (20 percent of turnover) and China (19 percent). The global F&B market has seen healthy growth over the last ten years and this is expected to continue.

The F&B industry is structured around several sub-sectors among which the main are: the *beverage industry* (carbonated and noncarbonated soft drinks, bottled water, ice, and alcoholic beverages); the *dairy industry* (dairy-based products from both raw and processed milk, as well as dairy substitutes); the *fruits and vegetables industry* (including fresh fruits, vegetables, spices, and herbs); *grains* (including flour, rice, and malted grains, as well as mixed prepared flour

53 See Penrose (1959), Chandler (1962), Dosi et al. (1988), Lazonick (1990 and 2009) and Andreoni (2014 and 2018).

mixes and dough); the *meat, poultry and sea food* cluster of industries; and finally, the *sugar and confectionery* industry (raw and refined sugar for industrial and consumer use).

Figure 3.2 gives the top exporters of food and changes in world market export shares between 2000 and 2018. Within the EU, alongside big countries like Germany and France and Italy, top exporters of F&B products include small countries like Denmark, Netherlands and Belgium. These countries have managed to gain large global market shares thanks to their advanced technological capabilities in processing, supply chain and logistics management. In some cases, they have also developed niche segments and became major suppliers of these products for larger economies. While production scale and market size are important industrial parameters, a few countries have managed successfully to draw on other industrial parameters.

The Food and Beverages industry is one of the largest global manufacturing sectors worth over

8 trillion US dollars in 2018

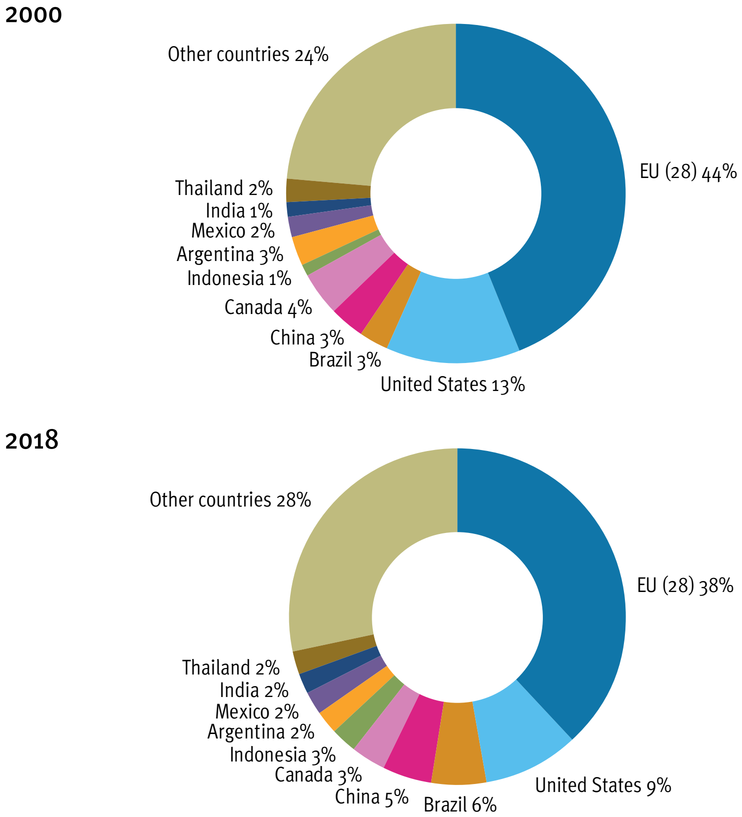
approximately **10%** *of the world's GDP.*

The F&B industry is largely fragmented, and there is space for new entrants, especially in emerging countries where demographic trends and urbanization are expanding the domestic market. Nonetheless, the global industry remains dominated by a few giant players, such as Nestlé, followed in market value by PepsiCo and Coca-Cola and Anheuser-Busch InBev.

3.2.2. Sector-specific industrial parameters for success

Success in the F&B industry is driven by several industrial parameters. Among these, changes in the extent and type of markets, supply chain management, and product and process quality standards, are particularly important. Changes in markets are often associated with broader socio-economic dynamics, including

Figure 3.2: Top ten exporters of food, 2000 and 2018 (world market shares)



Note: Food includes food and live animals (SITC section 0), beverages and tobacco (SITC section 1), animals and vegetable oils, fats and waxes (SITC section 4), and oil seeds and oleaginous fruits (SITC section 22).

Source: UNIDO elaboration based on World Trade Statistical Review, WTO (2019).

demographic trends, urbanization, the rise of a middle-class and related changes in food consumption patterns. By 2030 it is estimated that 65 percent of the world's middle-class will be living in the Asia Pacific region. Emerging markets in China, India and Indonesia will increasingly drive demand in the industry. Securing access to these markets is critical, and some manufacturers have already started shifting to these markets to be closer to the growing customer base. These rising markets are also a key export target for firms from industrializing economies.

It is also estimated that by 2050, two thirds of the world population will be living in cities, and that urbanization will result in an increasing demand for processed foods, dairy products, fish and meat protein. Demand for these products puts significant pressure on production of grain inputs and other backward-linked industries along the food value chain. Larger countries are better positioned to capture this rising demand for extensive crops and large-scale industrial farming and fishing. Opportunities for high-value agro-food industries, like fruits and vegetables, are also rising in both mature and fast emerging markets. In these markets, consumers are becoming increasingly concerned about health and, thus, the quality of food. Food origin, its freshness and safety, are becoming new critical industrial parameters for success in these markets. Freshness, in particular, has opened an important opportunities for developing F&B industries in emerging countries like Chile, and more recently South Africa and Ethiopia (Chiroso-Dube et al. 2018; Cramer et al., 2018). Some of these countries have managed to build competitive advantages in some high-value and labour-intensive product segments such as fresh fruits and flowers. Growing demand above supply capacity has driven the industry across almost all countries. [54]

By

2050

it is estimated that

2/3

of the world population

will be living in cities resulting in an increasing demand for processed foods

Demand for higher quality has raised significantly the technological and organizational industrial parameters required for success, which has favoured more established players. Technological change in the industry is not new and can be traced back to canning and pasteurization processes introduced in the nineteenth century. However, since then, the agriculture-food-beverages value chain has witnessed massive transformation, including the increasing use of capital-intensive technologies; continuing application of biological/genetic science to food production; increasing resistance of crops from pests; and greater improvements in product-life and freshness thanks to advancements in packaging and logistics.

54 Even across Africa several indigenous business groups have succeeded in building profitable segments of the F&B industry (Goga and Bosiu, 2019).

It has thus become more intensive in the use of new technologies and dominated by highly demanding standards. These include both technical product standards—mainly related to the testable physical characteristics of products, including product safety; but also process standards—mainly related to production, handling and processing, including labour and environmental standards. Standards are not simply a key technological parameter, but are also critical from an organizational perspective, since with the increasing globalization of the industry, processed foods have become increasingly dependent on longer supply chains, which poses a challenge to assuring food safety. Being standards compliant is critical for all activities along the value chain from producers to processors, and from processors to distributors and consumers. Thus, companies wishing to link into this GVC will have to be able to meet product labelling and traceability conditions to account for the sourcing, handling, and quality control of food products involved. Governments can play a key role in supporting company efforts in this area; particularly in relation to acquiring and diffusing key organizational practices (such as best practice in food storage) as well as data system management (such as the application of track and trace technologies). Governments have traditionally focussed on food processors, as used to be considered the key players in terms of guaranteeing food safety, but distributors are becoming equally important, given the increasingly long supply chains and just-in-time logistics solutions used to preserve product quality standards in GVCs.

The globalization of the industry has led to greater specialization—especially across processing companies—and more variety at lower prices. A number of major multinationals operating in the processing segment of the value chain and exporting to emerging markets, have consolidated their operations to reach efficient production scale, often boosted by advantageous subsidy policies in developed countries. This up-scaling, consolidation and price distortions in the global industry have compressed prices, making difficult for small domestic processors to compete. Despite this, across developing and emerging markets, several natural protective barriers remain in their domestic markets. Multinationals face difficulties in operating supply chains in markets with poor infrastructure and often an unreliable supply of raw materials. National processing firms might have a competitive advantage, in these circumstances, provided that the domestic agricultural sector is able to supply the quality and quantity of raw materials needed. As discussed in Chapter 2, to develop an industry that has backward linkages with agriculture like F&B, it is important to transform agriculture sector, so high levels of productivity can be achieved. The industry is particularly sensitive to resource access and affordability backwards in the supply chain. Investment in the infrastructure that provides access to key raw materials and resources can also be critical, as the industry is highly resource-intensive, considering the large amounts of water and energy needed to generate the raw materials for processing. Thus, a binding parameter is access to these resources in a reliable and affordable way.

While price competitiveness has been strong, food prices in the industry have been growing given the gap between global demand and supply. Meeting this growing demand in an increasingly sustainable way is also changing some of the industrial parameters of production. Production efficiency can be raised by innovation in processing, but also in relation to improved energy efficiency and waste management. Another major factor is the development of innovative packaging solutions. Packaging is important in improving efficiency and meeting standards along the value chain, as well as in penetrating new markets. It is estimated that more than 50 percent of all purchasing decisions are made at the point of sale and that packaging plays a key role in the final consumer decision. Thus, countries wishing to develop a F&B industry should also focus on this closely complementary industry.

3.2.3. What sector-specific policies matter? The case of Chile

Chapter 2 highlighted several country cases across early, recent and emerging industrializers who have developed a strong agricultural sector and F&B industry. The success stories referred to three large countries at different stages of development—Brazil, Ethiopia and the United States. Size matters, but it does not exclude other smaller countries from succeeding in the industry. Chile is the best-known example of a relatively small economy, which has managed to develop a sophisticated F&B industry and gained world leadership in specific product segments, like salmon. Over the 1990s Chile managed to become the largest exporter of farmed salmon in the world, as well as one of the main exporters of fresh and processed fruit and tomatoes (Bell and Juma, 2007)

At the centre of the transformative policy package implemented in Chile in support of this industry, was an intermediate technology institute, Fundación Chile (FCh). Since its establishment in 1976, FCh has undergone various phases of transformation, however, it has retained its main vocation as 'public-private partnership for innovation' with a strong business orientation and a focus on export markets. While FCh provides a number of technology and business services comparable with the Embrapa case discussed in Chapter 2, FCh has followed a quite different development path focussed on high-value food products.

Over the 1980s, FCh started a number of targeted experiments and demonstration projects to acquire foreign technology, develop domestic capabilities and learn about international market standards. Experimental tests on food production and processes were conducted as a form of reverse engineering to learn from international standards and benchmark domestic production capabilities. Learning about foreign markets and standards is a critical step if companies want to succeed in the industry. Demonstration projects can be used to transfer and diffuse foreign technologies in specific sub-segments of an industry. Experiments and demonstration projects targeted a number of products and processes, including the freezing of blackberries, strawberries, and vegetables; the cultivation of green asparagus; aquaculture; and the production of vegetable seeds for export.

These first engagements with the industry became increasingly institutionalized. In some cases demonstration projects resulted in the creation of a new laboratory (as occurred with the Marine Laboratory and Oyster Growing Station in Tongoy), which allowed FCh to acquire the official status of a quality certification entity for fruit and vegetable exports (in 1985, this license was extended to other products such as meat, seafood, vegetables and housing industries). In other cases, research led to the establishment of specialist institutes such as the centre for aquaculture in Coquimbo. Some of these institutions operating under the FCh umbrella also started providing consulting services, for example, to the fruit industry on quality control of fruit for export and on refining fish oil for edible and industrial uses (Andreoni and Chang, 2014).

While FCh was building the capabilities needed for success in the industry, markets analyses were also conducted to tailor the domestic effort to foreign market quality standards and needs. For example, as part of the Asparagus Cultivation programme, FCh provided technical assistance to farmers to introduce a new variety of asparagus which was in high demand in the United States and Europe. With this assistance, the area planted and operated grew by 40 percent of the national acreage dedicated to green asparagus crops.

Another strategy adopted for the penetration of foreign markets was the acquisition of foreign companies. In 1982, FCh acquired a company Domsea Farms specialized in aquaculture techniques. This company was later transformed into Salmones Antártica S.A (the first fully-integrated company in the Chilean salmon farming industry). When the original company was acquired, Chile's total national salmon exports were around 300 tons per annum. In 1988, when Salmones Antártica S.A. was sold for 22 million US dollars, Chile exported more than 250,000 tons and exports grew approximately 17-fold over the 1990s reaching a world market share of 35 percent in 2002 (export value was of 1,2 billion US dollars in 2003). Other companies were sold in the subsequent years, based on a model according to which the invested capital was recouped through sale and re-invested in new ventures as soon as innovative technologies were transferred and disseminated through demonstration companies.

The development of the salmon industry was driven by technology transfer and technological adaptation. First, FCh acquired and adopted the salmon 'cage cultivation' technology by initial experiments and by hiring national and international consultants, as well as training company staff at farms and fish technology centres abroad. Second, the fundamental structure of cages was redesigned locally and manufactured with Chilean wood instead of steel. Additionally, a new feed mixture based on local resources was manufactured.[55] One of the main challenges that firms in the salmon industry faced in the early stage of development was the difficulty of achieving an efficient production scale, an international reputation and quality certification. The establishment of a Chilean brand occurred through the establishment of an institution specialized in quality control and certification (the Salmon Technology Institute or

55 During the 1980s and 1990s, the salmon industry developed 'freshwater fish farming centres, seawater grow-out facilities, dry and wet fish feed plants, and processing installations, enabling it to produce smolts, salmon ova, and feed to satisfy its own and third-party needs, as well as fresh and frozen salmon for export''. After its consolidation it also "focussed on species diversification, supporting affiliates in operation until their sale, verifying the health of salmon in laboratories, introducing more suitable species of salmon for the XII region and designing model fish culture for Pacific Salmon" (Bell and Juma, 2007:308).

Intesal) in 1994 due to the creation of a producer association (Association of Salmon and Trout Producers of Chile) supported by the government.

The tomato processing industry is another example of the process described above for salmon, especially with respect to the strategy adopted to reach scale economies. In the case of tomato processing, another public institution (the Production Development Corporation or CORFO) was centrally involved with FCh. CORFO adopted the world's best industrial tomato varieties and transferred the technologies of major established competitors to Chile. Adaptation was based on the Malloa model, a network enterprise system, allowing the diffusion of crop-rotation and cultivation-scheduling techniques among SMEs. Company associations and export committees working to improve quality to meet international standards and develop new products were part financed by the government.

3.3. Garment industry

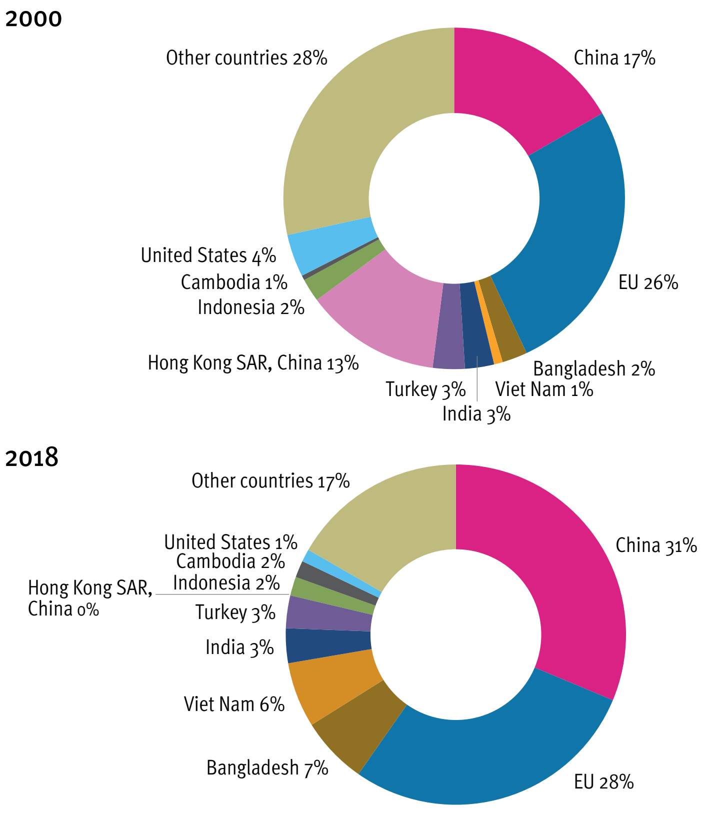
3.3.1. Industry overview: Global parameters and segmentation

The garment industry (also referred to as the apparel' and clothing' industry) is made up of a diverse set of activities from design and branding, and manufacturing, to marketing and retailing. It also includes several products—principally clothing, footwear, sportswear and accessories—and serves very different market segments. The garment industry is backward-related to the textile industry for the transformation of traditional raw materials—such as cotton and wool—into yarn and fabrics. The use of synthetic fibres and advanced technical materials has also led to the development of a backward linkage with the chemical industry, where technical textiles are produced for several sectors. Given that the boundaries between these different activities along the textile-garments-retailing value chain are blurred, estimates of the scale of the global industry vary significantly.

In terms of trade, apparel (SITC 84) exports totalled 505 billion US dollars in 2018, and with an increase of 11.1 percent from a year earlier (Figure 3.3). China, the EU, Bangladesh and Viet Nam are by far the top four global exporters with a combined 72.3 percent world market share in 2018 (with China alone accounting for half of this). Between 2002 and 2010, China's share of global garments exports increased from 26 to 43 percent. Although over the last decade, this share has declined, China had a significant upgrading in its garment industry with a shift towards product categories with higher unit values, such as coats, dresses and skirts and within product categories, such as knitted shirts. Due to China's fast structural change and increase in minimum wages, over the last decade, Bangladesh has strengthened its position and Viet Nam has emerged as a major exporter. Other developing countries such as Cambodia and Ethiopia have emerged as important exporters more recently.

Given their huge internal markets, the EU, United States and Japan remain the world's top three importers of apparel in 2018 with a combined world import share of 61.5 percent. Several emerging economies are also becoming fast growing consumers of a diversified set of garment products. The largest and the fastest

Figure 3.3: Top ten exporters of garments, 2000 and 2018 (world market shares)



Source: UNIDO elaboration based on World Trade Statistical Review, WTO 2019.

growing consumer markets are in the Asia-Pacific region (China, Japan, the ROK, Australia and Russia) with a compound annual growth rate three times higher than the world market rate (Frederick and Daly, 2019).

The garment industry is relatively fragmented with the largest top six groups by revenue—VF Corporation, PVH, Hanes, Ralph Lauren, Tapestry and Levi's—controlling a portfolio of powerful global brands commanding the largest shares in the most profitable markets. The majority of these top multinationals are companies of the United States and specialize in branding, marketing and sales. Companies in countries such as China, Bangladesh, Viet Nam and Cambodia have managed to link to these global multinational buyers or Original Brand Manufacturers (OBMs) by joining GVCs spanning several countries. Within these supply chains companies are organized around several tiers and follow different business models. For example, Cut, Make & Trim providers (CMTs) are responsible for cutting, sewing and adding trim to produce garments; Original Equipment Manufacturers (OEMs) perform CMT activities but also source raw materials; Original Design Manufacturers (ODMs) design and develop products, while overseeing the production process.

3.3.2. Sector-specific industrial parameters for success

Traditionally, the garment industry has been the entry point for industrialization for many early, recent and emerging industrializers (see Chapter 2). Early industrializers developed vertically integrated textile-garment industries with a focus on domestic markets. In contrast, starting from the 1970s and 1980s, recent and emerging industrializers developed their garment industry by linking into the global garment value chain. This linking up process was possible because of the low sector-specific barriers to entry in terms of capital, technology and skills. In the garment industry skills can be acquired easily, raw materials are widely available, processes are standardized and production technologies like sewing machines are transferable and lasting technologies. These industrial parameters are less demanding in comparison to the textile industry, for example, which tends to be more capital- and scale-intensive, and requires relatively higher technical skills and organizational capabilities. The relatively lighter industrial parameters in garments have also made the industry one of the most globalized (Pickles et al. 2015).

However, low entry barriers tend to result in fierce price competition, especially at the bottom end of the market, where companies compete on cost and depend on international buyers to access markets. Specifically, in the garment industry price competition has resulted in the adoption of aggressive sourcing and contracting practices along the supply chain. Throughout the 1980s and 1990s, the garment industry has seen a race to the bottom with enormous price-cutting pressure on lower tiers of the supply chain and the widespread diffusion of low-wage clothing assembly factories (so-called 'sweat shops'). This has also resulted in a geographical shift of garment production from relatively more regulated and unionized national suppliers, to companies operating in more flexible locations such as special economic zones, export platforms, border zones and other greenfield locations in less regulated countries.

Over the last two decades, countries who have been able to escape from this downward spiral are those who have been able to upgrade, diversify and meet the new emerging industrial parameters. Without upgrading, garment manufacturers remain in a situation where they can only remain linked into the global market by cutting costs. With upgrading, on the other hand, companies can move to higher-value segments of the industry where other industrial parameters play a role in the sourcing decisions of international buyers. In these segments it is also possible to acquire critical design, branding and marketing capabilities, which are often associated with more product diversification and higher value-added (Gereffi, 2013; Staritz, 2011). These capabilities can in turn be deployed to develop national and regional value chains and can support entry into markets where global players are relatively less dominant (Boys and Andreoni, 2020).

Upgrading in the garment industry is also critical for meeting the binding industrial parameters which have emerged over the last two decades. Wage costs remain an important factor in the sourcing decision of global buyers (especially for lower product segments and in the case of firms from emerging industry entrants like Ethiopia and Cambodia). However, the global garment industry has increasingly shifted its focus to other industrial parameters such as production efficiency, supply chain management (in relation to reduction in lead time and logistic costs), production flexibility, and reliability. The potential reputational damage associated with low labour standards—especially in developed country markets—has also affected international buyers sourcing strategies and made it increasingly risky to use traditional cost-cutting strategies. These strategies are also ineffective when more demanding production, technological and organizational parameters are driving production.

From this perspective, to achieve profitability at a lower price in a sustained way, garment manufacturers must invest in (i) training staff; (ii) upgrading the technology level of industrial sewing machines, including their degree of automation; (iii) guaranteeing availability and quality of materials; (iv) applying standard systems and processes, including deploying ICT to monitor and collect data for traceability purposes; and (v) customer services to improve responsiveness to changing market preferences. An effective factory layout optimizing space and reducing movement of materials and labour, can also result in a smooth work flow across the production process, improved production efficiency and higher productivity. Upgrading manufacturing processes across these different industrial parameters will allow companies to reduce pressure on wages and also achieve better levels of compliance and traceability. In turn, these industrial parameters are critical for winning larger orders and enhancing wage-earning opportunities for the workforce.

In order to upgrade and meet these demanding parameters, over the years there has been a consolidation of the supply chain and the emergence of larger and more capable suppliers providing more extensive functions. In some cases, this consolidation has also led to the shortening of the supply chain and a vertical-reintegration of the activities, which are critical to meet quality and reliability. In this process of consolidation, and partially in response to raising wages in China, international buyers have looked for alternative manufacturing locations. Attractive locations have large-volume low cost producers that are able to meet quality standards and respond to fast-changing consumer preferences with shorter lead times.

Time to the market is also a matter of proximity, thus, companies which are located close to major markets (particularly the EU, United States and Japan) have been particularly successful. The surge in production and export in countries like Mexico and Turkey has much to do with their proximity to large markets. In large emerging economies like China, manufacturing companies have also been able to link up domestically with large international OBMs, which were attracted by rising domestic demand. This allowed some suppliers to move up the supply chain and become major global suppliers for OBMs across regional markets.

Sourcing decisions are also affected by different sourcing requirements in the respective major markets and the tariff regimes regulating trade between producing countries and final markets. Regarding sourcing requirements, EU and United States buyers tend to have very a different size of orders. EU buyers tend to contract for smaller volumes across a larger number of suppliers in comparison with similar-sized United States buyers. This difference has implications in terms of the scale of suppliers and the type of production facilities and services they have to invest in. Regulations and standards are in some cases more stringent in some buyers than in others, again impacting on the technological and organizational capabilities suppliers have to develop. Standards are used by some governments as non-tariff barriers to preclude access to the domestic market. In other cases, countries deploy traditional tariff and quota barriers. Given the low mark-ups in the manufacturing segment of the garment industry, the presence of these tariffs or quotas can be a major factor in determining market access. For example, in South Asia, even if the Multi-Fibre Agreement (MFA) quota regime is no longer in place, textile and apparel products are often subject to restrictions in export markets.

3.3.3. What sector-specific policies matter? The case of Bangladesh

Bangladesh is today one of the top exporters of garment in the world, with a specialization in ready-made garments including knitwear and woven products. More than half of its exports go to the EU market and another 20 percent to the United States. Despite having a longstanding cultural tradition in textile and garment production, in the 1970s there were only a dozen companies in operation producing around 9 million garments a year (Spinanger, 1987). Bangladesh was also a very poor country with a limited domestic demand, thus the industry needed access international markets.

Over the last four decades, the Bangladesh garment industry has managed to develop and flourish under different trade regimes and despite mounting competition from regional players, including China and Viet Nam. It has also managed to develop a dense network of domestically owned companies well integrated in the global garment value chain. This success has been attributed to several international factors, in particular the end of the MFA quota system after 1994, and later the introduction of the EU’s Everything but Arms (EBA) initiative (Fernandez-Stark et al., 2011). While these trade regimes were important in terms of market access, it is important to understand the measure taken domestically to ensure that the industry was in a position to benefit from them.

The first opportunity for linking into the global garment industry came in the late 1970s when Korean companies were looking to set up new manufacturing plants to export garments to the United States under the MFA system. Bangladesh was a low-wage location, but its industry was unable to provide the high quality garments needed for the demanding United States' market. A collaboration between the Daewoo conglomerate and a Bangladeshi businessman led to the establishment of *Desh Garments Ltd*. To make this company capable of supplying garments efficiently, Daewoo took 130 Bangladeshi workers and managers and trained them in its own plants in the ROK for six months. Training in factory management, international procurement and marketing were particularly important given the sector-specific industrial parameters discussed above. Daewoo also provided detailed specifications for the building of a production facility in Bangladesh. The establishment of this company and the backing provided by a well-established international company like Daewoo, are considered the first catalytic factor behind the sector's success.

The government, however, played a key role in seizing the opportunity offered by this first development and supported the industry with several policy instruments. First, to scale up the Daewoo experience, limits to foreign companies' investment were lifted and several incentives were provided to support technology transfer. These included licenses to import specific machinery duty free; a duty-free allowance for raw materials and intermediate products used in export-oriented industries; and a cash subsidy of 5 percent of the value of the fabrics to manufacturers of indigenous fabrics supplying their products to fully export-oriented garment producers.

Second, financial services were provided to garment exporters. For example, to facilitate import of raw materials, the government introduced a back-to-back letter of credit facility. Subsidized credit and bonded warehouses were also introduced to facilitate imports of technology and machinery. Third, the government promoted the establishment of two EPZs in Chittagong and Dhaka in 1983 and 1993, respectively (Fernandez-Stark et al., 2011). These were designed with a view to supporting operations within GVCs, while also linking back to the local supply chain. EPZ regulations required backward linkages in spinning, weaving/knitting, dyeing and finishing, and therefore encouraged the establishment of knitwear factories. Moreover, foreign investors were expected to transfer production technologies and support their adoption. Finally, backward integration into textiles was supported in exchange for several incentives (Moazzem and Sehrin, 2016). These included 10-year tax holidays for newly established textile firms; duty-free imports of construction materials, machinery, office equipment and spare parts; and relief from double taxation. The development of a textile industry soon proved beneficial for the garment sector, as it reduced lead times and improved reliability in raw materials supply.

Investment in the garment industry was not limited to EPZs. Outside these zones, jointly with the private sector the government steered the development of the industry. The Bangladesh Board of Investment and the Bangladesh Garment Manufacturers and Exporters Association worked closely with the government from the 1980s to negotiate quotas and address issues, like compliance with labour standards. Many of the companies in the Association were linked with Desh Garments Ltd, as many of the 130 workers and managers trained in Daewoo realized that they could use their newly gained technical and organizational skills to set up new companies or become managers and traders in newly established factories. A number of these companies developed vertically integrated facilities starting with the import of cotton or yarn and engaging in all manufacturing processes up to garment production. Other factories imported fabric and specialized in cut, make and trim processes mainly for woven products. Similar to the case of Chile discussed above, the establishment of new companies had a key demonstration effect. However, differently from the salmon industry, in garments meeting the key industrial parameters required extensive acquisition of manufacturing process capabilities and shop-floor managerial skills, without which cost competitiveness could have not been achieved and retained.

3.4. Automotive industry

3.4.1. Industry overview: Global parameters and segmentation

The automotive industry is a capital-intensive and technology-intensive industry which has contributed dramatically to the structural transformation of today's industrialized and emerging economies. As shown in Figure 3.1, if garments represent a typical entry sector for industrialization, automotive is the sector providing a country with sustained industrial deepening and widening through multiplier effects in supply chains. This long-lasting contribution to GDP is however mainly concentrated across large economies.

The automotive industry plays a catalytic role for industrialization, given its large and diverse backward linkages (for example in steel, iron, aluminium, plastic, glass, carpeting, textiles, computer chips, and rubber) and its impact on employment. The automotive industry accounts for about half of the world consumption of oil, rubber, about one quarter of glass output, and one sixth of steel. Only aircraft construction has higher backward linkages in intermediate goods. The share of the automobile industry in the GDP of developed countries ranges from 5 to 10 percent (Anzolin et al., 2020).

After the collapse in world production in 2009 (-12.8 percent), the industry bounced back strongly and has reported positive growth rates until 2017.[56] In 2017 the automotive sector invested 84 billion Euro in research, development and production and the sector currently absorbs almost 37 percent of the total number of industrial robots worldwide. The average annual turnover of the global automotive industry is nearly 4 percent of world GDP (Andreoni and Anzolin, 2019).

However, given that economies of scale are the most critical industrial parameter for this sector, only a few countries have managed to develop the industry (Table 3.3). Over recent decades, moreover, there has been further consolidation around major markets and the restructuring of the value chain around a few major OEMs and powerful first tier suppliers. The automotive industry spreads across all continents with Europe (including Turkey) producing around 21 million vehicles, America (including NAFTA and South America) another 20 million vehicles, while Asia reaching 52 million vehicles in 2018 is the region with the largest production, with China the largest producer with almost 28 million vehicles. Brazil, India, Mexico, Thailand and the ROK are the only recent and emerging industrializers which have managed to reach a domestic production of above 2 million vehicles (Figure 3.4).

56 Source: http://www.oica.net/

Table 3.3: World production of all vehicles by country over 1 million in 2018 (except for Africa) and variation between 2017 and 2018

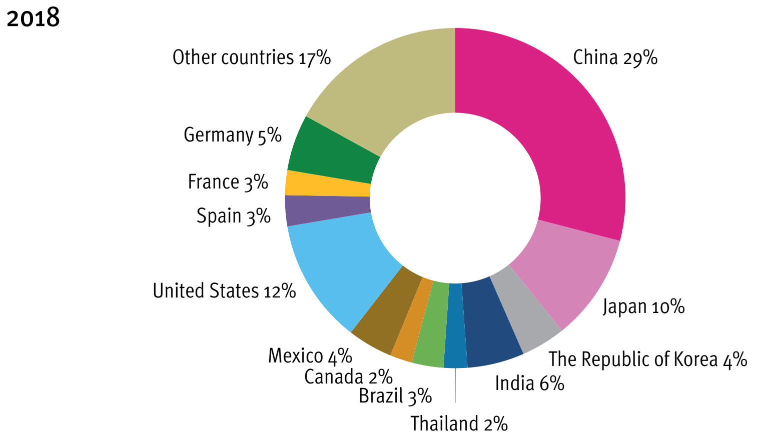
All vehicles (units)	2018	Variation (%) 2017 - 2018	Variation (units) 2017 - 2018
EUROPE	**21,333,651**	**-1.4%**	**-300,651**
EUROPEAN UNION 28 countries	**17,955,308**	**-2.2%**	**-402,898**
EUROPEAN UNION 15 countries	**13,743,486**	**-4.3%**	**-614,652**
France (only cars and LCV)	2,269,600	2.0%	43,900
Germany (only cars)	5,120,409	-9.3%	-525,175
Italy	1,060,068	-7.2%	-82,142
Spain	2,819,565	-1.0%	-28,752
United Kingdom	1,604,328	-8.3%	-145,057
Czechia	1,345,041	0	39,176
Slovakia	1,090,000	5.6%	57,555
Russian Federation	1,767,674	13.9%	215,765
TURKEY	**1,550,150**	**-8.6%**	**-145,581**
AMERICA	**20,800,328**	**0.4%**	**86,298**
NAFTA	**17,436,070**	**-0.2%**	**-42,750**
Canada	2,020,840	-7.9%	-173,163
Mexico	4,100,525	0.1%	5,693
United States	11,314,705	1.1%	124,720
SOUTH AMERICA	**3,364,258**	**4.0%**	**129,048**
Brazil	2,879,809	5.2%	143,007
ASIA-OCEANIA	**52,449,078**	**-1.8%**	**-946,133**
China	27,809,196	-4.2%	-1,206,238
India	5,174,645	8.0%	382,414
Indonesia	1,343,714	10.3%	125,608
Iran	1,095,526	-27.7%	-419,870
Japan	9,728,528	0.4%	37,854
Republic of Korea	4,028,834	-2.1%	-86,079
Thailand	2,167,694	9.0%	178,871
AFRICA	**1,123,236**	**12.0%**	**119,977**
Morocco	402,085	17.6%	60,283
South Africa	610,854	3.5%	20,903
WORLD TOTAL	**95,706,293**	**-1.1%**	**-1,040,509**

Source: UNIDO elaboration based on International Organization of Motor Vehicle Manufacturers (http://www.oica.net/category/sales-statistics/).

3.4.2. Sector-specific industrial parameters for success

In the automotive sector efficiency and profitability can be achieved only if companies operate above the minimum efficient scale set by investment in automated production lines and capital-intensive technologies. In turn capital

Figure 3.4: Top producers of vehicles, 2018 (world market shares)



Note: The figure only includes those economies that produced 2 million vehicles or more in 2018. Germany refers to only cars and France to cars and LCV.

Source: UNIDO elaboration based on International Organization of Motor Vehicle Manufacturers (http://www.oica.net/category/sales-statistics/).

and technology intensity at this scale also determine several other industrial parameters. Automotive is a skills-intensive sector, given that the workforce has to operate in a highly automated production setting and meet very strict quality standards. The fact that passenger cars and trucks have become increasingly complex and utilize several ICT-based components, also means that the sector needs a wide range of technical capabilities spanning several domains beyond mechanical competence. Electronics, system product integration, advanced materials, process automation, and data analytics, are only a few of the main technological capabilities automotive companies have to master to be competitive. Hence there are a number of organizational parameters in addition to scale that are important, such as just-in-time delivery processes, lean manufacturing and supply chain management. Mastery of these organizational and managerial capabilities has led to significant increases in productivity, and they, as much as minimum efficient production scale, represent significant barriers to entry.

Production, technological and organizational parameters are extremely relevant in the industry, especially because they have to be met along the entire value chain. The automotive value chain is global and comprises two main segments: Original Equipment Manufacturers (OEMs) and several tiers of suppliers of components such as bodies and parts, windshields, chassis and drivetrain parts, electrical components (such as fans, compressors, storage batteries, signalling equipment), engines, brake fluid, antifreeze, and tyres. Leading automotive companies such as Daimler, Fiat Chrysler Automobiles (FCA), Ford, Toyota and Volkswagen have established assembly plants throughout the world in proximity to the major markets, while small markets are served by sophisticated export and distribution operations.

The **automotive sector** *currently absorbs almost*
37%
of the total number of
industrial robots worldwide

A number of OEMs design and manufacture parts required for the assembly of specific cars and trucks. In many cases to meet minimum scale requirements they produce a vehicle model for the global market under the same product platform. OEM plants producing the same models for different regional markets are closely and constantly benchmarked to improve efficiency and productivity, and in some cases as a way of determining global sourcing strategies. OEMs manage complex supply chains made of specialized Tier 1 suppliers as well as many Tier 2 (and lower tier) manufacturers of automotive parts, who are often SMEs. Pre-production and engineering activities through which conceptual designs are translated into modularized systems and sub-systems and later engineered for assembly into large scale facilities are controlled by the global lead firms. Only a few powerful first tier suppliers have managed to gain control over some of these high-value activities, and they have done so by operating in close proximity to the headquarters of the lead firms (Sturgeon et al., 2008).

Despite the fact that the sector is no longer a typically vertically-integrated industry, second and third tier suppliers operate as an extension of the lead firms (or first tier suppliers) within very strict parameters enforced through extremely detailed process and product standards. As a result, even second and third tier suppliers have to develop precision engineering capabilities and equip themselves with control systems to monitor quality and provide data for traceability. OEMs rely on preferential sourcing and investment decisions to achieve just-in-time delivery from these suppliers and maintain productivity levels. Global first tier suppliers have emerged as an effective way of guaranteeing just-in-time delivery, through close management of lower tiers of the chain. Among first Tier 1 suppliers, companies such as Bosch, Continental, Denso, and Valeo are similar to OEMs in that they are large and manage complex operations with investments throughout the world. For example, in 2014 Denso had approximately 140,000 employees and operated in 35 countries, with global sales totalling 39.8 billion US dollars. In contrast, most Tier 2, 3 and 4 suppliers are not equipped with the management and resources required to export and operate internationally. As a result, their market access depends on their relationship with Tier 1 firms and OEMs. In many cases building and retaining these relationships determine decisions of Tier 2, 3 and 4 suppliers in terms of location, scale of investment and technology (Andreoni and Anzolin, 2020).

The last decades have witnessed a consolidation in the automaker market around sixteen major players. In 2015, ten OEMs accounted for three quarters of global production with the top five accounting for 50 percent of total production.[57] This concentration has also affected first tier suppliers and the number of component manufacturers has dropped from 40,000 in 1970 to less than 3,000 in 2015 (Wong, 2017). Hence, fewer larger first-tier suppliers have survived and consolidated while, at the same time, they have developed a close relationship with the big OEMs. Given the small number of global system-integrator automotive firms and their strong purchasing power, suppliers are forced to adopt specific standards, information systems and even production technologies.

This consolidation and geographical reorganization of the industry was led by several technological changes which have reshaped some of the main technological parameters. First, to better synchronize just-in-time-delivery of complex modular units, it has become increasingly important to be located close to car assemblers, especially for Tier 1 suppliers. Second, since the early 2000s and with a significant acceleration over the last decade, companies have been engaged in a race to improve the energy efficiency of cars, while shifting to new sources of energy. Industrial policies, such as on vehicle efficiency and carbon emission regulations, have played an important role in directing the industry towards increasing production of zero emission vehicles, with a shift towards more diverse fuels and drivetrain technologies. At the same time, several technological improvements in advanced drivetrain technologies are making them more feasible for mainstream production. First, most manufacturers have been focussing on reducing vehicle weight through the deployment of advanced composite materials, high strength metals and smaller, more efficient electronics. Reducing weight lowers the amount of energy needed to move and stop the vehicle, without reduction in a vehicle's size and performance. Second, combustion engines efficiency has improved dramatically. Companies are increasingly using turbochargers, advanced ignition, variable valve technology and direct fuel injection to increase power and enable engine downsizing. Third, there has been a shift towards electric drive technologies. This includes both hybrid vehicles equipped with electric drive components to recapture energy and petrol engine and hydrogen fuel cell vehicles, where fuel cells produce electricity through a chemical reaction. Policy in many countries is

57 See International Organization of Motor Vehicle Manufacturers (2015).

offering tax incentives to promote electric and plug-in vehicles and, for example, China is pushing the electrification of its vehicle fleet with significant purchase incentives and the construction of the largest set of electric-vehicle charging stations worldwide.

The transition to new technologies and mobility solutions in the automotive industry will take time to develop and spread across countries. In 2020, conventional internal combustion engines still accounted for more than 90 percent of cars. In this transition major OEMs are restructuring their locations and enhancing their supply chains to respond to shifts in the global market towards Asia and the new type of more sustainable vehicles. Suppliers will become more important in terms of how much value they add, especially in the new area of electric vehicles where OEMs have not as yet developed core competences. Technological and logistical support in emerging markets will open new opportunities for countries willing to invest in the new developments, especially those countries which have already developed capabilities in supply of electronics, software, and batteries.

3.4.3. What sector-specific policies matter? The case of Thailand

Thailand is today the fifth largest producer of automotive vehicles in Asia, immediately after two giant economies—China and India—and two of the most successful industrializers of last century—Japan and the ROK. Production was 2.1 million cars in 2018 with a 9 percent growth over 2017-2018. The main lesson from the Thai experience in the sector is that success requires long-term government commitment and the capacity to adapt policy in response to major changes in global industrial parameters.

The formation of the Thai auto sector began in the 1960s, when automotive development was part of a more general import substitution policy. Import tariffs on vehicles rose to over 50 percent for trucks, and higher for passenger vehicles. Import tariffs on components for assembly (CKD kits) rose substantially also, although they were not as high as on vehicles, and from 1975 local content requirements were imposed to stimulate domestic value addition. Local parts manufacturers became a powerful lobby and established the Thai Automotive Parts Manufacturer's Association in 1972. As a result, local content requirements were progressively raised until the 1990s, and a ban on passenger car imports was imposed between 1978 and 1991. The industry's impressive growth was helped in part by a large influx of FDI from Japan during the 1980s, which accelerated immediately after the Asian financial crisis in 1998. During the trade liberalization in the 1990s, Thailand cut import tariffs on both vehicles and components, while retaining local content requirements. Large automobile assemblers such as Nissan and Toyota were able to increase their local content targets. When local content requirements were lifted in 2000, the large American assemblers—Chrysler, General Motors and Ford—decided to establish their own assembly plants in Thailand as regional hubs for Asia, while Japanese producers, such as Honda and Toyota, decided to expand their production capacity in the country.

From the early 2000s, through the Board of Investment, the government has been using tax and other incentives to promote particular types of vehicle as national product champions. First, excise taxes on double-cab pick-up trucks were reduced from between 35 percent and 48 to 12 percent and on other pick-up trucks to 3 to 5 percent, while on passenger vehicles (less than 2400 cc) the tax was reduced only slightly from 37.5 to 35 percent. Second, the import tariff rate on components (CKD kits) was increased from 20 to 33 percent to support vehicle parts producers. Third, corporate tax exemptions were offered to foreign investors for a period of 3-8 years for projects over 10 billion baht with further tariff reductions on imported machinery and materials. Fourth, tax incentives were offered to foreign investors to transfer R&D facilities to Thailand. This resulted in Toyota establishing its first external R&D centre outside North America and Europe in the country. Toyota also relocated most of its regional operating functions from Singapore to Thailand by establishing Toyota Motor Asia Pacific Engineering & Manufacturing in 2007. Finally, non-tax incentives were offered, including the right to 100 percent foreign ownership and permission to bring in foreign experts, own land, and freely remit foreign currency abroad. The implementation of these policy instruments benefitted significantly from the establishment of the Thai Automotive Institute in 1998. As discussed in Chapter 4, the Thai Automotive Institute is an example of a sector-specialized organizational model used to coordinate government and private sector initiatives.

In early 2004, the government launched the so-called, 'Detroit of Asia' plan, later renamed the 'Production of Asia', plan. This plan envisioned Thailand becoming the regional hub for automotive production in Southeast Asia and targeted 2.5 million units of vehicle production by 2016. In this plan, the government targeted the development of small, economical, and ecological passenger vehicles. Human resource development was promoted with a joint initiative between the Thai and Japanese government. The "Automotive Human Resource Development Project (AHRDP)" was launched in 2006 as a public-private collaborative programme for automobile components suppliers, in particular focussing on the local technological capacity of 2nd and 3rd Tier suppliers.[58] The 'Eco Car' project was also launched in 2007 as a product champion scheme to support investment in new green technologies for the industry. Support under the scheme came with specific conditions. OEM investments were required to meet two criteria to qualify: first, a minimum demonstrated volume output of 100,000 units, and secondly, the processing of certain engine parts locally. The first criterion was to encourage OEMs to prioritize investment in a narrow range of vehicle platforms, so that globally competitive economies of scale could be achieved at the assembly level and potentially through the value chain. The second criterion aimed to develop local value chains by making the incentive contingent upon certain processes, such as engine assembly and the processing of important drivetrain parts, being undertaken locally and by offering incentives to invest in prioritized supplier process technologies.

58 Four Japanese companies—Denso, Honda, Nisan and Toyota—trained over 300 master trainers for 2nd and 3rd tier suppliers in Phase 1 (2006-2007). In turn, these master trainers trained over 4,000 workers within their company in Phase 2 (2008-2010).

In 2012 the Thai Automotive Industry Masterplan was launched to make Thailand the regional hub for automotive exports. Under this the government established an automotive testing, R&D centre, an automotive information centre and a specialized human resource development institute. These initiatives targeted more than 690 Tier 1 and 1,700 Tier 2 and 3 suppliers and further encouraged investment from other component manufacturers. In 2017 as part of the Robotics Development Plan, the automotive sector was supported by a fund of 6 billion US dollars to create an ecosystem for robotics. From a demand-side perspective, the government aimed at boosting the adoption of robots with a specific package of complementary measures, including: 50 percent double tax deduction; 200 percent deduction for expenses in training; and a dedicated credit line for investments in automation. From a supply-side perspective, companies introducing robotics have been supported in technology absorption and effective deployment with the establishment of a Centre of Robotic Excellence (with a focus on certified technologies, human resource development and prototyping) and the removal of the import duty on robotics spare parts. Alongside this centre, more than 10 different intermediate technology institutions, including Thailand Institute of Field Robotics and the Thai Automation & Robotics Association, provide extension and scaling-up services to companies along the automotive supply chain.

3.5. Machinery and equipment industry

3.5.1. Industry overview: Global parameters and segmentation

The machinery and equipment industry is an extremely heterogenous sector providing technologies enabling production in almost all other manufacturing activities. Machinery and equipment are used to manufacture everyday objects, including both durable and consumable goods such as home appliances, pens, bicycles, cars, planes, medical devices or wind turbines (and parts for many other products like consumer electronics). They are used to fabricate products out of metal, plastic, rubber, and composites as well as other natural or industrial materials.

ISIC distinguishes several industry groupings within the industry Division 29 Manufacture of Machinery and Equipment including two main groups: the manufacture of general-purpose machinery and components and those with special applications.[59] The second group includes the manufacture of: motors and engines (except electric motors), turbines, pumps, compressors, valves and transmissions; ovens, burners, lifting and handling equipment, cooling and ventilation equipment, other general-purpose machinery (such as packaging equipment, weighing machines and water purification equipment); agricultural machinery, machine tools, machinery for other specific industrial purposes (such as for metal production, building and civil engineering, mining or the manufacture of foodstuffs, textiles, paper, printed matter, plastic and rubber products); and weapons and munitions.

59 The manufacture of metal products for general use (Division 28), associated control devices, computer equipment, measurement and testing equipment, electricity distribution and control apparatus (Divisions 30-33) and general-purpose motor vehicles (Divisions 34 and 35) are excluded.

Machine tools and equipment are extremely complex product systems, often made of several sub-systems with hundreds or sometimes thousands of parts—including nuts and bolts, bearings and pins, sheet metal enclosures, belts, shafts and so on. Some can produce components with extreme accuracy (within less than a micrometer) and many do so in a fully automated way. Industrial automation is the use of control systems, such as computers or robots, and information technologies for handling different processes often performed by different machinery and equipment with minimal or limited human intervention. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, and electronic devices and computers, usually in combination. Complex production systems, such as modern manufacturing factories, or complex product systems such as airplanes typically use all these combined automation technologies (Andreoni and Anzolin, 2019).

Historically developed industrial economies, such as Germany, Japan, the United States and Italy have dominated the industry, but more recently competition from China and the ROK has shifted the centre of the industry with the United States losing world market share. While Europe has maintained global leadership in specific segments, Asia has become the largest consumer and producer. Of the twenty largest machine tool producers globally, ten are based in the Asia-Pacific region (Japan accounts for seven, China for two, and the ROK one).

3.5.2. Sector-specific industrial parameters for success

Industrial parameters within the machinery and equipment sector are quite different for different types of activity, as they depend on the type of processes and technologies involved, the degree of automation of the final machinery and equipment, the degree of complexity of the machinery components and the capabilities required for their integration. Many of these differences stem from the fact that companies in the sector produce technology- and skills- intensive products for a variety of end-users, each with very specific needs and standards. For example, the aerospace and medical devices industry require extremely sophisticated and reliable machinery and equipment, based on very demanding precision engineering capabilities to reach the highest standards of safety. Other industries such as pharmaceuticals also need production lines—for example sorting and packaging machinery—based on sophisticated technologies for data analytics and traceability purposes. In other sectors like garment, while quality standards matter, precision engineering requirements are less stringent as tolerance to defects is higher.

The fact that firms in the machinery and equipment sector need to respond to such a variety of end-users, makes customization capabilities one of the most important industrial parameters for success. Machine tools are rarely mass-produced, and, in most situations, modifications to their basic design are needed to match customers' specific requirements. The ability to develop technology solutions tailored to companies' unique technology specifications requires a combination of different production, technological and organizational capabilities, which are often tacit and develop only incrementally over time. While these factors make the development of the industry challenging from a capabilities perspective, they also open opportunities for indigenous innovation and allow a range of firms of different size and degree of specialization.

Although building large machinery and equipment is a capital-intensive activity companies can also specialize in relatively less capital-intensive processes, such as the production of sub-systems and components for larger firms. Moreover, given that the production of these components tends to respond to very different needs and parameters (in terms of reliability, productivity, accuracy, speed, efficiency, quality, flexibility and durability), suppliers in the machinery and equipment sector are more specialized than those in sectors such as textiles and automotive and can control important R&D activities, which can lead to independent innovation and growth. These dynamics have led to the flourishing of industrial ecosystems around the world dominated by highly specialized small companies employing relatively few people and producing a few hundred units per year. Examples are the Boston Route 158 in Massachusetts, United States (Best, 2018), the Emilia Romagna ecosystem in Italy (Andreoni, et al. 2017; Andreoni, 2018) as well as several industrial hubs across emerging economies (Oqubay and Lin, 2019), such as the mining equipment industry in the Gauteng region around Johannesburg in South Africa (Torreggiani and Andreoni, 2019).

The industry is also populated by a number of large companies with thousands of employees that manufacture many hundreds of machines per year and have developed exceptional organizational and management capabilities. They often orchestrate long- and multi-tier supply chains and operate in the global markets with preferential supplying contracts. These larger companies meet the same industrial parameters discussed above by diversifying their portfolio of products and careful segmentation of markets. This can also mean differentiating machinery and equipment in such a way that pricing does not preclude access to emerging markets. Chinese and Indian machinery and equipment companies, for example, have been able to set competitive prices by reducing the number of functions of their machinery and equipment. Thanks to the increased affordability of their products, these companies have managed to penetrate emerging markets traditionally dominated by companies from advanced economies. Differentiation also comes from the after-sale package of services that manufacturers offer their customers, including application engineering, maintenance and repair and onsite training of operators. These services are an integral part of the production solutions customers buy from machinery and equipment manufacturers and a significant source of income for the latter.

The boundaries between the machinery and equipment industry and the business service industry are thus blurring. This process has been accelerated by the fact that machinery and equipment production is increasingly using intelligent automation solutions and hardware components such as sensors, actuators, electrical relays and control equipment (Andreoni and Anzolin, 2019). Digitalization in the machinery and equipment industry is enabled by advances in data, analytics and connectivity and intersects with increasing automation and robotization. The increasing deployment of digital production technologies opens new opportunities for increasing sustainability, through energy and resource saving across the entire range of manufacturing and enables a shift towards a more circular economy, focussing on the reuse, refurbishment, remanufacturing and recycling of products and materials. These are the new technological parameters that increasingly companies in the machinery and equipment industry have to deal with to retain competitiveness.

3.5.3. What sector-specific policies matter? The case of China

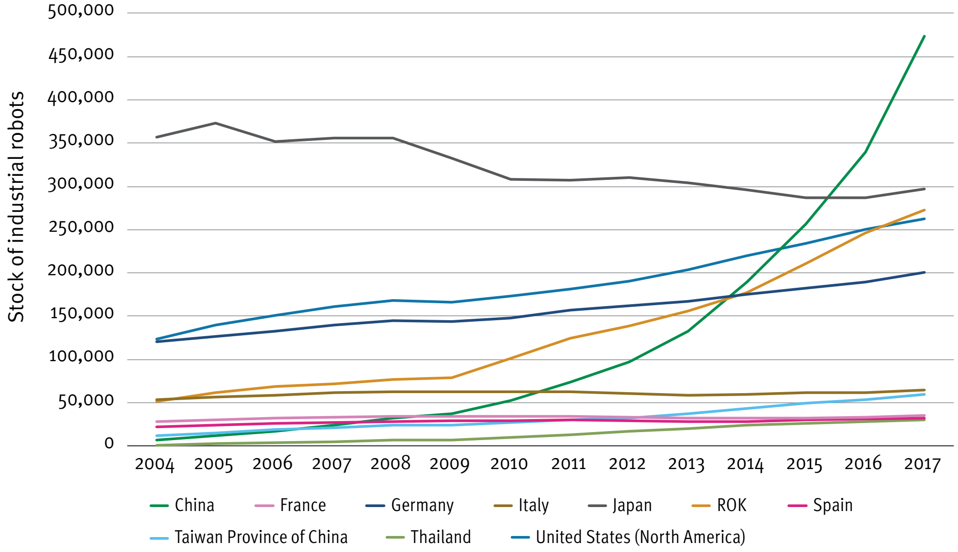
Given the enormous importance of the machinery and equipment industry for broader industrial development, historically many governments have supported its development. Today, intelligent automation is the new frontier of the industry and governments in emerging countries such as China, Malaysia and Thailand have targeted robotization as a key technology for industrialization. In 2017, 96 percent of the operational stock of all industrial robots was present in 37 countries. The global stock of industrial robots is highly concentrated within this group of countries. The top ten countries have 86 percent of world industrial operational robots alone, with the top five countries having 75 percent of all industrial robots (Figure 3.5).

In **2017, 96%** *of the operational stock of all industrial robots was present in* **37 countries**.

The top five economies include three leading industrialized nations—Japan, Germany and the United States—and two of the fastest industrializers of the last century—China and the ROK. Taiwan Province of China and Thailand are, together with China, the only two recent industrializers in the top ten. The development of electronics has been the major driver of robotization in Taiwan Province of China. In Thailand, instead, robotization was driven by the more recent expansion of the automotive industry.

China has been successful in pushing robotization on a large scale across several sectors. Growth in their use started in the 2000s, with a major acceleration between

Figure 3.5: Evolution in the stock of industrial robots in the top ten economies, 2004-2017

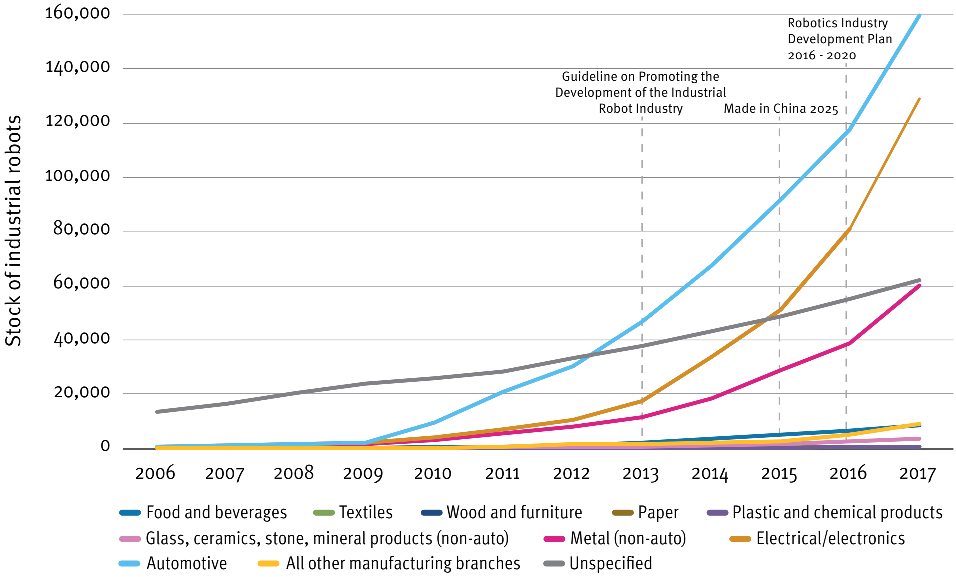


Source: UNIDO elaboration based on data from International Federation of Robotics, World Robotics (IFR, 2017).

2010 and 2014, when the demand for industrial robots quadrupled (in the same period it doubled in the United States). In 2013, China became the world's largest market for industrial robots and it has remained so (Figure 3.6). By 2017, China accounted for 36 percent of the global sale of industrial robots, and the total stock of industrial robots in operation there reached half a million units (of which roughly 80 percent were in manufacturing). In terms of domestic production, only 5 800 robots were produced in China in 2012. By 2017, the number of robots produced in the country had risen more than twentyfold to reach 131 000 (30 percent produced by domestic companies) (Cheng et al, 2019).

The government has played a key role in driving robotization in China (Ray et al., 2016). The Seventh Five-Year Plan (1986 to 1990) was the first to promote industrial robotic R&D as one of 76 national key technology programmes. During this period, a number of newly established research institutes focussed on fundamental technologies and components, different types of structures, and application engineering for industrial robots. In the 1990s, under the Eighth and Ninth Five-Year Plans, China shifted to a prototype development phase concentrated on the initial design and limited production of robots and advances in computer numerical control (CNC) lathes, relevant technologies for excavation and tunnelling robots,

Figure 3.6: Evolution in the stock of industrial robots by sector in China, 2006-2017



Note: The data report the manufacturing sectors and unspecified (which covers both manufacturing and non-manufacturing sectors). The data in the graph represents 98.8 percent of the total industrial robots in China at the end of 2017.

Source: UNIDO elaboration based on International Federation of Robotics, World Robotics (IFR, 2017).

and assembly automation robots. This was made possible by investment in nine robotic centres—including the emergence of leading robot manufacturers like Shenyang Siasun—and seven R&D bases, including the Beijing Research Institute of Automation for Machinery Industry (originally founded in 1954). The start of the so-called 'surging development and application' period in China's industrial robotization has been associated mainly with the Twelfth Five-Year Plan (2011 to 2015), which focussed on intelligent manufacturing. The plan called for the development of specific technologies, including sensors, industrial communication networks and controllers.

In 2015, with the launch of *Made in China 2025*—a major plan to improve the competitiveness, and green characteristics of China's manufacturing sector—intelligent manufacturing and robots received even more priority.[60] In 2016, the MIIT, the National Development and Reform Commission and the Ministry of Finance jointly launched the Robotics Industry Development Plan (2016-2020).

60 According to Miao Wei, Minister of MIIT, robots have been recognized as the technology that will allow China to address the so-called 'double press', that is, to compete with developed countries in advanced technologies and with developing countries with cheap labour.

The industrial policy instruments in support of robotization in China operate on both national and provincial levels. The most common form of government support is subsidies. The developer or manufacturer of robots can obtain a subsidy of up to 15 or 30 percent of the cost, when the robot is finally assembled. Subsidies can also be complemented by low-interest loans, land-rental incentives and other forms of tax relief. 15 percent of all robot-using firms have declared receiving some form of government subsidy (Cheng et al 2019).

The government also supports companies investing in the implementation of robotics-enabled automation in key manufacturing industries and logistic services. Building on the 2008 Enterprise Income Tax Law, in 2018 the State Council announced that it would cut more than 8.78 billion US dollars in taxes for SMEs and high-tech firms to reduce their operating costs and spur innovation. Over recent years these subsidies and tax exemptions have made it more attractive to invest in robots and robotic-based technology. For example, for a welding robot in the automotive industry the pay-back period (the time it takes for a company's investment in a robot to pay off), is estimated to have dropped from 5.3 to 1.7 years between 2010 and 2015, reaching 1.3 years in 2017 (Cheng et al 2019). At the national level, the government has also promoted the acquisition of leading robotics companies and the establishment of joint ventures with leading international producers. For example, the German robotics company, KUKA, was purchased by a Chinese appliance manufacturer, the Midea Group, for 5 billion US dollars in 2016.

In 2018, the Ministry of Industry and Information Technology announced the establishment of a National Robotics Centre that focusses on tackling common bottlenecks in the application of robotics, such as human-machine interaction technologies. The new Centre joins several universities and research institutes currently focussing on robotics, including Harbin Institute of Technology, Shenyang Automation Research Institute, Beijing University of Aeronautics and Astronautics, and the Shanghai Jiao Tong University. A number of these institutions are part of the so-called *China Robot Industry Alliance*. It is a non-profit national industry association for China's robotics industry, with the main objective of supporting policy towards the industry, and promoting exchange and information among members in terms of technology and markets.

Over the years, China has also established 40 robotics-focussed industrial parks throughout the country, supported financially by the government. The Yangtze River Delta (Shanghai, Kunshan, Changshou, Xuzhou and Nanjing), as well as the Pearl River Delta (Shenzhen), are the main regional hubs of robotization. At the provincial level, governments have set up investment funds to support robotization and different provinces have implemented different schemes and incentive packages for attracting investment and developing robotic hubs. Competition among provinces is strong, since provinces like Guangdong, Jiangsu, Shandong and Zhejiang are regions with annual GDPs of 1 trillion US dollars or more, and each are the location for tens of thousands of factories still based on non-robotic technology, which provide a large potential market for robotization.

3.6. Electronics industry

3.6.1. Industry overview: Global parameters and segmentation

The electronics sector is today one of the largest and most internationally tradable. The industry provides critical components to a large variety of other sectors such as automotive and machinery and equipment. It is also a key industry of the so-called Fourth Industrial Revolution (4IR), as electronics is one of the main enablers of many 4IR technological innovations and industrial applications (for example in the medical devices industry discussed below). Within the industry there are sub-sectors with very different degrees of capital, technology, R&D and skills intensity. For illustration the industry can be disaggregated into five product groups:

i. Telecommunications, including smartphones, wireless networks, and wireless infrastructure like 5G and the Internet of Things (IoT);
ii. Computers and tablets;
iii. Consumer electronics, including digital TVs, audio, and game consoles;
iv. Automotive electronics, including advanced electronics and sensors integrated in vehicles;
v. Industrial electronics, including smart grids, electronics for automation and robotics, electronics for the health and medical device industry, and Artificial Intelligence.

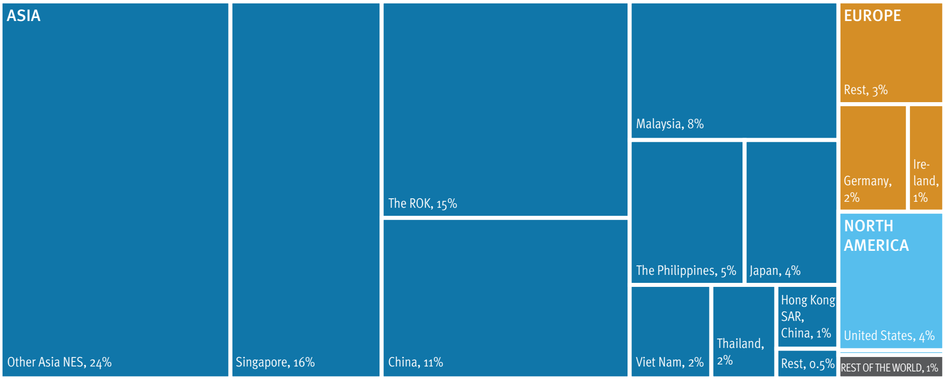
Despite this variety of sub-sectors and industrial applications, at the core of the electronics sector is the semiconductor industry. Since the invention of transistors in the Bell Laboratories in 1947 and their first industrial applications by Sony in consumer electronics in the 1950s, all electronic products have been built on metal-oxide semiconductor transistors, especially metal oxide semiconductor field effect transistors (MOSFET) and integrated circuits (often on printed circuit boards). MOSFET is still today the most widely manufactured electronic device produced. Without semiconductors, machines and increasingly consumer products would not be able to collect, process and distribute information.

World trade statistics reveal that integrated circuits are the third most traded product globally (valued at around 700 billion US dollars) and that Asia dominates the industry (Figure 3.7). The top exporters of integrated circuits in 2017 were Singapore ($115 billion), the ROK ($104 billion), China ($80.1 billion) and Malaysia ($55.7 billion), with Other Asian economies (including Taiwan Province of China) accounting for $170 billion. The top importers were China ($207 billion), Hong Kong SAR, China ($168 billion), Singapore ($57.8 billion), the ROK ($38.6 billion) and Malaysia ($37.3 billion). China is also the largest importer and exporter of semiconductor devices.

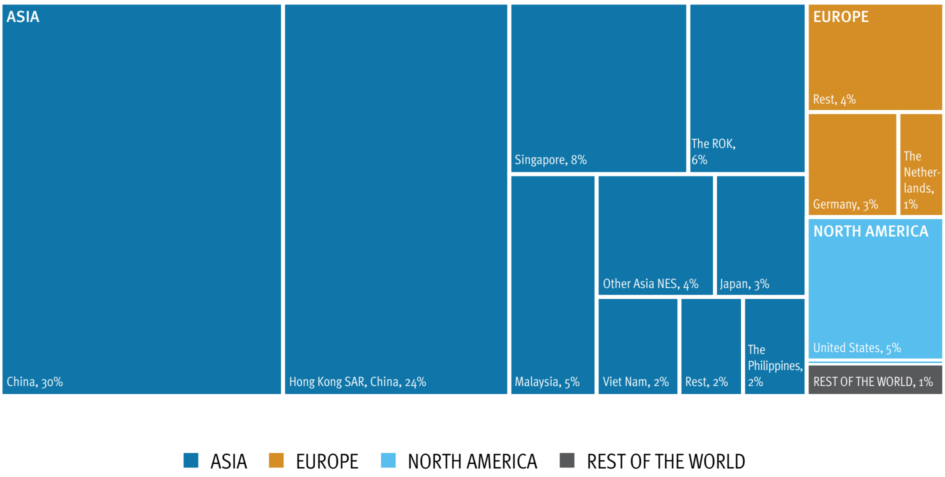
A key feature of the electronics industry is that it is structured around an intricated regional web of producers of semiconductors, mainly located across Asia, as successful East Asian countries created lead firms or first tier suppliers at an early stage in the

Figure 3.7: Exports and imports of integrated circuits and semiconductor devices, 2017

Main Exporters of Integrated Circuits, 2017



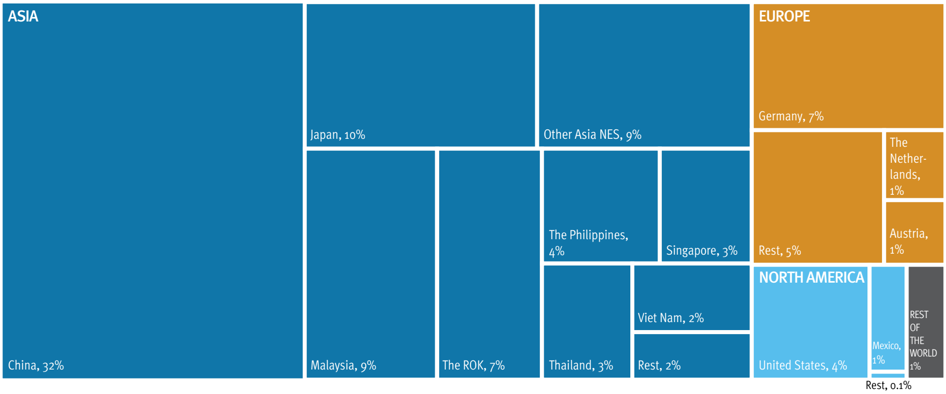
Main Importers of Integrated Circuits, 2017



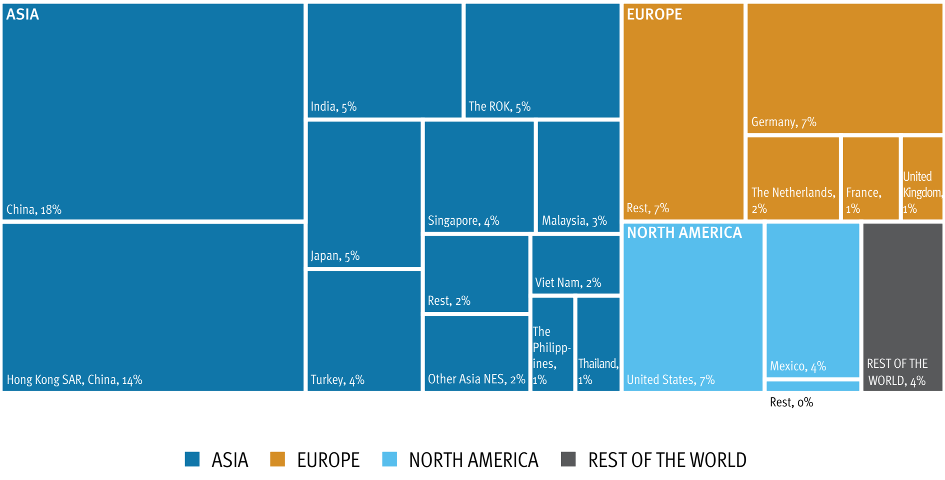
Note: NES stands for "not elsewhere specified". The group Other Asia NES includes trade data for Taiwan Province of China.
Source: UNIDO elaboration based on Observatory of Economic Complexity (https://oec.world/en/).

Figure 3.7 (cont.): Exports and imports of integrated circuits and semiconductor devices, 2017

Main Exporters of Semiconductor Devices, 2017



Main Importers of Semiconductor Devices, 2017



Note: NES stands for "not elsewhere specified". The group Other Asia NES includes trade data for Taiwan Province of China.
Source: UNIDO elaboration based on Observatory of Economic Complexity (https://oec.world/en/).

growth of the industry.[61] Outside Asia only Germany and the United States are major players in the two main segments of the industry reported in Figure 3.7.

The semiconductor supply chain is long and complex, mainly including four types of companies, either based on a fully integrated value chain, or different versions of a disintegrated value chain:

i. *Integrated Device Manufacturers (IDMs)* are vertically integrated companies covering the design, manufacture and sale of their own semiconductors (for example, Intel and Samsung);
ii. *Fabless companies (Fabless)* design semiconductors and contract out the manufacture of their proprietary designs to either dedicated foundries or IDMs with spare manufacturing capacity (for example, Qualcomm);
iii. *Dedicated Foundries (DFs)* are contract manufacturers producing semiconductors to customers' specifications (for example, Globalfoundries and Taiwan Semiconductor Manufacturing Company);
iv. *Outsourced semiconductor assembly and test (OSAT)* companies specialize in assembling, packaging and testing semiconductors. As this is a more automated part of the manufacturing process, IDMs tend to have their own captive packaging business in dedicated subsidiaries in China, Taiwan Province of China and other Asian countries.

Companies of the United States retain a global leadership in both IDMs and Fabless, with Samsung being the only main world firm with a lead in the global high bandwidth memory (HBM) and dynamic random-access memory (DRAM) markets. Several companies from Taiwan Province of China dominate the DFs segment with over 70 percent of the world market. Among them, world leading companies like Foxconn and Quanta operate both as contractors and as original design manufacturers (ODM) with several factories across China. This means that they operate both as contractors and with their own intellectual property for a small number of specific product types. Japanese companies are important suppliers of semiconductor materials, high-end equipment and special semiconductors.

The global demand for electronics products these companies compete for has been changing. While consumer electronics is reaching saturation point in higher income economies, emerging markets across Asia have seen the rise of a middle-class eager to buy innovative electronics products thus pushing new investment even in more mature product segments of the industry. In addition, new opportunities are emerging in the industrial electronics segment and new 4IR applications. For example, the adoption of safety-related electronics systems has grown rapidly in the automotive industry and the new 5G developments in the telecommunication industry are also stimulating investment.

61 Already in 1985, Dieter Ernst observed how: "inside almost any electronic product—whether it is a computer or a consumer item—components can be found which have been made in more than a dozen factories in at least half a dozen countries. Even one subassembly may be the result of an odyssey" (Ernst, 1985:25).

3.6.2. Sector-specific industrial parameters for success

The binding industrial parameters for the electronics industry are mainly determined by its organizational and governance structure. Parameters have therefore been evolving over time in response to changes in the electronics value chain. The global electronics value chain can be traced originally to the 1950s, when companies of the United States started locating assembling plants for consumer electronics in Japan, Taiwan Province of China and Hong Kong SAR, China. At this stage cost reduction and cheap labour were the main drivers of outsourcing. The outsourcing of the manufacture of semiconductors commenced in the 1970s and of hard disk drives for computers in the 1980s (Ernst, 1985). In the 1980s Japan gained leadership in two main segments of the industry—semiconductor miniaturization and consumer electronics diversification. Thanks to its organizational innovations, especially just-in-time supply management and lean production, Japan started developing long chains of supply across East Asia in China, Malaysia and Thailand. Organizational innovation allowed Japanese companies to retain quality, while pushing down prices. As discussed in Chapter 2, the fact that many recent and emerging industrializers established special economic zones and incentives for FDI also played a major role in stimulating investment in electronics across the region.

From the 1990s the organizational and technological parameters of the industry have evolved further with different effects across the different types of companies discussed above—IDMs, Fabless, DFs and OSAT (Sturgeon and Kawakami, 2011). Lead electronics firms (especially from the United States) started focussing on core competence in chips design, branding and marketing, while capital-intensive manufacturing processes were outsourced first to domestic and then increasingly international suppliers. Lead electronics companies became high-tech and R&D-intensive firms focussing on intellectual property protection, licensing, R&D spending and trade secret protection. The development of the semiconductor industry was also a major target of the government of the United States, so companies could draw on large public R&D spending in developing their technological leadership (see Chapter 2). Building on this business model, and leveraging the proliferation of efficient suppliers and contract manufacturing foundries, a number of Fabless firms emerged focussing exclusively on software development and branding (for example, Cisco). Fabless firms have set the most demanding technological parameters in the industry in terms of R&D, skills and technology. However, in doing so, they have left DFs to set the production and organizational parameters.

Industrial parameters among contract manufacturers are very different from those for lead firms. Contract manufacturers operate in a highly competitive segment of the industry where cost, but also quality standards, are crucial. Economies of scale are obtained with large capital investment in specific assets; however, to be able to exploit these fully contract manufacturers have to work for several companies. A single state-of-the-art Fab requires a capital investment of five to ten billion US dollars, and to be cost-efficient needs to operate constantly at almost full capacity. Given that Fabless electronics companies are required to produce different types of products with different specifications, contract manufacturers must balance the problem of operating at an efficient scale, while retaining flexibility. They also need to have a global presence to be able to serve the lead firms in different markets on a timely basis. On-time delivery is a key parameter for buyers and a key determinant of buyers' retention of contract manufacturers. Achieving on-time delivery is challenging. Chip manufacturing is an intricate process requiring four to six months to complete and the launch of new products in the market is dependent on timely delivery of these key components. Supply chain management optimization, includes inventories, overall cycle times and fill rates and can be difficult to achieve. Companies which have managed to meet these parameters have often received significant policy support in the form of technology services, as well as access to a wide range of highly-specialized electronics engineers and technicians (see Chapter 2).

Finally, given the competition and low margins at the level of manufacturing processes, contract manufacturing foundries have increasingly started providing complementary services ranging from assembling of semiconductor devices, electronics products, packaging and testing. Some have also started operating as first tier mega suppliers (also known as 'specialized verticals') and organize around them second-tier suppliers of manufacturers located in countries with low labour costs. Thus, the electronics industry has been both stretched (de-verticalisation) and compressed (re-verticalisation) with firms at the latter stage concentrated at the centre of the value chain. This evolution in the value chain structure is partially reflected in Figure 3.7 above, as these dynamics are regional more than national, and shape trade patterns.

For today's developing countries, entering this highly competitive segment of the electronics value chain requires developing a competitive advantage in those production and organizational parameters determining product and process standards, economies of scale, on time-delivery and skills, while exploiting labour cost advantages. As seen in the case of the ROK, discussed below, the learning cycle in some segments of the electronics industry can be relatively short. This opens opportunities to develop productive capabilities and linking up in the global value chain. Another window of opportunity is represented by the OSAT segment of the industry, that is, a focus on potentially less capital-intensive activities such as assembling, packaging and testing of semiconductors. While these activities are less technology and skills-intensive, so they can provide an entry point into the industry, many of the activities are becoming increasingly automated. Therefore, given the high potential for labour/capital substitutability, in this segment governments will have to see the extent to which investments here can support job creation.

Over the last two decades, firms from recent industrializers have attempted to challenge the leadership of firms of the United States. However, firms from Taiwan Province of China such as Asus, Acer and HTC have struggled to gain significant market shares in the main United States and EU markets. Over the last decade, Chinese firms Huawei, Oppo, TCL, Vivo and ZTE and have become strong players in the telecommunications industry and in other consumer electronics segments. Huawei in particular has become the biggest electronics company in the world and a major player in 5G infrastructure. Japanese and the Korean firms have also gained significant shares mainly by remaining vertically integrated (IDM model)—thus retaining some production activities in-house and providing specialized foundry services—as well as by launching several mergers and acquisitions. Samsung is the only Asian company which has managed to become a global brand in a vast range of consumer electronics and telecommunication products (although Huawei is fast emerging across several industry segments). Samsung designs and manufactures its own semiconductors—thus it is both an R&D and capital-intensive firm—and integrates its core technology with several other components along several global value chains. Some of these components are less technology and capital-intensive, thus, they offer supplier firms an opportunity for linking up with a global industrial leader in the electronics industry. As discussed below, this is a strategy that worked for Samsung itself when it took its first steps in the electronics industry.

The other two critical industrial parameters to take into consideration are related to the evolving demand for electronics and the change introduced by 4IR technology. As noted above, the demand for consumer electronics is flattening in high income markets, but it is boosted by the rise of robust domestic demand in emerging economies. Competition is also rising among electronic retailers, especially with the surge in online stores. Major brands such as Samsung are responding to this challenge by establishing their own stores to sell their own products. There are also other sources of demand. The digitalization of the agricultural, industrial and service sectors is creating new types of demand and establishing new industrial parameters. Production automation and robotization, new energy and mobility systems, digital connectivity and security, digital health and medical devices, are all bringing in technological changes based around semiconductors. Moreover, the development of new advanced materials is making semiconductors present in all objects through the IoT. For example, cloud and data analytics are the biggest markets for the AI chips widely used in data centres. Processing electronics (storage and cloud computing) and communication electronics (wireless) are other key markets. If firms manage to build the capabilities required for linking up in any of these emerging industries, they can expect sustained demand growth.

3.6.3. What sector-specific policies matter? The case of the Republic of Korea

The electronics industry presents several challenges, but also opportunities for new entrants. The successful experience of the ROK in the development of the electronics industry shows how industrial policy and public-private consortia can play a very important role in linking up in the industry and capturing technological opportunities. The ROK took its first steps in the semiconductor industry in the middle of the 1960s by attracting companies of the United States in search of cheap assembling facilities. The sector emerged as an enclave disconnected from the rest of the economy, but one where skills and organizational capabilities started developing. Throughout the 1970s and 1980s the government emulated that of Japan in implementing widespread industrial policy measures, including support of family-controlled diversified business groups, the chaebol. These business groups developed significant mass-production organizational capabilities and accumulated significant financial resources from exporting consumer electronics. In 1984 of the first commercial DRAM product was launched and in less than ten years, Samsung became the largest world producer of DRAM (Shin, 2017).

Another important development was the move into the digital television industry (Lee et al., 2005). During the 1990s the electronics industry underwent a shift in technological paradigm with the move from analogue to digital products. When technological shifts of this type happen, governments can play a critical role in coordinating industrialization efforts and creating markets through the setting of industrial standards. The government recognized the technological and market potential of the high definition (HD) segment of the industry. The country was already a mass producer of analogue TV, and capabilities developed there could be redeployed for the new HD product. However, further technological capability was needed. In 1989, the government set up a Committee for Co-development of HD TV comprised of three ministries (Ministry of Commerce, Industry and Energy; Ministry of Information and Communication, and Ministry of Science and Technology) and 17 institutions comprising private firms, government research institutes, and universities. This resulted in the establishment of a 'grand research consortium' led by Video Industrial R&D Association of Korea and including the Korea Electronics Technology Institute (KETI) and the Korea Institute of Industrial Technology (KITECH), and joined by Daewoo Electronics, Hyundai, LG, Samsung and other private sector firms. Video was assigned the important role of evaluating the technical aspects of research proposals for funding and of monitoring their development. KITECH and KETI provided administrative and technical support, including monitoring of smaller groups within the consortium. Between 1990 and 1994 the research consortium was allocated 100 million US dollars, with half of the funding from the government and half from the private sector.

The research consortium's work focussed initially on technology transfer and absorption from the technological leading countries, Japan and the United States. Moreover, given that the standards for digital TV had not yet been established, the consortium promoted the development of alternative standards among members. Each major company was assigned to develop one of the leading standards emerging from the United States. Through the use of significant public funding and expertise the consortium largely removed the risk associated with early stage development of a new product. The government also provided coordination of the efforts of different companies, while leaving space for competition and the appropriability of innovation.[62] Alongside these joint research efforts, Korean companies also started establishing research teams and centres in the United States close to universities and other research institutes.

62 As documented in Lee et al. (2005:50) "[t]he whole project was divided into digital signalling (satellite and terrestrial), display (CRT, LCD, PDP) and ASIC chips (application-specific integrated circuits chips, encoding, decoding, demultiplexer, display processor). Each unit, GRI or private firm, was assigned to different tasks with some intentional overlaps among them, namely two units to undertake the same task to avoid the monopoly of the research outcomes. While each unit is supposed to share the results with other firms, the private companies are observed to have tended to do research on diverse aspects of the digital TV technology and to keep important or core findings to themselves".

By October 1993, the consortium, with Samsung and LG as the de facto leaders, presented a first prototype showing the technical feasibility of digital TV broadcasting and receiving. At this stage, companies persuaded the government to launch a second stage of the grand research consortium focussing on the industrialization and commercialization of the new prototype. Starting in 1995, the new consortium worked on the development and miniaturization of ASIC chips. As in 1990, the different stakeholders targeted different technical aspects, although many companies competed to get to the final commercial product, which was launched by Samsung in 1998.

The success of the sector was the result of strategic government vision and competition among leading companies. Research institutes also played a key role, especially monitoring the technological feasibility of the project and identifying future winners, such as the small firm Qualcomm. They also supported the government in developing the standards for the new products, something which proved critical in catching up with competitors. Finally, the consortium model acted an institutional solution to the need to pull together complementary capabilities to speed up the learning process, as well as generating new capabilities for future diversification.

3.7. Emerging industries using Fourth Industrial Revolution technologies

3.7.1. Industry overview: Global parameters and segmentation

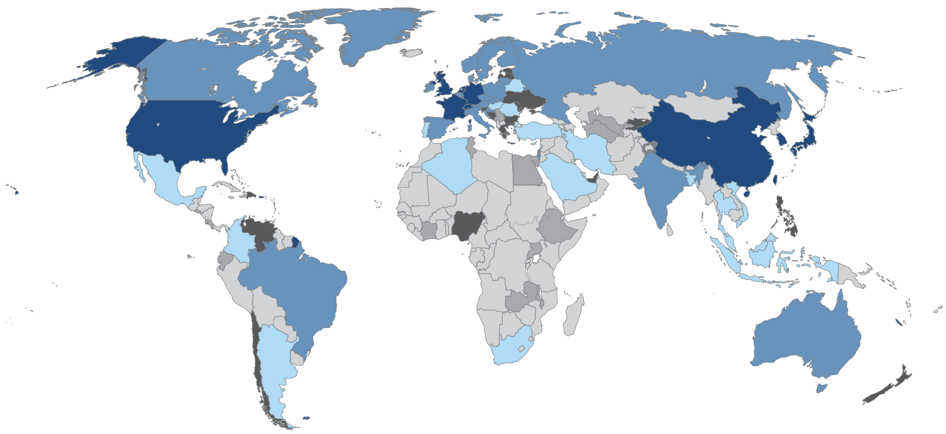
The so called Fourth Industrial Revolution (4IR) encompasses different types of technologies, which are altering production and service activities within and across different value chains. Advances in fields such as robotization and additive manufacturing, as well as related data analytics and systems, digital platforms and digital supply chains, are opening up new opportunities to accelerate innovation and increase the value-added content of production (OECD, 2017a; UNIDO, 2019). Some of these technologies have sector-specific applications, although the majority of them are platform technologies deployable in multiple sectors (Andreoni, 2020).

4IR technologies are combining the physical with the digital realms of production and products, while merging different technology and science fields—so called technology fusion. The availability of more and better-quality data is at the core of today's digital industrial revolution. Data are central in product and process design, process control, coding and tracking of products, within a firm and along its supply chain. Already in the so-called Third Industrial Revolution, the diffusion of measurements and standards, and the initial sensorisation of machinery, have opened the way to a series of key production improvements such as system automation and predictive maintenance. However, with the development of increasingly advanced data analytics capabilities and artificial intelligence several industries are entering a new era of digital industrialization era.

The different levels of engagement of countries in different regions with the digital technologies of 4IR is determined by their existing production structure and the extent to which they are equipped with the necessary basic capabilities and enabling digital infrastructure. Figure 3.8 shows the diffusion—measured both in terms of production and use—of digital production technologies across several countries. Only 50 economies can be considered as actively engaging with digital technologies.

Thus, 4IR opportunities are not equally distributed as companies and countries face different challenges. The effective adoption of these new technologies presupposes the existence of productive organizations endowed with basic and intermediate production capabilities and supported by enabling infrastructure such as reliable electricity, standardisation and connectivity (UNIDO, 2019a). These conditions are missing in many of developing countries, as well as in regions in both emerging countries and mature industrial economies.

Figure 3.8: Production and use of advanced digital production technologies



Economies actively engaging with ADP technologies

- Frontrunners
- Followers in production
- Followers in use
- Latecomers in production
- Latecomers in use
- Laggards

Note: ADP is advanced digital production. The map is presented solely for graphical illustration and does not express any opinion on the part of the UNIDO Secretariat concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries. The boundaries and names shown and the designations used on this map do not imply official endorsement or acceptance by the United Nations. Dotted line represents approximately the Line of Control in Jammu and Kashmir agreed upon by India and Pakistan. The final status of Jammu and Kashmir has not yet been agreed upon by the parties. Final boundary between the Republic of Sudan and the Republic of South Sudan has not yet been determined.

Source: UNIDO (2019a).

3.7.2. Sector-specific industrial parameters for success[63]

Over the last few years, companies and countries driving the 4IR have started redesigning many of the traditional industrial parameters, which have determined earlier success. While these new parameters are going to be critical in the coming decades, a number of challenges must be addressed across developing countries if they are to capture a digital dividend from 4IR technology. As the Korean experience in the electronics industry has shown and the following country case of Costa Rica, demonstrates further, learning to industrialize takes time and a number of basic capabilities must be developed to capture the digital dividend. In what follows five main challenges and related industrial parameters which are critical for today's developing countries wishing to engage with 4IR technology are highlighted.

A. Technology absorption, effective deployment and capability threshold

Digital technologies have raised the capability threshold that companies are required to achieve to make effective use of the new technologies. This is because the 4IR is about the 'fusion of existing and new technologies' into complex integrated technology systems (Tassey, 2007). Managing complex integrated technology systems like a fully automated production line, combining robots and IoT technology, is an extremely demanding task for a productive organization in a developing country, where the necessary capability is in scarce supply.

B. Production system retrofitting and integration

Industrialization is about commitment of resources under uncertainty (Chang and Andreoni, 2020). Most of these commitments involve physical capital that embodies certain technologies and cannot be re-moulded in any significant way to embody other technologies. Very often the commitments are organizational also, and involve the specialization of individuals in specific skills. These commitments are critical because they raise productivity, however, depending on the degree of reversibility of the investment, these commitments make future change more difficult. This introduces a very specific challenge in developing countries. The existing companies who can make technology investments have already committed resources and have to see how they can retrofit and integrate the new digital production technologies into their existing production plants. The setting up of wholly new plants requires significant long-term investment and access to markets.

C. Basic and digital infrastructure

Digital technologies are very demanding in terms of the infrastructure required to enable their use in production. Many developing countries face significant challenges when it comes to providing affordable and reliable electricity, as well as adequate connectivity. In some cases, these infrastructure bottlenecks have been bypassed by off-grid energy technologies and wireless connectivity systems. While these solutions work in certain areas, they are not always able to provide the quality and reliability of service needed to run digital production technologies effectively.

63 This section draws from UNIDO (2019a).

As a result, the productivity and quality improvements that digital production technologies offer are offset by these infrastructure bottlenecks, which can make the technology investments by individual companies high risk and therefore unattractive.

D. Technology diffusion, 4IR islands and the digital capability gap

Despite the fact that in almost all developing countries it is possible to find 4IR islands, where a few companies are engaging with some digital production technologies, many of these technologies remain contained within the company. Occasionally, a few close suppliers who have the basic production capabilities to use them might be linked to these companies, who often rely on their own infrastructure facilities. At the same time the large majority of companies and sectors will still be operating within an earlier technology paradigm. This means that it is extremely difficult for the leading companies—such as an OEM—to link backwards and develop a domestic supply chain. The digital capability gap between island companies and suppliers can be so extreme and so costly to address that the diffusion of 4IR technologies remains very limited.

E. Endogenous asymmetries in technology access and affordability

Digital technologies are complex and are controlled by a limited number of leading firms in advanced countries. Firms in value chains from developing countries rely heavily on the importation of these technologies, and in many cases even when they are able to mobilize the resources to access them, they are tied to their buyers both with respect to the hardware and software components of the technology. In GVCs international buyers and OEMs control the source, type and utilization of digital production technologies by setting the terms of access of their suppliers. The importance of using common protocols and software platforms for the deployment of digital technologies can create a concentration of power within GVCs. Also, for many of these technologies the acquisition of the hardware is accompanied by the need for expensive technology services and royalties for the use of the related software (Sturgeon, 2017).

3.7.3. What sector-specific policies matter? The case of Costa Rica in digital medical devices

In some of the sectoral success stories discussed above, the opportunities and challenges associated with the use of 4IR technologies were highlighted; for example, intelligent automation and robotization is pushing the frontiers of the machinery and equipment sector and new market and technological opportunities are shaping the electronics industry. Another sector in which 4IR technologies are playing a major transformative role is medical devices. Medical devices is a high-technology sector producing sophisticated ‘critical system products’ made up of thousands of micro-components. They are called critical system products because, as in the case of airplanes, the risk of failure must be minimized to guarantee human safety. Given its R&D intensity and high-technology and safety standards, a few countries (United States, EU and Japan) and companies (GE Healthcare, Johnson &

Johnson, Medtronic, Siemens Healthiness, Fresenius and Baxter) have traditionally dominated the industry. Moreover, companies tend to operate surrounded by their suppliers, given the importance of retaining a close link between research, development and manufacturing. Example of bio-medical clusters can be found in Massachusetts (United States), Emilia Romagna (Italy) and the West of Ireland. These are also the countries and companies which are leading in areas like artificial organ bio-engineering, regenerative medicine, precision medicine, nano-biotechnology and e-health.

Over the last two decades, Costa Rica has emerged as a global medical device centre of more than 70 specialist companies, including some leading multinationals, such as Baxter and Medtronic. The medical device industry has expanded, diversified and upgraded substantially over this period, going from Class I medical devices (such as disposables) to Class III medical devices (such as surgical instruments, therapeutic devices, infusion and drug delivery systems, implantable and diagnostic equipment). These medical devices are used in the most critical fields such as for the treatment of cardiovascular, neuro-endovascular, and neuro-modulation conditions. In many of these areas, digitalization is the new technology platform and to be competitive the digital capability threshold of firms must be high.

Costa Rica has managed to overcome this threshold and move from a low-tech manufacturing hub for multinationals to an R&D and advanced manufacturing ecosystem. Between 2007 and 2018, medical device exports tripled to become Costa Rica's largest export (export value of just under 3 billion US dollars, almost 30 percent of total export value). Although a small country, Costa Rica is the second exporter in Latin America, after Mexico. This success has been driven by companies like Establishment Labs, a global medical device company operating in the breast aesthetics and reconstruction market. Their products combine nanotechnology and 3D printers to obtain a more biocompatible product, designed to improve patient safety due to a cell-friendly surface on smart breast implants. In 2018 Establishment Lab was the first Costa Rican company to go public on the NASDAQ stock exchange.

Industrial policy has played an important role in shaping this sector and overcoming many of the challenges related to the use of 4IR technology discussed above. Since the late 1980s, the government has targeted FDI and invested in those skills and infrastructure needed to upgrade along the value chain. The large medical equipment firm Baxter set up a plant in Costa Rica in 1987 and Intel picked Costa Rica, alongside China and Malaysia, as the three locations outside the United States to manufacture microprocessors. From the beginning of the policy of attracting FDI the government realized that high-tech sectors must be targeted to increase value domestically and spur innovation. The government and the investment promotion agency (CINDE) planned to move away from electronics given the volatility of the industry and the potential for low margins for assemblers. The medical device industry was targeted and building on the experience with Baxter and Intel, the government developed an incentive policy and combined this with targeted investments in the development of capabilities.

First, the government offered high-tech multinationals operating within its free trade zone an attractive tax incentive package which included (in the first period) full exemption from income tax, full exemption from import tariffs (on intermediate capital goods, raw materials and inputs), full exemption from local taxes (sales, VAT, municipal and royalties) and free management of foreign exchange. Over the years these tax incentives were adjusted and some were renewed. Initially companies were required to meet an export threshold, which was later removed, while minimum employment and investment thresholds were retained for selected investors. With the establishment of the Export Promotion Agency (Promotora de Comercio Exterior de Costa Rica, PROCOMER), the government also developed a supplier matching system through which the procurement needs of multinationals were matched with local suppliers. A detailed capability assessment of local suppliers was also managed through CINDE and capability gaps in production, organization and technology were identified for targeted interventions. CINDE also played an important facilitating and intermediating role, for example, managing an international forum to make domestic suppliers aware of technological and market developments.

Medical device production is skills-intensive, requiring a combination of different science and manufacturing capabilities. It is also a highly regulated industry with very strict standards. For a long period of time, Costa Rica has committed around 8 percent of GDP to education. The Instituto Tecnológico de Costa Rica (TEC), one of the top public universities of Costa Rica, set up a specialized master training programme in medical devices in collaboration with the University of Minnesota. A highly educated and relatively cheap labour force close to the United States' market was a major factor in attracting FDI. Further collaboration with leading research universities like Georgia Tech and the Copenhagen Institute for Interaction Design have been launched to develop high quality skills and to engage with the frontier technologies, which are transforming the medical device sector (such as analytics, data visualization, user-experience and interaction, and machine-learning). Over the years, the government's emphasis on investment in technological upgrading has established the country as research centre. Hence when Intel relocated its microprocessor plants to Asia, Intel's Global Services Centre, as well as the company's Engineering and Design Centre, remained in Costa Rica. In the medical device sector, currently there are around 30 research institutions and almost 7,000 specialized researchers.

In 2017 the government launched a new package of industrial policies for the digitalization of the economy in the Digital Transformation Strategy 2018-2022. The medical device sector is a key target of the strategy. Among its six strategic pillars, the government is promoting further development of technology parks, in which companies are offered office rental, data centres, high speed internet services, and other facilities. For a sector like medical devices, a key infrastructure is the hospitals where learning by users is key to innovation. Hospitals and universities in the country are progressively incorporating new generations of human androids for advanced training. Robots for simulation have been used for almost a decade for systematic training of medical personnel. The government is now promoting the introduction of new devices able to recreate symptoms and test therapeutic responses and the effectiveness of medical devices. Finally, new technology partnerships have been promoted to explore frontiers of AI in medicine. For example, 3D digitalization of images taken from radiographs, magnetic resonances, CT scans or ultrasound can be analysed with AI algorithms and enhance doctors' diagnostic capacity and help identify new therapies.

The fact that Costa Rica is today ready to engage with 4IR is the result of a long journey in which the government has shaped and given direction to the medical device sector in close collaboration with companies. Without such an industrial ecosystem of business enterprises, research institutions and incentives, 4IR applications in medical device could have not developed.

3.8. Key lessons: Tailoring industrial policy for sectoral development

Sector-specific industrial parameters need to be considered in the design of a sector-appropriate industrial policy and binding constraints need to be identified. The sector analyses presented in this Chapter highlighted sectoral heterogeneity as a critical factor in successful industrialization, so that general parameters for a sector need not apply to all sub-sectors. Chapter 4 discusses how the industrial policy design process benefits from government-business interactions exactly because business enterprises operating in a certain sector can provide detailed information on these industrial parameters. Governments can use this information to make sure that industrial policy is effective not simply formally—using the right industrial policy instrument—but also functionally, that is, the policy instrument has been chosen to respond to the sector-specific conditions, as defined by the key industrial parameters. Table 3.4 provides a summary benchmarking the sectors considered against different industrial parameters. It points to the policy experiences reviewed above and the main instruments adopted for development in different sectors. Building on these cases, five principles for sector-specific industrial policy are highlighted.

A. Building sector-specific capabilities

First, the government can play a key role in building the necessary productive, technological and organizational capabilities that are specific to that sector. There might be several cases of under-investment in sector-specific capabilities that undermine business enterprises' general efforts in making a sector productive and competitive internationally. The government can fill this investment gap in three main ways: (i) directing resources for capability building where needed; (ii) offering incentives to companies to invest in capabilities to meet sector-specific needs; (iii) providing industrial and technology services directly to companies.

B. Raising awareness of binding sector constraints

Second, the government can develop a more fundamental capability, that is, helping companies in realizing why they are not successful in a certain sector. In

Table 3.4: Sector-specific industrial policy benchmarking

Industrial policy experiences and main policy instruments	Chile	Bangladesh	Thailand	China	The ROK	Costa Rica
	Technology intermediary Demonstration projects Export markets targeting	Technology transfer FDI incentive policy Export Promotion Zones	Strategic trade policy FDI incentive policy Technology upgrading policy	R&D policy FDI incentive policy Mission-oriented robotization policy	Research consortium Technology transfer Standards setting	Education & Technology Policy FDI incentive policy 4IR Experimentations
Sectors	**Food & beverages**	**Garment**	**Automotive**	**Machinery & Equipment**	**Electronics**	**4IR: Medical device case**
Industrial parameters						
Production						
Reliance on specific/ non-reproducible resource	***	**	**	**	**	**
Energy intensity and quality	**	**	***	*	**	**
Capital intensity and type	**	**	***	**	***	***
Production time and cycle	*	***	***	**	***	**
Scale economies and minimum scale efficiency	**	**	***	**	***	**
Labour intensity	*	*	*	**	**	*
Skills intensity	**	*	***	***	***	***
Scope for automation and robotization	**	**	***	***	***	**
Capital / Labour substitutability	**	**	***	**	***	**
Process standardization	***	*	***	**	***	***
Organizational						
Degree of vertically (dis-)integration	**	***	**	**	**	**
Administrative hierarchic (de-) centralization	**	**	**	**	**	**
Process modularization scope	*	*	***	***	***	***
Geographical spread and distribution	***	***	**	***	***	**
Supply chain management capabilities	***	***	***	**	***	**
Organizational integration capabilities	**	**	***	***	***	***
Scope for organizational diversification	***	*	*	***	***	***

Table 3.4 continued: Sector-specific industrial policy benchmarking

Industrial policy experiences and main policy instruments	Chile	Bangladesh	Thailand	China	The ROK	Costa Rica
	Technology intermediary Demonstration projects Export markets targeting	Technology transfer FDI incentive policy Export Promotion Zones	Strategic trade policy FDI incentive policy Technology upgrading policy	R&D policy FDI incentive policy Mission-oriented robotization policy	Research consortium Technology transfer Standards setting	Education & Technology Policy FDI incentive policy 4IR Experimentations
Sectors	**Food & beverages**	**Garment**	**Automotive**	**Machinery & Equipment**	**Electronics**	**4IR: Medical device case**
Industrial parameters						
Technological						
Basic science dependence	**	*	***	***	***	***
Technology intensity	**	*	***	***	***	***
Technology standardization	**	*	***	***	***	***
Learning cycles (how long it takes to learn)	*	*	***	***	**	***
Product customization	*	**	**	***	**	***
Product reliability (critical product systems)	*	*	***	***	**	***
Scope for technological diversification	*	*	**	***	***	***
Market						
Extent (size of the market)	*	*	***	**	***	***
Type (segmentation and structure)	**	**	**	***	***	***
Demand elasticity (income and price)	**	***	***	**	***	**
Degree of tradability	***	***	***	***	***	**
Proximity to markets advantage	*	**	**	***	**	***
Accessibility (transportation costs)	*	*	**	**	**	**
Protection (tariff and non-tariff barriers)	***	*	**	*	**	***
Competition	**	***	***	**	***	***
Regulations and standards	***	**	***	**	***	***

Note: When an industrial parameter is 'relevant' for the industry in general it is identified by one star (*)

When an industrial parameter is 'important' for the industry competitiveness but not binding it is identified by two stars (**)

When an industrial parameter is 'binding' for the industry competitiveness it is identified by three stars (***)

Source: UNIDO elaboration.

some instances, uncompetitive companies may not be aware of the real reasons underlying their poor productivity and competitive performance. The government can benchmark domestic companies against those of other countries and identify what industrial parameters matter most and how far domestic companies are from the international benchmark.

C. Creating and shaping sectoral markets

Third, the government can shape and create markets in a sector with targeted procurement and other policies. The markets can be strongly influenced by governments both at the micro level, for example through regulation and competition policy, and at the macro level, through fiscal, monetary and exchange rate policy. Governments can shape the structure of a sector by promoting consolidation and regulating competition. This means that many of the market-related industrial parameters are policy-made.

D. Changing industrial parameters

Fourth, industrial policy is about finding ways to build production, organizational and technological capabilities to meet but also to change the parameters determining success in a sector. Many—although not all—industrial parameters are redesigned by technological change. For example, ICT changed the organizational parameters of many sectors and increased their geographical scope. Digital production technologies are redesigning productivity parameters and intelligent automation is changing the scope for robotization, beyond traditional sectors like automotive. Experiences discussed in Chapter 2 demonstrate how in varying ways the government has acted as a major technological entrepreneur. It has done so by creating the technological infrastructure from which technological innovation has developed, including investment in basic science, standardization and technology intermediation services.

E. Capturing windows of opportunity

Fifth, technological change constantly redefines sectoral boundaries. In recent years sectoral boundaries have become increasingly blurred when structural interdependence across different sectors is redefined by the emergence of cross-cutting platform technologies, such as many associated with 4IR (Andreoni, 2020; UNIDO, 2019a). As a result of these transformations, sector-specific industrial parameters also change. For example, while scale economies may remain a key binding constraint in some sectors, additive manufacturing and new advanced materials will have affected the supply chain of spare parts and the customization of components. Changes in critical industrial parameters and sectoral boundaries offer an opportunity for alternative patterns of industrialization beyond those suggested by comparative advantage.

4 GOVERNING INDUSTRIAL POLICY

Processes and governance solutions for effective industrial policy making

4.1. Governing industrial policy: The technical and political dimensions

Successful industrialization is not simply about picking the right policy instruments and institutions, but also learning how to build, use and coordinate them in an effective way. This chapter focusses on how to govern industrial policy instruments and institutions effectively. It addresses the role that processes, policy alignment and coordination across organizations play in successful industrial policy making. As already highlighted in Chapter 2 with reference to several country experiences, industrial policy is not simply a technical process, but is also and foremost a political one.[64] These two processes are intertwined affecting each other along the industrial policy cycle—from design, to implementation and enforcement, as well as from monitoring, to experimentation and adaptation.

To illustrate the relationship between the political and technical, the problem of enforceability can be considered. This problem is about how governments make sure that those companies that receive some form of policy support—such as a subsidy—deliver what they promised—such as making an investment resulting in higher productivity. First, it is a technical problem of how ex ante policies are designed to reduce the risk of unproductive use of rents or 'policy capture'. But second it is a political problem of how throughout the policy process coalitions of interests are established to manage conflicts and ensure the funds are used as intended. The enforcement of the policy is about both technical solutions and political economy.

64 There is an extensive literature on this; see for example Hirschman (1958); Wade (1990); Chang (1994); Khan and Jomo (2000); Whitfield et al. (2015); Andreoni and Chang (2019); Chang and Andreoni (2020).

These twin challenges are at the core of industrial policy making and both need to be addressed. At the same time, it is unrealistic to expect any country, especially developing countries, to have highly effective processes, institutions and coordination mechanisms to design, implement and enforce a very demanding industrial policy. It is not only that governments have relatively limited capabilities in developing countries, the private sector has a limited capacity to respond effectively to the incentives and opportunities offered by industrial policy. Exactly because the economy has not yet industrialized, enterprises lack those productive, organizational and technological capabilities that allow the productive use of the rents governments allocate through industrial policy. This is why it is critical for the government and private sector to build coalitions of interests and sustain them by managing conflicts as they arise. It is argued frequently that industrial policy making is the most challenging exactly where it is needed most, so the problem is not about avoiding failures, some of which will be inevitable, but about learning how to fail better (Oqubay, 2016).

Learning, experimentation and adaption are essential in industrial policy making. The fact that industrial policy is about learning is perhaps the most profound insight of the so called 'East Asian Miracle'.[65] The experiences of early, recent and emerging industrializers reviewed in Chapter 2 also point in the same direction.[66] In what follows the discussion aims to unpack a number of key processes of policy making to support industrialization.

First, it focusses on best practice procedures underpinning effective policy design, and their limitations in real policy making. These limitations and the lessons and strategies to overcome them are discussed in section 4.2. The analysis then considers ways in which different policy instruments can be aligned within policy packages of interactive measures (section 4.3). Policy alignment is a key factor differentiating successful from other cases. An industrial policy matrix framework is used to identify the opportunities and challenges arising from industrial policy alignment.[67] Section 4.4 analyses several governance organization models for co-ordination inter and intra ministries, departments and agencies. Any real world set of power relationships will be highly context-specific reflecting a state's own political economy. What such general models offer are schematic frameworks to manage power relations and address industrial governance challenges within the public sector and across the public and private sectors.

In the context of the relationship between the public and private sectors, the enforceability comes to the fore, as there is no point in aligning and coordinating

65 Again, there is a large literature; see for example Johnson (1982); Amsden (1989); Wade (1990); Chang (1993); Evans (1995); and Andreoni and Chang (2017).

66 The idea of 'self-discovery' by firms to identify what they are good at producing has been highlighted as an outcome of a successful policy that supports innovation (Hausmann and Rodrik, 2003). This concept differs from the idea of learning how to apply industrial policy, which is the concern here. Further the experience of many African countries points to the fact that prevailing interests and endowment structure might lead to self-discovery by firms, but of the type which is not conducive to better quality of growth (Kanbur et al., 2019).

67 This draws on Andreoni (2016) and Andreoni and Chang (2019).

policies if policy instruments are not enforceable. Two main processes underpinning policy enforcement—building coalitions of interests and managing conflicts—and lessons on how to manage them are addressed in section 4.5

Finally, section 4.6 considers the trade-off between continuity in policy making and the need to adapt to changing circumstances and experiment with ways of doing things differently.

4.2. Industrial policy design: Selectivity, feasibility and orientation

In today's developing countries there is no lack of industrial policy documents. Almost all countries have produced at least one industrial policy document over the last two decades. In some cases, governments have produced several industrial policies, and for each of them several implementation strategies, master plans and blueprints. It is also common to find that policies produced by different government bodies—such as the Ministry of Industry and Trade and the Ministry of Finance or the Ministry of Economic Planning—coexist and are poorly aligned.

This proliferation of industrial policy documents is due to the resurgence of interest in industrial policy.[68] It is also the result of a scattered policy design process reflecting lack of vision, policy duplication, poor management of political economy issues and coordination challenges in governance. In fact, despite the recent popularity of industrial policy, it is relatively rare to find countries which have fully implemented their policies, or done so effectively. The successful case studies reviewed in Chapter 2 were at least partially affected by this governance challenge as well, especially in the early stages of the application of policies to support industry. However, they managed to govern their industrial policy making process over time better than other countries and an effective industrial policy process is a key factor distinguishing the successful from other countries.

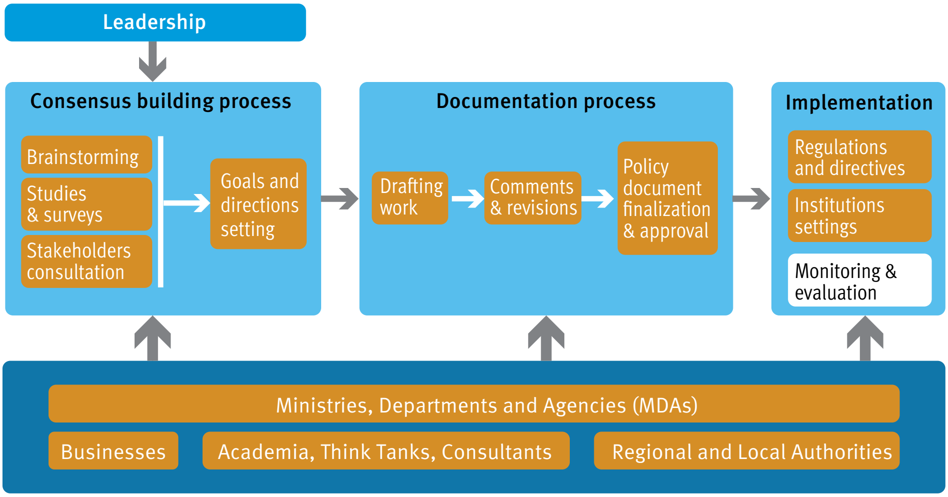
4.2.1. Best practice in policy formulation, and what factors make it work 'really'

There is a standard three-level model for best practices in policy formulation, as presented in Figure 4.1.[69] Here committed leadership plays a central role in setting the industrialization vision for the country (first layer). This vision is then discussed as part of a consensus building process, which leads through an iterative process to the design and formulation of a policy document (second layer). Both the processes of consensus building and policy design/formulation are supported by relevant stakeholders from within the government, as well as the broader society (third layer).

68 See for example, Rodrik (2008); Stiglitz and Lin (2013); Salazar-Xirinachs et al. (2014); Noman and Stiglitz (2016); Storm (2017); Andreoni, Chang and Scazzieri (2019); and Chang and Andreoni (2020)

69 According to Ohno (2013:92) '[i]n policy formulation, the procedure by which policy is made is often more important that the final document which is drafted and approved'.

Figure 4.1: Standard policy making procedure model



Source: UNIDO elaboration adapted from Ohno, 2013.

However, this is not how policy design and formulation develop in practice, as several factors disrupt this simple linear process. For example both technical and political factors can play a role in the context of setting up and sustaining the leadership vision; in the process of building consensus across government; and in the process of delivering effective documentation. Across these processes, three specific factors determining success—selectivity, feasibility and orientation—are given particular emphasis in the next sub-sections.

A. Leadership vision

The leadership vision is often articulated in long term (ten years plus) vision documents spanning several governments. If countries experience changes in leadership in the short or medium term, the vision might remain in place, but with limited political traction. This is the case even for countries with relatively long-established presidential governments—for example across several African and East Asian countries. In these cases, while leadership remains the same for relatively long periods of time, the powerful groups supporting the leadership tend to change, reflecting the internal evolution of political parties and domestic power conflicts. Finally, even assuming committed leadership at the beginning of the policy process, government commitment might weaken over the years and impact negatively on the implementation of the vision.

Those countries that managed to have a strong and persistent vision relied on long-lasting leaders. Classic cases can be found among recent industrializers in East

Asia—for example, Singapore, the Republic of Korea (ROK) and China, although the top leadership was not the only success factor in these countries. In successful countries leaders managed to ‘embed’ their vision in government institutions, as well as in the broader society, by using ideology and creating and maintaining lasting coalitions of interests linking public and private sectors. A strong embedding effort is needed if visions are to guide policy making and this process takes time and resources. Embedding efforts are a key background factor supporting the processes of consensus building and policy design. They also provide a platform for political continuity and create scope for experimentation. Political continuity does not mean lack of adaption or experimentation. Instead, it provides a way of reducing some of the uncertainty faced by the government and private sector. In this respect, leadership vision is useful even when it is ‘wrong’, as vision is a necessary condition for coordination and under the right circumstances a vision can be converted into a mission-oriented approach to industrialization.

B. Consensus building

The consensus building process is aimed mainly at translating the vision and giving it a policy structure—including specific targets, selection of policy instrument, prioritization through budgetary allocations, time frames, and indicators for monitoring and evaluation. A successful consultation process requires involvement of stakeholders across the private sector—including business associations, sectoral councils, and associations of employers—as well as trade unions and public sector bodies, especially the Ministries and agencies, which have a direct stake in the policy process. Identification of specific policy targets brings to the fore resource allocation trade-offs and intra-government conflicts of interest. Ministries and agencies with relatively more power will attempt to shape the consensus building process to retain or increase their power. Those which are less powerful will focus their efforts on resisting and protecting their budget. As a result, especially in countries with limited public resources to fund policy making, the consensus building process can be difficult.

Governments which have been successful in addressing this challenge have relied on a lead Ministry reporting to an inter-Ministerial committee/council to lead the industrial policy process. While this approach is often effective, it might not be sufficient. Other Ministries and agencies participating in the council/committee might feel that they do not own the policy. As a result, they might choose to exit from the process or they might even try to block it, if they feel their interests are affected negatively. This is why it is of paramount importance that any Ministry or agency in charge of the consensus building and documentation process is backed by the highest level of leadership in the country. In some countries, this has also meant using symbolic—though often effective—mechanisms, such as setting up and locating an office/committee under the President’s Office, or making the President the active chair of the inter-Ministerial committee/council. Organizational mechanisms that ensure evidence gathering, evidence-based discussion and policy learning from abroad are also critical. These coordination bodies also play a central role in the implementation, enforcement and monitoring of policy.

Another important factor in making the consensus building process more effective is to limit rivalry between public Ministries and agencies by adopting different types of budgeting procedures. All countries taking their first steps on the industrialization ladder have limited tax collection capability, and thus have limited resources to allocate in the industrial policy budget. Despite this, in these countries governments are typically a major source of demand through public spending and procurement and control a range of subsidies across different sectors. These segments of the government budget can be used strategically to support industrialization. For example, by creating a centralized procurement department across government entities, government can target demand at specific activities, expanding or creating a market. Energy subsidies can be used to promote specific industries. Tax exemptions can be rationalized and used more selectively to target investment. Successful countries have experimented with such budgeting (and related reporting/accountability) mechanisms to overcome a lack of direct funding for industrial policy.

Another way of concentrating resources behind specific goals is to define mission-oriented industrial policies. Given its role and mandate in the government, the Ministry of Finance is a key player in this budgeting process, but it is also a player generally biased towards stricter budgetary policies. The frequent tension between a Ministry of Industry and Trade—generally favouring a more expansionary budget policy—and a Ministry of Finance—more often inclined to follow a restrictive budgeting approach—is a major governance challenge. Mission-orientation can help in turning inter-ministerial budgetary conflicts into a problem-centred approach. As discussed below, a mission-oriented approach can help Ministries and agencies in focussing their efforts around a high-profile challenge and encourage them to develop mechanisms to contribute to the mission, thus gaining a political dividend.

The use of a mission-oriented policy framework is even more effective when private sector stakeholders are involved in these processes and deals can be struck between the government and private companies and constituencies. The involvement of the private sector is a necessary condition for success. Hearings in which official views are unilaterally communicated to the private sector, or where a large symposium is convened to collect general inputs, are of little effectiveness. The private sector needs a meaningful voice in discussions on policy. Sector-specific business councils have been established in several countries to allow companies to articulate concrete proposals. Within these councils, government can create a system of competitive proposals for support and govern the process by ensuring funding is allocated on the basis of an estimated contribution to the national interest, not simply as a result of lobbying or favouritism. When these mechanisms have been deployed effectively—for example when sectoral negotiations have been given sufficient time to develop—they have resulted in higher quality final policy documents.

C. Documentation process

There is no single blueprint for the structure of an industrial policy document. However, according to best practice, a structured document must include at least the following sections—vision, targets, situation analysis, policy issues and action plan. The action plan is the most detailed and challenging document to produce and should include a detailed master plan matrix articulating specific policy actions and related instruments; sub-actions; budget allocation; time frames; milestones; quantifiable goal targets; and the responsible Ministries or agencies.

A way of **concentrating resources** *behind specific goals is to define* **mission-oriented** *industrial policies.*

In many countries lacking general government capability or where specific industrial expertise has been lost, the documentation process is often outsourced to experts, typically international consultants. Policymakers from government Ministries, departments and agencies—contribute comments and revisions. Such a documentation process is doomed to fail for several reasons. Policy coherence is difficult to achieve from contrasting views, within the government. This is particularly the case when the consultation process ignores conflicting budgeting issues. Policy priorities are difficult to identify as all Ministries tend to push for their own targets to be the main priority of the strategy. In many cases, this outsourcing approach to policy documentation reflects limited policy commitment across the government.

On the contrary, governments which have been successful in industrial policy making have been willing to learn from foreign experience and expertise—especially in gathering and systematizing evidence—but have retained ownership of the documentation process. In doing so, they have been able to achieve three important objectives in terms of policy design. First, they have been able to make selective policy decisions, and thus, have prioritized interventions. Second, they have been able to assess the political economy feasibility of policy by gathering not only industrial data, but information on the political economy situation in the country and specific sectors. Third, they have been able to reach an agreement on the form of mission-oriented policies.

4.2.2. How to be selective in a smart way

Selectivity is about taking the political responsibility to make choices and prioritize targets, while balancing out trade-offs. All governments which have been successful in industrial policy making have used selectivity and the country evidence, reviewed in Chapters 2 and 3 supports this. To be selective in a smart way a number of principles must be taken into consideration.

First, successful governments have realized that not choosing a priority, whether a sector, a technology, or a region, is leaving choice to external factors. These external factors driven by markets forces, which are essential for industrialization, but need to be governed to achieve policy objectives and move the country forward on a path of inclusive and sustainable industrialization.

Second, successful governments have realized that there is no such a thing as a non-selective (also known as 'functional' or 'horizontal') policy, which benefits all equally. Beyond some basic public goods, such as primary education and health provision, any decision on capability building—say investment in physical infrastructure, or technical and higher education—has a disproportionate impact on some sectors or groups. Building an airport or a port, a highway or railway, means supporting the tradability of different type of products, just as investing in electrical, mechanical or civil engineers will support different activities (Andreoni and Chang, 2016). Following the discussion on sectoral heterogeneity in Chapter 3, industrial policies need to be selective exactly because industrialization opportunities and challenges are different across sectors.

Third, prioritization is essential given limited resources and selectivity is necessary for prioritization. The experiences reviewed in Chapter 2 showed how governments have relied on several policy instruments at the same time. Generally the further countries progress along the industrialization ladder and develop more capabilities within government, the more instruments they apply to address new and mounting challenges. For countries at early stages of industrialization, selectivity becomes an essential factor for success. Lack of selectivity means addressing too many too broad issues at the same time, and risks poor implementation. Lack of prioritization is not always accidental or due to lack of government capabilities. Instead, it may reflect a fragmented political economy, where conflicting claims on resources are difficult to reconcile.

Fourth, selectivity is often associated with the idea of picking winners, by selecting a specific sector or company for support. In this sense, selectivity is considered very risky as it can open the door to rent-seeking. However, there are several ways governments can take selective decisions in an effective way, while avoiding rent-seeking. Government can select the 'willing', more than the 'winners'. That is, it can select companies, which have already shown they are capable of competing and are willing to scale up their operations—for example by entering new export markets (see for example the case of Korean firms in the electronics sector discussed in Chapter 3). Selecting a sector can be also done indirectly by developing skills and providing specific technology services in key technology areas (several examples from Germany, Chile, China and Costa Rica are discussed in Chapters 2 and 3). Very often by picking technologies over sectors, new opportunities for sectoral diversification and development of linkages can arise and the more dynamic firms using these technologies can emerge without being targeted initially. Selectivity can be also achieved by a combination of measures aimed at a specific target without relying on a single policy instrument, like a subsidy, which could be more easily 'captured' or misused by recipients.

Finally, selective policies and instruments are easier to monitor than more general measures, which are likely to have more leakage into unproductive activity. In other policy areas, most obviously welfare provision, governments have always encouraged precisely targeted interventions because there are too many leakages from a universal system (Mkandawire, 2005). Some degree of targeting is inevitable, given resource limitations, but there is no simple linear relationship, positive or negative, between the degree of targeting and policy success. Successful experiences show that selective industrial policies must be feasible and well designed. Just as too little targeting can be ineffective, too much can be counter-productive (Andreoni and Chang, 2016).

4.2.3. How to make a political economy feasibility assessment

Selective industrial policies are powerful tools for targeting resources towards capability building and production transformation. By allocating rents—for example, by specific grants or subsidies, tax incentives or licensing—governments always favour selected activities and actors, instead of others. In some cases, the government will have to restrain certain economic activities to favour others, which otherwise might not develop. For example, in many countries at early stages of industrialization, controlling and restraining excessive imports can be a precondition for developing domestic production.

Developing a theory of change can be helpful in understanding industrial policy making. Theories of change are tools for industrial policy monitoring and evaluation and can be used to track the relationship between policy incentives and changes in the decisions of economic actors (Warwick, 2013). For example, such theories try to identify the channels through which a research grant or tax incentive will translate into increasing technology investment across targeted companies in a sector. Such theories can be extended to take into account the likelihood that certain policies will (or will not) be effective depending on the interests and organizational power of the economic actors involved (Khan et al., 2019). Assessing the interests and power of the relevant economic actors and the overall political economy configuration of a sector is relevant because economic actors are not passive recipients of policies. They can use their power to influence the industrial policy process and thus to promote and protect their economic interests.[70]

70 For example, smugglers might use their influence to undermine a government's industrial policy favouring infant industry protection. Andreoni et al. (2020) discuss this example for Tanzania in the context of the sugar industry and Andreoni et al. (2020) in the context of designing EPZs and selecting companies; see also several cases across Africa in Whitfield et al. (2015).

For the government, developing a theory of change based on appropriate information, can be a way to assess ex ante the feasibility in terms of political economy, and therefore the effectiveness, of a specific policy. To be useful this assessment, should consider specific policy instruments—say a tax incentive, import duty or license allocation—in a sector, while identifying the specific political economy dynamics, which affect the impact of the instrument used. Such an ex ante assessment does not exclude potential problems in the future, as there are many other factors, which can affect implementation and enforcement, especially where the balance of the political economy situation is evolving. It is, however, a way to reduce policy vulnerability to rent-seeking and by reducing vulnerability the government will be better equipped to enforce its policy objectives at the implementation stage.

In practice often these political economy feasibility assessments are left to the ex post analysis of policy failures. Policy design would be greatly improved if industrial diagnostics focussing on sectoral and technical issues are integrated with such political economy assessments. Independent academic institutions and multilateral organizations can play a useful role in supporting the government bureaucracy in applying this approach prior to decisions on specific policies (Khan et al., 2019).

4.2.4. How to give policy a mission orientation

As discussed above, policy visions often refer to very broad challenges and ambitions, and do not perform an essential coordination role. This is particularly the case if visions are not articulated in clear targeted missions and are not embedded in government institutions. An effective way to address these limitations—while improving the policy design process—it is to structure industrial policies around a number of missions. Mission-oriented industrial policies were used by early industrializers after the Second World War, when their economies needed systemic restructuring and new clusters of sectors had to be created.

Missions can work as a focussing and coordination device for industrial policy. In the context of mission-oriented innovation policy, it has been argued that missions must be bold and inspirational and have a wide societal relevance (Mazzucato 2013; 2018). They can play a role in mobilizing societal groups and can be used as an aspirational motivator. For example, they can be used to mobilize a society around environmental challenges and identify a number of mission projects which can contribute to the solution of the environmental challenge. Second, these mission projects should be targeted, measurable and time-bound. These are key qualities needed for clear policy direction.[71] Third, missions must be both ambitious and realistic, and focus on generating additionality above what would otherwise have happened, for example in investment in research. Fourth, they should be cross-disciplinary, cross-sectoral and involve different actors in the field of innovation. Finally, missions can be used to catalyse and coordinate several solutions across different levels of government, as

71 For example, if the mission is to reach a certain target in terms of greenhouse gas emissions by a certain date, a number of mission projects can be developed and aligned around measures like electric transport and carbon saving building design.

lower levels like regional and local government bodies can play an important role in co-developing and implementing mission-oriented policies.

Mission-orientation can be also used to address some of the governance challenges raised above. For example, coordinating budgeting exercises around missions more than around policy instruments or actors, like Ministries,—is a good way of ensuring narrow sectional interests do not dominate. Moreover, by developing a system of indicators attached to each policy action spelled out in the mission, the government will have an accountability instrument. These indicators can help in tracking flow of resources, their utilization (or lack of spending/implementation capacity in the relevant agencies), leakages and the overall distribution of the central budget. A mission approach also underlines the importance of effective policy alignment, as missions can never be achieved by deploying one policy instrument alone.

4.3. Industrial policy package alignment: More than just the sum of its parts

An important lesson from the East Asian Miracle experience is that successful industrial policy depends on the degree of strategic alignment of interacting policy instruments and institutions. Thus, governing industrial policy is in fact about governing a package of industrial policies.[72] The alignment of policies within a coherent policy package is a complex and dynamic process.[73] The main reason is that governments design and implement policies in historical time, thus, a new policy is never introduced in a vacuum of institutions and policies. Therefore, the challenge is to be able to identify how any new policy (or set of policy instruments) would interact with and impact on the existing package of policies and institutions (or how a new set of policies interact among themselves and with the existing policy and institutional framework).

Industrial policy alignment needs to achieve three main goals (Andreoni, 2016). The first is to make sure that a policy instrument will reach its intended target and deliver the desired development outcome. If potential interactions across policies are not considered in the policy design process, the new policy instrument might fail to hit the target. Many policies turn out to be ineffective not because of poor design, but because they are not consistent with the broader policy and institutional framework

72 Stiglitz (1996) emphasized this idea when he stated that the phenomenal industrialization of economies like Japan, the Republic of Korea, Singapore and Taiwan Province of China could be only understood by analysing their ‘packages of interactive measures’. Ha-Joon Chang has also stressed how combinations of different policies—sometimes even opposite policy instruments—can be used in a strategically aligned fashion to achieve certain industrial policy targets. For example, Chang (2011:100) writes, “In East Asia, free trade, export promotion (which is, of course, not free trade), and infant industry protection were organically integrated, both in cross-section terms (so there always will be some industries subject to each category of policy, sometimes more than one at the same time) and over time (so, the same industry may be subject to more than one of the three over time)”.

73 Andreoni (2016) analyses the degree of policy alignment achieved across six major economies (Brazil, China, Germany, Japan, South Africa and the United States) and shows how an aligned package of policies is more than the sum of its instrumental parts.

in which they are introduced. This is particularly the case when policies are simply copied from other countries without adaptation to the country's own context. The copy and paste syndrome in industrial policy making is particularly problematic when replicability and feasibility are not taken into consideration.

The second goal of policy alignment is for the government to achieve high degrees of complementarity between policies and institutions, so that policy complementarities enable a better outcome, than if policies were applied independently. For example, by coordinating two sets of policies—on technology policy and skills—the government can at the same time provide companies with (i) R&D funding to invest in product and process innovation (ii) technology services that support the scaling up and commercialization of innovation, and (iii) a specialized workforce that can contribute to the efficient production of the new products. If these policy instruments are not aligned, companies might still use one, such as the R&D fund, but they might not be able to scale up the production of the new product in the absence of the necessary skilled workforce.

The third goal of policy alignment is to avoid unintended consequences and specifically situations in which policy instruments and institutions undermine each other. This is a worse scenario than lack of alignment, as in this case internal policy contradictions result in negative outcomes. These contradictions tend to emerge when industrial policies are designed independently in Ministries, with a lack of coordination across government bodies at the national, regional and local levels.

Policy matrixes are useful diagnostic tools for addressing the challenges faced by industrial policymakers in aligning packages of interactive measures across different policy domains, levels of policy actions, as well as across different government bodies. A key factor in successful policy design is to assess the degree of policy coherence, the existence (or lack) of policy linkage opportunities and potential coordination (or duplication) problems across government bodies—both horizontally (across Ministries and national agencies) and vertically (between central and local authorities).

The policy matrix in Figure 4.2 is a mapping tool structured around two main dimensions[74]:

A. Industrial policy domains (clusters of supply and demand side policy instruments)

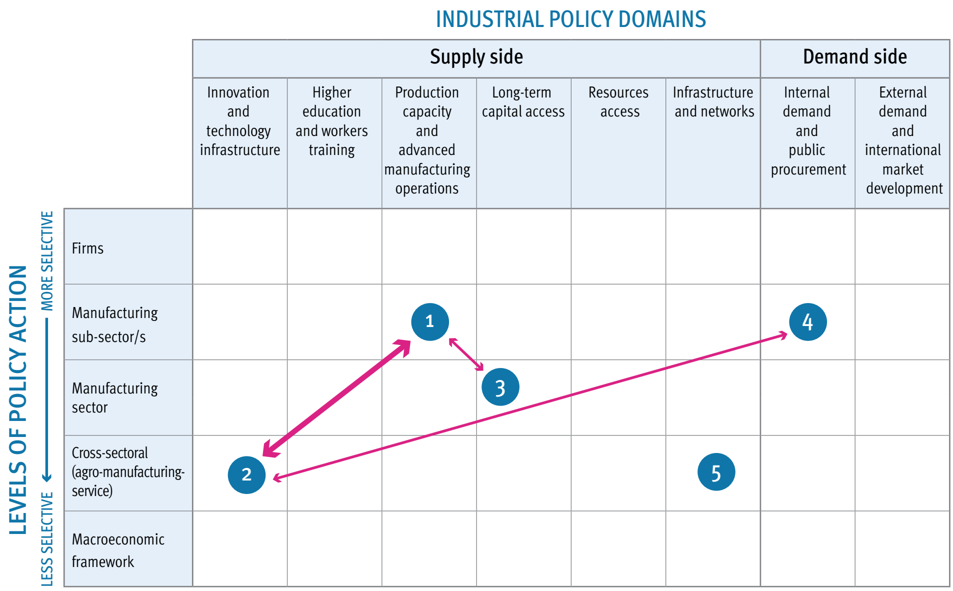
Each industrial policy instrument targets a specific set of goals, which can be clustered in various policy domains. For example, R&D credit, standardisation policy and public technology intermediaries are all instruments/measures/institutions targeting the 'Innovation and Technology Infrastructure' policy domain. While industrial policy generally relies on supply-side instruments, there are also policy domains including demand-side instruments such as procurement policy and external market development policies, and these are also included in the matrix.

74 The policy framework presented in Figure 4.2 draws on Andreoni (2016).

B. Levels of policy actions (degrees of policy selectivity)

Each industrial policy and institutions can target and operate at different levels of the economy, that is, based on different degrees of selectivity. Some policy instruments can target specific manufacturing sub-sector industrial parameters. In some cases, policies can also target specific firms within those sub-sectors (SMEs for example). There are also policies which are focussed on the manufacturing sector as a whole, in particular those targeting export promotion or development of technology platforms, which are critical for manufacturing development in general (such as intelligent automation). Some industrial policy instruments can be directly focussed on cross-sectoral targets, for example those targeting better integration between agriculture and manufacturing or manufacturing and business services. Finally, there are policies which are more macroeconomic in nature, such as interest rate and exchange rate

Figure 4.2: Policy matrix for industrial policy package analysis



Note: Each bullet number (1), (2), (3) … represents a policy instrument. This matrix illustrates five policy instruments that the government is using in its industrial policy package. As an example, policy instrument (1) is an investment matching grant targeted to the automotive sector (hence, an instrument operating under the supply side cluster of policies focussing on enhancing 'production capacity and advanced manufacturing operations'). Policy instrument (2) is a research grant for new sensors and embedded software (hence, it targets all companies across sectors and support their innovation and technological efforts). Policy instrument (4) is a public procurement scheme targeting a specific manufacturing subsector (hence, an instrument operating under the demand side cluster of policies focussing on creating internal demand for a specific product).

Each arrow represents a 'linkage' between two different policy instruments (1) (2), etc. The arrow points in the direction of a pair of policies to signal the existence of a complementarity between two policy instruments. The thicker the arrow the stronger is the degree of alignment achieved between two complementary policy instruments.

Source: UNIDO elaboration adapted from Andreoni (2016).

policies. Despite the fact that they tend to be relatively less selective, this does not mean that they will affect all sectors of the economy in the same way.[75]

As illustrated in Figure 4.2, an industrial policy package can include several policies which are more or less aligned with each other (the thickness of the arrow signals the degree of alignment). For example, measure (1)—a matching grant scheme focussing on automotives and aimed at increasing scale efficient investment—is strongly aligned with measure (2)—a research grant scheme aimed at supporting cross-sectoral investments in new sensors and embedded software to make several products including cars. Government procurement policy (4) is not strongly aligned with the technology policy (2); for example, there may be no pre-commercial public procurement component to support emerging technologies. The infrastructure policy (5) is largely nonaligned with the other policies (there is no arrow signalling a policy linkage). In this case, the policy matrix reveals that the government has not realized the importance of a certain type of infrastructure—such as digital—to make the other policies effective.

Each of the policies in the package are also implemented by different Ministries, departments and agencies at the regional/state level or at the national/federal level. When countries are part of supranational states such as a custom union or a free trade agreement, there is also a supranational level of policy making. The allocation of policies to different Ministries, departments and agencies defines the policy governance model discussed below.

The use of policy alignment tools like the policy matrix allows an improvement in policy effectiveness in five main ways.

First, a policy package matrix allows a mapping out and clustering of the different policy instruments a national government (and perhaps its different sub-regional governments) is implementing. In doing so it provides a basis for reflecting upon the degree of targeting of each policy instrument, the levels of policy intervention and the main policy domains that the government is investing in.

Second, the matrix helps in identifying the existing as well as the potential interactions linking the different policy instruments which are implemented by different institutions across different policy domains. This also means understanding the distribution of the different instruments and resources across institutions, and the extent to which they operate in the same policy domain.

Third, by revealing the presence of policy interactions within the overall policy package, it is possible to identify potential policy misalignment or trade-offs, which would otherwise go unnoticed. These misalignments might also be related to lack of coordination or duplication among Ministries, departments or agencies, as well as the fact that the instruments adopted by one government may not be aligned with those left by a previous government.

75 A certain interest rate policy will affect sectors with different degrees of capital intensity differently (Chang and Andreoni, 2020).

Fourth, the matrix suggests how countries can adopt different packages of industrial policy measures and can coordinate different policy instruments either to have a combined effect on the same target or to manage potential trade-offs among different goals. For example, education policies can be aligned with labour market reforms or technology policies can be aligned with trade policies or public procurement measures.

Fifth, by visualizing the linkages across policy domains and instruments, the policy package matrix stresses how the effectiveness of a single policy measure depends on its linkages with other policy measures, which impact upon the same companies, sectors and institutions. This implies that the policy effectiveness of a certain instrument might be improved by both/either using the instruments more effectively and/or by changing or introducing other complementary instruments. The combined effect of different policy instruments tends to be different from that achieved by the independent implementation of the same policy measures.

As discussed in section 4.6, policy alignment is also a dynamic process. This means that to maintain institutional complementarities and policy alignment, the government will have to adjust the package of interactive measures over time. In this respect, policy continuity alongside experimentation are critical ingredients for successful industrial policy.

4.4. Governance organizational model: Structures, capabilities and incentives

Governing packages of industrial policies—that is, making sure that policy interactions and trade-offs are properly managed—requires government organizational structures, capabilities and incentives. Organizational structures are critical for the effectiveness of industrial policy, especially because they structure power relationships within and across government Ministries, departments and agencies at different levels. They also govern the relationship between the government and the private sector. Within the public sector, governing industrial policy means structuring horizontal relationships, especially across Ministries at the central government level and allocating policy functions across different levels of government. It also means structuring vertical relationships linking the central government to regional or local governments, and thus establishing the balance between centralization and de-centralization. At the interface between government and the private sector, government capabilities can develop only if the right type of incentives and motivation are provided. This means establishing an embedded, but still autonomous relationship between the government and the private sector and leaving space for policy experimentation, while retaining policy continuity (Evans, 1995).

Governance organization models in developing countries are often dis-functional for a number of reasons. First, public bodies often proliferate as a result of political processes of consensus and clientelist network building. This proliferation at both the national and regional levels makes coordination and consensus building in the policy design process very difficult to achieve. Second, proliferation is often associated with duplication of functions. For example, within the same government the Ministry of Finance and the Ministry of Industry and Trade might run almost identical investment promotion or export promotion agencies, which are to allocate a similar set of tax incentives. Third, proliferation and duplication can also lead to organizational rigidity, and in some extreme cases to the paralysis of the state bureaucracy. Fourth, the lack of clearly structured governance models supporting the continuous policy process—from design, implementation and enforcement, and experimentation, and back again to design—creates uncertainty and, in doing so, can undermine policy effectiveness. In such an environment without clarity about the government governance structure and policy direction private companies are unable to commit significant resources over the medium-long term. This lack of clarity can induce rent-seeking within public sector, and between the public and private sector.

Today's successful industrializers have all faced many of these challenges. Over the years several governance organization models have been developed to overcome them. While there is no unique solution for all cases, a review of these models can identify alternative solutions and stimulate experimentation and adaption. In what follow, the focus is on two sets of governance organizational models. The first set of models mainly address issues relating to inter-ministerial coordination and stakeholder involvement. The second set are mainly about governing sectoral missions driven by specialized institutes or committees.[76]

These organizational models are not mutually exclusive, and in fact successful countries have used them in various combinations. It is worth pointing out that in the successful East Asian governance capabilities developed hand in hand with industrialization, so the two processes reinforced each other in a cumulative fashion. In other words, there was no good governance at the start of the process but it was an outcome not a pre-condition, which developed out of and reinforced industry-led structural transformation (Khan ,2010).[77]

4.4.1. Models for inter-ministerial coordination and stakeholder involvement

Figure 4.3 gives three stylized versions of three models for inter-ministerial coordination and stakeholder involvement which are strongly influenced by East Asian experience.[78]

A. Technocratic team

The establishment of a semi-permanent technocrat group working closely with the top leader was a successful organizational model used across East Asian

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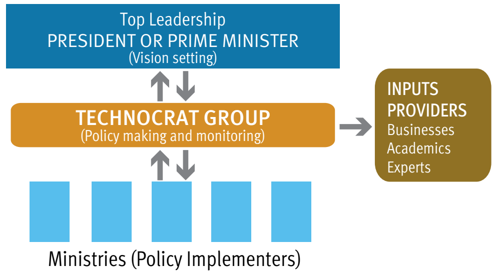
76 There is a large literature on these ideas; see Johnson (1982); Evans (1995); Amsden (1989); Wade (1990); Ohno (2013); Oqubay (2016); Andreoni (2016); Chang and Andreoni (2019).

77 See Noman et. al. (2012) for contributions on 'growth and governance in Africa and Khan and Jomo (2000), for South Asia

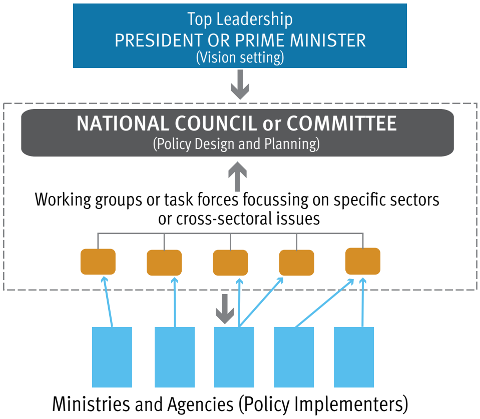
78 This taxonomy and the following sections draw heavily on Ohno (2013) Chapter 4.

Figure 4.3: Models for inter-ministerial coordination and stakeholder involvement

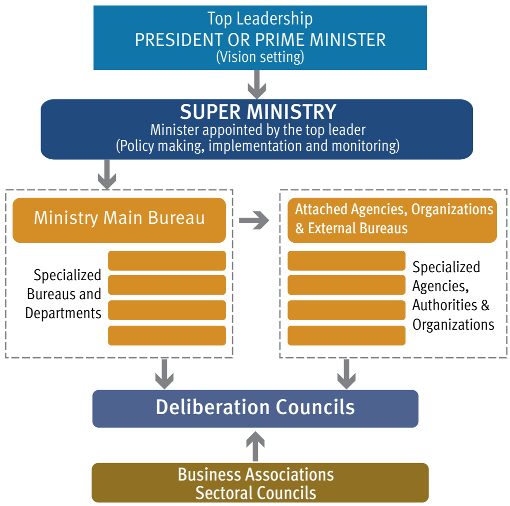
Model 1: Technocratic team



Model 2: National council or committee



Model 3: Super-ministry



Source: UNIDO elaboration adapted from Ohno (2013) and Okimoto (1989).

countries, such as ROK's Economic Planning Board (EPB), Malaysia's Economic Planning Unit (EPU), and Thailand's National Economic and Social Development Board (NESDB). By pulling together the best technocrats, senior academics and business leaders, these technocratic teams performed three key functions. First, in providing the top leader with the best knowledge available; second, insulating part of the policy design process from Ministerial influence; third, operating as the main coordination mechanism in the policy process, including in relation to monitoring and enforcement. This model tends to work best in countries where strong leaders are in power, for a relatively long period of time.

B. National council or committee

A variant of the first model, this one relies on a committee headed by the top leader, a near-top leader such as the vice president or deputy prime minister, or someone trusted and appointed by the top leader. The committee membership tends to be wide including Ministers or Vice Ministers, business people, academics, retired officials, civil society leaders, and the media. The committee is thus supposed to represent all national stakeholders and is tasked with leading the policy formulation process. In this sense the committee replicates some of the policy design and coordination functions of the technocrat team in the previous model. But it does not do so in a permanent way. National committees are mainly created for the building of consensus or for specific cross-sectoral initiatives. From an operational point of view, the committee is supported by a secretariat staffed by seconded officials from related Ministries. Working groups (or task forces) prepare studies, in specialized fields.

The national committee model tends to be more inclusive—and potentially more accountable—than the technocrat model. This makes it more acceptable for government bodies, who in this model are involved fully in the policy formulation process and are not simply recipients of instructions. However, there is a risk that if too many national committees are set up and are captured by specific Ministries, the national committee model can end up being affected by the same inter-Ministerial coordination challenges it tries to solve. This is particularly the case if someone who is not the top leader is in charge of the committee. It is significant that countries like the ROK shifted from the technocrat team to the national council models only in the more advanced stages of their industrialization.

C. Super-ministry

The third model is a super-Ministry, epitomized by the Japanese experience with the Ministry of International Trade and Industry (MITI)—which operated from 1949 to 2001. Over the years, it also inspired similar approaches across South East Asia as well as Africa (Figure 4.3). Within this model, the government assigns one Ministry the main role of designing and implementing industrial strategies, including the preparation of the necessary laws and regulations, which will apply across the areas of responsibility of different Ministries. While the super-Ministry does not have highest legal standing, in this model it is provided with sufficient authority so that coordination across Ministries is possible. In this model the institutionalization of the industrialization vision (and related missions) is a key factor as it enables more effective inter-Ministerial coordination. The super-Ministry also needs to draw on the best expertise in government to produce the vision and ensure its effective implementation. This can happen with or without a strong and long-established leader.

This was the case with MITI which had authority over several economic sectors and operated with several cross-sectoral bureaus.[79] As a super-Ministry it had broad authority over the creation of visions and strategies, individual industrial sectors, a wide range of regulations, such as those relating to intellectual property rights, competition and anti-monopoly policy, SME development, restructuring of declining industries and energy and the environment. While working closely with the Economic Planning Agency (EPA) under the Prime Minister's Office and the Ministry of Finance, MITI relied on several Deliberation Councils as consensus building mechanism between government and private stakeholders. The most prominent was the Industrial Structure Council, which over several decades remained in charge of the drafting of the main industrial policy documents. Similar to national committees, Deliberation Councils included representatives from related Ministries, business leaders, and independent experts and academics. However, MITI had the responsibility for streamlining the decision process, addressing conflicts of interest and trade-offs, and achieving aligned and coordinated solutions.

4.4.2. Models for governing sectoral missions: Specialized institutes

Within these broad models national and regional governments pursuing specific sectoral missions can also draw on a specialized institute (or a network of such institutes) operating as a policymaker and implementor.[80] Such institutes may also be location-specific, where due to agglomeration effects they support locally-focussed sector development. Within this model, the central government sets the industrial vision and broad direction using one of the governance models discussed above. At a more disaggregate level the specialized institutes, on the other hand, draw on specialized sector knowledge and their local embeddedness to develop a detailed masterplan and engage with sectoral stakeholders. These institutes can also incorporate other bottom-up inputs, for example from academics or local communities, in policy. The specialized institutes are then mandated to implement sectoral policy.

This organizational model was used in Thailand for the successful development of the Automotive Industry (see Chapter 3). Following the Asian financial crisis, the government formulated the *Industrial Restructuring Plan* under the leadership of the Ministry of Industry (MOI). MOI established ten specialized institutes to design sector-specific masterplans and implement the policy actions. Six of these were industry-specific institutes, four were thematic (for example covering technical

79 See Johnson (1982), Okimoto (1989), and Ohno (2013)

80 For further details see O'Sullivan (2011), Ohno (2013), Andreoni (2016), Oqubay (2016), Andreoni et al. (2017); and Ohno and Oqubay (2020).

training, management and certification, and SME development). Of these industry-specific institutes, the Thailand Automotive Institute (TAI) was one of the most successful. TAI relied on a tripartite structure (including government, companies and experts) and was in charge of designing and implementing the masterplan for the automotive sector (an approach later copied by other countries such as South Africa). As a specialized institute (see model 1 of Figure 4.4), TAI cooperates with different Ministries, conducts joint research with universities, provides research and information services and manages a website for automotive part makers as a way of supporting backward linkages. Over the years, the provision of these services has also allowed TAI to become financially independent.[81]

Other countries have used the specialized institute model to address governance challenges encountered in the use of other inter-Ministerial coordination models. For example, as part of the Ethiopian Agriculture-Led Industrial Development Vision, the government used autonomous specialized institutes (such as the Leather Industry Development Institute) to support export-oriented industries after several failed attempts to use directorates within the regular bureaucracy and the National Export Coordination Committee (see Chapter 2).

Finally, given the flexibility of the specialized institute model, other countries have relied on this approach to coordinate networks of institutes at the national and regional levels. When sectors are spread across different regions, such networks can provide critical coordination functions in the policy making process, as well as supporting implementation, for example through the provision of technology services. Chapter 2 has discussed examples of the role of such networks of institutes. For example, this model was used in Brazil for the development of the agricultural sector and agro-industries, in Germany in the form of the Fraunhofer-Gesellschaft institutes, and by the Emilia Romagna regional government in Italy in the form of the High Technology Network of Technopoles (see Figure 4.4).

The Fraunhofer-Gesellschaft is a network of specialized institutes organized around seven groups devoted to specific broad research areas.[82] There is a complex organizational structure which aims to coordinate top-bottom and bottom-up policy making (see model 2 Figure 4.4). Similarly, in the North of Italy, the Emilia Romagna region has developed a high technology network comprising 82 Industrial research laboratories and 14 Innovation centres (see model 3 Figure 4.4).[83] These three specialized institute models show how different organizational models can support very selective industrial policy, that is, policy instruments targeting specific industrial parameters at the sub-sectoral and product levels.

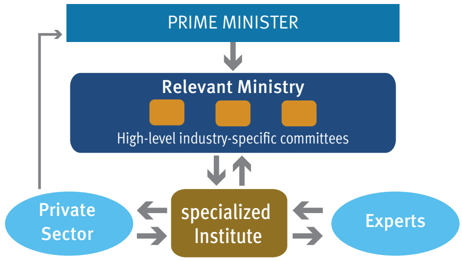
81 For more details see Ohno (2013).

82 These research areas cover: the ICT Group, the Innovation Research Group, the Life Sciences Group, the Light & Surfaces Group, the Microelectronics Group, the Production Group, the Defense and Security Group and the Materials and Components Group. Each of these groups comprises several closely complementary institutes and coordinates work across them.

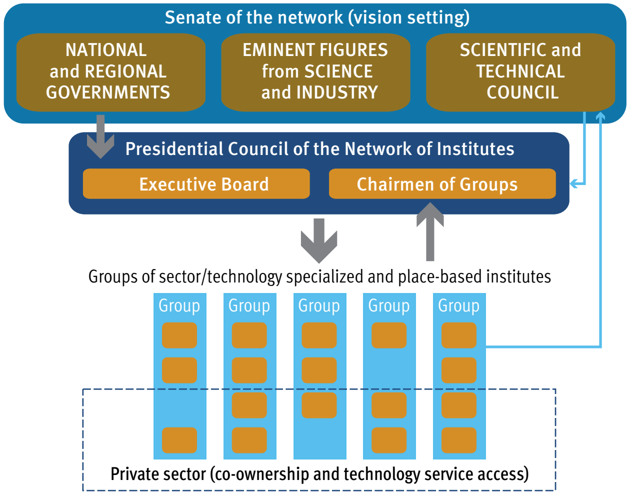
83 These networks operate in the following fields: agri-food, construction, energy and environment, ICT and design, life science, mechanics and materials. For more details on the German and Italian cases see Andreoni et al. (2017) and Andreoni (2018).

Figure 4.4: Models for governing sectoral missions: specialized institutes and networks

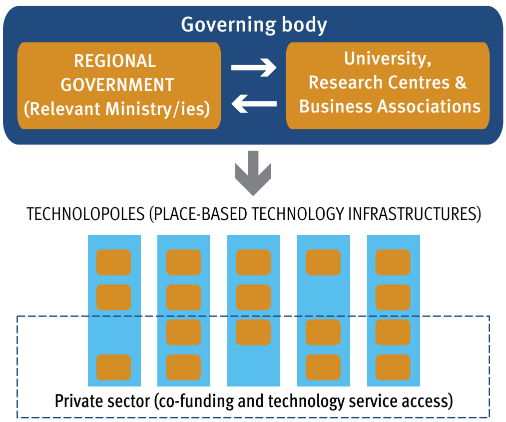
Model 1: Specialized Institute



Model 2: National network of specialized institutes



Model 3: Regional network of specialized institutes



Source: UNIDO elaboration based on Ohno (2013), the Fraunhofer model and the Emilia Romagna High Technology Network model (see Andreoni et al., 2017).

4.5. Policy enforcement: Building productive coalitions of interests and managing conflicts

Effective government-business interactions have been a key to success in industrial policy making across early, recent and emerging industrializers. Governance organizational models discussed above offer the institutional framework to establish these interactions. For example, businesses can provide information on the binding sectoral constraints, which can help in designing selective and more effective interventions. Business involvement in the policy design process can help building trust, ownership and commitment, as well as introduce some element of accountability in government-business interactions. Continuous engagement can also favour experimentation and open opportunities for piloting sector-specific institutional solutions to problems in areas like technical skills provision, technology services, employment regulations, energy solutions, development finance, licencing, and custom procedures. The quality of government-business interactions is the result of a long process, and improvement takes time and resources—thus, the policy design process should not be rushed. Ultimately, the policy process matters much more than the formal policy document, if the process leads to feasible strategies supported by the relevant groups involved.

However, in building this relationship, it is also important that the government does not become beholden to particular industrial interests or is captured by powerful groups. This is usually expressed as 'embedded autonomy', which means that the government needs to have roots in the society and business community (embeddedness), but also has to have its own will and power (autonomy) in order to be effective in its interventions (Evans, 1995). Embedded autonomy is critical in the policy design process, but even more so at the implementation and enforcement stages. This is when the government needs to be able to discipline recipients of rents—from subsidies, licences, grants and so forth—if they fail to invest productively and, as a result, fall short in delivering the desired policy outcomes. Lack of enforcement can result from lack of government capabilities, but also from situations in which sections of the government and the private sector engage in collusive rent-seeking behaviour.

Historically, these unproductive coalitions of interest between governments and the private sector have been found at certain times in all countries reviewed in Chapter 2, in particular when these countries were relatively underdeveloped and their economies were relatively informal. This is because rents capture is primarily a structural problem associated with lack of productivity in the economy and a distribution of organizational power among different groups at an early stage of development.[84] These powerful groups include business and political elites and also intermediate groups (like bureaucracies) operating in the public and private sectors. In developing countries, the relationship between government and business has always been close. The key policy challenge is to develop this relationship in a way that is productive for the economy, so government-business interaction results in

84 This argument is developed in Khan (2010) and Khan et al (2019).

productive coalitions of interests. Productive coalitions of interests develop when the effective implementation and enforcement of an industrial policy can deliver both a tangible political dividend for government and the private sector perceives that the required productive investment and capability building are both achievable and can provide them with an acceptable level of profit.

Given these blurred boundaries and the complex political economy dynamics involved, as suggested above, it is important to conduct an ex ante political economy feasibility assessment of policies, to assess how different groups will respond to policy, and to judge the extent to which there is a political dividend and a profitable opportunity for the private sector. This assessment can reduce the vulnerability to corruption of individual policies, and make their enforceability more effective.

Building productive coalitions of interests, however, is only the start. Industrialization will inevitably involve some potential conflicts, either openly or in a latent form. Learning how to manage conflicts is key to success in industrial policy making, as unresolved conflicts can result in both passive and active resistance to industrial policies. Depending on the way in which conflicts are addressed (and eventually resolved, or not), policies have different distributional effects. In general, the more targeted is a policy, and thus the easier it is to identify winners and the losers, the more immediately it is likely to provoke conflict. This means that more targeted policies are likely to require more conflict management.

There are two types of measures that the industrial policymaker can use in managing conflicts—anticipatory measures of conflict management and reactive measures of conflict management (Chang and Andreoni, 2020). Anticipatory measures of conflict management can be of various types. They often involve a measure to reduce uncertainty. For example, a clear sectoral mission, with clear targets and timeframes, which is credible and accountable, can provide businesses with certainty about the future and thus make change less problematic. In other cases, these anticipatory measures can provide forms of social insurance for workers (such as life time employment contracts) or a firm's owners (such as limited liability and modern bankruptcy laws).

Reactive measures of conflict management can be subdivided into two categories, one temporary and the other permanent. When the difficulty a particular sector is experiencing is deemed to be of a temporary nature, the government can reduce conflict in the sector by offering temporary protection and subsidies. For example, use of emergency tariffs is allowed under the WTO as a temporary response to a sudden surge in competing imports. However, when problems call for significant restructuring of a sector more drastic measures may be necessary. For example, governments can mediate negotiated scrapping of capacity between firms in a sector, as the Japanese government did with the shipbuilding industry in the 1980s (Dore, 1986). Second, it can offer subsidies for the scrapping of obsolete machinery and the purchase of new machines, as the Korean government did with the textile industry, also in the 1980s (Chang, 1993). Third, it can bail out the enterprises in difficulty, as the government of the United States did with the auto industry after the

2008 financial crisis. Fourth, the government can nationalize an industry, with a view to winding it down (as in the case of the nationalization of the Swedish shipbuilding industry in the 1970s) or with a view to restructuring and eventually privatizing the temporarily nationalized firms (as in the case of Volkswagen in Germany, in the 1970s). While these measures may be expensive, the government might end up facing an even higher economic and social cost if lack of conflict management results in active resistance to much needed industrial restructuring.

4.6. Key lessons: Learning through policy continuity alongside experimentation

As in the case of industrialization itself, learning about industrial policy is part of the policy making process. A number of practical implications can be identified for improving learning in relation to industrial policy.

First, there is no learning without reflection and reflection needs monitoring of the industrial policy process. Monitoring policy along the entire process is challenging as industrial policy tends to trigger both intended and unintended outcomes. This means that it is critical to set up monitoring targets that are based on an understanding of the industrialization process and of what has been termed here 'a theory of change' for industrial policy in the country concerned is needed. The parameters selected must be limited because data collection is costly and business enterprises operating in semi-formal economies do not always have effective systems for data collection. Finally, capabilities must be built up in government to understand and make use of the data.

Second, when monitoring systems are effective, they provide the evidence base for informing short policy learning cycles. A short policy learning cycle starts from short-term monitoring (such as monthly reporting) and a growing understanding of what is working, what is not working and why. Many of the governance organization models discussed above would be unable to function and develop government capabilities without such short-term learning cycles.

Over the relatively longer run (starting with quarterly and then yearly reporting), the government can also come to realize if the policy has fundamental flaws and therefore needs significant reframing. Reasons can vary, from lack of selectivity and alignment to unexpected market responses. It can also be because the coalition of interests supporting the policy fragments or eventually collapses, perhaps because unmanaged conflicts are undermining the policy and complementary instruments must be introduced to address these. Long policy learning cycles call for significant policy change and the establishment of new design processes.

Government flexibility and capability in adapting programming and policy instruments are critical. What is even more important is the development of a government mentality that is not afraid of failure and welcomes experimentation. This was argued many years ago by Hirschman who stressed the importance of encouraging policymakers to engage with problems for which they are unfit—that is, problems that are beyond their 'policy latitude'. In doing so, he saw the unfolding of what he called the 'law of the hiding hand'. This is a 'transition mechanism through which decision makers learn to take risks; and the shorter the transition and the faster the learning, the better' (Hirschman, 1967:28). In the absence of this government mentality, the risk is that Ministries and their related bodies will avoid reporting or will underestimate danger signals in the monitoring system to avoid being accused of failure. In other cases, data may be hidden or presented in a less than transparent way. Where such behaviour becomes institutionalized within government, it will undermine short learning cycles and block learning and policy adaptation.

Government ***flexibility*** *and* ***capability*** *in* ***adapting*** *programming and policy instruments are* ***critical.***

Experimentation must therefore be welcomed in industrial policy making. Experimentation can be also a way of calibrating the right degree of selectivity of a policy instrument to the specific and evolving dynamics of a sector, technology or market. Experimentation can lead to demonstration projects which can be scaled up within and across sectors (for example Chapter 3 cites demonstration projects in Bangladesh with the development of garments and in Chile in the salmon industry).

However, experimentation must be also managed carefully to avoid a situation in which governments constantly experiment and change policy instruments, and in doing so undermine the overall implementation of the industrial policy package. Frequent change can lead to policy incoherence, increases uncertainty in the business environment and can undermine the long-term policy vision. Finally, even when experiments are successful, this does not mean that they can be easily scaled-up and turned into policy. Very often when measures are scaled-up, for example if they are extended from a region to an entire country, a number of unforeseeable challenges may emerge. These can be of both of a technical nature, such as lack of government capabilities, or political—affecting the interests of powerful groups. Thus, policy experimentation must not undermine policy continuity. Many of the most successful industrial policy instruments discussed in Chapters 2, are those which have been developed within this balanced approach.

5 WHAT HAVE WE LEARNT?

Industrial policy and support programmes for inclusive and sustainable industrialization

5.1. The importance of Inclusive and Sustainable Industrial Development

This book has identified industrialization as one of the key drivers for success in the achievement of the Sustainable Development Goals (SDGs). Historically, the phenomenon of industrialization, featuring the establishment of a thriving manufacturing sector nurtured by innovation and supportive infrastructure, went hand in hand with economic development. Grounded on this historic regularity, industrialization can be regarded as the main path towards both economic prosperity and well-being in today's developing countries. Considering that there are only ten years remaining to achieve the SDGs, this book provides a timely attempt to assess the significance of successful industrialization for delivering these Goals by 2030. The book has sought to look beyond the arguments for the importance of manufacturing for growth and has identified the application of flexible and well-designed industrial policy as key for successful industrialization and the structural transformation of the economy. By highlighting the crucial role industrial policy plays in this regard, the findings of this book have important implications for the development community.

UNIDO has long been a major advocate of the need for industrial development. The Lima Declaration on Industrial Development and Cooperation of the Second General Conference of UNIDO in 1975 proclaimed industrialization to be the driver of development and set the objective for developing countries to produce 20 per cent of global manufacturing output by 2000. This was achieved when developing countries accounted for 27.1 per cent of global MVA and when this share rose further to 41.2 per cent in 2013. This led to a second Lima Declaration on Inclusive and Sustainable Industrial Development (ISID) at the Fifteenth Session of the UNIDO General Conference in Lima, Peru 2013. By stating that "*industry increases productivity, job* *creation and generates income, thereby contributing to poverty eradication and addressing other development goals, as well as providing opportunities for social inclusion, including gender equality, empowering women and girls and creating decent employment for the youth"* (GC.15/Res.1), the declaration confirmed UNIDO's commitment to ISID as the main driver of development.

The mandate for ISID is anchored within the internationally agreed 2030 Agenda for Sustainable Development. Of the 17 SDGs that make up this agenda, Goal 9: "build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation" is especially relevant to UNIDO's work. As outlined in Chapter 1, however, the importance of ISID goes beyond SDG 9 and is of high significance for the 2030 Agenda's overall achievement. Building on the notion of ISID, UNIDO's programmatic approach is guided by three interrelated themes: First, creating shared prosperity; second, advancing economic competitiveness; and third, safeguarding the environment. This applies to all of UNIDO's work: technical cooperation activities, analytical and policy advisory services, standard-setting and compliance, as well as its convening and partnership building role. Since the adoption of the Second Lima Declaration in 2013, UNIDO has focussed its efforts on the achievement of enhanced ISID. ISID, together with the comprehensive Goals set by the global community in the 2030 Agenda cannot be attained in isolation, or by a single organization or country alone. Achieving the SDGs requires an unprecedented level of collaboration across all countries and stakeholders, the pooling of resources from diverse actors through multi-stakeholder partnerships that mobilize and share knowledge, expertise, technology and financial resources.

This chapter summarizes the main findings of the book, which emphasize the importance of ISID for the success of the 2030 Agenda and UNIDO's role in achieving it. The first section presents the main insights from Chapter 1, which gives strong justification to UNIDO's mandate of supporting its Member States in achieving ISID. The following sections summarize the main findings and lessons from Chapters 2 to 4 on technical cooperation projects by international development organizations. The last section introduces UNIDO's Programme for Country Partnership (PCP) and explains how this initiative relates to the recommendations arising from this book.

5.2. Industrialization and its relationship with the 2030 Agenda for Sustainable Development

Chapter 1 has outlined the significance of industrialization and the manufacturing sector for the achievement of Agenda 2030 and the renewed interest in industrial development. While the relevance of industrialization was discounted during the era of the Millennium Development Goals (MDGs), the SDGs have restored the international community's interest in ISID through Goal 9. The rediscovery of the key role the manufacturing sector plays in development builds on the arguments of industrialization as the engine of growth put forward by Nicholas Kaldor (1960). Kaldor argued that the industrial sector, in particular manufacturing activities, should be viewed as the entire economy's engine of growth due to its special characteristics (see Box 1.1 for a summary of why manufacturing is generally considered to play a special role).

The first chapter confirms the engine of growth hypothesis based on an analysis of the relationship between progress made on SDG 9 and other socio-economic SDGs. At an aggregate level, the achievement of SDGs is positively correlated with countries' stages of economic development. Similarly, the analysis found evidence that industry-driven economies grow significantly faster than others. Positive performance on the SGD index is correlated even more strongly with industrialization and the intensity of manufacturing, defined as MVA per capita. This result is in line with historical evidence, which shows that economic development is typically spurred by industrialization.

Since industrialization affects socio-economic SDGs as well as economic growth, governments need to be aware that it can be an important factor in improving the well-being and inclusiveness of society. At a more disaggregate level, the analysis finds that the advancement of SDG 9 has strong positive and direct effects on economic growth (SDG 8) and poverty reduction (SDG 1). Additionally, it indicates some positive effects of industrialization on the socio-economic dimensions of health and well-being (SDG 3); decent work (SDG 8); and reduced inequality (SDG 10). At the same time, through its effect on SDG 8 and economic growth, industrialization has additional positive indirect effects on SDGs 3, 4, 8 and 10. While industrialization is, of course, not the only factor determining the progress achieved on these SDGs, the acknowledgement of the positive effects, both direct and indirect, has important implications for and underpins UNIDO's mandate for the promotion of industrialization.

Beyond supporting growth and social inclusion, industrialization at the same time can be sustainable and promote environmentally friendly development. Whereas industrialization is often associated with polluting chimneys during the first industrial revolution, the analysis of this book reveals that in today's context, industrialization does not necessarily need to come at the expense of the environment. SDG 9 itself has an environmental component based on the objective to lower CO_2 emissions from manufacturing. The analysis indicates that carbon dioxide emissions per unit of manufacturing value added are strongly associated with the given stage of economic development, with higher GDP per capita associated with lower carbon emissions per unit of manufacturing. Additionally, an increase in manufacturing is also shown to be related to relatively lower carbon dioxide emission per unit of manufacturing value added. However, there is a caveat, as this relationship can turn negative, depending on the type of industrial activities being promoted. In addition to this effect on CO_2, and indirectly through its effect on economic growth, industrialization can help promote other SDGs with an environment component, in particular water use efficiency (SDG 6), energy intensity (SDG 7) and domestic material consumption (SDG 12). This means that the promotion of ISID and progress towards industrial patterns that minimize greenhouse gas emissions, including through sustainable energy solutions, resource efficiency and cleaner production and consumption, are important factors for the overall achievement of the Agenda 2030.

5.3. Key factors of successful industrialization in the past

The study of successful cases of industrialization, both at the country and sub-sector level, and the governance of industrial policy used in those cases, uncovers important lessons for the international community in the promotion of ISID. Put briefly, successful industrialization has often been a process of finding the appropriate industrial policy measures that target selected priority sectors and adjust to a specific policy space.

Chapter 1 shows that successful industrialization is an important factor not only for economic development, but also in terms of socio-economic and environmentally-related aspects. Successful industrialization itself, however, is a complex process that is not automatic and requires targeted support from governments and the international community. Chapters 2 to 4 explore the key determining factors behind past cases of successful industrialization.

Although countries have used different strategies to climb up the industrialization ladder and have had to deal with differences in policy space, the one commonality across all examples is the promotion and use of industrial policy measures. Other factors such as natural endowments, geography or historical legacy, also shape the success and failure of countries in their path towards industrialization, but they are not deterministic. The final outcome depends on what countries do with these endowments or inherited characteristics. Governments have a range of opportunities to work with their individual country characteristics, although their choices are limited by their policy space, defined as the policy measures that are politically and administratively feasible at a given time. Constrained by different policy spaces, successful cases of industrialization have been shaped by industrial policies tailored to the industrialization challenges they faced. Three broad challenges, whose scope differ depending on a country's level of industrialization and integration into global manufacturing, are identified as: (1) breaking into the world economy; (2) linking back in the domestic production system; and (3) keeping pace with technological change.

There is no silver bullet set of industrial policy measures, and countries must customize policies to their specific contexts. Understanding the industrialization challenge the given country faces is an important prerequisite for the formulation of an ambitious, yet realistic industrial development strategy. The analysis of country examples that effectively dealt with these challenges clearly show that even when the policy space of the industrialization challenge is taken into account, there is no 'one-size-fits-all' policy that ensures successful industrialization. Instead, a variety of instruments and institutions perform different functions that countries can rely on.

The shrinking industrial policy space—most notably the rules and regulations adopted by the WTO and bilateral trade and investment agreements—puts serious constraints on the industrial development goals of today's developing countries. Even within this reduced policy space, opportunities remain, however, for developing countries to use industrial policy measures. In many places, the multilateral rules provide for plenty of room for interventions of choice. For example, international rules do not always apply to developing countries and some measures, such as export subsidies for LDCs or export taxes under Article 11 of GATT, are still feasible policy options. The international community should help developing countries find such opportunities. Policymakers in developing countries should be encouraged to recognize the existence of these opportunities and to effectively utilize them.

There is **no silver bullet** *set of industrial policy measures, and countries must* **customize policies** *to their specific contexts.*

While the cases reviewed in this book provide lessons that can inspire policymakers in other countries, successful industrialization will always be a process of experimentation characterized by both successes and failures. It should be viewed as a process of 'learning to learn'. This book can serve as a useful entry point from which to launch this process.

5.4. The significance of sector prioritization

Industrialization is a process that involves structural transformation not only of the economy, but also within the manufacturing sector itself. Understanding the key characteristics of different manufacturing sub-sectors (or industries) is important for successful industrialization. While overall country-level conditions play a role, individual sub-sectors have sector-specific characteristics that must be taken into account in policy design. Chapter 3 outlines some of these sub-sectoral differences and provides case studies for selected industries.

Differences across manufacturing industries include a variety of parameters such as energy intensity, the use of specific resources and the degree of vertical integration, geographical scope, local clustering, technological complexity and international tradability of products. As a result, some sub-sectors are more prone to internal competition or might be more easily integrated into global value chains than others. For industrial policy to be effective in achieving ISID, these differences must be understood and acknowledged. This is particularly the case for the political economy of the different industries and the power relations between groups and organizations, and represents a key factor of the success of industrial policies. This means that targeted industrial policy measures should be chosen according to the needs of the specific sub-sector and not according to a standard blueprint. Failing to understand key sub-sector-specific characteristics can lead to the failure of otherwise well-functioning policy measures.

Chapter 3 finds that there is a 'normal' pattern of sub-sectoral structural change where certain sub-sectors tend to contribute more value addition and employment than others, at different stages of economic development. These normal patterns of structural change are important benchmarks in terms of locating countries along the industrialization ladder. Different sub-sectors have different characteristics, however, defined by a set of industrial parameters that need to be addressed if policy measures are to be successful. The parameter map provided in Chapter 3 can help governments focus their efforts on those parameters that are binding for the development of the given sub-sector/industry. Prioritizing sector-specific industrial policy interventions is essential for the success of industrial policy.

The book has reviewed selected sub-sectors—Food and beverages, Garments, Automotive, Machinery and equipment, Electronics and Medical devices using 4IR technologies—and based on their characteristics, identified the key sub-sector-specific industrial parameters of each. This was achieved through a case study for each sub-sector and provides useful benchmarks for policymakers.

5.5. Lessons to be learnt from the implementation and governance of industrial strategies

Chapter 4 reveals that industrial policy making should be viewed as a political process that involves institutional learning on how to build, use and coordinate policy measures. The central insight is that ownership of the industrial policy formulation process is a key determining feature, and is often more important than the final policy document. In the long run, the process of drafting the policy document and policymakers' willingness to learn are critical. The government's level of commitment and ownership during the policy formulation process has an impact on the level of its commitment during the implementation stage. Strategies for industrial development cannot be successful unless they are implemented with commitment at the highest political level. In addition, if beneficiaries do not feel they own a strategy, but are only passively involved under the supervision of international experts, commitment is likely to be limited. Therefore, the presence of local ownership is an essential condition for implementing future development cooperation in this area.

Consequently, this means that although policymakers should be assisted when they lack certain capabilities, the drafting of an industrial policy should not be outsourced to international experts. External consultants can facilitate the process of industrial policy making and advise policymakers on different options. They should only play an advisory role, however, especially at the crucial initial stage. The more thoroughly policymakers reflect on the past, analyse the current situation and plan possible courses of action, the higher the likelihood that their levels of commitment and subsequent learning will increase, leading to future adaptation and success.

The policy formulation process should always start with an assessment of the sub-sector's political economy. Failure to do so may result in rent-seeking and ultimately, failure to meet the policy goals. The analysis of the underlying political economy should be complemented by a comprehensive understanding of the governance model and organizational structures that are relied upon in the policy formulation process. Understanding this is necessary for a successful alignment of the policy package across different ministries, departments and agencies. Industrial development should thus be seen as a fundamentally political process.

The projects of many development agencies often do not appear to pay sufficient attention to the political economy context nor to allocate adequate time for the above-mentioned crucial preparatory phase of industrial policy formulation for and by policymakers. Development organizations are often under pressure to increase implementation. They therefore focus more intently on the delivery of planned activities, measured on the basis of spending. This means that a coherent assessment of the political economy in a specific context is often disregarded or at best, only analysed superficially. Additionally, the initial learning stage, which is neither visible in terms of active external interventions, nor rewarding for project implementers in terms of the progress measured by monetary spending, tends to receive little attention.

Governing industrial policies is not about the management of individual policies, but rather the strategic alignment of interacting policy instruments in an industrial policy package. As this frequently involves several ministries, departments and agencies using different—possibly even opposing—policy measures operating at different levels, a strategic alignment is required. Industrial policy matrixes or taxonomies, such as the one presented in Chapter 4, can help the international community and policymakers map out existing and planned policy packages and ensure policy coherence. Such an analysis should always precede the implementation of new industrial policies. Failure to align the different policy measures can result in unintended side effects or even negate the intended effect of individual policies. Industrial policy packages are often implemented and designed by a range of different ministries, departments and agencies. Understanding the relationship between these actors and the organizational structure of the government is crucial for the policies to be effective. A clear understanding of these relationships not only helps ensure effective alignment of various measures, but also allows a more substantial relationship with the private sector. The models for inter-ministerial coordination and stakeholder involvement presented in the book can serve as a useful reference for understanding a country's governance structure.

Lastly, industrial policy entails learning by doing, where the process takes time and often involves mistakes or sub-optimal policy choices. This means that there is constant need for reflection and monitoring of clear targets. Effective monitoring systems can provide evidence on which policies are working and which are not. If policies are found to be flawed or require significant reframing, the government must be flexible and capable of revising and adapting new policy instruments. As a result, it is very important for the government to embrace experimentation and, when necessary, accept the failure of a specific industrial policy measure, but not the entire policy agenda. This means that governments should embrace failure and weak initial results as lessons learnt that will help them improve the industrial policy package in a process of fine-tuning.

The main lessons from this book can be summarized as the following: first, industrialization is the main avenue for sustainable development, but it is neither automatic nor guaranteed, requiring strong efforts and policy intervention from governments. Second, despite shrinking policy space, industrial policies remain a promising tool to support development and the attainment of the SDGs, and governments should be assisted in identifying possible policy options. Third, government ownership of the industrial policy formulation process is of utmost importance and learning by policymakers is often more important than the final policy document. Fourth, industrial policy formulation should always start with a comprehensive analysis of the political economy and the resulting power relations in a specific country, sector or sub-sector context. Fifth, industrial policy measures should be aligned between different ministries, departments and agencies to create an effective strategy. Sixth, industrial policy measures should target selected sub-sectors or industries, thereby aligning these measures to the industries' specific characteristics. Seventh, industrial policies should be seen as a process of learning by doing, where failure of specific measures should be embraced as opportunities, rather than signalling the end of an industrialization strategy.

5.6. An example from the ground: UNIDO's Programme for Country Partnership

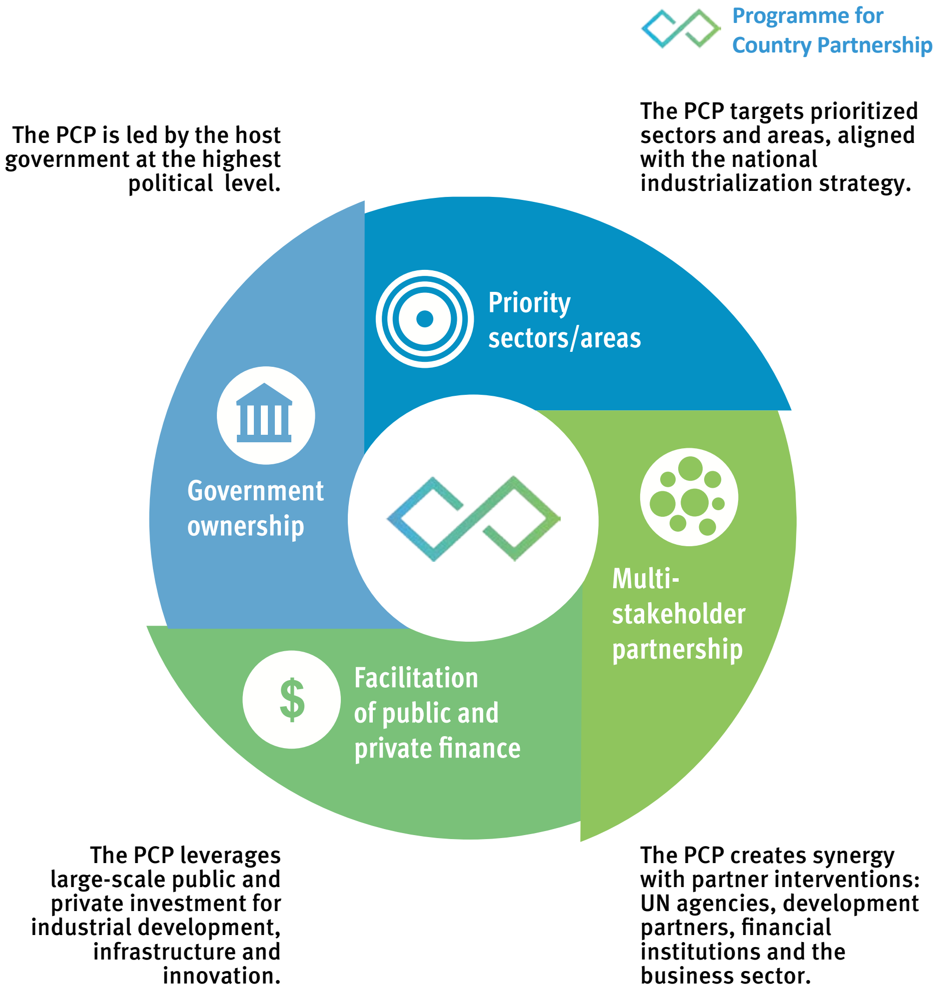
To facilitate this process and support countries in their efforts to climb up the industrialization ladder, UNIDO recently introduced the Programme for Country Partnership (PCP) framework as a mechanism to implement its ISID mandate. Following extensive consultations with stakeholders and potential counterparts, including during two ISID Forums in 2014, the process culminated in the development of a new service package for UNIDO Member States: the PCP. The objective is "*to mobilize external partners and additional resources in order to extend the impact of UNIDO's technical cooperation and accelerate inclusive and sustainable industrial* *development in Member States*". The PCP framework was launched on a pilot base in Ethiopia, Senegal and Peru; today, there are additional ongoing PCPs in Cambodia, Kyrgyzstan and Morocco as well as initiated processes in Côte d'Ivoire, Egypt, Rwanda and Zambia. Through the PCP, UNIDO aims to further support Member State governments in developing a strategy to prioritize and ultimately accelerate inclusive and sustainable industrialization.

The PCP approach's key characteristics are ownership by the host country, the identification of priority sectors, the facilitation of public and private finance, and multi-stakeholder partnerships. Firstly, UNIDO assumes a leading role during the PCP formulation based on an initial country diagnostic, which identifies the main opportunities and bottlenecks for industrialization, and serves as the foundation for the selection of priority sectors. Yet the leadership always resides with the host government, and the PCP is aligned with the national industrialization strategy. During the formulation of the PCP, UNIDO prepares feasibility studies for large-scale industrial infrastructure development projects geared towards mobilizing additional investment for industrial development. UNIDO also identifies and liaises with essential partners to raise support for these projects.

Secondly, by identifying priority sectors or areas, the PCP creates an industrialization strategy with a strong potential for job creation, increasing exports and attracting national and foreign direct investment. Thirdly, to ensure the success of this industrialization strategy, the PCP relies on multi-stakeholder partnerships from programme design to implementation. It aligns national governments' industrial development efforts with the work of United Nations agencies, development partners, financial institutions, the business sector, academia and civil society. As each of these stakeholders has different priorities and specific mandates, an alignment of the different efforts is necessary to avoid duplication or potential contradiction. Lastly, the PCP facilitates the mobilization and coordination of three sources of financial resources: 1) public finance, 2) business sector investment, and 3) official development assistance. With the help of UNIDO's PCP, a country should be able to improve its overall investment environment and promote specific investment opportunities to attract domestic as well as foreign direct investment. Each PCP is assisted by a strong analytical framework tailored to the specific country needs, and a monitoring and evaluation system to measure the progress and programme-level impact.

Each PCP runs through four distinct phases: 1) initiation; 2) programming; 3) implementation, and 4) completion. The programming stage starts with a UNIDO country diagnostics which identifies the main opportunities and bottlenecks for a country's industrialization. Based on this, the government in close consultation with UNIDO designs a comprehensive programme with complementary interventions and projects. Additionally, the host government establishes a National Coordination Body to supervise and manage implementation during the PCP's third stage. The National Coordination Body provides strategic guidance for the execution of the PCP, reviews progress and ensures synergies between different actors involved. The implementation phase also comprises continuous monitoring and evaluation

Figure 5.1: The key features of UNIDO's Programme for Country Partnership (PCP)



Source: UNIDO.

against the baseline defined during the country diagnostics, and the PCP results framework and intervention logic. The data collected provide the basis for the independent final evaluation carried out during the completion phase. During the last phase, the host government and UNIDO, together with main partners and stakeholders, will reflect on the lessons learnt and decide whether to extend the current PCP with existing priority sectors; refocussing the PCP towards new industrial sectors or geographical locations; or conclude the PCP and integrate its most valuable structures into national entities.

5.7. Going forward

This book provides analytical support for the approach adopted in the PCP programme, since much of the insights from Chapters 2 to 4 and the resulting recommendations are already integrated in UNIDO's PCP approach. With the key characteristics of government ownership, priority sectors and multi-stakeholder partnerships, many of the lessons highlighted in this book are reflected in the PCP approach. Based on government ownership at the highest political level and a formulation process that is assisted but ultimately conducted by national policymakers, UNIDO's PCP approach creates an environment with opportunities and lasting support for a process of learning. The initiation and programming phase of each PCP is specifically designed to ensure ownership at the highest government levels and to facilitate inter-ministerial coordination.

UNIDO recognizes the importance of industrial policy alignment, and the PCP relies on a National Coordination Body established by the host government to monitor the programme's implementation, including efficient resource allocation among Ministries, departments and agencies. The Body is responsible for overall PCP coordination, prioritizes projects and programmes, ensures synergies between funding and investment from different partners and monitors progress. This alignment is further ensured through coordination between all ministries relevant for industrial development – including the Ministry of Finance—and development partners.

By identifying priority activities based on job creation potential, availability of raw materials, export potential and potential to attract investment, the PCP approach naturally considers the specific characteristics of different sub-sectors. As discussed in Chapter 3, different manufacturing industries present different opportunities and challenges, depending on a country's specific conditions at a given time. This means that the chosen industrial policy measures are more likely to yield positive results when they are specifically designed for a selected priority sector and not simply copied from experience in another context.

Chapter 4 argues that the consultation process is key for the formulation of a strategy, policy or programme. Consultation at the design stage influences the effectiveness and efficiency of industrial policy during implementation. By relying on a multi-stakeholder partnership from programme design to implementation, UNIDO's PCP approach attempts linking the respective government's industrial development efforts with different actors ranging from United Nations agencies, development partners and financial institutions, to representatives from the business sector, academia and civil society. As each of these actors have different sets of priorities and preferences, attention is paid to the political economy of the respective context. Nonetheless, future PCPs should ensure that as much attention as possible is given to the assessment of the political economy context during the initiation and programming phases.

As regards the importance of experimentation and the assessment of individual industrial policy measures, continuous monitoring and evaluation is an essential aspect of each PCP's implementation phase. Additionally, the completion phase of each PCP includes an independent evaluation, which assesses and verifies achievements according to the PCP results framework. This evaluation is of particular relevance as it will be used at the end of each PCP to decide, together with the main partners and stakeholders, whether the programme should be refocussed on any specific aspect, expanded to other priority sectors or concluded.

The findings of Chapter 2 are particularly relevant for UNIDO's future PCPs, as they provide valuable insights for future policy and advisory services to respective governments on industrial policy-related issues. Lessons can be gleaned from the experience of different country groups, such as the early, recent and emerging industrializers identified in the book, and the differences and commonalities between their experiences. At the same time, the experiences from past PCPs can serve as additional reference points for how countries have managed to navigate the changing landscape of industrial policy space. Chapter 3 provides useful examples of different sub-sectors and their potential as priority sectors. Lastly, Chapter 4 presents important lessons for the implementation and governance of industrial policies that support the PCP approach with its strong emphasis on government ownership and national coordination.

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Appendix

Appendix 1: List of socio-economic indicators studied in detail

Table A.1.1: Selected SDG goals, targets and indicators

List of indicators studied in detail

Goal	Target	Indicator	Series code
1	1.1	1.1.1	SI_POV_DAY1
3	3.3	3.3.2	SH_TBS_INCID
3	3.1	3.3.1	SH_STA_MMR
3	3.2	3.2.1	SH_DYN_IMRT
4	4.3	4.3.1	SE_ADT_EDUCTRN
6	6.4	6.4.1	ER_H2O_WUEYST
7	7.3	7.3.1	EG_EGY_PRIM
8	8.1	8.1.1	NY_GDP_PCAP
8	8.3	8.3.1	SL_ISV_IFRM
8	8.6	8.6.1	SL_TLF_NEET
9	9.4	9.4.1	EN_ATM_CO2MVA
10	10.1	10.1.1	SI_HEI_BTN40
10	10.4	10.4.1	SL_EMP_GTOTL
12	12.2	12.2.2	EN_MAT_DOMCMPT
16	16.5	16.5.2	IC_FRM_BRIB

Source: Global SDG Database (available at: https://unstats.un.org/sdgs/indicators/database/).

Appendix 2: Definition of fast-industrializing economies

Economies were classified as 'fast industrializing economies' or 'fast industrializers', if three criteria were met:

Criterion 1: The annual growth rate of real MVA was greater than the corresponding growth rate of real GDP over the period 1970-2017.

Criterion 2: The country's nominal share of manufacturing amounted to at least 15 per cent of GDP, on average, for the period 1970-2017 or increased by 5 percentage points or more over that period.

Criterion 3: The country had a positive real growth rate of GDP per capita over the period 1970-2017.

Table A.2.1: List of fast industrializers

Austria	Lithuania
Bangladesh	Myanmar
Belarus	Nicaragua
Bosnia and Herzegovina	Poland
Bulgaria	Puerto Rico
Cambodia	Romania
China	Slovakia
Czechia	Slovenia
Estonia	The Republic of Korea
Germany	Swaziland
Hungary	Switzerland
Indonesia	Trinidad and Tobago
Ireland	Turkey
Japan	Turkmenistan
Jordan	Vietnam
Lesotho	

Source: UNIDO elaboration.

United Nations Industrial Development Organization
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