2. Reframing structural transformation towards sustainable and inclusive prosperity

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1. INTRODUCTION

Structural transformation has always been (and remains) central to a developmentalist agenda that is inclusive and sustainable. Structural transformation can create material conditions for equitable and sustainable prosperity and trigger changes in the institutional fabric and political economy of countries. These conditions are necessary but not sufficient. The main transformative processes and channels through which structural transformation delivers the developmental outcomes mentioned above are: (i) the building up and accumulation of productive, technological and organizational capabilities; (ii) the creation of decent jobs and their continuous betterment through formalization, unionization and skills development; and (iii) investments in systems of welfare provision that increase socio-economic resilience and state legitimation. These transformative processes do not emerge spontaneously. They must be directed, governed and shaped to address immediate and long-term societal and environmental needs; new pathways need to be opened, markets and institutions created, and industry transformed; trade-offs and conflicting claims have to be managed along the way via the coordination of industrial, competition, energy and welfare policies, to mention but a few.

Structural transformation processes today are occurring simultaneously and at a more rapid pace – hence, they are "compressed" (Whittaker et al. 2020) and challenged by several mega-trends characterizing global markets, industries and technologies (Andreoni and Tregenna 2020). These include the increasing industry concentration and power of digital platforms, power asymmetries along value chains, premature de-industrialization and new trade wars and competition for digital and green technologies and critical minerals (Andreoni and Roberts 2022; United Nations Conference on Trade and Development (UNCTAD) 2023). Against this challenging global landscape, developing countries are the countries most negatively affected by the overlapping crises of climate change, the lingering fallout from the COVID-19 pandemic, and the cost-of-living crisis, including food prices. This confrontation with multiple crises poses significant challenges to governments, who must address – simultaneously and with limited resources – immediate societal needs as well as the long-term strategic goals of structural transformation.

This coexistence of multiple challenges and crises demands a reframing of structural transformation to address the blind spots of traditional approaches and to broaden the structural transformation framework to fully and dynamically integrate the specific and interdependent challenges today facing developing countries. This chapter advances a sustainable and inclusive structural transformation framework that developing countries can use to navigate multiple challenges in today's compressed development regime. This framework contributes to the debate by updating classical structural transformation perspectives and identifying specific compression mechanisms and new challenges facing developing countries. The first additional challenge for countries undergoing a transformation process today is the challenge of industrializing in an environmentally sustainable way. The second additional challenge is keeping up with digital technologies and digitalizing the economy. Finally, the third challenge is about transforming the structure of the economy so that it creates jobs and social inclusiveness. In this chapter we refer to these compounded challenges as "the triple challenge of structural transformation", that is, making the transformation in an environmentally sustainable, digitally compatible and socially inclusive manner. Each of these challenges also provides opportunities that countries can use to drive a new pattern of structural transformation that is sustainable from an environmental perspective and inclusive from a job-creation perspective.

2. STRUCTURAL CHANGE AND TRANSFORMATION: AN INTRODUCTION TO AN EVOLVING FRAMEWORK

Classical development economists have analysed countries' development within a structural change and transformation framework (Chang and Andreoni, 2020). In their analysis of development and underdevelopment, they have mainly focused on countries' long-term structural change and on the identification of structural bottlenecks impeding capital accumulation and industrialization. "Balanced growth" models proposed by economists like Paul Rosenstein-Rodan (1961) and Ragnar Nurkse (1956) were built around the idea that unlocking productive development and escaping a vicious poverty cycle required a series of complementary investments within and across sectors. Only such a big and coordinated investment push would be able to deliver development, and only the state had the resources and planning capability to drive this transformation. Such an approach to structural change was diametrically different from the "unbalanced growth" model advanced by Albert Hirschman (1958). The latter shared an appreciation of structural interdependencies and promoted selective policy interventions favouring and prioritizing certain sectors with respect to others. The underlying idea was that changes in "focal points" of the economy and the governance of structural imbalances would trigger compulsion mechanisms and chains of investments in other sectors of the economy, and that employment would adjust to these changes.

Within these structuralist approaches to development, manufacturing development was recognized to play a critical transformative role given its capacity to boost capital accumulation, productivity increases and technological change. Building on the classic work on increasing returns by Allyn Young (1928) and several empirical regularities, Nicholas Kaldor (1966 and 1981) developed his three famous "growth laws". These showed the existence of increasing returns within manufacturing and the reasons why manufacturing was the engine of aggregate growth.

The "special properties" that make manufacturing more effective in triggering the growth of the overall economy than other types of economic activity (through the working of the first and third of Kaldor's law) are threefold. Firstly, there are relatively broader opportunities for capital accumulation and intensification in manufacturing (than in agriculture or services). Secondly, there are greater possibilities of exploiting economies of scale induced by large-scale production and technical indivisibilities, both within and across industries. Finally, there are higher learning opportunities in manufacturing production through which embodied and disembodied technological progress may be generated. Given these special properties, specialization in manufacturing implies a double productivity gain, since it allows countries to get a "structural change bonus" and avoid a "structural change burden". The former results from transferring labour from agriculture to manufacturing, while the latter relates to the so-called "Baumol's cost disease" (an overall slowdown of productivity resulting from an overdependence on services, especially labour-intensive ones such as personal services).

The mechanisms through which manufacturing is able to extend its special properties to the rest of the economy were explicitly formulated by Albert Hirschman (1958 and 1977). In his "unbalanced growth model" each sector is linked with the rest of the economic system by its direct and indirect intermediate purchase of productive inputs and sales of productive outputs – that is, backward and forward linkages. According to its system of linkages, each sector exercises "push" and "pull" forces on the rest of the economy. Moreover, the embodied and disembodied knowledge generated within the manufacturing sector connects within and across sectors through so-called "spillover effects". The latter take the form of product and process technologies (hardware) on which software-producing and software-using service sectors are based (Szirmai 2011).

Economists embracing a manufacturing-oriented view also stressed the importance of manufacturing in relation to other macroeconomic issues. Crucially, manufactured products have a high income elasticity of demand. This opens dynamic opportunities for the development of manufacturing production. Moreover, flourishing production of manufactured tradable goods was considered a fundamental condition for avoiding balance-of-payments crises. This was particularly the case for countries that could not rely on a high-value primary commodity export sector and where the income elasticity of demand for imports was higher than the foreign income elasticity of demand for exports (Prebisch 1950). In this regard, Latin American structuralism, encapsulated in the work of Raul Prebisch (1950) and Celso Furtado (1964), focused on the "centre–periphery" relationships in international trade and, thus, on the geography of power. Problems connected to lack of foreign exchange, dualism in international trade, technology transfer and capital accumulation were all emphasized.

3. BLIND SPOTS IN THE STRUCTURAL CHANGE AND TRANSFORMATION LITERATURE

The classical structural change literature has offered development scholars and policymakers critical insights into the ways in which economic structures change over time. Indeed, structural change theories and evidence have primarily developed at the interface of macro-sectoral (capital accumulation and economic growth) and meso-sectoral (structural change) levels of analysis. The adoption of these macro–meso analytical lenses has given the theories important explanatory power; however, this perspective also has several shortcomings and blind spots with increasingly important implications for theory, evidence and policy.

3.1 Linearity or Symbiosis?

Structural change has traditionally been biased towards a linear view of change, as highlighted by the grading of sectors from primary to secondary and tertiary. This linear view of structural change is, however, problematic with respect to analysis of the evolving relationships between agriculture and manufacturing, between manufacturing and services and between services and agriculture. The reason is that, in the process of structural change, traditionally defined sectors continually cross their own boundaries and thus shift their sectoral terrains (Andreoni 2020). Technical change and technological interdependencies across sectors cause a large part of these sectoral crossings and shifts during the process of structural change, with implications for the economy's structure and the composition of employment.

Kay (2009) points out how the relationship between agriculture and manufacturing, for example, is symbiotic in their economic development, since the development of each sector creates the conditions for the development and productivity increases of the other, in more of a circular and cumulative manner than a linear one. Increasing agricultural productivity results from industrializing agricultural processes through technical change stemming mainly from manufacturing. The bundle of interactions that connects manufacturing and services has also become increasingly dense, owing to the outsourcing of services activities from manufacturing firms to service providers, and also to the changing technological linkages between manufacturing and services – in particular, production-related services (for further discussion of the services sector, see Chapter 6). Empirical studies have found that

> the evolution of the intersectoral relationship between services and manufacturing in the course of development is symbiotic, in the sense that the growth of the service sector depends not only on that of the manufacturing sector, but also structural change of the former is bound to affect that of the latter. (Park and Chan 1989, 212)

Precisely these effects have been recently confirmed by several studies. Guerrieri and Meliciani (2005) show that a country's capacity to develop its services sector depends on the specific structural/technological composition of its manufacturing sector. Gonzales et al. (2019) investigate empirically the extent to which participation in business services' global value chains (GVCs) may open up new opportunities for developing countries to catch up. These authors find evidence that factor endowments and costs are not the only drivers of the emergence of business services' GVCs and that the specific domestic structure of backward linkages à la Hirschman is very important: the presence of a core, backward-linked manufacturing base is central to driving service business development (see also Savona 2021).

3.2 Structural and Sectoral Heterogeneity

The very concept of structural change deals with the overall structure of the economy and hence focuses on shifts between broad sectors in terms of both value addition and employment. Sectors are, however, made of highly heterogeneous subsectors and activities characterized by different degrees of technological intensity, different speeds of technological change, different levels of scale efficiency, different degrees of tradability, different skills, different workforce composition, etc. Andreoni and Chang (2017) identify several reasons why real-world production is characterized by "structural heterogeneity", beyond simple differences in capital–labour ratios (see also Amsden 1991).

Haraguchi (2016) illustrates such structural heterogeneity for the industrial sector by unpacking normal patterns of structural change at the subsectoral manufacturing level for three distinctive groups of countries – small, medium-sized and large countries. The findings point to high levels of structural heterogeneity within manufacturing, with important implications for alternative subsectoral patterns of structural change. The food and beverages and the textiles and apparel industries are typically the first to start to grow. However, food and beverages tends to remain a major sector (especially among large countries), whereas textiles and apparel tends to decline after reaching a contribution peak of around US$8,000 per capita. Other industries, such as chemicals, undergo a profound transformation and increasing internal heterogeneity. While the chemical industry emerges quite early in the form of the production 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 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 them, the motor vehicle industry is the one in which economies of scale tend to play the most dramatic role; this industry also demonstrates a high multiplier effect in employment.

3.3 The Environmental Kuznets Curve and Material Resource Boundaries

For several decades, the environmental sustainability of structural change and the role of natural resources in constraining the increase of production scale have remained largely unexplored. Even in those cases in which natural resources and sustainability issues were factored in (Leontief et al. 1977; Kuznets 1965), the dominant idea was that technologies can neutralize such problems by shifting them to an "indefinite" long term. However, the literature has become increasingly more aware of systemic challenges like climate change and resource constraints.

The relationship between economic growth and aggregate emissions has been studied in terms of the so-called "environmental Kuznets curve" (EKC) hypothesis. According to the EKC, environmental degradation increases in the early stages of economic development, and, after reaching a peak at some level of per capita income, it decreases as economic activity continues expanding.

The origin of the EKC goes back to a study by Grossman and Krueger (1993) on the potential environmental impacts of the North American Free Trade Agreement (NAFTA). They proposed three mechanisms by which a change in trade conditions can affect the environment in a country: a scale effect, a composition effect and a technique effect.

There have been various critiques of the EKC relationship, among them one based on the importance of differentiating between pollutants and other environmental impacts (Stern 2017). Moreover, findings remain mixed. For example, Panayotou, Peterson and Sachs (2000) have studied whether structural change drives the environmental transition using an income and population data series covering 1870 to 1994 for 17 industrialized countries. They find that (i) capital accumulation increases emissions in the early stages of development, whereas they fall and become negative in the post-industrial stage; and (ii) trade generally increases emissions, but, at high levels of income, trade tends to reduce them. More recently, Hardt et al. (2021) have studied empirically which specific sectors need to expand or shrink in terms of their output or employment share, and the effect that this change will have on labour productivity and energy intensity. Economic sectors are grouped into four groups defined by two dimensions and degrees of intensity: energy-intensive, energy-light, and labour-intensive, labour-light. They find structural change goals for each group; for instance, the main goal for group one – "energy-intensive and labour-light sectors", composed of those sectors producing agricultural goods, transportation services and manufactured goods – is to reduce the share of these sectors in output and final demand.

Decoupling structural change and carbon dioxide emissions is only one side of the coin. The other side is the relationship between structural change and resource constraints (Andreoni 2015). Although a certain endowment of natural resources may not constitute a constraint for a given sector, it can become a binding constraint as soon as more than one sector relies, both directly and indirectly, on the same type of natural resources. Critical minerals, for example, have gained increasing attention in this respect, since they underpin sectors producing digital technologies and renewable energy. Resource bottlenecks may unfold at a certain point in time and along a certain national structural trajectory. Even when these natural resources are renewable, the time required to produce or restore them may be too long to satisfy the pressure that fast manufacturing subsectors may impose on some of them. The second issue that emerges from linking structural change to resource scarcity is that there are different types of natural resources: soft commodities, hard commodities and energy commodities. The relationships these different types of resources have with each sector are complex and non-linear.

3.4 Micro–Meso Dynamics of Production and Employment under Different Development Regimes

The last two blind spots of the structural change literature are related. The process of structural change is driven by country-specific micro–meso dynamics of productive and employment change and is affected by the overall global development regime under which a country undergoes its socio-economic transformation (Andreoni and Chang 2017). The micro–meso dynamics of productive and employment change are in turn driven by two processes involving key actors of change – that is, productive organizations and governments. Change is driven by firms and their workers and the different ways in which they become collectively more productive and innovative and hence develop and cumulate productive, technological and organizational capabilities. It is also driven by the ways in which the government is willing and able to direct and shape industry and markets towards sustained prosperity (Amsden 1989 and 2001; Wade 1990; Chang 1994). Although firm-level internal dynamics of collective learning and organizational integration are essential to the structural change process, they remain opaque in the structural change literature. For example, the ways in which workers and organization retrain and retool themselves to operate under a new technological paradigm remain a black box within the standard structural change macro–meso approach.

The creation of jobs and their formalization and unionization sit at the centre of this micro–meso process of transformation, since they affect the extent to which firms can learn and innovate, and the extent to which the structural change's productivity dividend is distributed across society and directed towards sustained productive uses. The evolution of labour market and welfare institutions to nurture social provisioning plays a central role in determining the extent to which an economy undergoing structural change – moving towards more highly productive activities – can deliver inclusive and sustainable prosperity. Indeed, the social contract linking workers, firms and governments can lead to very different outcomes of structural change. With the escalating climate change crisis, the scope of this social contract is increasingly expanding to incorporate both social and environmental issues and the ways in which they interact (see also Chapter 1 on the evolving social contracts). From this perspective, structural change is only one necessary, although not sufficient, condition for a broader process of inclusive and sustainable structural transformation.

The social–environmental contract underpinning an inclusive and sustainable process of structural transformation is not simply a domestic matter; it is also affected by forces and mega-trends operating at the international level and evolving over time. In this regard, the concept of "development regimes" has been used to capture two important factors that frame country-specific structural transformation pathways and differentiate them over time (Whittaker et al. 2020). A development regime is defined by the presence of a certain dominant *industrial paradigm* and a certain amount of *policy space.* The idea of an "industrial paradigm" (Perez 2002) allows us to identify the dominant set of technologies that shape production and firm–labour relationships, as well as the dominant organizational mode of production through which local and global firms interact. The industrial paradigm constantly changes also because of changes in global regulations, and allows an expansion of the geographic scope of production. The policy space that is available to countries determines the extent to which the international political economy settings and rules allow a government to pursue structural transformation and/or negotiate the conditions under which firms and workers integrate into the global economy (Chang 1994).

Since the first Industrial Revolution, different historical periods have been dominated by different industrial paradigms, different technologies – from steam power to digital technologies – and changing organizational models of production, including the change from mass production to networked and platform production. Finally, the geographic scope of production has moved from national to multinational, to be increasingly structured around global value chains. Table 2.1 presents a schematic of the dominant industrial paradigm since the 1860s. The dynamics and scope for structural change under different industrial paradigms are varied. Depending on the dominant technologies and organizational model of production (and the resulting geographic scope), countries will face different challenges during their process of structural transformation.

Table 2.1 Industrial paradigms from 1860 to present

Industrial paradigms	1861–1913	1896–1945	1955–1990	1991–2005	2008 to present
Techno-economic paradigm	Steam power and rail	Steel and electricity	Automobiles and oil	Computers and ICT	Digital technologies and renewables
Organi-zational model of production	Managerial firm and local suppliers	Corporation and mass production	Multinational corporation and mass production	Network production and GVCs	GVCs and digital platforms
Geographic scope	National	National Multi-national	Multinational	Global and multipolar	

Source: Adapted from Whittaker et al. (2020).

The emergence of a new industrial paradigm and the evolution in the policy space are interrelated. For example, one key dimension determining a country's policy space is the space in its trade policy – that is, its ability to use tariffs strategically to sustain the process of industrial learning (Chang and Andreoni 2020). Since the Uruguay Round was started in 1986 and completed in 1994 and then with the establishment of the World Trade Organization, the global policy space has been shrinking as a result of bilateral trade agreements and the introduction of a more comprehensive set of regulations on investments, intellectual property rights and other sectors of the economy that were previously unregulated. The reduction in trade policy space opened the way to the affirmation and expansion of a new organizational model of production based on GVCs, starting in the 1970s and accelerating in the 1990s and 2000s.

4. SUSTAINABLE STRUCTURAL TRANSFORMATION UNDER COMPRESSED DEVELOPMENT: A FRAMEWORK

Structural transformation – especially for low- and middle-income countries – cannot today be rethought without addressing the blind spots and shortcomings of the classical theories of structural change highlighted in section 3. In this section we take on this task by, firstly, focusing our attention on the specific structural transformation challenges that countries face today. We build on two streams of literature focusing on the so-called "middle-income trap" (Lee 2013; Kang and Paus 2019; Andreoni and Tregenna 2020) and compressed development (Whittaker et al. 2020; Andreoni 2022). This literature provides a more realistic understanding of the micro–meso dynamics of structural change with the current industrial paradigm and global landscape. Specifically, it points to compression mechanisms affecting productive transformation and to implications for employment generation in the context of GVCs and rapid technological change. Secondly, we expand the literature on compressed development by looking at the emerging triple challenges and trade-offs that countries face in their structural transformation under the current development regime.

Whittaker et al. (2020) argue that the there is something unique in the regime of development experienced by countries from 1990 onwards. According to these authors, we have entered a phase of compressed development, a historical phase (or regime) of global capitalist transformation characterized by "out-of-sequence" and "simultaneous" phenomena. For example, countries have witnessed the coexistence of "de-industrialization" in developed economies and "premature de-industrialization" and "thin industrialization" among several middle-income countries. Furthermore, during this phase of compressed development, "transmission mechanisms" like GVCs and deregulated financial markets make phenomena like de-industrialization and concentration widespread (and interdependent) across developed and developing countries. The recent energy and food crises are examples of the widespread presence of global transmission mechanisms affecting countries in unexpected ways.

Whittaker et al. (2020) also highlight the fact that across developing countries "thin industrialization" and "out-of-sequence" sectoral developments (for example, retailing without manufacturing) are perhaps the most striking phenomena of the current era dominated by GVCs. Since the 1960s, these industrial dynamics have been accompanied by demographic transitions led by rising education, changes in family structures and a decline in mortality rates. They have been also coupled with social compression and the disembedding of market from society. These structural interdependencies pose new development trade-offs in the form of competing challenges (and related dual burdens if the matter be considered from a policy perspective), especially for countries aspiring to achieve socially inclusive and sustainable industrialization.

4.1 Structural Transformation Challenges under a Regime of Compression

The emerging literature on the middle-income trap (Lee 2013; Kang and Paus 2019) and middle-income technology trap (Andreoni and Tregenna 2020) has focused its attention on the large and diverse group of middle-income countries to highlight how difficult it is to transform the economy and move towards highly productive sectors to become a high-income country. Five main structural transformation challenges have been highlighted.

(a) Breaking into the global economy in the context of increasing concentration. Low- and middle-income countries face the challenge of breaking into the global economy, especially at early stages of their industrialization when access to technologies and external demand are paramount. Haraguchi, Cheng and Smeets (2017) find that global industry has become increasingly concentrated. The Group of Seven (G7) countries no longer command as high a share of global manufacturing as previously, yet their share remains high even though the successful new entrants – China in particular – have gained significant market shares. The G7 countries have erected several entry barriers, including requirements to develop global economies of scale, international and domestic institutions, and capabilities of technological development and innovation. The emergence of major national champions and multinational companies operating globally has also introduced new forms of direct and indirect (via global supply chains) competition in middle-income countries' domestic markets. Such competitive environments can lead to asymmetrical integration into global markets, in that only a specific, typically low-value-added segment of a value chain emerges in a developing economy, without wider domestic linkages and impact on employment and wages.

(b) Linking up into GVCs. Integration into regional and global value chains has been seen as a pathway for structural change. By linking up into GVCs, business enterprises can move to more profitable and/or technologically sophisticated capital- and skills-intensive economic activities with higher potential for value creation. Companies can specialize in specific production tasks or components while avoiding the building up of entire vertically integrated industrial sectors or blocks of industries (Milberg and Winkler 2013). First-tier suppliers and original equipment manufacturer (OEM) companies in low- and middle-income countries, however, face multiple challenges in linking up into GVCs. Firstly, focusing on the production of low-value-added parts and components does not automatically lead to the upgrading of domestic technological capabilities, especially given the endogenous asymmetries characterizing GVCs and the higher capability threshold that companies have to reach to engage with digital production technologies (Andreoni, Chang and Labrunie 2021). Moreover, in several cases middle-income countries that have attempted to integrate globally have also ended up "de-linking domestically" and hollowing out the domestic manufacturing sector.

(c) Linking up while linking back. Linking up to international companies and markets while "linking back" to local producers and local supply chains is central to inclusive and transformative structural change. The creation of domestic productive, technological and organizational capabilities is an essential step towards increasing productivity and working conditions among domestic firms and workers. The Republic of Korea and Taiwan, China, between 1970 and 1990 and China in the 1980s and 1990s all started their industrialization by linking (backwards) to global supply chains and adding value (forwards) in electronics and other industries, starting in particular with industries characterized by short technology cycles (Lee 2013). With the expansion of the local production system, more opportunities for backward integration open up as domestic companies start importing more intermediate goods while diversifying their export baskets. Over the last two decades, a very small number of middle-income countries have been successful in linking up while linking back. There are several reasons for this, including lack of productive, technological and organizational capabilities among domestic firms, but also lack of specialized institutions, including technology and research centres, universities and development banks.

(d) Keeping pace with technological change. Linking up and back successfully presupposes technological upgrading. Countries need to upgrade 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). Sectoral value chains are based on specific combinations of complementary technological capabilities required to execute tasks in the different stages of the chain. Keeping pace with technical change effectively may be challenged by the existence of investment gaps along different stages of technological development – the so-called "middle-income technology trap" (Andreoni and Tregenna 2020). For example, firms in middle-income countries may not be able to leverage a well-funded and diversified domestic science base that provides access to generic technologies. Companies are often unable or unwilling to make significant investments in basic research, since the long-term capital commitment is prohibitive or the long-term investment is too risky. The fact that the industrial base in these countries has limited diversification and technological depth also means that the scaling up of the new product or technology will rely on external inputs.
(e) Competing for innovation. Finally, those middle-income countries that 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, are ready to engage in sustained processes of industrial innovation. Nonetheless, competing in innovation at the global frontier is no easy task, especially under the most recent industrial paradigm of the digital economy (Andreoni, Chang and Labrunie 2021). The "digital capability threshold" that companies must reach to undertake digital innovations and industrialize them is particularly high, especially in domains such as artificial intelligence, data science, and robotization. Moreover, the digital economy presents new entry barriers in the form of network economies and global concentration in specific industries – especially digital platforms – and endogenous asymmetries along value chains (Sturgeon 2017).

4.2 Dual and Triple Challenges and Virtuous Loops

Today's low- and middle-income countries are all facing the five structural transformation challenges highlighted above. Some of these structural transformation challenges were present, although often in different forms, under previous development regimes. These structural transformation challenges are even more pressing if we look at the broader process of *inclusive* and *sustainable* structural transformation. In this process, countries do not simply transform their economy; they also increase the prosperity and welfare of increasingly larger segments of the population – and do so in an increasingly environmentally sustainable manner. Whittaker at al. (2020, 141) argue that

> the key challenge in the era of compressed development is not so much technological catch-up and upgrading per se, although this is difficult enough. Rather, it is to establish a virtuous loop between economic or technological development on the one hand, and equitable, inclusive growth and social development on the other.

The establishment of virtuous loops between economic and technological development, on the one hand, and inclusive as well as sustainable structural transformation, on the other, is a complex process. Figure 2.1 provides a conceptual framework to unpack the multiple relationships in play. The framework is structured around four dimensions – industry, technology, environment and society – as well as multiple dyadic relationships interlinking these dimensions.

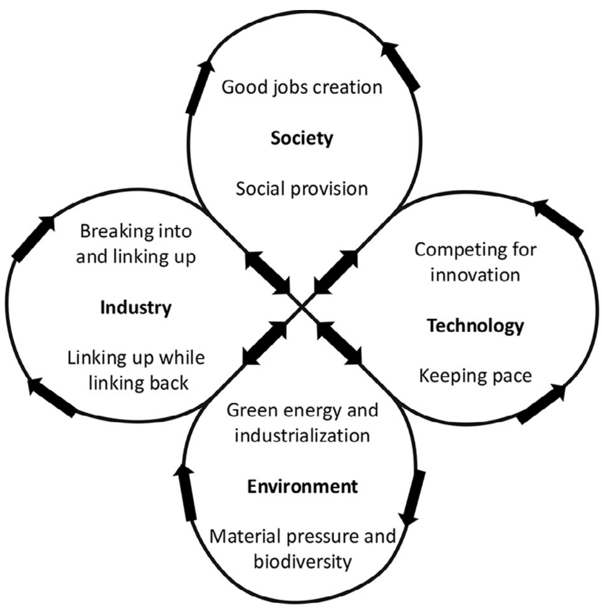

Figure 2.1 Inclusive and sustainable structural transformation integrated framework

The first dyadic relationship, between industry and technology, is central to understanding the economy and its evolving material structures. It is also where the five structural transformation challenges discussed above are most in play. Addressing these structural transformation challenges is, however, only the first necessary step towards inclusive and sustainable structural transformation. The second relationship, between industry and environment, is at the core of industrial sustainability, while the third relationship, between industry and society, is central to delivering inclusive and transformative social development. But the links work also in the opposite direction: technology is a key enabler of structural transformation through industrial applications and in its relationship with environment and society, provided that technological change is directed towards multiple goals of industry, society and environment. Finally, a dyadic relationship linking environmental sustainability and social inclusiveness also has to be taken into account. Without environmental sustainability, we cannot have social inclusiveness; and without social support and inclusiveness, the pressure on the environment cannot be addressed. Environmental sustainability thus needs to go hand in hand with social inclusiveness. The two processes reinforce each other in a dyadic loop.

Figure 2.1 also highlights the four interlinked dimensions of sustainable and inclusive structural transformation and policy. For each dimension, a number of critical issues are identified. For example, for the industry dimension a central challenge is the ongoing tension between breaking into the global economy and linking up into GVCs, while at the same time linking back into the local economy.

Sustainable and inclusive structural transformation involves closing the self-reinforcing loops among the four dimensions, as well as addressing several trade-offs. There are both static and dynamic trade-offs to consider, which relate to conflicting claims between sectors and social groups. Trade-offs exist because under a compression regime countries face multiple challenges at the same time and, in many cases, are affected by out-of-sync processes of structural change. In many cases these trade-offs can be overcome only when loops involving several dimensions are closed and developed. In the next subsections we unpack the three main sets of challenges that countries face. In the final section we move one step further in identifying pathways for reconciling these challenges, with a focus on the opportunities of environmentally sustainable structural transformation with green jobs.

4.2.1 Sustainable industrialization with green jobs

Climate change is the most pressing challenge of the twenty-first century. Climate change risks are expected to increase inequalities within and between countries among different social groups. Developing countries are already bearing the costs of a climate change crisis not of their making, in a context of limited financial and technological support and looming debt spirals. Countries face both the challenge of mobilizing large technical and financial resources and the challenge of directing them towards sustainable structural transformation that is also socially inclusive. Despite these persistent challenges, there are, however, increasing signs of gains arising from developing countries closing and reinforcing the loops linking domestic industrialization, green energy and industrial green transition, and decent job creation.

First, structural change – towards medium- and high-tech sectors – is both an outcome and a driver of green industrialization. The sectoral composition of low- and middle-income countries makes green industrialization particularly challenging in these countries, given that low- and medium-tech sectors tend to be associated with higher carbon dioxide emissions. Avenjo and Tregenna (2022) analyse the relationship between industrialization and carbon dioxide emissions for a panel of 68 developing and emerging economies over the period 1990–2016 and find that medium- and high-tech manufacturing industries are associated with lower carbon dioxide emissions than are low-tech manufacturing industries and that these differences vary with the countries' income levels. These findings point to specific structural composition challenges for developing countries; at the same time, they highlight how a shift towards medium- and high-tech sectors is in itself a way of decarbonizing their economies.

To transform their economic structures and make them increasingly carbon neutral, low- and middle-income countries also need to fuel their industries with cleaner energy, so they face the dual challenge of undergoing industrialization and reforming their energy system at the same time. This challenge becomes a triple one if we also consider that these transformations need to have a net positive impact on jobs. Although there are encouraging signs that in the long term green industries and renewable energy sectors can generate more employment, in the short and medium term the potential loss of jobs needs to be addressed with social protection and active labour policies, such as retraining of the workforce. Thus, sustainable industrialization is a quintessentially cross-sectoral political economy challenge, since it affects all productive, re-productive and consumption activities in society, from industrial production to energy and social infrastructure.

There has been an increasing realization that the energy sector is a key leverage point through which to address interdependent social and economic challenges (Sovacool and Cooper 2013) (see also Chapter 4 for further discussion). Since 2009, the dramatic decline in the cost of electricity from renewables – solar photovoltaics and wind, onshore in particular – has offered a viable pathway for accelerating energy transition, and the renewable sector has become a new source of employment (International Energy Agency (IEA) 2022). The increasing installed capacity of renewables technologies is responsible for such a dramatic shift in prices and the opening of new windows for green opportunities. By tapping into nature's continuous flow of present and future energy, rather than past energy stored in the ground, renewables technologies – and their continuous innovation – coupled with appropriate infrastructure can drive a sustainable energy transition. Continuous innovation is needed because even manufacturing development and technologies can hit non-reproducible resource boundaries (Andreoni 2015). For example, batteries for electric mobility rely on a limited non-reproducible resource – lithium – and solar panel manufacturing also relies on some non-reproducible resources. However, continuous innovation in manufacturing processes and product technologies for energy generation, as well as circular economy solutions, can shift these non-reproducibility boundaries, reduce reliance on non-reproducible resources and make energy transition feasible and sustainable.

Opportunities for green jobs are also becoming more widespread with the increasing mainstreaming of renewable energy technologies (International Labour Organization (ILO) 2018; IEA 2022). There are several direct and indirect channels through which it is possible to promote green jobs and thereby address the combined challenge of industrial upgrading, energy system restructuring and social inclusiveness. Green jobs emerge from the development of new value chains producing renewable energy technologies, as well as from the development and maintenance of a more distributed and resilient energy infrastructure. Green technology innovation and diffusion, and complementary investments in enabling infrastructure, should not be seen from a supply-side perspective only. They are in fact major sources of new intermediate and final demand for green products and services that can induce investment and job creation while opening pathways for all economies to restructure their industries. Creating and exploiting these new sources of demand to create a broader support for energy transition is as important as promoting supply-side innovation and industrial restructuring.

4.2.2 Digital industrialization with skilled jobs and social provision

Linking sustainable industrialization to green job creation is an important pathway for inclusive and sustainable structural transformation. More broadly, however, social inclusiveness can be only achieved if the loop linking technological change and innovation, on the one hand, and job creation, on the other, is also closed in all industries, not just in energy-related sectors. Decent job creation needs to be reconciled with the emerging digital technology paradigm characterizing the current regime of compressed development. The emergence, deployment and diffusion of new digital technologies clustered around the so-called "Fourth Industrial Revolution" (4IR) is increasingly altering the nature of manufacturing production and blurring the boundaries between physical and digital production technologies and systems. Advances in fields such as artificial intelligence, intelligent automated systems, robotization, and additive manufacturing are generating opportunities to accelerate technological and organizational innovation with dramatic impact on the modes and social conditions of production – in particular, business models, employment patterns and labour organization. The potentially disruptive impact of these new technologies on employment has received particular attention in both mature economies and emerging ones. Two main views have been advanced.

The "optimistic view" perceives the 4IR as a new source of job-creation opportunities in emerging industries, resulting in labour moving from old activities or sectors to new and growing ones, and that job gains are higher than job losses. Proponents of this view maintain that the "false alarmism" around the impact of digital production technologies (Atkinson and Wu 2017) derives from overlooking the strong legacy of preceding technological shifts in the 4IR. They advocate the prospect that more and better jobs will be created. According to this perspective, we are currently "unlearning the old and learning the new phase" (Freeman and Perez 1989), but, just as in the past, a new golden age for job creation is on the horizon if governments and business make good use of these new technological opportunities. Some authors stress that the impact of the new technologies on employment will depend on institutional factors: what is made of these technologies is what matters most (Gordon 2014). Any loss of jobs will be linked to more pervasive structural issues such as employment conditions and trade union disruptions – and will force down the wages of low-skilled workers – as well as to the financialization of corporations leading to a collapse in investment.

The more "pessimistic view", on the other hand, essentially argues that "this time it is different": the 4IR will not generate as many (good) jobs as the numbers of workers who will be displaced. Proponents of this view claim that job creation will be insufficient for the growing population, particularly for the low-skilled workers whose jobs are the most likely to be automated (Hawking 2016). This pessimistic view also stresses how the fact that labour will increasingly be replaced by automation systems, and other digital technologies in mature economies will also reduce the potential for jobs offshoring into low- and middle-income countries.

Technological and organizational change driven by new technologies has disproportional impacts on workers of different skills but also on workers of different gender. Automation, for example, may lead to a widening of the inequality gap in terms of wage and power inequality, skill inequality and gender inequality, among others. It is very unlikely that technological change and automation will affect male and female workers equally, and for various reasons. Apart from a social and cultural bias against female workers in high-tech production processes, female and male workers still present very different skills and occupational trends. Women are less inclined to study STEM (science, technology, engineering and mathematics) disciplines and less likely to enjoy stable working contracts. Being less involved in such disciplines, women are less likely to get the high-skilled jobs that tend to complement the introduction of new technologies.

Almost all the studies on the relationship between digitalization and jobs are on advanced economies; and they obtain mixed results (see Andreoni and Anzolin 2019 for a review). The few contributions on developing countries do not find evidence of polarization in the least developed countries and highlight a pattern of strong heterogeneity (Maloney and Molina 2016). Focusing on 74 economies between 2004 and 2016, Fu et al. (2021) found a disproportional impact of robotization among developed and developing countries. Robot adoption is associated with significant gains in labour productivity and total employment in developed economies, while such effects are insignificant in developing countries. Overall, for both country groups, there is no evidence of technological unemployment, but robotization is linked with significantly higher income inequality.

In low- and middle-income countries, several structural issues can hinder the adoption of advanced digital technologies by firms – especially ones that are not multinational corporations or internationally competitive – and hence affect the digitalization–employment relationship. A lack of basic and intermediate digital capabilities – digital skills in particular – and enabling infrastructural capabilities undermines domestic firms' technological efforts, especially these firms' absorption of digital technologies, integration into existing production systems, and retrofitting (United Nations Industrial Development Organization (UNIDO) 2019; Ferraz et al. 2019). Digitalization exacerbates the already significant skills-development challenges in several ways. Emerging technologies, including green technologies, demand a new set of digital skills profiles – for example, programming skills, web and application development skills, digital design, data management, visualization and analytics – which build on advanced literacy, numeracy and ICT (information and communications technology) skills (see also Chapter 9). Given that digital and green technologies draw on and integrate different science and technology fields in new ways, traditional training often does not prepare people for the use of integrated technologies (Andreoni, Chang and Labrunie 2021).

Training institutions, technical colleges, and universities in low- and middle-income countries perform two important and complementary functions. First, they are essential for skilled-job creation and domestic technology absorption and diffusion. Second, they are also important as channels of social mobility and inclusiveness. At the same time, these institutions are asked to address the need for inclusive "basic education" alongside the need for "advanced education" to develop technological and innovation capabilities. Social provision policy was a key, although often implicit, ingredient of late industrialization (Mkandawire 2004). This key policy has become increasingly difficult to deliver under compressed development.

Closing the loop between technology and society – keeping pace with digitalization while creating decent jobs – requires an engagement with several dynamics at the same time. We have highlighted three main ones here: (i) managing the potential static trade-offs between digitalization – automation in particular – and job creation, by focusing on the new job opportunities that technological change creates dynamically along the path of structural transformation; (ii) identifying ways in which digital technologies enable the greening of the energy sector and domestic economy, hence creating a loop between green industrialization, digitalization and job creation (many green jobs today are enabled by digital technologies; (iii) looking at social policies and institutions, education in particular, as integral to an inclusive and sustainable structural transformation process. The specific opportunities that emerge from developing skills for the industries and technologies of the future – digital and green – must be seized alongside an attention to social inclusion. Creating virtuous loops among these self-reinforcing dyads and dimensions of structural transformation requires context-specific policy experimentation and institutional innovation.

5. CONCLUSIONS

Classical approaches to structural change and transformation have been central to understanding the causes of development and underdevelopment. There have been, however, a few blind spots and gaps, especially among those approaches taking a simple macro–meso perspective. This perspective does not provide enough granular understanding of the complex and evolving interdependencies linking sectors and subsectors of the economy and does not focus on the global organization of production and labour into sectoral value chains. In this chapter we have argued that understanding these micro–meso dynamics of structural change and transformation together with expanding the classical dimensions of interest in the literature are particularly important steps, especially in the current regime of compressed development and in the face of multiple crises. We have shown how countries have entered a specific global development regime characterized by out-of-sync and simultaneous compression dynamics and resulting in new structural transformation challenges. We have analysed these challenges with a view to understanding the tensions and trade-offs constituting the relationships between industry and technology.

The dyadic relationship between industry and technology has been always central to the structural change and transformation literature, although studied at different levels of disaggregation. In this chapter I have pointed out how two further dimensions – the environmental and social – must be fully integrated into the structural transformation framework. Inclusion of these two dimensions allows a more holistic understanding of the multiple and interlocked dyadic relationships at the core of inclusive and sustainable structural transformation. I have stressed how these relationships are not always aligned and that there are inter-temporal trade-offs that need to be governed. We have focused specifically on the link between green industrialization and job creation, as well as that between digital industrialization and job creation. It can be challenging to create virtuous loops reinforcing the links between the four dimensions of industry, technology, society and environment, especially in the face of conflicting claims on resources and interests. However, developmental governance of these relationships can also deliver solutions to interlocked problems at the same time and hence reduce the compression that developing countries face today in their development journey.

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