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Contents

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1. Looking back, redefining the future: an overview of the state of play of green structural transformation and the factors critical to its success

Elina Scheja and Kee Beom Kim

1. INTRODUCTION

Movement towards economically, socially and environmentally sustainable societies is the direction of travel, but the current speed of progress has been rather disappointing. Recent reports on the status of climate change and biodiversity testify to the inadequate action taken to change the development paths of economies despite the wide-ranging global commitments to the contrary.

Since the United Nations Framework Convention on Climate Change (UNFCCC) was adopted at the 1992 Earth Summit in Rio de Janeiro, the Parties to the Convention have met annually at United Nations (UN) Climate Change Conferences (Conferences of the Parties – COP) to address climate change. One of the most significant milestones towards the implementation of the UNFCCC was the 21st session of the Conference of the Parties (COP21), when the Paris Agreement was adopted and the Parties committed to holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels. The agreement was not limited to climate goals and noted also the need to take "into account the imperatives of a just transition of the workforce and the creation of decent work and quality jobs in accordance with nationally defined development priorities" (UN 2015a), which implies more overarching reform of the current economic landscape. More recently, the Parties have specified that keeping within the Paris Agreement requires reductions in global greenhouse gas emissions of 43 per cent by 2030 and 60 per cent by 2035 relative to the 2019 level, and reaching net zero carbon dioxide emissions by 2050 (UNFCCC 2023). Building on the Convention on Biological Diversity, adopted at the Earth Summit in Rio de Janeiro in 1992, the Kunming–Montreal Global Biodiversity Framework

(GBF), adopted in 2022, provides a range of goals and targets to be achieved by 2030, including the effective conservation and management of at least 30 per cent of the world's lands, inland waters, coastal areas and oceans (United Nations Environment Programme (UNEP) 2022a).

Agenda-setting for climate and biodiversity action has taken place in parallel with a bold new ambition for economic and social progress that would eradicate poverty in all its forms by 2030 (UN 2015b). The Sustainable Development Goals (SDGs) adopted by all UN Member States in 2015 recognize that environmental sustainability is not an isolated goal but an integral component of economic and social development. They recognize the critical role of productive structural transformation, that is, of moving output and employment from lower-productivity activities to higher-productivity activities by means of diversification, technological upgrading and innovation, and a focus on high-value-added and labour-intensive sectors, while at the same time decoupling economic transformation from environmental degradation through the adoption of green technologies, resource efficiency and sustainable production and consumption patterns.[1] The 2030 Agenda for Sustainable Development (UN 2015b) has set the bar high for international cooperation and national-level action on several interlinked but mutually reinforcing areas of human development.

Despite the political commitments, progress has fallen short of the ambition of the Paris Agreement. The United Nations Environment Programme (UNEP 2022b) estimates that global temperature increases may reach 2.8°C by the end of the century, much above the target levels set in Paris. According to the International Monetary Fund (IMF) (IMF 2023) estimates, existing and planned climate policies in the Group of 20 (G20) countries will lower emissions by 13 per cent compared with the 25–50 per cent reduction required by 2030 to achieve the Paris target levels. Moreover, the targets for social and economic development are off track, and the progress on some indicators was even reversed during the global COVID-19 pandemic.[2]

At the same time, sustainable and productive structural transformation has been elusive for many countries around the world. These setbacks are not only a political failure but are felt in the lives of the millions of people who face the

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[1] See, in particular, SDG 8 on promoting sustained, inclusive and sustainable economic growth, full and productive employment, and decent work for all, and SDG 9 on building resilient infrastructure, promoting inclusive and sustainable industrialization and fostering innovation.

[2] For measuring progress on the SDGs, see, for example, Our World in Data, “SDG Tracker: Measuring Progress towards the Sustainable Development Goals”, https://ourworldindata.org/sdgs.

implications of climate change in their daily lives and who still lack productive and decent employment that could lift them out of poverty. In addition to the social factors, a recent survey by the World Economic Forum (WEF) (WEF 2024) shows that societal and environmental risks dominate the medium-term considerations of the world's academic, business, government, civil society and thought leaders; the quest for sustainable new economic practices is business-critical. The survey also emphasizes that today's world of multiple crises (or "polycrisis") presents an increasingly complex set of challenges to achieving a sustainable future. For example, immediate risks, such as disinformation, geoeconomic tensions and debt vulnerabilities, divert our attention from longer-term trends such as climate change, which is arguably the defining challenge of our time.

There is a need to find a new narrative for the development paradigm as we go forward. The Center for Global Development calculates that the 52 lowest-income countries, which host 1.4 billion people (19 per cent of the world's population), account for only 1.6 per cent of global emissions (Baker and Mitchell 2020). Furthermore, beyond environmental concerns, a growing apprehension has emerged that the classical path of economic transformation hitherto pursued by the high-income economies, and successfully adopted by their East Asian counterparts on their path to catching up, is no longer a viable option for many low- and middle-income economies. These countries have encountered a phenomenon often termed "premature industrialization" (Dasgupta and Singh 2006), characterized by a structural transition predominantly from low-productivity agriculture to low-productivity services. This shift bypasses the potential productivity spillovers typically associated with manufacturing, thus raising doubts about the sustainability of these countries' growth trajectories (Rodrik 2016; Andreoni and Chang 2016; Dasgupta, Kim and Pinedo-Caro 2017). With the world now facing mounting environmental challenges and resource constraints and limited income convergence between low- and high-income countries, it is clear that previous development paths are no longer feasible or desirable for today's developing countries. Instead, these countries must chart a course towards more sustainable and productive patterns of structural transformation to bring about economic and social progress and environmental stewardship. Green structural transformation pathways must be designed and pursued.

As previous pathways have not delivered the necessary progress or are no longer feasible, alternative routes will need to be envisioned, and then followed, to ensure the well-being of the planet and its people, including workers. The current volume offers some pieces of the puzzle with a view to stimulating further discussion on possible pathways forward. It consists of independent contributions from scholars and development practitioners who are facing the challenges from different angles and are able to propose solutions along different avenues. The aim of this volume is not to cover every aspect of the subject, but to contribute from a labour market perspective to the discussion about an alternative framework for conceptualizing the process of structural transformation in the context of ongoing climate change and ecological crisis, and to offer glimpses of innovative policy solutions to tackle the pressing challenges.

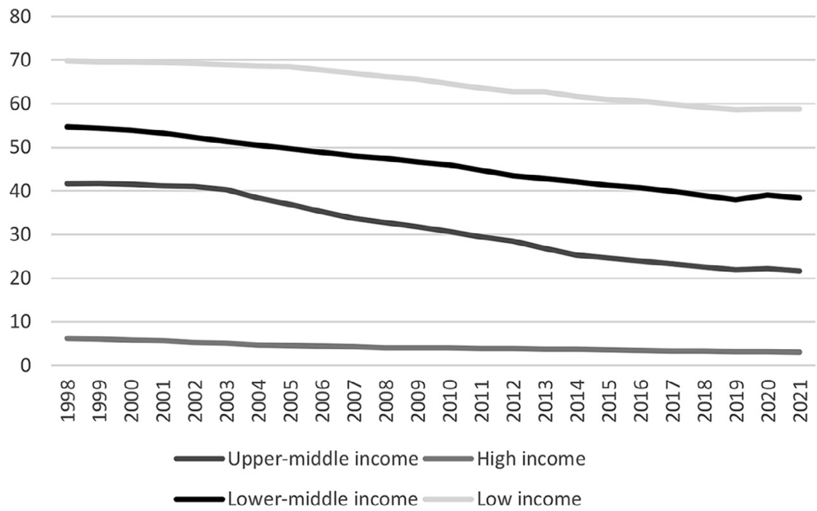
The first section of the volume (Chapters 1 and 2) provides the bigger picture of the current state of affairs and re-examines the theoretical underpinnings of structural change as a paradigm for economic development. The second section includes thematic deep dives into the main economic sectors and discusses: how to redefine the role of the agricultural sector and rural areas in the green transition in terms of their provision of nature-based solutions that create both economic and environmental value and resilience (Chapter 3); how to rethink industrialization through a green energy transition and alternative production patterns (Chapter 4); the opportunities and risks presented by a circular economy (Chapter 5); and how the services sector should be understood in the current context of environmental sustainability, digitalization, international value chains, and servitization, the last of which expands the offer of traditional goods (Chapter 6). The last section focuses on the enabling policies and institutional reforms that are required to manage the transition. Chapter 7 discusses economic steering mechanisms, zeroing in on carbon taxes, which can be used to correct market failures and incentivize development towards greener economies while generating a source of finance for the necessary investments and duly accounting for the disruption the green transition may cause to the labour market and household welfare. Chapter 8 introduces a new proactive role for social protection in the context of a just transition and discusses the complementarities of social protection and active labour market policies (ALMPs) in focusing on people and facilitating social and economic transition. Finally, Chapter 9 highlights the role of skills, as both an enabler of transition and a buffer against adverse effects, in maximizing the speed and benefits of greening the economy.

2. STRUCTURAL TRANSFORMATION? UNFINISHED BUSINESS

The significance of economic structure in shaping the growth trajectory of modern economies was advanced by Kaldor (1966, 1967 and 1968). His seminal contributions underscored that, while each economic sector had distinct characteristics, it was the dynamic interplay among these sectors that determined the temporal evolution and character of economic growth. The insights offered by Kaldor found resonance in subsequent research and have significantly enriched understanding of the modern economic growth process. Kuznets (1971) identified structural transformation as one of the six characteristics of modern economic growth, and Herrendorf, Rogerson and Valentinyi (2013) have underscored that changes in sectoral composition and their relative contributions to economic output are critical in driving economic and labour market outcomes, including income convergence, productivity and wage inequality. Structural transformation is not only about the changing sectoral composition of the economy but also about evolving change in the structural interdependencies linking sectors of the economy, including the transformation of the underlying productive and technological structures as well as changes in the composition of demand, in both the quantity and quality (Chenery, Robinson and Syrquin 1986; Andreoni and Chang 2017).

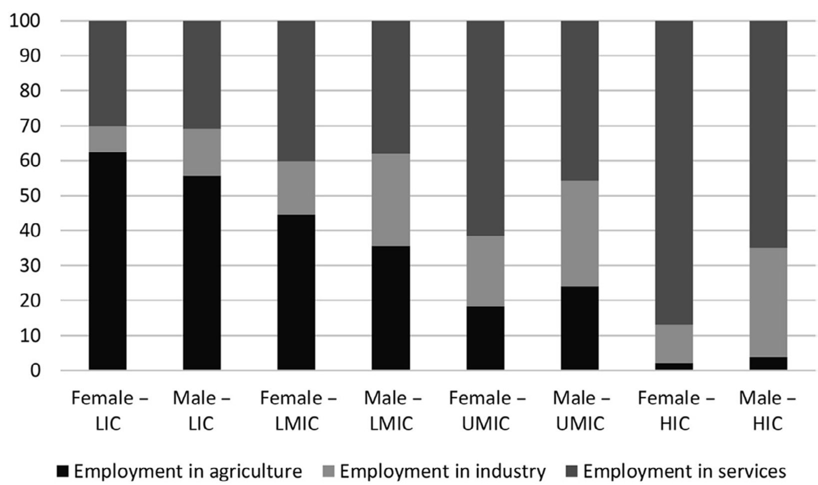
Nonetheless, productive structural transformation has not been an easy or automatic process. In some instances, it has entailed resource reallocations from sectors characterized by higher productivity to ones marked by lower productivity (McMillan, Rodrik and Verduzco-Gallo 2014). In others, the pace of productive structural transformation has been far too slow to generate sufficient decent jobs and lift the poor out of poverty. At the same time, low-income countries have not been able to escape the "commodity development trap", resource extraction having intensified since the mid 1990s without any substantive upgrading of these countries' positions in global value chains or any changes in their peripheral roles in global trade (United Nations Conference on Trade and Development (UNCTAD) 2022). In these economies, the agricultural sector – which is typically characterized by high labour input, low productivity and low wages and where the vast majority of the poor earn their livelihood – the share of agricultural employment has decreased by only 10 percentage points over the past 20 years (Figure 1.1). In upper-middle-income countries, in comparison, the corresponding share has declined at twice the rate. The slow pace of structural transformation in low-income countries also carries important gender implications, since agriculture accounts for the largest share of women's employment in these countries, as well as in lower-middle-income countries (Figure 1.2).

In some countries, after an initial period of productive structural transformation, the continuity of productive patterns and pace have not been sustained, leading to the often-cited phenomenon of the "middle-income trap". Even more distressingly, many low-income countries have simply not been able to move into middle-income status and converge their income levels closer to those of high-income countries. In low-income economies, levels of labour productivity relative to those of high-income countries fell from 6.9 per cent in 1991 to 5.5 per cent in 2022 (Figure 1.3). Lower-middle-income countries fared better, the corresponding ratio advancing from 13.7 per cent in 1991 to 19.9 per cent in 2022. Notably, upper-middle-income countries, in large part owing to China, doubled their levels of productivity relative to those of high-income countries, from around 18 per cent to 36 per cent.



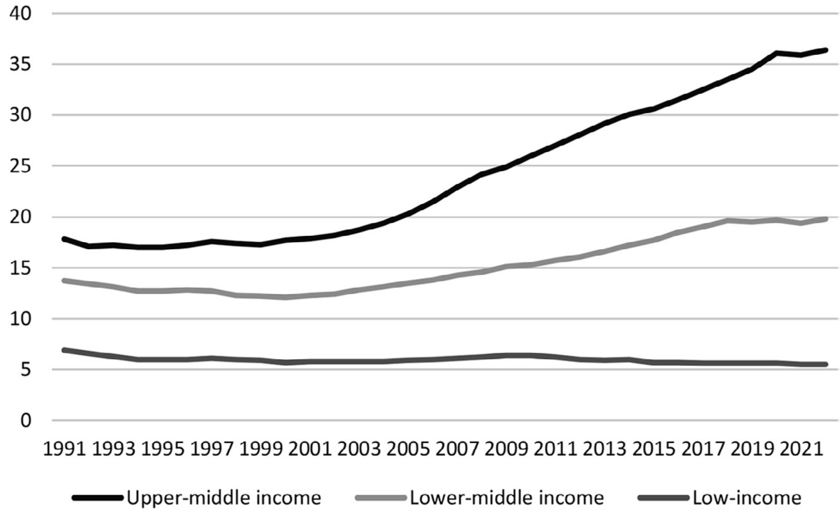
Source: ILO modelled estimates, November 2022.

Figure 1.1 Share of agriculture in total employment (percentages)



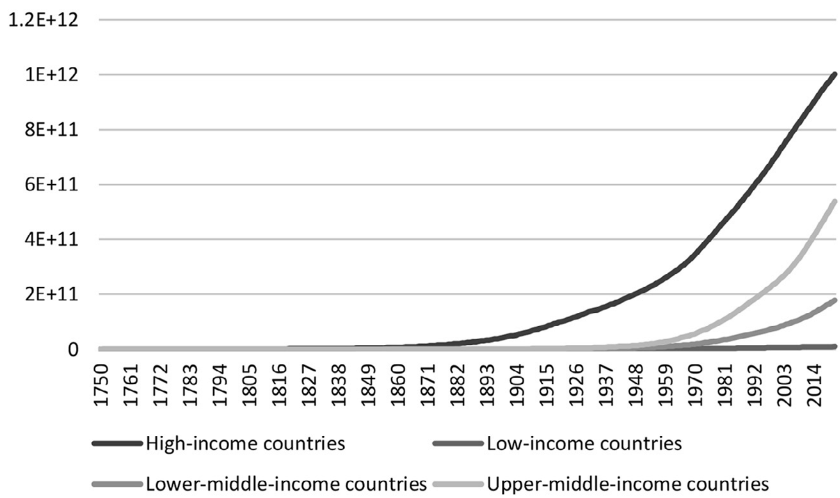
Note: LIC = lower-income countries; LMIC = lower-middle-income countries; UMIC = upper-middle-income countries; HIC = high-income countries.
Source: ILO modelled estimates, November 2022.

Figure 1.2 Employment by sector, sex and country income group in 2021 (percentages)



Source: ILO modelled estimates, November 2022.

Figure 1.3 Level of labour productivity as percentage of that in high-income countries



Source: Global Carbon Project.

Figure 1.4 Cumulative carbon dioxide emissions (excluding those from land use change) by income group

The structural transformation experienced earlier by the current high-income countries has also led to an exponential increase in greenhouse gas emissions (Figure 1.4) and an acceleration of anthropogenic climate change. It is widely recognized that, although all countries and individuals contribute to global emissions, their respective contributions are highly unequal (Chancel, Bothe and Voituriez 2023). Although a higher standard of living often corresponds to a higher impact on the environment, this does not need to be the case. Classifying countries by their income and emissions shows that some high-income countries (such as Romania and Chile) are low emitters per capita and that middle-income economies can choose very different routes to development (India being a low emitter and China a high emitter per capita relative to their respective income levels) (Fengler, Gill and Kharas 2023). The empirical evidence suggests that there is more than one pathway to prosperity and that it is more critical than ever to choose the more sustainable pathways.

3. THE HUMAN FACE OF CHANGE

The pursuit of a more sustainable route to development will involve a radical restructuring of the economy, the adoption of new technologies and, consequently, fundamental changes in the world of work. The expanding literature on the expected consequences of green transition on the workforce highlight that, while the majority of jobs are likely to experience a change in the character of work, the net employment effect of a green transition is likely to be small but positive (ILO 2018 and 2022a). The direction of the net employment effect (the difference between jobs created and jobs eliminated) will depend on how green policies affect countries' overall economic activity, the level of capital investment in green industries, and the extent of spillovers to supplier industries, among other factors. Moreover, looking only at the net employment effects masks the employment disruptions and losses that will inevitably affect some workers more than others, even in countries where the net aggregate impact is positive. The range of potential labour market frictions and misalignments means that the transition is unlikely to be smooth for all workers unless appropriately supported through public policies (Malerba 2022).

As explored in different chapters of this volume, the misalignments of the supply and demand for labour which will be caused by the green transition may be temporal, geographical, sectoral, and/or skills specific. Firstly, there is likely to be a temporal lag between job gains and losses, meaning that jobs may be lost before new green jobs are created (International Renewable Energy Agency (IRENA) 2020) and that there could be a temporary increase in unemployment while green industries and jobs are being created.

Job losses in the green transition are also likely to be geographically concentrated, and the jobs emerging from the green transition may not be located in the same areas as the eliminated jobs (IRENA 2020; Organisation for Economic Co-operation and Development (OECD) 2021). In many countries, carbon-intensive jobs such as coal mining are geographically concentrated in specific regions (International Energy Agency (IEA) 2022). Although coal mining typically accounts for less than 1 per cent of national employment, the IEA estimates that it accounts for around 5–8 per cent of employment in coal-intensive regions such as Shanxi in China, East Kalimantan in Indonesia, and Mpumalanga in South Africa. Even in flexible labour markets with low formal barriers to migration, past experiences of coal transitions demonstrate that labour mobility is generally more limited than theory might suggest (Spencer et al. 2018). The spatial concentration of environmentally harmful industries also means that they are often important to the local economy and that their phase-out can have significant knock-on employment effects on other sectors.

Sectoral misalignments mean that the new jobs may be available in different sectors from those where jobs are eliminated and that not all workers will manage to move seamlessly across sectors (IRENA 2020). This phenomenon may be more pronounced in low- and middle-income countries, where labour has been found to be less mobile across sectors than in industrialized countries (Hafstead et al. 2018). Sectoral shifts may also have gender implications. For example, in South Africa the transition may reduce the share of women in employment, since sectoral transformation is likely to focus on male-dominated industries such as renewables, manufacturing and construction (Omer and Capaldo 2023). In Latin America, the ILO and Inter-American Development Bank (IDB) estimate that male-dominated occupations will experience a higher proportional job gain than female-dominated occupations (IDB and ILO 2020).

Finally, there may be a mismatch between displaced workers' education and skills and the requirements of the newly created jobs (IRENA 2020). Older workers may be particularly affected because they face disproportionate displacement challenges (OECD 2021). Their shorter period of remaining professional life means that the returns from retraining are likely to be lower, and they may face a range of other formal and informal barriers to reskilling in old age. This problem is exacerbated by the disproportionate numbers of older workers in carbon-intensive industries, particularly in many OECD countries (OECD 2018).

If they do not address these misalignments, the affected countries could experience an increase in structural and frictional unemployment, at least in the short term, with impacts on both inequality and poverty (Hafstead et al. 2018). This risks undermining the political acceptance and thus feasibility of green policies (Maestre-Andrés, Drews and van den Bergh 2019; OECD 2021). Volatility and sudden increases of energy and food prices have repeatedly triggered social unrest and induced significant political pressure to delay or withdraw necessary reforms (IRENA and ILO 2022). Thus, decisive action requires understanding of the political economy behind the winners and losers in the different policy options to combat the climate crisis and transform the economy.

Responsivity to the concerns of those who risk falling behind need not prevent rapid and determined action towards green structural transformation. In fact, research into the potential trade-off between poverty reduction and achieving climate goals has proven that eradicating extreme poverty will have only a marginal impact on climate and thus the two objectives are not in conflict (Chancel, Bothe and Voituriez 2023; Wollburg, Hallegatte and Gerszon Mahler 2023). It has also been shown that achieving social goals, such as improved gender equality, also leads to advancements in economic and climate objectives (see, for example, Altunbas et al. 2022).

4. WHY IS THE CHANGE NOT HAPPENING?

The transition towards more economically, socially and environmentally sustainable economies faces multifaceted challenges that have hindered its realization. First, the current economic system has led to stark inequalities in economic opportunities and outcomes, which have brought about demands for climate justice. However, the fear of potential welfare and inequality implications stemming from the proposed policy shifts can create resistance to their effective implementation. At the same time, pockets of opposition to the green agenda have emerged from segments of society that fear the immediate costs of environmental actions in their daily lives – a sentiment exemplified by movements like the "Yellow Vests". In the light of such resistance, it is increasingly imperative to garner public support for the transformative reforms required for a sustainable future, to facilitate the transition for individuals and to bolster social protection mechanisms for those at risk of being left behind.

Furthermore, recent political shifts in many high-income countries have been accompanied by a notable backlash against green reforms. This polarization of the political landscape, coupled with the politicization of climate change discussions along ideological lines, has led to difficulties in achieving parliamentary support for many of the required policy changes. At the same time, prices of crude oil and gas have spiked as a result of the recovery from COVID-19, the war in Ukraine, and the potential broadening of the Israeli–Palestinian conflict; a situation that may entice economies and firms to postpone the phasing out or even the phasing down of fossil fuels, despite commitments to the contrary.

Antonio Andreoni, in Chapter 2, argues that the inequalities in economic opportunities and outcomes faced by low-income countries and those in the middle-income trap are also a result of simultaneous and out-of-sync dynamics of "compressed development". These dynamics are driven by a number of factors, including the challenge of breaking into the global economy amidst a highly competitive and protectionist setting maintained by the key economic powers. This economic power imbalance can lead to an asymmetrical integration of smaller economies into global markets, characterized by integration into low-value-added segments of global supply chains (GSCs). The low- and middle-income countries also face the challenge of linking up to lead firms in GSCs while linking back to local suppliers and producers in their domestic economy in such a way as to improve employment and wages. Other challenges include keeping pace with technological change, particularly in the context of investment gaps in low- and middle-income countries, and competing for innovation at the global frontier.

These challenges often start in agriculture in developing countries. In agriculture, asymmetrical integration into global markets manifests as a heavy reliance on the export of primary commodities, or basic agricultural products, which are often subject to price volatility, and this reliance can hinder the development of more advanced agricultural value chains. Agriculture-based economies often find it difficult to access higher-value markets or compete effectively, owing to trade barriers, quality standards and limited bargaining power. The lack of robust linkages between agriculture and other sectors of the economy also results in inefficiencies, such as post-harvest losses, and missed opportunities for value addition. Furthermore, the global agricultural sector is highly competitive, driven by ongoing innovation in areas such as biotechnology, precision agriculture, and sustainable farming practices, but developing economies often face barriers to accessing and adopting these technological advancements, owing to financial constraints, regulatory hurdles and a lack of research infrastructure.

Today, agriculture, often regarded as both a driver and a victim of environmental change, stands at a critical crossroads. On one hand, it is central to the global food system, providing sustenance for billions of people and being the cornerstone from which the structural transformation process must commence. On the other hand, it is a significant contributor to deforestation, greenhouse gas emissions, and habitat destruction. It is estimated that agriculture and related land use account for around 17 per cent of global greenhouse gas emissions, second only to the power sector at 23 per cent (Intergovernmental Panel on Climate Change (IPCC) 2022). In fact, a poignant confluence is emerging where between 1.3 and 1.8 billion people are concentrated in poverty "hotspots" characterized by poor agricultural potential, susceptibility to drought and climate change, and insufficient market access (Ahmadzai, Tutundjian and Elouafi 2021).

In Chapter 3, Maikel Lieuw-Kie-Song highlights the importance of investments in natural capital, which provides the ecosystem services essential to increasing agricultural and rural productivity in order to kick off and sustain structural transformation, while at the same time generating a number of broader climate and biodiversity benefits. In particular, nature-based solutions – which can be broadly defined as actions to protect, conserve, restore, sustainably use and manage natural or modified ecosystems while effectively and adaptively addressing social, economic and environmental challenges (UNEP 2022c) – are increasingly recognized as a powerful ally in the quest for sustainability and as playing a critical role in addressing the climate change and biodiversity crises. As with the employment impacts of the green transition mentioned earlier, urgently and massively scaling up these solutions will have wide implications for rural labour markets, including the nature of work and the demand for labour. This discussion is particularly important because, in an effort to advocate change and elicit the political backing for an ambitious reform agenda for green structural transformation, voices have been raised to redefine the social contract to include ecosystem services and responsible management of natural resources (see, for example, Norton 2023).

Another current impediment to swift progress towards economically, socially and environmentally sustainable societies lies in the challenge of decoupling economic development and employment generation from carbon dioxide emissions, particularly in industrial sectors. The special role of industry, and especially manufacturing, in structural transformation and development derives from its ability through spillover effects to raise overall productivity, while providing employment at the scale required to absorb those leaving other sectors as well new entrants into the labour market. Although job creation remains a paramount concern for policymakers worldwide, the conundrum of concurrently addressing this imperative and mitigating global emissions has proven to be challenging. In Chapter 4, Antonio Andreoni builds on his earlier chapter to provide empirical evidence of the limited decoupling between 2014 and 2018 for over 100 countries. He underscores that all industrial sectors, including the energy sector, but also other industrial sectors such as agro-food and garments, chemicals and steel, and the aerospace and automotive industries, contribute to climate change dynamics not only through direct emissions but also along upstream and downstream value chain segments. In the energy sector alone, the IEA (IEA 2023a), in its updated road map, finds that global renewable power capacity must triple by 2030, which signifies that fossil fuel demand must fall by a quarter; that the annual rate of energy efficiency improvement must double; that sales of electric vehicles and heat pumps must rise sharply; and that energy sector methane emissions must fall by 75 per cent – all in order to keep the pathway to the 1.5°C goal within reach. Such a transformation of the energy sector could play an important role in decoupling emission growth from employment growth, the latest estimates indicating that the renewable energy sector almost doubled its direct and indirect employment from 7.3 million in 2012 to 13.7 million in 2022 (IRINA and ILO 2023).

The emergence of a circular economy signifies a departure from the traditional linear resource path often found in industrial sectors, with the aims of addressing resource depletion, enabling the closure of energy and material loops and realizing the SDGs (Prieto-Sandoval, Jaca and Ormazabal 2018). Such a paradigm shift also offers key opportunities for developing countries to facilitate structural transformation through the remanufacturing of goods (UNCTAD 2021). Nonetheless, this paradigm shift is not without pitfalls, as Anna Barford argues in Chapter 5 with a deep dive into plastics recycling. The circular economy today includes the prevalence of minimal workers' rights, subpar occupational safety and health conditions, and poor pay compensation. The possible coexistence of environmental gains and social disparities exemplifies the challenges that impede the seamless adoption of circular economy models.

The concept of the circular economy entails a complex web of services, including elements such as refurbishment, product design, and repair and maintenance services. These activities constitute an important avenue for developing countries to transition towards higher-productivity sectors. However, as noted, the trajectory of structural transformation in many developing countries has led predominantly to the expansion of low-productivity services rather than of modern, high-productivity services. Although the services sector is often perceived as posing less environmental harm, its growing contribution to the overall economy also raises concerns about its escalating impact on global emissions. In Chapter 6, Patrik Ström notes how the absence of well-functioning markets, domestic capabilities, infrastructure and skills often channels lower-income countries into lower-productivity segments of the services sector. This trend not only restrains economic development but also diminishes the potential of services to serve as intermediaries between industries and the imparting of critical knowledge to make industrial processes more environmentally sustainable. A particularly salient challenge lies in the underdevelopment of digital services and producer services, which significantly hinders the sector's capacity to effectively support green transition.

Another constraint upon greener productive structural transformation is the evolving landscape of financing, which has witnessed significant turbulence in the wake of the COVID-19 pandemic, trade and investment fragmentation and escalating geopolitical tensions and conflicts. These destabilizing factors have catalysed a surge in inflation, financing costs and debt vulnerabilities across countries. Yet, as indicated in the outcome of the first global stocktake after COP28, there is a growing gap between the needs of developing countries and the financing provided and mobilized to fund their efforts to implement their nationally determined climate pledges under the Paris Agreement. This financing gap is currently estimated to be US$5.8–5.9 trillion for the 2021–2030 period.[3] In addition, the adaptation finance needs of developing countries are estimated to be US$215–387 billion annually until 2030, and about US$4.3 trillion per year needs to be invested in clean energy until 2030, increasing thereafter to US$5 trillion per year until 2050, in order that net zero emissions be reached by 2050 (UNFCCC 2023).[4]

Financing sustainable development does not revolve solely around green financing; there is also a pressing demand for development finance to support social and economic investment, and this remains in short supply. The OECD (2022) estimates that the annual financing gap for achieving the SDGs is at least US$3.9 trillion. Compounding these challenges, the current era of high interest rates has severely constrained the fiscal space available to many emerging economies and had increased the cost for the private sector to engage. With higher financing costs, capital-intensive projects such as green energy infrastructure that otherwise could have been economically viable for private investors risk becoming unbankable. As outlined by the UNCTAD (UNCTAD 2023), nearly half of the world's population reside in countries where interest payments on debt exceed investments in education and health care. Furthermore, only a small share of climate financing is channelled towards adaptation and climate resiliency – areas where low-income economies in particular require resources.

The necessity – and challenge – of financing change in various dimensions has triggered calls for a comprehensive overhaul of the global financial system. Most notably, the Bridgetown Agenda, led by Prime Minister Mia Mottley of Barbados, the Summit for a New Global Financial Pact in Paris in June 2023 and the G20 Summit in September 2023 have provided forums to negotiate a new framework that would reform the terms of how funding is loaned and repaid, so as to channel substantially more finance into climate resilience and create a new mechanism that would enhance countries' ability to act in response to a climate disaster. Further proposals for reform include broadening the eligibility criteria for countries to access loans at below-market rates and establishing a loss-and-damage fund that disburses funds in the event of a climate disaster. Ramping up the effort to mobilize finance from public and private sources is a crucial piece of the puzzle to solve the challenge of climate change and environmental degradation.

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3 UNFCCC (2023, paragraph 67), with further reference to UNFCCC (2021).

4 UNFCCC (2023, paragraph 68), with further reference to UNEP (2023), IRENA (2023) and IEA (2023b).

5. HOW TO GET THE JOB DONE: SUGGESTED POLICIES FOR GREEN STRUCTURAL TRANSFORMATION

Although the direction of the political ambition is clear, there are different paths that could be chosen to reach the overall objective of green structural transformation. Coordinated action is required on several fronts to foster new economic models while ensuring that the interests of people and planet are accounted for. As argued in the chapters that follow, decisive action is needed (i) to create and implement comprehensive and coordinated policy frameworks, (ii) to design bold industrial and sectoral policies for key sections of the economy and (iii) to produce accompanying social policies and regulatory frameworks to ensure that the process is just.

5.1 Comprehensive Policy Frameworks: Their Coordination, Financing and Implementation

As countries are facing several overlapping transitions, it is essential to find policies that address several domains simultaneously; meanwhile the goal of a sustainable economy requires a wide overhaul of the policy landscape. Environmental and climate change will need to be an integral part of economic policymaking, just as economic and social impacts of environmental change will need to be factored into energy transition and climate goals (see, for example, IPCC 2022; van der Ree 2022; ILO 2023). The introduction of policies that enhance economic prosperity today while strengthening resilience for tomorrow does exist, but setting political priorities in a resource-scarce environment most often entails striking a balance between immediate gains in the well-being of people and investing in more resilient opportunities in the future (Brunckhorst et al. 2023). Important elements of such a comprehensive policy framework include:

(a) *Economic steering mechanisms.* As highlighted by Marco Fugazza in Chapter 7, tools such as carbon taxes that adjust the prices of goods and services according to their carbon footprint can reduce emissions and generate fiscal revenues. But carbon pricing mechanisms can also lead to distributional tensions and trade implications. Fugazza notes the critical importance of tax reforms coupled with labour market policies to enhance fairness and labour market outcomes while minimizing these challenges of the transition to sustainability. At the same time, the implementation of mechanisms to address carbon leakages – such as carbon border adjustment schemes, which entered a trial phase in the European Union on 1 October 2023 – introduces a further layer of complexity to the calculus of finding the optimal set of carbon-pricing instruments. Although such schemes can be valuable tools to address environmental externalities, they may exert pressures on international competitiveness and exacerbate adjustment challenges within the labour markets of developing countries. It is increasingly evident that international cooperation and solidarity are indispensable in navigating the intricate interplay between environmental sustainability, economic development and labour market dynamics.

Furthermore, as highlighted by the IMF (2023), to address climate change through spending measures alone risks placing countries' public debt on an unsustainable path and so carbon pricing policies are also needed to generate revenue and reduce debt burdens. As highlighted in recent G20 statements (G20 2023, paragraph 39), a policy mix of fiscal, market and regulatory mechanisms, including carbon pricing and non-pricing mechanisms, is required. This volume also discusses other economic steering mechanisms, including capitalizing on carbon credits by putting a price on ecosystem services that offset emissions[5] (see Chapter 3) and revenue recycling alongside other financing modalities to ensure a just transition (see Chapter 8).

(b) *Robust systems of social protection and active labour market policies.* As highlighted by Jana Bischler, Marie-Christina Dankmeyer, Christina Behrendt, Marcelo Cuautle Segovia and Karina Levina in Chapter 8, these systems are crucial to ensuring that the benefits of green structural transformation are inclusive and equitable, through mitigating the potential adverse impacts of transformative change on vulnerable individuals and communities and enhancing general societal resilience. Furthermore, they play an important role in fostering acceptance and ensuring the enduring success of transition policies. As the same chapter argues, policies and investment strategies should also be informed by estimates of the transaction costs and externalities of decarbonizing industries and sectors in the medium and long term (ILO 2021; Pee et al. 2018). This includes using estimations and models such as microsimulations of the impact of a carbon tax on poverty and inequality; estimates of the number and location of affected workers, including their age, gender and skills profiles; and estimates of the spillover effects in the wider economy, including job losses in value chains. Although many countries may already dispose of relatively solid information about the existing coverage and adequacy of social protection systems and the

[5] See the example of Suriname selling carbon credits under a system set up by the Paris Agreement (Spring 2023).

supply of ALMPs, and related gaps, further analysis may be necessary to identify the extent of additional demand to support a just transition and address the existing gaps in provision. Analysis will also be necessary to cost the additional financing requirements and institutional capacities required to scale up provision to meet evolving needs.

(c) *Skilling, reskilling and upskilling.* Similar logic applies, throughout the formulation of broader economic policies, to taking a holistic look at the changing skills needs. As much turnover is expected in the medium-skill occupations, it is crucial to incorporate relevant skills into the development or renewal of competency standards, curricula, training, and assessment packages in skills development. The success of an individual in a greener labour market will be determined by a good combination of occupational and technical skills, such as engineering and installation, construction and energy efficiency, sales and marketing, as well as core (soft) skills, such as collaboration, communication, systems thinking and problem-solving. Where technical and vocational education and training (TVET) provision is underdeveloped, capacity development will be needed if the green agenda is to be embraced fully and effectively (ILO 2022b). In Chapter 9, Hae Kyeung Chun elucidates the skills policies required, including: strengthening labour market information systems and skills anticipation mechanisms; targeted measures for disadvantaged and vulnerable groups, such as apprenticeships and the validation and recognition of all forms of prior learning; innovative mechanisms to finance skills development and lifelong learning; and using participatory approaches and social dialogue mechanisms, that is, ones involving consultation between government and representatives of workers and employers, to encourage enterprises, particularly micro, small and medium-sized ones, to engage with the green and skills agendas.

(d) *Social dialogue.* As argued in Chapter 2, sustainable development 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. This challenge requires inclusive social dialogue that ensures the participation of employers' and workers' organization as well as other relevant stakeholders in formulating, implementing and monitoring policies. Such social dialogue will help to facilitate conducive institutional frameworks and partnerships to support green structural transitions and elicit broader public support.

5.2 Bold Industrial and Sectoral Policies to Facilitate the Green Structural Transformation

Green structural transformation requires rethinking the ways in which industrialization takes place. As noted above, a handful of sectors dominate the climate footprint of industrial production. The continued growth of energy, transport, steel and agriculture will require the development of technologies enabling more sustainable practices in these sectors, and the access of developing countries to these technologies. Green electrification will be key to industrialization and economic prosperity within the planet's limits.

Historically, industrial policies, or sectoral policies, have been widely used to facilitate economic transformations. What is required now is a new generation of industrial policies that delivers inclusive growth, creates decent jobs, sufficiently decarbonizes economies and preserves natural capital. Industrial policies have enjoyed a renaissance in recent years, in both developing and advanced economies, driven by the quest for "enhanced economic sovereignty" and by geoeconomic fragmentation. The imperative to transition to a greener economy has also been a significant factor in the revival of such policies, exemplified most notably by the Inflation Reduction Act in the United States of America, which was followed by similar policies around the world, such as the Net Zero Industry Act (NZIA) of the European Union. As articulated in Chapter 4, developing economies have also made use of green industrial policy instruments, including green taxes (Chile), public finance (Thailand), public procurement (South Africa) and technology services to support renewable energy uptake and training for green jobs (Tanzania).

Transitioning to a greener economy also entails recognizing the importance of the services sector in creating productive jobs and in decarbonization efforts, including by facilitating the integration of environmentally sustainable practices and knowledge into industrial processes. Building capacity in local higher education and training facilities will enable countries to more easily develop local human capital, while international collaboration through exchange programmes between different countries' university systems can help people to connect, explore, and develop their networks (see Chapter 6). To fully exploit the possibilities offered by the services sector, paramount priorities will be digitalization, connection to global value chains through trade, business model development, innovation to enable further servitization, and international collaboration with advanced economies.

5.3 Policies to Ensure that Transition is Accompanied by Social Justice

Structural transformation, and the concomitant reallocation of labour and capital, have historically had far-reaching distributional effects. Climate, biodiversity and SDG ambitions will require significant scaling up of actions, which in turn will entail even more profound social and labour market implications. In this regard, skills development goes beyond equipping workers for the emerging service and industrial jobs and is an essential tool of green transition, since it can function as an enabler of productive transformation and as a buffer to help workers manage the transition.

As green structural transformation proceeds, new jobs will emerge, and there is an urgent need to ensure that the regulatory frameworks and means for the protection of workers keep pace with the transformation of the world of work. Some of the new green jobs provide lucrative employment opportunities in green finance, carbon services and training, and ecotourism, while others, such as waste picking, involve hazardous conditions and workers receive only modest compensation for their work in the recycling sector. As argued in Chapter 5 on the circular economy, new regulation will be needed to ensure that workers in vulnerable positions are protected when performing valuable services for the economy. Decisive efforts are needed to ensure that ongoing work in the recycling and other evolving sectors is safe, respected, protected and well remunerated.[6]

Although there are encouraging signs that green industries and renewable energy sectors can generate more employment in the long term, in the short and medium term the potential loss of jobs needs to be addressed with vigorously reinforced social protection and active labour policies (see Chapter 9). A concerted effort is needed to accelerate progress in closing coverage gaps and ensuring adequate provision. This imperative is particularly pronounced in countries with high levels of informality. These countries require the extension of social protection to those who are not yet sufficiently covered, including those in the informal economy (ILO 2021 and 2022c).

Moreover, to ensure that everyone is able to take part in the transition will require that reskilling efforts be designed in an inclusive manner. This could mean maximizing the potential of digital learning tools, or ensuring the gender-responsive design of training schemes with positive female role models in male-dominated occupations, or – where the cost of training is inhibiting – possibly offering training grants to enable participation from all income backgrounds.

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[6] For examples, see ILO 2022d.

The set of policies presented above and in the rest of this book do not constitute a comprehensive package for policymakers aspiring to put their countries on a more sustainable trajectory. They present a menu of options to choose from and be inspired by. The policy mix for each country will depend on the country's characteristics and political priorities. The only policy option that is no longer available is inaction.

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2. Reframing structural transformation towards sustainable and inclusive prosperity

Antonio Andreoni

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.

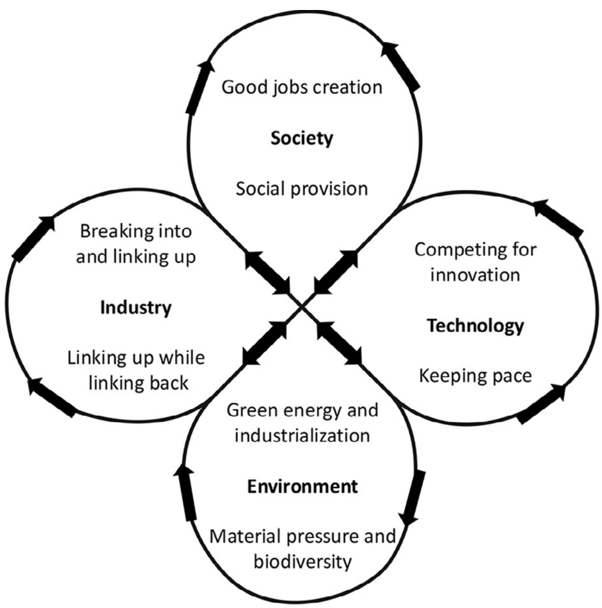

Figure 2.1 Inclusive and sustainable structural transformation integrated framework

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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3. Green structural transformation and rural employment: what role can nature-based solutions play?

Maikel Lieuw-Kie-Song

1. INTRODUCTION

This chapter explores the potential of using nature-based solutions (NbS) in rural areas to contribute to green structural transformation (GST) by enhancing rural productivity, employment and incomes. Green structural transformation requires a shift to more sustainable modes of production and consumption, as well as the creation of decent jobs and livelihoods for rural populations. However, many rural areas face multiple challenges that increase the vulnerability of their populations, such as environmental degradation, low agricultural yields, low labour productivity and persistent poverty. NbS, which are interventions that use natural processes and ecosystems to address societal challenges, can offer multiple benefits for rural development, such as restoring degraded lands, improving water and food security, enhancing biodiversity and climate resilience and providing opportunities for income generation. This chapter examines how NbS can generate decent rural employment and improve rural incomes and living standards, and thus support GST. It first discusses the role of rural areas in structural transformation, after which it explores the concept of NbS and how these can also be considered an investment in natural capital, which in turn supports rural development and will have to be an important element of GST. The chapter then discusses the various ways in which increased use of NbS may impact on rural employment, including labour demand as well as potential changes in labour productivity and incomes.

2. RURAL AREAS AND STRUCTURAL TRANSFORMATION

The role of rural areas in conventional thinking about structural transformation is often underestimated. Structural transformation is commonly conceptualized as involving shifts from low-productivity sectors to higher-productivity ones. In practical terms, this often translates into the movement of labour from agriculture to the manufacturing and services sectors, which are predominantly urban. In this context, a process known as "de-ruralization" plays a significant role in structural transformation. Historically, this phenomenon of "de-ruralization" is most notably observed in the declining contribution of agriculture to both gross domestic product (GDP) and employment in countries that have undergone structural transformation.

However, it is important to note that, although the relative decline of rural populations can be substantial, it is slower in absolute terms. To illustrate, among the countries listed in Table 3.1, all of which are arguably still undergoing structural transformation, only Brazil and China have experienced an absolute decline in rural population, according to data from 1962 to 2022. The other countries have witnessed moderate to substantial increases in rural population, although in some of these countries the rural population may have reached a peak.

Table 3.1 Demographic changes between 1962 and 2022 for selected countries

Country	Rural and urban population in 1962 (millions)	Rural and urban population in 2022 (millions)	Change (percentages)	Rural share of total (percentages)
Brazil	Rural: 40.2 Urban: 37.3	Rural: 21.5 Urban: 188.5	Rural: −47 Urban: 400.5	1962: 51.9 2022: 12.4
China	Rural: 551 Urban: 114	Rural: 515 Urban: 897	Rural: −6.5 Urban: 686	1962: 82.7 2022: 36.4
Colombia	Rural: 8.4 Urban: 8.2	Rural: 9.3 Urban: 42.6	Rural: 11 Urban 419	1962: 50.9 2022: 18.0
Egypt	Rural: 17.5 Urban 11.0	Rural: 63.3 Urban: 47.7	Rural: 262 Urban 333	1962: 61.4 2021: 57.3
Malaysia	Rural: 6.0 Urban: 2.3	Rural: 7.3 Urban: 26.5	Rural: 21 Urban: 1005	1962: 72.1 2022: 21.8
Nigeria	Rural: 39.4 Urban: 7.4	Rural: 101.5 Urban: 117	Rural: 158 Urban: 1481	1963: 84.1 2021: 46.5

Source: Compiled from https://www.macrotrends.net/.

This trend is important to understanding the nature and role of rural economies in the process of structural transformation. It means that the same or an increasing population remains in the rural economy throughout a large part of the structural transformation process. Furthermore, structural transformation is often not only accompanied but also underpinned by increasing rural production and a transformation of the agriculture sector. This increased agricultural production enables the remaining rural population to feed a much faster-growing urban population, which typically tends to shift into non-food-producing sectors. Increased agricultural production is also seen as critical to generating foreign exchange to finance the imports of goods and services often demanded by the urban population (Ranis and Fei 1961).

Therefore, structural transformation should not be understood as a simple process of rural decline. What can be considered "successful structural transformation" requires that there is also continued investment in rural areas to improve skills, deepen the capital base and enhance productivity to generate income growth and improved living standards. From an employment perspective, the preferred scenario is that, in the transition, workers are "pulled" into urban areas and sectors because the jobs available there are more attractive, rather than being "pushed" out of rural areas by low productivity or declining incomes and job quality.

However, the notion of rural productivity requires some unpacking. For simplicity we focus on agriculture, since this is the sector that, in countries embarking on structural transformation, is the largest employer in rural areas. In examining agricultural productivity it is essential to clearly distinguish between the effect of increasing yields (productivity of the land) and increasing labour productivity. Although these two things influence each other, it is possible to increase yields without increasing labour productivity, and vice versa. An important aspect of structural transformation is that both these forms of productivity tend to increase but that labour productivity increases faster than yields. For example, over the twentieth century in the United States, yields increased fivefold, but labour productivity in agriculture increased fifteenfold (Cock et al. 2022). Although improved yields increase food production, it is increases in labour productivity that tend to have the larger impact on poverty (Cock et al. 2022). Although the greater impact of increased use of NbS is likely to be on yields, this often requires changes in farming practices and so the change in yields, in turn, tends to impact on labour productivity. These impacts can be either negative or positive, depending on the farming practice adopted.

However, in most countries, increasing yields have come at significant environmental cost. Although a large share of increased production has come from technological innovation linked to the "Green Revolution" (improved seeds, fertilizer, irrigation), it has also involved unsustainable use of renewable resources – in particular, soil, water and surrounding ecosystems – which has in turn limited the ability of nature to continue providing these services. It has also resulted in other negative environmental impacts, including the loss of habitat in which to maintain biodiversity, pollution from nutrient run-off, increasing greenhouse gas (GHG) emissions, sedimentation of waterways, and pesticide and herbicide poisoning of non-target species and humans (Zhang et al. 2007). Green structural transformation requires limiting all these impacts to levels where they are sustainable.

Thus, developed countries that have already gone through structural transformation will need to shift to more sustainable agricultural practices. At the same time, it will also be essential that as developing countries go through their own structural transformation, they take a more sustainable route and ensure that rural areas are also part of the process of GST. This will require a more sustainable approach to increasing rural productivity – and agricultural production in particular. Although this will involve a wide range of interventions, investment in natural capital plays a critical role in providing many of the ecosystem services essential to increasing rural productivity. Furthermore, countries facing agricultural output and yield losses owing to the impacts of climate change will need to adapt and thus to increase their resilience. Increased use of NbS can be part of the response to these issues and has the potential not only to reduce negative impacts but also to generate several broader climate and biodiversity benefits, with important implications for rural employment.

3. NATURE-BASED SOLUTIONS AS INVESTMENT IN NATURAL CAPITAL

Although the concept of natural capital has been around for more than 50 years, and is increasingly recognized as essential to human well-being, it is still not widely incorporated into economic analysis. Various definitions of natural capital exist; a useful one is from the Capitals Coalition: "Natural capital is the stock of renewable and non-renewable resources (e.g. plants, animals, air, water, soils, minerals) that combine to yield a flow of benefits to people."[1]

The focus of this chapter is not on all natural capital but only on the stock of renewable resources, since NbS are only an investment in the renewable resource stock of natural capital. Furthermore, for the sectors that generate most rural employment – agriculture, livestock and forestry – it is the stock of renewable resources that is of interest, since they generate the ecosystem services these rural sectors benefit from. For agriculture, the most important

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1 Definition from the Capitals Coalition (formerly Natural Capital Coalition): https://capitalscoalition.org/capitals-approach/.

ecosystem services are water quantity and quality, soil structure and fertility, biological pest control, pollination, and the landscapes that facilitate the delivery of these services to agriculture (Power 2010). Well-planned and executed NbS can help improve the quantity and quality of all these ecosystem services.

As with all forms of capital, natural capital can be enhanced through investment. The use of NbS is one way of doing so. "Nature-based solutions" are defined as actions to protect, conserve, restore, sustainably use and manage natural or modified terrestrial, freshwater, coastal and marine ecosystems, which address social, economic and environmental challenges effectively and adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits (United Nations Environment Programme (UNEP) 2022, para. 7; see also Box 3.1).

BOX 3.1 WHAT EXACTLY ARE AND ARE NOT NBS?

Nature-based solutions are a relatively new concept, which has gained substantial traction globally in recent years. Over the course of 2023, UNEP led global intergovernmental consultations on NbS, based on the definition adopted in 2022, in order, among other things, to identify possible standards guidelines and best practices.[2] No typology of NbS has yet been developed, and exactly how various sustainable agricultural practices relate to NbS is still the subject of debate among stakeholders. Although the focus in this chapter is on the use of NbS in rural areas, it is important to note that there is a wide range of urban NbS as well.

It is thus challenging to use the term "NbS" in a precise sense, which is why terms "NbS-like actions" or "NbS-related activities" are often used when there are doubts whether the actions in question are NbS. This allows discussions to look at the broader potential benefits and implications of the use of NbS while taking account of the risks of using the concept too loosely by indicating that not all measures discussed may ultimately be categorized as NbS.

The investment thus takes place through the "actions to protect, conserve, restore, sustainably use and manage". Consistent with the natural capital definition, the goal is to yield a flow of benefits to people in the form of "address[ing] social, economic and environmental challenges effectively and

[2] https://www.unep.org/about-un-environment/intergovernmental-consultations-nbs.

adaptively, while simultaneously providing human well-being, ecosystem services and resilience and biodiversity benefits".

At a spatial level, NbS take a landscape approach, meaning they consider a larger region such as a watershed. This perspective also requires that when one looks at economic activity and employment, the scope is extended beyond what happens on agricultural land, to the surrounding land as well. The term "agriculture and land use" (ALU) will be used to refer to this. An ALU approach allows the interactions between farms and the surrounding areas to be considered, whether it be the farm's dependence on the water management services provided by the surrounding forest, or the impacts of insecticides used on the farmland upon species in that same forest. A similar approach is also used when assessing climate and environmental impacts.[3]

By implementing NbS, societies can protect and enhance natural capital, ensuring the continued and enhanced availability of ecosystem services and the benefits they provide (see Box 3.2). The relationship between natural capital and NbS can thus be seen as a virtuous circle. Nature-based solutions aim to enhance and restore natural capital by promoting the conservation and sustainable use of natural resources. Natural capital in turn provides the foundation for NbS by offering the necessary resources and ecosystem services.

BOX 3.2 FINANCING AND THE INVESTMENT CASE FOR NBS

Before NbS can create jobs, there need to be parties who are willing to invest in these solutions. The investment case for NbS is that they are an investment that solves societal problems while generally also strengthening public goods. As many of the problems that NbS can address are societal, governments are currently the largest investors in NbS (UNEP 2022). One example of this is the Sloping Land Conversion Programme in China, where the government wanted to reduce the massive costs of soil erosion

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[3] For example, in looking at GHG emissions, a similar approach is used where the impacts not only of agriculture but of the entire food and land use system are considered. See, for example, Poore and Nemecek (2018) and Hawken (2017), both of which include land use in their analyses, reflecting the relationships between food production, agriculture and land use, and their collective environmental impacts. Project Drawdown (https://drawdown.org/) uses the term FALU (food, agriculture and land use) to encompass the impacts of food production and use, including processing, transport, and waste. FALU has inspired the use of ALU in this chapter.

and water pollution, and the restoration of forests on sloping land was seen as an effective solution.

Carbon sequestration (direct carbon capture) is an important co-benefit of NbS. As the drive towards net zero strengthens and the need for carbon sequestration increases, carbon offsets could become an increasingly large financing source for NbS. Although this is not without its controversies, it is nonetheless an important potential funding avenue that can benefit farmers in particular, as will be discussed further in this chapter.

A third major avenue for investing in NbS arises from the need to adapt to climate change. NbS can be used for specific measures like coastal protection or flood management, and ecosystem-based adaptation is well established in relation to making food production more resilient. Adaptation in high-income countries incorporating NbS is financed through public and private avenues and without much controversy. In lower-income countries, this is less common, but also links to the larger question of their financing capacity and whether these countries should be supported in adapting to climate change, since their historical share of emissions has been small.

There is also an increasing interest in financing the preservation of biodiversity. In some cases, this is simply because of the intrinsic value attached to biodiversity, but in other cases it also comes from increased recognition of the economic value of biodiversity. The main sources of investment at present are governments, and governments are motivated by the need to reduce negative environmental impacts and their associated costs. The combination of the multiple benefits and co-benefits derived from investing in nature can also boost economic activity. For example, Batini et al. (2021) find that spending on what they refer to as “green land use” has had large positive multipliers, and much higher than the spending multipliers of “non-eco-friendly land use”, especially when considered over a five-year investment period.

A key obstacle to increased investment in NbS is how the economic system continues to deal with externalities. Negative externalities like pollution, emissions and biodiversity loss are to a large extent still not accounted for, and the positive externalities generated by nature are still not fully valued. This places NbS on a tilted playing field when compared with other solutions. As a result, economic and social values are not being converted into financial value. These paradigms need to be changed to build economic systems that will drive GST.

4. IMPACTS OF INCREASED USE OF NBS AND IMPLICATIONS FOR RURAL EMPLOYMENT AND LIVELIHOODS

As discussed above, productive structural transformation requires simultaneous improvements in yields and labour productivity, while GST also requires a concurrent shift to more sustainable farming practices to reduce or even transform the negative impacts into environmental benefits. The use of NbS can play an important role in this process, since they can influence yields and labour productivity and environmental impacts. There are five drivers linked to the increased use of NbS that will influence labour markets. The first is the direct labour demanded by the implementation of NbS. The second is the impact of the co-benefits of NbS, which are likely to increase labour demand and/or increase incomes. The third, the possible restrictions on the use of natural capital, may have negative employment impacts, although NbS frameworks try to minimize these. The fourth is the impact on yields. In low-income countries improved yields tend to boost labour demand in the short term.[4] But increased yields also tend to increase labour productivity in the medium term, which in turn will reduce the demand for labour. The fifth factor is the impacts on labour productivity, which are more difficult to predict. Transitioning to sustainable practices can impact on labour productivity in either direction, since some relevant agronomic practices are more labour intensive, while others increase productivity.

In practice, the magnitude of these impacts on rural labour markets will depend on numerous factors, including current yields, levels of degradation of agricultural land, existing use of chemical inputs, access to other capital, how levels of mechanization evolve, and the state of natural capital and the extent of ecosystem services it provides. It is therefore not possible to predict the magnitude of each of the effects and the extent to which the net shift will be positive or negative. However, in countries in the process of structural transformation, where yields are still low and the state of natural capital is poor or deteriorating, it is more likely that the net employment effect will be positive. These effects are presented conceptually in Figure 3.1, emphasizing again that the relative sizes of these effects are difficult to predict and that it is the directions of the arrows that are most significant.

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[4] This is a complex field, since sustainable practices incorporating NbS may also imply a more mixed use of land and crops and thus a more diverse range of products. Crop rotation could be introduced, as could agroforestry and hence the dedication of some land to trees generating other products. This complexity makes it difficult to compare yields and related employment impacts.

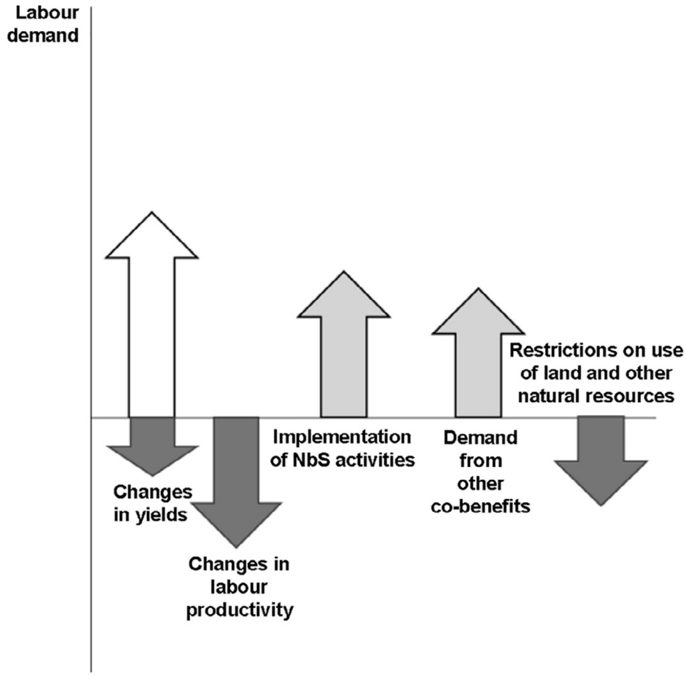

Figure 3.1 Influences of increased use of NbS on rural employment

5. EMPLOYMENT EFFECT OF IMPLEMENTING NBS

The employment impact of large-scale NbS implementation is relatively straightforward to grasp. Increased utilization of NbS leads to greater local demand for labour in activities relating to the protection, conservation, restoration, sustainable utilization, and management of ecosystems. This entails labour inputs for activities like watershed rehabilitation, afforestation efforts, safeguarding protected areas, or planting and managing trees as part of transitioning to agroforestry.

A recent report estimated that approximately 73 million people are currently engaged in such NbS-related activities worldwide. Moreover, according to conservative estimates, increased investment in NbS focusing on four specific areas – reforestation, silvopasture, peatland restoration and mangrove restoration – could potentially generate an additional 20 million jobs globally (International Labour Organization (ILO), United Nations Environment Programme (UNEP) and International Union for Conservation of Nature (IUCN) 2022). Out of these, roughly 14 million jobs would be concentrated in the agriculture and forestry sectors, predominantly in rural regions, with approximately 95 per cent located in middle-income countries. The challenges focused on were climate change, biodiversity and land degradation – which is why most of the jobs would be rural. It is worth noting that in these countries many of the associated tasks remain labour intensive, while the benefits in low-income countries are likely to be underestimated owing to limited data being available to model the effects.

There are other areas where the increased use of NbS will potentially increase labour demand. As NbS are implemented at the landscape level, they require the management of a larger area of land than just agricultural land, and this is likely to further increase labour demand. Another area of potential new labour demand for higher-skilled workers will be increased research, development monitoring, and evaluation of NbS practices. This will include both research on how to use NbS more effectively and also monitoring outcomes such as whether biodiversity or the carbon content of soils is increasing. It could also result in the increased use of certification schemes, which in turn require labour. Nature-based solutions could also play an important role in rural infrastructure development, which is essential to both rural productivity and quality of life; here NbS can be both an alternative and a complement to more traditional "grey" infrastructure. For example, the extent to which NbS can be used to support flood risk management or to stabilize slopes will vary, and this will in turn impact on local labour demand.

There are other mechanisms for implementing NbS at a large scale which create employment. In developing countries, the use of public employment programmes (PEPs) is common (see Box 3.3 for the example of China). These are used in many countries to supplement rural employment and incomes. Increasingly, NbS-related activities such as land restoration, reforestation, and measures to combat soil erosion are important elements of these programmes; the majority of people worldwide engaged in NbS-related work do so through PEPs (ILO, UNEP and IUCN 2022).

BOX 3.3 SLOPING LAND CONVERSION PROGRAMME

The Sloping Land Conversion Programme (also known as "Grain for Green") in China is an interesting example that demonstrates the impact of large-scale adoption of land restoration on labour demand. Between 1999 and 2019, 41 million households participated in the programme. Each participating household received a total of 9,000 yuan (CNY) (about US$1,300) on average. In return, these households collectively provided an estimated

36 million full-time-equivalent years of labour input over this period to restore and reforest land. As payments were made in three tranches over the five-year period, and not on a regular basis, many farmers formed cooperatives to implement the restoration work, so as to receive more frequent payments. By 2021, China had 23,000 forestation cooperatives in 22 provinces, creating job opportunities for 1.6 million people with low incomes and increasing their annual per capita income by more than CNY3,000 (US$435).

On the other hand, one of the most immediate negative impacts of this programme was to restrict logging activities on degraded or sensitive land, which led to the loss of 700,000 jobs in state-owned enterprises in the forestry sector.

Source: Adapted from ILO, UNEP and IUCN (2022).

In many ways PEPs are an ideal instrument, since they allow governments to play the role that other economic actors are not able to – that of placing a value on the benefits and co-benefits of NbS and directing funds to rural populations. In this arrangement the PEP may, for example, restore land and employ local people to do so. These people are paid, but they also gain from some of the more local co-benefits, such as enhanced water management and increased resilience. There is increasing evidence that NbS can have such broad socio-economic impacts. For example, in Malawi it has been found that land restoration has positive impacts on four household-level socio-economic indicators: food and non-food expenditure, crop sales, and food consumption (Ding et al. 2023). As part of this arrangement, the government could claim carbon credits for any carbon sequestration benefits generated, through, for example, internationally transferable mitigation outcomes (ITMO),[5] which can help to pay the salaries of those employed. The claiming of credits could be extended to other co-benefits – such as improved water quality or increased biodiversity – if financing mechanisms were available for them.

Another important mechanism is payment for ecosystem services (PES) schemes, which involves paying the rural population for the ecosystem services provided by the land they are custodians of. Although these usually do not have a specific employment objective, they often do require that specific

[5] Internationally transferable mitigation outcomes are allowed for by the Paris Agreement and enable one Party to the agreement to pay another Party for mitigation outcomes achieved.

tasks be performed, for which persons or households are renumerated (ILO, UNEP and IUCN 2022).

6. EMPLOYMENT EFFECTS OF THE CO-BENEFITS FROM USING NBS

The way that co-benefits of NbS could impact on employment is more indirect and requires clarity as to what is meant by "co-benefits" in this context. Nature-based solutions are typically used to gain a specific benefit. A common example is for water companies to restore upstream forest areas. This benefits the water company by improving water quality, reducing treatment costs, providing more stable water inflow and reducing storage costs. This approach also reduces the risks of flooding, which can severely raise the company's costs. However, the restoration of upstream forests also produces a range of other benefits, such as carbon dioxide sequestration and storage, habitat for biodiversity, and the availability of certain forest products. These are referred to as "co-benefits". An important characteristic of NbS is that they produce a wide range of co-benefits, many of which tend to accrue not to the entity doing the investment (in this case the water company), but to other actors or to society at large.

In rural areas, these co-benefits have the potential to impact on local employment and livelihoods in a variety of ways. In the example above, the availability of forest products may create the opportunity for members of local communities to harvest and process these, creating employment in the process. The co-benefits also have the potential to increase incomes for various stakeholders, if there is a mechanism for the co-benefits to be monetized and paid to those implementing the NbS.

There are already examples of such mechanisms to pay for other co-benefits of NbS. The impact on improving water quantity and quality is possibly the most well established. Improved management of watersheds enhances both the quality and quantity of water, something that governments and water utility companies in many countries are now aware of. There is also an increasing willingness to pay for these improvements, since they reduce the cost of treatment and ensure a more stable and predictable water supply. Brazil's National Water Agency (ANA) developed the concept of "Water Producer" for farmers who protect and restore riverside forests on their land and who are in turn compensated to the tune of approximately US$80 per hectare (ha).[6] This is often done through the establishment of water funds: users pay into the funds, and

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[6] https://www.nature.org/en-us/about-us/where-we-work/latin-america/stories-in-latin-america/water-funds-of-south-america/.

the funds in turn pay for forest conservation along rivers, streams and lakes. In Latin America alone, such funds have been established in Brazil, Colombia, Ecuador, Peru and Mexico. Such funds are likely to become more common in many other countries around the world.

With the continued development of carbon markets, the carbon sequestration co-benefit of NbS has large potential to generate financial revenues (see also Chapter 7 for a discussion on carbon taxes). Agriculture and land use emissions currently amount to 21 per cent of global GHG emissions and so there is an urgent imperative to reduce them. Nature-based solutions provide some of the most important avenues towards reducing ALU emissions. However, beyond reducing emissions, the potential of ALU to sequester carbon and transform ALU from a carbon source to a carbon sink is particularly interesting because of the potential to sell the carbon sequestered as offsets on carbon markets and so generate income for people working in the ALU sector.

Carbon sequestration is one of the key co-benefits of NbS. Using nature to sequester carbon from the atmosphere remains the only large-scale proven direct air capture "technology".[7] Although it needs to be stressed that its capacity is by no means sufficient to achieve global climate goals and that it must be accompanied by drastic reductions of emissions in other parts of the economy, carbon sequestration using nature is part of every feasible pathway to limiting temperature rises to 1.5°C or 2°C (UNEP and IUCN 2021). It is likely, therefore, that carbon sequestration using NbS will gain in importance as part of the path to net zero.

The main mechanism currently in place to incentivize carbon sequestration using nature is the carbon offset market. This market is currently voluntary and faces important limitations, increasing opposition from stakeholders, and deteriorating credibility. However, it is likely that the market for offsets along with other carbon markets will evolve and will be able to pay for the

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[7] Removing carbon dioxide is also referred to as "direct air capture" (DAC) and is different from carbon capture and storage (CCS), which captures carbon dioxide at source – for example, at a coal-fired power plant – and stores it. Carbon capture and storage in essence only prevents additional carbon from being added to the atmosphere. In contrast, DAC captures carbon dioxide already in the atmosphere, something the achievement of net zero will require. Plants capture carbon dioxide through photosynthesis; other technologies to do so are severely limited. Current DAC operations around the world capture and store, in total, around 0.01 megatonnes (Mt) of carbon dioxide a year (https://www.iea.org/energy-system/carbon-capture-utilisation-and-storage/direct-air-capture). In contrast, terrestrial vegetation currently absorbs between 112 and 169 gigatonnes (Gt) per year (Sha et al. 2022). According to the 30-year potential of Table 3.2, this could be increased by 7.7–12.7 Gt (7,700–12,700 Mt) of carbon dioxide per year.

carbon sequestration co-benefit of NbS in a more reliable manner. Its potential is therefore worth discussing in more detail, since it could become a major financing mechanism for GST in rural areas.

Table 3.2 provides a list of ALU-related actions, and their carbon sequestration potential expressed in gigatonnes. The lower and upper values are based on levels of sequestration required to stay within the 1.5°C and 2°C scenarios. It is important to emphasize that these actions are not all strictly NbS; it depends on how they are implemented (see Box 3.4).

BOX 3.4 CHALLENGES OF FORESTATION-RELATED CARBON OFFSETS

It is important to point out that offsets in general and indiscriminate forestation with the sole objective of carbon sequestration and selling the carbon sequestered as offsets have been heavily criticized for several reasons (Seddon et al. 2021). One is that many carbon sequestration initiatives have neglected the rights of rural people (including indigenous and tribal people) residing in the areas in question, through either displacing them or enforcing limits on their use of land. Furthermore, only minimal shares of the financial benefits of selling carbon credits have reached these groups. Many schemes have also been criticized for environmental reasons, the main ones being that the forestation may have used inappropriate species of plants and trees, that it has been done on land ecologically not suitable for forestation, and that forestation has taken the form of monoculture plantations that, among other things, have negatively impacted on biodiversity and increased the risks of wildfires. Finally, the sustainability of these schemes has been questioned because they need to be monitored for decades or longer to ensure that carbon is truly sequestered and remains stored. Forestation that does not address these important challenges is generally not considered NbS, but rather is used as an example of “bad NbS”.

The actions of interest to those involved in agriculture are those relating to the shift to sustainable farming practices, of which carbon sequestration is clearly a co-benefit and not the main driver. Collectively, they have the potential to shift many agricultural activities towards greater sustainability and from being carbon sources to becoming carbon sinks, while also having a large potential to increase farmers’ incomes. Here it is important to highlight that these actions can store carbon not only in above-ground vegetation but also below ground, through increasing the quantity of soil organic matter and living biomass (Nair

Table 3.2 Carbon sequestration potential of ALU-related actions

Support ALU as a sink	Estimated sequestration potential 2020–2050 (total CO_2 equivalent in Gt)	
Protect and restore ecosystems	Lower range	Upper range
Tropical forest restoration	54.5	85.1
Temperate forest restoration	19.4	27.8
Grassland protection	0.2	0.2
Indigenous people's forest tenure	1.7	2.6
Forest protection	1.1	1.9
Peatland protection and rewetting	0.6	1.0
Subtotal	77.5	118.6
Shift agricultural practices	Lower range	Upper range
Conservation agriculture	8.3	11.9
Regenerative annual cropping	13.6	20.8
Silvopasture	26.6	42.3
Perennial staple crops	15.5	31.3
Tree intercropping	15.0	24.4
Multistrata agroforestry	11.3	20.4
Managed grazing	16.4	26.0
Perennial biomass production	4.0	7.0
Subtotal	110.7	184.1
Protect ecosystems and shift agricultural practices	Lower range	Upper range
Sustainable intensification for smallholders	0.6	1.2
Subtotal	0.6	1.2
Use degraded land	Lower range	Upper range
Abandoned farmland restoration	12.5	20.3
Tree plantations on degraded land	22.2	35.9
Bamboo production	8.3	21.3
Subtotal	43.0	77.5
Total	231.8	381.4

Note: See Hawken (2017) and Wilkinson (2020) for a detailed description of these actions and explanations of the lower and upper values.
Source: Wilkinson (2020).

2012).[8] This sequestration co-benefit could generate additional income for farmers and farming enterprises if the carbon captured could be sold as carbon credits through offsets or other mechanisms. Potential income for farmers will vary depending on the farming system used and the price per tonne of carbon sequestered. Luedeling et al. (2011) show that in Africa, for various agroforestry systems, gross income could reach up to US$450 per ha at a carbon price of US$35 per tonne, but that for most agroforestry systems it would not exceed US$100 per ha at this carbon price. Although a carbon price of US$35 for offsets seems high now, if offsets that are currently traded on voluntary markets could converge towards prices on compliance markets, such a price would be more realistic.[9]

It is important to put this level of potential income into perspective. At a yield of 2 tonnes of maize per ha and a farmgate price of US$200 per tonne, which are typical for Africa, a farmer earns about US$400 per ha from growing maize. Thus, the potential of sequestration for increasing farmers' income is clearly significant, and "carbon farming" could become an important complementary income source for farmers adopting more sustainable practices. Furthermore, increasing soil organic matter also increases soil health and fertility and so could improve yields, making it economically even more attractive to switch to such practices.

Using the sequestration potential in Table 3.2, it is possible to estimate the global income for farmers if a system to pay for carbon sequestration could be realized. If we only include the actions under "Shift agricultural practices" in Table 3.2, the potential for sequestration between 2020 and 2050 is estimated

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8 This also underlies the global 4/1000 initiative launched at COP21 in Paris, which aims to increase global soil health by increasing its carbon content by 4 parts per 1000 per year and so make soils a key contributor to sequestration (https://4p1000.org/discover/?lang=en).

9 In 2023, carbon prices on European compliance markets were around €80 per tonne, while on voluntary markets they were less than €1 per tonne. Such a shift in carbon prices would also require changes and innovations in regulatory and certification practices, which would have their own transaction costs, but in a context where a shift to net zero was a policy imperative, this price shift would not be unlikely. Other mechanisms for offsets allowed include ITMO; the first of these being considered, for Suriname, is looking at a price of US$10 per tonne (see Spring 2023).

to be 110.7 and 181.4 gigatonnes, respectively.[10] Dividing this by 30 gives an annual sequestration potential of between 3.7 and 6 gigatonnes per year.[11]

Figure 3.2 plots the value of this sequestration potential (in billions of US dollars), which can be seen as potential farmer incomes at different carbon prices (in US dollars per tonne). It shows that, depending on the carbon price, the total annual farmer income from carbon sequestration could range from US$37 billion to US$60 billion per annum at US$10 per tonne, to US$221 billion to US$363 billion at US$60 per tonne. To put this into perspective, the Food and Agriculture Organization (FAO) estimated that in 2019 agriculture's contribution to global GDP was US$3,500 billion or about 4.3 per cent of global GDP (FAO 2021). At the higher end of such estimates, income from offsets could be more than 10 per cent of global agriculture's GDP.

These are of course only global estimates; additional work would be required to estimate how such income would be distributed regionally, or by country, type of farm, or farming practice. It is also important to point out that this potential is based on changing the agricultural practices, not reducing the levels of agricultural activity. Furthermore, the main reason for changing these practices would not be carbon sequestration but, rather, improving the overall sustainability and resilience of agriculture; carbon sequestration would just be a co-benefit. It should also be recognized that shifting these practices carries costs and risks, which raises questions about what policies and mechanisms need to be in place to prevent the transferring of these costs and risks to farmers. On such matters, the ILO has been advocating the use of "just transition" policies (ILO 2015), such as policies including income support, access to finance, and incentives to enable farming enterprises to make such a shift.

It remains a great challenge to put in place the necessary financial, monitoring and certification mechanisms to make it possible for farmers to obtain this kind of income. It may thus be preferable to do this first in the domestic market, to simplify the process and its monitoring and certification, before transitioning to more global markets.

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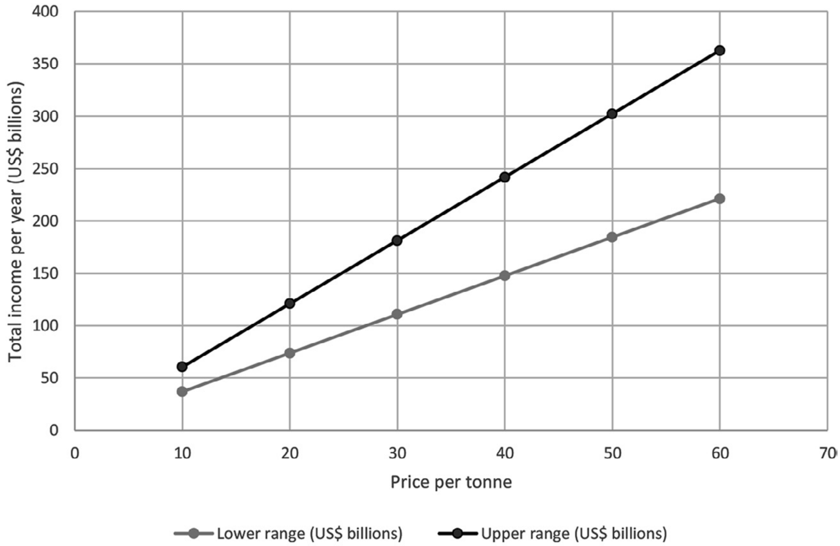
[10] It is important to note that the lower and upper ranges were defined not by physical limits but by how aggressively these measures could be adopted in order to stay within the 1.5°C scenario for the upper range and the 2°C scenario for the lower range.

[11] This is a simplification, since the ability of these approaches to sequester carbon increases over time, but the purpose here is merely to provide an indication of potential.



Source: Author on the basis of Wilkinson (2020).

Figure 3.2 Range of potential annual income for farmers from carbon sequestration at different carbon prices

7. EMPLOYMENT EFFECTS OF CHANGES IN AGRICULTURAL YIELDS AND LABOUR PRODUCTIVITY

When discussing agricultural employment, it is useful to recall the difference between the effect of increasing yields (productivity of the land) and increasing labour productivity. The first question is how shifts to more sustainable practices will impact on yields. Evidence for this is mixed. In areas seeking high yields through the use of chemical inputs, it may be difficult to improve yields and the shifts in question may possibly reduce yields, depending on crop and climate, among other things. In many developing countries yields are typically still low, and so shifting to more sustainable practices is more likely to increase yields. It is important to emphasize here that NbS are not necessarily more effective in raising yields than synthetic fertilizer and other chemical inputs, but that they are more sustainable and have lower negative impacts as well as a range of positive impacts. Furthermore, the situation is dynamic and a general green transition may potentially reduce the emissions arising from artificial inputs, for example through the production of fertilizer increasingly using green hydrogen rather than fossil fuels.

Increases in yield (in tonnes per ha) typically tend to boost demand for labour, since more work is required in, for example, planting and harvesting. In a labour surplus environment, this will be manifest in more hours worked and an increase in employment. Such a context is characteristic of many lower-income countries where yields are still low and rural under-employment and/or unemployment are high (and wages low). However, in a labour-constrained environment, increases in yield may lead to investment in mechanization, which will increase labour productivity and wages. To increase yields using sustainable agricultural practices may also take time. In the transition period, labour demand may decrease, although in some cases the work required to make the transition may require additional labour inputs. It is thus hard to generalize how increased yield from the use of NbS or related actions in agriculture will impact on employment, since such impacts are context specific. However, in poorer areas with a combination of low yields, surplus labour and low labour productivity, the impacts can be expected to be largely positive.

The other question is how the use of NbS may impact on labour productivity, which in turn drives workers' wages and incomes and rural poverty. This is related to but different from agricultural productivity, which considers all inputs (land, labour and others) and how these translate into total output. It is possible to increase overall productivity without increasing yields, for example by reducing labour inputs through mechanization. This is part of the explanation for reduced employment in agriculture when increases in agricultural labour productivity are far higher than increases in yields – the so-called "yield gap" (Cock et al. 2022).

Here again the evidence is mixed. Some sustainable agronomic practices that are part of more sustainable agriculture require higher labour inputs. For example, weeding by using herbicides may be restricted in some practices, but weeding by hand is far more labour intensive than using herbicides and is a key factor that keeps down labour productivity. On the other hand, reduced or minimal tillage reduces labour demand without impact on yields, thus increasing labour productivity (Ekboir 2003). Another interesting observation is that, for some crops, increased yields can boost labour productivity in cases where larger volume can be harvested with the same effort. A final aspect is that higher-value crops also increase labour productivity, at least in monetary terms. As sustainably produced food – such as organic or fair-trade goods – tends to have higher prices, the result is higher-value crops and a boost to labour productivity.

Sustainable practices may replace some synthetic inputs with locally produced inputs with respect to fertilization and pest control. Local composting and other techniques can partially localize the production of fertilizer, reducing the need to import. There is an extensive literature on the extent to which organic fertilizer can replace inorganic fertilizer and on the relative impacts on yields, soil health, and biodiversity. Much of this work points to the increased need for the benefits of combined approaches and for local research to consider local crop type, soil type and agronomic practices, and different combinations of fertilizers.[12] Sustainable practices may also reduce the use of imported chemical inputs. The extent to which this then increases labour productivity is not clear, since it depends on the cost of the additional labour required to implement the sustainable techniques compared with the cost of imported fertilizer or other chemicals.

Another question relates to the fact that shifting to more sustainable practices in essence entails a shift in technology, which generally changes labour requirements. Again the evidence as to whether shifting to more sustainable practices is more labour intensive is mixed and depends heavily on local factors such as crops and production techniques (ILO, UNEP and IUCN 2022).

It is also important to consider the impact of the actual transition to more sustainable farming practices. Productivity can decline during the transition period. Farmers and farmworkers need to learn and to adjust their practices, which may result in reductions in output and carry a risk of failure or mistakes. Furthermore, more sustainable practices, which are more reliant on ecosystem services, may take more time to increase productivity. For example, Ajayi et al. (2009) and Lucantoni (2020) found that agroforestry-based soil fertility practices take longer to produce benefits than does the use of conventional fertilizer. The Africa Regenerative Agriculture Study Group (2021) draws similar conclusions: “implementing new practices takes time and knowledge, and benefits are not always immediate. Responsive and timely access to training, investment incentives and capital is therefore critical for success.” This raises important questions regarding the type of just transition policies required to enable farmers to adopt sustainable farming approaches and NbS practices that support decent work outcomes (ILO, UNEP and IUCN 2022). The effects of changes in overall agricultural productivity on agricultural employment can be mixed, since they can both reduce and increase demand for labour as well as impact on shifts to mechanization.

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[12] For examples, see two recent meta-analyses on these by Allam et al. (2022) and Bebber and Richards (2022).

8. THE NEGATIVE EFFECTS OF REDUCED OR RESTRICTED USE OF NATURAL RESOURCES

A final question is whether increased use of NbS will reduce, or place restrictions on, the use of natural resources. The most important of these restrictions are likely to be upon harvesting certain products and upon land use. In countries where rural populations have grown, many people have been forced onto land unsuitable for pursuing their livelihood in a sustainable manner, or onto protected land. A striking example of regulation to address such a situation are the efforts in China to reduce erosion and land degradation – starting with the Sloping Land Conversion Programme, which restricted logging on sloping land and other sensitive areas because it caused, among other things, erosion, landslides, and sedimentation of rivers (see Box 3.1). These restrictions had large negative employment impacts: about 700,000 workers in state-owned forestry enterprises were laid off between 1997 and 2010. In response, the government introduced transition measures – including job placement services, early retirement, and unemployment benefits – to reduce the impact on these workers (ILO 2020). The efforts in China also involved farmers dedicating part of their land to reforestation with non-commercial tree species, which meant a reduction in their cropland.

In areas where land has already been degraded and natural resources have been exhausted, this negative impact will be less, since the economic activities that depend on nature have in effect already been reduced dramatically or ceased to be viable. The estimated global area of abandoned agricultural land is between 385 and 472 million ha (Campbell et al. 2008). Restoring this land would probably have little negative impact on existing employment but could potentially create additional short-term and long-term employment.

The global total negative impact of restrictions on the use of natural resources is extremely hard to estimate; the impact will vary strongly from area to area. It is desirable to design NbS practices to minimize such impacts, for example by promoting agroforestry rather than reforestation on land currently in use. Where impacts are unavoidable, it is important that just transition measures are adopted to mitigate them. This would be in line with both IUCN NbS Global Standards as well as the ILO Just Transition Guidelines. Researchers are aware of these risks to jobs from changes in land use. For example, global estimations of the potential of NbS to mitigate climate change mitigation (see Griscom et al. 2017) deliberately exclude the conversion of cropland in their estimates so as to minimize potential negative impacts on food security. Furthermore, good practice in NbS as proposed in the IUCN Global Standards requires high involvement of local stakeholders in decision-making, according to principles of free, prior and informed consent (IUCN 2020). However, such awareness does not consistently translate into sufficient and appropriate local measures to avoid, minimize or mitigate losses in employment and incomes.

9. OVERALL EFFECT

On the basis of the discussion above, it is difficult to predict the net effect on employment. On balance, it seems likely that in developing countries the net effect will be positive, because:

- It is likely (and indeed necessary) for both yields and labour productivity to increase in the course of GST, since the current levels are low and they may decrease further because of climate change.
- Implementation of NbS in these countries is likely to be more labour intensive and to generate additional labour demand.
- Incomes from co-benefits are likely to have positive impacts on the incomes of rural workers.
- Although the negative effects of restriction could be important, they are unlikely to be larger than the positive benefits. According to the principles of good NbS, local stakeholders should be consulted, and this is likely to limit such drastic impacts.

10. NATURAL CAPITAL, NBS, ALU AND EMPLOYMENT

Investment in NbS and related actions can pay off in several ways. Firstly, it reduces the negative impacts of existing practices. In addition, enhanced ecosystem services can improve the productivity of rural sectors and generate various additional benefits, some of which accrue directly to the rural economy (enhanced resilience, improved water quality), and some of which accrue to society at large (carbon sequestration, increased biodiversity). From this perspective, investment in NbS can be seen not just as an investment in natural capital but also as an investment in the rural economy. Furthermore, if there were mechanisms for also rewarding those in rural areas for these benefits to society at large, this could result in increases in rural incomes and well-being.

Green structural transformation requires a shift to a more sustainable approach in agriculture, which in turn necessitates maximizing the services that can be provided through natural capital – and prudently complementing these with synthetic inputs. The pursuit of this balance is still the focus of debate, research and testing. Although the environmental costs of conventional approaches to increasing agricultural production are increasingly recognized, the limiting of these must be weighed against the immediate goal of guaranteeing global food security.[13] The wide range of sustainable practices being used and promoted in agriculture are all manifestations of this.[14] However, the extent and speed of transitions to more sustainable practices are dependent on many factors – including, among others, crop types, farming practices and scale, geography, climate, the risk to food security such transitions may pose, and the ability of farmers to take certain risks. A just transition policy framework to manage such transitions is thus essential.

11. CONCLUSION

In summary, the increasing adoption of NbS is an important addition to instruments for advancing GST. Nature-based solutions align with the core principles of GST by promoting productivity enhancements and add natural capital as an investment option to offer a multifaceted approach to structural transformation.

Given the number of people who continue to find a livelihood in rural areas and given the need for food production, continued investment in rural areas is imperative. Nature-based solutions are emerging as a pillar of such investment to ensure a greener path to structural transformation than via more conventional approaches to increasing food production. Integrating NbS into rural development strategies can also increase rural labour demand, bolstering employment opportunities and income generation. The potential income from carbon offsets resulting from sustainable farming practices can augment farmers' income, making sustainable agriculture more financially attractive.

Beyond economic advantages, NbS demonstrate their worth by ameliorating some of the harmful impacts on biodiversity and climate associated with conventional structural transformation. They facilitate a more gradual transition from rural to urban settings by attracting labour to more rural sectors rather than forcing rural–urban migration. They also contribute to the resilience of rural economies by generating positive environmental impacts. Moreover, the impending challenges posed by climate change necessitate adaptation strategies, in which NbS are emerging as an indispensable response.

It is essential to acknowledge that NbS do not present a panacea. Pragmatic approaches must be adopted, recognizing that NbS will often compete with alternative measures and that trade-offs may be required. Nevertheless,

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[13] When long-term food security goals are considered, this trade-off becomes less prominent, since the risks of depleting nature in order to produce food are clearer in the long term.

[14] See, for example, Larbodière et al. (2020) for an overview of this range of approaches.

a comprehensive rural development and investment strategy that effectively integrates NbS promises not only environmental benefits but also substantial gains in local employment.

Furthermore, the implementation of just transition policies is pertinent to the costs, skill development, and transition costs associated with embracing sustainable practices. Employment policies must align with the principles of GST, facilitating transitions, NbS investments, skills development and improved working conditions within the NbS sector.

Schemes such as PEPs and PES offer viable avenues to generating employment and income in rural populations while implementing various NbS projects. These initiatives can be partially funded through revenue sources like carbon credits or taxation, in recognition of the broader environmental benefits accrued for society as a whole.

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4. Coupling environmental and social sustainability: countries’ trajectories, pathways and policies towards sustainable job creation

Antonio Andreoni

1. INTRODUCTION

Since the Paris Agreement, progress towards reducing global greenhouse gas emissions while ensuring social sustainability of such efforts has been slow to materialize. Yet, the most recent reports by the International Renewable Energy Agency (IRENA) and the International Labour Organization (ILO) (IRENA and ILO 2022) and the International Energy Agency (IEA) (2022a) suggest that there are plenty of emerging opportunities to couple decarbonization with job creation in new green sectors and to leverage these opportunities in order to generate further jobs across the economy. However, investment and long-term financial commitment are needed to seize these green job opportunities and to restructure economies, beginning with their energy systems. The energy sector accounts for at least a third of all emissions globally. Generating electricity in a more efficient way will play a systemic role in decoupling, since all economic sectors rely on electricity generation. Sustainable electricity generation is also essential to the creation of employment in a sustainably expanding economy.

In its most recent road map towards “Net Zero by 2050”, the IEA has highlighted the need for a dramatic acceleration in clean energy investment, the rapid deployment and diffusion of available technologies, and the implementation of climate policies across more than 400 sectoral and technology milestones (IEA 2021). The IEA has also denounced the fact that countries’ commitments have often fallen short in implementation. The rate of energy efficiency improvement must increase to three times the average rate achieved over the last two decades. A 4 per cent per year average increase till 2030 is necessary if economic growth is to be decoupled from energy consumption. On the technological end, this requires a fivefold increase in energy capacity from solar and wind technologies, as well as the exploitation of wide opportunities arising from advanced batteries, hydrogen electrolysers, and direct air capture and storage. To support this energy transition will demand an estimated US$90 billion of public investment to be mobilized globally and new measures to redirect finance away from new coal plants and to crowd in further clean energy investments to the tune of more than US$4 trillion.

In this chapter, we focus our attention on the different pathways and policies that countries need to pursue in order to decouple job creation from carbon dioxide emissions. We start from an empirical assessment of the extent to which countries have been progressing towards increasing environmental sustainability and job creation. We focus on the period 2014–2018 and combine different sources of data available for over 100 countries, including several low- and middle-income countries. Time points before the Paris Agreement and before the global pandemic are used to define countries' data points in order to study the key relationships linking jobs creation to carbon dioxide emissions, energy efficiency, installed renewable capacity at the country level, and global shares in carbon dioxide emissions. We highlight several stylized facts and identify countries that have been clear outliers in terms of their performance, whether positive or negative.

Behind each of these countries' trajectories are heterogeneous factors driving or constraining decarbonization. In the second part of the chapter, we focus on five main potential decarbonization pathways and related windows of green jobs opportunity:

(a) planned phase-out or exit from fossil fuel industry extraction for energy generation and export (coal and oil);
(b) decarbonization of existing energy-intensive industries (such as iron and steel, chemicals and plastics, and cement);
(c) development of new renewable technology industries (solar, wind and hydrogen);
(d) development of new and retrofitting of existing energy infrastructure (main grid, mini-grids, storage, export facilities);
(e) circular economy models linking (b), (c) and (d) and mainstreaming them across industries.

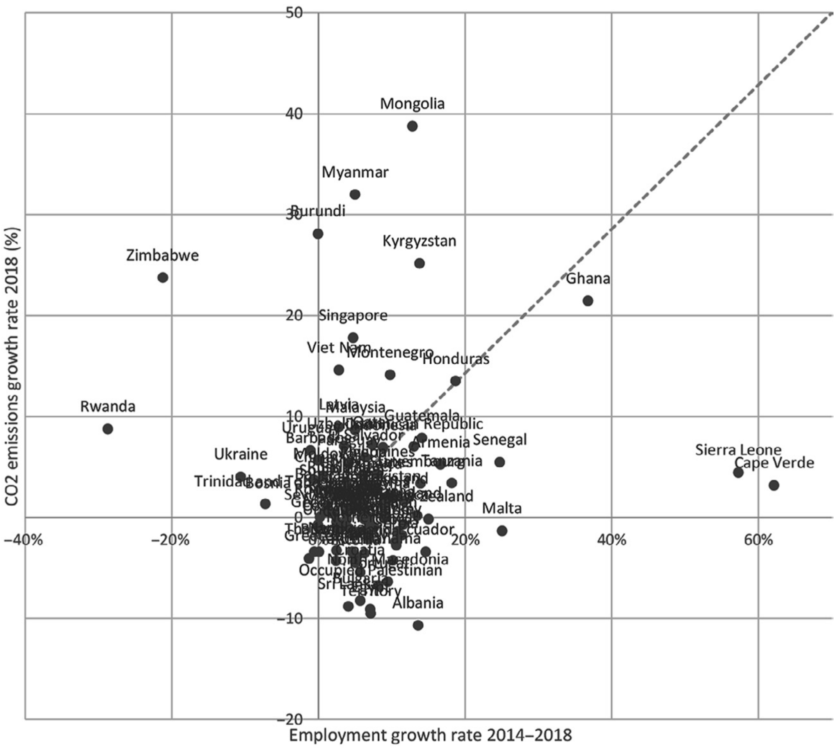
These are essential pathways for sustainable industrialization, but their ramping up will need to be socially inclusive and create jobs, especially in developing countries. Such pathways can only be pursued if countries deploy well-designed industrial policies to coordinate sector-specific decarbonization efforts as well as seize opportunities for job creation. I discuss different types of industrial policy instruments by providing examples from Chile, South Africa, the United Republic of Tanzania, and Thailand. Each country case study highlights both challenges and the potential transformative role of certain initiatives.

2. MAPPING COUNTRIES' SUSTAINABLE STRUCTURAL TRANSFORMATION: STARTING POINTS AND STYLIZED TRAJECTORIES

Empirical evidence shows that during the period 2014–2018 the relationship, globally, between employment generation and the latest rate of growth in carbon dioxide emissions (2018) has largely remained coupled. However, there are signs that some countries have started recording a *slower than proportional* acceleration in carbon dioxide emissions. This means that, despite the efforts made, most countries are finding it difficult to create more jobs without increasing carbon dioxide emissions, at least in the short to medium term. Figure 4.1 shows this relationship for all countries and highlights those in which employment generation has come with a *more than proportional* expansion in carbon dioxide emissions (above the 45-degree dotted line). This group of countries includes Mongolia, Myanmar, Kyrgyzstan, Singapore and Viet Nam, where carbon dioxide emissions have grown between 15 per cent and 40 per cent despite relatively modest expansionary employment dynamics. Countries below the 45-degree dotted line are those where some decoupling has started, but only those below the x-axis have managed to increase jobs without additional impact on the environment.

The poorest-performing countries in this analysis are ones where the carbon dioxide growth rate in 2018 was rising faster than the employment rate. Here we find large middle-income countries such as Malaysia, but also Bangladesh and the Russian Federation, as well as smaller economies such as Romania, the Republic of Moldova, and Paraguay. However, in the vast majority of countries, employment growth outpaced carbon dioxide emission growth, suggesting some initial though tentative signs of decoupling. This group includes countries like the United States where decoupling is only happening marginally. It must be noted that most of the countries are concentrated below the 5 per cent employment growth rate. These are countries where employment expansion has largely slowed down and, in some cases, stalled.

Countries below the x-axis include those that are experiencing a real decoupling. They include European countries such as Germany, France, the United Kingdom of Great Britain and Northern Ireland, Italy, the Netherlands and Spain, as well as Japan. Their reduction in carbon dioxide emissions is, however, relatively modest, below 2 per cent, except in the cases of Germany and France. This highlights the fact that even large advanced economies are struggling to make a decisive shift towards sustainable and inclusive structural transformation. Among the largest developing and emerging economies, the



Source: Based on consolidated data from ILOSTAT (https://ilostat.ilo.org/) and Our World in Data (https://ourworldindata.org/) (100 countries).

Figure 4.1 Employment growth and environmental pressure: growth rates in carbon dioxide emissions and employment, 2014–2018

carbon dioxide emissions growth rate has remained above 5 per cent, India experiencing a 6.82 per cent rate, Nigeria, 12.17 per cent and China, a more modest 3.72 per cent.

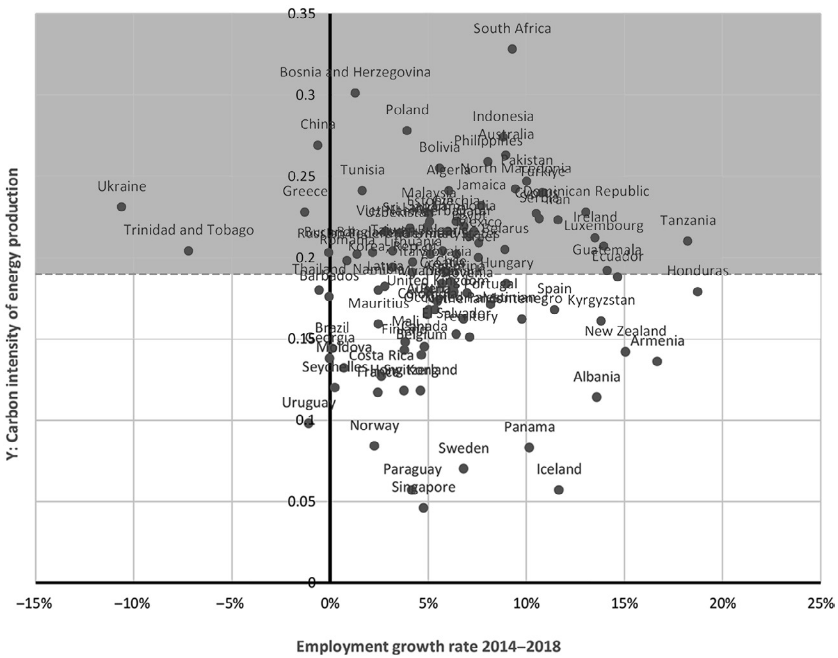
Overall, the analysis shows that even those countries that manage to fall below the 45-degree dotted line find it difficult to accelerate their decoupling and in many cases are stuck on a low employment growth path. Hence there is need to create more jobs while shifting gradually below the x-axis.

An important step in the direction of decoupling employment growth from carbon dioxide growth is to promote a transformation of the energy sector. Such a transformation could reduce the carbon intensity of energy generation and provide a way to dramatically scale up renewable energy technologies.

Employment generation could be compatible with such transformation. In fact, the renewable energy sector is already becoming a major source of employment growth.

Figure 4.2 maps the carbon intensity of energy generation in 2018 against the employment growth rate for the period 2014–2018. Countries above the dotted line are those in which the carbon intensity of energy generation is above the world average at 0.19. Below this line we find those economies in which energy transition has been faster; they include the United Kingdom, Belgium, Spain and New Zealand, among others, as well as France, whose energy system has a strong nuclear component. The only large middle-income economy below the average indicated by the dotted line is Brazil. However, Brazil's employment dynamics were very poor in 2014–2018, and hence the country has not benefited from a coupled energy-efficiency–employment-generation loop.

In the grey zone we find a very heterogeneous group of countries. This heterogeneity can be better understood by matching the information con-



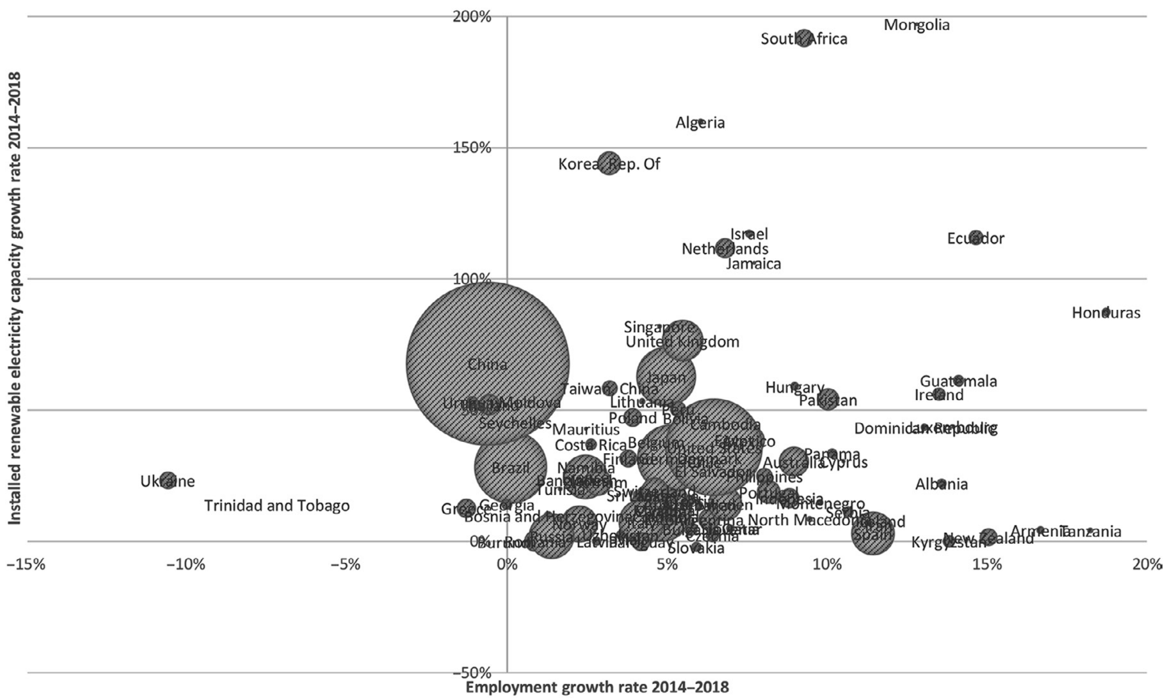
Source: Based on consolidated data from ILOSTAT and Our World in Data.

Figure 4.2 Energy efficiency of employment growth: carbon intensity of energy production per employment growth rate, 2014–2018 tained in Figure 4.2 with that in Figure 4.3, which maps countries' renewable energy generation, on the vertical axis, and their renewable energy capacity, captured by the size of the bubbles. In the grey zone of Figure 4.2, just above the world average, are large, highly industrialized economies – such as Germany, Japan, Italy and the Republic of Korea – whose productive structure includes several highly energy-intensive sectors. These countries have expanded their renewable energy generation at significant speed and at considerable scale. The United States and Australia are countries in the grey zone in which the expansion of the renewable sector has moved relatively slowly or the sector has not reached a significant size compared with the size of the economy. This is in contrast to Canada, which has obtained a considerable renewable energy generation capacity and is positioned well below the grey zone.

In the grey zone of Figure 4.2 we also find a set of large emerging economies. These include China; South Africa, Indonesia and the Philippines in the Global South; and Poland and Türkiye in Europe and western Asia. Among the countries shown in Figure 4.2, South Africa has by far the highest carbon intensity of energy production. Although it has seen a dramatic acceleration in renewable energy generation, the size of the bubble remains very small. Indeed, South Africa has only recently attempted to accelerate its energy transition. Indonesia and the Philippines have also witnessed some increasing renewable capacity but at a very slow speed. Poland is showing a faster acceleration, pulled by the European Union's highly regulated economy.

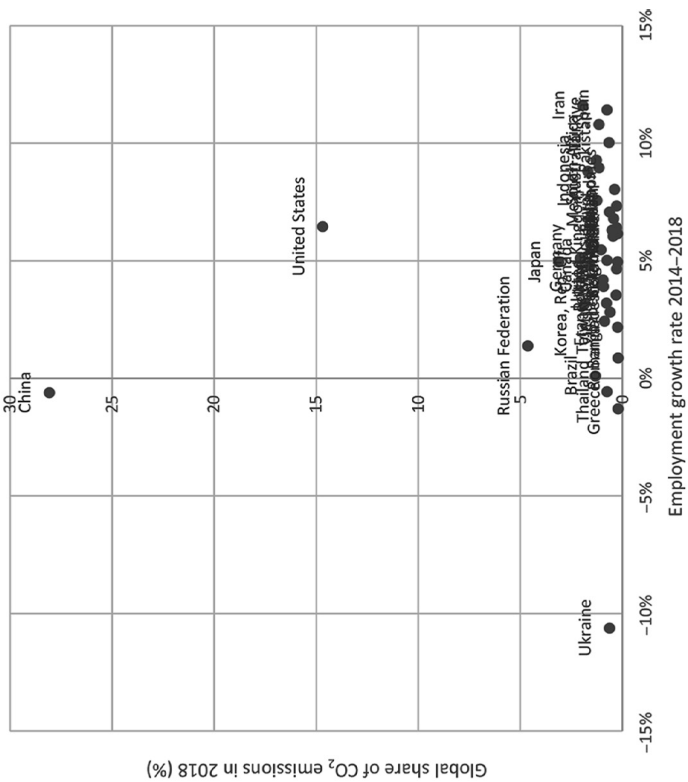
China is certainly the most striking case. The country has still a significant carbon intensity footprint in energy generation, but it has also managed to build the biggest renewable energy capacity in the world (see Figure 4.3). This sector is still growing and becoming a major source of employment generation, despite the contractionary employment dynamic experienced by China in the period 2014–2018. The only other comparable economy with a large renewable sector is Brazil.

The heterogeneous performances of countries, finally, can be illustrated by looking at their global shares in carbon dioxide emissions. Figures 4.4 and 4.5 show the high degree of concentration of emissions in China, the United States and the Russian Federation, followed by Japan and Germany (which two countries account for a much smaller share, below 2 per cent each). These countries are among those with the highest stakes and responsibility. They are also countries with tremendous technological capabilities to drive the transition. The extent to which these technological capabilities have been put into action depends on several country-specific factors, including sector-specific challenges in both the energy and industrial sectors. Countries in the 1–2 per cent band include the largest emerging economies (Brazil, Mexico, Indonesia,



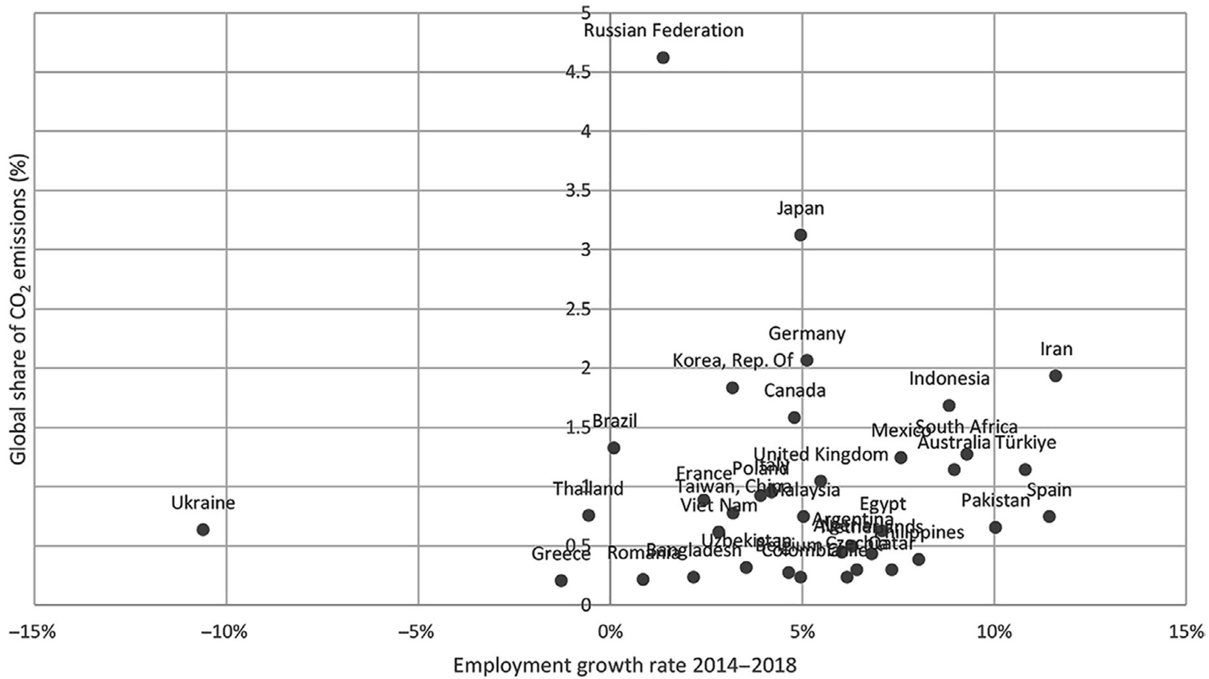
Note: The size of the bubble indicates the renewable energy capacity in MW.
Source: Based on consolidated data from ILOSTAT and IRENA (top 50 countries by MW renewable capacity).

Figure 4.3 Decoupling employment growth and environmental pressure via renewable energy generation, 2014–2018



Source: Based on consolidated data from ILOSTAT and Our World in Data.

Figure 4.4 Employment growth and global emissions shares: carbon dioxide emissions global share relative to employment growth, 2014–2018



Source: Based on consolidated data from ILOSTAT and Our World in Data.

Figure 4.5 *Employment growth and global emissions shares: Carbon dioxide emissions global share relative to employment growth, 2014–2018 (excluding China and the United States)*

South Africa and the Islamic Republic of Iran) as well as advanced economies, especially in Europe.

3. FIVE PATHWAYS FOR ENERGY TRANSITION AND GREEN INDUSTRIALIZATION: A SECTORAL PERSPECTIVE

The mapping in section 2 has pointed to a high level of heterogeneity and a severity of challenges that countries face in reducing carbon dioxide emissions while expanding employment. The coupling of decarbonization and employment generation follows different dynamics in different sectors of an economy. Countries have increasingly embraced more sector-specific approaches to developing feasible pathways towards sustainable structural transformation. The most prominent policy initiative is the IEA Breakthrough Agenda 2022, which is supported by several countries and multilateral organizations (IEA 2022b). Each of the supporting countries is setting sector-specific goals and identifying ways in which such goals can be achieved within a sustainable structural transformation framework.

Although in 2019 the energy sector accounted for around 13 gigatonnes of carbon dioxide equivalent ($GtCO_2e$), or 23 per cent of total global emissions, and is therefore central to sustainable structural transformation, decarbonization cannot be limited to the energy sector. All industrial sectors – from agro-food and garments, to chemicals and steel, and aerospace and automotive industries – contribute to climate change differently in direct but also indirect and mediated ways along upstream and downstream value chain segments. For example, the steel sector, a key upstream industry, accounts for around 3 $GtCO_2e$, or 5 per cent of total emissions. That has risen by around 15 per cent since 2010. Agriculture and related land use account for around 10 $GtCO_2e$, or 17 per cent of total emissions. Of those, about 7 $GtCO_2e$ come from direct farmgate emissions. Farmgate emissions have increased by 0.6 per cent per year since 2000.

On the basis of these sectoral differences, we can distinguish five main potential pathways for sustainable structural transformation. These pathways are particularly challenging in developing countries, where constraints and compression mechanisms are more severe given the multiple challenges that developing countries face.

3.1 Pathway 1: Planned Phase-Out of and Final Exit from Fossil Fuel Industry Extraction for Energy Generation and Export

The IEA Breakthrough Agenda 2022 sets very ambitious targets for the power sector globally (IEA 2022b). First, emissions from the power sector should fall by around 8 per cent each year till 2030, while electricity access should reach 100 per cent by 2030, if not before. Investment will need to grow 25 per cent each year, reaching US$2 trillion per annum by 2030. The IEA Breakthrough Agenda 2022 also highlights the need to mobilize the additional 7.4–8 terawatts (TW) of renewable power capacity, and other clean power options, that will be needed globally by 2030.

To achieve these ambitious goals, developing countries need dedicated international support. In particular, in those countries whose export basket and government revenues are dominated by fossil fuel rents (for example, Nigeria) and/or for which coal is still the major source of energy (for example, South Africa), it is not politically feasible to plan a rapid phase-out of the fossil fuel industry without developing alternative sources of revenue and job creation. Opportunities to develop these do exist and must be pursued. In South Africa, for example, proposals have been made to build solar power farms in existing coal-mining sites in Mpumalanga – the state where most of the coal and energy plants are located – and to retrain the workforce and retrofit the grid to channel clean energy into the economy (Andreoni et al. 2022).

In some cases, such phase-out also entails exploring opportunities for infrastructure development, including interconnectors to support the integration of larger shares of low-cost clean power into the grid. The demonstration and testing of power system flexibility solutions, including long-term storage, will be needed to enable planned phase-out alongside new infrastructure development to achieve fully net zero power.

3.2 Pathway 2: Development of New Renewable Technology Industries

The dramatic decline in the cost of electricity from digitally enabled renewables – solar photovoltaics and wind, onshore in particular – has offered a viable pathway for accelerating the energy transition. Furthermore, green hydrogen is becoming a feasible option to replace fossil fuels (especially in highly energy-intensive difficult-to-abate industries such as steel, metal foundries, and chemicals and plastics) as well as liquid fuels for heavy transport and industrial logistics.

Many developing countries do not have technological and organizational capabilities for developing renewable technologies; however, they can leverage their critical minerals and natural capital (sun, wind and hydro) to attract investment in upstream industries (from mineral processing to battery and fuel cell manufacturing) and promote joint ventures, technology licensing and indigenous innovation. Developing countries in the Global South can become energy superpowers and leverage that status to attract investment co-location. Lithium, nickel, cobalt, manganese and graphite are crucial to battery performance, longevity and energy density. Rare earth elements are essential for the permanent magnets that are vital for wind turbines and electric vehicle motors. Electricity networks need a huge amount of copper and aluminium; copper is a cornerstone of all electricity-related technologies. These critical minerals are geographically concentrated. Several African countries are endowed with large amounts of critical mineral resources, which provide important opportunities for these countries in the world's technological development. For example, 70 per cent of global cobalt production comes from the Democratic Republic of the Congo, and over 80 per cent of platinum and manganese resources are in South Africa and Zimbabwe (Andreoni and Avenyo 2023). The Democratic Republic of the Congo and Zambia are also important sources of copper. Leveraging mineral resources for sustainable structural transformation offers a unique opportunity for Africa and other countries such as Chile and Peru, and also for Myanmar and Indonesia, which have large amounts of lithium, rare earths, copper and nickel.

Hydrogen production and use account for around 0.9 $GtCO_2e$ of emissions per year, or 1.5 per cent of total emissions. Renewable and low-carbon hydrogen production currently accounts for less than 1 per cent of global hydrogen production. To increase the availability and affordability of renewable and low-carbon hydrogen, the IEA Breakthrough Agenda 2022 has pointed out the importance of creating larger markets for its deployment and trade, including through purchase commitments (IEA 2022b). This will also incentivize investment in production, which must scale up from less than 1 megatonne (Mt) in 2020 to around 140–155 Mt per year by 2030. Such an ambitious target can only be achieved if governments and companies coordinate full deployment of green hydrogen in those sectors in which green hydrogen is already a proven substitute for fossil fuels (Andreoni and Roberts 2022). Accelerating the deployment of hydrogen in new applications such as steel, shipping, and energy storage requires increasing the number and geographical distribution of demonstration projects, backed by targeted technical and financial assistance, including agreeing on safety, operational and emissions standards in deployment and trade.

3.3 Pathway 3: Decarbonization of Difficult-to-Abate Sectors and Carbon-Intensive Sectors

The so-called "difficult-to-abate industries" (such as iron and steel, chemicals and plastics, and cement) account for more than 50 per cent of all industrial emissions. Countries can move away from the worst fossil fuels towards gas and renewables and, incrementally, free themselves from gas in the direction of blue and green hydrogen (the former relying on carbon capture technologies). For many other relatively less-energy-intensive sectors, opportunities for industry efficiency-enhancing retrofitting will have to be pursued to retain access to global markets. Two sectors (steel and agriculture) are examined below.

(a) *Steel sector.* According to the IEA, the steel sector accounts for around 3 $GtCO_2e$ of emissions per year, or 5 per cent of total emissions. That share has risen by around 15 per cent since 2010. The IEA Breakthrough Agenda 2022 sets an ambitious target for the sector: global average direct emissions intensity of steel production needs to fall by around 30 per cent by 2030 (IEA 2022b). In 2022, less than 1 Mt of primary near-zero-emission steel per year was being produced, whereas over 100 Mt per year will be needed by 2030. Conventional high-emission plants with a production capacity of 114 Mt are currently underway or in planning.

Given the scale and capital intensity of the steel sector, joint procurement commitments by groups of countries and companies could create sufficiently large demand to attract investments. Capital intensity could be further supported by advance purchase commitments to address inter-temporal commitment of finance and specialized capital. The Green Steel Deal is an example of trade measures to ensure that near-zero-emission steel can compete in international markets. Such trade policy measures depend on countries' coordination on definitions and standards for low-emission and near-zero-emission steel, without which procurement and trade will not take off.

(b) *Agricultural sector.* According to the IEA (2022b), agriculture and related land use account for around 10 $GtCO_2e$ per year, or 17 per cent of total emissions. Of these, about 7 $GtCO_2e$ come from direct farmgate emissions, which have increased by 0.6 per cent per year since 2000. Farmgate emissions need to fall by around 20 per cent by 2030. Twenty-seven per cent of all agricultural and land use emissions can be attributed to agricultural products that are internationally traded. Smallholders produce about 30 per cent of global food production.

Along with reducing waste, changing diets and promoting smart agriculture in developed countries, the model for agriculture in rapidly urbanizing developing countries is a critical lever in changing the direction of the world's development. African countries, for example, are net food importers and yet Africa has the areas in the world with greatest potential for expanded sustainable agricultural production, given water availability and without deforestation – for example, in countries like Zambia and Tanzania. As attention shifts to the emissions entailed in consumption (meaning that industrialized countries will consider the carbon costs of the produce they import, and hence mechanisms such as carbon border taxes – see Chapter 7), investment in agriculture in developing countries needs to be consistent with a produce mix (less meat) and production methods that involve much lower emissions. Food supply chains need to be smart, using less fertilizer and pesticides and transporting and packaging the produce more efficiently. Climate-sensitive consumers can verify responsible farming methods if appropriate codes are in place. For example, exports of fresh fruit have boomed from many countries and can earn good returns for producers with traceability in place. Finally, in order to reduce emissions and increase productivity, jobs and resilience, especially among smallholders in developing countries, public finance will be needed to disseminate new sustainable production technologies in the sector.

3.4 Pathway 4: Development of New and Retrofitting of Existing Energy Infrastructure and the Built Environment

Sustainable structural transformation demands new patterns of production as well as consumption, as spelled out in United Nations Sustainable Development Goal 12. These new patterns of sustainable production involve building new and digitally enabled energy systems, governing the critical mineral supply chains underpinning these technologies, and reorganizing the geography of production. These transformations can only work if a new infrastructure of the built environment and everyday life is put in place. Buildings and transport feature prominently in the built environment as two of the most important areas in which patterns of consumption need to become sustainable. These two sectors are key contributors to carbon emissions. Their transformation could generate tremendous demand pulls for sustainable structural transformation, including new green jobs.

Effective deployment of renewable energy can follow several infrastructural models; and old infrastructure can be redeployed to support a more sustainable energy system. Energy infrastructure maintenance and redesign offer opportunities for jobs creation and are moving towards diffused energy governance. Alongside energy infrastructure, road infrastructure is a major contributor to emissions. According to the IEA (2022b), the road transport sector accounts for around 6 $GtCO_2e$ per year, or 10 per cent of total emissions. This figure had risen by 13 per cent since 2010; it needs to fall by nearly a third by 2030. Zero-emission vehicles accounted for around 9 per cent of global car sales in 2021; this should reach about 60 per cent by 2030.

Countries and manufacturers should align target dates for all new road vehicles to be zero emission, in order to shift investment more quickly towards the new technologies and accelerate their cost reduction. This coordination should include mobilizing investment in charging infrastructure, and developing the underlying soft infrastructure – harmonized standards to ensure sustainability in battery supply chains. The manufacturing of electric vehicles is a major contributor of green jobs, and employment generation opportunities can be generated along the battery value chain, including in upstream industries as well as downstream in the maintenance of the charging infrastructure.

3.5 Pathway 5: Circular Economy Models

Circular economy models' main tenet is that it is possible to reduce the pressure on scarce resources by reducing material waste and scrap and incentivizing recycling (see also Chapter 5). These models reinsert material waste and scrap into production processes. For example, agriculture-based economies can utilize organic waste and by-products to produce biofertilizers or bio-stimulants, thereby closing biological loops and simultaneously generating new jobs and income streams. The circular economy pathway is cross-sectoral and links pathways 1, 2, 3 and 4 described above. The deployment of this model is also cross-national and hence points to the need to consider global systemic interdependencies, to improve social inclusion and to generate employment, especially in developing countries. For example, various trade flows can be directly linked to different circularity strategies, including trade in secondary raw materials, in waste and scrap for recovery strategies, in goods for refurbishment and remanufacturing, in second-hand goods and in services. Digital technologies can also enable product dematerialization via advanced new materials and process efficiency – for example, with the deployment of digitally enabled predictive maintenance technologies.

4. WINDOWS OF OPPORTUNITY FOR GREEN JOBS

When considering policies to advance a shift to a sustainable energy mix, it is important to factor in the effects on labour and income distribution. Garcia-Garcia, Carpintero and Buendia (2020) provide a theoretical schematic to unpack various causative mechanisms and channels through which energy transition will ultimately affect labour and incomes. Positive effects are mainly driven by new investments in green technologies, and sectors can open windows to both direct and indirect job creation. The indirect effect originates from a "sectoral multiplier" effect, that is, the generation of jobs in upstream and downstream industries associated with the new green technology investments. For example, the shift towards renewable energy generation technologies is creating jobs in the entire renewable value chain industry, including the post-sale maintenance and repair services required to keep solar and wind technologies in operation. There are also "macro-multiplier" effects that can derive from more systemic changes in the energy mix and the increasing sectoral reconfiguration driven by technologies such as green hydrogen.

Although positive effects are expected to become dominant in the medium to long term once sectors have managed to go through such industrial restructuring, there are also potential negative effects that will be difficult to mitigate in the short to medium term. Negative effects include job losses, owing to decreases of investment in non-green sectors, as well as through the overall increases in prices which may compress disposable income and aggregate demand; hence an indirect negative impact on the job expansion potential of the economy. In this process of transition demanded by climate change, jobs will be substituted, redefined and in some cases eliminated.

A first important attempt to estimate empirically some of the direct effects on jobs comes from recent work by IRENA and the ILO (2022). In their analysis of the evolution of global renewable energy employment, between 2012 and 2021, over 12 million new jobs were created, a third of them from the solar photovoltaic industry. The top three contributors are (i) solar photovoltaic, (ii) bioenergy and (iii) hydropower. Wind energy has provided a more modest contribution to job creation, partially because wind technologies have undergone more limited diffusion and are more capital intensive. Solar heating/cooling, geothermal energy, concentrated solar power, heat pumps and green waste management are among the other sectors that, to date, have brought limited job creation.

The potential for job creation depends on the technology, its diffusion and its value chain structure. For example, the IEA (2022c) has estimated that the solar photovoltaic industry could create 1,300 manufacturing jobs for each gigawatt of production capacity. To be on track to meet the increased demand projected in the IEA's "Net Zero by 2050" scenario, the solar photovoltaic manufacturing sector needs to nearly double the number of jobs globally by 2030. These jobs will be distributed along the photovoltaic value chains and related sectors, such as those involving the manufacturing of components such as glass, EVA (ethylene vinyl acetate), backsheets, inverters and mounting systems. These indirect jobs are anticipated to add a quarter of a million jobs to this industry's total job creation. In contrast, thin-film module manufacturing, which is less job intensive than crystalline silicon technology, creates only around 200 jobs per gigawatt because it entails fewer production steps and they are mostly automatized.

The job creation potential depends on the extent to which countries investing in photovoltaic manufacturing are able to link up into global value chains and markets and link back to their local production systems. The degree of engagement in technology development also impacts on the skills intensity of jobs. Photovoltaic manufacturing requires a diversity of workers, including production engineers, material handlers and assemblers. Owing to the current geographical concentration of the solar photovoltaic supply chain, the majority of skilled personnel are based in China and South East Asia. In many countries, these new skills need to be created and training needs to be scaled up so that windows of job opportunities materialize in the local production system. Demand pull for photovoltaic technologies is also central to encouraging investment and skills development, and public procurement has become an important policy tool for the green transition (see section 5).

As mentioned above, the potential for indirect jobs and the potential sectoral multiplier must also be taken into account. A study by Garrett-Peltier (2017) developed an input–output method to estimate the potential inter-sectoral multiplier effect that renewable energy, energy efficiency and fossil fuels can have on employment. The study uses input–output (I–O) tables to create "synthetic" industries – namely, clean energy industries that do not currently exist in I–O tables – to estimate the employment impacts in the short to medium term of different green and brown investments. The study finds that, on average, 2.65 full-time-equivalent (FTE) jobs are created from US$1 million of spending on fossil fuels, whereas that same amount of spending would create 7.49 or 7.72 FTE jobs in renewables or energy efficiency. Thus each US$1 million shifted from brown to green energy will create a net increase of five jobs.

Recent work by the IEA (2022a) seems to confirm the higher job creation potential of green sectors and the overall global shift in employment generation in the energy sector from brown to green jobs. By using over 15,000 data points on employment and wages gathered from national labour accounts, company reports, in-country experts, international databases and academic literature, the IEA (2022a) has produced a baseline by sector, region, and value chain segment to assess global energy employment. According to their estimation, the energy sector employed over 65 million people in 2019, equivalent to around 2 per cent of global employment. These jobs are roughly equally distributed across fuel supply (21 million), the power sector (20 million) and end uses (24 million) such as energy efficiency and vehicle manufacturing. Clean energy employs over 50 per cent of all energy workers, owing to the substantial growth of new projects coming into operation since the COVID-19 crisis.

Globally, wind and solar already employ the same number of people as the fossil fuel industry. In a number of regions clean energy jobs have already outpaced traditional jobs in the fossil-fuel-based energy sector. Forty-five per cent of the employment in the energy sector is considered to be high skilled, with the sector requiring higher-skilled workers than other industries (see Chapter 9). Many of the skills from brown industries can be also used as a foundation upon which to retrain workers in green energy generation. Such a sectoral shift is also emerging in other sectoral value chains. For example, in the automotive industry, 10 per cent of total employment is already generated in the manufacturing of electric vehicles and their components and batteries (IEA 2022a).

These windows of opportunity for green jobs are opening disproportionally in the Asia–Pacific region, where China alone accounts for almost 30 per cent of global energy employment. In this region, green jobs have emerged as a result of rapid energy infrastructure expansion and relatively lower-cost skilled labour, which together have enabled a demand pull and supply push for the emergence of clean energy manufacturing hubs. These hubs have become the world suppliers for green projects worldwide, notably for solar power and electric and hybrid vehicles and batteries. The emergence of these local production systems and their global strength offer opportunities for countries still catching up in the green transition. The rapid learning curves in solar and wind have been driven by green project investments. However, developing countries may also face obstacles to entering these supply chains as producers. Leveraging the critical minerals essential for the manufacture of digitally enabled green technologies is one of the possible pathways that catching-up countries can follow to break into these new clean energy industries and markets.

The IEA (2022a) have produced some employment estimates, based on a 2019 baseline, to look at employment distribution in the energy sector in 2030. Such estimates are evaluated in two scenarios: the announced pledges scenario (APS), where all announced climate pledges are met on time and in full, and the net zero emissions (NZE) by 2050 scenario, which is consistent with limiting global surface temperature warming to 1.5°C by 2100. According to the IEA, in both the APS and NZE scenarios, job growth more than offsets a decline in the traditional fossil fuel supply sectors, although the new jobs will be created in different sectors from the sectors where jobs used to be. This sectoral employment shift requires retraining and new skills development, and other infrastructural policies to govern and direct a just transition.

5. GREEN INDUSTRIAL POLICY FOR GREEN TRANSITION AND GREEN JOBS CREATION: CASE STUDIES

Historically, the state has played a key role in addressing structural transformation challenges through a range of industrial policies (Andreoni 2016; Chang and Andreoni 2020). It will be no surprise, then, if most countries, both advanced and developing economies, are looking to green industrial policy to decarbonize their economies along the various pathways and to capture some of the windows of opportunity to create green jobs.

Governments can reshape industries, align incentives among institutions and organizations, build coalitions of interests and drive technological and organizational innovation. This does not necessarily mean preselecting certain technological pathways to the exclusion of others, or limiting private sector initiative. On the contrary, the state can steer the search for both sector-specific and cross-sectoral solutions that rely on environmentally sustainable technology. Governments can also de-risk experimentation and innovation efforts, especially in sectors like green hydrogen and energy generation, which require long-term financial commitment. Finally, governments can crowd in private investments and promote the diffusion of renewable technologies by committing to infrastructural investments or by creating demand via public procurement.

Although there are many green industrial policy instruments that governments can deploy, ultimately their effectiveness is likely to increase if policy instruments are effectively aligned (Andreoni and Chang 2019). Coupling of decarbonization and job creation can be only achieved with well-coordinated industrial policy instruments and packages including public finance and public procurement, setting standards and providing technology services along the entire innovation and production chain, from basic research to full deployment and diffusion of new technologies. In the design of each of these industrial policy instruments, various types of conditionalities can be introduced to reflect risk–reward arrangements supporting sustainable prosperity. These conditionalities can operate *ex ante* by setting different types of requirements on the types of firms that can access incentives or by selecting the types of activities to be supported. They can also operate *ex post* by setting specific requirements on firms' future performance or corporate governance decisions (for example, limiting stock buy-backs or dividend distribution). It is no longer taboo to attach conditions to policies such as those on financing and procurement, or on company bail-outs, investment attraction schemes, business restructuring, etc. Experiences from Austria and France during the COVID-19 pandemic are testament to such public–private conditionalities. Conditionalities are a way to steer financial resources strategically and make sure they are retained and reinvested within productive business organizations to improve social, economic and environmental outcomes.

Although green industrial policy has become very popular, very few governments have managed to deploy coordinated packages of interventions including well-designed conditionalities. One of the green industrial instruments that have been more widely used is green taxes (see Box 4.1 for the case of Chile and also Chapter 7). Green taxes are mainly market-fixing "horizontal" measures that rely on market pricing to motivate or discourage specific types of investments. Carbon pricing in the form of carbon taxes is a good example of market-fixing policy. Green taxes have an important role to play (Rodrik 2014), since there is an increasing recognition that markets have failed to internalize environmental costs at the scale and speed required. Markets alone have also proven incapable of promoting the development and widespread diffusion of green technologies or steering economies towards the much-needed energy and industrial transition. The reason is that the market performs poorly in allocating and committing resources under uncertainty, especially when productive and technology assets are highly specialized and when specific markets do not exist yet (Chang and Andreoni 2020).

BOX 4.1 CHILE'S GREEN TAX

Since ratifying the United Nations Framework Convention on Climate Change (UNFCCC) in 1994 and signing the Kyoto Protocol in 2002 and Paris Agreement in 2016, Chile has actively engaged in the formulation of policies and instruments to address the climate change challenge, including a carbon tax called the "green tax". This tax has its basis in Article 8 of Law 20780 of 2014 and entered full operation in 2017. Green taxes have been used in various countries to take into account the negative externalities of pollution while nudging producers, investors and consumers towards more sustainable production and consumption practices.

The Chilean green tax is an annual tax for all owners of large industrial establishments that generate emissions of particulate matter (PM), nitrogen oxides (NOx), sulphur dioxide (SO_2) and carbon dioxide (CO_2) – above 100 tonnes of PM per year, or over 25,000 tonnes of carbon dioxide per year (Law 20780 of 2014). In 2021, the government embarked on a process of further strengthening this tool over a period of six to eight years. These improvements aim, on one hand, to gradually increase the carbon dioxide tax from US$5 to US$40 per tonne of carbon dioxide; the other goal is to extend the tax's scope to cover different emission sources and selectively apply it across sectors, taking into account the different green transition pathways that are feasible.

Following the examples of Colombia and Mexico, Chile also intends to introduce a provision that allows companies to offset their emissions by financing the development of sustainable projects in the country. This compensation mechanism is intended to provide companies with different pathways to reducing their carbon dioxide emissions. The implementation of a more articulated measure, however, requires the establishment of procedures and obligations for the evaluation, verification and certification of projects that reduce emissions. For example, it is important to make sure that the emissions taxed can only be compensated for by projects that reduce emissions of the same pollutant (CO_2, PM, NOx and SO_2).

Development finance and green finance are further policy instruments widely adopted to decarbonize the economy and grow green sectors, technologies and jobs (see Box 4.2 for the case of Thailand). From a directionality perspective, however, more finance is not always the solution. What matters most is the specific type of finance and how it is directed towards addressing grand challenges. Mazzucato and Semieniuk (2017 and 2018) show empirically how financial actors vary considerably in the composition of their investment portfolio and in their selection of green technologies to invest in. They also differ in their approach to high- and low-risk technologies, private actors favouring low risk much more than public ones. Public financial actors tend to invest in portfolios with higher-risk technologies, thereby creating directionality. They also generally increase their share in total investment dramatically over time and can better afford to commit resources amidst uncertainty across a larger portfolio of projects that provide viable *ex post* solutions (Chang and Andreoni 2020).

Public financing is not simply important in terms of delivering portfolios of viable innovative solutions and crowding in private investors (Mazzucato and Penna 2017). It is also critical to addressing problems associated with the effective scaling up, deployment and diffusion of new technologies. These problems are particularly challenging in economies affected by the "middle-income technology trap" (Andreoni and Tregenna 2020), that is, lack of a well-funded set of intermediate technology institutions and of small and medium-sized enterprises (SMEs) big enough to be capable of absorbing new technologies for energy transition. A combination of weak supply push and demand pull dynamics levels down overall investment and makes gaps along the innovation and production chain even more problematic.

BOX 4.2 THAILAND'S PROMOTION OF GREEN GROWTH AND BIOECONOMY

The Global Climate Risk Index ranks Thailand as eighth out of the ten countries in the world most affected by extreme weather events between 1999 and 2018, the resulting losses estimated to be almost 1 per cent of gross domestic product (GDP) per year over the same period (Eckstein, Hutfils and Winges 2019). The agricultural sector is expected to have borne the brunt of the impact, which has affected the livelihoods of farmers and rural communities. Expected sea level rise is of concern, given the location of Bangkok and key industries along the exposed coastline of the country. Thailand's vision of transitioning its economy into an innovation- and technology-driven "Thailand 4.0", especially through its "bio, circular and green" (BCG) economy model, will not be achievable without significant progress towards green growth. The Thai government's vision of bioeconomy is to modernize agriculture by adding value to raw materials from farmers' fields. This value addition, in the government's view, can help Thailand overcome the middle-income trap, as well as reduce inequality, create jobs and ameliorate the environmental impacts.

Public finance plays an important role in spurring green investment in Thailand. Two on-budget funds – the Energy Conservation Promotion (ENCON) Fund and the Energy Service Companies (ESCO) Fund – have been important precursors to action on energy conservation and efficiency and have also helped Thai banks to develop green lending. The main drivers of investments have been investment incentives, including concessional finance, to promote new green businesses and projects, as well as to encourage "non-green" projects to take up more efficient technologies and improve their environmental performance. Green sectors actively promoted by the Thai Board of Investment (BOI) through this strategy include renewable energy and biodegradable plastics. Other incentives include tax-based incentives, such as exemptions from corporate income tax or import duties, and non-tax-based incentives, such as waiving restrictions on foreign ownership and granting permission to bring in skilled foreign workers. Thailand has also implemented various subsidy schemes to kick-start the renewable energy market. For example, in 2014 the government introduced a feed-in-tariff (FiT) scheme and a competitive bidding mechanism for projects (IRENA 2017). The system was run as a reverse auction where project proponents competed on pricing, with the FiT set as the ceiling price. The FiT covers several sources, including community ground-mounted and rooftop solar, waste-to-energy plant, biomass, biogas and wind.

Source: Based on Organisation for Economic Co-operation and Development (OECD) 2021 and Stockholm Environment Institute (SEI) 2020.

Although supply-side measures like green finance are essential, a green industrial policy must ensure that investments into low-carbon innovation are rewarded and, when markets do not exist, that they are created. Governments tend to focus their attention on supply-side intervention such as tax credit and subsidies, even when the additionality of these measures and the extent to which these types of incentives are sufficient remain unclear. Demand-side measures, especially procurement policies, can play a central role in energy transition, especially given the important role the public sector plays in energy supply and infrastructure management (see Box 4.3 for the case of South

Africa). Public procurement can be used to perform various functions (Edquist and Zabala-Iturriagagoitia 2012).

First, public procurement can create (or increase) the demand for products – goods and services – as well as emerging technologies. This is particularly important in areas where markets tend to underinvest or where infrastructure bottlenecks have to be overcome to make the use of certain technologies viable. Second, if markets do not exist, public procurement can be used to contrive demand and the conditions for competitive processes whereby new firms emerge and old ones are encouraged to diversify into new technology areas and markets (in some cases shifting away from their old core business).

BOX 4.3 SOUTH AFRICA'S PROCUREMENT REFORMS AND CLUSTER MODELS

South Africa's inability to ensure its economy has a reliable electricity supply has without doubt been an important contributor to the country's low economic growth and inability to create jobs and economic opportunities for its citizens – that is to say, to its halting structural transformation (Andreoni et al. 2021). South Africa is also a disproportionate contributor to climate change, and its power generation is largely coal based. Therefore, an accelerated electricity sector transition is the key to South Africa's sustained economic recovery. Several coal power stations that were built decades ago are at the end of their lives and can now be replaced by an energy mix including large-scale investments in renewable energy sources. Such building of new electricity generation capacity is being implemented via government procurement instruments, such as the Integrated Resource Plan (IRP2019) and Risk Mitigation Independent Power Producer Procurement Programme (RMIPPPP).

After competitive bidding processes, Eskom – or a future central entity following the restructuring of Eskom – will procure this additional electricity via purchasing power agreements and will pass on the costs of such electricity to consumers. As for the deregulation of independent power generation, the IRP2019 states that "The development of generation for own use must also be encouraged through the enactment of policies and regulations that eliminate red tape without compromising security of supply." This is the most effective option to reduce the supply gap in the short term. In 2021, reforms were announced to allow a licence exemption for independent power generation projects of up to 100 megawatts (MW). It is also expected that the regulations will allow firms to sell excess power to unrelated parties and to "wheel" excess electricity across the grid for a fee.

In South Africa, coal production and energy generation are geographically concentrated in the Mpumalanga province. The province faces a multitude of socio-economic and environmental challenges, including high levels of unemployment, inequality and poverty as pressure mounts to transition away from a coal-based economy. The Mpumalanga provincial government has been proactive in exploring opportunities to transition the region to a labour-absorbing green-focused economy, hence creating a positive loop between green transition and job creation. Among the many opportunities, the government is focusing on repurposing land on ultimately decommissioned mines and coal-fired stations to pivot to renewable energy production, utilizing the existing transmission assets in the region. Alongside the repurposing opportunities, the government is also interested in specific investment opportunities in the agricultural sector, where a large segment of the population works. Sector-specific opportunities include: renewable energy applications, regenerative agriculture, controlled environment agriculture, smart farming and precision agriculture, and agri-waste management. The Mpumalanga Green Cluster Agency was created to capture such opportunities and coordinate efforts among businesses, government, academia and civil society in the direction of a just transition. By supporting these stakeholders, the agency aims to facilitate more investment and stimulate job creation in Mpumalanga's green economy.

Source: Based on Andreoni et al. (2022) and https://mpumalangagreencluster.co.za/.

Furthermore, public procurement can set the standards and regulatory requirements (on, for example, emissions, performance targets, energy intensity) under which the products and technologies are both produced and deployed. Standard-setting is of central importance not simply because it can be used to shape the emerging markets and industry; it is also central to coordination among innovation and technology investments (Blind and Thumm 2004).

Technology services and access to infra-technologies (such as data, prototyping and metrology systems) also matter greatly in the scaling up of a decentralized and more resilient energy system (see Box 4.4 for the case of the United Republic of Tanzania). Manufacturing extension services can help small and medium-sized firms to adopt sustainable manufacturing processes and technologies along sectoral value chains.

BOX 4.4 THE UNITED REPUBLIC OF TANZANIA'S DIFFUSION OF RENEWABLE ENERGY TECHNOLOGIES

Sub-Saharan African countries are among the most electricity-deprived countries in the world. The lack of sufficient electricity generation results in large segments of the population – especially in remote areas – being deprived of reliable and affordable electricity. In urban areas the increasing population has also brought new pressures on the existing capacity and electricity infrastructure. Despite some notable progress in some countries since the 1990s, governments have been facing mounting pressure and trade-offs, including: the need to increase access while keeping electricity affordable through subsidies; managing stranded electricity generation assets such as coal plant (and related powerful interests) while investing in scaling up renewable energy technologies; and leveraging domestic investments and meeting international private investors' conditions for developing electricity generation capacity.

Electrification has sped up over recent years, and ambitious plans have been confirmed by the Tanzanian government. The United Republic of Tanzania is expected to more than double its energy needs by 2040, and these needs will need to be met with a different mix of energy generation technologies. Increasingly the lowest-cost option is wind or solar. The average levelized cost of energy (LCOE) for utility-scale solar photovoltaic and onshore wind is now often below gas (average LCOEs being US$56 per megawatt-hour (MWh), US$50 per MWh and US$71 per MWh, respectively, according to IEA and Nuclear Energy Agency (NEA) (2020) projections), and records for lower electricity pricing from solar and wind projects fall every year (CDC Group 2021). Furthermore, off-grid or micro-grid renewable energy solutions – most notably, solar energy options – provide a viable alternative source of electricity and opportunity to continue improving both access and connectivity for regions facing the risk of disconnection from the grid via transmission infrastructure degradation. The implementation of such decentralized alternative infrastructure will require localized offices and expertise, employing local labour to maintain the equipment and thereby providing new economic growth and employment opportunities for those dwelling in rural areas. Off-grid or micro-grid solar can accelerate the roll-out of geospatial network expansion plans by establishing forward hubs of supply that delayed transmission infrastructure may later hook into.

Source: Based on Andreoni et al. (2021).

6. CONCLUSIONS

Over the last decade, and in particular since the Paris Agreement, climate change has taken central stage in governments' policy agendas. Furthermore, governments have become increasingly aware of the importance of coupling the decarbonization agenda with job creation. Nevertheless, despite several rounds of international negotiations and commitments at Conferences of the Parties, progress has been slow and in some cases countries have regressed and scaled down their ambitions in the face of new challenges. Much more investment in and widespread deployment of green industrial policy instruments are needed to transform the energy sector and move other carbon-intensive sectors towards more environmentally sustainable pathways.

In this chapter we have found that countries have been struggling to improve their environmental sustainability while creating jobs. Although several factors contribute to job creation dynamics, more sustained investment in green sectors and jobs could have both a direct and multiplier effect across the economy. There is increasing evidence that several windows of opportunity for job creation are associated with renewable technologies as well as with green technologies for sustainable mobility.

Windows of opportunity for green jobs are opening too slowly, however. Well-coordinated packages of green industrial policies are needed to ensure that investments are directed and coordinated, new green markets and infrastructure are created and companies are able to operate more sustainably. There are several country experiences across the Global South of more or less successful implementation of green industrial policy instruments. We have looked at the experience of a few of them in relation to the most well-known and used policy instruments: green taxes (Chile), public finance (Thailand), public procurement (South Africa), and technological services to support renewable energy uptake and training for green jobs (the United Republic of Tanzania).

No policy instrument alone is sufficient, especially when countries want to couple decarbonization and job creation. I have emphasized how packages of well-aligned policy instruments and conditionalities can have a more transformative impact at the sectoral and cross-sectoral level. Taking such an approach to green industrial policy means considering the overall structural transformation of the economy and going beyond only the creation of direct green jobs. Ultimately, in a transformed economy, all jobs should be sustainable. It is essential to create new jobs and retrain workers in order to move towards this scenario.

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5. Avoiding the decent work deficits of the circular economy

Anna Barford

1. INTRODUCTION TO A (SHRINKING) CIRCULAR ECONOMY

The circular economy is an apparently simple concept, standing in contrast to today's dominant linear mode which extracts raw materials, makes products, uses them and then disposes of these items. Circularity connects the two ends of this linear model – creating a loop – so used materials become an input for another process. The benefits include lessening demand for virgin materials, reducing waste and reducing carbon dioxide emissions. As with many apparently simple concepts, complications arise when the concept is applied to the real world. At present, many industries remain heavily invested in linear models and throwaway consumption is built into many people's lives.

Mainstream circular economy thinking focuses on material flows. In recent years, considerable media and public attention has been paid to materials, especially to electronics and plastics. Electronics present challenges and offer opportunities. The highly polluting impacts of e-waste and its valuable components create a pressing need for circularity (ILO 2019a; Lundgren 2012). Meanwhile digitalization could enable greater circularity through providing information on product availability, location and condition (Antikainen, Uusitalo and Kivikytö-Reponen 2018; Daum, Stoler and Grant 2017).

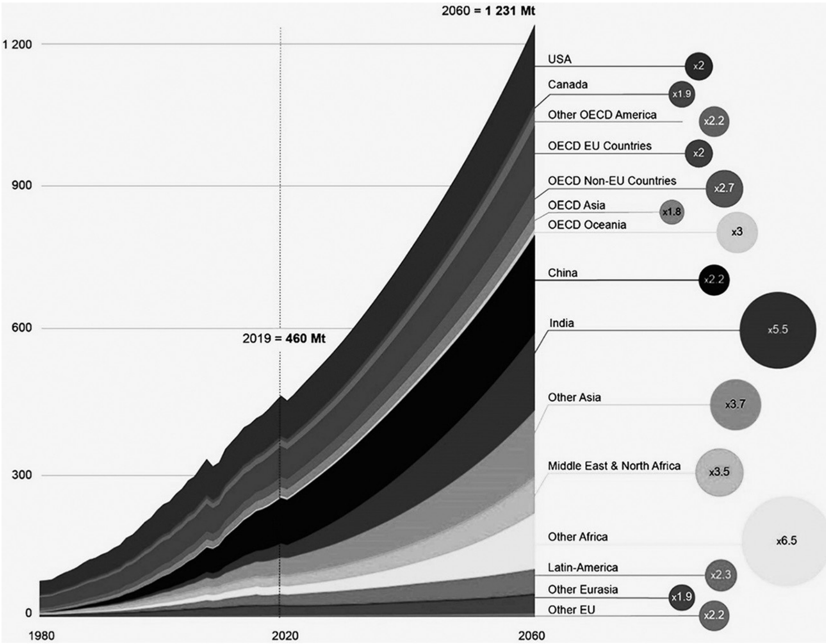
Acknowledging the enormous breadth of circular possibilities, including for biologically based and human-made materials, this chapter focuses on plastics, which in and of themselves present an enormous challenge. To underscore the magnitude of the plastics problem: every minute, an average of 1 million plastic bottles are purchased (United Nations Environment Programme (UNEP) 2023). This situation seems set to escalate further – with plastic use and plastic waste forecast to roughly triple between 2019 and 2060 (Organisation for Economic Co-operation and Development (OECD) 2022).

Circular economy responses to this challenge, as eloquently described by Nancy Bocken et al. (2016), could alter resource flows to reduce waste. This principle could be applied to plastics. Firstly, the volumes of plastic could be *reduced* – for instance by making thinner plastic packaging. Secondly, plastic usage could be *extended*. Examples such as durable “bag for life” shopping bags and refillable plastic containers shift plastics from being single use to multiple use. Thirdly, the loops need to be *closed* so that, instead of being landfilled or incinerated, plastics are recycled to become entirely new items. When possible, using these approaches together is optimally efficient.

The various types of circular economy responses are not equal. Efficiencies come from material cycles operating over small distances (Desai and Riddlestone 2002), making it easier to save energy and maintain value. This entails prioritizing reuse (with repair when needed) over recycling. Durable and repairable products, such as the modular mobile phones produced by Fairphone, fit this bill. Sharing – including through rental arrangements, public transport and publicly owned goods such as library books – has the potential to reduce total material use. Another option is dematerialization, observed in the shift from material DVDs and CDs to streaming services. Although popular and widespread, recycling is a generally less ambitious form of circularity owing to the energy demands of collection and processing, the need to mix in new materials and the tendency of materials to lose value during this process (Webster 2021; Ellen MacArthur Foundation 2015). This leads to the view that “Circular initiatives to date have been too narrow to deliver substantial benefits, with their focus mainly on recycling and waste management and considering circularity as an end goal on its own” (World Economic Forum (WEF) 2023, 7).

Each year the Dutch think tank Circle Economy announces what proportion of the global economy is circular. Increases in raw material extraction have led global circularity to shrink from 9.1 per cent in 2018 to 7.2 per cent in 2023 (Circle Economy 2023). This means that the rise of new circular economy endeavours has not kept pace with rapid increases in material use (Figure 5.1). It is worth noting that sustainability considerations and, within these, circular economy goals, are increasingly guiding industrial commitments and subsequent industrial transformations (Barford and Ahmad 2022). Yet, despite working towards circular economy solutions over many years, governments and businesses often face challenges concerning policy and regulation, systems-wide partnerships and business models. This has led to calls for a systems-wide approach to move from disparate “circularity” activities to a “circular transformation” of the global economy (WEF 2023).

Despite the issues outlined above, circular economy activities could offer significant environmental benefits. Firstly, an estimated 45 per cent of global greenhouse gas emissions are associated with material products – emissions that circularity could reduce (Ellen MacArthur Foundation 2021). Secondly,



Note: Plastic use is stated in millions of tonnes (Mt). The multipliers in the circles to the right show regional growth in plastic use from 2019 to 2060. Both plastic use and plastic waste are expected to roughly triple during this period. It is projected that, by 2060, 50 per cent of this plastic will go to landfill, 18 per cent will be incinerated, 17 per cent will be recycled and 15 per cent will be mismanaged.
Source: OECD (2022, Figure 1.3).

Figure 5.1 Projected plastic use up to 2060 using the "baseline scenario"

more efficient material use offers localized benefits such as reducing toxic air pollution from the burning of plastic waste and forestalling problems such as flooding from plastics blocking river channels or animals inadvertently choking on plastic (Verma et al. 2016; Barford and Ahmad 2022). Plastics in watercourses and waterbodies also harm aquatic life (United Nations Educational, Scientific and Cultural Organization (UNESCO) 2022). As human life and work rely upon the environment, these environmental considerations are highly relevant to employment and livelihood.

Circular models of production and consumption can help to tackle contemporary challenges caused by an excess of plastic waste. However, it is crucial that moves towards greater economic efficiency and a greener economy also explicitly address how these changes will influence people's working lives.

This chapter discusses work in the circular economy, before focusing on working conditions specifically in low-paid, informal jobs within the recycling circular economy. The chapter then contrasts the increased attention to materials with the relative silence about labour, arguing for the need to improve working conditions while growing the circular economy. To illustrate existing efforts to achieve this goal, three examples are shared from Haiti and Uganda. The chapter concludes by positioning decent work as a prerequisite for successful circular economies.

2. WORK IN THE CIRCULAR ECONOMY

For practitioners and scholars concerned with work and employment, many questions arise about what the circular economy may offer. How many new jobs could a circular economy create? Which jobs will be lost as linear production is phased out, and what types of new jobs may arise? There are also questions about distribution: who would get the new jobs and who would not? And are these new jobs likely to be formal and properly paid, or is there a risk that working conditions will be poor or even dangerous, and pay low? Various models and predictions offer scenarios for this potentially enormous shift, yet the precise forms of future circular economies are yet to be seen. Large gaps remain in the literature on work and the circular economy, especially given the current bias towards researching the Global North. Sub-Saharan Africa, Eastern Europe, and the Middle East and North Africa are often overlooked (Circle Economy, International Labour Organization (ILO) and S4YE 2023). To date, research has also tended to focus on the number of jobs but not their quality, there being limited work on occupational safety and health, and little work on the informal sector despite its importance to the circular economy in many countries (Circle Economy, ILO and S4YE 2023).

At the time of writing, in 2023, in a 7.2 per cent circular economy world, much of our understanding of what future circularity offers comes from models, theory and conjecture. Some of what is known comes from the sometimes-novel, sometimes-traditional activities that are circular by design. Projections suggest that many of the new circular economy jobs to be created will be in waste and renewables, with job losses expected in mining and manufacturing (ILO 2018, 51–52; Chewpreecha 2019). There remain considerable uncertainties about how new forms of circularity will play out. Unnada Chewpreecha (2019) explains that some models overestimate the actual number of new circular jobs because they fail to account for lost jobs in other sectors and because business processes are meanwhile changing. For example, although many new jobs are expected in waste management, this sector is being automated and so some jobs that might be expected are being designed out. Overall, however, a job-rich, green and just transition offers one way to contribute to countries' nationally determined contributions to cutting greenhouse gas emissions (ILO 2022a).

Beyond the new paid jobs associated with the circular economy, there are plenty of unpaid domestic activities associated with repair, reuse and recycling. Compared with the "convenient" purchase–use–dispose model, in many contexts the minimizing of materials' consumption involves extra work and organization. For instance, household-level refillable containers in the UK require the washing and storing of empty bottles and jars, with periodic visits to a refill shop to replenish supplies. Khaled Soufani, of the University of Cambridge's Judge Business School, recounts his grandmother reknitting the same wool multiple times so that his jumper grew with him, eventually becoming a tank top when there was no longer sufficient wool for the arms. Repairing an item can be much more time consuming than buying a brand new one, and any savings may be minimal. Given that, worldwide, much unpaid domestic work falls to women (Addati et al. 2018), it is likely that women will continue to cover many unpaid circular economy tasks in the future.

The challenge of engaging people, or "consumers", in circular economy activities is often cited as a barrier to rolling out circularity. One break in a circular flow can lead to leakage of materials, potentially negating the careful handling of materials elsewhere in a cycle. However, at times, consumers become scapegoats for an immature circular economy infrastructure. In the Karamoja subregion of Uganda, a full day's drive from the capital Kampala, post-consumer plastics cluster at roadsides and along the riverbanks of the town of Moroto. Fast-moving consumer goods companies and their supply chains are adroit in distributing products to remote locations, but meanwhile there is little in place to manage the resultant waste. Without recycling or other circular options available, and with the low value of plastics rendering the transportation of waste back to recycling centres unprofitable, Moroto faces mounting plastic waste.

Given the problems and challenges associated with plastics waste, there is a growing drive towards circular economy commitments among incumbent and new companies. To date, a great deal of this activity is concerned with one of the less ambitious and least disruptive forms of circular economy: recycling (Barford and Ahmad 2022, 2024). To date, a great deal of this activity is concerned with one of the less ambitious and least disruptive forms of circular economy: recycling (Barford and Ahmad 2022). The next section considers the characteristics of waste work within the recycling circular economy.

3. WORKING AT THE BASE OF THE CIRCULAR ECONOMY PYRAMID

Many contemporary circular economy interventions focus on transitions towards recycling (Barford and Ahmad 2022). The hierarchical roles within the recycled plastics supply chain are characterized in Figure 5.2. Although the set-up varies with context – according to local infrastructure, institutions and regulations – materials typically pass through the hands of several key groups. Firstly, waste pickers collect and sort materials, often in dumpsites or sometimes from outside homes or businesses. This work is the lowest paid and the material is usually at its lowest value at this point. Waste pickers then sell the collected materials to waste collectors, who sell it on to middle agents, who take it to recycling plants for processing. As the plastics move along this chain their value increases, and earnings and working conditions also improve. Ultimately, recycled plastics are incorporated in some new product or packag-

Note: This figure is based on studies from Colombia, India, Indonesia, Kenya and South Africa.
Source: Barford and Ahmad (2021).

Figure 5.2 Hierarchy of plastic recycling

ing – such as a shampoo bottle, trainers or even a bench (Barford and Ahmad 2021).

Although advances are being made to put waste materials back into use, the workers handling these materials are largely overlooked. Some materials are visible and traceable owing to indelible branding. This branding has enabled public media campaigns, such as those of Greenpeace, which demand greater corporate responsibility for plastic waste. Meanwhile, the most disadvantaged workers in this chain – with low wages, poor working conditions and informal conditions – have much less visibility. For female waste pickers on the outskirts of the city of Jinja, Uganda, it takes several days to collect and sort a large sack of plastics that can be sold for less than US$2 (Figure 5.3). With bare hands and often flip-flopped feet, women sort and collect waste for recycling, pulling items from an assortment of domestic and industrial rubbish. Such outcomes are part of today's multifaceted circular economy.

Academic studies of the lives and working conditions of waste pickers in Brazil, Indonesia, Nigeria and South Africa confirm that these observations from Uganda are part of a wider trend (Table 5.1). Waste pickers form a sizeable group – estimated to be 11 million people globally – and handle 58 per cent of plastics collected for recycling (Cook and Velis 2021). They thus play a crucial role in the recycling circular economy. Despite their numbers and contribution to recycling, waste pickers typically work in difficult conditions (low wages, no social protection, informal) and often face occupational safety and health hazards.

Major health risks to waste pickers include accidents (for examples, fires, falls, truck accidents, or cuts from sharp items), infection (for example, from waste, infected wounds or animal bites), chronic disease (for example, respiratory diseases or heat stress) and exposure to toxic or contaminated items (Al-Khatib, Al-Sari' and Kontogianni 2020; ILO 2019b). The ILO's Working Environment (Air Pollution, Noise and Vibration) Convention (No. 148) and Recommendation (No. 156), 1977, require the reduction and/or management of exposure to harmful air pollution, noise and vibration. To date, the convention has been ratified by 48 countries, and only three countries have not submitted to the recommendation, which includes the self-employed (ILO 1977a and 1977b).

In the context of growing political and business momentum for circularity, and the strong focus on materials, the relative silence around working conditions is surprising. The circular economy principles of regeneration and rejuvenation might helpfully contribute to this lacuna when underpinned by the principle that labour is not a commodity (ILO 1944). This could help to address the fact that the people doing waste-picking work often have low social status in their communities. Low social status can be reinforced and compounded by doing work that is undervalued.

Note: Notice the large bags of sorted plastics, which take several days to fill.
Source: Author's photograph, taken with permission.

Figure 5.3 Waste pickers and their sacks of sorted plastic, Uganda

Table 5.1 Informal waste collection in four countries

Country	Contribution to recycling (percentages)	Working conditions	Worker characteristics
Brazil	90	Lack of equipment; earnings below minimum wage; price variations; exploitation; homelessness	40 per cent illiteracy or incomplete primary education
Indonesia	86 (paper) 8 (plastics) (in Bandung)	Hazardous medical waste; no potable water	Mainly young people and children; 99 per cent of unpaid waste pickers are women
Nigeria	80 (in Lagos)	Poor living conditions; low wages; no boss	Low-level education; low social status
South Africa	80–90 (paper waste and packaging)	No social protection; crowded living; poor hygiene; women earn less than men	Viewed largely as "invisible"

Note: Owing to difficulties collecting reliable data about waste pickers, there is a tendency to undercount (Bonner and Carré 2013).
Source: Adapted and updated from Barford (2020), drawing upon the following sources: Godfrey, Strydom and Phukubye (2016); International Alliance of Waste Pickers (IAWP) (2008); Mbah et al. (2019); Mkhize, Dube and Quazi (2014); Nzeadibe and Iwuoha (2008); Rutkowski and Rutkowski (2017); Samson (2020); Sasaki et al. (2014); Sembiring and Nitivattananon (2010).

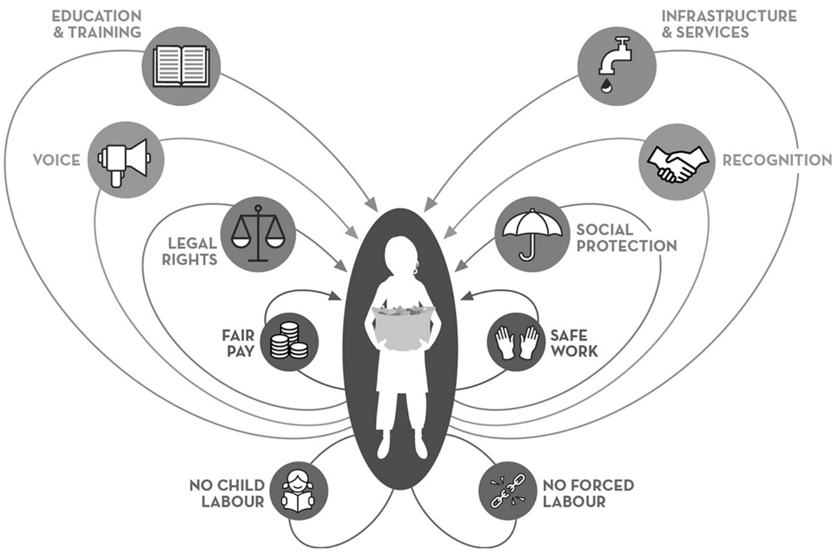
4. APPLYING THE PRINCIPLES OF CIRCULARITY TO LABOUR RELATIONSHIPS

The circular economy is currently under construction. Within this transitional building phase are a plethora of vested interests, profits, losses, some greenwashing, and of course some mistakes associated with innovation and experimentation. Also in the mix are workers who face difficult working conditions; workers who stand to lose work (for example, coal miners in Mpumalanga, South Africa); and other workers who mine rare earth metals to support the dominant technology-enabled and high-consumption pathway to circularity. Other transitional work involves building new infrastructure and designing new circular processes. All of this exists in a wider context of 73 million young people worldwide being unemployed, with many more who are underemployed but seeking to make a living in an increasingly disruptive climate (ILO 2022b; Barford et al. 2021). To build greater societal resilience, decision-makers might consider how to build the principles of social and economic restoration, rejuvenation and redistribution into emerging circular economies.

The circular economy could take various forms, ranging from a socially and economically extractive and exploitative mode, to a restorative and regenerative mode. A socially just circular economy would enable people to meet their basic needs – most likely through a combination of wages and other income, social protection, basic incomes, shared ownership and market provision. At present, market provision is rapidly developing, including by moving towards rental models in which people sign up for long-term loans (for example, for vehicles and light bulbs) or shorter-term loans (for example, for apparel). Such provisions may mean signing up for ongoing payments – which can smooth business incomes but possibly reduce individuals' control over their own spending. If circular economy developments continue to revolve around market provisions, attention will be needed to bridge any gaps in access that stem from widespread poverty and persistent inequalities.

The provision of decent work, including establishing living wages as a minimum, is a standard that could be built into new circular economies. After all, if we are approaching a major transition towards a circular economy, why not build in social and economic justice at the same time? An environmentally sound but socially unjust economy would be only a partial success. The provision of adequate wages or living wages is essential to sustaining decent living standards (Reynaud 2017; ILO 2022c). Alongside the human rights, social justice and well-being case for improving wages, there is a business case to be made. With living wages – which provide sufficient income for a family to meet their health care, education, water, housing and food needs – wider benefits can be found in core operations, supply chains and the wider operating environment (Barford et al. 2022). The implications are potentially transformative, since higher wage costs become investments in the workforce rather than financial losses.

Core operations can be strengthened through establishing the living wage as a new wage floor (Barford et al. 2022). Benefits include reduced sick leave and higher worker retention, and workers being better rested and more motivated. When organizations extend living wage commitments beyond direct employees and into supply chains, similar benefits can be replicated along these chains, leading to improved supplier performance, reduced pay disputes (reducing the costs of disruption and time spent negotiating) and greater predictability and resilience. Lastly, the wider operating environment includes tangibly addressing working poverty and thereby contributing to greater social cohesion and boosting employers' reputations and their social licence to operate. As with environmental responsibility, consumer pressure and expectation play a role in encouraging early adopters to voluntarily adopt such standards. Regulation and enforcement offer more systematic ways



Source: Barford and Ahmad (2021), inspired by Ellen MacArthur Foundation (2019a and 2019b) and the ILO definition of "decent work" (ILO 1999).

Figure 5.4 A socially restorative butterfly for the circular economy

to shift business incentive structures towards living wages, for example by raising legal minimum wages to living wage levels to ensure the latter have broad coverage.

Inspired by the Ellen MacArthur Foundation "butterfly" of the circular economy, with its focus on technical and biological flows, Figure 5.4 describes key social considerations for the circular economy. Extending circular economy thinking to a model that is less extractive, depleting and wasteful requires a discussion about decent work and the labour relationship. The socially restorative butterfly of the circular economy identifies key components of decent work (ILO n.d.) to suggest how each component could reinforce individuals' economic security, legal position and well-being. While achieving improvements in any of these components is likely to bring some benefits, their collective impact is even greater.

Decent work can be tricky to operationalize (Piasna et al. 2017) – in part because of its many component parts, the shared responsibility, and the many scales at which changes need to occur. The trickiness of operationalizing decent work is illustrated by Brendan Burchell's driver–car–road analogy (Piasna et al. 2017). Personal features relate to the driver, or worker. For a driver: are they old enough to drive, a licence-holder and sober? For a worker: is this child labour or forced labour? The immediate environment relates to the car, or workplace. Is the car roadworthy? Is the workplace safe? Are workers listened to and paid fairly? All this occurs within the wider road environment, or wider context. Is the road in good repair, with functioning traffic lights, and are the rules of the road properly upheld? For work: what is the legal context and are services and infrastructure functioning and accessible? This multilevel responsibility for decent work and the dispersed authority to instate change involve many actors.

Designing and building a circular economy requires a great deal of collaboration, coordination and change. Alongside the focus on material flows, a parallel and complementary focus is needed to establish and sustain decent work throughout circular economy supply chains. This is a question of human rights and social and economic justice, and, as discussed above, there are business benefits from treating workers properly. Unless decent work exists throughout supply chains, circular economy businesses risk more days of sickness, worker fatigue, unstable supply chains, and reputational hazard. Some of this risk was highlighted during the early stages of the COVID-19 pandemic in South Africa, where waste pickers lacked the rights and protections afforded to other essential workers, were locked out of waste sites and excluded from government support. Thus, people on very low incomes were prevented from working but denied alternative support; meanwhile their collection and sorting provide material inputs for production, saving South African municipalities roughly US$41.7 million per annum (Samson 2020 and 2021).

5. BETTER WORK IN A RECYCLING CIRCULAR ECONOMY

In the aftermath of the COVID-19 pandemic, which laid bare the pre-existing precarity of waste-picking and many other forms of work (Barford et al. 2024), this section focuses on two organizations creating more decent and inclusive work for waste pickers, and an example of a young entrepreneur. Semi-structured interviews were used to understand better how people from organizations working with waste pickers were addressing certain decent work deficits associated with the recycled plastics supply chain. In an industry often characterized by systemic, intersecting and compounding disadvantages, the interviews revealed how change can occur. Although these case studies of work in Haiti and Uganda do not illustrate full resolution of all decent work challenges, they demonstrate proactive engagement in a wider context in which waste pickers often have to fend for themselves (see ILO 2019b for examples of waste picker movements).

Two of the three examples discussed below are organizations that have started to handle post-consumer plastic waste in countries without formalized recycling systems. As mentioned earlier, sizeable influxes of plastics without a system to handle them pose tangible dangers. Although considerable media attention has been given to the crisis of ocean plastics, there are also disastrous land-based impacts. In particular, the burning of plastics, often in low-income communities, produces toxic fumes resulting in illness and sometimes death. An estimated 400,000 to 1 million deaths per year are caused by mismanaged waste, which can lead to deadly diseases such as malaria, diarrhoea, cancer and heart disease (Tearfund et al. 2019). The following examples – EcoBrixs and First Mile – respond to this by addressing environmental challenges while proactively improving working conditions (see also Barford and Ahmad 2024).

EcoBrixs began in 2017 in the city of Masaka, Uganda, with aim of addressing the twin challenges of huge volumes of plastic waste and insufficient work by starting a recycling centre (EcoBrixs 2023). The materials, machinery, markets, health benefits and funding are crucial parts of the story of EcoBrix's closed loop model – which began by recycling plastics into paving "stones", chairs, fence posts and plastic bricks. For workers, EcoBrixs modified typical informal waste collection systems to improve working conditions. Many waste pickers in Uganda face unpredictable pricing for collected plastics (when oil is cheap, virgin plastic is cheap and so plastics recycling becomes uneconomical). EcoBrixs commits to greater price stability and fairer prices. A uniform and personal protective equipment are provided, which have improved safety and generate pride in what is often stigmatized work. As a result, people now approach EcoBrixs for work. EcoBrixs also seeks to create work for disadvantaged groups: 50 per cent of their plastic collection network is managed by people living with disabilities.

First Mile began in Haiti when one of its founders visited Haiti in 2010 and witnessed the plastic waste problem. Haiti, one of the poorest countries in the world, has been struck by a series of natural, political and health-related disasters (Farmer 2012; Smallman-Raynor, Cliff and Barford 2015). First Mile took a whole-system approach, identifying a buyer for recyclable plastics before collection began. Over the years, they have teamed up with a host of partners, mainly clothing companies, but also banks and computer hardware companies (Brain 2020). Having identified a supply and found buyers, First Mile recruited people to collect plastic. The initiative's whole-system approach addresses workers' readiness to work, including by ensuring that their household can access health care, their children are in school and their accommodation is secure. The workers then undertake some training before they begin work. The programme ensures ongoing access to health care and education, funded by the employer. Given the priority of meeting workers' ongoing needs, recruitment is somewhat cautious, to maintain financial stability and reliable services for those involved.

Source: Author's own photograph.

Figure 5.5 *Used plastic bundling straps that can be woven into handbags*

Both examples above involve international collaboration – with organizations that engage on the global stage with major brands, UN organizations, and NGOs. The last example we shall look at involves smaller-scale work done locally. As young people in Uganda seek work, in a context where entrepreneurship is widespread and encouraged, especially given the scarce opportunities for formal employment, some turn to green jobs. One young woman learnt to weave handbags out of the discarded plastic bundling straps heaped up at the nearby dumpsite (Figure 5.5). She sold these bags for profit, so benefiting from these free and plentiful raw materials. Like many other informal entrepreneurs, she is unlikely to have benefited from wider social protection, legal rights, income security or other hallmarks of decent work. Nor is she likely to have received micro-enterprise support, such as business development and financial services. Nevertheless, she was adding value to plastic waste while also working in safer conditions and with more autonomy than many waste-pickers.

The examples of EcoBrixs and First Mile show how some organizations are successfully designing social concerns into circular economy business models. In both cases social concerns are integral to the values and processes of these enterprises, and tackling social injustice alongside environmental challenges was a founding principle for both. Both were also enabled by the international collaborations they were able to set up. The example of young entrepreneurs in Uganda complements these examples by showing how many young people are obliged to create their own work and contribute to circular economy practices, but with little of the stability, security or services offered by more formalized models.

6. LOOKING AHEAD TO A BETTER CIRCULAR ECONOMY

In March 2022, the United Nations Member States endorsed a resolution to "End Plastic Pollution" and develop a legally binding global agreement by 2024; the circular economy is central to achieving this. The United Nations Environment Programme (UNEP 2022) notes that the circular economy offers a potential 55 per cent reduction in virgin plastic production, which could save governments US$70 billion (by 2040) and create 700,000 new jobs. An equitable circular economy nevertheless faces a swathe of barriers. Some of these are regulatory barriers, which often involve unambitious targets and irregular enforcement (Bening, Pruess and Blum 2021); other barriers concern the deeply embedded decent work deficit that troubles both the circular and linear economies.

The message of this chapter is that, as new pathways towards a more circular economy are found, it is crucial that people are given consideration alongside materials in this evolving system. In already existing versions of the circular economy, examples of ongoing poor pay, minimal rights and dangerous work are readily identified. Such conditions are observed among people who are performing essential work that supports local and global environmental improvements. Stronger circular systems could prevent much post-consumer plastic waste landing on the world's dumpsites and would be accompanied by guarantees of recycling work being safe, respected, protected and well remunerated. The green economy could also contribute to job creation, especially for young people, who as a cohort are often disadvantaged relative to mature adults in the labour market (ILO 2022b).

Decision-makers seeking to promote a job-rich circular economy, founded on the principles of decent work, have a deeply important task ahead. If it is done well, it could lift some of the poorest workers out of poverty while substantially improving the local environment and mitigating climate change. First Mile demonstrates how change is possible through successfully linking the environmental and social sustainability agendas of multinationals to recyclable materials collected in Haiti, and committing to health care and education paired with proper pay and safe work. Reinforcement is needed from wider international trade offering new opportunities for the harmonization of standards, expanding certain types of trade, such as trade in materials for recycling, secondary raw materials, second-hand goods, and goods for refurbishment and remanufacture (Yamaguchi 2018).

Governments could support waste pickers by formally recognizing their occupation while also granting legal identities to waste pickers and their organizations (ILO 2019b). Governments can also introduce policies that shift examples of better practice from being the exception to being the norm. Legislation and regulation regarding the quality of jobs – including in the informal economy and among the self-employed – could raise the standards of working conditions. Socially just circular economies are a cornerstone of the urgently needed just transition towards environmentally sustainable economies and societies for all. It is imperative that greater attention be paid to the details of how to ensure that socially just circular economies are achieved – and examples of good policy and practice should be shared widely.

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6. Services and the green transition in developing countries

Patrik Ström

1. INTRODUCTION

Today, the services sector constitutes the largest component of the economy in advanced economies around the world. Among the Organisation for Economic Co-operation and Development (OECD) economies, the services sector contributes approximately 65 to 85 per cent of both gross domestic product (GDP) and employment (OECD 2020 and 2024).

Over recent decades, the importance of the services sector's contribution to growth and employment has also increased in numerous low- and middle-income countries. In these economies the contribution of services to GDP has averaged around 50 per cent over the last 20 years (World Bank 2023). However, substantial regional disparities often exist, and urban areas (often the capital region) are more closely linked to the global market than is the rest of the country (Alvstam, Ström and Wentrup 2016). These economic and geographic disparities also result in differences in the structure of the economies. Countries with robust connections to the global market through services trade tend to possess a broader industrial base and a more modern services sector. Conversely, in other developing countries with limited international connections, non-traded and traditional services are more prevalent.

In the dynamic and fast-growing economies of Asia, which underwent rapid post-war economic development primarily driven by manufacturing industries, services are regarded as the next pivotal aspect of the economy in which to sustain regional and national growth (Asian Development Bank (ADB) 2012; European Commission 2018). However, the transition to a services-led growth model in developing countries, coupled with the goal of a green transition, presents intricate challenges. Many developing countries contend with low-productivity services involving extensive low-paid and informal work, which pose a substantial obstacle to these countries moving up the value chain and thereby achieving sustained welfare enhancement.

In advanced economies, the growing significance of services in relation to goods production through servitization – encompassing the convergence of goods and services – has emerged as a key element of competitive advantage in value chains and production networks (Raddats et al. 2019). This evolution has been driven by trade liberalization and the facilitation of foreign direct investment (FDI) by the globalization of resources, financial markets, and knowledge.

In numerous developing or emerging market economies, a similar development trajectory is observed, driven not only by enhanced economic integration but also by technological advancement. The increasing ability to deliver services via the internet has rendered broadband access an indispensable tool of economic growth and productivity. However, the availability of broadband can vary significantly. For instance, countries like the Republic of Korea that adopted fixed broadband infrastructure early on could leverage this advancement not only to develop digital services but also to upgrade services within the manufacturing sector. In less developed countries, recent investments in mobile broadband have opened up new avenues for domestic digital services. Nevertheless, the pace of this transformation varies considerably according to the degree of connection to the global economy and the configuration of the industrial base.

In parallel with the economic development of the past few decades, there has emerged increasing awareness of the escalating negative repercussions of climate change. The global economy is currently grappling with the task of facilitating a green transition in both advanced and developing economies, and the demand for broader advancement of a sustainable or green economy has been steadily gaining momentum. What originated from the Brundtland (1987) report on sustainable economic development has evolved into demands for policy enactment and into mounting pressure on the private sector to engage more comprehensively in sustainability. The green economy aims to foster growth while avoiding detrimental impacts on the environment (United Nations Environment Programme (UNEP) 2011, 3). However, the notion of the "green economy" has not escaped critique; some are instead advocating "degrowth" (see Gibbs 2020). The concept has, moreover, been examined through different lenses in advanced economies and the Global South (see Murphy 2024). This divergence in perspective underscores the variances – within and among academia, non-governmental organizations, and policy spheres – on appropriate pathways towards economically, socially and environmentally sustainable societies. Nonetheless, the setting of a carbon dioxide limit by the Paris Agreement has bolstered political commitment (United Nations (UN) 2015a and 2015b).

Against this backdrop, the global economy is now confronted with a dual challenge. On one hand, economic growth remains imperative for both advanced and developing economies in order to sustain and establish the foundations for job creation and well-being. The services industry, through its large share of the total economy in both advanced and developing countries, will play a pivotal role in enabling such progress. On the other hand, growth must be ecologically friendly and sustainable, and this necessitates the curbing of detrimental environmental practices. Industrial trajectories that once propelled economic advancement in developing economies can no longer be emulated (see Chapters 1 and 2). Novel pathways must be charted to address these twin challenges.

This chapter delves into the prerequisites for a services-led green transition in the context of industrial reconfiguration and development in developing countries. The analysis takes a granular approach, focusing on subsectors within the services sector, and their geographical distribution and economic integration. This granular perspective encompasses the broader definitions utilized in the services sector, without singling out any specific subsector. The intent is to examine the horizontal issues that interconnect these subsectors, rather than to isolate them. This pertains to the methodological challenge of categorization and definition within the services sector for the purposes of policy analysis (for example, European Commission 2014).

The potential influence of services in driving the green transition will be explored alongside the challenges of bolstering competitive advantage in developing economies. The objective of this chapter is to advance the argument that services can be interlinked with sustainable development. It acknowledges that numerous subsector services are low-productivity activities, often undertaken in the informal economy – traditionally difficult to measure in real economic terms. Nevertheless, the chapter's focus is on services that can either be part of or contribute to a green value chain and thereby help to effectuate a lasting shift. Consequently, the discussion primarily revolves around producer services, or what are sometimes denoted as "business services". Services with substantial digital content targeting consumer markets are also examined. The discussion involves the burgeoning concept of services content associated with manufactured goods and the potential for cross-border services delivery.

2. THE ROLE OF SERVICES

Over the past few decades, services have increasingly come to be recognized as indispensable to development. Countries that primarily fostered economic growth through manufacturing during the early stages of their industrial upgrading now view services as a natural progression. For example, numerous East and South East Asian economies have undergone rapid manufacturing-led economic development in the past five decades, and in these countries services are now playing a growing role (ADB 2012).

Multiple classifications of the services sector exist, often conceptualized in such a way as to facilitate the economic measurement of services, but also to reflect its heterogeneity. Some categorizations are tailored to specific studies or policy recommendations. For instance, a recent World Bank study (Nayyar, Hallward-Driemeier and Elwyn 2021) employs a classification that highlights service heterogeneity: global innovator services, low-skills tradable services, high-skills social services, and low-skills domestic services. The majority of developing countries have witnessed a structural shift in services which is characterized more by the growth of low-productivity sub-industries than by the growth of technology-intensive sub-industries. To enhance future competitiveness, structural transformation towards services with higher productivity potential is imperative.

Numerous issues concerning the internationalization of services trade and FDI are important to developing countries. For developing nations that have yet to integrate portions of their services economy into the global economic fabric, the challenges fundamentally involve cultivating domestic capabilities. This entails creating markets, enhancing technological capabilities and investing in infrastructure and education. This developmental process necessitates collaboration with and support from more advanced economies.

For developing countries that have managed to establish robust connections to the global economy, the overall configuration of production via global value chains (GVCs) and/or global production networks (GPNs) is important in terms of their potential to integrate, enhance and transform these countries' position in the global economy. As a greater portion of value-added content becomes subject to knowledge-based production or heightened servitization, it is becoming essential to find ways to anchor this economic activity in a wider industrial setting. Trade agreements, rules of origin, and other non-tariff barriers will also be important factors in determining developing countries' ability to connect with the international market. Moreover, for countries nurturing domestic services markets, the opportunity to extend market presence abroad could facilitate job creation, income generation and welfare enhancement.

Negotiations on trade in services will involve discussions ranging beyond more traditional topics related to trade liberalization and FDI. Tariffs have generally undergone broad reductions through negotiations in the post-war economy, within both multilateral agreements and regional free trade agreements (RFAs). When it comes to trade in services, the challenges have proven to be considerably more intricate. This is evident not only in advanced economies, where bilateral service-related negotiations pose difficulties, as in the suspended negotiations between the European Union and the United States on the proposed Transatlantic Trade and Investment Partnership (TTIP). Even within the single market, integrating services have posed challenges; it was only in 2009 that the "Services Directive" was introduced and implemented in all Member States (Ström 2020). Several subsectors that it was initially intended would be covered were excluded from the directive, including health care, gambling and some utilities. The introduction of the Services Directive also triggered a more comprehensive discussion on the functioning of the single market for services (see European Commission 2014).

In recent years, there has been a growing emphasis on services development in tandem with the broader transition towards the green economy. This convergence raises the question of how services and manufacturing can facilitate such a transition while concurrently enriching the circular dimensions of industry. A structural shift in which a larger share of GDP is generated through services will not be enough to sustain future economic development, but it will be one means, in combination with manufacturing, of facilitating a green transition of the economy.

3. SERVICES AND THE GREEN ECONOMY

Services could play a substantial role in the green transition (see Jones et al. 2016). Critically, services can act as intermediaries between industries, imparting knowledge to make industrial processes more environmentally sustainable. This competitive advantage has been effectively harnessed by service providers in the consulting sector. The cross-fertilization of industries thus emerges as a significant outcome of an expanding services sector.

The importance of services as a contributor to future economic and jobs growth extends beyond advanced economies. Even low-productivity services, which are prevalent in developing countries, can support the trajectory towards a green economy. However, in the globalized economy, it's imperative to consider the interconnectedness of industries geographically. This brings us to two pressing questions about services and the green transition in developing countries. First, how can developing countries sustain economic growth and industrial upgrading while nurturing a growing services sector or fostering services value creation to generate welfare? Secondly, how can the services sector become a driving force of the green transition in developing countries?

Services can be positioned in relation to the green transition in several ways. Our discussion here draws from various conceptual and theoretical contributions to the literature, including the concepts of service-dominant logic (SDL) (Vargo and Lusch 2004), which frames services more inclusively; services ecosystems (for example, Sklyar et al. 2019), in which different actors interact at the junction of services with the broader economy and production chain; product–service systems (PSS), which take a broader perspective on the role of services in the value chain (for example, Annarelli, Battistella and Ninino 2016); and servitization (for example, Raddats 2019), which establishes a strong connection between services and manufactured goods.

First, services have the potential to contribute to other sectors by acting as intermediaries that connect different streams of knowledge. Thus insights generated to enhance sustainability can be horizontally applied across sectors, owing to evolving industrial and economic boundaries. This inter-sectoral connection is a crucial attribute of services in the green transition. For instance, consulting services developed to enhance a company's or sector's sustainability can be extended to other clients. Second, services firms themselves can contribute to greening the economy through their unique business models. The proliferation of green service firms can cascade a green impact throughout the broader economy. A greater focus on the green transition among numerous companies will collectively diminish potential environmentally detrimental consequences. In the long run, this implies that a substantial portion of service providers in the green economy will specialize in green and sustainable services. Last, various forms of servitization integrated into industrial processes can pave the way for a greener industrial and manufacturing foundation. This dimension encompasses the ways manufacturing companies employ in-house services to enhance efficiency, as well as their collaborations with external knowledge providers to generate value at the intersection of goods and services, to thereby yield a positive environmental impact.

The development of a growing service economy will need to include wider environmental considerations. Ultimately, the internationalization of these service activities, as per the World Trade Organization (WTO) classification, will become pivotal. This involves refining the conceptual framework for future trade in services to better encompass digital services and servitization, potentially through the introduction of a "Mode 5" – dealing with the encapsulated combined value of services and manufacturing (Cernat and Kutlina-Dimitrova 2014). As concepts evolve to harness services to enhance the overall environmental and social sustainability of economic growth, challenges will emerge in relation to measurement and data collection. Addressing these methodological aspects will help to optimize policy impact.

4. SERVICES-DRIVEN DEVELOPMENT

As the global economy sought to recover from the COVID-19 pandemic, a host of challenges emerged in relation to economic and industrial development (Fang and Hassler 2021). Developing countries have grappled with escalating debt and the ramifications of soaring living costs, which have particularly impacted on vulnerable economies. Simultaneously, smaller economies, often endowed with limited resources, face the challenge of rejuvenating their economic landscape. Among these economies, those reliant on tourism have encountered difficulties. However, building economic growth through the tourism industry can be a double-edged sword, since it poses obstacles to transitioning to a green economy. Long-distance air travel together with the environmental impact on local communities can have negative repercussions. This is one example of areas where services-led development and the green transition encounter challenges. Moreover, the evolving landscape of de-industrialization, characterized by heightened competition among developing economies and increasing digitalization, is making the traditional development trajectory less viable (see also Chapters 1 and 2). Studies by the Asian Development Bank (ADB 2012) and the World Bank (Nayyar, Hallward-Driemeier and Elwyn 2021) reveal that the industrial pathways followed by East Asia, anchored in manufacturing for global market integration, may no longer be tenable for more recent entrants into economic development.

In this context, it is important to tailor industrial upgrading to local specifics, including sustainability considerations. The connection of services to the entire product life cycle has importance in identifying industrial activities that align with the ambition to advance the green transition. An approach centred on the product life cycle can establish services-related activities that not only foster development but also facilitate sustainable value chain enhancement. For developing countries, the crucial challenge is to identify industries with comparative advantages that can be leveraged to bolster both the domestic economy and a global market presence.

This challenge has been addressed in a recent United Nations Conference on Trade and Development (UNCTAD) report (2023) that highlights the coalescence of digitalization and the green transition. Digitalization can expedite industrial change, as evidenced by the emergence of services and digitalization in manufacturing under the banner of Industry 4.0, the proliferation of the internet of things, and the integration of artificial intelligence. This transformation can be orchestrated in a manner that yields a more sustainable production system. For developing countries, connectivity with GVCs and GPNs will have a pivotal role in parallel with green economic transition.

Concurrently, digitalization presents both opportunities and challenges for developing economies. It furnishes new avenues for economic activities while exerting pressure on job creation in traditional low-value-added manufacturing. The ADB (2012) indicates that services are poised to be a pivotal facet of the developmental process, generating new job opportunities and transitioning informal jobs into the formal economy. Such a transformation can underpin welfare creation and establish a more stable tax base. The services economy can thus emerge as a resilient segment of the larger economy. The central challenge for developing countries lies in incentivizing and facilitating this transformation while identifying promising segments of the services sector for sustainable economic growth and social development.

Recent studies by the World Bank (Nayyar, Hallward-Driemeier and Elwyn 2021) and UNCTAD (2023) suggest that structural transformation towards services has not necessarily become smoother over the past decade; a host of challenges have emerged that pertain to digitalization, regulations, and positioning within GVCs. Although this is true, particularly for knowledge-intensive services, services with lower productivity profiles may face somewhat fewer hurdles. However, it is not easy to gauge the depth of impact of such services on the green transition. The climate crisis has intensified over the past decade, adversely affecting numerous developing countries. Consequently, there have been calls to pivot towards a circular economy across both advanced and developing economies (see Chapter 5). However, significant concerns have been raised about environmentally detrimental shifting of industrial processes from advanced economies to developing countries (Tukker 2015). Although certain segments of the industrial value chain may become greener, other aspects could merely be relocated to other regions with lower environmental standards. This underscores the importance of examining the implications of a circular economy in developing countries in order to better coordinate public and private initiatives. As services assume a larger role in the value chain and value addition, developing economies have an opportunity to contribute in novel ways to domestic growth and global economic integration. Although studies of the circular economy have traditionally focused on the tangible aspects of production, the burgeoning services economy in both advanced and developing nations draws attention to the importance of services in the circular economy.

5. WHAT CAN BE DONE TO DRIVE THE SERVICES TRANSITION IN THE GREEN ECONOMY?

Earlier studies primarily focused on how services could drive a green transition within the European Union's single market (Ström 2020). These studies, in conjunction with enquiries into the functioning of the internal services market, underscore the potential inherent in the services industry (European Commission 2014). However, they also recognize the challenges of establishing a harmonized market and subsequent cross-border trade. Several factors presented in these studies also have relevance to the evolution of green services in developing countries, where the dual objective is to bolster the services economy while simultaneously establishing a sustainable development trajectory. This goal is encapsulated in the Bridgetown Covenant: From Inequality and Vulnerability to Prosperity for All, which strives to lay the foundations for sustainable and diversified economic activities (UNCTAD 2021). Recent research has also taken a broader perspective on services growth in developing countries (see Nayyar, Hallward-Driemeier and Elwyn 2021) and has delved into the specific trajectories of economic growth vis-à-vis sustainability and green transition with a focus on technology (see UNCTAD 2023).

There have been numerous noteworthy achievements in developing countries. In East Asia, a region that integrated into the global economy on the basis of manufacturing, countries have leveraged their strong positions in GVCs and GPNs to accommodate an upsurge in the added value of knowledge and services in the final output. Nonetheless, the strategy of heightened servitization is not devoid of challenges concerning job creation (Grover and Mattoo 2021). Novel business models are required, and collaboration with larger firms, often multinational enterprises (MNEs), is indispensable to sustaining industrial upgrading and at the same time to securing a position within GVCs that may be regarded as contributing to green transition. There are compelling instances where services have emerged as integral components of development and thus of the green transition, particularly in Africa and Latin America.

To delve more specifically into Latin America's services development, countries such as Costa Rica and Chile have made great strides in augmenting their respective economies through the cultivation of business-focused services, servitization and digital services (see Box 6.1). According to Stark et al. (2014), firms generally undertake four kinds of change to leverage diverse location advantages along the services value chain, thereby fostering domestic competence and demand or tapping into regional or global services production networks:

- Product upgrading – entails striving for higher value to secure a more robust position within the overall value chain.
- Process upgrading – means improvements in production system efficiency. Enhanced processes allow firms to boost efficiency, not only within their own corporate capacity but also in their contribution to business customer processes.
- Functional upgrading – involves moving to higher-value stages in the chain that demand additional skills and enable firms to make more substantial contributions.
- Chain or inter-sectoral upgrading – means entering a new value chain by leveraging knowledge and skills. This enables firms to penetrate new industries and cater to new customers.

These four alterations of business activity also have the potential to contribute to green transition if they are sufficiently linked into sustainable production. Thus, new competitive advantage can be created in sustainable GVCs. The growth of the services sector has generally given rise to a structure that divides into two main categories. One is driven by global market connections through offshoring and back-office functions. The other pertains to the regional market, where Multilatinas (companies originating from Latin America, working across the continent) operate in business services and retail sectors (Ström, Alvstam and Jones 2016). These firms have capitalized on regional economic growth and integration but face limited short-term prospects of expanding beyond Latin America. The trajectory of intra-regional Multilatinas will be interesting to monitor in the future. The upcoming challenge lies in whether these firms can establish competitive advantages that will drive long-term competitiveness and steer services-based economic development.

Research into Africa's services economy underscores its economic growth potential. Development is hindered by inadequate investment in technologies that facilitate internet penetration, which has limited the prospects of sustainable growth and integration into the global economy (Wentrup, Ström and Nakamura 2016). Favourable economic geography is unevenly distributed across the continent: larger metropolitan areas are linked to the global economy while other regions remain in the shadows (Alvstam, Ström and Wentrup 2016). This doesn't imply a lack of services, but rather highlights the prevalence of low-skilled and low-productivity services not easily visible in economic statistics. This state of affairs will present ongoing challenges to developing African countries' ability to leapfrog into an economic development path that fosters domestic demand for services contributing to both welfare and green transition.

Studies also underscore the disadvantaged position of entrepreneurship in the digital services economy, which may present an obstacle to building these services into the green transition. A pivotal factor in bridging the digital entrepreneurship gap is to bring skilled returnee entrepreneurs together, merging them with local talent and empowering them in policymaking (Wentrup, Nakamura and Ström 2020). Such individuals can serve as role models for future indigenous digital entrepreneurs. This approach blends the local workforce with international market experience and can be leveraged to develop the local economy. The transfer of knowledge would be much more challenging without this person-based expertise. Knowledge can place developing countries in a more robust position when combined with investment in information technology infrastructure and education.

BOX 6.1 EXAMPLES OF SERVICES-DRIVEN DEVELOPMENT ENABLING GREEN TRANSITION

A range of examples from developing countries demonstrate the potential of services-driven development to catalyse green transition. A critical factor is to establish fertile ground for knowledge-intensive services with the capacity to enhance productivity and access to digital services. Coexisting alongside low-productivity services that contribute to local employment, high-productivity services wield a positive influence on the domestic market while also providing avenues to link domestic services to regional or global value chains. The indirect effects of expanded low-productivity services can help facilitate transition to a green economy through the development of jobs that are less harmful to the environment than are jobs in raw material industries and low-end manufacturing, yet it is the knowledge-intensive services that have the potential to build linkages with other sectors of the domestic economy and make them more sustainable.

In Latin America, both Costa Rica and Chile have achieved commendable progress in nurturing their respective services sectors (Stark et al. 2014). Costa Rica strategically developed domestic infrastructure in tandem with heightened education levels, thereby attracting FDI in knowledge-intensive and digital services. The advantage of proximity to North American markets has fostered the growth of information technology and high-end consulting companies in the country. This economic advancement has also elevated Costa Rica's position in regional and global value chains (Flores Saens 2014). This is not only an example of service economy development but also a sign of how services can facilitate domestic and international green economic transition through building new competitive advantage. Chile, too, has seen a positive trajectory in information technology services, alongside a robust presence of services-oriented companies in finance and retail, capitalizing on the economic integration of Latin America via the emergence of so-called "Multilatinas". Even a traditional sector like the wine industry in Chile has augmented the services content of its production – by, for example, marketing wines with strong ecological labels (Berry, Mulder and Olmos 2016). These advances show the potential of service value creation in combination with an ambition of facilitating green economic growth.

Morocco is an illustrative example of a country where "returnee entrepreneurs" have played a pivotal role in fostering the domestic market for digital services while the country has concurrently established crucial global connections in which digital services thrive (Wentrup, Nakamura and Ström 2020). Often linked to entrepreneurial and financial hubs, these entrepreneurs bring their competencies and network associations back to Morocco and leverage them in the domestic market. The spectrum of domestic services encompasses producer-oriented and consumer services, ranging from car-sharing and health-related services to advertising, e-commerce and e-invoicing. Challenges persist, chiefly related to relatively modest domestic capacities in terms of educated workforce, financing, and local policies geared to such novel services firms.

These examples underscore the potential inherent in various types of services in developing countries to steer the economy towards a green transition. Augmented services within traditional agricultural sectors can curb deleterious environmental impacts and positively influence working conditions. Investment in infrastructure and education has the potential to nurture a greener domestic services market while fortifying its readiness to interface with GVCs.

The climate crisis demands extensive international collaboration. Both advanced and developing countries must explore avenues to synergize their capabilities in order to facilitate transition towards a greener future. Given the surge in digitalization and mounting pressure on low-value-added manufacturing, the complexity of this endeavour surpasses the challenges of three or four decades ago, when regional and global trade and investment integration commenced. The fallout from the COVID-19 pandemic has further underscored the difficulties faced by developing countries. Nonetheless, instances abound that demonstrate how innovative models of international collaboration can yield benefits for both advanced and developing economies. In the integrated world economy, where services are playing an ever more important role, international collaboration will be pivotal to the green economic transition.

BOX 6.2 COUNTRY-LEVEL ACTION AND COLLABORATION

The Strategic Partnership Agreement (SPA) established between Japan and the European Union in 2019 is a prime example of a collaborative accord that looks to future challenges (Ström, Söderberg and Malmström-Rognes 2021). Simultaneously, the Economic Partnership Agreement (EPA) was established, focusing on conventional objectives to enhance economic integration (Nakamura and Ström 2021).

Encompassing a diverse range of 40 topics, the SPA's coverage is notably comprehensive (European Commission 2023). After initial gradual progression, recent indications point to accelerated advancements in areas like connectivity, digitalization, climate change, and security. These domains align with ambitions to contribute to more sustainable economic growth. A significant aspect of this innovative international collaboration is its potential to provide a framework for collaborative efforts between Japan, the European Union and developing countries worldwide. Activities under the SPA harmonize with broader policy endeavours such as the European Union's Green Deal and Japan's pursuit of carbon neutrality. In 2021, these considerations led to the establishment of the Green Alliance, a platform aiming to facilitate transition towards a green economy. An integral objective of this alliance is to foster cooperative endeavours with developing countries, leveraging technology, regulations and financing to facilitate green transition (European Commission 2021). The SPA has also precipitated tangible efforts in areas like connectivity, digitalization and infrastructure in order to bolster economic integration with developing economies (European External Action Service (EEAS) 2019). The role of services, horizontally cutting across these domains, will be vital to prospects of facilitating more sustainable economic growth.

6. POLICY RECOMMENDATIONS

The importance of precise definitions emerges from previous studies as pivotal to harnessing the potential of services in fostering a greener economy in both advanced and developing countries. An initial step involves conceptually framing "green services"; this is followed by the consideration of related standards. Previous standards, such as those set by the European Committee for Standardization (CEN) within the European Union's single market, can serve as benchmarks for shaping standards that align with green services.[1] This use of standardization not only encompasses discrete service activities but also emphasizes the crucial role of services' interlinkage with wider manufacturing and resource-intensive components of the economy. In this context the Sustainable Development Goals (SDGs) offer a valuable framework to steer the definition and standardization of green services. Firms can supply services separately or in combination with manufactured goods in such a way as to pursue the specific ambitions of relevant goals and subgoals. This means that firms can more clearly define how their work can contribute to the green transition.

The prevailing academic literature and policy studies consistently underscore the dearth of reliable data concerning services production, measurement, cross-border trade, and FDI. Multiple international entities, including the WTO, UNCTAD, European Union and OECD, have initiated projects to enhance the quantification of service activities. The rise of digitalization has

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1 https://www.cencenelec.eu/areas-of-work/cen-sectors/services/.

further expanded the horizons of data collection, enhancing the precision of policy interventions and regulations. For developing countries, to channel resources towards sustainable development requires a solid foundation of knowledge and productive capacities. The advent of digital services coupled with the dematerialization of segments of the value creation process intensifies the need for accurate data. Without proper conceptualization of services in the green economy, and the consequent measurement of data, an overall green transition will be difficult to accommodate.

As is evident in earlier research, education and training are pivotal to fostering economic growth in developing countries, and thus also to the green transition (see Chapter 9). These domains present both substantial challenges and significant opportunities. Bolstering the capacity of local higher education and training institutions empowers countries to cultivate local human capital and thus improve opportunities to move away from low-productivity services, or services that are today found in the informal sector. Concurrently, international collaboration through exchange programmes with universities in advanced economies is playing a pivotal role in enabling individuals to connect, explore, and expand their networks. The Moroccan case of returnee entrepreneurs exemplifies the enduring impact of education, both domestically and internationally (see Box 6.1). Hence, governments of developing countries should prioritize education and training programmes tailored to industries. In contexts where education levels are limited, readiness to capitalize on the knowledge or services economy remains distant. In such a situation, building upon local strengths and fostering incremental innovations aligned with new business models can yield significant value. Good examples exist, as seen in digital services provided in developing countries, or upgrading from tourism-focused local economies. Education also forms the bedrock for creating institutional preparedness in developing countries. An educated workforce can adapt, and utilize opportunities for growth, and hence support the green transition of GVCs.

The confluence of achieving economic growth through services while curbing environmentally detrimental activities demands collaborative efforts between advanced and developing economies. The SPA between the European Union and Japan illustrates a novel form of collaboration transcending conventional trade agreements (see Box 6.2). Crucially, this agreement explicitly underscores the parties' commitment to collaboration and to engaging with developing countries around the world. This entails a focus on areas closely aligned with the growth of the services sector in the developing world. The SPA highlights quality infrastructure, connectivity and digitalization. International collaboration could evolve beyond mere verbal agreements to encompass areas such as integrating developing economies into GVCs and fostering smart city development to address the challenges of urbanization.

This kind of international collaboration, through legal agreements, can support green transition by enhancing commitment among private and public actors.

Trade and open markets are pivotal to efficiently allocating resources and thereby enabling developing countries to integrate into the global market. The structural adjustments arising from such transformations may occur rapidly or progressively. Despite the positive long-term impacts, the adjustments pose significant challenges for the workforce (OECD 2023). This phenomenon is not novel; it is an intrinsic element of structural economic shifts over time (for example, Chang 2002). As both advanced and developing countries are increasingly relying on services – encompassing both low-productivity and high-productivity domains – it is supremely important to facilitate fluid movement between sectors and to establish robust social protection frameworks (see Chapter 8). Tariffs are not always the foremost hindrance to cross-border service delivery; various non-tariff barriers – such as regulations, lack of competency or occupational harmonization, and rules of origin – often present substantial challenges. Unhindered trade flow, according to the nature of the services and their often complex trade delivery mode, will be critical to future development. Impeding or complicating trade will hinder progress towards a green economy. In a context of heightened demand for international collaboration, trade also facilitates cooperation between private and public stakeholders. Disrupting trade would not only sever connections to GVCs and production networks but also impact on tax structures relating to digital services. Such disruptions could impede the potential expansion of developing countries in specific services subsectors, many of which directly or indirectly contribute to the transition to a green economy. Despite challenges stemming from competition and digitalization, it is not feasible to rely solely on domestic markets. The emphasis should instead be on finding remedies, including through reskilling or robust social protection systems, for the negative consequences of the service trade liberalization and consequent structural shifts that are part of green economic transition.

In recent decades, the global economy has been propelled by economic integration through trade and FDI. Intermediary trade within MNEs has constituted a crucial element of economic growth. Over time, services trade has progressively gained significance, particularly at the intersection of manufactured goods and services (Daniels 2000). In the light of the COVID-19 pandemic and shifting geopolitical dynamics, concerns about potential deglobalization have emerged. The intricacies of GVCs and production networks have prompted discussions about risk, particularly amidst geopolitical uncertainties, environmental disasters and the repercussions of pandemics (Solingen, Meng and Xu 2021). Such disruptions underscore the interconnected nature of the global economy. Resilience has emerged as a critical capacity, alongside traditional efficiency optimization within GVCs. It will be vital that traded services within

GVCs be made resilient if the transition towards the green economy is to be sustained and not interrupted by challenging events in the global marketplace.

The burgeoning potential of digital services delivery has at the same time spurred the services industry in new directions. An increasing share of value addition occurs at the convergence of manufacturing and services, the phenomenon referred to as “servitization”. This development of GVCs and GPNs aligns closely with the trajectory of servitization. These frameworks provide developing countries with opportunities to engage with the global economy. However, there are also risks in this developing business model of increased service content, particularly for small and medium-sized companies that need to secure a new position in the industrial process. Thus, it is vital to empower policymakers, workers and enterprises to leverage the potential for development. The developmental pathways of East Asia and Latin America illustrate the importance of connections with MNEs through GVCs and GPNs. The importance of international networks connected to returnee entrepreneurs was also shown in the case of Morocco. A solid foundation for development and green transition can be built upon local competitive advantages, using business models that advance digital services in agriculture, mining, fishery, energy generation and distribution, and manufacturing (see, for example, Jones et al. 2016).

Lastly, it is essential to nurture a green transition in established services subsectors. But the green transition has also given rise to new subsectors, such as green finance, spanning areas like green bonds and investment portfolios aligned with the SDGs, as well as services related to the energy sector, sustainable tourism, carbon reduction, and public and private education and training. Effectively implementing and navigating such transformations is challenging and often contentious. Numerous developing countries rely heavily on tourism-generated income, so it is crucial to address challenges like travel-related emissions and environmental sustainability. While it is essential to capitalize on existing strengths, policies to diversify the economy will be equally crucial. Education, digitalization, GVC integration through trade, business model innovation, and international collaboration with advanced economies are collectively shaping the way forward.

7. CONCLUSION

This chapter has examined, through the prism of services, the array of challenges confronted by developing countries as they navigate green structural transformation. Although services are poised to play a pivotal role in this transformation, developing countries are grappling with the challenges of heightened competition in light manufacturing and with mounting pressures arising from digitalization and automation. In response to these emerging challenges, a comprehensive set of recommendations to facilitate continuous enhancement of the economic landscape have been presented. These recommendations, often intertwined, synergize to support the overarching shift towards a green economy in which services will assume a central role. From the coverage of this chapter, a series of conclusions can be gleaned.

First, developing countries face the intricate task of concurrently managing the growth of their services sector and orchestrating a green transition amidst intense global market competition. At the same time, the notion of "de-industrialization", without the conventional development trajectory centred on manufacturing, has been posited in this chapter. Although de-industrialization brings challenges (see Chapter 2), it also offers developing countries novel avenues through which to nurture domestic markets in which services will be integral components of a broader economic reconfiguration. If value is generated through a dematerialization process, this may have a positive impact on the green transition, creating jobs in new subsectors less harmful to the environment.

Second, while low-productivity services contribute to the construction of domestic markets, high-productivity or knowledge-based services have paramount importance in the green transition. This transition can be advanced through a symbiosis between services and manufacturing which fosters the gradual evolution of services with augmented value added.

Third, the imperative of international collaboration looms large as a prerequisite to fostering an inclusive and sustainable expansion of the services sector. The challenges precipitated by the climate crisis and the quest to usher in a green economic transition hinge upon the collective effort of public and private sectors in both advanced and developing nations. This transition requires investment in the infrastructure that will underpin the journey towards services and a green economy. Robust knowledge exchange and support for education have also emerged as critical components.

Fourth, the SDGs provide a pivotal framework to guide efforts towards green transition. However, they require further conceptual and methodological refinement to establish a dependable analytical framework in which to understand the contribution of services. The main possibilities lie in private sector firms finding SDGs that match their own particular strengths and capabilities in driving the green transition. This endeavour will augment collaboration within the private sector on GVCs and production networks. Collaboration among companies within and across industries where GVCs are becoming more complex could also help to facilitate the green transition. Service providers should of course seek to make their own business models greener, but, most importantly, they can also support their clients' sustainability efforts. One good example is telecom and information technology companies and their role in the overall value chain in most industries.

Future research should pivot towards more specific economic geographies in developing nations and undertake industry-level investigations. Moreover, the exploration of firm-level dynamics through case studies could furnish richer understanding of how both low- and high-productivity services can contribute to environmental sustainability in developing economies.

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7. Carbon pricing and the labour market

Marco Fugazza

1. INTRODUCTION

Climate change presents significant costs and risks that threaten both present and future generations with far-reaching impacts on various aspects of human existence. The economic consequences are projected to be substantial, as Cruz and Rossi-Hansberg (2021) have pointed out.

However, current market prices do not accurately reflect the true costs and risks associated with climate change. To address this issue, carbon pricing has emerged as a crucial tool in the transition towards a decarbonized economy.[1] By adjusting prices of goods and services according to their carbon footprint, carbon pricing aims to influence consumer and producer behaviour, promoting a shift towards low greenhouse gas (GHG)-intensive activities and ultimately reducing emissions. This approach is deemed highly efficient in achieving emissions reductions (Auffhammer et al. 2016; Tietenberg 1990). Nevertheless, carbon pricing cannot be relied upon as the sole instrument of a climate policy package for effective emissions reduction. It is vital to integrate carbon pricing into a comprehensive set of public policies that ensure a just transition for businesses and households towards a net zero emissions economy.

Carbon-pricing reforms can result in positive or negative employment multipliers. The outcomes will depend on various factors, including policy design, the country's economic structure, integration into global value chains, and the climate goals of trading partners. The reallocation of sectors will have diverse effects on income groups, skill levels, occupations and geographical regions.

Beyond traditional cost-effectiveness calculations, carbon pricing may have broader impacts. One concerning aspect is its potential to create distributional tensions within a country. Putting a price on emissions may disproportionately

[1] The concept of carbon pricing, particularly in the form of a carbon tax, has roots in the economic theory of internalizing externalities. Discussions about it can be traced back to the seminal work of Pigou (1920).

affect the poorest segments of the population, particularly if they allocate a significant portion of their income to carbon-intensive goods (see, for example, Andersson and Atkinson 2020; Fullerton 2011). Market adjustments resulting from firms' reactions to carbon pricing can further exacerbate distributional tensions. These impacts may pose challenges to the political feasibility of swift and effective implementation of carbon pricing.

Carbon-pricing schemes, like other policy instruments influencing production costs, can have significant trade implications. Some companies may relocate their production facilities to countries with weaker environmental regulations in order to avoid the cost increases associated with carbon pricing. Countries with stringent environmental policies and legally binding carbon-pricing schemes may resort to alternative measures, such as carbon border adjustment (CBA) schemes, to counterbalance the effects of weak global coordination. Careful design and coordination with international partners can address potential competitiveness issues, ensuring that lax environmental regulations in some regions do not undermine the progress made by countries with stricter policies.

Carbon pricing has the potential to generate fiscal revenues, something especially valuable in supporting decarbonization initiatives when budgets are constrained. These revenues can be used in diverse ways to enhance the effectiveness of emissions reduction efforts, such as mitigating costs related to emissions reduction and addressing potential income distribution disparities arising from carbon-pricing policies. Targeted interventions in labour markets and other social policies can facilitate and streamline transitions in occupations or regions while minimizing associated costs and challenges.

Although carbon pricing offers an efficient approach to reducing emissions, it is essential to a just transition to integrate these schemes into a comprehensive set of public policies. Consideration of distributional tensions, trade implications and fiscal revenue usage is vital to effective and equitable climate policies.

The rest of this chapter is structured as follows. Section 2 reviews different carbon-pricing schemes, assessing their anticipated effects and merits. Market-based and non-market-based approaches are differentiated. Section 3 offers theoretical insights into the economic and environmental consequences of these schemes. Its analysis of empirical evidence focuses particularly on carbon taxes and emissions-trading systems (ETS). Section 4 delves into potential distributional conflicts arising from the effects of carbon pricing, emphasizing labour market outcomes. The concluding section examines strategies to optimize GHG emissions mitigation through effective and efficient policies.

Table 7.1 Main carbon-pricing schemes and instruments

Mechanism	Instruments
Market	• ETS and derivatives • Carbon offsets • Carbon tax, excise tax and tariff • Carbon border adjustment tax • Hybrid: ETS + out-of-allowance carbon tax
Non-market	• Emissions cap • Results-based carbon financing • Internal pricing • Standards and other regulations • Labels

2. CARBON-PRICING SCHEMES

Putting a price on carbon internalizes negative GHG externalities. It follows the polluter-pays principle, reducing GHG-intensive activities by increasing their price relative to non-emitting goods. Costs are shared between producers and consumers on the basis of market power and behavioural parameters. Governments can reduce GHG content in services and investments. They may also be able to intervene *ex post* to influence carbon cost distribution (for example, through broader redistribution policies).

Carbon pricing can be implemented via several different policy schemes and instruments, as shown in Table 7.1. A distinction can be made between carbon-pricing instruments based on market mechanisms (for example, carbon taxes and emissions permit markets)[2] and those based on non-market mechanisms (command-and-control tools, labels and information, or voluntary initiatives). It is crucial to ensure there is coordination and coherence among these instruments to avoid a situation in which conflicting policies lead to adverse environmental outcomes and an overall negative economic impact, potentially influenced by protectionist tendencies.

2.1 Market-Based Carbon-Pricing Schemes

Carbon-pricing schemes, like carbon taxes and ETS, are widely used (Box 7.1) and have been the dominant schemes used so far. However, their design and implementation vary across jurisdictions. A carbon tax directly prices each unit

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[2] A carbon tax is usually perceived as being based on a market mechanism, since it relies on price adjustments to affect emissions (that is, quantities).

of emitted greenhouse gas, based on a specific tax rate per tonne of emissions.[3] Emissions-trading systems work on a cap-and-trade mechanism, with a set limit on total emissions, and participants buying and selling emissions allowances in a regulated carbon market.[4] Higher market prices create stronger incentives to reduce emissions. Offset mechanisms allow organizations to compensate for emissions by investing in emissions-reducing projects elsewhere (see Chapter 3). These projects can include renewable energy initiatives, afforestation, and projects that improve energy efficiency. The offsets generated by such projects can be used, although not systematically, to compensate for emissions produced by the organization. In choosing a carbon-pricing strategy, governments should consider national circumstances and political realities. Market-based carbon pricing generally affects prices throughout the supply chain, regardless of the specific scheme or the specific location in the production process.

2.2 Non-Market-Based Carbon-Pricing Schemes

There are a large and growing number of non-market-based mechanisms. Many companies adopt voluntary internal carbon-pricing practices to internalize the economic cost of their GHG emissions.[5] This involves setting a carbon price, sometimes based on mandatory initiatives, or a range of prices to account for differences across jurisdictions or anticipate future increases. Internal carbon pricing supports decarbonization strategies and acts as a risk management tool of regulatory climate policies. Greenhouse gas emissions can be classified into three categories as per the GHG Protocol:[6] Scope 1 (direct emissions); Scope 2 (indirect emissions, steam, heating and cooling consumed by the reporting

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3 Emissions can, in principle, be of any GHG (such as methane, nitrous oxides, fluorinated gases), but in practice the focus is on carbon dioxide, owing to its predominance in the greenhouse effect.

4 The alternative system mechanism is called “baseline-and-credit”. Baseline emissions levels are defined for individual regulated entities, and permits are issued to entities that have reduced their emissions below this level. These credits can be sold to other entities that exceed their baseline emissions levels. Cap-and-trade and baseline-and-credit should in principle lead to the same long-term equilibrium, at least in terms of total emissions, if the baseline information is correct. However, insights from theory (for example, Buckley, Mestelman and Muller 2006) suggest that the long-run equilibria of the two approaches will differ if baselines in the baseline-and-credit system are proportional to output.

5 See Institute for Climate Economics and Entreprises pour l’environnement (I4CE and EPE) (2016) for a large set of practical implementation examples.

6 Greenhouse gas emissions are categorized by the most widely used international accounting tool, the GHG Protocol. This Protocol was jointly convened in

company); and Scope 3 (other indirect emissions in the value chain). The indirect emissions in the value chain (Scope 3) account for a significant portion of most companies' carbon impact,[7] and it is thus imperative to reduce them, but estimating, tracking and reporting them can be a complex task. Both the economic and environmental impacts of addressing these emissions are uncertain. Reporting firms, often located in developing countries, need decisional leverage to reduce the emission factors involved, but such decisional leverage may impose higher production costs and/or lower prices on producers of inputs. As reporting requirements become more widespread, as in the 2023 Corporate Sustainability Reporting Directive of the European Union (EU),[8] countries whose exports are essentially commodities may be significantly affected.

BOX 7.1 CARBON PRICING IN PRACTICE

In spite of the increasing significance attributed to carbon credits, the prevailing mechanisms continue to be ETS and carbon taxes. These mechanisms are primarily found in middle-income and high-income countries. In 2023, 77 jurisdictions had put a price on carbon: one supranational (the EU), 39 national and 33 subnational. The implemented carbon-pricing initiatives cover a total of 11.66 gigatonnes of carbon dioxide equivalent ($GtCO_2e$), corresponding to 23 per cent of global GHG emissions.[9]

Nine developing countries so far have implemented a carbon-pricing scheme. Argentina, Chile, Colombia and South Africa have implemented a carbon tax. China, Indonesia, Kazakhstan and the Republic of Korea have implemented an ETS. Mexico has implemented both carbon taxes and an ETS at either national or subnational level.[10] Four other developing countries have planned to implement a carbon tax,[11] and seven have planned the implementation of an ETS to regulate their emissions.[12] Overall,

1998 by the World Business Council for Sustainable Development (WBCSD) and World Resources Institute (WRI) and was first established in 2001.

7 See Hertwich and Wood (2018) for recent sectoral estimates.

8 On 5 January 2023, the Corporate Sustainability Reporting Directive came into force in the EU, under which large companies and listed small and medium-sized enterprises are required to report on sustainability. See https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32022L2464.

9 Figures were retrieved from https://carbonpricingdashboard.worldbank.org/.

10 Box 6 in World Bank (2023) provides a detailed description of the various implemented and scheduled carbon-pricing schemes in Mexico.

11 Botswana, Indonesia, Morocco and Senegal.

12 Brazil, Chile, Colombia, Malaysia, Pakistan, Thailand and Viet Nam.

carbon-pricing schemes in developing countries cover 6.35 $GtCO_2e$, corresponding to about 13 per cent of global GHG emissions. Schemes in China alone cover 4.50 $GtCO_2e$ (9 per cent of global GHG emissions).

Carbon tax rates and ETS prices vary by income level. High-income countries commonly exceed US$50 per tonne of carbon dioxide, whereas in many middle-income nations the price falls below US$10. Exceptions include China's pilot ETS programmes, Latvia's carbon tax and Mexico's subnational carbon taxes.

In 2020, carbon tax and ETS revenues grew more than 10 per cent over the previous year, to nearly US$95 billion. Emissions-trading schemes contributed 69 per cent of global government revenues from direct carbon pricing, while carbon taxes contributed 31 per cent. Higher prices, higher emissions, and design variations enable high-income countries to dominate revenue collection. In 2022, the EU ETS generated 76 per cent of the global revenue increase. Sweden's road transport carbon tax led in per capita revenue. Middle-income countries lean towards carbon taxes for revenue generation.

Carbon tax and ETS revenues are often allocated to specific goals in order to alleviate political resistance. According to the World Bank (2023), 40 per cent of these revenues target green initiatives, a further 10 per cent supporting vulnerable households and businesses. The remaining funds are dispersed among general budgets (20 per cent), tax reductions (9 per cent) and other uses (6 per cent). These shares indicate an increased allocation to specific goals, which may be attributed largely to the EU ETS's boosted revenue. Within the EU ETS, a considerable portion of Member States' auction revenue supports climate- and energy-related aims.

3. THE ENVIRONMENTAL AND ECONOMIC EFFECTS OF CARBON PRICING

Carbon pricing, whether through market- or non-market-based mechanisms, has predictable primary effects on production costs and, potentially, prices for companies; and consumption may adjust when households are affected. However, secondary or general equilibrium effects can be more complex and varied, as illustrated by Figure 7.1.

Different carbon-pricing approaches can impact on the economy, sectors and agents differently. There may be a trade-off between production/employment effects and environmental impacts, especially for companies facing carbon pricing for the first time. Quantitative assessment and empirical evidence are

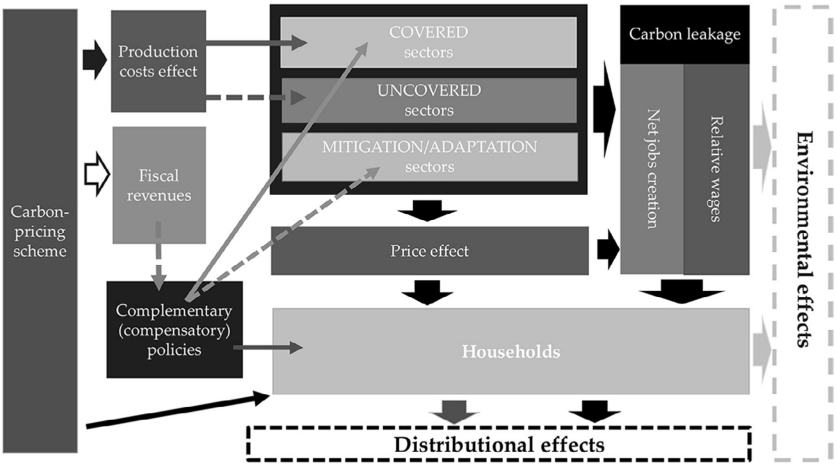

Figure 7.1 Economic, environmental and distributional effects of carbon pricing

essential to understanding such trade-offs in diverse policy and institutional contexts. Government intervention can help reconcile socio-economic and environmental effects.

3.1 Theoretical Insights

Carbon-pricing schemes presented in the previous section have a direct impact on either firms or households (or both). Carbon pricing is expected to affect production costs when imposed on firms and net income when imposed on households. Changes in production costs are expected to be passed on to final consumers through changes in the prices of goods and services. Changes in net income should primarily affect consumption.

Carbon pricing thus impacts on production and employment decisions. High-carbon industries, like fossil fuel extraction and energy-intensive manufacturing, may experience reduced employment owing to increased costs and decreased competitiveness. Conversely, low-carbon sectors supporting emissions reduction efforts – such as renewable energy, clean technologies and energy-efficient infrastructure – could see job growth as they become economically viable. This transition will also require appropriately skilled workers in areas like renewable energy and environmental management.

The effects of carbon pricing on employment are thus expected to vary across sectors and eventually across socio-economic groups. Depending on the design and revenue recycling and similar measures, the burden of carbon pricing may disproportionately affect certain households, particularly lower-income groups, since these groups may face proportionally larger increases in the costs of energy and goods. The same groups may also experience an increased risk of unemployment or displacement, owing to their higher representation in high-carbon industries.

Carbon pricing can impact on international competitiveness and trade. Domestic industries subject to carbon taxes may incur higher costs compared to competitors in countries without such taxes. This cost disparity could lead to increased imports of similar products from untaxed foreign producers, as they become more price-competitive substitutes for domestic goods. This may raise uncertainty about environmental effects, since the imports could be more carbon intensive, widening the gap between national inventory and footprint. Thus, a shift from domestic products to carbon-intensive imports could weaken the global emissions reduction impact of carbon pricing, in turn reducing its global cost-efficiency. Firms may relocate to countries with lax environmental policies to evade costs – a phenomenon known as "carbon leakage" and amplified by global production chain fragmentation. A situation in which developing countries become pollution havens could raise global emissions (Copeland 2008). Governments may counter this with measures like CBA mechanisms, but the original environmental goals may not be fully realized.

3.2 Quantitative Assessments and Empirical Evidence

Three main categories of assessment approaches applied to carbon-pricing schemes can be identified. The first category includes all computable economic models, usually referred to as "integrated assessment models" (IAMs) and typically used for the *ex ante* assessment of carbon-pricing policies and to project the impact of carbon-pricing schemes. Such projections rely heavily on modelling choices and parameterizations.[13] The second category includes all empirical studies proposing an *ex post* assessment of implemented carbon-pricing instruments. The last category also allows the evaluation of the impact of carbon-pricing schemes implemented in the past but is based on quasi-experimental designs that are in principle able to identify causal relationships more precisely.[14]

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13 See Pindyck (2017) for a discussion about the contrasting conclusions about the path of climate policy to be followed as a result of the various modelling and parameters choices to be made.

14 See Box 3 in UNCTAD (2022b) for a discussion.

Existing studies principally offer impact estimates of either carbon taxes or ETS. Specific evidence about the effects of non-market-based carbon-pricing schemes is missing, largely owing to the relatively small scale of such schemes. Because carbon pricing has only recently been adopted, empirical evidence is often limited and hence *ex ante* methods using IAMs are prevalent. Integrated assessment models, centred on price effects, mainly focus on tax-based tools because these can be readily translated into price impacts. Equilibrium prices in ETS are less straightforward in models, given their intricate dynamics and integration complexities. Employment impacts are often overlooked owing to assumed perfect competition in factor markets, which implies full employment.

3.2.1 Domestic carbon-pricing schemes

A number of trends emerge from the existing literature. On average, emissions notably decrease with carbon pricing, particularly in sectors with relatively inelastic demand (for example, transport) and in institutional set-ups with high taxes or high carbon prices. However, without complementary policies, emissions cuts may trigger output and job losses, and hence the risk of economic decline. Direct household transfers prove most efficient in offsetting the economic drawbacks and provide a potential "double dividend". This notion integrates economic and environmental goals, suggesting that revenue from environmental taxes can simultaneously address ecological objectives and foster positive macroeconomic results such as increased employment and economic growth (Grottera, Pereira and La Rovere 2017).

Ex ante analysis. As shown in subsection 3.1, the introduction of a carbon-pricing tool, other factors being unchanged, is projected to adversely impact on both production and emissions reduction, as observed in general equilibrium simulations. This inverse relationship between carbon cost, on one hand, and gross domestic product (GDP) and emissions, on the other, is consistently observed.

To address the balance between environmental policy and economic activity necessitates complementary strategies, as demonstrated in Table 7.2. Studies like Grottera, Pereira and La Rovere's (2017) for Brazil and Liu and Lu's (2015) for China propose that channelling carbon tax revenues into productive endeavours (for example, endogenous corporate or production taxes) can significantly mitigate GDP losses. Meanwhile, Telaye et al. (2019) for Ethiopia, and other research, suggest that lump sum transfers may surpass proportional tax reductions in effectiveness.

Calculations can be performed to accurately evaluate the reform options and their cost-effectiveness. Table 7.2's final columns provide ratios of GDP and employment changes to emissions. Lower values indicate greater efficiency in emissions reduction from GDP or employment perspectives. Positive values confirm the trade-off discussed earlier. Negative values signify a disconnect

Table 7.2 Ex ante *analysis results for carbon taxes*

Country	Reference	Method/ data	Carbon price (US$/ tCO_2e or % of product price)	GDP variation (%)	Emissions (%)	Use of carbon revenues	Employment variation (%)	Policy elasticity (GDP)	Policy elasticity (employ-ment)
Brazil	Grottera et al. (2017)	SAM 2002–2003 data (Static)	4.7	–3.1	–5.94	Endogenous budget deficit	–3.76	0.52	0.63
			9.5	–5.4	–10.6		–6.68	0.51	0.63
			4.7	–1.5	–3.92	Endogenous consumption tax	–2.38	0.38	0.61
			9.5	–2.5	–6.8		–4.05	0.37	0.60
			4.7	0.29	–2.96	Endogenous production tax	–1.10	–0.10	0.37
			9.5	–2.1	–7.45		–3.88		
	Pereda et al. (2019)	Input–output model (Static)	10	–0.2	–1.2	Endogenous budget deficit	–0.21	0.17	0.18
			50	–1	–6.0		–1.03	0.17	0.17
			35.68	0.47	–3.4	Reform of domestic tax system	0.53	–0.14	–0.16

Country	Reference	Method/ data	Carbon price (US$/ tCO_2e or % of product price)	GDP variation (%)	Emissions (%)	Use of carbon revenues	Employment variation (%)	Policy elasticity (GDP)	Policy elasticity (employ- ment)
China	Liu and Lu (2015)	CASIPM-GE	16	–8.15	–1.17	Endogenous budget deficit	–0.31	6.97	0.26
				–8.49	–1.10	Endogenous consumption tax	–0.33	7.72	0.30
				–7.13	–0.29	Endogenous production tax	–0.25	24.59	0.86
	Bi, Xiao and Sun (2019)	MCHUGE model (2020–2030)	3.6	–0.13	–0.297	Endogenous budget deficit	–0.038	0.44	0.13
			ETS	0.02	–0.089		–0.058	–0.22	0.65
			Hybrid	–0.1	–0.364		–0.01	0.27	0.03
Ethiopia	Telaye et al. (2019)	IFPRI model (2018–2030)	From 5 in 2018 to 30 in 2030	–1.6	–1.2	Endogenous sales taxes	–1.4 (urban)	1.33	1.17
				–0.74	–0.52	Transfers to households	–1.0 (urban)	1.42	1.92
				–1.6	–1.18	Endogenous public savings	–1.4 (urban)	1.36	1.19
				–0.83	–0.73	Endogenous personal income tax	–1.4 (urban)	1.14	1.92
				–1.7	–1.16	Endogenous corporate tax	–0.9 (urban)	1.47	0.78

Country	Reference	Method/data	Carbon price (US$/ tCO_2e or % of product price)	GDP variation (%)	Emissions (%)	Use of carbon revenues	Employment variation (%)	Policy elasticity (GDP)	Policy elasticity (employment)
Iran	Moosavian, Zahedi and Hajinezhad (2022)	CGE model	10%	–1.38	–24.2	Endogenous budget deficit	0.1	0.06	–0.01
			20%	–1.55	–40.3		0.2	0.04	–0.01
			30%	–1.91	–51.2		–0.8	0.04	0.02
South Africa	Alton et al. (2014)	CGE (2010–2025)	3 rising to 30	–1.23	–40.4	Endogenous indirect sales taxes	–0.56	0.03	0.01
			3 rising to 30 + CBA	–1.07	–41.4	Endogenous corporate tax	–0.5	0.03	0.01
			3 rising to 30 + CBA	–0.59	–41.5	Endogenous social transfers	–0.82	0.01	0.02
			3 rising to 30 + CBA	–1.65	–41.6	Endogenous budget deficit	–1.27	0.04	0.03
			CBA abroad	–1	–21		–0. 83	0.05	0.04
	Ward and de Battista (2016)	UPGEM model (2015–2035)	8.5	–0.2	–33	Endogenous budget deficit	–1.4	0.01	0.04

Country	Reference	Method/ data	Carbon price (US$/ tCO_2e or % of product price)	GDP variation (%)	Emissions (%)	Use of carbon revenues	Employment variation (%)	Policy elasticity (GDP)	Policy elasticity (employ-ment)
Thailand	Puttana-pong et al. (2015)	Monte Carlo CGE model (2010–2019)	6.2	–0.3	–0.7	Endogenous budget deficit	−0.7	0.43	1.00
			12.6	–0.9	–1.5		−1.5	0.60	1.00
			18.9	–1.2	–2.4		−2.4	0.50	1.00
Türkiye	Kolsuz and Yeldan (2017)	CGE model, 2010 data (2015–2030)	30	–7.2	–31.8	Endogenous green jobs	–9.5	0.23	0.30
				1.6	–25.6	Endogenous green jobs plus endogenous labour tax	13	–0.06	–0.51

Notes: SAM = social accounting matrix. CGE = computable general equilibrium. CASIPM-GE is a dynamic CGE model of the Chinese economy developed by the Institute of Policy and Management. The MCHUGE model is a dynamic CGE model of the Chinese economy developed jointly by Hunan University and Monash University. The IFPRI model is a dynamic CGE model of the world economy developed by the International Food Policy Research Institute. The UPGEM model is a dynamic general equilibrium model of the South African economy developed by the University of Pretoria. "Static" refers to static CGE models that compare two different states of an economy, before and after the implementation of a carbon-pricing scheme. If a time period is reported in brackets, it implies that a dynamic CGE model has been implemented to simulate the effects of a carbon-pricing scheme during that period. Reported results still refer to pre- and post-policy-implementation equilibrium conditions. However, a full adjustment path has been explicitly considered.

between the activity and emissions reduction, but this scenario is seldom observed in the results.

The aforementioned ratios do not necessarily provide accurate shadow prices,[15] since cost-effectiveness is viewed via complementary policies, not via the carbon-pricing method itself. In Grottera, Pereira and La Rovere (2017), for instance, a carbon tax of US$4.7 per tonne of carbon dioxide equivalent (tCO_2e) results in a 1 per cent emissions reduction linked to a 0.52 per cent GDP drop and a 3.76 per cent employment decrease without revenue recycling. With an endogenous consumption tax, the GDP decline lessens to 0.38 per cent and the employment decline lessens to 2.38 per cent. For an endogenous production tax, a 1 per cent emissions reduction could even yield a 0.1 per cent GDP rise, although employment would still decrease by 1.10 per cent. These findings highlight the potential double dividend of revenue-recycling policies.

Maxim, Zander and Patuelli (2019) conduct a comprehensive meta-regression analysis incorporating 33 simulation studies, which collectively comprise 146 simulations. The objective is to explore the hypothesis of an employment double dividend. The research shows that tax policies and revenue-recycling measures play a significant role in determining the existence of an employment double dividend. These authors also note that the most effective combination of policies varies between European and non-European countries, underscoring the need for tailored, region-specific policy designs.

Ex post analysis. The global adoption of carbon taxation, which goes back to the early 1990s, allows empirical analyses of historical experiences. Regarding emissions impact, Green (2021) notes that carbon-pricing policies typically result in limited aggregate emissions reductions of 0 to 2 per cent annually, although specific sectors have shown substantial decreases. German manufacturers, for instance, achieved 25 to 28 per cent lower emissions between 2008 and 2010 than domestic counterparts in unregulated sectors, and their French counterparts saw 9.8 to 13.5 per cent reductions, attributed to fuel changes (Petrick and Wagner 2014).

Employment effects vary in carbon tax research. Yip (2018) examines the impact of the carbon tax introduced in British Columbia in 2008 – the first and most extensively studied in North America – upon labour markets. He

[15] Carbon shadow prices are a possible metric to assess the cost-efficiency of a given carbon-pricing scheme. Shadow prices represent the opportunity costs of reducing carbon emissions. The carbon shadow price is obtained by evaluating the economic loss owing to the reduction in carbon emissions. Economic losses can be expressed, for instance, in terms of GDP variations, but also in terms of changes in net employment.

notes a slight increase in unemployment among individuals with lower levels of education. Yamazaki (2017) evaluates the consequences for employment and identifies a favourable outcome. Azevedo, Wolff and Yamazaki (2023) uncover varied responses across industries but find no overall impact on employment, while Bernard, Kichian and Islam (2018) report a 4.5 per cent increase in overall employment from 2008 to 2016. The United Kingdom's electricity consumption carbon tax of 2001, according to Martin, de Preux and Wager (2014), reduced energy intensity and usage without detrimental effects on employment or business metrics. Flues and Lutz (2015) found no substantial impacts on German firms from an electricity tax. Hille and Möbius (2019) studied 33 sectors across 27 Organisation for Economic Co-operation and Development (OECD) nations and found favourable overall employment effects tied to energy and shadow price increases. On average, a 1 per cent energy price hike corresponded to a 0.32 per cent increase in employment, and similar shadow price growth led to a 0.21 per cent rise in employment. Variation existed among sectors and countries; manufacturing showed minor impacts and the services and agricultural sectors displayed significant positive outcomes.

European carbon tax analyses by Metcalf and Stock (2020) disclosed average positive effects on GDP growth and employment. Although occasionally statistically significant, the effects often were not statistically different from zero, indicating no discernible influence on GDP or employment growth rates. Importantly, the study refuted claims of negative macroeconomic repercussions of carbon taxation, finding no robust evidence for such impacts.[16]

Overall, the empirical evidence illustrates that carbon taxation has varied effects across countries and sectors. Although some sectors show significant emission reductions, the aggregate impact on emissions is limited. Employment effects also vary, with some studies reporting positive outcomes and others showing slight rises in unemployment. On the macroeconomic level, the evidence suggests that carbon taxes do not lead to discernible negative impacts on GDP or employment growth rates. However, it is essential to consider these results in the context of the specific policies and conditions of each country or region.

[16] In the study, the possibility of leakage is controlled for. However, any leakage that may have occurred in the EU from country-specific carbon taxes will negatively bias the results, that is, will overstate the harm of a carbon tax, relative to the effects of the tax under autarchy.

3.2.2 Carbon border adjustment schemes

As carbon border measures have not yet been fully implemented, evidence of their effects is obtained exclusively using *ex ante* analysis tools. Carbon border measures have been simulated in various contexts. As discussed in subsection 3.1, such measures are expected to affect production, both domestic and foreign, through their direct impact on trade flows. United Nations Conference on Trade and Development (UNCTAD) (2021) simulation results obtained for the EU CBA scheme suggest that the introduction of a carbon border tax to contain possible carbon leakage appears to work efficiently. It also exerts downward pressures on GDP. In particular, least-developed countries (LDCs) could be severely negatively affected by such mechanisms (UNCTAD 2022a).[17]

Alton et al. (2014) simulated the impact on the South African economy of a domestic carbon tax introduced together with a carbon border tax under different redistributive schemes (Table 7.2). The inclusion of a carbon border tax appears to reduce further emissions while imposing downward pressures on both GDP and employment. The imposition of carbon border taxes by trade partners alone could also negatively affect domestic production and employment.[18]

Veenendaal and Manders (2008) directly examine the effectiveness of a CBA policy on the competitiveness and carbon leakage of the EU, assuming that the EU is the sole adopter of this approach. Through a general equilibrium analysis, they quantitatively assess the impact of various policy scenarios, with a specific emphasis on the energy-intensive sectors regulated by the EU's ETS. Their findings indicate that, in the absence of a CBA (or a corresponding transfer mechanism like the Clean Development Mechanism – CDM), the introduction of a domestic carbon tax (or ETS) negatively affects production and employment within these sectors. However, the implementation of a CBA (excluding the CDM) can partially alleviate the decline in competitiveness, reducing the impact on production and employment by half.

Eurofound (2023) assess the impact of the Carbon Border Adjustment Mechanism (CBAM) in the context of the "Fit for 55" policy package to be implemented by the EU. At the EU level, "Fit for 55" has a modest yet positive net impact on GDP: a 0.19 per cent increase from benchmark levels over the period 2019 to 2030. The effect on net employment is marginally positive: a

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[17] Brenton et al. (2023) present an index of export exposure to the EU CBA mechanism for EU trade partners. The EU Carbon Border Adjustment Mechanism (CBAM) exposure index helps identify countries needing support to reduce carbon content in industrial products and boost competitiveness in EU markets.

[18] See UNCTAD (2022b) for a discussion about the theoretical mechanisms behind such effects.

0.10 per cent increase from benchmark levels. As the EU enhances its carbon pricing and reduces the allocation of free allowances to certain industries, their production costs increase more than in competing countries. This results in a loss of competitiveness, leading to decreased exports relative to benchmark levels. The introduction of the CBAM helps alleviate the loss of competitiveness in the EU internal market by applying a carbon price at the border to offset the costs of EU imports. It cannot fully prevent the anticipated export losses; nevertheless, the transition has an overall positive effect, since there is increased investment demand in emerging sectors – such as the production of efficient electric appliances, wind turbines, electric vehicles, and construction – compared with benchmark levels. Despite these positive aspects, the overall impacts remain marginal in light of the ambitious efforts of pre-existing climate policies.

3.2.3 Emissions trading

The evidence on ETS and cap-and-trade policies offers valuable insights, but limitations in their implementation to date constrain empirical investigations. As Green (2021) has discussed, although carbon taxes seem to outperform ETS in terms of mitigation effects, differences in results may arise from unreliable empirical strategies and insufficient long-term data. Some ETS experiences reveal effects beyond emissions, such as instances of increased value added and productivity in Norway (Klemetsen, Rosendahl and Jakobsen 2016), but decreased employment in covered sectors in France (Wagner et al. 2016). Petrick and Wagner (2014) show that in Germany the EU ETS did not reduce firms' employment, turnover or exports.

Dechezleprêtre, Nachtigall and Venmans (2018) demonstrate that the EU ETS led to a significant reduction in carbon emissions and had positive effects on firm-level performance in several European countries. Compared with non-ETS firms, ETS firms enjoyed greater employment and profits as well as higher revenue (16 per cent higher on average) and fixed assets (8 per cent higher on average). Smaller firms saw greater revenue increases, while larger firms demonstrated more capacity to pass carbon costs on to customers. Känzig (2023) finds that carbon pricing effectively reduces emissions but also leads to a decrease in industrial production and an increase in unemployment. Similarly, Zhang and Duan (2020) note that China's pilot ETS have negatively affected industrial output value. Furthermore, a notable decrease in employment within the covered industrial subsectors is observed; estimated coefficients show a decreasing trend between 2013 and 2015, indicating that the negative impact of pilot ETS increased year on year. The results suggest that, in the short term, China's pilot ETS have not effectively facilitated the decoupling of carbon emissions from economic output in the industrial subsectors. In spite of their aim of promoting carbon emissions reductions, these pilot ETS have been unsuccessful in avoiding a negative impact on competitiveness.

4. THE DISTRIBUTIONAL EFFECTS OF CARBON PRICING

Carbon-pricing policies can have distributional effects within the country implementing them. These effects can occur across firms and sectors. Participation in ETS tends to benefit larger firms. However, carbon taxes and cap-and-trade systems can be designed to generate similar distributional effects among participating firms.

4.1 Theoretical Insights

The impacts of carbon taxes and cap-and-trade systems on households can be similar, depending on revenue recycling and other factors.[19] Two components of the impacts can be defined. The first component, the so-called "use-side impacts", is the policy impact of carbon pricing on the relative prices of goods and services purchased by households – and, eventually, on household expenditures. The other component, the so-called "source-side impacts", reflects the policy impact on nominal wages, capital, transfers and, eventually, household income. Without revenue recycling, carbon pricing is generally regressive on the use side but progressive on the source side because the burden falls more on capital than on labour income.[20] Progressivity on the source side reflects the fact that carbon-intensive industries tend to be relatively capital intensive. As a result, the burden of carbon taxation falls more on capital than on labour and hence tends to reduce returns to capital more than returns to labour. Since capital income represents a larger share of total income in wealthier households than in poorer households, the impacts from reduced returns to capital are progressive.

When some revenue-recycling policy is in place, source-side impacts tend to dominate, making the overall impact of carbon pricing progressive. Lump sum transfers can further enhance progressivity, but tax rate cuts will be more

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[19] See, for instance, Metcalf (2016) and Stavins (2022) for an extensive discussion.

[20] A regressive policy implies a larger financial burden as a share of consumption (or income) upon lower-income households than on higher-income households; a progressive policy implies the opposite.

cost-effective – because of the double dividend effect discussed above – albeit less progressive.[21]

Carbon taxes and cap-and-trade systems can be designed to have similar distributional effects among firms, especially when allowances are auctioned, as shown by Goulder and Schein (2013). However, the impact may differ when allowances are freely distributed, with some firms emitting GHGs without direct costs. Equivalence between cap-and-trade with freely allocated allowances and a carbon tax with tradable tax exemptions for emissions is possible in principle.

The impact of carbon-pricing schemes on progressivity/regressivity in different countries remains an open question. Poorer households are likely to spend a higher portion of their income on carbon-intensive goods, but other factors, such as location, may influence spending patterns. For example, households in rural areas may have different consumption habits. The empirical literature seems to suggest that carbon-pricing instruments tend to be regressive in most high-income and some middle-income countries, but that they can be progressive in some lower-income countries (Dorband et al. 2019; Alonso and Kilpatrick 2022). Nonetheless, findings from microsimulations also show that, in most countries, uncompensated price increases can lead to increases in the absolute number of people living in poverty and to increases in the depth of poverty of those households already below the poverty line (Malerba, Gaentzsch and Ward 2021; Cuesta Leiva, El-Lahga and Ibarra 2015; Schaffitzel et al. 2020). Particularly in low- and middle-income countries, this effect is largely driven by the indirect impact that higher energy prices also have on food, transport, and agricultural inputs such as fertilizer. The evidence of potential negative welfare effects of carbon-pricing instruments does not preclude fossil fuel price reform, through either carbon taxation or the removal of subsidies. The potential fiscal, environmental and distributive benefits of both direct and indirect carbon-pricing mechanisms are enormous (Parry, Black and Vernon 2021). However, it is important to estimate welfare impacts before making such reforms and to invest in adequate social protection to cushion negative impacts and compensate households for price increases, including by recycling the revenues from the reforms. This is key to avoiding spikes in poverty and to the acceptability, effectiveness and credibility of the reforms. Further empirical evidence is needed to precisely understand the profiles of carbon-pricing schemes, since the degree of regressivity is expected to be influenced by country-specific characteristics.

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[21] See, for instance, Goulder et al. (2019).

4.2 Quantitative Assessments and Empirical Evidence

4.2.1 Domestic carbon tax

Dorband et al. (2019) used a computational approach to compare the effects of a US$30 per tCO_2e carbon tax across 87 low- and middle-income countries. Their microsimulation model, combined with econometric estimates of energy Engel curves, showed that the carbon tax would be progressive for lower-income countries and regressive for higher-income ones. The strongest regressive effect was observed in Bosnia and Herzegovina, where the lowest-income group, relative to their income, would pay more than three times as much as the country average. In Belarus, Serbia, Montenegro and South Africa, this figure was 1.5 times. On the other hand, most sub-Saharan African countries, as well as lower-income countries in South East Asia and Latin America, exhibited progressive outcomes.

On average, countries with per capita incomes below about US$15,000 would experience progressive effects from the carbon tax, whereas higher-income countries would experience regressive effects. This US$15,000 threshold is linked to the fact that energy expenditure shares increase up to a household per capita income of around US$8,000–10,000 (adjusted by a purchasing power parity deflator) and then decrease. This pattern results mainly due to differences in energy expenditure between urban and rural households. Since higher-income countries tend to be more urbanized, urban households using more transportation and having access only to taxable energy sources, the impact on poorer households is more significant in these countries.

According to International Monetary Fund (IMF) (2019) projections, the regressivity of a carbon tax varies according to the country's specific characteristics. In developed economies, higher-income households spend more on energy, but such expenditure constitutes a larger proportion of disposable income for lower-income households. A US$50 per tCO_2e carbon tax in 2030, without accompanying measures, would be moderately regressive in China and the United States and neutral in Canada. This progressivity arises from lower-income households allocating a higher share of their budget to electricity. Simulations also suggest that a third to a half of the increased energy price burden on households indirectly results from higher general consumer product prices.

In developing countries, however, results are mixed. IMF (2019) projections indicate that the carbon tax would be moderately progressive in India. Progressive impacts are also obtained in Indonesia (Yusuf and Resosudarmo 2015), Viet Nam (Nurdianto and Resosudarmo 2016) and Mexico (Renner 2018). Regressive impacts are found in South Africa (Devarajan et al. 2011), Malaysia and the Philippines (Nurdianto and Resosudarmo 2016) and Brazil (da Silva Freitas et al. 2016). Results, however, may vary with the different computational or empirical strategies adopted. For instance, van Heerden et al. (2006) find a progressive carbon tax in South Africa, and not a regressive one as in Devarajan et al. (2011).

4.2.2 Emissions trading

Känzig (2023) demonstrates that, under the EU ETS, low-income households experience a greater impact than high-income households in two distinct ways. First, they face a more significant and noticeable increase in their energy expenses. This can be attributed to the fact that these households already allocate a higher proportion of their income to energy costs and that financial constraints limit the flexibility of their demand for energy. Secondly, low-income households face a more pronounced decline in their income.

High-energy-intensity sectors do experience a lesser decline in incomes than do lower-intensity sectors, but the differences are not significant. However, the sensitivity of sectors to demand plays a crucial role. More demand-sensitive sectors witness more substantial income reduction, whereas less demand-sensitive sectors see more restrained responses. This difference in sensitivity explains the variations in income responses. When these sectors face a carbon policy shock, demand decreases, leading to lay-offs and compensation cuts by companies. As low-income households are more prevalent in these sectors, they bear a disproportionate impact and hence suffer a significant reduction in discretionary income. This forces economically disadvantaged households, already facing financial limitations, to make more substantial expenditure cuts.

These findings provide additional evidence that carbon policy shocks have a significant impact on the economy, not only through the conventional cost channel but also through the demand side. A novel insight from Känzig's (2023) study is that where households are heterogeneous the influence of the demand channel may be even more pronounced.

5. IMPLICATIONS FOR POLICY

Carbon pricing is pivotal to countering global warming, yet the potential adverse economic and distributional effects must be considered. Tax reforms, coupled with labour market policies, can improve fairness and employment while minimizing transition challenges.

To optimize the reduction of carbon dioxide emissions and to minimize societal costs, countries must act on three fronts: policy design, complementary measures and societal acceptance and adhesion. It is crucial to address global spillovers and emissions leakage. International cooperation is required to combat global warming in our interconnected world.

5.1 Carbon-Pricing Scheme Design and Revenue Recycling

No consistent trade-off is observed between cost-effectiveness and distributional fairness when one considers households and the relationship between households and firms. The complexity of designing and implementing a carbon-pricing policy package is evident in the wide range of input parameters and outcomes which reflect the unique socio-economic conditions of each country.

5.1.1 Picking the most appropriate carbon-pricing scheme

Although cap-and-trade schemes and carbon taxes are theoretically able to generate similar environmental, economic and distributional results, practical considerations may significantly influence a government's choice of carbon-pricing scheme. The chosen scheme should be the best adapted to prevailing economic and social conditions. Carbon taxes are transparent about the price to be paid per unit of carbon dioxide equivalent emissions. This is not the case in ETS, where prices are a market outcome and can be affected by several factors beyond the government's control. However, whereas the impact on GHG emissions is only imprecisely known in the case of a carbon tax, cap-and-trade systems clearly define a ceiling for GHGs from the covered sectors. In the presence of a well-functioning fiscal system, a carbon tax may be favoured, so long as the affected economic agents accept its implementation. Emissions-trading systems based on cap-and-trade systems may be less problematic from a societal point of view, but their design and implementation require careful and well-informed fine tuning.

5.1.2 Carbon-pricing schemes and scope

The implementation of carbon-pricing initiatives remains limited; in 2023, they covered only 23 per cent of global GHG emissions.[22] To make them more effective in reducing emissions will require expanding the coverage across various sectors. Research by Nong et al. (2020) suggests that broader sectoral coverage leads to a smaller negative impact on GDP while achieving more significant emissions reduction. Full sectoral coverage with a carbon price of US$36 per tCO_2e is more efficient than partial coverage requiring a price of US$109 per tCO_2e. This may be a crucial consideration in deciding the sectoral coverage of an ETS or a carbon tax scheme.

The EU's "Fit for 55" package plans to increase sectoral coverage – for example, by including the maritime sector in the EU ETS. Reforming the

[22] Data retrieved from https://carbonpricingdashboard.worldbank.org/ on 20 December 2023.

functioning and institutional rules of ETS can further improve such schemes' impact in reducing GHG emissions. Phasing out free allowances, as the EU intends to do for aviation and sectors covered by the CBAM, can incentivize decarbonization efforts.

Effective carbon taxation may necessitate broadening the tax base or increasing tax rates. Austria's Eco-Social Tax Reform Act 2022 aims to gradually raise the carbon tax to reduce GHG emissions. However, carbon pricing can lead to increased production costs and potential negative effects on domestic production, exports and the labour market. To address competitiveness concerns, governments often provide direct or indirect rebates as part of a broader tax reform.

A large and inclusive sectoral coverage of either a carbon tax or an ETS could facilitate governmental intervention and redistribution schemes to promote fiscal equity and carbon-pricing neutrality for the most disadvantaged households.

5.1.3 Recycling revenues from carbon pricing

Quantitative assessments and empirical evidence emphasize the importance of recycling carbon-pricing revenues for cost-effectiveness and progressivity. However, the recycling of carbon-pricing revenues is a sensitive political issue that requires attention and transparency. By redirecting revenues from carbon pricing to reduce other more distortive taxes, such as labour and income taxes, and simultaneously providing targeted support to vulnerable groups and those most impacted by the transition, a balance can be achieved between revenue neutrality, equity and substantial emissions reductions. Redistributive policies protect lower-income households and aid the transition of energy workers into greener jobs. Fullerton and Metcalf (2002) argue that simply implementing carbon taxes without considering existing distortions in commodity and factor markets may not reduce GHG emissions in a cost-efficient manner.

Recycling the revenue generated from carbon pricing plays a crucial role in the concept of the double dividend. This approach would lead to environmental improvements through reducing emissions and simultaneously addressing distortions caused by other revenue-oriented taxes. Lump sum transfers to individuals would support redistributive policy objectives (the so-called "carbon tax and dividend strategy"), while a general fiscal reform or financial support to firms (the so-called "double dividend strategy") would support cost-effectiveness.

Känzig (2023) simulates how different carbon revenue redistribution schemes affect the transmission of carbon policy shocks in the EU. Redistributing carbon revenues has significant consequences: it has a smaller impact on aggregate consumption and income than does non-redistribution; however, it has a smaller effect on the emissions response as well. A redistribution scheme stabilizes the income of poor households, leading to a smaller change in their consumption behaviour, since they have a higher marginal propensity to consume. Capital owners experience a more prolonged income decline but can smooth the impact on their consumption over time. As a result, carbon revenue redistribution reduces consumption inequality among different groups, including capital owners.

According to World Bank (2022) findings based on simulations for four European countries (Bulgaria, Croatia, Poland and Romania), increasing carbon prices will generally have a positive impact on employment, but the effects will be uneven, leading to some challenges for low-income individuals. The impact of carbon prices varies considerably across different sectors, occupations and countries, owing to their specific economic structures. However, in all four of those EU countries the overall impact on equity can be progressive if the carbon tax revenues are used to expand social assistance and related policies and to help workers to transition to new job opportunities during labour market transitions.

Where there are both broad sectoral coverage of carbon-pricing schemes and widespread direct effects among households, governments may consider introducing effective social protection schemes with a strong focus on the least-endowed households, as discussed in Chapter 8.

5.2 Labour Market Entrepreneurship Policies

Hille and Möbius (2019) indicate that job losses arising from carbon-pricing schemes are often a matter of job reallocation rather than complete loss. The extent of reallocation depends on accompanying policies, including revenue recycling and labour market interventions. Some sectors are affected differently by carbon pricing: mining faces significant job declines, whereas electricity and services sectors see job growth. Studies like that of Azevedo, Wolff and Yamazaki (2023) suggest that carbon taxes may generate job opportunities in local services. Energy-intensive manufacturing will experience job losses, but reallocation to energy-efficient firms is observed by Dussaux (2020). In France, a higher carbon tax could lead to an 8.7 per cent emissions reduction and 0.24 per cent workforce reallocation in manufacturing. Marin and Vona (2019) note varying impacts of energy prices on workforce skills; these impacts favour technicians but negatively affect manual workers. Rising energy prices accounted for between 9.2 and 17.5 per cent of the increase in the share of technicians between 1995 and 2011. They also accounted for between 4.2 and 8.0 per cent of the decrease in the share of manual workers.

These findings suggest the need to implement complementary labour market policies to support affected workers and facilitate smoother job transitions between firms. Proactive skills development for greener roles would support an inclusive and equitable transition, bolstering worker employability and enterprise adaptability for new green initiatives (see Chapter 9). Although many skills are transferable, active labour market support, such as retraining and upskilling programmes, significantly helps workers to transition across diverse sectors.

Firms respond to environmental policies by modifying inputs, emissions reduction strategies, technology usage and market participation. A wide breadth of adjustments in firms is vital to help mitigate the labour market consequences of carbon taxes (Shapiro and Metcalf 2021). However, many climate policies disregard micro-level market failures, impeding sustainable practices and the adoption of carbon-efficient technologies. Decarbonization necessitates substantial adjustments, possibly widening the productivity gap between firms in developed and developing countries. Customized support initiatives are vital to encourage firms to adopt mitigation measures. Distributive programmes and global transfers can help bridge this divide between firms in developed and developing countries. As discussed in section 4, carbon pricing disproportionately affects smaller firms, influencing the extensive margin adjustment (Shapiro and Metcalf 2021). These firms' reactions to carbon-pricing schemes should be of particular concern.

5.3 International Coordination and Cooperation

Although developing countries may ultimately benefit from global mitigation initiatives, owing to their heightened vulnerability to climate risks, they may have limited short-term incentive to undertake expensive emissions reductions. The majority of developing nations may have difficulty mobilizing domestic funds to facilitate the transition to cleaner technologies. These countries' institutional capacity to implement carbon-pricing mechanisms like ETS could also be restricted.

International cooperation is crucial to combating global warming effectively. Advanced countries should fulfil their commitments to providing climate finance to help less developed economies adopt cleaner technologies. The International Energy Agency (IEA) (2021) estimates that the objective of net zero carbon emissions by 2050 will expand the annual investment in energy from just over US$2 trillion globally on average during 2015–2020 to about US$5 trillion by 2030 and US$4.5 trillion by 2050.

The formation of climate clubs is seen as a vital step for international coordination (see Nordhaus 2015), but it may exclude and discriminate against developing countries,[23] especially with the implementation of CBA schemes

[23] Members of the climate club would introduce domestic carbon taxes and impose a uniform tariff on non-participants to incentivize them to join the club.

like the European CBAM. The identification of exceptions to these schemes is essential for cooperation, but such exceptions require careful consideration, since some developing countries' exports may be influenced by transnational entities and global value chains, which will lead to leakage and ineffective emissions reductions. One solution could involve imposing conditions on waivers to carbon border measures, including establishing active ecological transition policies funded by international financial transfers.

A more comprehensive solution would involve implementing carbon-pricing schemes in most countries, reducing the need for CBA and avoiding unfair international competition. However, equity concerns may arise if carbon price uniformity is expected. To address this, lower charges would be justified in less developed countries to support poorer individuals' consumption. In such cases, international transfers would play a central role in helping countries achieve distributional objectives in their ecological transition strategies.

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8. Social protection and active labour market policies for inclusive green structural transformation[1]

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1. INTRODUCTION

Green structural transformation is necessary to transition the world to net zero carbon emissions and keep climate change within the temperature boundaries defined by the Paris Agreement. The policy and market responses required to reduce emissions can have both positive and negative consequences for people. Green structural transformation has the potential to create opportunities for green growth, decent jobs creation and poverty eradication, but these benefits are not automatic. In fact, without social protection and labour market support, existing inequalities may be exacerbated and disadvantaged groups may be left behind. Moreover, even if temperature increases can be limited, climate change is already adversely affecting people and society, demonstrating the need for adaptation (Intergovernmental Panel on Climate Change (IPCC) 2023b).

To leverage the opportunities of green structural transformation, while at the same time helping people to manage the risks of both the transition and climate change itself, just transition principles are critical (International Labour Organization (ILO) 2015 and 2023a).[2] Without a just transition, public support

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[2] The *ILO Guidelines for a Just Transition towards Environmentally Sustainable Economies and Societies for All* (ILO 2015 – reaffirmed in 2023)

for and acceptance of green transformation policies may be undermined, which could slow down, halt or even undo progress.

A just transition requires comprehensive and coordinated social protection and active labour market policies (ALMPs) (ILO 2024). Social protection can protect people from the adverse impacts of climate change as well as from the negative effects of transition policies, and ALMPs can facilitate people's (re) integration into the labour market (see Box 8.1). In the context of facilitating labour transitions during the green structural transformation, social protection and ALMPs have a greater impact when implemented in a coordinated manner.

BOX 8.1 DEFINITIONS OF SOCIAL PROTECTION AND ALMPS

"Social protection", or "social security", is defined as the set of policies and programmes designed to reduce and prevent poverty, vulnerability and social exclusion throughout the life cycle. Social protection includes both contributory (social insurance) and non-contributory (tax-financed) schemes across nine areas: child and family benefits, maternity protection, unemployment support, employment injury benefits, sickness benefits, health protection, old age benefits, disability benefits and survivors' benefits.

"Active labour market policies" seek to reduce unemployment and maintain individuals' attachment to the labour market by: (i) matching job-seekers with current vacancies through direct job search assistance or information provision; (ii) upgrading and adapting the skills of current job-seekers in order to improve their employability; (iii) providing incentives to individuals or firms to take up certain jobs or hire certain categories of workers; and (iv) creating jobs either in the form of public sector employment or by the provision of subsidies for private sector work.

Sources: ILO (2021a and 2016); ILO, International Social Security Association (ISSA) and Organisation for Economic Co-operation and Development (OECD) (2021).

This chapter begins by outlining the role that social protection and ALMPs can play in supporting labour market transitions during the green transformation. It goes on to review the role of social protection in addressing the negative impacts of potential price increases on people throughout the energy transition

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provide a policy framework for operationalizing a just transition which represents a joint commitment by governments and employers' and workers' organizations.

and then discusses how social protection can help people to adapt to climate risks. The chapter concludes by reflecting on what a green structural transformation will require of both the policy design and the financing of social protection systems and ALMPs.

2. ENSURING SMOOTH LABOUR MARKET TRANSITIONS THROUGH COORDINATED SOCIAL PROTECTION AND ALMPS FOR GREEN STRUCTURAL TRANSFORMATION

Although globally the net employment effects of green structural transformation are likely to be positive, the process will not be smooth for all workers (see Chapter 1). Social protection and ALMPs can help address employment disruptions associated with green structural transformation. Social protection and ALMPs are complementary and most effective in smoothing the transition of workers when implemented in a coordinated manner (ILO 2021a; Asenjo, Escudero and Liepmann 2022). By providing income security and access to health care, social protection benefits allow workers to find a new job that matches their skills and experience without having to resort to negative coping strategies, such as taking up low-quality jobs in the informal economy. Yet, social protection alone is frequently not sufficient to safeguard and improve workers' skills and employment prospects (ILO 2020a). Likewise, ALMPs achieve more sustainable and inclusive results when implemented in combination with temporary income support measures (ILO 2023a). This is particularly important for disadvantaged job-seekers in developing countries, including young people, women and people with disabilities, who often face significant economic barriers to participation in ALMPs (Asenjo, Escudero and Liepmann 2022; ILO 2016). Such barriers may include the cost of transportation, care responsibilities or other direct and indirect costs affecting participation in ALMPs.

A range of social protection and ALMP instruments can support workers during the process of green structural transformation (see Figure 8.1). The recommended mix of instruments will depend on various factors, such as the maturity of social protection and labour market policies and institutions, labour and social security legislation, the level and structure of informality, and the number, location and profile of workers affected. National assessments of the employment impacts of the transition policies, the social protection system and the ALMPs landscape can help identify which instruments are most suited to supporting labour market transitions throughout the green structural transformation (see section 4).

Social protection measures that can provide temporary income support to workers affected by the green transition include unemployment benefits, social assistance and, when affected workers are already close to retirement age,

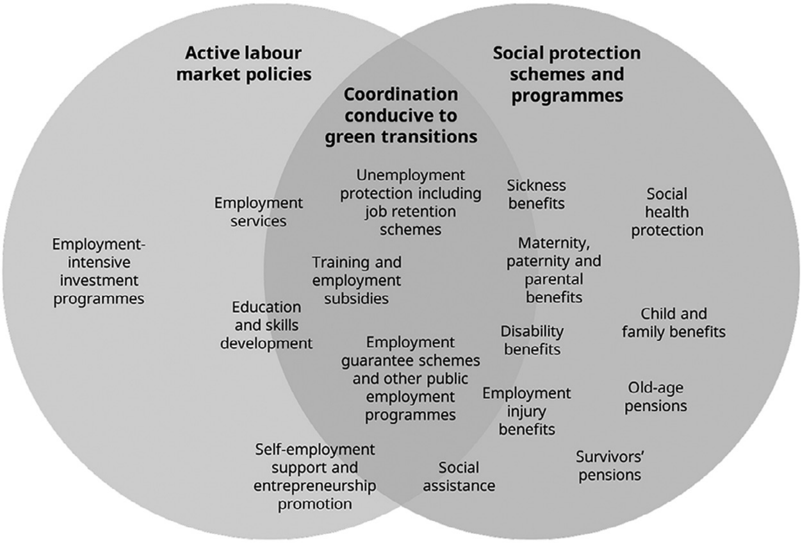


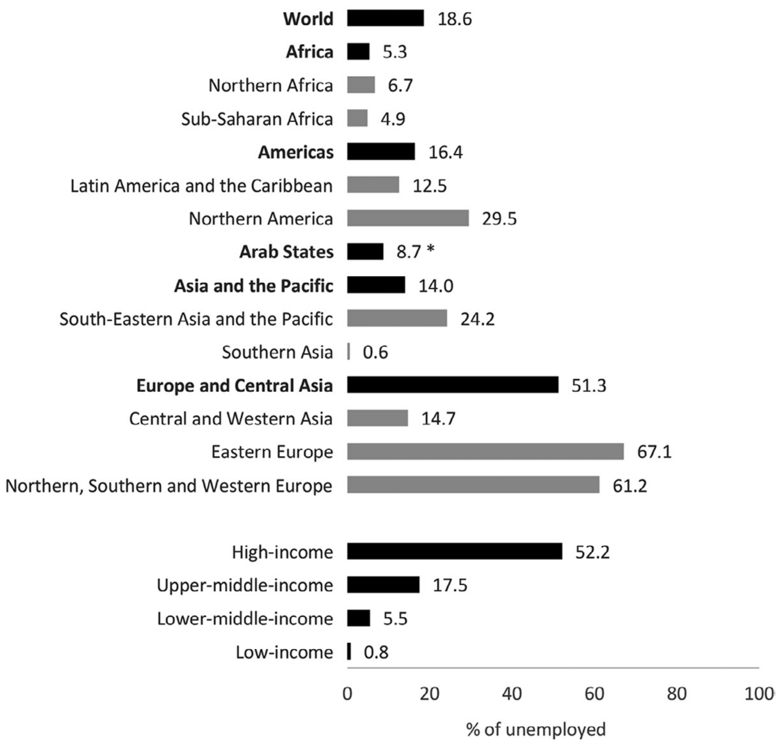
Figure 8.1 *Coordination between active labour market and social protection policies to support the green structural transformation*

pre-retirement or early retirement pension arrangements. It is also essential to ensure uninterrupted access to other social protection measures, such as access to health protection.

Unemployment benefits can provide temporary income support for involuntarily unemployed or underemployed workers during the green transition.[3] Such provision may necessitate adjusting the eligibility conditions of unemployment insurance schemes, by shortening qualifying periods or covering those who have not contributed enough through tax-financed benefits, to ensure that all affected workers have access to temporary income support when needed (ILO 2020b). To facilitate the transition into a new job, unemployment benefits should be combined with effective employment services, skills development measures, training, and employment subsidies or other ALMPs.

Many countries do not yet have unemployment protection schemes in place. Globally, only 18.6 per cent of unemployed people receive unemployment

[3] Unemployment benefits can be provided through either (contributory) social insurance schemes (unemployment insurance), or less frequently through (non-contributory) tax-financed mechanisms (unemployment assistance), or through a combination of both.



Note: The regional estimate for Arab States should be interpreted with caution, since it is based on reported data coverage of less than 40 per cent of the population.
Source: ILO (2021a, Figure 4.29).

Figure 8.2 SDG indicator 1.3.1 on effective coverage of unemployment protection (percentage of unemployed persons receiving cash benefits, by region, subregion and income level, 2020 or latest available year)

cash benefits (ILO 2021a; and see Figure 8.2). Moreover, most unemployment protection schemes cover salaried workers in the formal sector, largely excluding self-employed workers and workers in the informal sector (Peyron Bista and Carter 2017). Where unemployment insurance coverage is low, governments should consider including, within just transition packages, the provision of temporary income support to workers who have been negatively affected. They should also take note that unemployment protection schemes may require transfers from the government in periods of crisis or transition, to accommodate higher demand and allow the extension of coverage to uncovered populations (ILO 2021a).

Social assistance schemes can provide basic income support to affected workers where unemployment protection schemes do not exist or where regular unemployment benefits have been exhausted. Social assistance schemes usually provide lower levels of benefit than does unemployment insurance. They are usually tax funded and means tested, and so eligibility is restricted to households living in poverty.

Early retirement pensions have been used in transition contexts to provide income security for affected older workers in circumstances in which they are unlikely to find new employment but have not yet reached the regular pensionable age.[4] For example, early retirement options were offered during the phase-out of coal mining in Germany and Spain for affected miners above the ages of 58 and 48, respectively (World Resources Institute (WRI) 2021a and 2021b). In both cases the involvement of unions, businesses and the government enabled socially acceptable collective agreements to be reached. However, in recent years there has been a trend to limit opportunities for early retirement in an effort to increase the retirement age in the context of population ageing (ILO 2013 and 2019a). In these all cases, ALMPs, in combination with income support measures tailored to the needs of older workers, have an even more important role in facilitating green transition in a spirit of inter-generational solidarity.

Active labour market policies are interventions and programmes to directly influence and improve labour market outcomes – in particular, reducing unemployment, improving workers' employability and enhancing the efficiency of labour markets. Active labour market policies are targeted interventions that are typically directed towards disadvantaged groups in the labour market, such as women and young people. Although the primary function of ALMPs has been to achieve full employment, developing countries have adopted economic and social goals resulting from the need to reduce poverty and inequality (Malo 2018; ILO 2016). Amidst the climate crisis, ALMPs can help meet environmental objectives conducive to green structural transformation. They can improve the employability and labour market attachment of workers, job-seekers and inactive people through training, job search assistance, and intermediation in the green economy. They can support labour demand by promoting decent green jobs through wage subsidies and create temporary

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4 Provision for early retirement is an integral part of the old-age insurance system, usually conditional upon arduous working conditions or long contribution histories, yet this instrument has also been used to deal with the large-scale displacement of workers or long-term unemployment of older workers.

employment through green works programmes while skilling workers for the green economy. Furthermore, ALMPs can help to bring about a green business environment by equipping workers with relevant skills and satisfying employers' labour force needs through employment services. Active labour market policies can, therefore, influence the demand and supply of labour as well as working conditions in green or greening sectors, thus easing the transition to a carbon-neutral economy while ensuring that no one is left behind (ILO 2015). There are five main categories of ALMPs:

- *Employment services* facilitate matching and intermediation to support the transition of people into employment through job counselling, job search assistance, and/or mentoring services for activation (or reactivation), which are often complemented by job placement and technical or financial assistance. They can be provided either through entirely public provision or via partnership with private actors, involving countries' public employment services (PESs) and/or well-regulated private employment agencies.
- *Public employment services* and training institutions can develop strategies to support laid-off workers, workers at risk of losing their jobs because of skills obsolescence, and workers who want to reskill or upskill for the green economy (see also Chapter 9). As hiring costs are high, especially for micro, small and medium-sized enterprises, employment services can support them by referring their workers to training institutions that will equip them with the skills necessary to green the production of goods and services, and by supplying them with green-skilled workers. They can equally provide self-employment support and entrepreneurship promotion to start or expand a sustainable business. Employment services can promote job matching and training assistance for job-seekers to work in enterprises that adhere to high environmental standards. Public employment service staff can also be trained to provide counselling and career advice to support occupational mobility from polluting to greener sectors and jobs.
- *Education and training* include all organized, systematic education and training activities in which people obtain knowledge and/or learn new skills for a current or future job or to increase their earnings, improve their career opportunities in a current or other field, or generally improve their opportunities for advancement and promotion. As part of ALMPs, education and training can equip workers with skills in demand in the green economy (see Chapter 9). Training subsidies can be provided to the unemployed, to workers at risk of unemployment because of the decarbonization of industries, and to workers in enterprises in the process of becoming green (ILO 2023a).
- *Self-employment support and entrepreneurship promotion* are labour demand interventions that aim to provide advisory services and to facil-

itate access to finance and markets for unemployed and inactive individuals who are willing to start an economic activity, for example as micro-entrepreneurs. These programmes can increase the climate resilience of microenterprises while providing guidance and support to make them green.

- *Employment subsidies* are financial incentives paid to firms to either preserve existing jobs (for example, short-term work schemes) or create new ones (for example, hiring and wage subsidies) by reducing the wage bill. Hiring and wage subsidies can be provided to enterprises in green or greening sectors to promote the creation of green jobs and to facilitate the hiring of workers with the skills required to expedite the transition to a green economy.
- *Employment-intensive (investment) programmes* (EIIPs) are short-term (emergency) employment initiatives and longer-term public employment programmes (PEPs) that aim to create employment through productive activities, including in the aftermath of a natural disaster or a crisis. Employment-intensive (investment) programmes are also a way for governments to invest in public goods and services that contribute to climate change adaptation and mitigation, including through nature-based solutions (see Chapter 3). Frequently serving double objectives of protection and activation, EIIPs provide space for sustainable coordination between ALMPs and social protection measures.

Evidence suggests that integrated packages of ALMPs[5] and income support could lead to particularly effective outcomes with positive impacts for individual workers, enterprises and the economy as a whole (for example, Asenjo, Escudero and Liepmann 2022), including in developing countries. Moreover, income support can facilitate better job search and matching as part of ALMPs, by allowing workers more time to conduct their job-seeking. Finally, a coherent framework of integrated ALMPs and income support, together with social protection coverage in other areas such as health, will help tackle long-standing barriers that trap workers in working poverty and will improve work quality (Asenjo, Escudero and Liepmann 2022), effectively freeing them from the poverty trap.

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[5] Integrated packages of ALMPs consist of several interventions such as career guidance, training and job matching, delivered in a coherent manner as part of the activation offer for job-seekers.

3. ADDRESSING THE IMPACTS OF ENERGY-TRANSITION-RELATED PRICE INCREASES THROUGH SOCIAL PROTECTION

Beyond labour market impacts, some climate policies may have negative implications for people, and particularly for lower-income households. This is especially the case with carbon-pricing policies, including the removal of fossil fuel subsidies (see Chapter 7). One negative impact is that of potential rising energy prices on households. Countries have several options to cushion such impacts, including the provision of direct income support through a country's social protection system, as well as price support measures (for example, fixed or capped prices, reduced taxes, fees and excises, or exemptions and rebates), or reducing income taxes (Arregui et al. 2022). However, the reduction of income taxes may not reach many affected households in countries with high levels of informality, and price support measures are likely to weaken the price signals of carbon-pricing instruments and thus undermine their effectiveness as a climate change mitigation policy (OECD 2022a). Expanding social protection with the help of revenues from environmental fiscal reforms allows countries to simultaneously pursue goals of poverty reduction, social inclusion and climate change mitigation (Vogt-Schilb et al. 2019; Malerba 2023).

Social protection systems can identify and adequately support those parts of the population most affected by carbon-pricing policies or other cost-of-living shocks arising from transition, while still allowing price signals to incentivize energy savings and switching to lower-emission fuels. Integrating transition-related income support into social protection systems allows well-designed, cost-effective, equitable and sustainable policy responses, especially when prices remain elevated for an extended period of time (OECD 2022a).

Countries' social protection systems, whether well developed or nascent, provide a variety of avenues to reach individuals and households suffering from increased prices:

- *Expanding and increasing child or family benefits and supplements* to compensate for a higher cost of living, especially food and energy costs. According to the United Nations Children's Fund (UNICEF), in several countries recent price shocks disproportionally affected families with multiple children and with lower incomes, owing to the greater share of food and energy expenditure in their household budget. Universal or quasi-universal child benefits provide strong policy options to channel support to families (ILO, UNICEF and Learning for Well-Being Institute 2024).

- *Existing social assistance or unemployment benefit programmes* can be expanded to reach those already income insecure and therefore likely to be at particular risk of no longer being able to meet their basic needs because of price increases. For example, in Portugal in 2022, additional support was provided to low-income households through an 8 per cent increase in the country's social support index, which is the reference for calculating, for example, family allowance, social inclusion benefit and social insertion income; this impacted on the lives of 1.6 million beneficiaries (Sgaravetti et al. 2023). A carbon-pricing simulation study for six countries showed that three social protection reform scenarios – topping up existing benefits, expanding coverage to more people, and new categories of benefits – cushion the overall drop in mean income and consumption significantly at the bottom of the distribution range (Gasior et al. 2024). For example, in Ecuador, South Africa or Viet Nam, an increase in the value of existing tax-financed benefits would lead to a significant reduction in poverty, given the already high coverage rates. Where big coverage gaps exist, increasing benefit values does not necessarily yield the best cushioning effects for the lower quintiles, which would be better served by increasing coverage, for example in South Africa and Zambia. Research also highlights the potential of expanding existing social protection measures in the context of fossil fuel subsidy reform. For example, findings from Ecuador show that removing all energy subsidies and increasing the benefits from the Bono de Desarrollo Humano cash transfer programme by US$50 per month would increase the real income of the poorest quintile by 10 per cent (above pre-subsidy reform levels), while still leaving more than US$1.3 billion in subsidy savings for the public budget (Schaffitzel et al. 2020).
- *Introducing new benefits* for specific categories of the population can be an interesting policy option to stabilize income and consumption across the population, especially in countries where poverty is widespread, as, for example, in Zambia and the United Republic of Tanzania. Potentially easier administration can reduce the burden on nascent systems compared with means-tested approaches (Gasior et al. 2024).

The impact of price increases across households can be highly heterogeneous, depending on multiple factors, including housing location and quality, household composition, and access to energy and public transport. Therefore, policy responses, whether provided as part of the social protection system or through other means, need to take into account these determinants of households' financial vulnerability to energy price hikes (OECD 2022a):

- Energy price allowances can be paid through existing non-contributory or contributory social protection schemes, such as unemployment benefits or pensions. In Spain, for example, the annual Thermal Social Bonus was increased permanently, eligibility being based on the existing Social Bonus for low-income households, pensioners, those with permanent disabilities, and large families, all of whom receive a discount on electricity in the form of a monthly voucher (Endesa 2023).

- Energy-related allowances are often implemented for a limited period to address temporary price hikes, as, for example, in the case of Austria's Climate Bonus, a one-off lump sum universal payment automatically transferred to those who already receive social protection benefits, such as pensioners, and recipients of child benefits, nursing care allowances, unemployment or student benefits.[6] However, targeted transfers in low- and middle-income countries without adequate identification systems, comprehensive social registries and effective delivery systems may be difficult to implement (McCord and Costella 2023). Direct income support may be more viable through existing social protection programmes with relatively high coverage (ILO 2021a).
- Compensation for increases in heating costs linked to energy efficiency measures can be provided through social assistance or housing or unemployment benefits or as stand-alone measures. In Germany, for example, the "Housing Benefit Plus Act" aims to increase the size of housing benefits by about 100 per cent as well as the number of households receiving them from 600,000 to about two million by 2023 (Federal Government of Germany 2022). A permanent heating cost component and climate component (surcharge on the maximum amount of the rent or charge) was also added as a flat rate to simplify administration and incentivize people to save energy (Federal Government of Germany 2022). Other measures include extraordinary rent reductions in social housing for vulnerable tenants, as in Denmark's 2023 inflation support measures (International Energy Agency (IEA) 2023a), or support in kind, as under the United Kingdom's Home Upgrade Grant, which aims to target 25,000 low-income households by providing funds to local authorities, providers of social housing, and charities, for energy efficiency upgrades linked to the Social Housing Decarbonisation Fund (Department for Energy Security and Net Zero 2023). Such measures, however, can come with increased costs through higher overheads and may not lead to the best solutions for end consumers, compared with individual transfers targeting low-income households through social protection programmes.
- Transport support may include allowances or reimbursements for commuters to use local public transport or subsidized transportation that can be

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6 https://www.klimabonus.gv.at/en/.

provided either stand-alone or as part of other social protection schemes. For example, France's "Energy Sobriety" plan, which aims to consume less energy and improve energy efficiency, includes a transport component by offering employees a sustainable mobility package of up to €700 per year, which is exempt from social security contributions and can be combined with public transport reimbursement of up to €800 (Sgaravetti et al. 2023). Subsidized public transport services can mitigate the impact of one of the largest indirect price rises induced by carbon taxes and energy subsidy reform and so reduce household consumption costs, but their effectiveness in reducing welfare losses will depend on mobility patterns and therefore be highly context specific (McCord and Costella 2023).

- In sectors affected directly by price increases, enterprises and workers can also be temporarily supported through benefits provided by unemployment insurance – including unemployment benefits and job retention benefits (short-time work benefits) (ILO 2020b) – or through severance pay, in particular in the case of workers who have contributed to a (sector-wide) social security fund or worked for a certain period of time at an affected company. Employment guarantee or other public employment programmes can provide some income security when the cost of living is increasing, and can help workers to safeguard and develop their skills and eventually transition to other (greener) jobs and livelihoods (see section 2). In Uruguay, the National Social Emergency Response Plan (PANES) was implemented during an economic crisis in the early 2000s; it combined cash transfers (Ingreso Ciudadano) with a five-month public works scheme (Trabajo por Uruguay), which included a training component and job search assistance (ILO 2019b).
- Contributory schemes can be adapted in a similar way to non-contributory mechanisms – for example, through increased benefits (or rather reductions in social security contributions), relaxation of eligibility requirements, or extended (mandatory) coverage. For example, in Switzerland, carbon tax revenue was used to reduce social contributions made by employers, and households benefited from tax reductions (Metivier and Postic 2018). Several studies using data from Spain found that the macroeconomic impact tends to be more positive if revenues are recycled to reduce social security contributions rather than to reduce indirect or capital taxes (Labandeira, Labeaga and Rodriguez 2004; Estrada and Santabárbara 2021). However, such measures must always ensure that sustainable and equitable financing of social insurance is not compromised.

Considering the low coverage and large exclusion errors, particularly in lower-middle-income countries, inclusive green transition may require strategic investment in social protection systems with suitable programme design and implementation (see section 5).

4. ADDRESSING THE SOCIO-ECONOMIC IMPACTS OF CLIMATE HAZARDS: REDUCING VULNERABILITY, BUILDING RESILIENCE AND SUPPORTING ADAPTATION

A successful green structural transformation will require robust mechanisms to address the short-term and longer-term socio-economic impacts of climate hazards. Although climate change affects everyone, vulnerability to climate hazards is higher among locations and people with high levels of poverty, limited access to basic services and resources, and highly climate-sensitive livelihoods (for example, smallholders, pastoralists and fishing communities) (IPCC 2023a). Children, people with disabilities, and older people are particularly vulnerable to the impacts of climate hazards. Climate hazards are likely to increase poverty among those who are already living in poverty and to push many others into poverty. According to some estimates, climate change could result in an additional 100 million people living in extreme poverty by 2030 in the absence of effective measures to reduce vulnerability and to support adaptation (Hallegatte et al. 2016). These risks could potentially derail efforts to accomplish a green structural transformation, and therefore need to be taken into account in policy responses to improve preparedness.

Climate hazards can increase poverty and vulnerability through a range of channels. Extreme climate-related events destroy assets, disrupt livelihoods and children's education and lead to negative coping strategies and adverse effects on health and mortality, which in turn lead to further adverse effects on well-being in the medium and long term (such as poverty traps). Extreme events and gradual changes also impact on agricultural productivity and crop yields, which can in turn negatively affect food prices and food security, as especially seen in sub-Saharan Africa (IPCC 2023a). Higher temperatures can also reduce labour productivity; this particularly affects the incomes of workers who are more likely to work outside or without access to air conditioning (Hallegatte et al. 2016; ILO 2019c). Sectors that are particularly affected are agriculture, construction and tourism, as well as manufacturing in factories without effective cooling systems, for example (ILO 2018). Finally, extreme events and higher temperatures lead to more injuries, the spread of waterborne, vector-borne and infectious diseases, heatstroke and the disruption of chronic disease management and care (Tennison et al. 2021; Shreya Louis et al. 2021). Given that, particularly in low- and middle-income countries, coverage of social health protection is low and out-of-pocket expenditure can be significant, a rising incidence of disease and injury places additional financial and psychological strain on people, especially disadvantaged groups such as children, older people and people with disabilities, who are both significantly more affected and less protected (ILO 2023b).

Social protection can help people manage the risks from climate change in various ways, including by preventing and reducing poverty (which in turn reduces vulnerability to climate-related hazards), ensuring there is effective access to health care, smoothing consumption during shocks, and enabling long-term adaptation of livelihoods (Costella et al. 2023). The stronger the coverage, adequacy and comprehensiveness of the social protection system, the more prepared countries are to help their populations manage climate risks. Better coordination between social protection and ALMPs can increase the economic and labour market benefits of climate-responsive policies and investments directed to a human-centred, green structural transformation.

4.1 Reducing Vulnerability and Enhancing Resilience through Social Protection

An extensive body of evidence shows that social protection systems prevent or at least reduce poverty throughout the life cycle (Bastagli et al. 2016) and enhance the capacity of individuals and societies to prepare for, cope with and recover from shocks. Recent crises have shown how social protection systems, including both social insurance and non-contributory (tax-financed) schemes, act as automatic stabilizers, have positive impacts on food security, consumption, educational attainment, health and savings and can prevent negative coping strategies in response to shocks.

Emerging evidence shows that, by preventing – or at least reducing – poverty, social protection systems can reduce vulnerability to climate hazards (Agrawal et al. 2020). For example, Zambia's child benefit programme was found to mitigate the negative impact of weather shocks such as rainfall failure, particularly on the poorest households (Asfaw and Davis 2018). The COVID-19 pandemic has also shown that programmes designed for stable periods can play important stabilizing roles during crises (ILO 2021a). For example, during the economic shock from COVID-19, Bolivia's near universal non-contributory pension prevented declines in food security and reduced income insecurity in multigenerational households; low-income households experienced the greatest positive benefits (Bottan, Hoffmann and Vera-Cossio 2021).

Social health protection, too, plays an important role in reducing vulnerability to climate change. Such schemes provide people with access to health care without hardship as well as income security in times of sickness and maternity. They reduce the need for out-of-pocket or catastrophic health expenditure or forgone income, a function that is particularly important given the impact of climate change on the prevalence and transmission of injuries and diseases. Both the prevention of hardship owing to catastrophic health expenditure *and* the general improvements in health indicators support people's productive and adaptive capacity and reduce poverty, thereby also reducing climate vulnerability.

However, the coverage, adequacy and comprehensiveness of social protection systems, including social health protection, is lowest in the regions and among the groups that are disproportionately vulnerable to climate change. About 80 per cent of the population of the 58 countries that are part of the Climate Vulnerable Forum (CVF)[7] do not have access to any form of social protection, compared with 53 per cent of the total world population (ILO 2021a).

4.2 Harnessing Social Protection Systems for Disaster Response

While a green transition will help to reduce climate risks, adequate crisis responses are essential to prevent an increase in vulnerability. Social protection plays an important role in responses to disasters. In the event of a crisis, a quick response at scale can be achieved by temporarily expanding existing schemes and programmes either horizontally (adjusting the coverage to reach affected populations) or vertically (adjusting the benefit value to account for increased needs) (Asfaw and Davis 2018; McCord et al. 2021; ILO 2021a). Such expansions may use programmes that are designed for a different purpose, for example child benefit programmes, simply because they have the widest coverage or strongest existing delivery systems. However, especially in climate-vulnerable countries, existing programmes often have low coverage and inadequate benefit levels and therefore a limited ability to provide the necessary income support when disaster strikes. The strengthening of social protection systems to try to cover all life cycle risks for all people will enable these systems to respond better to disasters and other crises.

Efforts to strengthen specific programme design, delivery and financing in combination with disaster risk management (DRM) strategies, so that the social protection systems can provide additional support to people affected by large-scale climate shocks, are often referred to as "adaptive social protection" or "shock-responsive social protection".

Some countries have implemented national programmes that are specifically designed to address climate risks by means of inbuilt scalability frameworks

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[7] The CVF is a global partnership of countries that are disproportionately affected by the consequences of climate change. The CVF is an extension of the V20.

linked to climate indicators. In Kenya, the Hunger Safety Net Programme (HSNP) provides regular support to chronically food-insecure households and can expand to provide additional support to regular and existing households in response to drought-related triggers. Similarly, in Mozambique, the Direct Social Action Programme – Post Emergency (PASD-PE) can be activated in the event of emergencies, including natural disasters, to provide temporary cash benefits to affected populations. In all cases, it is crucial that eligibility, transfer values and duration, triggers and financing are predefined and that these parameters are anchored in laws, policies and protocols so that support is provided on a predictable and rights-based basis, rather than ad hoc. In a similar way, existing social health protection mechanisms help to facilitate access to health care during disasters. Although a lot of work related to expanding social protection programmes in response to climate shocks revolves around social assistance programmes and other non-contributory programmes, adapted social insurance and ALMPs can also play an important role in providing support during disasters (Sengupta, Tsuruga and Dankmeyer 2023; ILO 2023b).

4.3 Coordinated Approaches to Enabling Long-Term Adaptation of Livelihoods

Access to social protection is essential to help small-scale farmers and other workers dependent on natural resources to adapt their livelihood and/or diversify their income sources. Evidence shows that many social protection programmes designed to address life cycle risks increase investment in productive assets, including livestock and agricultural inputs, and/or encourage a diversification of income streams which decreases reliance on livelihoods that are vulnerable to climate change impacts (Asfaw and Davis 2018) or climate-related policies and investment decisions.

However, social protection programmes alone are often not sufficient to achieve transformative outcomes in terms of shifting production practices and facilitating adaptation, especially when their design features do not consider climate-specific needs (Costella et al. 2023). Without appropriate guidance, some investments could even lead to maladaptation. Evidence shows that social protection programmes work most effectively to encourage long-term adaptation when they are integrated with livelihood promotion and diversification programmes such as agricultural extension services for the most vulnerable farmers, in-kind transfers (seeds, tools, etc.), and education and training for sustainable fishing or agriculture (Tenzing 2020). This approach follows a similar logic to the integration of social protection and ALMPs (see section 2), in which the role of social protection is to provide income security that allows workers to participate in labour market programmes, take risks and engage in forward-looking planning.

Income support conducive to increasing the ALMP participation of disadvantaged groups in sectors and occupations impacted by climate change can be provided through multiple channels. First, it can be a component of active labour market programmes, specifically targeting those who could otherwise not participate in them. Second, it can be delivered as part of national social protection systems, where these are available. Third, it can be provided by other stakeholders such as government agencies, non-governmental organizations and international development agencies. Income support provided by the second and third of these channels which is not conditioned upon participation in ALMPs could improve labour market outcomes for the green structural transformation if it is coordinated with labour market institutions such as PESs. Beneficiaries of income support from social protection systems could be referred to PESs for activation in greening or green sectors, while potential participants in ALMPs could be referred to social protection institutions, especially in developing countries where high levels of informality are prevalent. In these latter instances, coordination between institutions delivering ALMPs and social protection is critical.

5. DESIGNING AND FINANCING SOCIAL PROTECTION AND ALMP STRATEGIES FOR AN INCLUSIVE GREEN STRUCTURAL TRANSFORMATION

The previous sections have described why and how the green transformation needs to be accompanied by strong coordinated social protection and ALMP measures. This section provides concrete options and considerations in designing and financing social protection and ALMP systems to bring about a just transition in the context of green structural transformation (ILO 2024).

5.1 Designing and Implementing Social Protection and ALMPs for an Inclusive Green Structural Transformation

To harness their potential to facilitate a just transition, it is crucial that social protection and ALMPs are coordinated not only with each other but also with other sectors and policy areas involved in the green transformation. Although all countries have existing social protection and ALMP systems, these need to be coordinated, strengthened and prepared for the challenges arising from both the green transformation and climate change.

(a) *The design of social protection and ALMPs should be informed by estimations and modelling of the expected socio-economic impacts of green transformation policies.* This includes microsimulations of the impact on poverty and inequality of a carbon-pricing measure; estimates of the number and location of workers affected by mitigation and adaptation policies, including their age, gender and skills profile; and the spillover effects on the wider economy, including job losses in value chains. Estimation of the environmental policy impacts on poverty, inequality and employment may be complemented with costings of social protection and ALMP responses. Finally, evidence and data on the impacts of climate change itself, including the impact of extreme weather events on people's income security and livelihoods, can provide information about the likely changes in demand for social protection and ALMPs and the emerging risks that will require adaptations of the social protection system.

(b) *Social protection and ALMPs for a just transition require inter-sectoral policy coordination and planning.* A successful just transition that achieves both environmental and socio-economic objectives requires coordination between industrial, labour, social protection, education, environmental and fiscal policy frameworks (ILO 2015). Social protection and ALMPs also need to be explicitly reflected in climate change and transition policy strategies such as nationally determined contributions (NDCs), national adaptation plans (NAPs) and just transition plans. Social protection and ALMP policies and strategies must acknowledge the risks and opportunities arising from both climate change and the green transformation and include provisions for addressing these through their programmes. A coherent integration of climate and social protection policies is important because gaps on the policy level translate into gaps in financing and implementation.

(c) *Strong coordination among policymakers and implementers from different sectors, on national and subnational levels, is important, as is the participation of social partners in inclusive social dialogue.* Ministries of labour and social protection or social development as well as social protection and labour market institutions (such as PESs and social security institutions) need to be brought prominently into national just transition coordination groups to ensure that green transformation policies have strong social protection policies and ALMP components. To harness the contribution of social protection to building climate resilience and supporting adaptation, coordination mechanisms must be established between ministries of labour and social protection or social development, national DRM agencies, and ministries of agriculture. Ministries of finance need to coordinate green fiscal measures with ministries mandated to deliver social protection in order to ensure there is effective sequencing of carbon-pricing and compensation measures (see point (g) below).

(d) *The existing coverage, adequacy and capacity of social protection systems and supply of ALMPs should be regularly monitored to identify to what extent the system is adequately designed and resourced to support the new demands arising from green structural transformation and climate change.* For example, it may be important to assess the coverage of unemployment protection and ALMPs among workers affected by decarbonization policies, the adequacy of existing benefits in the context of climate risks, or the extent to which delivery systems are able to reach all those affected by potential price increases (usually the whole population) or climate-related disasters. Such analyses can be used to cost additional financing requirements and institutional capacities required to scale up provision to meet evolving needs. It is important to understand the effectiveness and responsiveness of the existing social protection system, since the shortcomings of the existing system are amplified when climate policies are introduced, and so these shortcomings need to be considered when transition reforms are being designed.

(e) *Even in countries with stronger social protection systems, eligibility criteria, targeting and delivery mechanisms may need to be reviewed to ensure that those affected are adequately supported.* In the German experience of transitioning away from coal, although the existing mandatory unemployment protection and pension schemes were very helpful in meeting the needs of affected workers, their families and communities, some specific additional measures were needed – in particular, higher employer pension contributions to the miners' pension insurance to allow for better retirement pensions for the years worked in mining (Furnaro et al. 2021).

(f) *Reliance on narrowly targeted social assistance programmes to support people affected by carbon-pricing policies risks making a significant part of the population worse off, an effect that could undermine the necessary public support for those policies* (Vogt-Schilb et al. 2019; Shang 2021; Malerba 2023). Although perfectly targeted cash transfers would be the most progressive redistributive option, in many countries this is unrealistic, since most poverty-targeted programmes have significant exclusion errors. For example, modelling the impact of a US$30 per tonne of carbon dioxide (tCO_2) tax in Brazil shows that, given targeting errors, about 20 per cent of the poorest quintile and 50 per cent of the second-poorest quintile would experience a net loss if compensation were poverty targeted (Vogt-Schilb et al. 2019). A universal cash transfer would fully offset the losses from carbon-pricing policies for everyone in the lowest two quintiles and for most people in the third quintile, whereas most people in the upper two quintiles would experience a net loss. While negative effects of carbon pricing often affect people across subgroups, depending on the policy's design, social protection benefits channel resources to specific age groups and household types. Therefore, analysis of their distributive effects is essential to inform policy choices on whether existing schemes can be used or the introduction of new schemes will be necessary (Gasior et al. 2024).

(g) *The sequencing of transition policies, social protection measures and ALMPs can affect their effectiveness.* In the case of carbon pricing and fossil fuel subsidy reforms, it is crucial to announce, explain and credibly deliver social protection measures before the implementation of the fiscal reforms (Malerba 2023). For example, the Iranian government started disbursing monthly cash to 70–80 per cent of households before removing subsidies in 2010. This is widely credited with having contributed to the successful reforms in the Islamic Republic of Iran (Rentschler and Bazilian 2017). On the other hand, Ecuador's attempt to remove fossil fuel subsidies in 2019 failed, partly because promised welfare payments were not delivered on time, leading to large-scale violent protests (International Institute for Sustainable Development (IISD) 2019). Social protection and ALMPs must be implemented simultaneously to take advantage of their mutually reinforcing protective and promotive effects. During Spain's coal transition, social protection measures were generally successful in maintaining consumption levels, but economic reactivation measures were sometimes too late or insufficient to enable a transition to alternative economic activities (WRI 2021b).

(h) *Social dialogue and the involvement of other stakeholders and public communication are indispensable to garnering popular support and ensuring an inclusive design of just transition policies.* In the case of industry closures, engagement with workers' and employers' organizations increases the support for green transformation policies, as is evidenced by Germany's and Spain's coal transitions (WRI 2021a and 2021b). Provision of clear information about the use of revenues from carbon pricing and subsidy reform can help to prevent social unrest and increase people's willingness to pay higher prices. A review of 25 fossil fuel subsidy reforms showed that 50 per cent of these reforms lacked a communication strategy and did not succeed (Sdralevich et al. 2014). In Canada and Switzerland, where revenues from carbon taxes were redistributed through reduced social security contributions, research found that most people were not aware of the link between the two measures (Mildenberger et al. 2022). In such a situation, people may perceive themselves as net losers from climate policies even when they are net beneficiaries.

(i) *Most importantly, a concerted effort is required to accelerate the closing of existing social protection coverage gaps, particularly in countries with high levels of informality.* This will require the extension of social protection to those who are not yet sufficiently covered, in a way that facilitates people's transition from the informal to the formal economy (ILO 2021b and 2022a). Higher social protection coverage rates reduce people's vulnerability to climate shocks, increase their adaptive capacity and place them in a better position to manage transition risks. Such efforts must include working towards universal delivery systems that can potentially reach the whole population, including to provide support in times of climate-related shock or energy price increase. Comprehensive social registries and digital tools for identification, registration and delivery (that is, payment) are essential if countries are to leverage their social protection systems to facilitate a just transition (Malerba 2023; McCord and Costella 2023).

5.2 Financing Social Protection and ALMPs for an Inclusive Green Structural Transformation

Ensuring the sustainable and equitable financing of social protection and ALMPs is indispensable to a just transition. The primary responsibility for providing social protection and access to ALMPs lies with national governments, and so these policies should be financed primarily from domestic revenues, including general taxation and contributions from employers and employees (Bierbaum and Schmitt 2022).[8] However, in low- and lower-middle-income countries, there are large financing gaps that translate into low coverage rates. In these countries, international official development assistance (ODA) and other transfers should play an important role to complement domestic resources at least temporarily to fill the large coverage gaps in social protection (Durán Valverde et al. 2020). In the context of climate change and green transformation, the role of global solidarity in financing is receiving increased attention and several international climate financing mechanisms and partnerships have been established.

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[8] For ALMPs, financing from general taxation is more common, yet contributions also play a role in some countries with strong unemployment insurance schemes.

This subsection presents a brief overview of the opportunities and challenges associated with financing social protection and ALMPs in the context of green structural transformation.

5.2.1 Ensuring there is sufficient fiscal space and incorporating new forms of taxation

To accommodate the impact of a green transformation, it will be important to create additional fiscal space for social protection and ALMPs, including in countries that heavily rely on income from fossil fuels for their growth and fiscal revenues and whose revenues from corporate taxes and royalties may decline as the demand for commodities such as oil, gas or coal decreases (Shang 2021; Mirzoev et al. 2020). Although the green transformation is giving rise to new industries, including the renewable sector, which is expected to at least partly offset the loss in revenues from fossil fuels, there are significant transition costs that need to be absorbed through social protection and ALMPs.

(a) *Environmental taxes, including carbon-pricing measures, and the removal of fossil fuel subsidies are possible sources of government revenue with significant growth potential and could create additional fiscal space for social protection* (ISSA, ILO and OECD 2023). In 2022, governments spent over US$1 trillion on fossil fuel subsidies (IEA 2023b). When one takes into account “implicit subsidies”, which the International Monetary Fund (IMF) defines as undercharging for the environmental costs of fossil fuel consumption (that is, forgone carbon taxes), this figure rises to US$7 trillion, or 7.1 per cent of global gross domestic product (GDP) in 2022 (Black et al. 2023). In 2020, it was estimated that closing the social protection financing gaps to provide at least a social protection floor would cost US$750 billion in upper-middle-income countries, US$363 billion in lower-middle-income countries and US$78 billion in low-income countries (ILO 2020c; Durán Valverde et al. 2020). In other words, the total financing gap for providing a social protection floor (US$1.2 billion) is less than 20 per cent of the implicit subsidies for fossil fuels.

(b) *Returning a significant share of the revenues to the population through social protection could garner public support for carbon-pricing policies.* Several studies argue that compensation can be achieved for relatively small percentages of the revenue raised, leaving scope for other areas of green spending (Alonso and Kilpatrick 2022). For example, across seven countries in Asia, modelling estimates show that the poorest 40 per cent of households could be fully compensated for the welfare loss from a carbon tax of US$50 per tCO_2 using less than a quarter of the tax revenues. However, the removal of fuel subsidies often constitutes a marked loss of disposable income for the emerging middle class, which can mean a significant increase in their vulnerability, and will need to be addressed through more inclusive policies (see section 5.1) to prevent vulnerability and increase the resilience of the population as a whole (ILO 2017).

(c) *In countries where carbon dioxide emissions are low and poverty is high, revenues from carbon pricing are unlikely to be sufficient to expand social protection enough to significantly reduce poverty and establish a social protection floor.* For example, estimates show that a carbon tax of US$20 per tCO_2 in the United Republic of Tanzania would only raise revenues equivalent to 0.2 per cent of GDP, given the country's low level of emissions (Gasior et al. 2024). It should also be noted that transitional earmarking of revenues from carbon taxes for social protection and ALMPs may not necessarily constitute a long-term source of financing. Other financing options need to be explored to guarantee at least a social protection floor, particularly in the face of the increasing climate risks that populations in the countries in question are facing.

(d) *Greater integration of disaster risk financing instruments in social protection financing is needed to enable a more effective and sustainable response to disasters through the social protection system* (UNICEF 2023). Such instruments may include contingency budgets, reserve funds and contingency credits or loans. National or regional governments may also make use of market-based risk transfer products such as insurance against losses from disasters. Anticipatory or forecast-based financing is an area of growing potential, since it is becoming increasingly possible to predict disasters before they strike. Disaster risk financing is usually embedded in a country's legal, policy and institutional arrangements; more work needs to be done to link disaster risk financing instruments to the social protection system, including its contingency plans for supporting people affected by climate-related disasters (UNICEF 2023). Care must, however, be taken that these additional sources do not displace other sources of financing that are necessary to the sustainable and equitable financing of social protection systems and ALMPs in the longer run.

5.2.2 Social security contributions throughout the green transformation

For social insurance to play a key role in the green transformation, some challenges and opportunities need to be well managed:

(a) *New jobs created through the green transformation must be decent jobs with social security.* This is a key element of integrated strategies to combine the promotion of environmental sustainability and the transition to formality of enterprises and workers (ILO 2022b), and to ensure there is a sustainable and equitable financing mix from social security contributions and general taxation.

(b) *Social security funds should factor climate risks into their reserves and their actuarial valuations to secure the financial sustainability of social security schemes* (ISSA, ILO and OECD 2023). There are increasingly accurate and comprehensive forecasts of the long-term impacts and risks of climate change, which may need to be considered by actuarial valuations to ensure that funds will be resilient. Social security schemes may also need to factor climate risks into their available reserves and contingency funds and plans, particularly because there are more and more cases where social insurance schemes are used to respond to climate shocks. For example, in Jamaica and Fiji, members of social insurance funds were allowed to make one-off withdrawals when the countries were affected by severe hurricanes. When factored into the reserves, such adaptations can play an important role in consumption smoothing, but, if not managed carefully, unplanned withdrawals could threaten the long-term financial sustainability of the schemes (Sengupta, Tsuruga and Dankmeyer 2023).

(c) *Public social security funds need to consider how their investment decisions could facilitate a green transformation and avoid contributing to the ecological crisis through environmentally harmful or carbon-intensive assets in their portfolios.* Many public social security funds have started environmental, social and governance (ESG) investing (Sengupta, Tsuruga and Dankmeyer 2023). Where investment decisions are pivoted towards the renewable energy or other sectors linked to green growth, social security funds can help finance the green transformation. In ESG investment there is also a growing focus on infrastructure investments intended to enhance domestic growth, which in turn could generate more financing options for social protection in the future (ISSA, ILO and OECD 2023).

5.2.3 Complementing ODA with directing international climate finance to social protection

International transfers from developed to developing countries increasingly come in the form of climate financing – to support the mitigation of and adaptation to climate change. The United Nations Framework Convention on Climate Change (UNFCCC) sets out the principle of "common but differentiated responsibility and respective capabilities", which means that developed countries are to provide financial resources to developing countries to implement the objectives of the UNFCCC (2023). Although total international climate financing has been increasing every year, by 2020 only US$83.3 billion of the promised US$100 billion per annum had been mobilized. Currently, most climate financing is provided in the form of loans, mainly targeted at mitigation actions in middle-income countries. Adaptation finance continues to grow but remains far below the required levels (OECD 2022b).

As the contributions of social protection to climate change adaptation, mitigation and loss and damage are recognized, there are growing opportunities to leverage international and regional climate funds and partnerships to finance social protection and ALMPs as key elements of climate policies.

(a) *Multilateral climate financing could be a source of finance for social protection and ALMPs, but greater integration of policy agendas is needed to access these funds.* Several multilateral climate funds, including the Global Climate Fund (GCF), the Global Environment Facility (GEF) and the Adaptation Fund (AF), could potentially support projects that incorporate social protection and ALMP elements. To date, however, there are only a few examples of projects with an explicit link to social protection. For example, Paraguay's Poverty, Reforestation, Energy and Climate Change (PROEZA) project provides additional income support to households participating in training in climate-smart agroforestry (Green Climate Fund 2018). More progress needs to be made in mainstreaming climate change objectives in social protection policy and vice versa, for example by anchoring the role of social protection in NDCs and NAPs. This is a precondition for directing multilateral climate financing to social protection.

(b) *The potential of other international and regional financing partnerships to finance social protection and ALMPs should also be leveraged.* The G7 countries established the Just Energy Transition Partnerships (JETPs) to support emerging economies in their transition from coal, oil and gas towards renewable energies. The first JETP was agreed following the 26th United Nations Climate Change Conference (COP26), at which the G7 countries committed to initially mobilize US$8.5 billion to support the just energy transition in South Africa. It is reported that some of the funds will be invested in ALMPs for affected workers, including to support the development of small enterprises, the training of 90,000 mine workers, and the creation of employment opportunities for women and young people (European Commission 2021). In 2022, over US$20 billion were committed for the JETP in Indonesia and discussions are underway for JETPs in Viet Nam, Senegal and India (Seiler, Brown and

Matthews 2023). The European Union, meanwhile, set up in 2021 a Just Transition Fund which has designated €17.5 billion for the support of workers in carbon-intensive industries (Vedder 2022).

(c) *Social protection also plays a role in international funds that are emerging to address loss and damage,*[9] *most notably the Global Shield Against Climate Risks and the Loss and Damage Fund.* Such funds are supposed to be in addition to finance directed to adaptation and mitigation actions. The Global Shield is an initiative of the G7 and Vulnerable 20 (V20) countries and has a clear mandate to support social protection that addresses loss and damage.[10] The Global Shield seeks to provide rapid financial relief directly to households and businesses in response to disaster-related losses. Such provision includes prearranging finance for governments' disaster preparedness and response, and strengthening the shock responsiveness of social protection systems. Formal agreement on the establishment of a Loss and Damage Fund was reached during COP27 in 2022. However, the fund is yet to be operationalized and the role of social protection in its functioning is not yet defined.

(d) *Climate financing that is directed towards social protection and ALMPs needs to be used to strengthen systems (as distinct from short-term project-based payment mechanisms), especially in countries with emerging social protection systems and nascent labour market institutions.* This is important to reduce people's vulnerability to climate change in the longer term, support universal social protection and decent work objectives and facilitate a just transition in the context of green structural transformation. The stronger the foundational social protection system, the more effective it will be in supporting climate change adaptation, mitigation, and loss and damage objectives.

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[9] "Loss and damage" is a term used in United Nations climate negotiations to refer to the impacts of climate change that go beyond what can be addressed by climate change mitigation and adaptation actions. Loss and damage can be of an economic or non-economic nature and usually result from extreme weather events and slower-onset events such as sea level rise (Bhandari et al. 2024).

[10] https://www.globalshield.org/wp-content/uploads/2023/10/Global-Shield-Overview.pdf.

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9. Falling through the cracks? Skilling, reskilling and upskilling for job transitions

Hae Kyeung Chun

1. GREEN STRUCTURAL TRANSFORMATION AND ITS IMPLICATIONS FOR SKILLS DEVELOPMENT

The transition to decarbonized and resource-efficient economies and societies is bringing profound impacts upon labour markets by creating new jobs, causing some job losses and changing the skills composition of many jobs. Fulfilment of the transition's potential for job creation depends on the availability of workers with the right mix of foundational, technical and core (soft) skills (International Labour Organization (ILO) 2022a). It will not be possible to ensure the green transition is fair and inclusive without providing proactive and targeted training and support for workers at risk of unemployment and for specific vulnerable groups, including women, young people, older workers and people with disabilities. The reskilling and upskilling of workers, together with lifelong learning for all individuals, is therefore vital to fulfil the potential for job creation and to minimize the burdens of the transition to more climate-neutral economies and societies.

Skills play an essential role not only in improving the employability and adaptability of workers but also in advancing green structural transformation. A skilled workforce tuned to the needs of green transition will bring innovation, efficiency and cost-effectiveness – all of which can enhance the competitiveness and productivity of green businesses and enterprises. The transition to a green economy involves the adoption of new green technologies and processes that require specialized skills and knowledge. Investment in skills development therefore facilitates the necessary advancement, application and transfer of technologies. Moreover, green socio-economic transformation requires a shift towards more resource-efficient and low-carbon practices. This shift can be expedited by educating and training individuals to use resources in a more sustainable manner and by adopting low-carbon practices with a view to transforming workplaces, communities and societies.

1.1 The Employment Effects of Greening the Economy

The pressing need to decarbonize the global economy has brought increased scholarly and policy interest in assessing the employment implications of the green transition. It is widely recognized that the effects on employment are complex and not uniform, varying according to specific country contexts, industry, policy approaches, technological advancements, and societal readiness for the transition (see also Chapter 1). Although it is crucial to understand these localized nuances, it is equally imperative to examine the overarching global trends that characterize the evolving landscape of employment in the context of green structural transformation.

In 2019, ILO research estimated that close to 103 million jobs could potentially be created but nearly 78 million jobs could be lost by 2030 under two global policy scenarios – the energy sustainability scenario and the circular economy scenario (ILO 2019; see Box 9.1). Although a large majority of workers at risk of losing jobs could be reallocated to the same occupation in another industry within the same country, an estimated 24 million workers would not be able to find such opportunities. This suggests that, although most workers will be able to relocate to other sectors using their existing set of skills and some upskilling and training relevant to the new industry, the remainder will require substantial reskilling so they can transition into other occupations.

BOX 9.1 SCENARIO-SPECIFIC DETAILS AND ASSUMPTIONS

The energy sustainability scenario implements the energy pathways for each country and industry up to 2030 as laid out by the International Energy Agency (IEA) (2017) for the policy goal of limiting global warming to 2°C (the 2°C scenario). This scenario considers substitution of fossil-fuel-based energy by renewables and improvements in energy efficiency, taking into account changes in electricity and heat generation, industry energy demand, transport and construction. Inherent in this scenario is a projected rise in the share of electric vehicles in the transport sector and building improvements to achieve greater energy efficiency in the construction sector. The 2°C scenario is compared with the IEA's business-as-usual scenario that forecasts global warming of 6°C.

The circular economy scenario considers the shift away from current models typified as linear – extract, manufacture, use and discard – to the principle of produce–use–service–reuse. It explores the employment impact of a sustained 5 per cent annual increase in recycling rates for plastics, glass, pulp, metals and minerals, across countries, replacing the direct extraction of the primary resources for these products. This scenario also models growth in the service economy which, through rental and repair services, reduces the ownership and replacement of goods. The scenario considers a 1 per cent annual growth in the services sector to replace the corresponding demand for the ownership and replacement of goods. It is also compared with the business-as-usual scenario (the IEA 6°C scenario).

Both scenarios draw on gross domestic product (GDP) growth projections from the International Monetary Fund (IMF) and the IEA, as well as population growth estimates from the United Nations, alongside additional supplementary data sources.

Sources: ILO and Organisation for Economic Co-operation and Development (OECD) (2022); ILO (2018).

In both the energy sustainability and the circular economy scenarios, job creation is expected to outpace job destruction globally. This trend is well aligned with other global estimates based on different scenario assumptions. Recent ILO research examining the youth employment impacts of the green, digital and care transitions estimates that implementation of the policy measures in the green scenario could lead to a net increase in global employment of 37.2 million by 2030,[1] relative to the business-as-usual scenario (ILO 2022b).

Recent IEA estimates also indicate that the transition to clean energy is expected to generate 10.3 million net new jobs around the world by 2030 under the announced pledges scenario (APS), in which all announced climate pledges as of mid 2021 are met on time and in full, and that job gains would more than double to 22.7 million new jobs under the net zero emissions (NZE) by 2050 scenario, a full net zero clean energy transition (IEA 2021).

At the regional level, the European Centre for the Development of Vocational Training (Cedefop) suggests that, according to the European Green

1 The green policies modelled in pursuit of climate neutrality include: increasing the uptake of renewable technologies through subsidies, feed-in tariffs and regulations; improving energy efficiency in appliances and buildings through subsidies and regulations; and increasing the share of electric vehicles and the deployment of public recharging and refuelling points through subsidies and other measures.

Deal (EGD) skills forecast scenario, the implementation of policies supporting EGD goals would lead to an additional employment growth of 1.2 percentage points by 2030, which translates into around 2.5 million additional jobs in the European Union (EU). Although employment declines are expected in certain sectors such as mining and quarrying, implementing the EGD will bring net job gains in the EU.

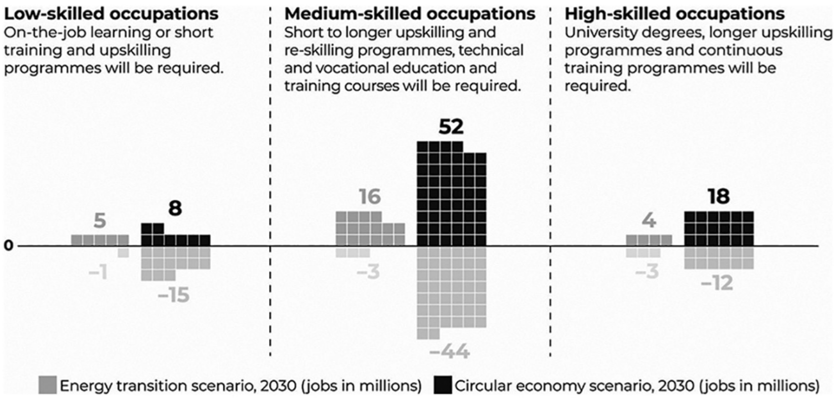
In the context of the COVID-19 green recovery and the fiscal and other policy measures undertaken, an assessment by the ILO and the Partnership for Action on Green Economy (PAGE) suggests that investments in renewable energy, building efficiency, green transport, and ecosystem restoration and reforestation projects could create a net gain, relative to the scenario of no policy action, of 20.5 million jobs worldwide by 2030 (PAGE 2021).

The above-mentioned and other various studies assessing the employment effects of greening economies are based on different assumptions and modelling methods; any scenario findings provide only suggestive approximations of future outcomes. Yet, they are useful in providing context and valuable insights to shape forward-looking ways of adapting employment and skills policies in response to rapidly changing labour market demands. To ensure clarity and consistency of analysis, the two ILO global scenarios outlined in Box 9.1 will be used as a basis for the analysis in this chapter.

1.2 Impact of the Green Economic Transformation by Skill Level and Gender

The impact of the green transition varies by skill level and gender. Although the green transition is likely to induce shifts in occupations across all skill levels, its impact varies significantly. Various studies indicate that higher demand is anticipated for occupations requiring higher skills (Chateau and Mavroeidi 2020; Bergant, Mano and Shibata 2022; Sanchez-Reaza, Ambasz and Djukic 2023). This transition necessitates a workforce with advanced expertise to undertake research, innovation, and green technological advancements. There is a concurrent emerging need for medium-skilled workers, encompassing roles such as technicians for renewable energy installations, energy-efficient retrofitting in construction, waste management, and skilled workers in sustainable agriculture.

For example, ILO research indicates that of the nearly 20 million and 70 million jobs created under the energy sustainability and circular economy scenarios, respectively, around 87 per cent of jobs created will be in medium- to high-skilled occupations (Figure 9.1). This suggests that the potential increase in demand for mid-skill occupations in the green transition may partly offset other labour market disruptions such as technology-induced job polarization (ILO 2019). It also highlights the important role of technical and



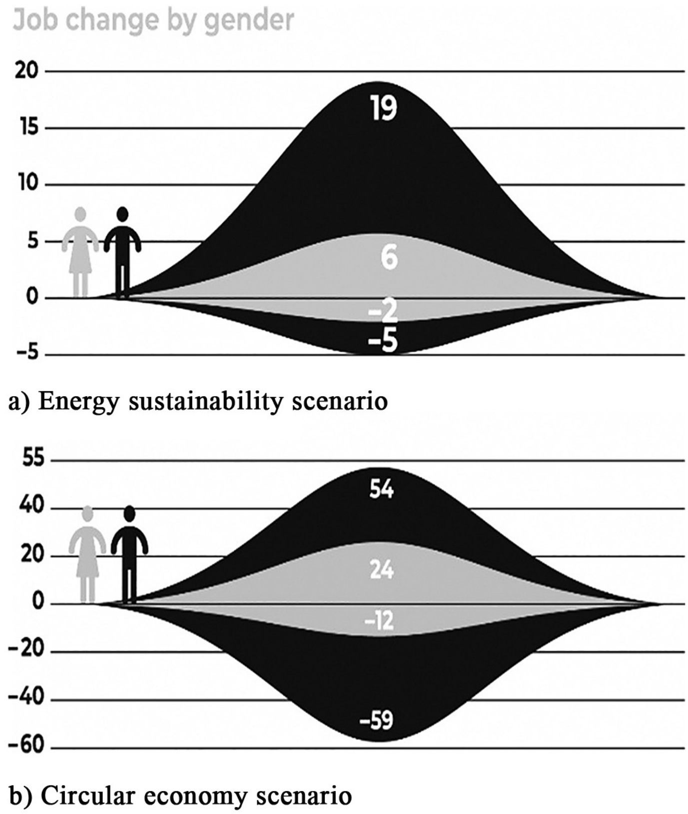
Source: ILO calculations based on EXIOBASE v3 and national labour force surveys.

Figure 9.1 Jobs created and destroyed in energy sustainability and circular economy scenarios, by skill level, to 2030

vocational education and training (TVET) in advancing the green transition, through providing relevant technical mid-skill-level training for the future workforce and supporting the reskilling and upskilling of current workers in medium-skilled occupations. Although the green transition will not generate more net jobs in high-skilled occupations than in medium-skilled occupations, these high-skilled occupations play a crucial role in developing groundbreaking green technologies and driving the green innovation that is vital to addressing climate and environmental challenges (Cedefop 2021).

However, net employment gains are not equally distributed among men and women in the labour market. Evidence from OECD countries shows that women are significantly under-represented in green jobs in comparison with men (OECD 2023a). Despite the urgent need for a skilled workforce in order to advance the green transition, gender disparities and biases that have persisted over time could hinder the transition and the equitable distribution of opportunities. Women often encounter barriers to entry and progression in green jobs; these barriers stem from historical gender role stereotypes, unequal access to education and training – particularly in fields essential to the green economy, such as science, technology, engineering and mathematics (STEM) – and a lack of supportive working environments (International Renewable Energy Association (IRENA) 2023).

The gender effect is more noticeable in the energy transition, which is expected to create many more job opportunities in occupations that are predominantly filled by men (Figure 9.2). This may be explained by the fact that



Source: ILO calculations based on EXIOBASE v3 and national labour force surveys.

Figure 9.2 Jobs created and destroyed in energy sustainability and circular economy scenarios, by gender, to 2030 (millions)

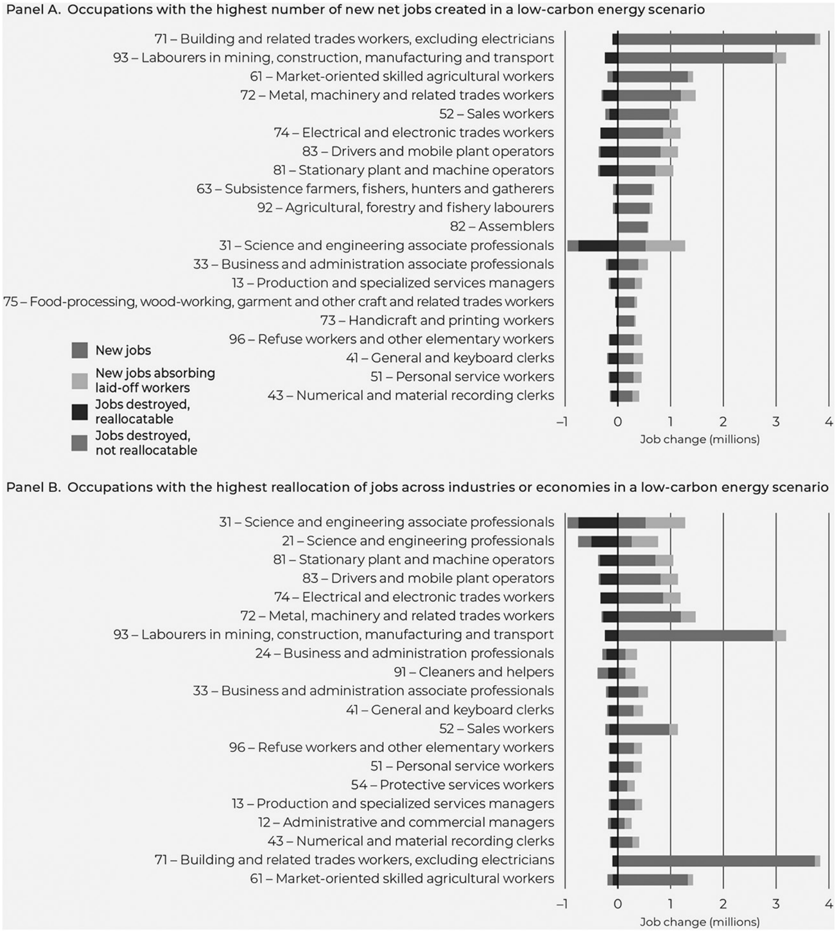
industries benefiting from the energy transition – such as construction, manufacturing and electricity production – are currently more male dominated than other industries (ILO 2019). Advancing the circular economy may increase employment chances for women, but that is not enough to offset the prevailing gender disparities. Moreover, some efforts to achieve gender equality in employment could bring the consequence of job losses for men.

Overall, in both the energy sustainability and the circular economy scenarios, the job creation and reallocation are most concentrated among mid-skill occupations, with the greatest impact in male-dominated occupations. Men in mid-skill occupations will have the greatest need of reskilling and upskilling to enable them to tap into new job opportunities. This implies that current occupational gender patterns are likely to continue till 2030 and therefore more job opportunities may arise for men during the green transition than for women (ILO 2019). The formulation of TVET and skills development policy, career guidance, social protection and active labour market policies (ALMPs) must thus take this into account and adopt a gender-inclusive approach so that the green transition does not accentuate current gender employment stereotypes and inequalities (see also Chapter 8).

1.3 Occupational Change and Transition Paths

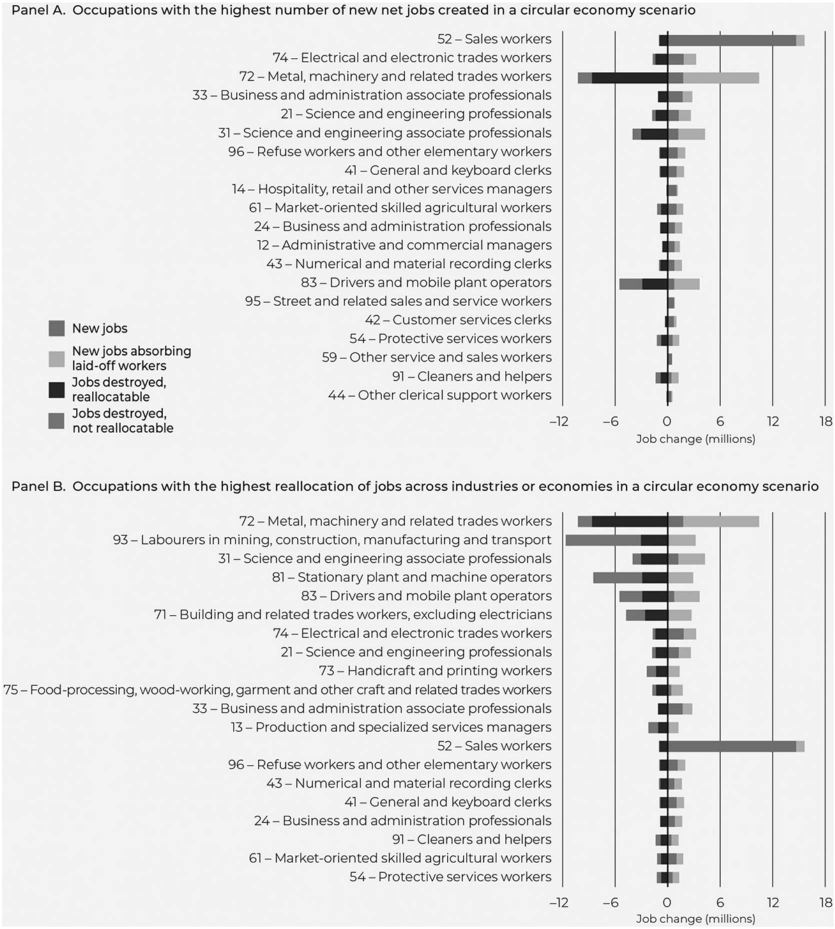
Most assessments of the labour market impacts of the green transition converge on the idea that new occupations will emerge in response to the growing prevalence of green economic activities and the advent of novel green technologies. Examples include solar photovoltaic installers and wind-turbine technicians, essential for the expansion of renewable energy infrastructure. Simultaneously, the green transition is anticipated to prompt within many existing occupations a transformation of the tasks they encompass, to align with the requirements of a green economy and the integration of new green technologies (European Training Foundation (ETF) 2023; OECD 2023b). For instance, construction jobs now involve the use of green materials, demanding new knowledge and techniques. The transformative process of the green transition is anticipated to exert a more pronounced influence on existing occupations and related tasks than in instigating the creation of entirely new ones, although some entirely new occupations will be created, especially at higher skill levels (Vandeplas et al. 2022; ILO 2022c).

Some 20 occupations have been identified that will see significant job growth, while some of these jobs will also undergo substantial changes or shifts in roles (reallocation) globally under the energy sustainability and circular economy scenario (see Figures 9.3 and 9.4) (ILO 2019). In the energy transition, the occupations that will experience the highest level of net job creation, requiring skills development among new and existing workers, include building and related trades workers; labourers in mining, construction, manufacturing and transport; market-oriented skilled agricultural workers; metal, machinery and related trades workers; and sales workers (see Figure 9.3, Panel A). Occupations projected to experience the highest reallocation across industries, requiring a policy focus on reskilling and/or upskilling, include science and engineering professionals and associate professionals, stationary plant and machine operators, drivers and mobile plant operators, and electrical and electronic trades workers (see Figure 9.3, Panel B). For instance, with some reskilling and/or upskilling training, science and engineering professionals can



Notes: Occupations measured at the ISCO-08 (International Standard Classification of Occupations 2008) two-digit level. Panel A shows the 20 occupations with the highest level of new jobs. Panel B shows the 20 occupations with the highest level of new jobs absorbing laid-off workers. "New jobs absorbing laid-off workers" are jobs that can be filled by similar (reallocatable) jobs lost in other industries in the same country or region ("Jobs destroyed, reallocatable"). "New jobs" are jobs created that cannot be filled by jobs lost in similar occupations from other industries in the same country or region. "Jobs destroyed, not reallocatable" are jobs for which vacancies in the same occupations in other industries in the same country or region will not be found. See ILO (2019) Annex 5 for methodological details and Annex 6 for the underlying data for all occupations.
Source: ILO calculations based on EXIOBASE v3 and national labour force surveys.

Figure 9.3 Jobs created and destroyed in an energy transition scenario, by occupation, to 2030



Notes: Occupations measured at the ISCO-08 two-digit level. Panel A shows the 20 occupations with the highest level of new jobs. Panel B shows the 20 occupations with the highest level of new jobs absorbing laid-off workers. “New jobs absorbing laid-off workers” are jobs in the same occupation in industries experiencing job losses which can be filled by similar (reallocatable) jobs in other industries in the same country or region (“Jobs destroyed, reallocatable”). “New jobs” are jobs created that cannot be filled by jobs lost in similar occupations from other industries in the same country or region. “Jobs destroyed, not reallocatable” are those jobs for which vacancies in the same occupations in other industries in the same country or region will not be found. See ILO (2019) Annex 5 for methodological details and Annex 6 for the underlying data for all occupations.
Source: ILO calculations based on EXIOBASE v3 and national labour force surveys.

Figure 9.4 *Jobs created and destroyed in a circular economy scenario, by occupation, to 2030* transition from industries connected to fossil fuel energy production to industries connected to renewable energy production (ILO 2019).

In the circular economy transition, net job creation is highest for sales workers, which may be attributed to the growth in household consumption (induced effects) and the consequent growth in the retail trade sector (see Figure 9.4, Panel A). For similar reasons, high net job creation also occurs in business administration, administrative and commercial management, and hospitality. High levels of net growth are also expected in occupations common to several industries and directly related to the circular economy, such as electrical and electronic trades; metal, machinery and related trades; science and engineering professionals and associates; and refuse workers. Many of the jobs created under the circular economy have the potential to absorb workers laid off from similar jobs in industries that experience job losses; this requires reskilling, career counselling and social protection measures to promote mobility within occupations (see Figure 9.4, Panel B). For instance, workers in the metal, machinery and related trades, and science and engineering associate professionals can move from industries connected to the extraction of materials and manufacturing of goods to industries connected to the repurposing of materials and the repair of goods (ILO 2019).

This occupational analysis also indicates that there will be a net increase in jobs beyond the positions that can be filled by reallocation, such as in building and related trades under the energy sustainability scenario, and in sales work under the circular economy scenario. The development of relevant training to prepare future workers will thus be much needed to prevent potential skill shortages. It will be essential to design training programmes to reskill laid-off workers who may not find jobs in their former occupations and so enable them to smoothly transition into newly growing occupations. Although a large majority of occupations affected by the green transition can be reallocated, there are some jobs at risk of destruction which it won't be possible to reallocate to the same or a similar occupation in another industry, hence potential risks of unemployment (ILO 2022a). Programmes could be delivered through ALMPs to address this issue, accompanied by relevant career guidance and social protection measures.

1.4 Types of Skills in Demand

Various terms and definitions have been assigned to the skills needed for greening economies and societies. These include "green skills", "green life skills", "skills for green jobs", "skills for green transition", and others, each with distinct definitions. For instance, Cedefop defines "green skills" as encompassing "the knowledge, abilities, values and attitudes needed to live in, develop and support a sustainable and resource-efficient society" (OECD and Cedefop 2014). The ILO uses the term "skills for green jobs", defined as

> skills that are necessary to successfully perform tasks for green jobs and to make any job greener. The term includes both core and technical skills, and covers all types of occupations that contribute to the process of greening products, services and processes, not only in environmental activities but also in other sectors. (ILO 2015)

Despite the variations in terms and definitions, there appears to be a fundamental consensus that green structural transformation requires both types of skills – technical and occupational skills as well as core (soft) skills (Kwauk and Casey 2022; Rutovitz et al. 2021; Langthaler, McGrath and Ramsarup 2021).

Analysis of Burning Glass Technologies' US data for 2017 indicates that workers may reuse three categories of skills in new jobs in the same groups of occupations in growing industries (ILO 2019). Such core employability skills include technical transferable skills, such as engineering, repairing and product development; semi-technical transferable skills, such as sales and marketing, customer handling and project management; and core (soft) and foundational skills, such as problem-solving, communication, teamwork, numeracy and literacy, including digital and climate literacy. Certain technical skills are unique to specific occupations. These skills are particularly sensitive to changes in technology and the industry they are associated with. In other words, they are closely tied to the tools, methods and knowledge required in particular jobs or sectors and are sensitive to advances in technology or shifts in an industry's practices or demands.

Some core (soft) skills are required by all workers, regardless of the general skill level of their occupation. Medium- to high-skilled occupations may require additional skills, as listed, non-exhaustively, in Table 9.1. This is an important axiom with significant implications for the update of competency standards and curricula in education and training at all levels as well as for the design of skills-training programmes as part of ALMP measures.

2. KEY SKILLS CHALLENGES FOR GREEN STRUCTURAL TRANSFORMATION

Despite some progress made in the past decade, a wide range of constraints and challenges continue to impede skills development, and this has an impact on the greening agenda. Coherency of employment, skills and environmental policies remains weak and fragmented in many countries (Cedefop 2019; ILO 2023). National commitments and sectoral priorities to implement the Paris Agreement have often not included sufficient skills development to support them; fulfilment of those commitments is highly unlikely without the

Table 9.1 Main core (soft) skills required for green transition, by skill level of occupation

Required across the labour force	Required in medium- to high-skilled occupations
• Environmental awareness and respect; willingness to learn about sustainable development • Adaptability and transferability skills, enabling workers to learn and apply the new technologies and processes required to green their jobs • Teamwork skills, reflecting the need for organizations to work collectively on tackling their environmental footprint • Resilience, to see through the changes required • Communication and negotiation skills, to promote required change to colleagues and customers • Entrepreneurial skills, to seize the opportunities of low-carbon technologies and environmental mitigation and adaptation • Occupational safety and health • Basic digital skills, enabling the use of technologies that can reduce environmental impacts	• Analytical thinking (including risk and systems analysis) to interpret and understand the need for change and the measures required • Coordination, management and business skills that can encompass holistic and interdisciplinary approaches incorporating economic, social and ecological objectives • Innovation skills, to identify opportunities and create new strategies to respond to green challenges • Marketing skills, to promote greener products and services • Consulting skills, to advise consumers about green solutions and to spread the use of green technologies • Networking, IT and language skills, to perform well in global markets • Strategic and leadership skills, enabling policymakers and business executives to set the right incentives and create conditions conducive to cleaner production and transportation

Source: Adapted from ILO (2022c).

existence of relevant skills in the labour market (International Organisation of Employers (IOE) 2023). The lack of strong policy coordination between government ministries, workers' and employers' organizations, education and training providers and other stakeholders is a key obstacle to effective and successful green transition. At the governmental level, responsibility for the areas of policy relevant to skills for green jobs is distributed across more than one ministry; this may lead to duplication and gaps if not adequately coordinated (ILO 2019). Ministries responsible for labour, employment, education and training tend to be ones least involved in policymaking and consultations on climate change and environment issues. Coordination is often geared to specific purposes, resulting in weak monitoring and unsystematic follow-up.

The growing skills gaps and shortages present a key constraint upon the progress of green structural transformation, but effective mechanisms to anticipate and monitor these skills needs have not been widely established. Developing countries are especially challenged by a lack of professionals and a scarcity of university graduates in general, especially those trained in STEM skills (United Nations (UN) 2022; ILO 2019). Even in high-income countries, the lack of both technical and transferable core skills remains a key factor contributing to hiring challenges faced by employers (ILO 2019). Inadequate systems to anticipate skills needs hinder countries' ability to identify skills gaps and analyse future training needs systematically and comprehensively. This in turn makes it difficult to develop specific skills and lifelong learning policies and to shape TVET and ALMPs to current and future demand in support of green structural transformation.

Although TVET and skills development systems have been adapting to changing skills demand, many remain insufficiently responsive to the changes required of a green economy and struggle to mainstream the green agenda in policy, practice and training delivery or adopt an integrated approach. Outdated competency standards and curricula, a shortage of qualified and empowered teachers and trainers, impractical training delivery, ineffective assessment, under-resourced and understaffed training providers, limited work-based learning and weak processes and structures connecting TVET to the world of work through engagement and collaboration with enterprises are key challenges to and constraints upon the effective tuning of TVET and skills development systems to the labour market needs of the green transition (World Bank, United Nations Educational, Scientific and Cultural Organization (UNESCO) and ILO 2023; OECD 2023a).

Enterprises have a pivotal position in facilitating green transition across multiple dimensions. This involves their active participation in generating and offering environmentally friendly goods and services, establishing environments conducive to the application and utilization of newly acquired skills in service to green transition, establishing sustainable and effective TVET systems and contributing to the upskilling and reskilling of the existing workforce through both sector-specific and internal training initiatives. However, their involvement in such efforts is unsystematic and ad hoc, particularly in many developing countries (World Bank, UNESCO and ILO 2023).

Traditionally, the allocation of funds for education and training has mainly been directed towards elementary and university-level education rather than technical and vocational training or non-formal education aimed at adult learners, including older workers, the unemployed, and inactive adults (OECD 2017; ILO 2021a). Work-based learning (WBL) often lacks financial backing, despite its significant role in cultivating skills within enterprises (World Bank, UNESCO and ILO 2023). The frequent funding obstacles in skills systems impede the progress of green structural transformation. Although there are indications of targeted efforts in certain sectors or enterprises, and of governments using specific financial incentives to promote the greening of skills development, the private sector finds it difficult to take independent action without such incentives (ILO 2019).

The specific needs of vulnerable and disadvantaged groups in coping with the changes brought about by green transition are not adequately taken into account in current education and training systems and policies (Janta, Kritikos and Clack 2023; ILO 2019). Despite the efforts of numerous countries, these groups continue to have insufficient financial support for and access to quality and practical education and training opportunities, a situation that hinders their acquisition of skills applicable to the green transition. The lack of sufficient information and disaggregated data on these vulnerable and disadvantaged groups poses an additional obstacle to addressing their specific needs (Janta, Kritikos and Clack 2023). There is an important need for systematic green reskilling and upskilling initiatives targeting specific groups, including young people, older workers, women, people with disabilities, indigenous people, migrant workers, unemployed people, informal workers, persons with HIV/AIDS, refugees, low-skilled workers, indigenous and tribal people, and those living in rural areas.

3. POLICY IMPLICATIONS FOR ADDRESSING THE SKILLS NEEDS

The greening agenda in skills development and lifelong learning systems in many countries remains constrained by challenges such as policy fragmentation and coordination gaps, inadequate financial allocation and incentives, supply-driven approaches, limited human resources and capacities, and lack of social inclusion in skills initiatives. These limitations necessitate collaborative efforts and a collective responsibility involving governments, employers and individual workers as well as education and training institutions, social partners, non-governmental organizations (NGOs), local community and other relevant stakeholders in order to build more relevant, effective, green and inclusive skills development and lifelong learning systems. Although there may not be a one-size-fits-all solution, green structural transformation requires enhanced policy coherence and coordination through social dialogue, effective skills need anticipation and matching mechanisms, training provision driven by demand, targeted skills initiatives for the vulnerable and disadvantaged groups, innovative financing mechanisms, and skills-oriented strategies at the enterprise and industry levels.

3.1 Strengthening Policy Coherence and Facilitating Systematic Policy Coordination

In the green transition, policy coherence is essential, so that policies can reinforce each other's impact, minimize duplication and maximize the effectiveness of different measures to promote environmentally sustainable economies and societies for all. A significant correlation has been observed between effectively aligned environmental and skills policies and the existence of mechanisms for coordination between different government ministries (ILO 2019). It is important to coordinate also with other public policies and strategies, including macroeconomic, investment, industrial, trade, sectoral and social policies in order to help businesses to innovate, green their production practices and provide environment-friendly products and services (OECD et al. 2015), and in order also to enhance job growth, orient education and training towards labour market needs and facilitate a smooth transition of workers from declining to growing industries.

Efficient and systematic coordination mechanisms can facilitate effective planning, design, implementation, and monitoring and evaluation of employment and skills development policies across diverse government ministries, departments and related agencies (OECD and Cedefop 2014; Auktor 2020). Successful design, planning and implementation of policies depends upon promoting broad participation of all relevant stakeholders, including governments, trade unions and employers' associations through social dialogue, as well as civil society actors, education and training providers at all levels, and the local community (ILO 2022a; OECD 2023b). Some countries have already established national multistakeholder bodies to promote such institutional coordination and policy coherence (see Box 9.2 for the case of France).

BOX 9.2 NATIONAL COORDINATION BODIES RELATED TO SKILLS FOR GREEN JOBS IN FRANCE

France has established dedicated institutions and skills policies to support environmental sustainability, climate action and green jobs, while simultaneously facilitating collaboration among key stakeholders. To support policy coordination, the Grenelle de l'environnement (Environment round table) was established in 2007, linking the public sector with civil society and social partners at national, sectoral and local levels. In 2012, a new principle of holding an annual national climate conference was introduced to reignite enthusiasm for the multilevel governance process introduced by the Grenelle. These conferences brought together the five partners that met within the framework of the Grenelle: the State, employers, unions, local authorities, and NGOs.

Alongside these developments, the National Observatory for Jobs and Occupations of the Green Economy (Onemev) was created in 2010 by the Ministry of Environment to analyse employment shifts and occupational implications and produce relevant methodologies and statistics. It brings together a broad range of institutions, including relevant national ministries and agencies, key public employment service organizations, the main TVET association, the national statistical institute, research bodies (including the Centre for Studies and Research on Employment and Skills) and regional employment and training observatories.

Source: Cedefop (2019).

Alongside enhanced coherence and coordination at national level, decentralized approaches at the sectoral and local levels could facilitate coordination and cohesion in the practicalities of implementation (Strietska-Ilina et al. 2011). An effective mix of top-down policy formulation and bottom-up initiatives could provide efficient and enduring support of green structural transformation (ILO 2019).

3.2 Identifying and Anticipating Skills Needs for Green Economic Transformation

To equip the current and future workforce with technical and core skills relevant to green structural transformation will require a comprehensive understanding of future skills needs. To understand the evolving dynamics of skills demand in the labour market, it will be essential to build – with the active engagement of the key stakeholders – systematic, innovative and institutionalized labour market information systems and skills needs anticipation systems (OECD 2016). Enhanced data and intelligence regarding skills needs and gaps allow more systematic and comprehensive analysis of future training needs and shortages. This, in turn, enables more informed policy formulation and more effective adaptation of education and training programmes and so improves the capacity to tackle skills-related challenges.

As one component of a broader labour market information system, successful institutional approaches to identify and anticipate necessary skills should bring together representatives of the main stakeholders concerned with skills for green jobs, including government ministries and agencies, employers, workers' representatives, the private sector, education and training providers, research institutions and civil society. The active participation of key industry players and trade unions is vital to developing a more nuanced understanding of skills needs (ILO 2022c). Such involvement will contribute insights from both the demand and supply perspectives, enriching the discussion and enabling the adjustment of sectoral and occupational forecasts. The institutional arrangements for anticipating skills needs can take several different forms at the national, regional and sectoral levels (see examples in Box 9.3).

BOX 9.3 COORDINATED APPROACH TO ANTICIPATING SKILLS NEEDS FOR GREEN JOBS IN INDIA

In India, the national government has taken a holistic approach that coordinates activities across ministries and private sector bodies. The Skill Council for Green Jobs (SCGJ) was set up in 2015 under the National Skill Development Mission and is promoted by the Ministry of New and Renewable Energy and the Confederation of Indian Industry. The SCGJ is a not-for-profit, autonomous, industry-led society, incorporated under the Societies Registration Act. Its objective is to identify skills needs in the green business sector and to implement nationwide, industry-led, collaborative skills development and entrepreneur development initiatives. Its governing council includes representatives of government ministries and employers' bodies as well as individual employers. By 2023, the SCGJ had a network of over 400 affiliated training institutions and centres, along with more than 4,000 trainers and assessors across the country. Their mission is to deliver training programmes in the field of green business. The SCGJ has also certified 536,000 training candidates.

In individual sectors, industry-led sector skills councils, responsible for the development of national occupational standards and qualifications, play a key role. For example, in the construction sector the Indian Green Building Council (a private sector institution) and the Bureau of Energy Efficiency (an agency of the government of India) conduct training programmes for energy managers and grant national certification for energy auditors.

Sources: SCGJ (https://sscgj.in/); ILO (2019).

The green economic transformation is a dynamic process in which jobs continually evolve, yet many countries face a scarcity of relevant labour market information. Robust infrastructure must be established to gather and analyse data relating to labour market trends and the skills required for green economic transformation. This involves employing the most practical combination of methods and tools. Easy access to and use of labour market information among all labour market actors are critical to the formulation and implementation of evidence-based, forward-looking skills policies.

3.3 Mainstreaming Skills for Green Jobs in Education and Training at All Levels, particularly TVET

The transition towards low-carbon and resource-efficient economies and societies necessitates a systematic engagement of educational and training institutions at all levels, particularly TVET, in response to the evolving landscape of employment prospects and skill requirements brought by the green transition (Cedefop 2022; ETF 2023). Commitment to this endeavour could ensure an equitable and impartial green transition by equipping the existing and future workforce with the relevant knowledge and skills to transform workplaces, communities and societies as a whole (UNESCO and UNEVOC 2017). It is therefore essential to take a holistic and systematic approach to enhancing the governance and management structures and processes involved in designing and delivering training required to mainstream green transition in education and training at all levels. As much turnover is expected in medium-skill occupations, relevant skills must be incorporated into the development or renewal of competency standards, curricula, training and assessment packages in both initial and continuing TVET (ILO 2022c).

Where TVET provision is underdeveloped, capacity will need to be developed if the green agenda is to be embraced fully and effectively (ILO 2022c). It will be necessary to empower the TVET institutions, managers, teachers and trainers who will be managing and delivering education and training for green structural transformation on the ground (UNESCO and UNEVOC 2021). In this process of greening TVET and skills development, it is important to sensitize and encourage enterprises and trade unions to engage (Box 9.4). Enterprises can inform the education and training providers about changing demand for skills in the labour market and offer more practical training and work opportunities for students and trainees. Trade unions can help to ensure that the rights of apprentices are respected and that the training needs of workers are collectively expressed. Another essential aspect is to ensure that the physical environments of teaching and learning contribute to the development of environmental awareness and behaviour.

BOX 9.4 A HOLISTIC APPROACH TO GREENING TVET AND SKILLS DEVELOPMENT – ZIMBABWE'S GREEN ENTERPRIZE PROGRAMME

In 2020, Zimbabwe's Green enterPRIZE programme launched a set of new TVET curricula focused on key parts of the country's green economy – climate-smart agriculture and renewable energy – with the goal of stimulating the market for new products and services and expanding employment opportunities. The programme also promotes partnerships between training providers and small and medium-sized enterprises (SMEs) to pilot innovative work-based learning programmes in the agricultural and renewable energy sectors.

The TVET programmes were developed from 2017 to 2021 by an inter-ministerial task force led by the Ministry of Higher and Tertiary Education, Innovation, Science and Technology Development and supported by line ministries responsible for young people, women and SMEs, energy, and agriculture; a network of TVET institutions and their faculties; representatives of industry and SMEs and technical experts from national and international organizations, including the ILO; workers' and employers' organizations; the National Manpower Advisory Council; and the Higher Education Examinations Council. The active involvement of experts from industry, employers' representatives and CEOs of SMEs in the renewable energy and agricultural sector at the very beginning of the process ensured a good alignment between demand and supply.

Source: ILO (2022c).

3.4 Targeted Measures Tuned to the Needs of Disadvantaged and Vulnerable Groups

The prospects for a green and just transition will be enhanced by facilitating equal opportunities for skills acquisition and continuous education and training among individuals in various life and career phases, coupled with interventions tailored to the needs of specific vulnerable and disadvantaged groups, including women, young people, migrants and rural and informal workers (Kwauk and Casey 2022). The validation and recognition of skills and all forms of prior learning experiences have significant implications for inclusivity. Most of an individual's learning happens through non-formal and informal channels, particularly in developing countries with large informal economies (ILO

2021b). When individuals' existing competencies, irrespective of their formal education, are acknowledged and accredited, both they and their employers can benefit. Individuals' employment prospects and earning potential can be improved, and they can gain self-esteem and better readiness for formal education and training (OECD 2010). Meanwhile employers can reap the benefit of reduced training expenditure (OECD 2010). Validation and recognition mechanisms can be targeted specifically at skills pertinent to green jobs and thereby can support the green transition (Pavlova and Singh 2022).

Increased apprenticeship opportunities are another crucial way to promote inclusivity. The creation of diverse opportunities across sectors with green growth potential could engage apprentices in hands-on, experiential learning and thereby nurture practical skills relevant to the green transition and enable these individuals to seamlessly transition into the workforce (Cedefop and OECD 2022). Apprenticeships within the informal economy could offer out-of-school youths the chance to acquire a craft and enter the labour market (ILO 2019). Facilitating the participation of women in apprenticeships and skills training geared to environmentally sustainable jobs, especially where female representation is lacking, will help to address both gender disparities and skill shortages prevalent in specific occupations.

Digital learning has great potential to enhance the inclusiveness of education on climate change and skills acquisition for green jobs. Digital solutions can enable wider access to educational and training resources, transcending geographical barriers and accommodating diverse learning preferences (World Bank 2023). For instance, someone residing in a remote rural area can now access higher-quality learning content on climate change, environmental sustainability, and biodiversity through online platforms that bridge the gap between urban and rural learning opportunities. Parents who are juggling family care responsibilities and the pursuit of training to develop skills essential to green structural transformation can particularly benefit from the convenience and flexibility offered by remote digital learning. A learner with a visual impairment can benefit from specialized digital tools that provide alternative formats like audio description. However, the application of digital solutions in education and training must be accompanied by the implementation of policies to enhance digital infrastructure, connectivity and equipment and to ensure equal access (ILO 2021b). These measures are imperative to ensure that the adoption of digital technology does not exacerbate the pre-existing digital divide.

The importance of effective teachers and trainers, as well as managers of education and training institutions, to effective education and training and to social inclusion cannot be overstated. They have a vital role, for instance, in establishing a gender-sensitive education and training environment, in the prevention of stereotyping and in raising the interest of female students in non-traditional occupations (UNESCO 2017). Gender-sensitive education and training accompanied by effective career guidance can lead more female students to take up traditionally male-dominated green jobs (Janta, Kritikos and Clack 2023). Teachers, trainers and institution managers can also encourage enterprises, including those with green potential, to offer equal opportunities to women and men for on-the-job training, including apprenticeships (ILO 2020). To this end, it is crucial that these educators undergo training that enhances their awareness of and responsiveness to gender-related issues in learning environments (UNESCO 2017).

When it comes to addressing gender biases in education and training, it is crucial to make precise interventions grounded in a robust comprehension of the different impacts experienced by different groups of women. This requires in-depth understanding of the many factors that contribute to gender-based occupational disparities (ILO 2020). There are strong reasons to enhance women's engagement in sectors with greening potential, and this can be efficiently promoted through the provision of technical training programmes, especially in STEM areas (IOE 2023; Janta, Kritikos and Clack 2023). This strategy not only addresses the pressing issue of skills shortages but also bolsters women's engagement in technology-intensive vocations. Nonetheless, a mere increase in the enrolment of female students on training programmes for specific occupations does not guarantee the active participation of women in the corresponding sectors (European Commission 2018). Additional ingredients, like mentorship and the presence of inspiring female role models in unconventional jobs for women, can strengthen awareness about career opportunities and draw in more girls and women (Box 9.5).

BOX 9.5 TARGETED MEASURES FOR WOMEN IN THE RENEWABLE ENERGY SECTOR

Established in Canada in 2013, Women in Renewable Energy (WiRE) has since expanded its reach across the world. The organization is dedicated to promoting and acknowledging the participation of women in the renewable energy sector. To this end, WiRE runs mentorship programmes, networking initiatives in collaboration with governmental bodies and renewable energy associations, and educational field trips to enhance skills and knowledge.

Since 2017, WiRE has actively supported the Leadership Accord for Gender Diversity in Canada's electricity sector. This accord involves employers, educators, unions and governments working together to increase the representation of women in the electricity and renewable energy sectors. WiRE is aligned with the Equal by 30 Campaign, which advocates equal pay, equal leadership opportunities and equal rights for women by 2030. WiRE also provides student bursaries, designed for women pursuing education at college or university, to help them explore internship and permanent career opportunities in the energy sector.

Source: IRENA (2019).

3.5 Innovative Mechanisms to Finance Skills Development and Lifelong Learning

Innovative and diverse ways of financing skills development and lifelong learning, combining private and public contributions, are instrumental in catalysing green structural transformation. They will enable individuals to access funding to undertake education and training relevant to green jobs. Meanwhile enterprises are encouraged to invest in greening the skills of their workforce and thereby enhance the enterprise's competitiveness and productivity.

A range of funding instruments offer diverse pathways to finance skills development and lifelong learning. Government budgetary funding is often the predominant source of funds. An increasingly popular approach to mobilizing resources involves earmarked training levies, whereby enterprises contribute a percentage of their payroll, profits, turnover or employees to the State (Ziderman 2016). National, regional, sectoral or industry-specific training funds offer supplementary financing beyond regular government budgets, so that the government budget is combined with funding from levies and donors (Johanson 2009; ILO 2021c). Social impact bonds and human capital performance bonds are relatively new and innovative instruments that provide funding for skills development projects, with the objective of producing social benefits through a debt instrument deployed by the government (Hanni 2019; ILO 2021a). Learners' contributions to training costs and income generation by training providers are two other strategies to increase the pool of funds for training (ILO 2021a).

Governments may provide direct support to individuals through various targeted subsidies, loans, grants, individual learning accounts, saving schemes, education and training leave and a variety of other incentives to encourage participation in training, respond better to the needs of learners and make TVET and lifelong learning affordable (ILO 2021c). Subsidies can incentivize enterprises to provide work-based learning opportunities, hire and train unemployed individuals, train existing workers and seek joint solutions involving several employers (OECD 2017; ILO 2021a). Grants, including levy–grant schemes, can facilitate cost-sharing solutions, normally by increasing employers' contribution to training costs; they also instigate a more structured approach to training (Ziderman 2016). Tax incentives, payback clauses, and education and training leave can also be used to encourage enterprises to finance employee training (OECD 2017; Ziderman 2016).

Each approach has its own strengths and weaknesses. The various options provide scope in each unique national context to tailor a specific national blend of instruments (ILO 2021c). These funding mechanisms can specifically target the acquisition of skills relevant to green structural transformation. For example, skills development vouchers or grants can be used to encourage individuals to enrol on accredited green training programmes. Funds dedicated to supporting skills development in sectors with greening potential could be established. Several innovative mechanisms to finance individuals' skills development and lifelong learning and also enterprise engagement already exist in some countries (Box 9.6).

Irrespective of the combination of financing mechanisms, effective, transparent and efficient financing systems are universally crucial. Such systems encompass the ways and means of resource mobilization, distribution and administration and ultimately influence the efficacy and efficiency of delivery (ETF 2018). Skills policies are more effective and efficient when the financing responsibilities are shared with all stakeholders and are perceived not as financial burdens but as strategic investments in the future of individuals, enterprises and societies as a whole (ILO 2021c). It is essential to involve employers and trade unions in the development and implementation of financing tools, since their involvement can enhance understanding of the needs of enterprises and workers and thereby enhance the pertinence, perception and adoption of the chosen financial mechanisms.

BOX 9.6 INNOVATIVE MECHANISMS TO FINANCE LIFELONG LEARNING

Funding assistance schemes for individuals and enterprises in Singapore. In Singapore, a "skills future credit" funding scheme encourages individual ownership of skills development and lifelong learning by providing all citizens 25 and over with a credit of US$370 (S$500) to their personal learning account, to be spent on work-related training. In addition, employer funding and assistance schemes, including enhanced training support for SMEs, career conversion programmes and "SkillsFuture enterprise credit" encourage enterprise participation in the skills development of their employees.

Green financial incentives for employers in Guyana. In Guyana, at least two commercial financial institutions and the Institute of Private Enterprise

Development (IPED), a microfinance organization, offer green financing, either as party to a public–private arrangement or independently. Guyana's Micro and Small Enterprise Development Programme, which provides competitive financing for green businesses, offers skills training coupons that beneficiaries trade in for a variety of business development and management training programmes delivered by pre-approved training organizations or experts.

Sources: ILO and UNESCO (2019); SkillsFuture (https://www.skillsfuture.gov.sg/); Workforce Singapore (https://www.wsg.gov.sg/); ILO (2019).

3.6 Activating Skills Response at the Enterprise and Industry Levels

Given that the transition to resource-efficient and lower-carbon processes begins in workplaces, it is imperative to empower enterprises and industries to fully harness opportunities to actively engage in the green transition. This necessitates skills development for the green economy, particularly in micro, small and medium-sized enterprises (MSMEs), given their limited resources to independently offer training (Johanson 2009; IOE 2023). There are various ways to encourage enterprises and industries to engage in the greening agenda, with a strong emphasis on skills development, beyond the aforementioned targeted financial incentives.

At national level, the institutional framework, including social dialogue, can be used with a range of policy instruments to foster awareness among enterprises (ILO 2022c). Some enterprises are impelled to spearhead green advancement autonomously, and others lag behind, necessitating differing levels of assistance and incentive. A more targeted approach, such as establishing a national council dedicated to green jobs or a designated national authority, could prove instrumental in engendering enterprise and industry engagement in green skills development.

Public–private partnerships (PPPs) for skills development for green jobs can help to meet education and training needs (IOE 2023). They can spur and amplify diversified and innovative approaches to financing lifelong learning; promote cooperative peer learning and the exchange of knowledge and experience among enterprises, workers and training establishments regarding the application of green technologies and practices; and provide a venue for collaborative efforts to strengthen education and training systems and make them greener (ILO 2022a). Encouraging close collaboration between businesses, particularly at the sectoral level, is another way to activate a skills response at the enterprise and industry level, given businesses' shared skills-related challenges and opportunities in the context of green structural transformation. Such collaboration can be especially helpful for MSMEs, which often face various challenges stemming from limitations in both financial and human resources.

Trade unions can help to influence employers to promote the skills development of their workers. They possess a profound understanding of their respective sectors and the capacity to suggest tangible and effective solutions reflecting the aspirations of workers (European Trade Union Confederation (ETUC) 2018). For example, trade unions in Denmark played an active role in regions with declining industries in supporting workers' transition into new green employment opportunities (see Box 9.7). Trade unions can also play an active role in anticipating skills needs for green jobs at national or sectoral level and within individual enterprises, and thereby can inspire skills development planning (ETUC 2018). They can provide information about workers' emerging skills needs with respect to green jobs and ensure that upskilling and reskilling for the green transition are reflected in employers' human resource development strategy and planning (ILO 2022c).

BOX 9.7 TRADE UNIONS SUPPORT TRAINING IN THE LATEST GREEN TECHNOLOGIES IN DENMARK

To offset the closure of the shipyards at the Port of Odense in Denmark in 2012, the Lindø Industrial Park (Lindø Industripark) was set up to support the growth of companies involved in the production, storage and discharge of components for offshore and heavy industries. A retraining and reskilling programme was established with the support of trade unions. This programme led to the creation of the Lindø Offshore Renewables Centre (LORC) and a research and development and training centre in which technologies used in offshore wind energy can be tested and produced. Trade unions are closely associated with the management of the centre, since the LORC council includes trade union representatives.

Source: ETUC (2018).

4. CONCLUSION

The success of the green structural transformation in creating positive employment opportunities hinges upon the availability of relevant skills and training. Effective labour market information systems and skill anticipation mechanisms will be crucial to understanding the employment shifts that will arise during the green structural transformation, and the consequent changes in skills demand. Informed policy formulation relies on thorough analysis of employment effects and skills needs and will in turn facilitate the integration of the skills necessary for green transition into existing education and training systems. The challenges of a just transition to a low-carbon and resource-efficient economy are complex and cannot be addressed by a single policy intervention. They require an approach that is coordinated and integrated with other policy measures such as career guidance, social protection and ALMPs. Integrating different perspectives and forming consensus among all key stakeholders in the discourse and implementation of environmental, employment and skills development policies will not only strengthen policy coherence and coordination but also enable the design of policies and measures that are more beneficial for workers, businesses of all sizes and the whole of society. Such integration also facilitates a smoother implementation of policies. A critical aspect of the green transition is prioritizing the needs of disadvantaged and vulnerable groups, especially those at risk of losing their jobs during the greening process. Innovative strategies to finance skills development and lifelong learning with particular attention to such groups is crucial to achieving a just and inclusive transition.

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Index