

Climate Change Mitigation for Late Industrialisers

The Role of Technology Intensity in Manufacturing

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CLIMATE CHANGE MITIGATION FOR LATE INDUSTRIALISERS: THE ROLE OF TECHNOLOGY INTENSITY IN MANUFACTURING

Elvis Korku Avenyo and Fiona Tregenna

1. Background

Many developing countries now have a renewed focus on industrialisation and industrial policy. This is based on the recognition that industrialisation is a key driver of long-term economic progress and is the central route to improve the well-being of citizens in developing countries (Chenery, 1955; Tregenna, 2016; United Nations Industrial Development Organization [UNIDO], 2016). At the same time, the climate crisis poses an existential threat to the global economy and to humanity and has emerged as a challenge to the industrial development prospects and pathways of developing countries. This is because industrialisation is an important contributor to global warming, specifically to anthropogenic emissions of carbon dioxide (CO₂) (Adom et al., 2012; Han & Chatterjee, 1997). **Late industrialisers thus face a dual challenge: industrialising while mitigating climate change** (Altenburg & Rodrik, 2017).

Hence, there is now a degree of tension as to how late industrialisers can achieve long-term economic development under paths involving heavy or

intensive industrialisation, while mitigating emissions and environmental damage more broadly. An emerging discourse recognises the critical need for developing countries to push towards industrial development that, while generating growth in productivity and jobs, is also environmentally sustainable. This is especially important, as poorer countries are particularly vulnerable to the immediate effects of the climate crisis (Altenburg & Rodrik, 2017; Padilla, 2017).

Thus, transforming towards sustainable production systems and green industrial policies offers developing countries opportunities to industrialise in an environmentally sustainable way while contributing to job creation and economic prosperity (Altenburg & Rodrik, 2017; Padilla, 2017; Rodrik, 2014). However, the high 'green premia' and new access barriers to the 'green' energy technologies from advanced economies directly threaten this potential sustainable industrial development pathway in developing countries.

The **African Industrial Policy in the 21st Century (AIP21)** network brings together scholars to share research results and outline a new research agenda in view of developing new thinking for a green and resilient industrial policy in Africa for the 21st century. The AIP21 Network organized a series of workshops in 2022 on green industrialization in Africa at Copenhagen Business School and the University of Johannesburg in South Africa, with co-funding from DANIDA's Knowledge in Action grant. These policy briefs are some of the outputs from the workshops.

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This is particularly the case given the fact that ‘green standards’ aimed at mitigating the climate crisis are driven predominantly by industrialised countries, with little or no meaningful deliberation and consensus with emerging and late industrialising countries. For instance, the European Green Deal (EGD) and the Carbon Border Adjustment Mechanism (CBAM) pose direct challenges to export-led growth strategies of developing countries. This is despite the fact that advanced economies are responsible for the climate crisis, and did not have to deal with these unique challenges of industrialising and reducing emissions during their own earlier phases of industrialisation.

Based on our recently published paper (Avenyo & Tregenna, 2022), this policy brief adds to these debates by contextualising the relative contributions of developed and developing countries to the climate crises, and discusses the role that technology-intensive manufacturing can play in reducing carbon dioxide emissions in developing and emerging economies. The research points towards an alternative understanding of how technology-intensive manufacturing affects CO2 emissions and suggests possible pathways for decarbonising industrialisation.

2. Inequality in emissions across developed and developing countries

There are pronounced inequalities between developed and developing countries in production-based CO2 emissions per capita. Figure 1a shows vividly that high-income countries have historically been and continue to be by far the top emitters of CO2 emissions, with minimal contributions by low-income countries. Figure 1b further shows that the consumption-based CO2 per capita for high-income countries (e.g., the United States and Germany) far outweighs that of all developing countries. The marked inequalities in both production- and consumption-based CO2 emissions per capita raise issues around moral responsibility and climate justice, given that developing countries emit less yet are disproportionately affected by the consequences of climate change. The disproportionate burden of these consequences is through channels that include effects on agricultural production and employment, water scarcity, and food.

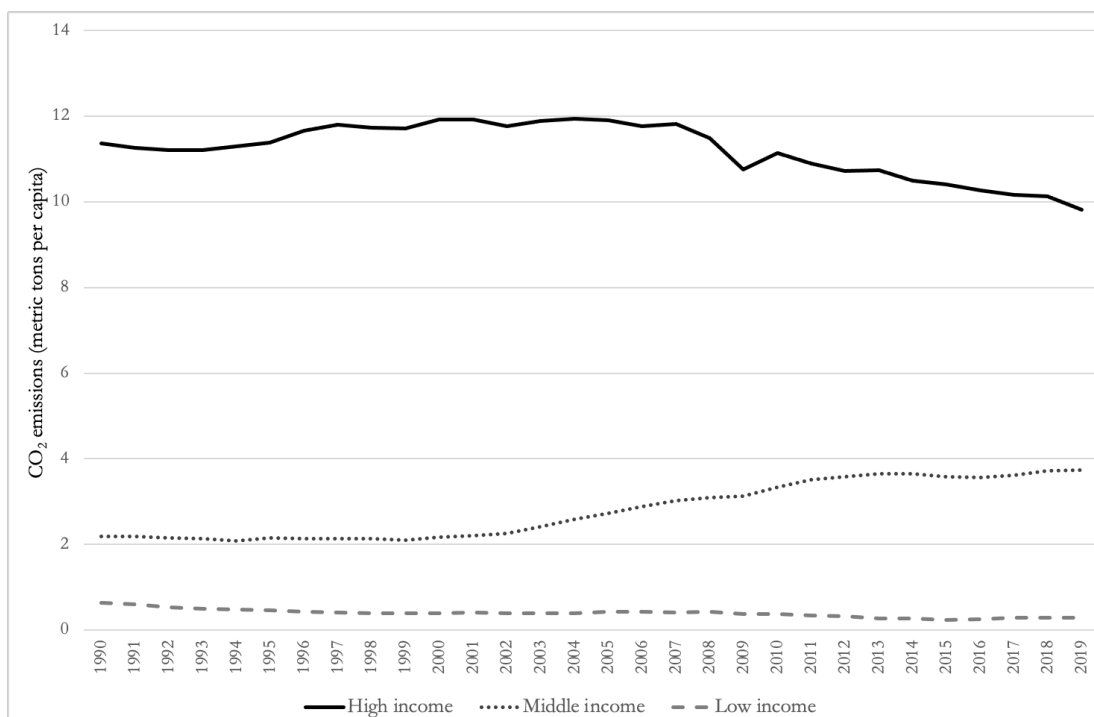


Figure 1a: CO2 emissions (mt) per capita

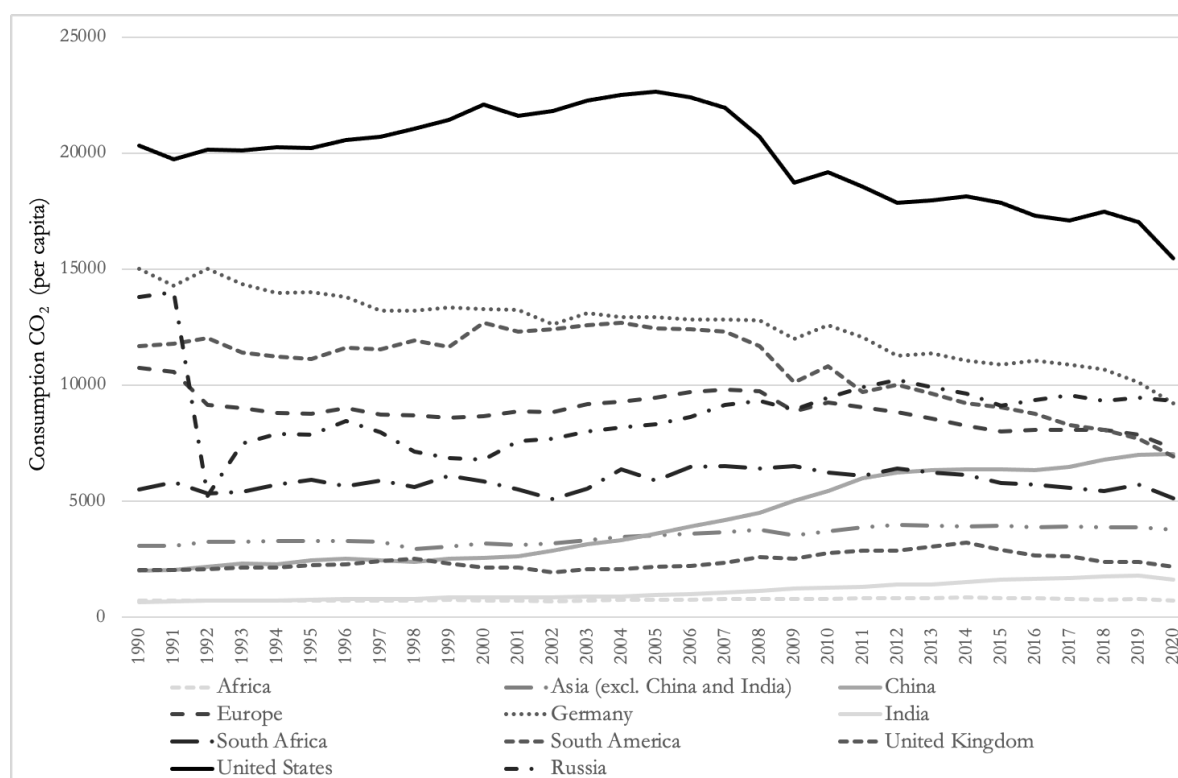


Figure 2b: Consumption CO₂ per capita

Sources: 1a: Authors' elaboration based on data from the World Development Indicators;
1b: Authors' elaboration based on data from Our World in Data (<https://ourworldindata.org>).

3. Emerging evidence on technology-intensive manufacturing and the mitigation of industrial emissions in developing countries

The evidence emerging from our analyses of data from 68 emerging and developing economies over the period 1990 to 2016 indicates that technology intensity in manufacturing matters for the intensity of CO₂ emissions. That is, whereas higher shares of low-technology manufacturing are associated with higher (at an increasing rate) emissions, higher shares of medium- and high- technology (MHT) manufacturing are associated with lower emissions in developing countries.

Technological upgrading has long been recognised as a central part of structural change and catching up (see, for example, UNIDO, 2016). This is important for developing countries' 'keeping pace' with technological change and avoiding a 'middle-

income technology trap' (Andreoni & Tregenna, 2020). MHT industries are generally characterised by advanced scientific and technological expertise and high R&D expenditure (Seyoum, 2004). Furthermore, MHT manufacturing industries do not follow the same path of industrialisation and deindustrialisation as do low-technology manufacturing industries (Tregenna & Andreoni, 2020). **Our findings suggest that, over and above the importance of MHT industries in these respects, upgrading the structure of developing countries' manufacturing towards MHT industries can also be key to sustainable industrialisation. MHT manufacturing industries can thus be important both for upgrading and catching up, and for the decarbonisation agenda in developing countries.**

Furthermore, there is a marked heterogeneity across developing countries by income groupings. The findings suggest that MHT-intensive manufacturing generates low levels of emissions in upper middle- income countries, with no significant

effect in lower middle-income countries. Conversely, low technology-intensive manufacturing in lower middle-income countries contributes to increases in emissions while mitigating emissions in upper middle-income countries.

4. Implications for policy debates on green industrialisation and catching up

First, the urgency and centrality of concerted efforts towards the mitigation of CO₂ emissions should not stand in the way of industrial development in developing countries. An industrialisation path in developing countries need not be environmentally destructive. Our research suggests that a shift to more technology-intensive industrialisation can be one aspect of a development trajectory that is both environmentally sustainable and provides a basis for high growth and catch-up. For developing countries to industrialise sustainably, industrial strategies need to be deliberately designed to include the sectoral targeting of ‘cleaner’ MHT industries that are able to generate rapid and sustainable economic growth.

This does not imply that more technology-intensive manufacturing does not contribute to harmful CO₂ emissions, or that a more technology-intensive industrialisation path is the ‘silver bullet’ for addressing the challenge of climate change. Rather, the research draws attention to the differences in emissions between low-technology and MHT manufacturing, suggesting that more technology-intensive manufacturing is less emissions-intensive. Still, it is important to recognise the diversity within each technology category of manufacturing, and that MHT manufacturing is still carbon-emitting. Similarly, there certainly is scope for making low-technology manufacturing less emissions-intensive, including through cleaner technologies in any sector of manufacturing. Furthermore, a shift towards higher-technology manufacturing in developing economies is not straightforward in practice, and issues may arise of alignment with the skills profile of the unemployed in developing countries. Still,

upgrading within manufacturing, and shifting towards more technology-intensive industries, can be important as part of a green transition in developing economies, and not only for industrialisation, growth and catching up.

Lastly, global policies that phase out fossil fuels and dramatically phase down CO₂ emissions in countries must be developmental and morally just. These policy actions need to be formulated and implemented in collaboration with developing countries as equal partners. Developed economies have a moral responsibility to contribute to a concerted global effort that is in tune with the growth aspirations of developing economies and that forestalls a global climate rupture, without ‘kicking away’ the ladder of development.

Full paper:

Avenyo, E. K., & Tregenna, F. (2022). Greening manufacturing: Technology intensity and carbon dioxide emissions in developing countries. *Applied Energy*, 324, 119726.

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