CHAPTER 4

Diversifying the traditional way will have high environmental costs

4 Diversifying the traditional way will have high environmental costs

This chapter highlights the historical perspective of successful economic diversification and its implications for energy use, emphasizing the need for CDDCs to transition to a low-carbon economy. It explores the relationship between economic diversification, growth, and energy intensity, using emissions-output elasticity estimates in an UNCTAD study.[1] Even though the elasticity estimates need to be interpreted with caution, they provide information that emphasizes the challenge of balancing development goals with reducing GHG emissions. They also illustrate the complexity of the relationship between output and GHG emissions. It depends on the income level of a country, the type of commodity a country depends on, and the timeframe considered. The chapter suggests that CDDCs would need to put in place a green industrial policy framework that could help them to develop an alternative diversification pathway that is compatible with the energy transition imperative. The policy framework is the subject of chapter 5.

Countries broaden their production and export bases by diversifying their economies. Diversification can change the structure of the economy when it creates more complex and sophisticated value chains in existing sectors or when it introduces new products and services. A number of countries have diversified and become more economically resilient.[2] In most cases, however, this has involved greater use of fossil fuels and emitting more greenhouse gases. In the current context of decarbonization, this is not a viable long-term option. CDDCs seeking just transitions will therefore need to carefully balance their sources of energy to meet the needs of current and future generations.

As the experiences of East Asia and Latin America have shown, economic diversification increases the number and value of exported goods, boosting sustainable economic growth. In turn, export diversification increases the stock of foreign currency needed to finance foreign inputs and develop infrastructure, and allows for more stable revenue that increases the capital available for investment, which in turn sustains economic growth, creating virtuous loops.[3, 4]

In addition, economic growth widens the tax base – boosting fiscal revenues that increase government capacity to invest in infrastructure, human capital, and skills. Governments can also offer local firms targeted subsidies for acquiring technologies and discovering new comparative advantages, opening up a wider range of possibilities.[5] For example, frontier technologies such as blockchain can improve traceability and transparency in commodity value chains. The use of robotics can also make operations more efficient, positively affecting firm profitability. CDDCs that are well-positioned to exploit these opportunities will reap valuable benefits.[6]

Most CDDCs need to transition from agrarian economies and low bases of industrialization, so at first they are likely to use more energy.[7,8] In countries that have recently achieved a high level of diversification, there was an increase in GHG emissions resulting from a high energy intensity of the production process. In China, for example, strong growth of the export sector and infrastructure development between 1997 and 2007 became the two main drivers of increasing energy intensity.[9] But this pattern need not continue indefinitely. As economic growth boosts income, countries have more resources to invest in environmental protection, so the environmental impact first grows with GDP and then falls – along an inverted 'Kuznets curve'.[10] However, the empirical evidence has been inconclusive, as different countries seem to follow different paths. For example, by adopting the right environmental policies, some CDDCs could leapfrog the worst phases of environmental degradation.[11]

In the process of diversification, CDDCs will continue to produce, and even increase, their current GHG emissions if they adopt the traditional energy systems and technologies that allowed developed countries to diversify. Indeed, there seems to be a trade-off between growth and environmental degradation, as suggested by the so-called 'Kaya Identity' that expresses GHG emissions as the product of population, per capita GDP, energy-intensity of GDP, and carbon-intensity of energy consumed.[12] However, adopting diversification strategies associated with a lower energy intensity of GDP or carbon intensity of GDP would generate lower GHG emissions while delivering the same level of GDP. Advocates of green industrialization argue that all countries can minimize carbon emissions by changing production and consumption patterns to achieve 'green growth,' which uses natural resources more efficiently and minimizes pollution and environmental damage.[13, 14] This calls for cuts in the use of fossil fuels and huge investments in efficient and green energy – while also protecting workers and communities whose livelihoods have depended on fossil-fuel-based industries.[15]

Because green growth ultimately increases employment and social welfare, it is likely to be more politically and socially acceptable and thus offers a pragmatic path towards a low-GHG economy. But whether CDDCs in their earlier stages of development will be able to follow this path remains an open question.

Tracking the links between GHG emissions and output

The link between GHG emissions and economic growth has been analysed using estimates of emissions-output elasticities. These elasticities provide measures of the number of units of GHG emissions associated with one unit of output. These measures provide a general view of this relationship but should be used with caution as the quality of the results depends on the quality of the data used. This report uses the most widely used data on GHG emissions, as in previous UNCTAD analyses (e.g., UNCTAD, 2019). Moreover, elasticities relating to groups of countries might hide country-specificities.[16] Nevertheless, empirical results on the links between GHG emissions and output provide a rich view of the complexity of this relationship, as discussed below.

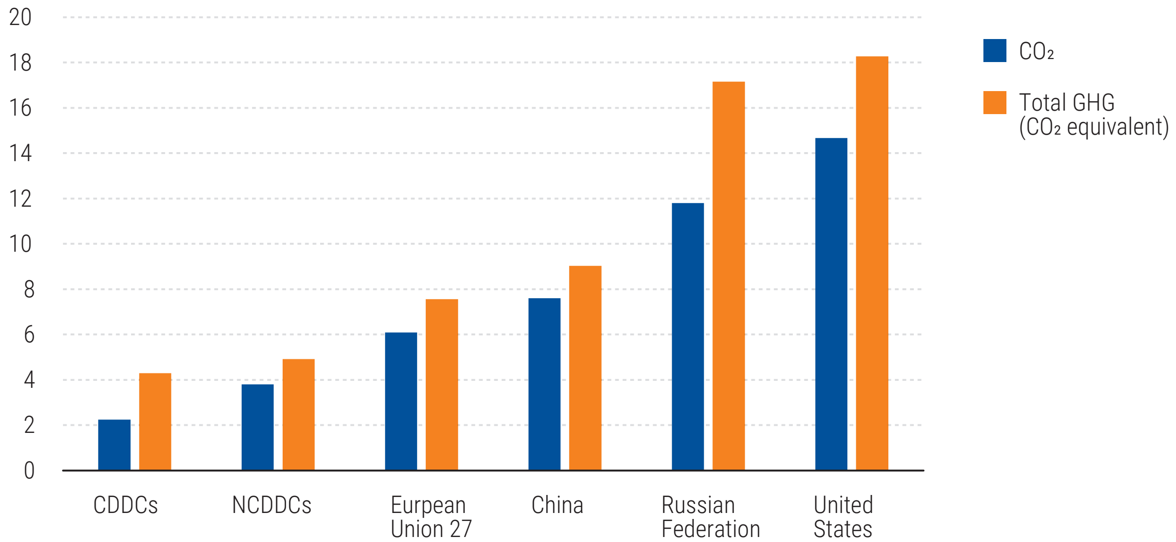
The methodology used to estimate emissions-output elasticities is outlined in Appendix B. This methodology has been mostly used in advanced economies. The few studies focusing on developing countries found that as incomes grew, so did emissions.[17] However, in the longer term, 15 of the 43 countries covered in one of the studies, for example, managed to reduce their emissions intensity of GDP.[18] Nevertheless, the result that long-run emissions-output elasticities were positive for all but six countries suggests that the majority of countries in the sample still needed to do more to decouple long-run income growth from GHG emissions.

Subsequent studies broke down growth in emissions and real GDP into their trend and cyclical components and estimated cyclical and trend elasticities (see Appendix B). Cyclical elasticities capture the fact that changes in emissions may be associated with the booms or downturns in business cycles. Trend elasticities capture structural or long-term effects that make the economy more or less emissions-dependent. Applying this method, previous studies found that trend emissions-output elasticities decline with per capita income. Hence, advanced countries have been able to decouple more rapidly in recent years.[19, 20] Another study of 46 commodity-exporting countries over the period from 1990 to 2014 found further evidence of decoupling, and that these changes were not cyclical but structural.[21]

To offer a wider perspective, this report uses material from an UNCTAD study that uses a larger data set, covering 186 countries classified as CDDCs, non-commodity dependent developing countries (NCDDCs), or developed countries over the period 1980-2018 (see Appendix B).[22] As indicated by descriptive statistics in Table 4.1, in 2018, CDDCs had the lowest average GDPs and had lower emissions than NCDDCs and developed countries. Emissions were lowest in sub-Saharan Africa and among low-income countries and highest in North America. Among CDDCs, fuel exporters had the highest emissions, though these were still substantially below those from North America. Emissions in NCDDCs and upper-middle-income countries were higher than those of high-income countries.

As indicated in Table 4.1, most of the emissions were of CO_2, which is why this report and other publications use carbon dioxide interchangeably with GHGs.[23] In fact, the concept of decarbonization, often used to refer to the reduction of GHG emissions, reflects the dominance of carbon dioxide among GHGs. Moreover, the analysis uses total rather than per capita emissions – though both measures convey a similar message – to account for the fact that what matters most is the total amount of CO_2 that a country emits into the atmosphere. Using per capita emissions in the analysis may convey an incorrect message that a small, sparsely populated country contributes more to GHG emissions than a larger, highly populated country. Irrespective of the measure used, CDDCs often have the lowest CO_2 emissions (Figure 4.1 and Table 4.2). Using data in Table 4.1, emissions in low-income countries are only about 10 per cent of those in high-income countries and 7 per cent of those of upper-middle-income countries – which are catching up with the developed countries and increasing GHG emissions per unit of output.

Figure 4.1 GHG emissions, metric tons per capita, 2019



Source: UNCTAD based on data from UNCTADstat database and World Development Indicators.

Note: Values for country groups represent population-weighted averages.

Table 4.1 Summary statistics for income and emissions, different country groups, 2018

Group	Average GDP (millions of dollars, 2015)	Average CO_2 emissions (ktons)	Average Greenhouse Gas emissions (ktons)
Commodity Dependence Status			
CDDC	99 530	90 625	92 149
NCDDC	479 519	436 640	440 073
Developed Countries	1 257 598	332 916	334 622
Commodity Type			
Agricultural CDDC	91 161	65 652	67 046
Fuel CDDC	178 541	186 131	188 777
Mineral CDDC	32 638	26 396	26 981
CDDCs by region			
East Asia and the Pacific	836 531	604 464	608 522
Europe and Central Asia	455 144	159 639	160 860
Latin America and the Caribbean	163 974	91 145	92 748
Middle East and North Africa	172 692	138 912	140 765
North America	10 605 611	3 159 749	3 175 320
South Asia	412 374	544 153	550 193
Sub-Saharan Africa	38 703	47 106	48 029
Income			
High	921 397	264 144	265 685
Low	17 510	27 449	28 161
Lower-middle	151 437	175 408	177 784
Upper-middle	436 648	383 338	386 605

Source: UNCTAD based on data from World Bank's World Development Indicators and Emissions Database for Global Atmospheric Research (EDGAR).

Note: Data on real output (in 2010 millions of United States dollars) are from the World Bank's World Development Indicators. Data on greenhouse gas emissions come from the EDGAR, which contains data sets covering the three direct greenhouse gases – carbon dioxide, nitrous oxide and methane aggregated by country and sector, using the IPCC 2006 sector designations.[24] For the historical analysis focusing on the five major industrialized economies, data for real GDP is from the Maddison Project, and data for historical carbon dioxide emissions are from the Carbon Dioxide Information and Analysis Center (CDIAC).[25] Total CO_2 emissions is the sum of fossil fuel emissions for solid, liquid, and gas fuels, as well as gas flaring and cement production. Combined GDP and CO_2 emissions data for each country is available as follows: United States (1800 - 2017), United Kingdom of Great Britain and Northern Ireland (1751 – 2017), Germany (1850 – 2017), France (1820 – 2017), and Japan (1870 – 2017).

Table 4.2 Top emitters (all values reported for 2018)

Country	GDP (millions of dollars, 2010)	Total CO_2 emissions (ktons)	Total GHG emissions (ktons)
CDDCs			
Brazil	1 797 739	1 201 539	1 224 978
Islamic Republic of Iran	425 620	666 693	675 341
Nigeria	492 075	591 952	600 732
Saudi Arabia	676 340	593 815	598 190
DDCs			
China	13 493 418	11 852 621	11 919 523
India	2 590 899	3 642 851	3 674 494
Indonesia	999 1789	991 355	1 006 355
Republic of Korea	1 601 904	696 868	698 605
Mexico	1 255 065	581 186	588 185
Developed countries			
United States	19 551 981	5 651 108	5 677 674
Russian Federation	1 430 115	1 823 398	1 840 037
Japan	4 578 914	1 225 865	1 228 035
Germany	3 561 302	853 765	856 454
Canada	1 659 241	668 390	672 966
Australia	1 463 016	478 238	482 964
Agricultural CDDCs			
Brazil	1 797 739	1 201 539	1 224 978
Argentina	583 430	276 514	281 884
Ethiopia	82 721	188 687	192 593
Myanmar	72 422	108 173	111 848
Uganda	37 239	72 737	73 944
Fuel CDDCs			
Islamic Republic of Iran	425 621	666 693	675 341
Nigeria	492 075	591 952	600 732
Saudi Arabia	676 340	593 815	598 190
Kazakhstan	202 016	284 797	287 526
Mineral CDDCs			
Chile	260 355	129 783	130 713
Democratic Republic of the Congo	42 619	95 172	96 705
Uzbekistan	95 650	93 780	96 502
Peru	210 308	73 978	75 189
United Republic of Tanzania	57 012	72 986	74 863

Source: UNCTAD.

Analysis of the data on the cyclical patterns of output and GHG emissions (Figure 4.2) suggests that in developed countries, GHG emissions seem to generally fluctuate with business cycles. This is an indication that GHG emissions in those countries vary with changes in economic activity. Another finding, from the relationship between emissions and GDP growth by type of commodity dependence, namely agriculture; minerals, ores and metals; and fuels; suggests that the cyclical relationship is stronger in agricultural and mineral CDDCs than in fuel-dependent CDDCs. This finding confirms that movements in fuels markets are less correlated with the business cycle than are markets for the other two types of commodities. Indeed, it is well known that fuel markets are highly volatile, responding to market as well as non-market signals that may not be associated with business cycles. For example, political events in major oil-producing countries generally have an immediate effect on prices, irrespective of the business cycle.

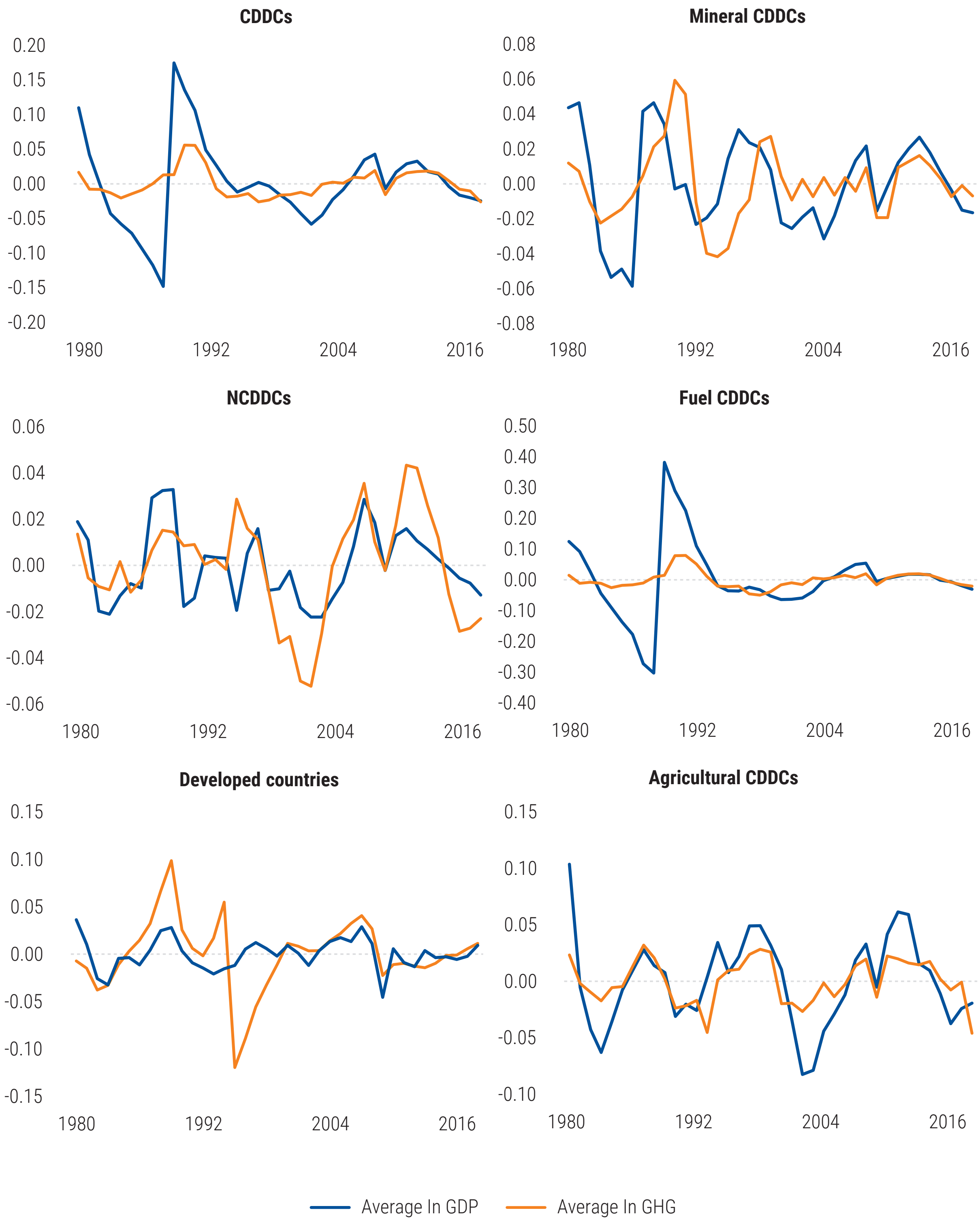
The trend relationship suggests that over time emissions rise with GDP growth in CDDCs and NCDDCs (Figure 4.3). Indeed, in developing countries, for both CDDCs and NCDDCs, changes in emissions are more likely to reflect long-term structural trends, as emissions gradually rise with GDP. Trend emissions in CDDCs have increased at least as fast as, or faster than, GDP, although starting from very low bases. This feature suggests that over time, as CDDCs diversify, they should pursue opportunities that help to restructure their economies in ways that decouple production from GHG emissions.

Moving on to the discussion of the estimates of cycle and trend emissions-output elasticities (Figure 4.4), it is worth highlighting, once more, a few findings that confirm the complexity of the relationship between output and GHG emissions. First, while developed countries have lower trend elasticities but higher cycle elasticities than CDDCs and NCDDCs, there are differences within the group of CDDCs. Trend elasticities are higher for CDDCs that depend on agricultural and fuel exports than those that are dependent on mineral exports, implying that efforts towards decarbonization of these economies as they diversify will need to be group or even country-specific.

The second finding relevant to the discussion of decarbonization and diversification in CDDCs is that high-income CDDCs have an average trend output-elasticity of GHG emissions that is almost double that of low-income and middle-income CDDCs. This result indicates that diversification strategies in high-income CDDCs would not necessarily be the same as those in lower-income CDDCs; there are specificities that will need to be accounted for.

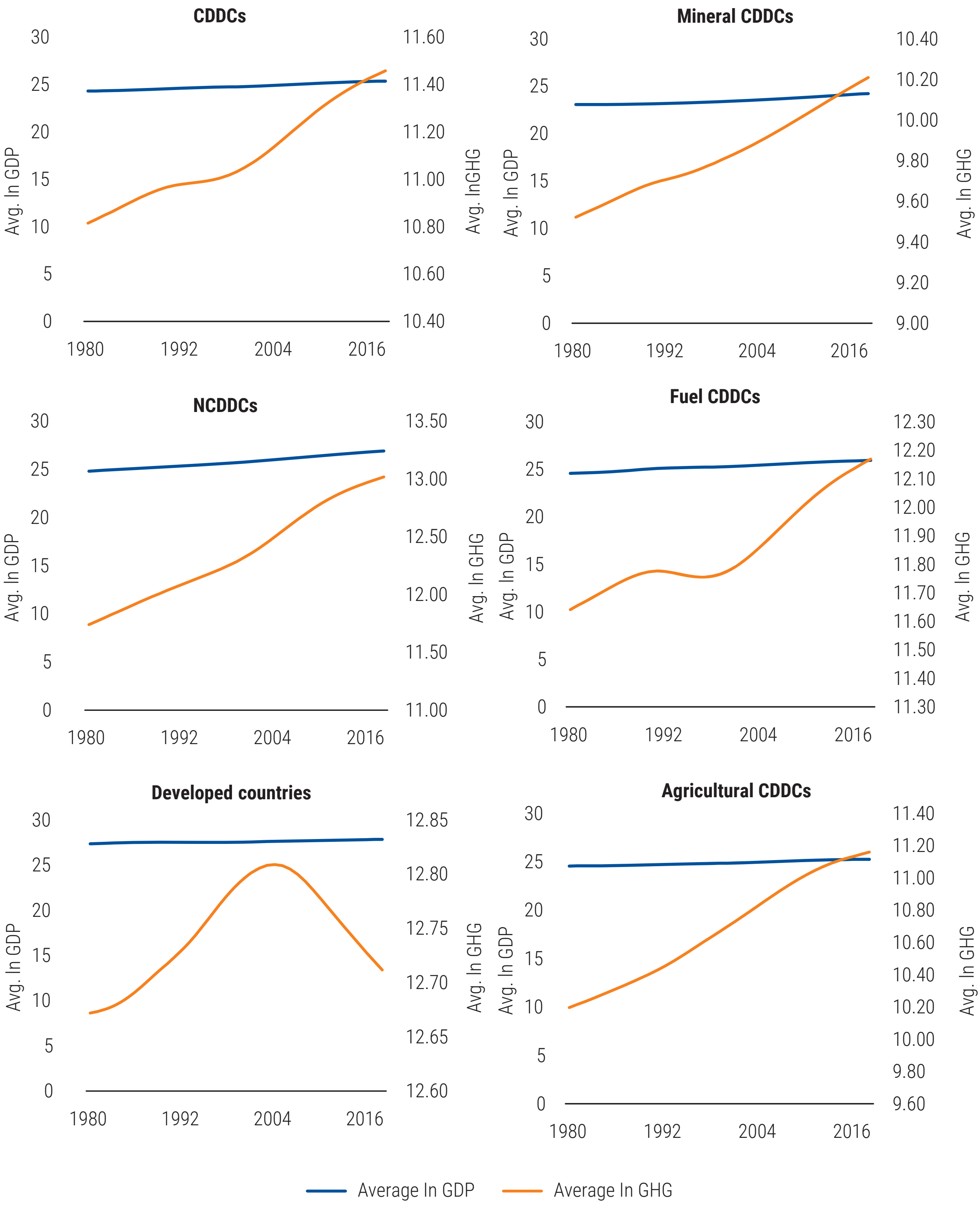
The third finding given in Figure 4.4 is that there are remarkable regional differences in terms of elasticity sizes. Elasticity estimates are highest in the Middle East and North Africa, a region that is highly dependent on hydrocarbons. A possible policy implication of this result is that this group of countries might consider diversification strategies that are oriented towards non-energy sectors with lower elasticities. But this will be contingent on each country's current and potential production possibilities in those sectors. A pairwise comparison of means reveals that compared with Europe and Central Asia, long-run elasticities are statistically higher in the Middle East and North Africa, sub-Saharan Africa, and Latin America and the Caribbean. Emissions are also the least pro-cyclical in sub-Saharan Africa and more procyclical in Latin America and the Caribbean. These regional differences are probably due to differences in types of commodity dependence and production processes across regions. It is also worth noting that within each region, there is considerable heterogeneity among countries.[26]

Figure 4.2 Cyclical GHG and GDP per commodity dependence status and commodity type
(in logarithm)



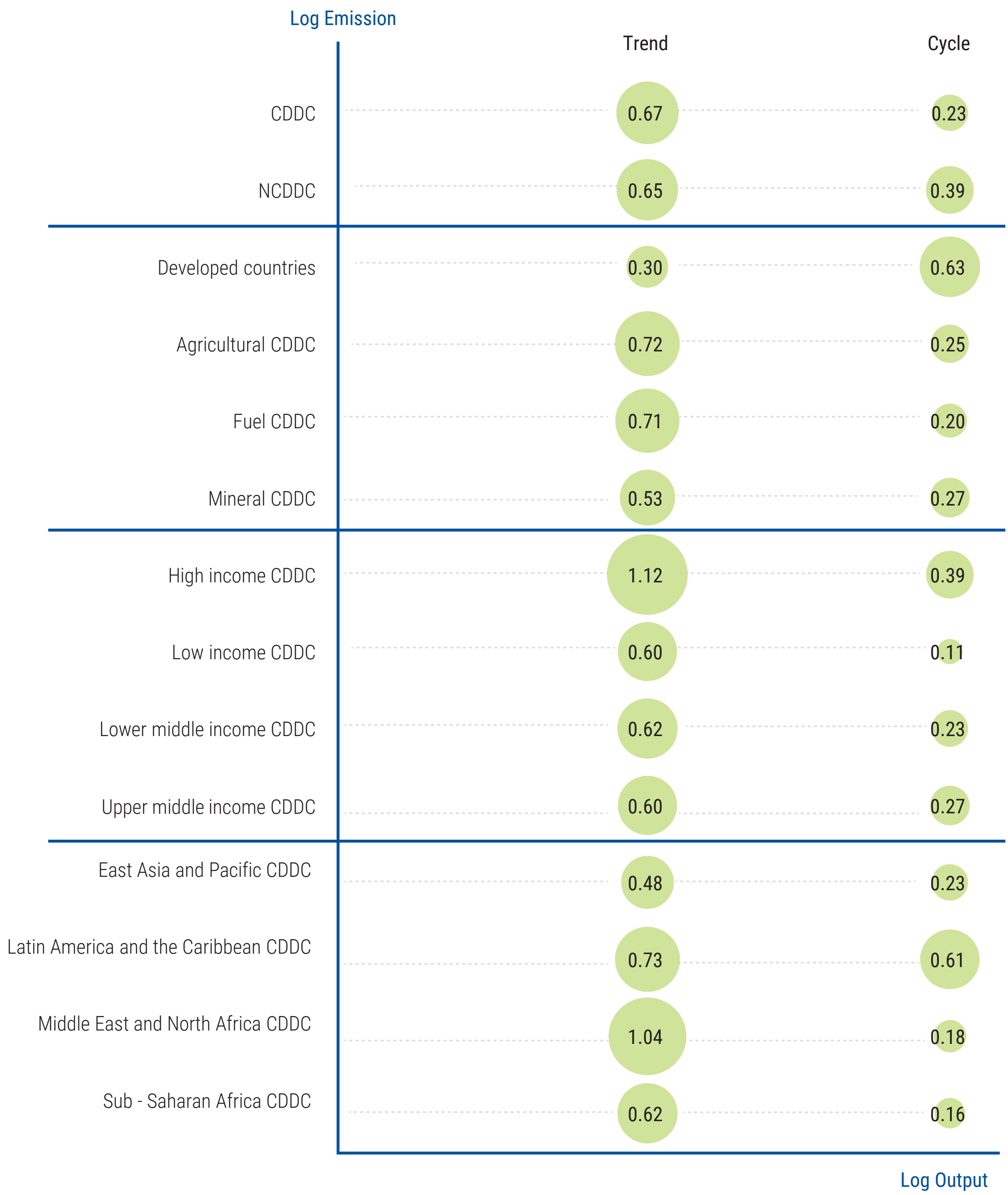
Source: UNCTAD.

Figure 4.3 Trend GHG and GDP per commodity dependence status and commodity type (in logarithm)



Source: UNCTAD.

Figure 4.4 Estimates of trend and cycle elasticities for different country groups



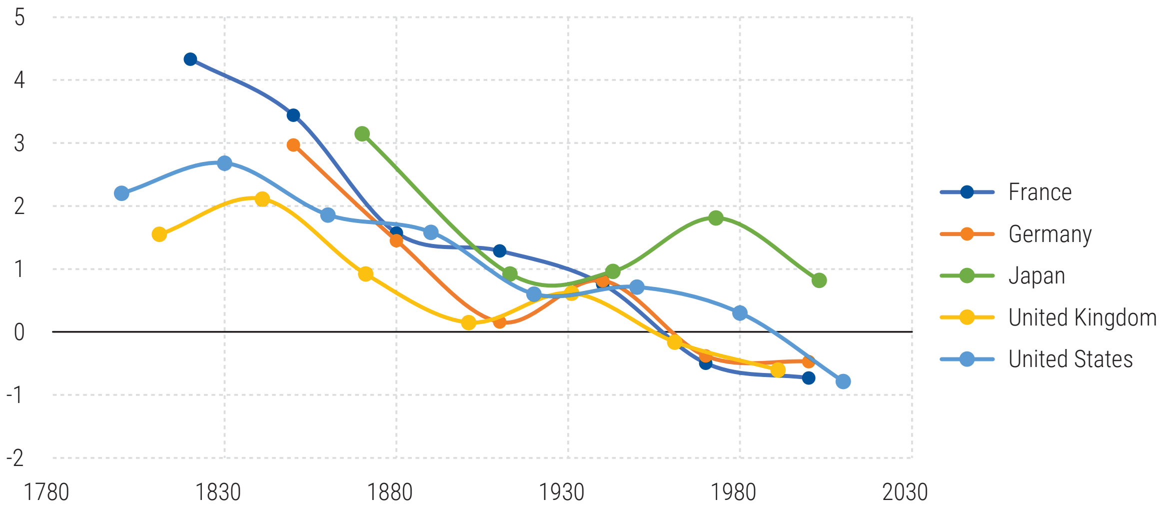
Source: UNCTAD.

A longer-term view: Decoupling is possible

Historical analysis using estimates of output and carbon emissions spanning more than two centuries provides insights into the process of decoupling as experienced by major industrialized economies. Two important messages may be derived from the elasticities captured in Figure 4.5. The first is that decoupling is possible, even though it took industrialized countries a relatively long time for their economies to experience a pattern of growth decoupled from emissions. As shown in Figure 4.5, output growth in the early periods of industrialization of major economies led to more than proportionate increases in emissions, with trend elasticities greater than 2 in the mid to late 19th century for all the countries. Over time, elasticities declined, hovering around zero in the most recent period, with experiences varying across countries.

For example, the United Kingdom had the lowest elasticity in its early industrialization, and it seems to have experienced a decoupling trend before 1880 when other countries had elasticities greater than one. Japan seems to have undergone a decoupling phase before 1930 but then increased its elasticity before showing another phase of decoupling by the end of the sample period in 2017. France had the highest elasticity at the beginning of the sample period in 1800 but continuously reduced its carbon emissions per unit of output until the end of the observation period in 2017. The lesson from these results is that decoupling experiences in industrialized countries were different, inviting some caution when referring to them. This might imply that CDDCs will also follow different pathways, with some countries decoupling faster than others. The difference between now and a century ago is that, on the one hand, the climate imperative is more acute now, and on the other hand, there are technologies that can help countries to follow a less carbon-intensive economic model.

Figure 4.5 Decoupling in industrialized countries followed a long period of industrialization: Trend emissions-output elasticities



Source: UNCTAD.

Note: The full-time series of the five countries are split up into 30-year periods. The trend elasticity equations are estimated on each of these 30-year subperiods.

The second message is that even though the only tested model for successful industrialization is the one followed by developed countries such as the ones depicted in Figure 4.5, CDDCs that would like to diversify today should aim for a different model; the traditional trajectory will not be compatible with the current and future efforts towards decarbonization. For those countries, embracing clean energies as early as possible should be considered as a part of their economic and environmental priorities.

Currently, developing countries – both CDDCs and NCDDCs – have emissions-output elasticities comparable to (and in several cases, less than) those of early industrializers when the latter were mostly well past a century of industrialization. The elasticities of several developing countries are at about the levels that the early industrializers reached in the mid-20th century.[27]

Experience will differ from one country to another and between the types of commodities countries depend on. Fossil-fuel-dependent economies, for example, may have more resources than agriculture-dependent economies to invest in economic transformation. The capacity to transform will also depend on the current level of emissions, the sensitivity of emissions to changes in output, and existing productive capabilities.

For low-income CDDCs, focusing exclusively on cutting emissions may therefore constrain their development without significant emissions benefits. And since energy access is critical for human wellbeing, for these countries, it may be more realistic to concentrate on building basic capabilities and ensuring access to energy using all available sources, including fossil fuels. A just energy transition implies that CDDCs, in general, and low-income CDDCs, in particular, might require relatively more of the remaining carbon budget. Moreover, these countries' development needs and their marginal responsibility in the climate crisis, as well as the principle of common but differentiated responsibilities, should justify more financial and technical support from developed partners in order to ensure that the process of decarbonization does not leave them behind.[28] Indeed, CDDCs should not stay at the margins of the decarbonization process. On the other hand, continuing to depend on carbon-intensive resources, as fossil fuels are being phased out elsewhere, may expose fossil fuel-dependent countries to significant losses as the natural resources and associated assets they have depended on are stranded.

Lowering GHG emissions will require efforts that should be commensurate with each stakeholder's capabilities. Some argue that given the strong association between economic growth and carbon emissions, more advanced economies should now forego economic growth while allowing "ecological space to permit development-through-growth to proceed for a short time in the Global South."[29]

However, allocating the burden solely to developed countries does not seem to be realistic.

Moreover, even if that were feasible, it would not slow the pace of climate change sufficiently. Contracting global GDP by 10 per cent between 2015 and 2030 might reduce emissions to 30 billion tons, but to achieve global climate mitigation targets, CO_2 emissions would need to fall to 20 billion tons by 2035.[30] In other words, that would require a reduction in global GDP four times larger than during the 2007-2009 recession.[31] The growth reduction necessary to bring about sufficient reductions in global CO_2 emissions would reduce living standards with little impact on overall emissions – and would probably widen inequality in wealth and income between and within countries.[32]

If the CDDCs are to meet their development goals while decreasing emissions, they will therefore need to strike a balance between traditional sources of energy and greener alternatives such as solar and wind power. This will require time and patience. They cannot base their current industrialization solely on green energy, which is not yet sufficiently widespread or efficient. Rather, they should use the most available and reliable sources of energy, while establishing the infrastructure that will enable them to switch seamlessly to greener sources. Over time, the demand for green products will increase, while that for traditional carbon-based products shrinks. And during this period CDDCs should not just be buyers of green energy systems but active participants as producers and innovators of green technologies.

The following chapter shows how they can do so in a comprehensive way through ‘green industrial policy.’

Endnotes

[1] Pickbourn et al., 2022

[2] Including highly vulnerable economies, particularly CDDCs, dependent on the export of a single commodity (e.g., sugar in Mauritius until the 1970s) or a limited number of commodity exports (e.g., coffee and bananas in Costa Rica until the 1980s).

[3] UNCTAD and FAO, 2017

[4] Agosin, 2009

[5] Ibid

[6] UNCTAD, 2021d

[7] Agosin, 2009

[8] Panayotou et al., 2000

[9] Zeng et al., 2014; Lin and Chen, 2019

[10] Pickbourn et al., 2022

[11] Padilla, 2017

[12] Kaya and Yokobori, 1997

[13] Anzolin and Lebdioui, 2021

[14] World Bank, 2012

[15] Pollin, 2015: 109, 111

[16] Please refer to Pickbourn et al. (2022) for the country level results.

[17] Narayan and Narayan, 2010

[18] More specifically, the authors find that for 15 out of the 43 countries in their sample, the long-run elasticity of emissions with respect to income is lower than the short-run elasticity, suggesting that in these countries, increases in income are associated with lower carbon dioxide emissions. However, the long-run income elasticity of carbon dioxide emissions was positive for all but six countries (the Congo, Iraq, Kenya, Nigeria, the United Arab Emirates and Yemen) indicating that the majority of countries in the sample still need to do more to decouple long-run income growth from carbon dioxide emissions.

[19] Gough, 2017; Jalles and Ge, 2020

[20] Cohen et al., 2018

[21] Jalles and Ge, 2020

[22] Pickbourn et al., 2022. These country categories were used in previous reports, including in UNCTAD (2019a) and UNCTAD (2021d). CDDCs are developing countries (using UNCTAD classification) that derive at least 60 per cent of their merchandise export revenue from commodities, as defined earlier. NCDDCs are developing countries that are not commodity-dependent. Developed countries are as defined by UNCTAD classification.

[23] see also UNCTAD, (2019a).

[24] The IPCC sectors are defined as follows: energy industries comprises emissions from fuels combusted by the fuel extraction or energy-producing industries; manufacturing industries are emissions from combustion of fuels in industry, and includes combustion for the generation of electricity and heat for own use in these industries; transportation sector refers to emissions from the combustion and evaporation of fuel for all transport activity excluding military transport; manufacturing non-energy covers emissions from industrial processes and product use, excluding those related to energy combustion. See the IPCC guidelines for further details.

[25] This dataset provides country-level time-series estimates of carbon dioxide CO_2 emissions from fossil fuel combustion and cement manufacture going back to 1751, and include emissions from solid fuel consumption, liquid fuel consumption, gas fuel consumption, cement production, and gas flaring https://data.ess-dive.lbl.gov/view/doi:10.15485/1712447

[26] Detailed information can be found in Pickbourn et al. (2022).

[27] Pickbourn et al., 2022

[28] UNCTAD, 2022b

[29] Gough, 2017: 171

[30] Pollin, 2015

[31] Pollin, 2015: 108

[32] Gough, 2017