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Growing the good and shrinking the bad: Output-emissions elasticities and green industrial policy in commodity-dependent developing countries

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Abstract

This paper attempts to answer a series of questions that continue to hamstring the policy space of commodity dependent developing countries (CDDCs), particularly considering commitments made in the context of climate change adaptation and mitigation measures. First, is it possible for CDDCs to meet their development goals while also fulfilling their commitments to climate change mitigation? Is it possible to manage the commodity sector in a way that fosters growth without worsening environmental outcomes? Can CDDCs at their current development stage decouple economic growth and development from increasing emissions, environmental pollution, and resource depletion? While the international community needs to consider the challenges facing CDDCs as they attempt to move towards a low-carbon growth path, CDDCs should embrace green industrial policies to position themselves as viable producers and exporters of green goods. Continued reliance on traditional commodities in an era of green transition may not be a viable long-term option.

Key words: Commodity-dependent developing countries; output-emissions elasticities; green industrial policy

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1. Introduction

In the 2021 edition of the annual World Energy Outlook (IEA, 2021), the International Energy Agency predicts that, as a result of rapid advancement in clean energy technologies, wind turbines and electric vehicles, the global use of fossil fuels will peak by the mid-2020s, with global oil demand declining permanently by the 2030s. However, the agency also points out that the transition away from fossil fuels is not happening fast enough to meet the goal of limiting average global warming to around 1.5 degrees Celsius by 2100, relative to pre-industrial levels. Meeting this goal would require slashing emissions to net zero by 2050 – a move that would involve, among other things, reducing fossil fuel production by roughly 6 per cent per year between 2020 and 2030 (SEI, 2021). Assuming that such a rapid phase-out of fossil fuel production and consumption does occur, the implications for growth and development in developing countries that are currently dependent on exports of fossil fuels will be significant.[1] These outcomes may not be limited only to fossil fuel exporters: climate change itself, together with climate change mitigation efforts in the global economy, pose major challenges to economic and human development in commodity dependent developing countries (CDDCs), more generally.

A country is considered commodity dependent if commodities account for more than 60 per cent of the value of total merchandise exports from that country (Janvier D. Nkurunziza et al., 2017; UNCTAD, 2019a). By this measure, 101 countries were commodity dependent in 2019, up from 93 in 2009 (UNCTAD, 2019a, 2021b). Commodity dependent developing countries are a heterogeneous group: they vary by the type of commodity, by income, and by geographical location (UNCTAD, 2019a). Of the countries that were commodity dependent in 2019, 37.6 per cent were dependent on agricultural commodities, 31.6 per cent on minerals ores and metals; and 30.6 per cent on fuel exports (UNCTAD, 2021b).

Commodity dependence is primarily a developing country phenomenon: almost two out of three developing countries were dependent on commodity exports in 2019, and 86 per cent of commodity dependent countries were developing countries (UNCTAD, 2021b). Between 2009 and 2019, commodity dependence even worsened. The average share of commodities in total merchandise exports increased from 64.1 per cent to 66.3 per cent over the period, while the median commodity share rose from 70.3 per cent to 74 per cent (UNCTAD, 2021b). Africa, which accounts for 44.5 per cent of all CDDCs, has the greatest incidence of commodity dependence, as 45 out of 54 African countries are commodity dependent (UNCTAD, 2021b). Commodity dependence is also strongly correlated with income: 91 per cent of low-income countries are dependent on commodity exports, and the share of commodities in total merchandise exports tends to fall as income rises, even within the group of CDDCs.

CDDCs, especially the poorest among them, are also disproportionately affected by climate change, even though the magnitude of the effect varies across countries depending on their geographical location, the commodities on which they depend, and their financial and technical capacity to adapt to climate change. Of the 40 countries most vulnerable to climate change, 37 are CDDCs; the 10 most vulnerable in this group are all low-income countries (UNCTAD, 2019). The economies of these countries are structured around the extraction and export of commodities, often just one commodity. Current projections for growth in these economies are predicated on their ability to maintain the status quo. However, climate change is likely to have an adverse effect on earnings from commodity exports in CDDCs, through reductions in productivity in key commodity sectors, or through reductions in the demand for their main commodity exports, as a result of climate change mitigation efforts by the world's largest economies. At the micro-level, these adverse impacts on CDDCs will be felt the most by poor, marginal and socially-excluded groups in these countries.

Although CDDCs as a group have contributed much less than more industrialized countries to emissions of greenhouse gases (GHGs), almost all CDDCs have signed on to the Paris Agreement and since 2015, have made significant commitments towards the global climate change mitigation effort (UNCTAD, 2019a). These commitments place them in something of a bind: on one hand, their continued dependence on the extraction of carbon-intensive commodities can make it more difficult to meet their commitments to climate change

[1] The report notes that current estimates project an actual average annual increase in fossil fuel production of 2 per cent (SEI et al.2020).

mitigation targets. On the other hand, honouring their climate change mitigation commitments could make it more difficult for CDDCs to meet their development goals.

The choices facing these countries appear stark: they can continue to rely on the extraction and export of emissions-intensive commodities as the primary source of export revenues and growth, regardless of the implications for climate change. But this strategy exposes them to the very real risk of declining export earnings stemming from falling productivity as the commodity sector is threatened by fluctuations in temperature and precipitation, or from a long-term decline in the demand for these commodities, as their major trading partners move towards greener alternatives (Anzolin and Lebdioui, 2021). Alternatively, CDDCs can meet their commitments to climate change mitigation by voluntarily stranding their resources or waiting for them to be stranded in response to changes in the market valuation of natural resource assets (McGlade and Ekins, 2015; Rempel and Gupta, 2021).[2] But this choice is likely to be politically unpopular, given the devastating economic consequences for these countries of such a drastic reduction in export revenues. There is a third path that would involve a fundamental reorientation of the economic structure of CDDCs through a process of industrialization, thereby diversifying their exports and reducing their dependence on commodity exports. However, industrial production has historically been carbon-intensive, and conventional strategies of industrialization in CDDCs could potentially hasten the pace of global warming (Naudé, 2011).

These challenges can be summed up in a series of questions that continue to hamstring climate talks: is it possible for CDDCs to meet their development goals while also fulfilling their commitments to climate change mitigation? Is it possible to manage the commodity sector in a way that fosters growth without worsening environmental outcomes? Can CDDCs at their current development stage decouple economic growth and development from increasing emissions, environmental pollution and resource depletion?

The answers to these questions require a full understanding of the evolving relationship between output and emissions in CDDCs. With the exception of a few studies, most research on this relationship has focused on developed economies (Cohen et al., 2018). This paper extends this strand of the literature by estimating short-run and long-run output elasticities of emissions for 127 countries, grouped by commodity dependence status over the period 1980 to 2018.[3] Although developed countries have lower output elasticity of emissions than developing countries, elasticity of emissions with respect to output is comparable across CDDCS and diversified developing countries (DDCs). To gain a more nuanced understanding of the relationship between growth and emissions in CDDCs, the CDDC group is disaggregated by type of commodity dependence, by income group, and by region, and estimate output-elasticities of emissions for the sub-groups. Doing so reveals considerable heterogeneity among CDDCs. In addition, to provide context for interpreting these estimates, historical output-elasticities of emissions are estimated for five major developed countries over the period 1800 – 2017. The results are comparable to, and in some cases, higher than the output elasticities of emissions for currently developing countries. The historical analysis highlights the environmental challenges inherent in conventional paths of diversification, industrialization and growth.

Our analysis suggests that although there is a tendency for emissions to increase with output among CDDCs, commodity dependence or export diversification *per se* do not determine the output elasticity of a country's emissions. Hence, there is a role for policy to guide the transition of CDDCs to a low-carbon growth path, one that also provides them with an alternative to commodity dependence. In addition, global policies to slow the pace of climate change by reducing emissions in CDDCs must be attentive to differences among these countries in terms of current levels of emissions and the sensitivity of emissions to output in these countries. Global climate policies that retard output growth in countries with low output-elasticities of emissions will have significant adverse impacts on living standards in those countries but little impact on overall emissions.

Furthermore, the high output-elasticities of emissions among diversified developing countries and among early industrializers in the first century of industrialization makes it clear that conventional patterns of diversification and industrialization are unlikely to be an environmentally sustainable option for CDDCs. This does not mean

[2] Rempel and Gupta (2021) define stranded assets as assets that have suffered from "unanticipated or premature write-downs, devaluations or conversion to liabilities" (p.146) and describe a best-case scenario that involves "equitably managing stranded assets to ensure that the burden falls on rich and capable actors, predominantly from the North."

[3] The sample includes CDDCs, diversified developing countries (DDCs) and developed countries.

that CDDCs must choose between climate change mitigation and development. The reappearance of industrial policy, in the form of green industrial policy (GIP), in mainstream economic analyses and policy discourses, offers the possibility for CDDCs to shape the contours of an alternative low-carbon development path, one in which these countries can accumulate the productive capabilities necessary for the export of green goods and services while also addressing the challenges of employment, technology and energy poverty (Anzolin and Lebdioui, 2021; Azad and Chakraborty, 2021).

While the extant literature has focused mostly on the role of GIP in facilitating the transition to a low-carbon economy in industrialized countries, this paper contends that GIP is especially relevant for CDDCs. GIP can enable CDDCs to shift resources to high productivity sectors while also maximizing the development spillovers from the transition to a low-carbon economy (Anzolin and Lebdioui, 2021). These spillovers include employment creation, expanded access to green energy, the ability to participate in the global economy as producers and innovators of green technologies instead of being merely consumers, and a reduction in the vulnerability of CDDCs to climate change and macroeconomic volatility associated with commodity dependence – vulnerabilities that are likely to worsen as the demand for carbon-intensive commodities declines (Chang and Andreoni, 2021; Pollin, 2015). However, the success of GIP in CDDCs will require complementary policies at the global level to provide access to finance, energy, technology, and a favourable institutional environment.

The structure of the paper is as follows. The next section discusses the various macroeconomic vulnerabilities of CDDCs associated with their dependence on commodities and the challenges that climate change poses for CDDCs. The third section reviews the literature on the relationship between output and environmental pollution, while the fourth section presents the empirical analysis of output elasticities of GHG emissions in CDDCs. The penultimate section explores the potential for green industrial policy in CDDCs, discusses the challenges posed by the current structure of production, trade and investment in the global economy and highlights the need for international policy coordination to ensure that the low-carbon transition is not detrimental to development in these countries. The final section concludes.

2. Commodity dependence, climate change and development

2.1 Commodity dependence and development

Debates over the role of commodity dependence in the process of economic and human development have focused on whether the commodity sector can generate sustained dynamic growth in developing countries, and on the extent to which commodity dependence limits industrial development in CDDCs, hampers their ability to diversify away from commodities or acts as a constraint on human development (Janvier D. Nkurunziza, 2021; Janvier D. Nkurunziza et al., 2017; José Antonio Ocampo, 2017).

The detrimental effects of specialization in commodity exports on economic development are captured in the Prebisch-Singer hypothesis. According to this hypothesis, the long-term downward trend in the net barter terms of trade between primary commodity exports and manufactured exports results in the benefits of trade accruing *primarily* to industrialized countries that specialize in manufactured exports (Prebisch, 1950; Singer, 1950). This hypothesis has spawned an abundant empirical literature which by and large supports the thesis of a long-run decline in the terms of trade of primary commodities relative to manufactured products (Erten and Ocampo, 2013; Grilli and Yang, 1988; Lutz, 1999; Jose Antonio Ocampo and Parra Lancourt, 2004; Sapsford, 1990; Sapsford and Chen, 1999; Sarkar, 2001; Spraos, 1980, 1984). The reasons for this long-run deterioration in the net barter terms of trade for primary commodities include low income and price-elasticities of demand for commodities, as well as the institutional and economic structure of CDDCs (Singer and Gray, 1988).

Commodity dependence is associated with both structural and macroeconomic vulnerabilities, most of which stem from the volatility of commodity prices which are subject to large cyclical movements related to changes in global aggregate demand and to technological innovation (Erten and Ocampo, 2013). This volatility tends to be particularly pronounced in periods of global economic crisis, such as the 2008 financial crisis. More recently, weak global aggregate demand resulting from the COVID-19 pandemic-related collapse of economic activity

and global trade in early 2020 contributed to significant downward pressure on commodity prices that year (Tröster, 2020; Tröster and Küblböck, 2020). Economic recovery from the pandemic led to higher demand for commodities, exerting upward pressure on prices.

The military invasion of Ukraine by the Russian Federation in February 2022 has compounded tensions in commodity markets, quickly turning the post-COVID recovery into a full-blown commodity market crisis. Food and fuel prices, as well as those of fertilizers, have increased dramatically owing to the importance of the Russian Federation and Ukraine in supplying those commodities to global markets (UNCTAD, 2022). It is worth adding that the financialization of commodity markets has further exacerbated the volatility of commodity prices (Ederer et al., 2016; Tröster et al., 2019).

The cyclical movements in commodity prices have implications for short-tern macroeconomic stability and economic growth in CDDCs. Cyclical movements in commodity prices lead to pro-cyclical fluctuations in income levels and in aggregate demand as resource-rich countries engage in costly investment programs during periods of booming commodity prices, often abandoning them when commodity prices slump (Nkurunziza et al., 2017). CDDCs also experience strong pro-cyclical patterns in the availability of finance and the cost of financing that follow the cycles of commodity prices (José Antonio Ocampo, 2017). These external factors lead to cyclical patterns in real exchange rates that further enhance fluctuations in aggregate demand. The current account balance is also affected by real exchange rate fluctuations: commodity price booms lead to a real appreciation of the domestic currency, stimulating imports and leading to reductions in exports of non-primary goods, while commodity price slumps can have the opposite effect (José Antonio Ocampo, 2017).

These short-term macroeconomic changes affect the performance of other sectors. For example, the increased spending associated with commodity booms can yield positive impacts in other sectors, but these may be countered by the negative effects of real exchange rate appreciation during commodity booms (José Antonio Ocampo, 2017). Overall, volatility in commodity terms of trade has a negative effect on economic growth, which offsets the positive impacts of commodity booms (Cavalcanti et al., 2011; Van der Ploeg and Poelhekke, 2009). From 2013 to 2017, for example, average commodity price levels fell far below their 2008-2012 levels, leading to economic contractions and recessions in 64 commodity-dependent countries (UNCTAD, 2019b).

CDDCs are also subject to structural vulnerabilities stemming from their dependence on commodity exports. Natural resource exhaustion, long-term changes in consumer demand, increased competition resulting from discovery of resource deposits in other countries and technological innovations that lead to changes in demand for some commodities are all potential causes of structural weaknesses in CDDCs (Chang and Lebdioui, 2020). The strength or weakness of linkages between the commodity sector and other sectors as well as the rate of productivity growth in the commodity sector also have long-term macroeconomic implications for CDDCs, including for their ability to diversify away from commodities (José Antonio Ocampo, 2017; Jose Antonio Ocampo and Parra Lancourt, 2004). Indeed, commodity dependence in developing countries appears to persist over the long-run, leading to what has been described as a commodity trap (Janvier D. Nkurunziza, 2021).

These negative associations between commodity dependence, on the one hand, and macroeconomic stability, long-term economic growth and human development on the other hand, have long provided a strong argument for CDDCs to reduce their dependence on commodity exports. The threat to CDDCs of climate change and the economic consequences of climate-change mitigation policies adopted by other countries provide an added layer of urgency to this argument.

2.2 Commodity dependence and climate change

The relationship between commodity dependence and climate change is multi-faceted, and the contributions of CDDCs to climate change as well as the impacts of climate change on CDDCs vary significantly across countries.

As a group, CDDCs contribute only modestly to climate change: they were responsible for only 21 per cent of the stock of greenhouse gas (GHG) emissions accumulated between 1990 and 2014 (UNCTAD, 2019a, p. 23). This pales in comparison to the 44 per cent attributable to the much smaller group of developed and transition

countries, and the 35 per cent attributable to diversified developing countries (UNCTAD, 2019a, p. 23).[4] Average emissions per capita in CDDCs amounted to 5.4 tons of CO2 equivalent (tCO2e) in 2014, significantly lower than the European Union (7.2 tCO2e), China (8.3 tCO2e), Russian Federation (14.1 tCO2e) and the United States (19.9 tCO2e) (UNCTAD, 2019a, p.24).

The contribution of individual commodity sectors to GHG emissions also varies across commodities. The combustion of fossil fuels for energy, heat and transport is the leading source of GHG emissions globally, accounting for nearly half of anthropogenic GHG emissions in 2010 (UNCTAD, 2019a, p.13). This is followed by agriculture, forestry and other land use, which contributed another 24 per cent (IPCC, 2014).[5] There is no reliable data on the contribution of minerals and metals to GHG emissions. However, the mining sector is energy-intensive and contributes to GHG emissions through the use of energy in mining and smelting operations. As global production of key minerals and metals increases, GHG emissions from mining have increased apace (UNCTAD, 2019a, p.17). In addition, as these resources are depleted, mining is expected to become increasingly carbon-intensive as more energy is needed to access deeper deposits and to refine poorer quality ores (UNCTAD, 2019a, p.17).

As a result of these differences across commodity sectors, there is considerable heterogeneity in per capita GHG emissions across CDDCs by type of commodity dependence and by income group. In 2014, high-income CDDCs averaged per capita emissions of 22.7 tCO2e, over 10 times the per capita emissions of low-income CDDCs. Among high-income CDDCs, fossil fuel exporters averaged per capita emissions of 31.6 tCO2e, compared to 8.6 tCO2e in other high-income CDDCs that depend on exports of agricultural or mining products (UNCTAD, 2019a, p. 25).

Climate change also reduces productivity in CDDCs. This may be directly through a reduction in yields, for example, or indirectly through the actions taken by CDDCs and by third countries to mitigate and adapt to climate change. CDDCs are vulnerable to the extreme weather patterns associated with climate change: according to the University of Notre-Dame's Global Adaptation Initiative Index, the 10 countries most vulnerable to climate change in 2019 were all low-income CDDCs.[6] Africa features prominently in the list of regions most vulnerable to climate change: 16 out of the 20 most vulnerable countries are in sub-Saharan Africa, and in 2015, four of the 10 countries most affected by extreme weather events associated with climate change were in Africa.[7] While climate change is expected to negatively impact the capacity of CDDCs to produce the commodities on which they depend, there is uncertainty about how exactly specific commodities will be affected. The impact of climate change on different countries will also depend on their geographical location.

The agricultural sector is one of the most exposed to climate change, although the impacts will vary across crops and across countries and regions. The increasing frequency and severity of extreme weather events such as floods and droughts pose a threat to agricultural productivity in the short-run, increasing the risk of crop, livestock and infrastructure losses. The FAO estimates that natural disasters caused $96 billion worth of crop and livestock loss to the agricultural sectors of developing countries over 2005-2016 (FAO, 2018a). Shifts in temperature and precipitation are also likely to cause long-term changes in the production of several crops; coffee yields, for example, are likely to be adversely affected by higher and more variable temperatures, and the global area suitable for cultivation is estimated to decline by up to 50 per cent by 2050 (Bunn et al., 2015).

The impact of climate change on agriculture has a regional dimension. Yields in low-latitude regions are projected to decrease with rising temperatures, while productivity in some high latitude regions may increase (UNCTAD 2019: 15). A large share of agriculture in national output and employment increases a country's vulnerability to climate change (SEI, 2021). Sub-Saharan Africa is especially exposed: 95 per cent of farmed land in the region is rain-fed, and West Africa has been identified as a climate change hotspot with negative impact of climate change on crop yields and production (IPCC, 2019). Climate change is also expected to have

[4] The report does not provide information on the number of developed countries and diversified developing countries used in this calculation.

[5] The biggest sources (63 per cent) of GHG emissions in the agricultural sector is enteric fermentation and manure associated with livestock production (UNCTAD 2019: 15).

[6] https://gain.nd.edu/our-work/country-index/rankings/

[7] The countries were Mozambique (1st), Malawi (3rd), Ghana and Madagascar (joint 8th position). Ninety per cent of the infrastructure was destroyed in Beira, Mozambique, the epicenter of the 2019 Cyclone Idai. Source: https://www.afdb.org/en/cop25/climate-change-africa

permanent adverse effects on freshwater and marine aquaculture in several CDDCs (FAO, 2018b). Small island developing states are some of the most vulnerable to climate change, and they have been among the earliest countries most affected by the risk of rising sea levels and falling revenues from fisheries (UNCTAD, 2019a, p.2).

Other commodity sectors are also vulnerable to climate change. Extreme weather events, rising temperatures, water scarcity and rising sea levels can cause damage to fossil fuel production sites, infrastructure, operations and supply chains (UNCTAD, 2019a, p.14). Although relatively few studies have been done on the potential impact of climate change on mining operations, existing projections of significant changes in climate in mineral-rich regions suggest that climate change may pose a threat to mining infrastructure, operations and transportation routes (UNCTAD, 2019a, p.18). Climate change also threatens forest ecosystems, increasing the susceptibility of forests to fires and altering forest cover, all of which will negatively affect the forestry sector, with adverse impacts on countries that are dependent on forestry-related activities and products, such as Cameroon (UNCTAD, 2019a, p.14).

2.3 Impacts of global climate policy on commodity markets

The mitigation and adaptation measures undertaken by third economies in response to climate change constitute an important source of vulnerability to climate change for CDDCs. Since 2015, the European Union, the United Kingdom, the United States of America, Japan, and the Republic of Korea have adopted net-zero emissions targets for 2050; China and the Russian Federation have pledged to reach this target by 2060, and India by 2070. These measures – especially those undertaken by the largest economies (China, the United States and the European Union) – will have negative implications for CDDCs, because of their impact on the global demand for emissions-intensive commodities (UNCTAD, 2019a, p.35). Mitigation efforts in these economies will increasingly require natural resources to be stranded, either as the direct result of regulatory efforts to combat climate change, or as the result of policy-induced changes in relative prices that reduce the competitiveness of these resources (UNCTAD, 2019a, p.18).

Fossil fuel exporters, in particular, are likely to be disproportionately affected as the global economy moves towards the use of less carbon-intensive sources of energy. At the recent climate summit in Glasgow, 46 countries pledged to phase out domestic coal while another 29 countries committed to ending new public support for fossil fuels and redirect public investment to clean energy. The Beyond Oil and Gas Alliance, led by Costa Rica and Denmark, also pledged to end new licensing rounds for oil and gas exploration. Together, these pledges imply substantial reductions in global fossil fuel use, and fossil fuel reserves are likely to become stranded if these countries succeed in implementing these policies effectively, and if the rapidly falling costs of low-carbon technology induce faster adoption globally (Mercure et al., 2021). This loss of export markets may however not be limited only to fossil fuel exporters: exporters of other commodities could potentially be affected in the long-run, as technological innovations lead to reductions in the demand for their commodity exports. For example, countries that depend on exports of carbon-intensive agricultural commodities will need to adapt to changing trade standards as consumer demand shifts towards more sustainably sourced agricultural products (Anzolin and Lebdioui, 2021).