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Re-globalization to promote environmental sustainability

This chapter examines the complex interplay between trade and environmental sustainability. It evaluates the potential risks associated with a fragmented approach to climate change and other environmental challenges, and it explores the benefits of re-globalization – or greater international cooperation – for sustainability in the context of various types of environmental policies and their cross-border effects. The chapter also emphasizes the critical importance of multilateral cooperation in enabling effective environmental protection while fostering equitable global growth.

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KEY POINTS

The interplay between trade and environmental sustainability is complex. Trade induces growth, reallocation of production across economies and changes in production technology. While trade does generate emissions from production and transport, it can mitigate negative environmental impacts by increasing the availability of environmental goods and services.

Because global problems need global solutions, a fragmented approach to climate change is less effective. This is true both in terms of fragmentation of climate policies, which would lead to inefficiently weak climate action, and in terms of a fragmentation of the global economy, which would hinder the technology diffusion necessary to mitigate the effects of climate change.

Re-globalization – or an increase in international cooperation and integration – is likely to result in environmental dividends because it encourages inherently greener trade, for example by means of digitally delivered services, and because it allows for more integrated trade and environmental governance.

1. Introduction

Trade can be an important part of the solution to climate crisis and other environmental problems, despite the fact that it can also contribute to emissions of greenhouse gases and other pollutants in the absence of appropriate environmental policies. However, effective environmental policies can mitigate the negative environmental impacts of trade while promoting sustainable trade. Crucially, such policies must be designed to reflect the global nature of environmental problems.

Fragmentation could hamper the diffusion of innovation in environmental technologies, increase prices by reducing economies of scale, and result in a slower and more costly transition towards environmental sustainability. Conversely, re-globalization – or a move towards greater international cooperation and integration – can advance services trade and allow a wider application of digital technologies, lowering the carbon intensity of trade.

Greater international cooperation is key if trade is to play an even more important role in environmental sustainability. The benefits of re-globalization include creating a more integrated global environmental governance system. Importantly, when combined with appropriate environmental policies, trade can significantly advance the green transition by unlocking green comparative advantage. This would enhance the ability of developing economies to tap into new trading opportunities arising from the green transition. The WTO can provide a forum to enhance the coherence between trade and environmental policies and can thereby further contribute to efforts to make trade more sustainable.

2. Trade can contribute to environmental sustainability

The view that international trade has played a significant role in the deterioration of the global environment does not take account of the many ways in which trade contributes to environmental sustainability. The relationship between trade and environmental sustainability is complicated and multi-faceted. This section explores the impact of trade on the environment in areas such as climate change, air and water quality, natural resource extraction and biodiversity.

Three effects of trade on the environment are highlighted: scale, composition and technique effects. Although trade may aggravate environmental problems by increasing the scale of transportation and production, trade also leads to positive environmental outcomes by affecting the composition of goods and services traded, and by helping to develop, deploy and diffuse environmental technologies.

(a) Trade increases transportation and production

International trade increases the efficiency of global production, which in turn leads to the expansion of global consumption of traded products and an improvement in global living standards. However, expanding production and consumption can contribute to greenhouse gas (GHG) emissions and other environmental problems. International trade also involves the movement of goods and people, which can result in negative impacts on the environment. Research suggests that on average, two-thirds of trade-related GHG emissions are related to production and one third to transportation (Cristea et al., 2013).

Despite the transportation sector being responsible for roughly a quarter of global carbon emissions, the direct carbon emissions linked to international trade in goods and services, specifically through international freight and passenger transport, make up approximately 10 per cent of global CO_2 emissions (OECD, 2022). In addition, the multiple crisscrossing of goods across borders as they are traded within global value chains (GVCs) implies additional packaging and increased fuel consumption for transportation. To address the carbon emissions associated with trade, several public and private actors have committed to decarbonize maritime and aviation transport through various initiatives (WTO, 2022g).[1]

When measuring the impact of trade on the environment, it is important not only to account for the amounts of pollution associated with trade, but also to consider a situation without international trade. In such a hypothetical case, domestic production would have to rise to meet consumer demands while maintaining the same standards of living. Consequently, the reduced pollution from less trade would be partly offset by increased pollution from domestic production. Moreover, without trade, economies lacking certain resources or production capacity would not be able to consume many products, while some producing economies would not be able to expand investments due to the limited scale of their domestic market. Some studies suggest that international trade increases carbon dioxide (CO_2) emissions by 5 per cent, compared with a scenario without trade. Moreover, the benefits of international trade exceed its environmental costs from CO_2 emissions by two orders of magnitude (Shapiro, 2016). Similar findings have been observed for sulphur dioxide (SO_2) emissions, where trade contributes to a 3-10 per cent increase in emissions compared to a scenario without trade (Grether, Mathys and de Melo, 2009).

In addition to its impact on climate change, international trade can also have negative environmental impacts by expanding activities that lead to deforestation, degradation of natural habitats, or unsustainable extraction of natural resources, in the absence of appropriate government regulations. International trade is estimated to be associated with around one-third of deforestation-related carbon emissions (Henders, Persson and Kastner, 2015), and, according to Lenzen et al. (2012), 30 per cent of global species threats are associated with international trade.

(b) Trade leads to relocation of production

Trade enables the specialization of production and consumption across regions, allowing economies to focus on their areas of comparative advantage. The environmental impact of trade depends on the specific activities in which economies hold a comparative advantage.

Comparative advantage can stem from varying costs of capital, labour, technology and differences in regulations.[2] In certain cases, disparities in property rights regimes among economies for accessing natural resources can create a basis for trade, influencing trade patterns and potentially contributing to the depletion of exhaustible natural resources (Chichilnisky, 1994; WTO, 2010).

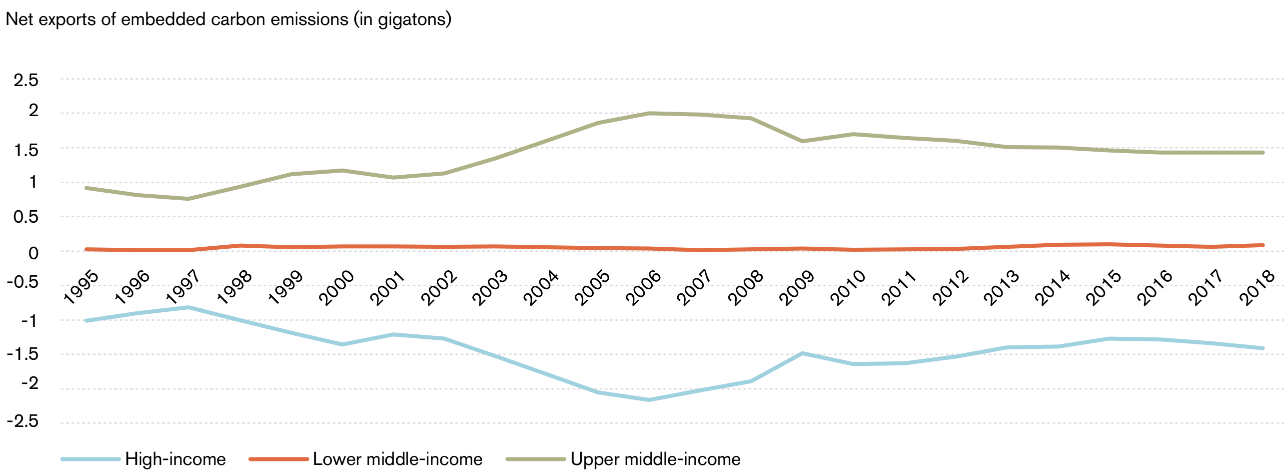
The "pollution haven hypothesis", according to which firms try to avoid the cost of strict environmental regulations by moving production to economies with less strict environmental norms, suggests that environmental policy is a key source of comparative advantage, and as such, opening up trade may lead to the relocation of pollution-intensive production to economies with more lenient environmental regulations. In the case of climate change policies, the relocation could result in "carbon leakage", a situation where efforts to reduce GHG emissions in one region can increase emissions in another region with less stringent climate regulations, leading to a transfer of emissions rather than an actual reduction.

At a global level, trade could lead to the overall reduction of pollution emissions if appropriate regulations are in place. Without appropriate environmental policies, however, international trade could relocate production to economies with the most lenient environmental policies, leading to an overall increase in pollution.

Empirical studies have generated mixed evidence on the validity of the pollution haven hypothesis, although they generally find that an increase in environmental standards reduces exports or increases imports of pollution-intensive goods, suggesting a pollution haven effect (Dechezleprêtre and Sato, 2017; Ederington, Paraschiv and Zanardi, 2022; Levinson and Taylor, 2008; Tanaka, Teshima and Verhoogen, 2022).[3] In the case of carbon leakage, *ex post* empirical analysis produces mixed results (Aichele and Felbermayr, 2015; Dechezleprêtre et al., 2022), partly due to the low emission prices and generous free allocation of allowances in existing emission trading systems. *Ex ante* simulation studies found some degree of carbon leakage ranging from 5 per cent to 30 per cent, indicating that a reduction of 100 units of domestic carbon emissions could be accompanied by an increase of 5 to 30 units of carbon emissions abroad (Branger and Quirion, 2014; Carbone and Rivers, 2020). More recent evidence points to a limited degree of carbon leakage, due to a narrowing gap in developed and developing country emission intensities (Meng et al., 2023; Nordström, 2023).

Figure E.1 illustrates the carbon emissions embedded in trade. High-income economies typically have a higher consumption than production of carbon-intensive goods and services, making them net importers of carbon emissions embedded in goods and services. In contrast, middle-income economies tend to be net exporters of carbon emissions. This pattern can be attributed to several factors, including the fact that high-income economies often have more stringent climate policies, which leads to carbon-intensive industries relocating to middle-income economies with more lenient climate policies. High-income economies also tend to specialize in less carbon-intensive sectors, such as services, that result in fewer production-related emissions. In contrast, carbon-intensive industries are more prevalent in the sectors where many middle-income economies have a comparative advantage. In addition, high-income economies often have more environmentally

Figure E.1: High-income economies tend to be net importers of carbon emissions



Source: Author's calculation based on OECD database on carbon dioxide emissions embodied in international trade ($TeCO_2$).
Note: Net exports of carbon emissions are the difference between carbon emissions embedded in exports and imports. Negative net exports correspond to net imports of carbon emissions. The income groups are based on 2023 World Bank classifications.

friendly and energy-efficient technologies, allowing them to generate smaller quantities of emissions for the same amount of production.

(c) Trade improves the environment by improving efficiency and diffusing green technologies

International trade can also have direct benefits on the environment by improving efficiency, increasing the scale and diffusion of environmental technology, as well as indirect benefits by improving incomes and living standards which in the long-term result in better environmental standards.

First, trade helps to diffuse environmental technologies across borders, by providing access to environmental technologies embedded in goods and boosting the energy efficiency through access to intermediate inputs. The efficiency of an economy's renewable energy generation depends on having access to high quality equipment and machinery available in international markets. For instance, high-quality wind turbines are imported because they deliver a level of efficiency which cannot be replicated in the importing economies (Garsous and Worack, 2021).

Trade in environmental goods has increased at a faster pace than total goods trade over the past two decades (see Figure B.13).[4] In addition, access to intermediate inputs can increase the energy efficiency of production. In the United States, for example, the decrease in intermediate import costs alone is found to explain about 8-10 per cent of the observed reduction in the aggregate energy use-related emissions intensity of nitrogen oxide (NOx) between 1998 and 2014 (Lim, 2022). There is also evidence that multinational companies, through foreign direct investment, can transfer their environmental technology, such as pollution abatement, renewable energy and energy-efficient technologies, to the economy hosting them (Eskeland and Harrison, 2003).

Second, trade-opening also enlarges the market share of larger firms that operate at more efficient scale, resulting in less pollution per unit of production. It is well documented in the literature that exporters are less pollution-intensive than non-exporters (Cui et al., 2016; Forslid et al., 2018; Richter and Schiersch, 2017). Forslid et al. (2018) find that trade liberalization allows for a higher production volume and makes exporters cleaner as they are induced to invest more in pollution abatement. A reduction in trade costs would allow more efficient firms to expand and redistribute output across firms, resulting in a fall in the average emission intensity of an industry. Barrows and Ollivier (2016) find that emission intensity in India dropped significantly between 1990 and 2010 through reallocating resources from less efficient to more efficient firms.

Third, international trade can incentivize innovation or investment in environmental technologies, as access to larger markets increases the scale of production and revenues from investment. Trade can affect firm innovation through exports (Aghion et al., 2022) or through import competition, which in turn increase firms' incentives to innovate (Impullitti et al., 2022). Exporting is found to increase firms' expenditure in pollution abatement (Banerjee et al., 2021) and improve their production processes to reduce emission intensity (Cui et al., 2020). As the development and production of clean energy involves significant upfront investment, the expanded market access associated with open trade could help reduce the unit cost of production in environmental goods and help to reap economies of scale.

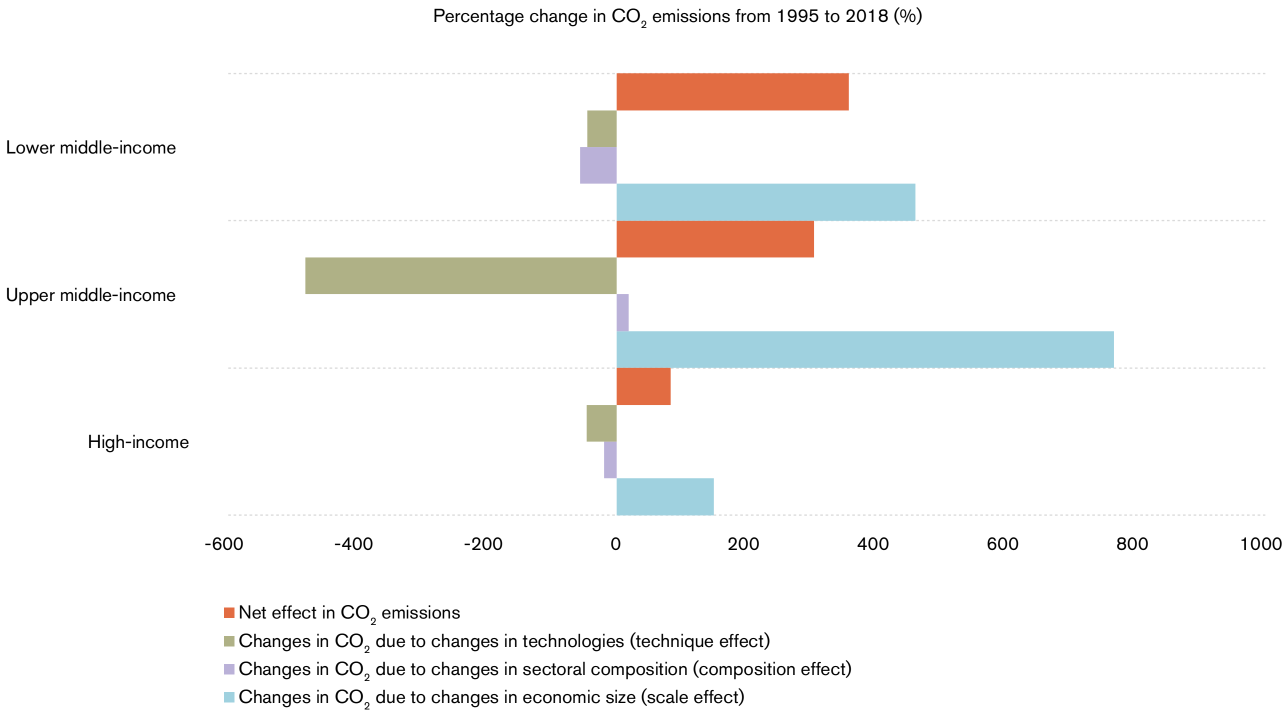
Finally, by raising *per capita* income, trade increases the demand for a better environment. The Environmental Kuznets Curve theory posits that environmental degradation initially worsens with higher per capita income, but eventually improves as societies become wealthier and develop a greater concern for the environment (Grossman and Krueger, 1995). The available evidence suggests that regulation is the dominant factor in explaining the decline in local pollution as economies grow beyond middle-income status. Higher-income economies regulate pollution more strictly for three main reasons. First, pollution damage is given higher priority once a society has completed basic investments in health and education. Second, higher-income societies have more plentiful technical personnel and budgets for monitoring and enforcement activities. Third, higher income and education empower local communities to enforce higher environmental standards (Dasgupta et al., 2002). It is worth noting that while the concentration of local pollution tends to be negatively correlated with income above a certain threshold, the relationship is less clear for global pollutants such as carbon emissions (Shahbaz and Sinha, 2019).

(d) Overall, improvements in production technology mitigates environmental problems

Trade has increased emissions over the past decades but the effect is in part offset by changes in technology. To calculate what share of the change in each country's emissions is due to scale, composition and technique effects, we use a standard decomposition method comparing the change in emissions and output between 1995 and 2018 for major economies. Figure E.2 illustrates this decomposition. It suggests that high-income economies experienced a slight increase in total CO_2 emissions since 1995, while the rise in CO_2 emissions in middle-income economies are larger, driven mainly by increases in their economic size. However, changes in production technology plays an important role in offsetting the increase in carbon emissions for upper-middle income economies.

The finding of a strong technique effect has also been echoed in studies based on evidence at the firm level. For example, following the North American Free Trade Agreement (NAFTA), trade-opening between Mexico and the United States led to substantial reductions in emissions of PM_{10} (i.e., inhalable particulate matter with a diameter of 10 micrometres or smaller) and SO_2 in US manufacturing plants. This reduction occurred in

Figure E.2: Technology improvements had a strong impact in reducing CO_2 emissions between 1995 and 2018



Source: Authors' calculation based on OECD Trade in value-added (TiVA) and CO_2 emissions embodied in international trade ($TeCO_2$) databases.
Notes: Scale effect represents the change in total output between 1995 and 2018. Scale + composition effect is calculated assuming emission rates (tonnes of CO_2 directly emitted per dollar of value added) remain the same for each country*sector in 2018 as it was in 1995. The net effect represents total change in emissions. Effects by countries are aggregated by World Bank income group, weighted by country GDP in 2018.

response to increased access to the Mexican market and to imported intermediate inputs available to US firms (Cherniwchan, 2017). Similarly, the reduction in air pollution emissions in the United States between 1990 and 2008 was found to be mainly driven by more stringent environmental regulations, while the compositional effect associated with trade played a small role (Shapiro and Walker, 2016). The improvement in environmental performance of Swedish manufacturing industry between 2007-2017 was mainly attributed to the technique effect, while the composition of output actually moved towards more pollution-intensive goods (Ustyuzhanina, 2022).

Developing economies generally see a rise in emissions as a result of trade openness, although the technique effect offsets part of the negative environmental impact. A study in India found that foreign demand growth increased CO_2 emissions for Indian manufacturing firms via output growth (scale effect), but reductions in emission intensity mitigated roughly 40 per cent of this effect, in part due to technology adoption (Barrows and Ollivier, 2021). The rapid expansion of Chinese exports between 1990 and 2010 was also found to contribute to the country's pollution, leading to higher infant mortality rates. However, a rise in income induced by exports has partly mitigated this effect (Bombardini and Li, 2020).

3. The costs of fragmentation on environmental sustainability

Fragmentation, both in terms of fragmented environmental policies and a fragmented global economy, gives rise to trade tensions and jeopardizes the effectiveness of policies to address environmental challenges. This section discusses the costs of both types of fragmentation.

First, policy-related tools to address environmental externalities are reviewed. It highlights that uncoordinated environmental policies could be less effective in addressing environmental challenges, lead to unintended consequences to trading partners and invite trade retaliatory measures. Second, the impact of geoeconomic fragmentation on the environment is examined, and the channels through which economic fragmentation might impede a transition towards environmental sustainability are outlined.

(a) Coordination is needed to ensure the effectiveness of environmental policies

Addressing environmental challenges often requires government interventions, since environmental problems involve many situations where the market alone cannot achieve optimal outcomes, i.e., market failures. One primary market failure is caused by the externality of polluting activities, where the costs of pollution are imposed on society and individuals while the polluters do not face the full consequences of their actions. Other market failures can include the positive externalities in environmental innovation, and path dependence that favour existing technologies over emerging ones. New environmental technologies may also require significant investment in infrastructure that features network effects and faces uncertainties and political risks.

(i) Government policies are necessary to address environmental challenges

To address these market failures, government interventions aim to enable economic agents to account for the external costs of environmental pollution and thereby incentivize investment in clean technology while discouraging the consumption of polluting goods and services. The portfolio of economic policy tools to fight climate change and address other environmental concerns includes environmental taxes/pricing, subsidies, regulations and standards, labelling requirements, and in some instances, quantitative trade restrictions. The following sections briefly discuss these policy tools.

Environmental tax and pricing systems

The textbook policy to address negative environmental externalities is an environmental tax that induces consumers and firms to internalize the social cost of their pollution emissions. Environmental taxes or pricing mechanisms such as a "cap-and-trade" system could reduce the demand for carbon-intensive products, thereby steering investment to clean technologies, and also generate more fiscal revenues for governments.[5]

The most prominent example of environmental pricing is to set a price on CO_2 emissions or equivalent GHG emissions. An increasing number of economies and governments have been implementing carbon emissions trading policies. According to the World Bank, over 70 carbon pricing initiatives have currently been implemented worldwide, covering 23 per cent of global emissions. However, there is significant diversity in the pricing levels applied, with prices ranging from over US$ 140 per ton of CO_2 emissions to less than US$ 1 per ton (World Bank, 2021).

The European Union's Emissions Trading System (ETS) is the first and by far the largest GHG emissions trading system in operation. While the ETS covers about 40 per cent of total EU emissions, a cap is reduced annually so that emissions in 2030 should be in line with the current ETS reduction target. The EU ETS has been found in some studies to be effective in promoting GHG abatement (Anderson and Di Maria, 2011) and to incentivize innovation and investment in low-carbon technologies, with regulated firms showing a 10 per cent increase in low-carbon innovation; at the same time, it does not crowd out patenting for other technologies (Calel and Dechezleprêtre, 2016).

Other environmental pricing schemes have also shown positive results in curbing pollution. The US Sulphur Dioxide Cap and Trade Program, established under the 1990 Clean Air Act Amendments, has led to significant reductions in emissions, promoted innovation and diffusion, and decreased overall costs of pollution abatement.. Annual emissions fell below the programme's target of 9 million tons by 2007, representing a 43 per cent reduction from 1990 levels (Stavins et al., 2012). The programme's SO_2 emission price incentivized technological advancements in scrubbers and power-plant operations (Burtraw, 2000; Lange and Bellas, 2005; Popp, 2003), resulting in compliance costs significantly lower than government and industry estimates by approximately US$ 5 billion (NAPAP 2005).

Environmental subsidies

Environmental subsidies aim to address the gap between private benefits and social benefits of environmental activities, such as renewable energy. Subsidies are often more politically feasible than taxes as they do not directly impose costs on firms and consumers.

Subsidies can come in the form of directed financial transfers, tax credits or energy-related goods or services provided by governments at less than full prices (Sovacool et al., 2017). They can also be applied at different stages of the technological and production process. For instance, a research and development (R&D) subsidy aims to expand innovation in environmental technologies; a production subsidy aims to scale up the production of clean and renewable energy or products; an investment subsidy aims to cover part of the fixed cost in infrastructure investment and to address the network externalities of clean investment, whereby the value of using a particular clean energy technology increases as more individuals, businesses, or industries adopt and use the same technology.

Research shows that subsidies can be effective in accelerating the low-carbon transition when coupled with environmental taxes, particularly when targeted at early stages of environmental technologies (Acemoglu et al., 2012; Fischer and Newell, 2008; Popp, 2006). By addressing the gap between the private and social benefits, subsidies for environmental technologies can result in higher deployment of these technologies, help spur and diffuse green innovation and enhance global welfare by reducing the cost of pollution mitigation or inducing the use of energy-efficient technology (Fischer, 2016). The International Renewable Energy Agency (IRENA) estimates that the total support to renewable power generation was around US$ 128 billion in 2017, and transport sector support added a further US$ 38 billion for biofuels (Taylor, 2020).

At the same time, some economists argue that subsidies can have negative effects on the economy by diverting government revenues from other uses and creating distortions (Blanchard, Gollier and Tirole, 2022). Moreover, subsidies in energy use can lead to an expansion of energy consumption, thus partially undo the environmental benefits of switching to clean energy. Only in the presence of strong learning-by-doing would subsidies be preferable to a carbon tax in achieving climate mitigation objectives (Bistline et al., 2023).

While support for clean energy and environmentally-friendly technologies can contribute to mitigating climate change, subsidies for fossil fuel consumption have the opposite effect. In 2022, global fossil fuel consumption subsidies are estimated to reach a staggering US$ 1 trillion (IEA, 2023). It is estimated that removing fossil fuel subsidies could reduce GHG emissions by about 6 per cent by 2030, and result in significant government revenue savings, totalling US$ 3 trillion cumulatively (Kuehl et al., 2021).

Likewise, fisheries subsidies encourage the fishing industry to catch fish more quickly than fish stocks can be rebuilt, damaging marine resources and ecosystems. Fisheries subsidies are estimated to be as high as US$ 35 billion worldwide, of which US$ 20 billion directly contributes to overfishing (Sumaila et al., 2019).

Environmental regulations and standards

Environmental regulations and standards set the performance requirements of products and production processes, often applied in specific sectors where taxing pollution emissions is infeasible for technical or political reasons.[6] Improvements in air quality are often observed as a result of environmental regulations, such as the US Clean Air Act (Henderson, 1996) or India's environmental regulations (Greenstone and Hanna, 2014).[7]

Regulations and standards are increasingly being used to induce decarbonization, reduce the environmental footprint, and enhance the environmental sustainability of supply chains. In the iron and steel sector alone, there are currently over 20 different decarbonization standards and initiatives, many of which have different boundaries and methodologies (WTO, 2023c). There has also been an increase in mandatory due diligence measures – which mandate companies to monitor adverse environmental impacts that may arise throughout their supply chains – such as the regulation on deforestation-free products.

In addition to mandatory regulations and standards, an increasing number of governments and the private sector are also introducing voluntary sustainability standards that specify requirements that producers, traders, manufacturers, retailers, or service providers may be asked to meet, relating to a wide range of sustainability metrics (UNFSS, 2013). According to the International Trade Centre (ITC) standards map,[8] there are 264 active voluntary sustainability standards in 194 countries and 15 sectors (Fiorini et al., 2020).

Information instruments, such as labelling requirements, provide valuable information to economic agents, allowing them to make informed decisions. These instruments encompass various environment-related information, including labelling programmes, rating and certification systems, public awareness campaigns, and environmental self-declaration claims (WTO, 2022g). An increasing number of firms are adopting eco-labelling to establish or foster niche markets for environmentally friendly products. Currently, there are 456 eco-labels operating in 199 countries and 25 industry sectors, according to the Ecolabel Index, a global database of eco-labels. Eco-labels play a vital role in creating awareness and motivating behavioural change among consumers, while also encouraging producers to adopt more environmentally friendly production processes (Cohen and Vandenbergh, 2012).

While environmental regulations and standards are primarily targeted towards domestic industries, they can also affect trading partners as products exported to the market must comply with these regulations. Research shows that labelling requirements such as "Fair Trade" certification can help secure high income for farm owners in exporting countries (Dragusanu, Montero and Nunn, 2022). Environmental labelling in particular can have a positive impact on exporters' environmental impact. For example, organic certification among coffee farmers in Costa Rica has been found to reduce the use of pesticides, herbicides and chemical fertilizers (Blackman and Naranjo, 2012).

Quantitative restrictions

Increasingly, governments are applying quantitative restrictions such as import and export prohibitions, quotas and licensing requirements, with the stated objective of protecting the environment. For example, many governments have implemented import bans or licensing procedures for waste materials containing potentially hazardous substances.

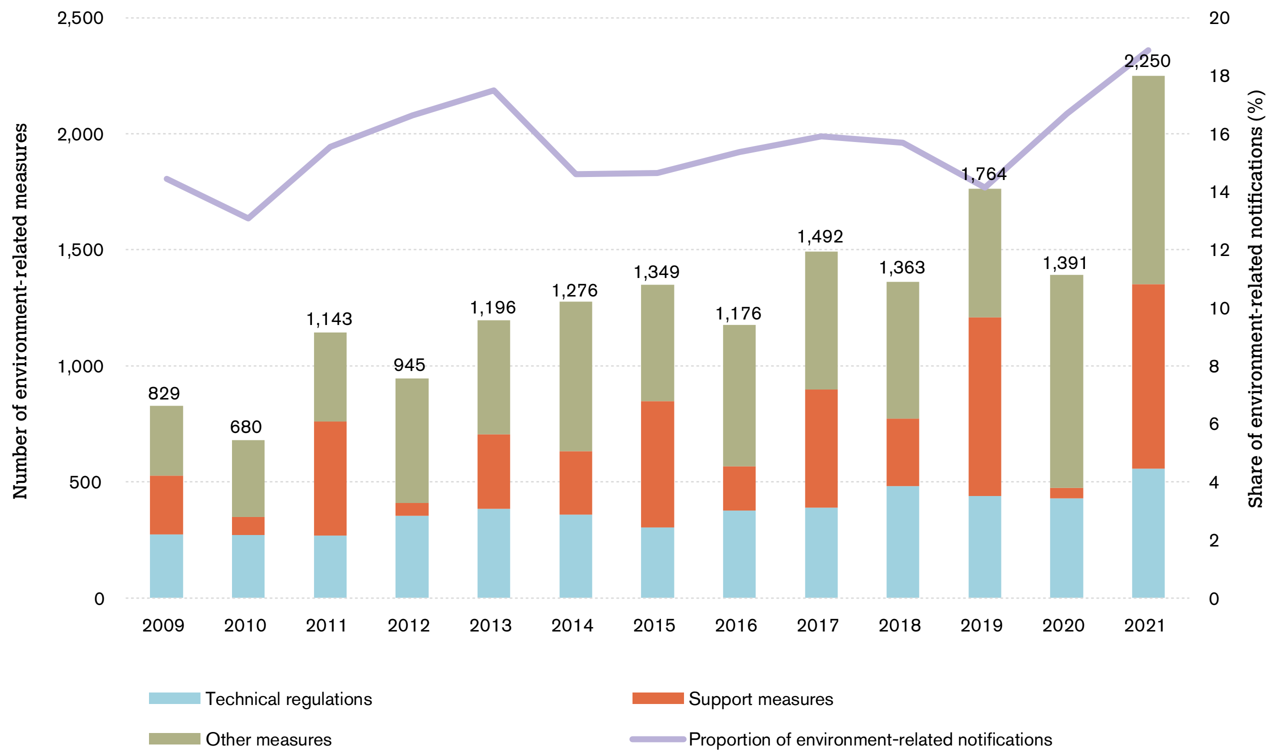
A notable example of import prohibition is China's 2017 announcement of an import ban on solid waste, including various plastics and recyclable waste. Consequently, countries that previously exported waste to China redirected most of their shipments to Southeast Asia. It is projected that by 2030, over 100 million metric tons of plastic waste will be displaced due to this policy (Brooks, Wang and Jambeck, 2018). However, in the long run, this import ban may encourage other countries to develop or improve waste disposal systems, resulting in an estimated annual saving of about EUR 1.54–3.20 billion in terms of costs to the ecosystem (Wen et al., 2021).

More recently, several governments have implemented export-restricting policies on raw materials, particularly minerals and metals, such as cobalt, copper, graphite, iridium, lithium, manganese, nickel and platinum, considered crucial inputs for a renewables-based energy transition. According to the OECD, the total count of export restriction measures in force across all industrial raw materials grew more than five-fold between 2009 and 2020, and about 10 per cent of the global value of critical raw material exports has faced at least one export restriction measure in recent years (Kowalski and Legendre, 2023). While export restrictions may assist countries in preserving exhaustible natural resources or upgrading domestic industries from mining to higher value-added activities, such measures could negatively affect the availability of raw materials and impede the global green transition.

Trade-related environmental policies are on the rise

There has been a proliferation of environmental policies in recent years with potential trade implications. This is

Figure E.3: Trade-related environmental policies have increased in recent years



Source: Authors' elaboration based on the WTO Environmental Database (https://edb.wto.org/).

reflected in the increasing numbers of measures notified to the WTO, as recorded in the WTO Environmental Database (see Figure E.3). The most common type of trade-related environmental measures is technical regulations, followed by government support measures. Other types of trade-related environmental measures include import licensing measures and quantitative restrictions, sanitary and phytosanitary (SPS) measures and trade facilitation measures.

(ii) Uncoordinated environmental policies risk slowing down the green transition

While environmental policies are important tools to protect the environment and accelerate the green transition, many of the policies are designed and implemented without considering their trade impacts. A lack of coordination of environmental policies not only affects the effectiveness of such policies, but also impacts trading partners and could invite trade retaliations.

Uncoordinated environmental policies are costly and less effective

A lack of coordination in environmental policies, such as carbon pricing and subsidies, can result in more costly and less effective policies. When environmental pricing schemes are not coordinated, they can result in a patchwork of diverse regimes with varying levels of ambition, potentially hindering an effective response to environmental challenges. For instance, studies find that if carbon prices were set by each region without cooperation, the average global carbon prices required to achieve the objective of keeping global warming to 2°C would be higher compared to a coordinated approach (Bekkers and Cariola, 2022; Böhringer et al., 2021). This is because globally coordinated carbon pricing reduces the welfare costs of climate change mitigation, as the reduction in emissions will take place in places where it is least costly. Consequently, regions heavily reliant on coal as an energy source would experience more significant emission reductions (WTO, 2022).

Moreover, differentiated carbon prices have been found to result in slightly higher economic costs than a uniform global price (Chateau, Jaumotte and Schwerhoff, 2023). In addition, uncoordinated carbon pricing schemes may lead to the implementation of carbon border adjustment mechanisms, imposing substantial compliance costs on businesses operating in or exporting to multiple jurisdictions, disrupting supply chains, and disproportionately impacting small enterprises (WTO, 2022).

Uncoordinated subsidy policies in the R&D in environmental technologies would also increase the costs of climate mitigation. This is due to the significant *ex ante* uncertainty involved in R&D for many environmental technologies, including unforeseen scientific and technological developments, as well as potentially unpredictable prices and other commercial trends. In the face of such uncertainty, it is optimal to finance a large group of technologies to increase the number of technologies that will be viable.

However, without international cooperation, countries would set their R&D policies independently, resulting in potentially duplicated spending in support of the same technologies. Bosetti et al. (2011) found that, if countries cooperated on R&D subsidies, in addition to setting up a single world carbon price, the loss of global consumption would be 10 per cent lower over the century, compared to a scenario where each region sets their R&D spending non-cooperatively but with a uniform carbon price.

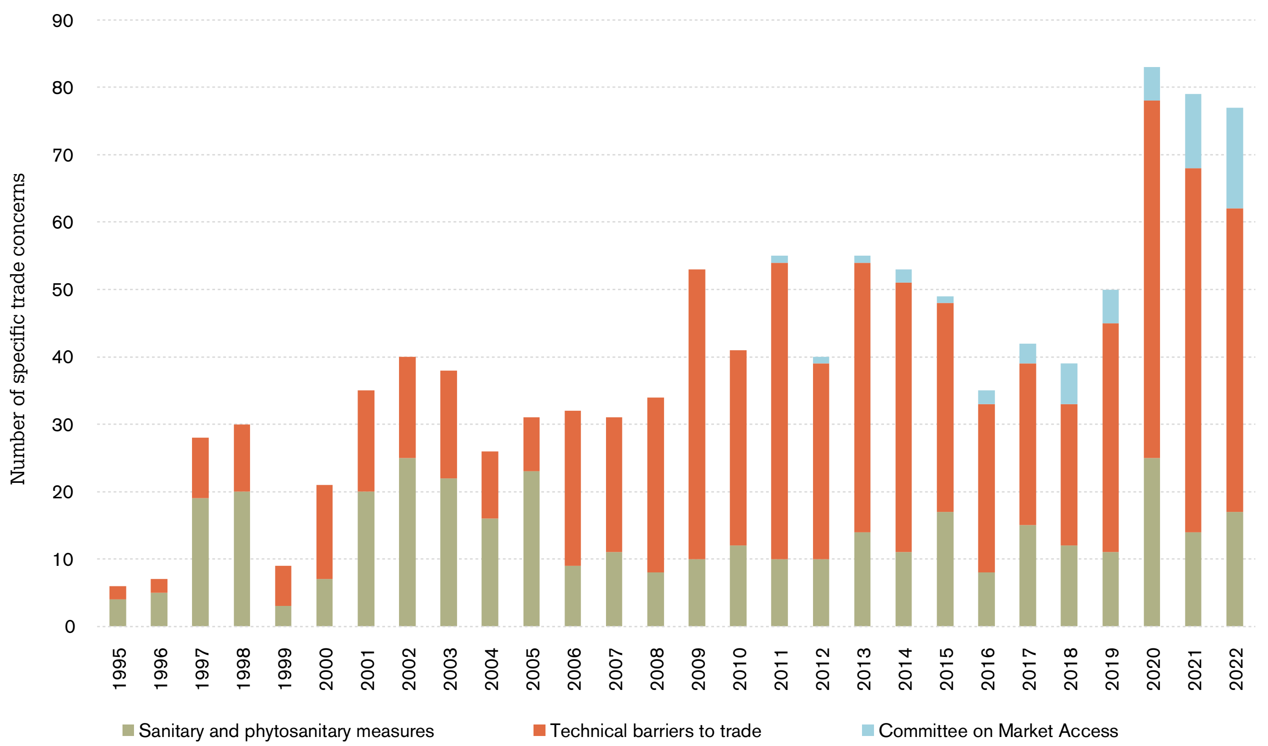
Furthermore, many of the environmental policies are accompanied by requirements to source from domestic suppliers, which can also hinder the effectiveness of environmental policies as they can reduce competition, weaken incentives to improve, and substitute cheaper and more efficient suppliers for costlier and less efficient ones. Sahoo and Shrimali (2013) show that local content requirements (LCR) reduce the global competitiveness of the domestic solar sector, because developers prefer to use alternative technology to bypass the LCR policy, limiting the dynamic learning gains among domestic PV manufacturers.

Uncoordinated policies can lead to unintended consequences on trading partners

Uncoordinated environmental policies can also lead to spillover impacts on trading partners. Figure E.4 illustrates the trade concerns raised in selected WTO committees and councils related to environmental policies applied by WTO members.[9] The process of raising and discussing trade concerns improves understanding of the rationale behind other members' regulations, shedding light on details regarding implementation and enforcement. There has been an increase in trade concerns associated with environmental measures, reflecting rising use of such measures and their trade implications. Most of these trade concerns are related to technical regulations, while SPS measures as well as market access-related measures have also been raised.

One of the most notable trade-related environmental measures is a border carbon adjustment (BCA) mechanism, a policy where a jurisdiction with carbon pricing applies import fees based on the carbon content of imported goods. While BCA mechanisms can help to address carbon leakage, competitiveness issues, and encourage ambitious environmental policies (Al Khourdajie and Finus, 2020), they can also have negative economic impacts on exporters of carbon-intensive products. The design of a BCA mechanism also raises practical challenges such as measuring the carbon footprint of trade, the country and sector coverage,

Figure E.4: Some environmental measures have raised concerns in the WTO



Source: Authors' elaboration based on the WTO Trade Concerns Database (https://tradeconcerns.wto.org/en).
Note: The database covers trade concerns raised in the Committee on Market Access (CMA), Sanitary and Phytosanitary Measures (SPS) Committee and Technical Barriers to Trade (TBT) Committee. Other trade concerns discussed in the WTO, such as in the Council for Trade in Goods, are not reported. Environment-related concerns are identified by a list of environment-related keywords.

and the complications in supply chains (Böhringer et al., 2022).

In April 2023, the European Council approved a carbon border adjustment mechanism (CBAM) to be phased in from October 2023. After a transitional phase, from 1 January 2026 the CBAM would impose a fee on imported goods in key energy-intensive, trade-exposed industries to offset the carbon costs of European producers. Simulation studies suggest that CBAM is likely to lead to a larger decrease in exports to the European Union from economies with a relatively high carbon intensity (European Commission, 2021; UNCTAD, 2021). Some WTO members have raised concerns about the proposed CBAM, citing potential discriminatory impacts on their exports. They argue that it may also lead to the adoption of European standards by other economies and impose significant compliance costs on exporters.[10]

Related to a BCA mechanism, a climate club has also been proposed to inspire greater mitigation action by having ambitious climate-policy "club" governments levy a broad tariff on less ambitious "non-club" economies (Nordhaus, 2015). Climate clubs differ from CBAMs in that they do not aim to level the playing field for specific goods but rather promote policy ambition by penalizing low-ambition economies with an across-the-board tariff on all imports. While administratively simpler, measuring climate ambition and determining tariff levels pose practical challenges for climate clubs. The rules of a climate club may also be hard to reconcile with commitments under WTO agreements (Clausing and Wolfram, 2023).

Furthermore, international spillovers occur when economies adopt diverse strategies in carbon mitigation, with some implementing carbon pricing while others subsidize clean production. In such cases, carbon-intensive producers in regions with carbon pricing face a competitive disadvantage compared to producers in regions with subsidies.

To be clear, environmental-related subsidies can have both positive and negative impacts on trading partners. On the positive side, R&D subsidies can lead to the development of new technologies that can be shared with other countries, allowing them to address environmental problems more effectively. In some instances, subsidies could lead to significant export growth in an industry that causes the global price of these goods to decline, leading to the worsening of a country's terms-of-trade while benefiting the consumers of importing countries (Lashkaripour and Lugovskyy, 2023).

On the negative side, subsidies aimed at expanding domestic production or exports could bring about adverse impacts on trading partners. Distortive subsidy policies could convey a strategic advantage to domestic firms at the expense of foreign competitors, cause distortions in supply and demand through value chains and trigger a global subsidies race to attract green industries. In addition, developing countries often lack the necessary resources and fiscal capacity to undertake significant climate change mitigation efforts, making them more vulnerable to the adverse impacts of unilateral environmental policies.

In addition, the proliferation of incompatible standards may cause uncertainty and confusion for producers and consumers, decrease efficiency, and unnecessarily increase trade costs. Export markets with more stringent technical regulations tend to have fewer exporters, lower export values and higher concentration rates, and tend to hit small firms' exports twice as hard as large firms' exports (Rollo, 2023). SPS measures that raise concerns at the WTO are seen as barriers for exporters, with smaller firms being more affected by restrictive regulatory measures (Fontagné et al., 2015). Similarly, TBT measures tend to reduce the number of new exporting countries and firms, as they may face challenges in entering the export market, while increasing the amounts of exports of existing firms (Bao and Qiu, 2012). A number of recently announced environmental regulations have triggered concerns for WTO members. For instance, several WTO members have asked questions and expressed concerns about new draft regulations on deforestation that set mandatory due diligence rules for commodities associated with deforestation and forest degradation.[11]

Efforts to harmonize standards are crucial in preventing policy fragmentation, lowering trade costs, and enhancing the effectiveness of environmental policies. Harmonization and mutual recognition of standards within regional trade agreements (RTAs) have been shown to boost trade flows between partner countries (Chen and Mattoo, 2008) and increase the likelihood of export and entry of third-country firms that previously traded with one of the RTA's partners (Lee et al., 2023). Harmonized standards have played a significant role in global trade growth, contributing up to 13 per cent of the growth in global trade and enabling firms to expand their export sales (Schmidt and Steingress, 2022).

Uncoordinated environmental policies can invite retaliation

Unilateral environmental policies that negatively impact trading partners could give rise to retaliatory measures leading to trade conflicts and could jeopardize the effectiveness of environmental policies. While some earlier economic studies find that carbon border adjustments can mitigate free-riding, whereby countries benefit from climate mitigation efforts without making equivalent contributions or taking similar actions, and reduce carbon leakage, such findings often rest on the assumption that trading partners do not retaliate against the border adjustment measures (Al Khourdajie and Finus, 2020). Recent economic analyses show that retaliatory trade measures reduce the appeal of import adjustments as a means to expand climate mitigation policies and adversely affect global welfare and emissions because the additional trade distortions can offset the environmental gains (Hagen and Schneider, 2021).

In response to subsidies announced by major economies in supporting their clean energy sector, many countries have announced plans to introduce subsidies in order to attract new investment or prevent more companies from shifting away (Chazan, Fleming and Inagaki, 2023). A global subsidies race can involve negative welfare consequences. Ferrari and Ossa (2023) investigate the impact of US state-level subsidies and discover that US states are strongly motivated to offer subsidies to attract firms from other states, creating negative effects on national welfare. This indicates that state-level subsidies are inefficient policies that can harm other regions within an economy. Although this research primarily examines domestic regional spillovers, its conclusions may also be applicable to cross-border effects.

Furthermore, environmental measures that run counter to WTO rules could have significant systemic implications, setting a precedent of disregarding global trade rules and potentially encouraging other countries to implement their own retaliatory measures in response. This escalation of trade tensions could hinder international cooperation and impede progress in addressing global environmental challenges effectively. As argued by Adam Posen in his opinion piece, better and more tranparent multilateral trading rules are needed to maximize the positive spillovers and prevent negative spillovers from environmental policies.

(b) Economic fragmentation can hinder the response to environmental challenges

Fragmentation of the global economy, motivated by strategic, geopolitical and other concerns, can also present challenges in environmental sustainability. Economic fragmentation means foregoing many of the environmental benefits of international trade discussed in Section E.2(c), thus resulting in detrimental environmental impacts, impeding innovation and diffusion of environmental technologies and raising the costs of environmental technology.

Although a full decoupling of economies remains a theoretical hypothesis, changes in trading relationships, including trade conflicts, can have a large impact on the distribution of GHG emissions across supply chains, resulting in changes in global emissions. The trade tensions between China and the United States offer an example. Simulation studies find that, in a scenario in which China and the United States stopped trading, the ensuing relocation of production to the rest of the world would increase net global GHG emissions by 0.3 per cent to 1.8 per cent (Yuan et al., 2023). A specific case in point is trade in soybeans. Due to the trade-restrictive measures imposed by China, US soybean exports to China dropped by 50 per cent in 2018. Estimates by Fuchs et al. (2019) suggested that, to fill the supply shortage, the area dedicated to soybean production could go by up to 39 per cent in the Amazon, with significant impacts on deforestation.

Furthermore, reduced trade between economies can limit positive technology spillovers, and this can hinder the response to environmental challenges. In a fragmented economy, lower knowledge spillovers not only diminish worldwide productivity but also increase the costs of climate mitigation. Importantly, GVCs can significantly amplify cross-border knowledge diffusion. Research indicates that R&D investment by a GVC partner can enhance a country's innovation by up to a third of its own R&D investment (Piermartini and Rubínová, 2021). Conversely, when economies or regions reduce their economic interdependence, and thereby limit trade and technological exchange, the flow of green technologies and knowledge may be impeded.

In a simulation study, Bretschger et al. (2017) demonstrate that knowledge diffusion leads to a "greening" of economies characterized by increased market shares of clean, low-carbon sectors and reduced economy-wide emissions intensities. Sectors with lower carbon intensities typically exhibit higher knowledge capital intensities and a greater absorptive capacity, meaning that knowledge diffusion enhances the productivity of these clean sectors. This greening effect has the potential to decrease the costs associated with global carbon mitigation policies significantly. For the same amount of CO_2 reduction, the carbon cost is estimated to be 16 to 47 per cent lower with knowledge diffusion compared to a scenario without knowledge diffusion. In other words, if economic fragmentation reduces the exchange of knowledge among countries, the economic costs of climate mitigation could be substantially higher.

Fragmentation could also reduce economies of scale and make environmental goods and services more expensive. Over the past 40 years, prices of solar photovoltaic (PV) goods have fallen by over 99 per cent, and in the most recent decade (2010-20), the global weighted-average levelized cost of energy of newly commissioned utility-scale solar PV fell by 85 per cent. This drastic cost reduction has been attributed to increased concentration of production and global supply chains, which allow for learning-by-doing and scale economies. China alone accounted for 78 per cent of global production of solar PV cells and modules in 2021. This has triggered policymakers to establish or consider incentives to boost domestic production and reduce reliance on imports.

Such a policy is not without economic costs. If governments had required domestic manufacturers to supply an increasing proportion of installed solar PV capacities over a 10-year period,[12] it is estimated that solar PV module prices in 2020 would have been 54 per cent higher in China, 83 per cent higher in Germany, and 107 per cent higher in the United States. The cost reduction as a result of global supply chains results in combined cumulative savings of US$ 67 billion across the three economies. Furthermore, if the same local PV manufacturing requirements continue to be in place, the estimated solar module prices are projected to be approximately 20 to 25 per cent higher in 2030 compared to a future with globalized supply chains (Helveston et al., 2022).

The higher prices associated with local content policies are likely, therefore, to result in less deployment of clean energy. In 2022, new solar installations in the United States experienced a 23 per cent decline, partly attributed to trade restrictions with China that had an impact on access to key low-cost parts and materials (Wood Mackenzie and SEIA, 2022).

Geopolitically motivated fragmentation could also severely restrict access to critical raw materials essential for the green transition (see Box E.1).

OPINION PIECE

Re-globalizing subsidies for a sooner, fairer green future

By Adam Posen

President, Peterson Institute for International Economics

The world's major economies have been giving manufacturing subsidies more often than not for decades. What makes today's versions worse is the betrayal this represents for addressing climate change.

The most important policy goal is to get the best green technologies into production and as widely adopted as possible. This subsidies race combined with trade barriers and domestic investment incentives means that we are likely to repeat what happened with vaccines during the COVID-19 pandemic: the largest economies producing locally and hoarding them, and low- and middle-income economies having to pledge loyalty to one bloc's champion tech versus the others, potentially for reasons unrelated to their own economies' green transitions. As a result, we will get far too little, far too slow availability of the best green tech; we will also see a lot of uncertainty and resentment in the rest of the world, slowing take-up of it.

This is short-sighted at home as well as globally. What matters to sustainable growth is how well an economy adopts and encourages change as the result of innovation, not the production of any given innovative product itself. This is what we saw with the last round of large-scale subsidies for semiconductors in the 80s and 90s. What had a lasting impact on employment and productivity was adoption and adaptation when the internet, fibre-optic cable and highly effective dispersed computing came along, enabled by semiconductors. Whereas, as the majority of semiconductor production moved from economy to economy over the last 35 years, little lasting loss or gain was seen among those locations.

When the focus instead was mistakenly on national vaccine production in 2020-21, what happened was that most of the world's people did not get the most effective vaccines in a rapid manner – including some producing countries preventing their own populations and aligned lower-income economies from getting the right shots.

The European Union has been leading the world in utilizing green tech to respond to climate change. This is because it has prioritized its carbon pricing scheme rather than local green production, up until now. The resultant cost-based shift of production of solar panels and some wind turbine components from the European Union to China enabled the rapid growth in EU renewables.

This demonstrates that for green technology going forward, it should not matter where the innovation originates that leads to the most energy-efficient housing or the best retention of charge in an electric battery or the cleanest way to create hydrogen for fuel. What matters is that as many people in as many places as possible get access to and change their behaviours to adopt that technology.

Given the rise of green manufacturing subsidies favouring local production, however, net progress on decarbonization is at risk, even if their underlying intentions may be laudable. As unfortunately seen during the COVID-19 pandemic, once governments support selected domestic producers, official priorities become claiming credit for jobs in specific districts, and visibly denouncing foreign competitors. In fact, having competing blocs subsidize and protect their champions will likely drive up the prices of green tech.

This is why we have multilateral trade rules and the WTO, to prevent these kinds of harmful spirals. We need some global limits to subsidies races, not least in the interest of lower-income economies that depend on large producer ones. There was an effort to create a multilateral subsidies code at and following the 11th WTO Ministerial Conference in 2017. A resumption of that effort should include:

- Making a transparent legal distinction between investment in productive factors (like human capital, R&D, supportive general regulation and infrastructure) and direct production subsidies, with the latter discouraged.
- Getting coordination on subsidizing the consumers, which means both household and other businesses, instead of export subsidies to the green tech producers, domestic and foreign. The less carbon they use, the more money they get back.
- Binding commitment to an international common fund that requires governments to invest a few cents for every dollar, euro or yuan which they spend in subsidies for domestic production, towards funding the spread of green technology and needed adaptation to the developing world.

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Box E.1: Fragmentation can hinder access to raw materials in the green transition

Achieving net zero carbon emissions will require large-scale production and sustainable use of several raw materials critical for the mass production of renewable technologies.

One sector of particular importance is electric vehicles (EV), which has witnessed exponential growth in recent years. Electric vehicle fleet is projected to grow by a factor of eight or more by 2030 to reach the announced climate mitigation pledges made by governments (IEA, 2022).

The exponential growth of the EV market raises concerns about the sustainable supply of primary raw materials needed for lithium-ion batteries, a key component in EVs. Projections indicate a substantial increase in global demand for materials such as lithium, cobalt and nickel from 2020 to 2050 (Xu et al., 2020).

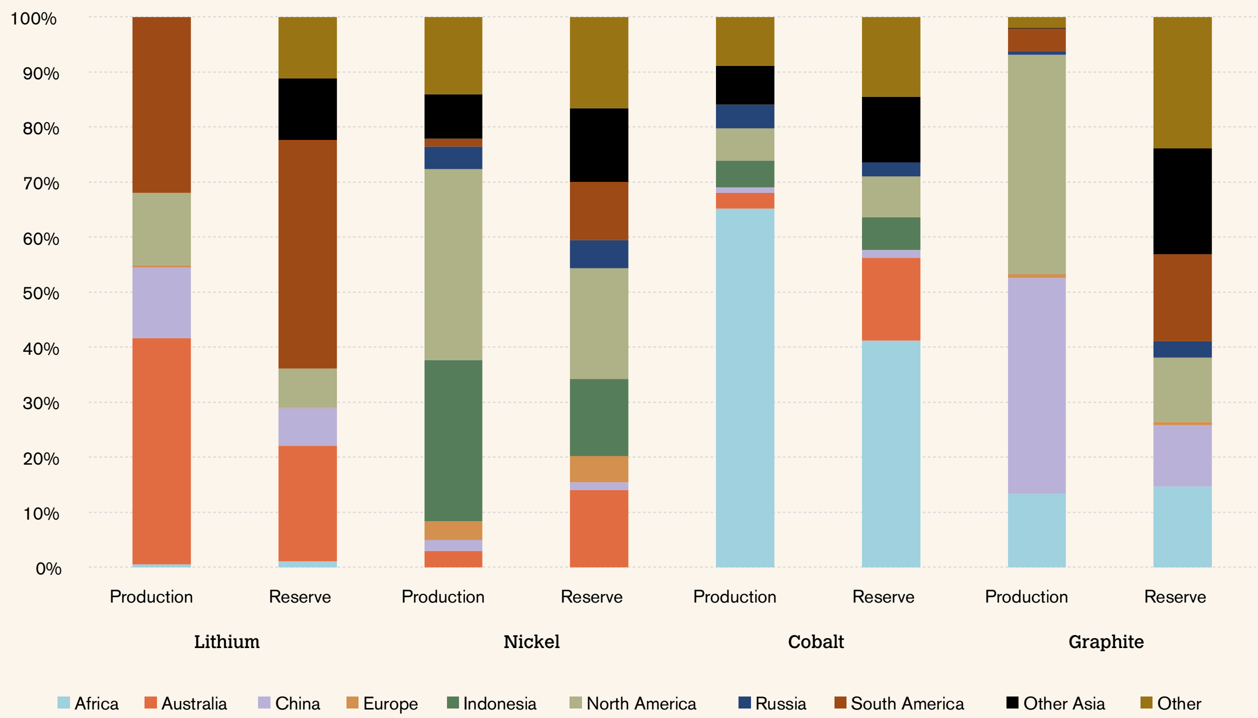
Currently, battery supply chains are concentrated in China, where the majority of lithium-ion batteries are produced, including significant production capacity for cathodes and anodes (IEA, 2022).

The mining of key raw materials predominantly occurs in resource-rich countries. However, the reserves of these metals are distributed across different countries, suggesting opportunities for diversifying battery metal extraction (see Figure E.5).

Nevertheless, geopolitical tensions can present challenges to diversifying raw material supplies. Many reserves of rare metals like nickel and cobalt are concentrated in regions which may be difficult to access for geopolitical reasons. To secure access to these critical raw materials, some economies have imposed export restrictions, affecting a significant portion of cobalt, manganese and nickel supplies (Kowalski and Legendre, 2023).

Addressing disruptions in primary raw material supplies and reducing environmental costs can be facilitated through recycling and recovery of materials from end-of-life batteries. This would necessitate international trade in lithium-ion battery waste to markets with economically viable recycling capacity (Moïsé and Rubínová, 2023).

Figure E.5: There is potential to diversify the supply of EV battery materials



Source: Authors' calculation based on US Geological Survey (2023) and BP Statistical Review (2022).
Note: Reserves are defined as part of the reserve base that could be economically extracted or produced at the time of determination.

4. The environmental gains from re-globalization

Re-globalization, through the process of increased global integration and cooperation, can help protect the environment in several ways. First, an increased share of digital and services trade could help to reduce the environmental footprint of international trade. Second, coordinated environmental policies are essential to ensure that trade contributes to solving global environmental challenges. Third, re-globalization can help developing economies to transition to a more sustainable growth path, while respecting their needs for economic development. The WTO can play an important role in ensuring trade supports the protection of the environment.

(a) Services and digital trade will reduce the carbon intensity of trade

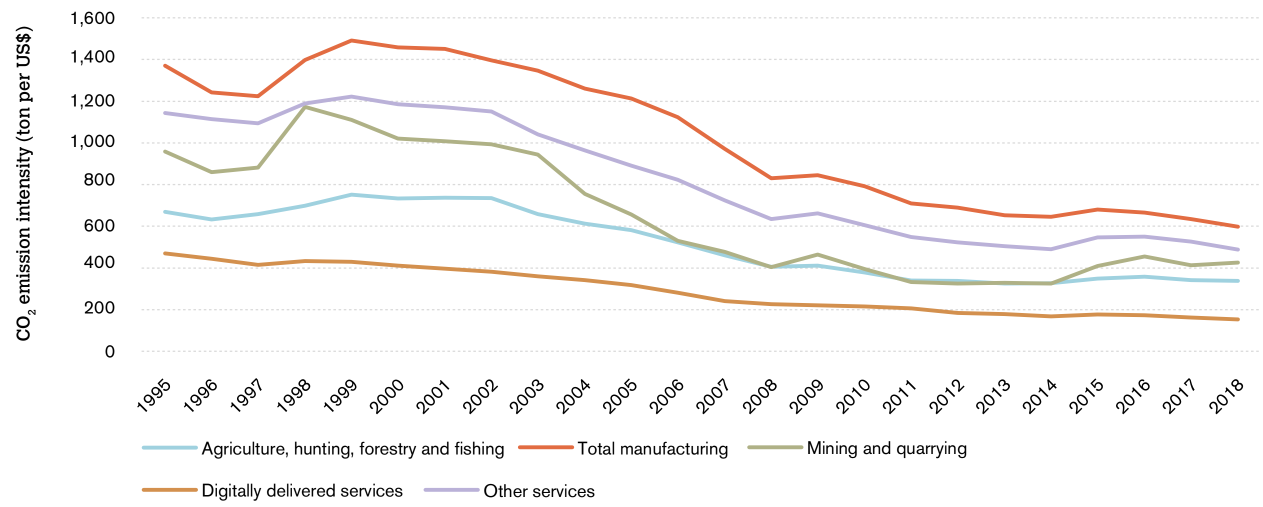
The future of globalization is expected to involve a greater share of trade in services and the widespread use of digital technologies (see Chapter B). These trends are likely to have implications for the environmental sustainability of trade.

Many services that were traditionally considered as non-tradeable can now be delivered digitally. These services include information and communications technology (ICT), financial and insurance activities, business services, arts, entertainment, and recreation. The carbon emission intensity of these services sectors, defined as the tonnes of CO_2 emissions per US$ of output, is lower than for other services sectors, as well as for agriculture, mining and manufacturing (see Figure E.6). Even though the share of trade in digitally delivered services has increased in the past decades, the CO_2 emissions embedded in the trade of these services have remained relatively stable, accounting for roughly 4 per cent of emissions embodied in trade.

In a future re-globalization scenario, the share of services trade is projected to rise above 30 per cent by 2040, with a particularly sharp increase in digitally delivered services, due to changes in technology and in trade policies (WTO, 2019b). The shift in the composition of trade means that a relatively larger share of trade would be relatively less carbon intensive. In addition, as digital technologies allow an increasing share of trade to take place without the cross-border movement of goods or persons, the carbon emissions associated with international transportation could be reduced. For instance, telecommunications services could reduce the need for in-person meetings and, thus, cut the demand for business flights.

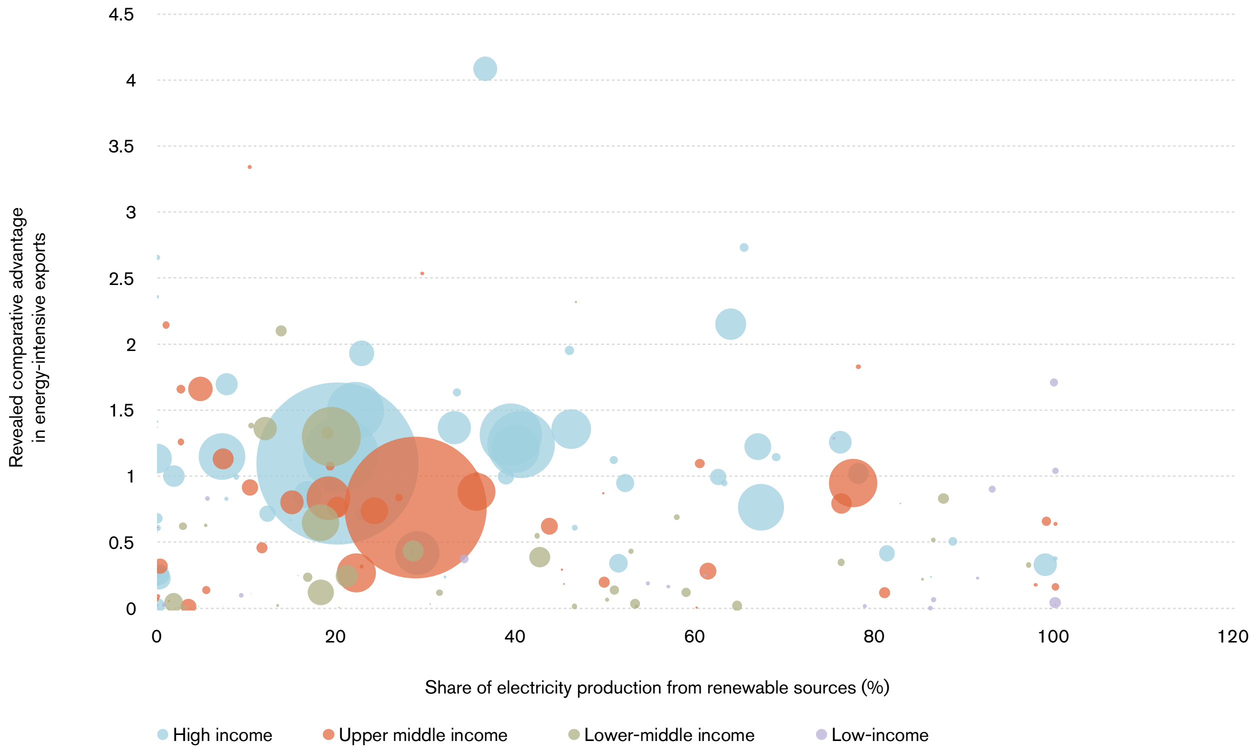
Moreover, digital technologies can accelerate the low-carbon transition. Digital solutions in energy, manufacturing, agriculture and land use, buildings, services, transportation and traffic management could reduce global carbon emissions by up to 15 per cent.[13] For instance, high-speed connectivity can enhance transportation optimization by enabling real-time data collection and analysis, leading to more efficient route planning, reduced congestion, and lower emissions. In addition, these technologies can promote sustainable transportation by supporting smart charging infrastructure, battery management systems, and predictive maintenance. Digital marketplaces can promote the circular economy by facilitating the exchange of used or refurbished products, which can reduce waste and increase resource efficiency. Digital traceability technologies such as blockchain can allow consumers and stakeholders to track the origin and environmental impact of products, thereby providing greater transparency and encouraging environmentally responsible practices (Parmentola et al., 2022).

Figure E.6: Carbon emissions intensity for digitally delivered services is relatively low



Source: Authors' calculation based on the OECD TeCO_2 database.
Note: Digitally delivered services include ICT, financial and insurance activities, other business services, and arts, entertainment and recreation.

Figure E.7: There is no correlation between renewable energy share and exports of energy-intensive products



Source: Authors' calculation based on BP Statistical Review (2022) and World Bank data for the share of electricity production from renewable sources, and UN Comtrade for the share of trade in energy-intensive products.
Note: Revealed comparative advantage is expressed as the share of energy-intensive products in total exports per country divided by the worldwide share of these products. Energy-intensive products include those in the following industries: basic metals, other non-metallic mineral products, chemicals and pharmaceutical products, and chemical products. The size of the bubble represents the GDP of the economy.

(b) Re-globalization can help to integrate trade and environmental governance

Global environmental challenges, including climate change and biodiversity loss, necessitate collective action on a global scale to achieve effective solutions. For local environmental problems such as water supply, sanitation and the management of solid waste, the transboundary nature of such problems implies that the actions of one economy can affect the well-being of neighbouring economies, or even of those further away. Therefore, a coordinated approach to addressing environmental sustainability is required, which, at the same time, ensures equitable economic growth. Re-globalization has the potential to provide a framework for such a coordinated approach.

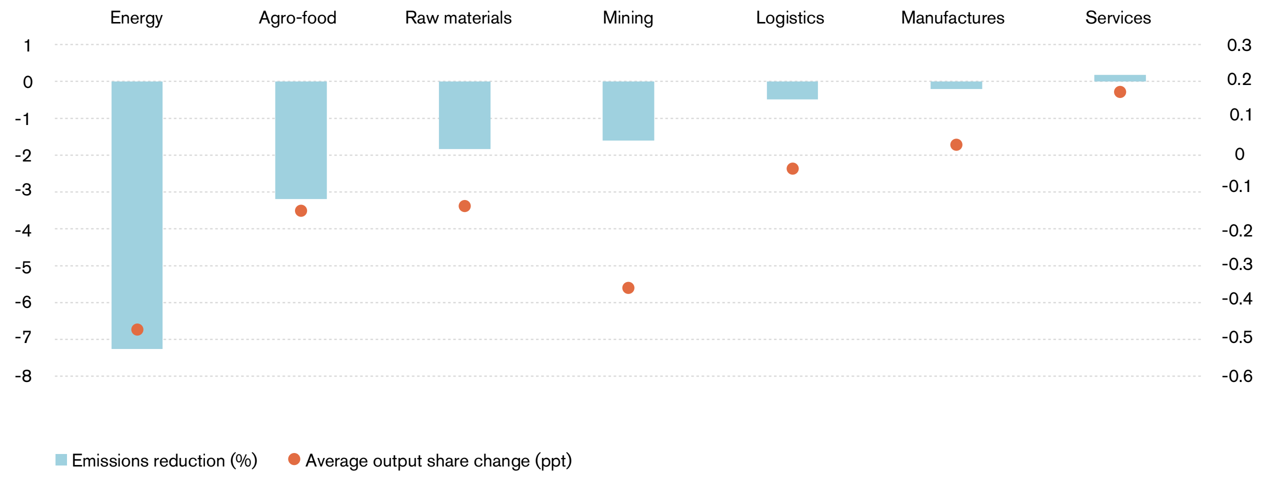
The benefits of coordinated global climate mitigation policies by means of a global CO_2 market could result in gains as high as US$ 106 billion in 2030, measured as the difference between the cost of CO_2 mitigation under a global carbon permit market and the cost of regional reductions in emissions under nationally determined contributions (Thube et al., 2022).

With the right policies in place, trade could bring many benefits to environmental sustainability. In the case of climate change, trade can allow economies that have relatively clean energy sources to specialize in the production and export of more energy-intensive goods and services. Currently, there is no significant correlation between an economy's share of renewable energy and its revealed comparative advantage in the exports of energy-intensive goods (see Figure E.7).[14] This is partly because other factors, such as capital, labour and productivity, also determine a country's comparative advantage, and partly because the cost of carbon emissions are not reflected in the cost of production in many economies.

When governments coordinate their climate policies, the costs of climate change are reflected in the prices of goods and service. Therefore, economies with relatively clean energy resources would have a comparative advantage in producing and exporting relatively energy-intensive goods and services, enabling trade to play a greater role in mitigating climate change.

Le Moigne (2023) finds that a uniform global carbon tax or equivalent mitigation policies are remarkably efficient in reducing GHG emissions. If governments were to adopt a

Figure E.8: Green comparative advantage enables substantial global emissions reduction with limited economic costs



Source: Le Moigne et al. (2023).
Note: The left axis represents the change in the emission share of each sector in global GHG emissions, due to trade originating from a relatively low-emission economy (the sourcing effect), in response to a carbon tax of US$ 100/tCO_2. The right axis represents the percentage change in the consumption share of the sector due to the sourcing effect, in response to a US$ 100/tCO_2 tax.

global carbon price at US$ 100 per tonne of CO_2 equivalent, global emissions decrease by 27.5 per cent, while reducing gross output by only 2.6 per cent and real income by a mere 0.7 per cent. International trade has, in fact, a positive role to play in the fight against climate change, by connecting consumers to the green origins of production.

Total GHG emissions would be reduced because of three effects. First, increasing the price of all products by their carbon cost would lead to an overall decline in quantities consumed and produced, which would mechanically decrease emissions (scale effect). Second, consumption would be diverted away from carbon-intensive sectors towards less carbon-intensive ones, thereby reducing global GHG emissions (composition effect). Third, economies' differences in production technology implies that a given good would be relatively cheaper when coming from a relatively environmentally friendly source, thereby reducing global production emissions for this product (sourcing effecting).

While the scale effect and the composition effect can occur in a closed economy world, the sourcing effect is fundamentally about international trade. In fact, more than a third of the GHG emission reduction from carbon pricing would be due to reallocating production to regions with a green comparative advantage. The largest emission reductions as a result of the sourcing effect come from two of the most carbon-intensive sectors: agro-food and energy, which would see reductions representing 3.2 per cent and 7.2 per cent of global emissions (see Figure E.8).

In addition, coordination in government support for the R&D of clean technologies can speed up the green transition. Acemoglu et al. (2015) show theoretically that the optimal solution to climate change necessarily requires global policy coordination, with the implementation of environment-oriented R&D subsidies and carbon taxes globally. If developed economies directed their own technical change towards clean technologies and then facilitated the diffusion of new clean technologies, progress could be made toward averting catastrophic global climate change. The higher the spillovers from developed economies' green innovation to developing economies, the more likely developing economies with absorption capacity of such technologies would implement clean technologies. Without policy coordination, however, the production of environmentally dirty inputs tends to migrate toward developing economies, and does not decline despite environmental regulations and innovation in clean technologies in developed economies.

Policy coordination not only applies to environmental policies, but also to trade policies. For instance, Shapiro (2021) finds that import tariffs and non-tariff barriers are substantially lower on products of carbon-intensive industries than on products of cleaner industries. This difference in trade policy creates a global implicit subsidy for CO_2 emissions associated with internationally traded goods in the range of US$ 550 to US$ 800 billion annually, thereby contributing to the acceleration of climate change. If each economy were to set the same tariffs and non-tariff barriers on clean and dirty industries, global CO_2 emissions could decrease by about 3.6 percentage points and global real income could increase by 0.7 percentage points. As carbon-intensive industries tend to be upstream industries within GVCs, multilateral negotiations to eliminate tariff escalation, the practice of protecting domestic processing industries and discouraging the development of processing activity in the countries where raw materials originate, could help to address the environmental bias of trade policies. Trade policies can also be used to address other global environmental issues, such as plastics pollution (see Box E.2).

(c) Re-globalization can provide development opportunities

As discussed in Chapter D, re-globalization also offers development opportunities for economies and groups previously marginalized by globalization. International environmental treaties recognize that different economies have different levels of responsibility for and capacity in addressing environmental problems. Re-globalization needs to ensure that efforts to curb environmental challenges do not come at the cost of compromised economic growth for populations that are still at the edge of poverty.

A study by WTO staff (Bekkers et al., forthcoming) highlights that a coordinated carbon pricing framework could help to achieve the target of the Paris Agreement to limit global warming while distributing mitigating responsibilities in proportion to economies' historical emissions and capabilities. Other international organizations have put forward proposals to coordinate carbon pricing globally. An International Carbon Price Floor proposed by International Monetary Fund (IMF) staff sets out global minimum carbon prices differentiated by levels of development. Simulation analysis suggests that the proposal could help scale up climate mitigation at relatively small macro-economic costs (Chateau et al., 2022).

Re-globalization also means new trading opportunities in renewable energy for many developing economies, notably economies in Africa and the Middle East that have abundant solar power resources. To harness the potential of renewable energy, it is important for these economies to be able to access technologies, such as solar panels, through trade and transfer of technology. Furthermore, many developing economies can be exporters of renewable energy, provided

Box E.2: Trade policies to address plastics pollution

Over the past few decades, plastics have been widely used as an important material, with exponential growth in production globally. Global exports of plastics or of goods made from plastic have more than doubled in value since 2005, and hit a value of US$ 1.2 trillion in 2021. Globally, only 9 per cent of plastic waste is recycled (OECD, 2022b).

Plastics pollution poses severe challenges to human health and to the environment – for example, the open burning of plastics generates dangerous air pollutants, harming both human health and the environment. GHG emissions associated with plastic production, use and disposal could account for 19 per cent of the Paris Agreement's total allowable emissions in 2040 (Pew Charitable Trusts and SYSTEMIQ, 2022). More than 800 marine and coastal species are affected by plastics pollution, for example through ingestion and entanglement (UNEP, 2021).

In March 2022, UN member states endorsed a historic resolution to end plastics pollution and forge an international legally binding instrument by 2024. The ongoing process is expected to conclude with the agreement of a legal instrument based on a comprehensive approach that addresses the full life cycle of plastic (UNEP, 2023a).[15] Following a request from member states, the UN Secretariat prepared a document containing "potential options for elements" that the instrument could contain (UNEP, 2023a), including several trade-related provisions.

Trade and trade policies can form a key part of the solution to plastics pollution. Trade measures to tackle plastics pollution can include the identification of plastics trade flows (including "hidden flows" of plastics embedded in internationally traded goods or used as packaging), promotion of the safe and environmentally sustainable recycling and re-use of plastics, and promotion of trade in sustainable and effective alternatives and substitutes to plastics. Besides its obvious benefits to the environment, sustainable management of plastics also represents substantial economic gains. It is estimated that a transformed plastics economy[16] could, by the year 2040, create 700,000 additional jobs and improve livelihoods for millions of workers, and while avoiding US$ 3.3 trillion in environmental and social costs (UNEP, 2023b).

A group of WTO members launched an initiative in November 2020 to explore how the WTO could contribute to efforts to reduce plastics pollution and promote the transition to more environmentally sustainable trade in plastics.[17] A Ministerial Statement issued in December 2021 sets out a roadmap and identifies some key areas of focus. These include improving the transparency of plastics trade flows, supply chains and trade policies, strengthening regulatory cooperation with other international bodies, identifying environmentally sustainable trade policies and mechanisms, and strengthening trade-related technical assistance for vulnerable economies, including LDCs and small island developing states. The Ministerial Statement calls for "concrete, pragmatic and effective outcomes" by the WTO's 13th Ministerial Conference, which has been scheduled for February 2024.

that the energy can be stored and transmitted over long distance (WTO, 2022g).

WTO simulations show that the decarbonization of the economy would change the pattern of energy exports in the long run (Bekkers et al., 2023). A higher uptake of technologies that facilitate the storage and long-distance transport of energy like green hydrogen can increase the share of energy exports. Furthermore, if economies with rich endowments in solar energy had greater access to renewable technology, they could increase their exports of green energy. In a scenario where an economy's ability to produce energy matches its natural endowment in solar power, coupled with a drastic uptake of green hydrogen, the share of energy exports in total energy production is estimated to reach up to 51 per cent for traditional fossil fuel exporters, 40 per cent for upper-middle income economies, and 18 per cent for lower-middle income economies.

Developing economies could also benefit from the green transition by specializing in products and services essential to that green transition. For instance, many developing economies are major exporters of raw materials critical for the green transition, such as lithium, aluminium ore, borates, cobalt and chromium (Kowalski and Legendre, 2023). However, to harness this export potential in an environmentally sustainable manner, it is essential to promote sustainable mining practices, invest in cleaner technologies, and adhere to environmental regulations to minimize the negative impacts of mining activities on the environment and local communities.

Trade in sustainable agriculture also offers export and development opportunities. The production and export of sustainably produced agricultural products, such as certified organic goods and fair-trade products, cater to the growing global demand for environmentally and socially responsible food items. The adoption of eco-friendly farming practices, such as organic farming, agroforestry, and precision agriculture, can enhance soil health, conserve water, and reduce the use of chemical inputs. In addition, fostering international partnerships and collaborations can facilitate knowledge exchange and technology transfer, supporting the dissemination of best practices and innovative solutions in sustainable agriculture. As argued in the opinion piece by Stephen Karingi, Melaku Desta and Jason McCormack, re-globalization around green trade presents both challenges and opportunities for Africa.

(d) The role of the WTO in supporting environmental sustainability

International cooperation is essential to address global and regional environmental issues, such as climate change, biodiversity and waste management. There are over 1,000 multilateral and regional environmental agreements currently in force dealing with various environmental issues. A limited number of these environmental agreements include specific trade-related obligations, such as requirements or restrictions on imported or exported products to prevent damage to the environment.[18] In that context, trade policy can be an effective tool for addressing specific environmental challenges and supporting more broadly sustainable development.

Regional trade agreements (RTAs) have been at the forefront of addressing trade and environment. An increasing number of RTAs contain environmental provisions. Most environmental provisions focus on similar environmental issues, even though they may differ in language, scope and enforceability. Some agreements require the adoption and enforcement of domestic environmental policies and multilateral environmental agreements. Promoting environmental goods and services, biodiversity and the sustainable management of forests and fisheries is also increasingly covered in RTAs (Monteiro and Trachtman, 2020; WTO, 2022g).

At the multilateral level, the WTO contributes to supporting environmental protection through its different functions. Sustainable development and the protection of the environment are recognized as central objectives of the multilateral trading system. WTO rules, by providing predictability and ensuring that protectionism is not introduced under the guise of protecting the environment, can contribute to more effective and coherent environment-related trade policies. Under the covered agreements, WTO members have the right to adopt trade-restrictive measures to protect the environment, at the level they choose, as long as they fulfil certain requirements such as not being means of arbitrary or unjustifiable discrimination or disguised restrictions on international trade.

The WTO Agreement on Fisheries Subsidies, adopted in 2022, is the first WTO agreement that focuses on the environment. The agreement prohibits subsidies to illegal, unreported and unregulated (IUU) fishing, and bans subsidies for fishing overfished stocks and for fishing on the unregulated high seas, which are key factors in the widespread depletion of the world's fish stocks. WTO members also agreed to continue negotiations on outstanding issues, including disciplines on subsidies contributing to overcapacity and overfishing.

Most WTO bodies, including the Committee on Trade and Environment, also discuss trade measures adopted for environmental objectives notified to the WTO. This information exchange can help to identify potential trade concerns and resolve them through discussion and consultation. In addition, the WTO's Dispute Settlement System can be used to resolve environment-related trade concerns. The WTO Secretariat also collaborates with international environmental bodies to promote mutual supportiveness between trade and environmental policies.

Ongoing discussions and potential reforms in the WTO have the potential to strengthen the role of trade and trade policy in supporting environmental protection. International trade cooperation can play a crucial role in facilitating the adoption of environmentally friendly technologies and practices. By promoting the development and

OPINION PIECE

Re-globalization around green trade: challenges and opportunities for Africa

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For decades, Africa has engaged with the multilateral trading system, but the continent has struggled to see the full benefits of globalization. Yet, globalization *per se* has never been the problem; the problem has been with the terms, ideological foundations and operational tools on which the edifice of globalization is built. Precisely because of this, today's Africa bears the brunt of the three major challenges identified by this World Trade Report – extreme and widespread poverty, environmental degradation, and a lack of security and resilience.

In this context, the proposition of re-globalizing for a resilient, inclusive and sustainable future must be welcomed by Africa and Africans – and, in fact, Africa is uniquely placed to energize re-globalization. The question then is how the world is to re-globalize. Here are a few thoughts from an African perspective.

First, we need to agree that the turn towards regional or bloc-based trade is second-best to globalization. But if all we mean by re-globalization is an expansion of the multilateral trading system towards new topics and new actors, then we are missing the point. We know that globalization did not lift all boats. Africa's share of global trade has remained stagnant and, as recently as 2021, nearly 70 per cent of Africa's global exports were primary commodities. Africa has also been dependent on the import of manufactured goods, a combination that has left the continent exposed to the vagaries of international commodity markets. Re-globalization cannot, therefore, be more of the same old globalization.

Second, re-globalization based on principles of fairness and equity, with human development at the core, is the only viable way forward. There is no viable alternative to rules-based multilateralism; only the nature of the rules on which we re-globalize needs proper reflection, discussion and decision.

Third, Africa's support for the agenda of re-globalization for a resilient, inclusive and sustainable future is founded on principles. At a time when rules-based multilateralism is under attack, Africa has been busy building a continental single market based on principles of fairness, non-discrimination, transparency and accountability. That is what the Agreement Establishing the African Continental Free Trade Area (AfCFTA) is all about. Modelling estimates by the United Nations Economic Commission for Africa (ECA) show that in 2045, Africa's agri-food, services and industry sectors will be 50.2 per cent, 37.6 per cent and 36.1 per cent higher, respectively, compared to a situation without the AfCFTA. The AfCFTA will position Africa as a powerful voice for rules-based multilateralism on the global stage.

Fourth, a revamped multilateral trading system underpinning re-globalization efforts needs to place development and sustainability at its core. Africa can pursue its development objectives in tandem with its environmental objectives thanks to its unique endowment in minerals critical to the green transition, such as its vast reserves of cobalt, lithium, nickel, and other commodities.

In sum, Africa should welcome re-globalization based on green trade. But a re-globalization that does not put development and justice at its core will likely face the same fate as today's version of globalization. Unfortunately, the introduction by major trading powers of unilateral measures in the name of fighting climate change risks stifling Africa's industrialization prospects under a re-globalization anchored around green trade.

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deployment of environmental goods and services, trade can encourage companies to reduce their environmental impact and improve the sustainability of their operations through investments in green technologies and production methods. Some scholars have proposed to establish an agreement under the auspices of the WTO which would aim to liberalize trade in green-tech products, facilitate investment in environmental industries, and facilitate the movement of skilled individuals to foster entrepreneurship and build skilled workforces (Hanson and Slaughter, 2023). In 2014, 18 participants representing 46 WTO members launched negotiations seeking to eliminate tariffs on a number of important environment-related products using the list of environmental goods identified by the Asia-Pacific Economic Cooperation (APEC) forum as starting point.[20] The negotiations have, however, been suspended since 2017.

More ambitious international trade cooperation could also help to address the environmental challenges associated with global supply chains by promoting transparency and accountability in supply chain management, including through the development of standards and certification schemes that promote sustainable production and trade practices, as well as through the implementation of traceability systems that enable businesses to track the environmental impact of their operations. In addition, supporting efforts to establish equivalence and mutual recognition of specific environmental standards can facilitate environmental protection without creating unnecessary trade barriers.

While WTO rules do not inherently restrict ambitious environmental actions, trade tensions related to certain climate policies have raised concerns about the applicability of certain WTO rules.[19] In light of these developments, there have been discussions and proposals regarding the need for a mutual understanding on the use of specific environment-related trade policies, such as environmental subsidies. Some WTO members have, in the past, formally proposed the reintroduction of the non-actionable subsidies category, including that adopted for environmental purposes, specifically in favour of developing-country members.[21] No decision on this matter has been adopted so far. Although challenging, maintaining a dialogue and clarifying WTO rules on these issues, if necessary, could help to avoid trade disputes and increase the predictability of environment-related trade policies.

WTO members have started to explore a new range of sustainability-focused initiatives that could lead to concrete trade-related actions to help address global environmental challenges. These new environmental initiatives include the Trade and Environmental Sustainability Structured Discussion (TESSD), the Informal Dialogue on Plastics Pollution and Sustainable Plastics Trade (see Box E.2) and the Fossil Fuel Subsidy Reform.

5. Conclusions

This chapter reviews the complex relationship between trade and the environment. Over the past few decades, international trade has undergone an unprecedented expansion, and during that time, advanced economies have experienced a modest rise in total CO_2 emissions, while middle-income economies saw a larger net increase in their CO_2 emissions. Although trade contributes to GHG emissions, it also improves the environment directly by boosting productivity and diffusing environmental technologies, and indirectly by raising income and the demand for a cleaner environment.

A growing number of governments have enacted environmental policies, ranging from carbon taxes and environmental subsidies to regulations and labelling requirements. While these policies can help to address environmental challenges domestically, they could also have trade and environmental effects on other economies and result in trade retaliations that hinder the effectiveness of such policies. International coordination on environmental policies is essential to maximize their potential impact, by enabling knowledge spillovers and reducing the costs of addressing environmental challenges through economies of scale.

Re-globalization, by advancing services trade and enabling a wider application of digital technologies, can lower the carbon intensity of trade. International cooperation on environmental policies could also enable economies to leverage their "green comparative advantages", further enhancing the role of trade in facilitating the green transition. If governments were to adopt a global carbon price, international trade would, in fact, have a positive role to play in climate mitigation by connecting consumers to the green origins of production. Many developing economies stand to gain from this green transition as exporters of renewable energy and sustainable agricultural goods. The WTO can play an important role in enhancing the coherence between trade and environmental policies, and can contribute to efforts to make trade more sustainable.

Endnotes

1. For instance, the International Marine Organization (IMO)'s GHG Strategy, adopted in 2018 and revised in 2023, provides a policy framework to reach net-zero GHG emissions from international shipping close to 2050, a commitment to ensure an uptake of alternative zero and near-zero GHG fuels by 2030. The International Civil Aviation Organization (ICAO) adopted in 2016 the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) to allow aircraft operators to buy emissions reduction offsets from other sectors to compensate for any increase in their own emissions above 2020 levels, thereby achieving carbon neutral growth from that year.
2. In addition, international trade is also driven by consumers' love of variety and economies of scale, as suggested by the literature on intra-industry trade.
3. Exposure to international trade is also found to worsen environmental attitudes domestically (Bez, Colantone and Zanardi, forthcoming).
4. The list of environmental goods, as defined in Sauvage (2014), encompass 248 six-digit Harmonized System (HS) lines. It is important to acknowledge that certain environmental goods might be used for non-environmental purposes, which result in an overestimation of their value and share in global trade.
5. Although both emission taxes or emission trading systems are broadly equivalent and can raise the same amount of revenue , there are important differences. An emission tax is determined by the regulator, while the amount of emissions released into the atmosphere is initially unknown and will depend on how firms and consumers respond to the tax. In contrast, an emission trading scheme provides more certainty about the quantity of emissions but implies higher price volatility. Moreover, an emission trading system could be more costly to set up and administer, at least initially.
6. For instance, most governments rely on standards to set quantitative limits on the permissible amount of pollution emissions in passenger vehicles, because direct measurement of pollution from individual vehicles is imperfect and prohibitively expensive (Venigalla, 2013).
7. The study focuses on two key air pollution policies: the Supreme Court Action Plans and the Mandated Catalytic Converters, as well as India's primary water policy, the National River Conservation Plan, which focused on reducing industrial pollution in rivers and creating sewage treatment facilities.
8. See https://standardsmap.org/en/home.
9. Trade concerns raised in WTO's technical committees, such as the Market Access, SPS, and TBT Committees, are sometimes also brought up and discussed in higher-level WTO bodies, including the Council for Trade in Goods. See Figure B.1 for an overview of trade concerns raised at different levels of WTO bodies.
10. See, for instance, report of the meeting of the Council for Trade in Goods of 7 and 8 July 2022 (WTO official document number G/C/M/143).
11. See report of the meeting of the Committee on Trade and Environment of 2 February 2022 (WTO official document number WT/CTE/M/74).
12. In this hypothetical scenario, economies are assumed to begin implementing nationalistic policies that gradually restrict learning to installations within their country borders, with annual installation capacities unchanged.
13. See https://exponentialroadmap.org/.
14. Energy-intensive goods include traded products that have a relatively higher energy intensity, such as basic metals, non-metallic mineral products, chemicals and pharmaceutical products. The revealed comparative advantage index is a useful metric for evaluating competitiveness of a country in exporting certain commodities. It is based on Ricardian trade theory, which posits that patterns of trade among economies are governed by their relative differences in productivity.
15. See https://www.unep.org/about-un-environment/inc-plastic-pollution.
16. Under this scenario, the inflow of new material for short-lived plastics is more than halved, while the flows of materials that are re-used or recycled increase to 27 per cent of the total.
17. More information on the Informal dialogue on plastics pollution and environmentally sustainable plastics trade can be found on the WTO website: https://www.wto.org/english/tratop_e/ppesp_e/ppesp_e.htm
18. Examples of these agreements include the Convention on International Trade in Endangered Species of Wild Fauna and Flora, the International Tropical Timber Agreement, the Convention on Biological Diversity, the United Nations Framework Convention on Climate Change and the Basel Convention on the Control of Transboundary Movements of Hazardous Wastes and their Disposal.
19. Some scholars have suggested the possibility of a climate waiver within the WTO framework, aiming to facilitate the implementation of carbon pricing measures and support the necessary transition to a greener global economy (Bacchus, 2018).
20. The 2012 Vladivostok APEC Leaders' Declaration marked the first time a group of economies agreed to a set of 54 environmental goods, with a view to reducing their respective applied tariff rates to 5 per cent or less by the end of 2020.
21. See WTO official documents number WT/MIN(01)/17, TN/RL/W/41 and WT/GC/W/773, which can be accessed at https://docs.wto.org/.