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CARBON PRICING, POLICY SPILLOVERS, AND GLOBAL CLIMATE GOALS

CONTENTS

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EXECUTIVE SUMMARY

In response to the threat of global warming, countries around the world are scaling up actions to limit climate change. Mitigation policies include carbon pricing, regulations, subsidies, and direct investments. Because economic and political contexts and available resources vary across countries, these policies differ in ambition, sequencing, and policy approaches. The Paris Agreement accommodates this diversity, and its bottom-up approach has helped to increase the ambition for climate action.

Yet more needs to be done. Both climate ambition and climate action must increase to achieve global emission reduction targets. Two barriers impede these goals. First, many countries struggle to introduce an effective mix of climate change policies. In particular, carbon pricing through carbon taxes or emissions trading systems (ETSs)—even though it can strongly contribute to cost-effective mitigation and raise badly needed revenues—has faced strong political headwinds because of visible distributional and competitiveness effects and carbon leakage concerns. Second, domestic climate policy choices can have global spillover effects and policy fragmentation from unilateral reactions to these spillovers can lead to trade tensions, with potential negative economic and climate impacts.

The World Trade Organization (WTO) convened the Task Force on Climate Action, Carbon Pricing, and Policy Spillovers—which was joined by the International Monetary Fund (IMF), Organisation for Economic Co-operation and Development (OECD), United Nations Conference on Trade and Development (UNCTAD), and the World Bank—to identify ways to foster coordination to maximize positive and limit negative cross-border spillovers from climate change mitigation policies; to introduce a common understanding of carbon pricing metrics; and to promote coordination to scale up climate action, including through carbon pricing.

Effective climate policies

Reducing greenhouse gas (GHG) emissions generates substantial global benefits by reducing or averting climate change. Individual countries that reduce GHG emissions can also experience significant immediate benefits by advancing several Sustainable Development Goals (SDGs). For instance, promoting energy efficiency and the deployment of low-cost green technologies, such as solar power and e-mobility, can expand access to energy services and improve air quality. In World Bank's Country Climate and Development Reports (CCDRs), low-emission scenarios have faster short-term economic growth than current economic trends in most countries studied, thanks to these co-benefits and assuming well-designed climate policies and a supportive economic environment.

Countries currently employ a range of policy instruments to reduce emissions. Momentum is building for explicit carbon pricing policies, with the use of such policies on the rise since 2010 according to OECD and World Bank research. Currently, 75 carbon taxes and ETSs are in operation worldwide, covering approximately 24 percent of global emissions. While most carbon pricing policies to date have been implemented in high-income countries, they are also gaining traction in middle-and low-income countries. Most countries also tax some fossil fuel use through energy or fuel taxes, creating an implicit carbon price that disincentivizes related GHG emissions. However, many subsidize fossil fuel with the reverse incentive, making subsidy reform an important component for the evolution of carbon pricing and climate action.

Carbon pricing is the only abatement instrument that can implement the Polluter Pays Principle. Introducing a charge per unit of emissions leads emitters to cut emissions as long as that is less costly than paying the carbon price. And because it makes polluters pay for each unit of emissions, it also creates a price signal to incentivize final consumers and other firms to reduce their consumption of carbon-intensive goods and services. For this reason, carbon pricing can form a key element of a cost-efficient emissions reduction policy package. It also creates revenues that can be used to ease adjustment costs as well as to contribute to the general budget and achieve other policy and development goals.

Even with mitigation policies creating incentives to invest in emission reducing technologies, other pervasive market failures can hinder their innovation and diffusion. These unaddressed market failures, infrastructure constraints, and other barriers can hinder the effectiveness of a climate policy mix. For that reason, non-carbon-pricing policies need to complement carbon pricing, if it is implemented, by dealing with other market failures so as to make carbon pricing more efficient and also more acceptable politically. Achieving the same level of emission reductions requires a higher carbon price if it is not complemented with non-pricing policies.

However, opposition to pricing instruments can be strong, as the benefits of carbon pricing are diffuse and indirect while the costs are often concentrated and visible. Contrary to carbon pricing, alternative policy instruments—like regulations and subsidies—often involve lower and less visible direct costs for polluters (and consumers of carbon-intensive goods and services), which is why they are often more readily accepted even when they have indirect effects that generate higher aggregate economic costs. Combining emission pricing with other policy interventions, such as strengthening public transport and public infrastructure and making benefits visible, such as through compensatory cash transfers, can strengthen social support for carbon pricing and fuel subsidy reforms. Support for carbon pricing and fossil fuel subsidy reforms can increase over time as the benefits of the reform materialize, making it essential to design reforms such that they generate visible early benefits. And intermediate solutions are available too, for instance using output-based rebates to minimize impacts on production costs while maintaining an incentive to reduce emissions.

A common understanding of carbon pricing metrics

Transparent carbon pricing metrics serve two key objectives. First, they can enhance transparency and accountability by informing on the extent and scale at which countries are shifting private sector incentives toward decarbonization through pricing. Second, they can inform on cross-country variation in carbon prices, a key determinant of international spillover effects and competitiveness concerns. Metrics for measuring the impact of carbon pricing and other climate mitigation policies on GHG emissions can also inform policy efforts to scale up climate action.

Carbon pricing metrics measure the price that households and firms that emit GHGs have to pay per unit of these emissions, either in the form of a tax or fee or by buying permits, or the rewards they receive if emissions are being subsidized. Carbon prices can measure average or marginal prices and can consider explicit carbon pricing or also implicit or indirect pricing. Explicit carbon prices capture the extent to which a cost is directly applied to GHGs in terms of a monetary unit per unit of warming effect. Fuel excise taxes and fossil fuel consumption subsidies can similarly be quantified as implicit carbon prices.

The World Bank's Carbon Pricing Dashboard considers explicit carbon taxes and ETS permit prices. The OECD's net effective carbon rate adds fossil fuel consumption taxes and subsidies that lower pre-tax fuel prices, and is available at the sector and fuel level in over 70 countries, covering 82 percent of global GHG emissions. The World Bank's total carbon price, available for over 140 countries, employs an alternative approach to data collection and calculation of carbon price levels by leveraging IMF estimates of fossil fuel taxes and subsidies. This taskforce on climate action, carbon pricing, and policy spillovers provides a common measurement framework, converging on a set of scopes and methodologies, while maintaining a diversity of metrics appropriate for different contexts and use cases.

Aggregated metrics cannot inform all decisions. To understand how carbon pricing affects competitiveness in relation to internationally traded products, disaggregated metrics measuring sector- and product-level carbon pricing are needed. To calculate embodied carbon pricing, such as for recognition in border carbon adjustment (BCA) measures, the carbon prices paid on all relevant direct and indirect emissions, as well as free allocations and rebates that reduce the payments on residual emissions, must be considered.

To estimate ex-ante the impact of carbon pricing and other policies on emissions, economic modeling or calculations based on estimated elasticities calibrated on historical data series reflecting behavioral responses can be employed. The World Bank's CCDRs and the OECD's Inclusive Forum on Carbon Mitigation Approaches (IFCMA) employ modeling. Elasticity-based calculations underlie the IMF's effective carbon price, which considers all price-based policies, or IMF's carbon price equivalent (CPE), which considers a broad range of policies, and calculates the uniform economywide carbon price that would generate the same emission reductions as the policies considered.

Coordination to maximize positive cross-border spillovers and limit negative cross-border impacts

When a jurisdiction introduces a climate policy, both positive and negative cross-border spillovers may ensue. In general, climate policies generate three types of positive spillovers. The first is the primary objective: reducing global GHG emissions helps limit climate change and thus reduces its cost everywhere. Second, climate policies can promote the development and dissemination of green technologies, which reduce the costs of the climate transition in other countries. Third, experience with climate policy approaches may encourage other countries to follow the example and implement their own policies.

Climate policies that raise costs for domestic producers, such as carbon pricing, present a risk that industrial activity and the associated emissions will shift to jurisdictions with less costly climate policies, possibly reducing the environmental benefits (carbon leakage). The shift of emissions abroad is a negative cross-border spillover, reducing the positive climate spillover of carbon pricing. To limit leakage, jurisdictions adopting carbon pricing have used free allowances or output-based subsidies, and are increasingly considering BCAs. In addition to limiting leakage, such policies can help buttress domestic support for climate action and create incentives for emission reductions in other countries exporting to countries introducing a BCA. However, BCAs can create nontrivial compliance and reporting costs for trade partners and the higher carbon intensity of developing countries and their lower financial and institutional capacity could make them more affected, with the risk of adversely affecting their position in global trade. Hence, they could lead to heightened trade tensions and risk inciting tit-for-tat trade actions. Designing BCAs to ensure proportionality with the impact of climate policies is challenging but important to promote environmental effectiveness.

Climate policies that reduce costs for domestic producers, such as subsidies to encourage decarbonization, can generate positive spillovers by reducing prices of low carbon goods globally due to learning by doing and innovation. However, they can also generate negative spillovers, because foreign producers of similar goods competing with the subsidized goods are adversely affected by producer subsidies or discriminatory demand subsidies, for example when accompanied by local content requirements. These policies pose the risk of hurting low- and lower-middle income countries that cannot invest in a lower-emission production process or cannot propose similar subsidies, for instance because of limited fiscal space and high debt-servicing costs.

International coordination can help to maximize positive spillovers and limit negative cross-border impacts of climate and climate-related policies. Coordination can focus on aligning methods of measuring carbon intensities and product-specific emission metrics to streamline reporting for anti-leakage measures, ensure their transparent application, avoid duplicative compliance costs, and limit market access concerns. Coordination could spur green technology dissemination globally by pooling resources, supporting technology deployment, and improving access to low-cost finance—enabling the investments needed to help countries increase their climate policy ambition and reduce emissions, while advancing the SDGs. However, it is challenging to implement such coordination in a balanced way. Developing a common understanding of cross-border spillovers and balancing issues in designing trade-related climate measures can help address concerns over arbitrariness, climate policy inefficiency, distrust, and protectionism.

Options to scale up climate action

International organizations help countries to implement a variety of climate policies by providing support through technical assistance, capacity building, analytical work, and climate finance. Enhanced international coordination aligned with the Paris Agreement principles—such as Common but Differentiated Responsibility and Respective Capabilities (CBDR-RC)—and with norms of other multilateral systems, like those of the WTO, can elevate climate action and should be designed to contribute to the SDGs. Such coordination can aim at closing the gaps in transparency, implementation, and ambition. The task force does not recommend a specific approach; rather, it encourages exploration of all possible options.

To close the transparency gap, countries could agree on enhanced reporting and transparency of their policy and economic environment related to climate change mitigation. Existing initiatives to identify the full set of climate policies and measure their impact on emissions comprise the World Bank's CCDRs, the IMF's calculation of the CPE, the IFCMA launched at the OECD, and the UNFCCC's Stocktake and Biennial Transparency Reports (BTRs). Enhanced transparency can facilitate peer exchange and self-discipline.

To close the implementation gap, countries could agree to implement certain policies and policy instruments such as fossil fuel subsidy reform, climate finance and technical cooperation under the UNFCCC's ongoing negotiations, sectoral measures, or a mix of climate policies delivering targeted emission reductions. Existing initiatives focus on emissions in specific sectors such as aviation, maritime shipping, or steel. Future initiatives could expand markets for deeply decarbonized products such as zero-carbon steel or aluminum.

To close the ambition gap, countries could coordinate on enhanced levels of ambition, ideally along with the policies to achieve these goals. The next round of updated nationally determined contributions (NDCs) leading up to the 30th UNFCCC conference of the Parties (COP30) is a key opportunity to increase countries' climate ambitions to be consistent with the Paris Agreement temperature goal. Enhanced ambition could be supported by initiatives led by a subgroup of countries defining and preparing "high-ambition NDCs" that meet commonly agreed criteria for ambition and implementation. In addition to be reflected in updated NDCs, such initiatives could take the form of open international coordination arrangements embedded in or aligned with the Paris Agreement. These initiatives could target emission reductions or alternatively equivalent carbon prices, although the latter approach presents challenges as it requires significant assumptions to convert policies into a carbon price equivalent. Research by the IMF on an International Carbon Price Floor, the WTO Secretariat on a Global Carbon Pricing Framework, the World Bank in Climate Change Development Reports, or OECDs IFCMA on a global stocktake of carbon mitigation approaches could help inform discussions at UNFCCC on such initiatives. Research by UNCTAD on the effect of climate policies on developing countries can also help ensure that they have a positive development impact.

International organizations' future joint work can help fill the knowledge and information gaps identified in this report, such as the need for more granular and better data on embedded carbon prices, the calculation of equivalent carbon prices, further analysis of the impact of domestic climate policies on other countries (including lower income countries), the costs of fragmentation of climate policies, design of border adjustment policies and their interoperability, solutions to promote and facilitate green technology and knowhow diffusion, and approaches to increased cooperation and climate finance which enhance climate action and ensure a just transition. This work will contribute to the optimization of climate policies for the benefit of all, ensuring no one is left behind, and to scale up climate action and sustainable development.

The state of global climate action

According to climate projections, gaps in ambition and implementation in nationally determined contributions (NDCs) need to be closed to achieve the objectives of the Paris Agreement. To meet their climate mitigation targets, countries rely on a range of climate policy instruments with momentum building for the use of carbon pricing policies. However, the current coverage and stringency levels of mitigation policies are not commensurate with the policies needed to achieve a 1.5°C pathway. A resilient, low-emission development pathway delivers many benefits and can help promote economic growth, supporting the achievements of various Sustainable Development Goals (SDGs).

1

1.1 Key climate projections show gaps in both ambition and implementation to achieve the objectives of the Paris Agreement

Increased climate ambition is needed to achieve rapid and sustained reductions in GHG emissions to limit global warming to the Paris Agreement's temperature goals. According to the first Global Stocktake (a five-yearly review of the Paris Agreement implementation), to maintain the commitment to limit long-term global warming to 1.5°C above pre-industrial levels in a cost effective way, GHG emissions need to decline by "43 percent by 2030 and 60 percent by 2035 relative to the 2019 level and reach net zero carbon dioxide emissions by 2050."[1] Nonetheless, while emissions have peaked in developed and some developing countries (Calvin et al., 2023), in the Global Stocktake all parties recognized that a gap exists in ambition, implying that objectives established in current NDCs are not enough to achieve the necessary emissions reductions for achieving the 2°C and 1.5°C targets (UNFCCC, 2023). IMF estimates suggest that despite countries having increased their mitigation ambition since the Paris Agreement was signed in 2015, current NDCs would lead to reductions of global GHG emissions of 11 percent by 2030 relative to 2019.[2] The United Nations Environment Programme' 2023 Emissions Gap Report estimates that full implementation of unconditional and conditional NDCs for 2030 would reduce expected emissions in 2030 by only 2 percent and 9 percent, respectively (United Nations Environment Programme (UNEP), 2023).

Countries are falling short of achieving the targets set in their NDCs, creating an implementation gap. Even if the ambition gap is closed through higher commitments in NDCs, all parties in the Global Stocktake recognize that a large implementation gap still exists, defined as the gap between NDC targets and actual policies implemented. IMF estimates suggest that in a business-as-usual scenario with no new or tightening of existing mitigation policies, global GHG emissions are projected to increase 5 percent—to 52 billion tons of CO_2 equivalent—by 2030 (Black, Parry, and Zhunussova, 2023). To address this gap, the Global Stocktake lists a series of "global efforts" for parties to implement, including: transitioning away from fossil fuels in energy systems, in a just, orderly and equitable manner; tripling renewable energy capacity globally and doubling the global average annual rate of energy efficiency improvements by 2030; and accelerating zero- and low-emission technologies.

Ramping up climate finance, affordable access to existing technologies, and development of new technologies are key to achieving the Paris Agreement goals. There is a large gap between current and needed climate mitigation finance and investment. IMF estimates suggest that public and private mitigation investment would need to increase sixfold globally and fivefold in developing countries for net zero scenarios by 2050 (Black, Parry, and Zhunussova, 2023). Most of the investment needs are in the energy sector, with half in electricity generation and distribution and one-quarter in energy efficiency. The High-Level Expert Group on Climate Finance (Songwe, Stern, and Bhattacharya, 2022) estimated total investment needs in climate and development at $1.2-1.7 trillion per year for emerging and developing economies (excluding China) in a global net zero scenario for 2050. In the same countries, but with country-specific scenarios, World Bank CCDRs identify around $600 billion per year in climate-related investment needs, combining resilience and low-emission development, with most absolute needs in higher-income countries but much larger relative needs as a share of GDP in low and lower income countries (World Bank, 2023a). Finally, decarbonization will require the swift deployment of low carbon technologies in all areas of the world and investment in the development of key technologies that are not yet fully ready to go to market, including in the aviation, shipping, cement, steel, agriculture, hydrogen, electric vehicles and batteries, and energy storage industries.

1.2 Countries rely on diverse climate policy instruments with momentum building for the use of carbon pricing policies

To meet their climate mitigation targets, countries rely on a range of policy instruments. These instruments include carbon pricing, which can be explicit or implicit, and can also take the form of mitigation credits. Countries also rely on non-carbon pricing incentive-based policies to promote, for example, improved technologies, energy efficiency, and other mitigation-related activities (such as subsidies or feebates) and other non–carbon-pricing policies, such as standards, regulations, and other instruments (for example, public investment policies). Table 1.1 contains examples of policy instruments.

Table 1.1: Examples of climate mitigation policy instruments

Category	Examples of policy instruments
Explicit carbon pricing	Carbon taxes Emissions trading systems
Implicit carbon pricing	Fuel excise taxes Fuel subsidies (negative carbon prices) Value-added tax differential for fuels
Mitigation crediting	Carbon crediting mechanisms Voluntary carbon markets
Incentive-based policies for technologies, efficiency, and other mitigation-related activities	Vehicle feebates Tradable fuel efficiency standards Feed-in tariffs Electricity excise taxes and subsidies Emissions-based vehicle taxes Tradable renewable portfolio standards Tradable renewable fuel standards Technological deployment subsidies Electric vehicle incentives Energy efficiency tax credits Certain industrial and agricultural subsidies
Standards (nontradable) and other regulations	Air pollution standards Greenhouse gas emissions intensity standards Clean energy standards Technology mandates or polluting product bans Fertilizer regulations Energy efficiency building codes Fuel efficiency regulations Energy market reform (Nontradable) renewable share mandates
Investment and other policies	Public investment (for example, public transportation, enabling infrastructure for innovation) Information policies (product labelling/rating, certification, information disclosure) Other electric vehicle policies Research and Development policies

Source: own elaboration by staff of the IMF, OECD, UNCTAD, WB, and WTO.
Note: Emissions trading Systems (ETSs) consist both of mass-based ETSs, including cap-and-trade systems with different allocation mechanisms, and rate-based ETSs, including tradable emission performance standards, output-based pricing systems, and low carbon fuel standards. Rate-based ETSs limit the intensity but not total amount of emissions; trading results in a price for incremental emissions but benchmark allocations limit the average pricing of emissions, much as with output-based allocation in cap-and-trade regimes or output-based rebating of emission taxes. Under rate-based systems, total emissions fluctuate with economic activity, but to a lesser extent than with carbon taxes. Flexibility mechanisms under cap-and-trade systems also allow emissions to vary but help promote price stability. Thus, subtle but important distinctions exist among the policies that can be blurred in practice. Not all international organizations categorize rate-based ETSs as explicit carbon pricing. When all trading occurs bilaterally or on secondary markets, the resulting emissions price may not be observable.

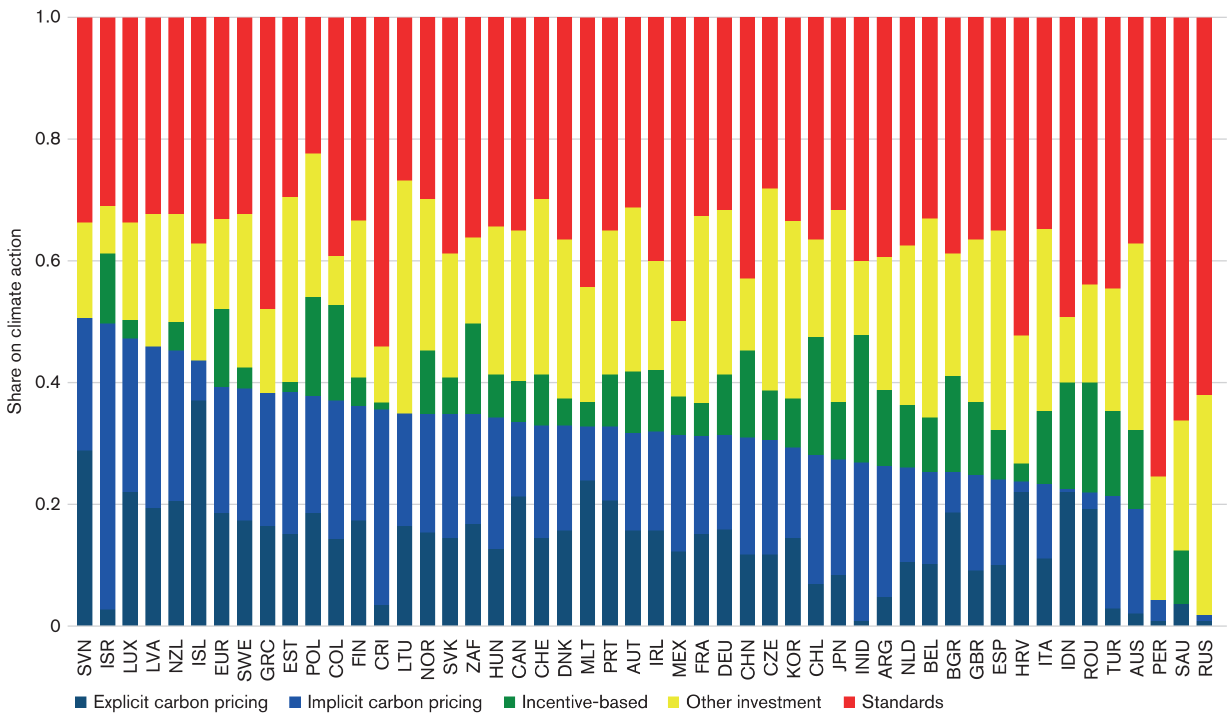
Policy mixes and the reliance on carbon pricing differ substantially across countries. While some countries rely more on carbon pricing, others rely more on standards and other regulations or on investment and other policies. Even within carbon pricing, countries differ in the extent to which they rely on implicit or explicit carbon pricing. Most countries use at least implicit carbon pricing, and 75 have moved to additionally pricing carbon explicitly. Figure 1.1 shows policy mixes for OECD countries and selected non-OECD countries relying on the OECD's Climate Actions and Policies Measurement Framework (CAPMF) (Nachtigall et al., 2022).[3]

In recent years, explicit carbon pricing instruments expanded significantly whereas implicit carbon pricing schemes mostly stagnated, but sharply decreased in 2022. The decrease of implicit carbon pricing was mostly related to record-high fossil fuel subsidies when energy prices soared in 2022. Climate action—measured as a combination of policy adoption and increases in policy stringency—grew strongly for standards and other regulations and somewhat for incentive-based policies and investment policies between 2010 and 2022 (Figure 1.2).[4] In 2010, most countries already had diverse policy mixes in place before ramping up explicit carbon pricing. This suggests that countries have often opted for policy sequences characterized by adopting other policy instruments before adopting and strengthening explicit carbon pricing schemes (Linsenmeier, Mohommad, and Schwerhoff, 2022).

Momentum is building for the adoption of explicit carbon pricing policies (carbon taxes and emissions trading policies) globally. Currently, 75 carbon taxes and ETSs are in operation worldwide (Figure 1.3), covering approximately 24 percent of global emissions—equivalent to almost 13 gigatons of CO_2. This represents an increase of about 10 percentage points since 2020 (Figure 1.4). While most of these policies are in high-income countries, carbon pricing is also gaining traction in middle-income nations, albeit at lower price levels (Figure 1.4).

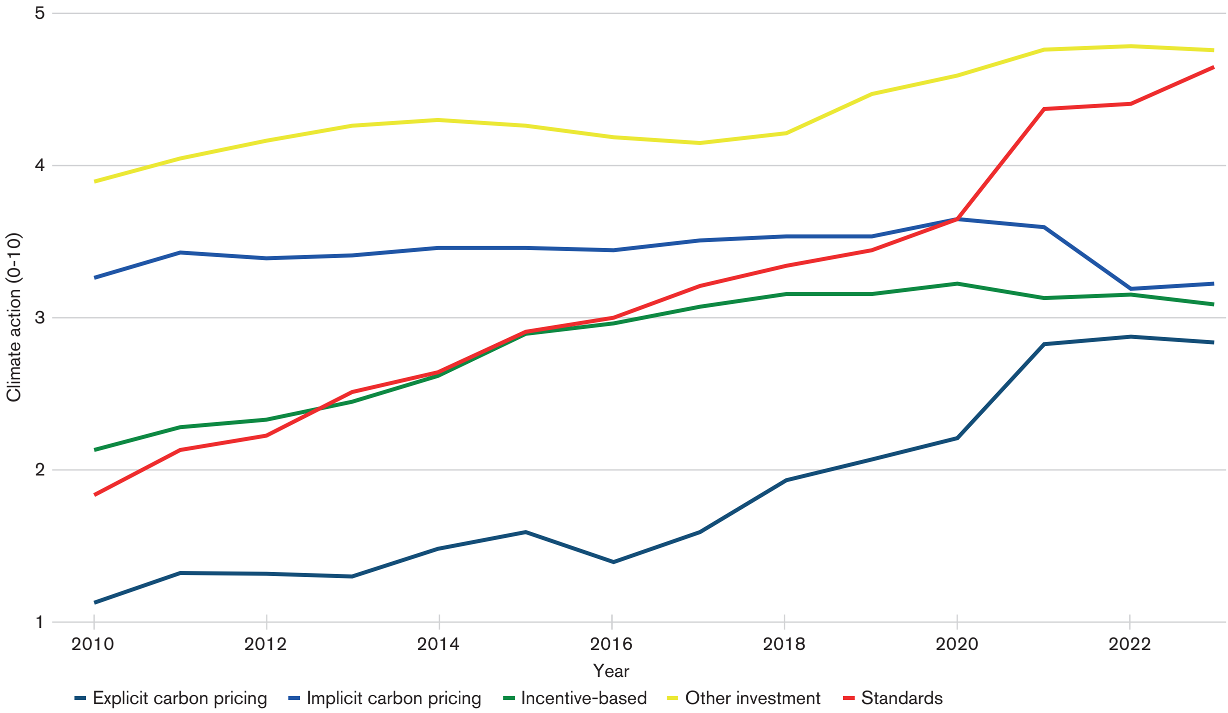
However, the current coverage and stringency levels of explicit carbon pricing policies are not commensurate with pathways conducive to limiting global warming to well below 2°C. Despite substantial growth in the coverage of emissions captured by explicit carbon pricing policies over the last five years, progress currently falls well short of the prices recommended to limit temperature rises to well below 2°C, even as part of a broader policy mix.

Figure 1.1: Policy mix by country



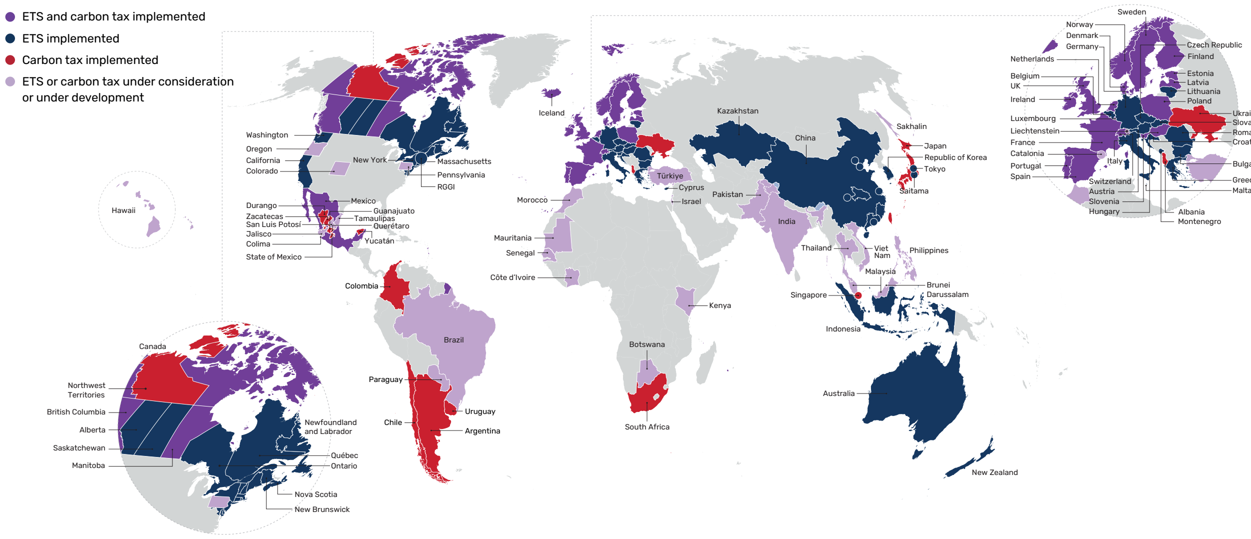
Source: Nachtigall et al. (2022).
Note: Climate action is measured as a combination of policy adoption and policy stringency on a scale from 0 (no climate action) to 1 (strong climate action).

Figure 1.2: Trends of climate policy instruments



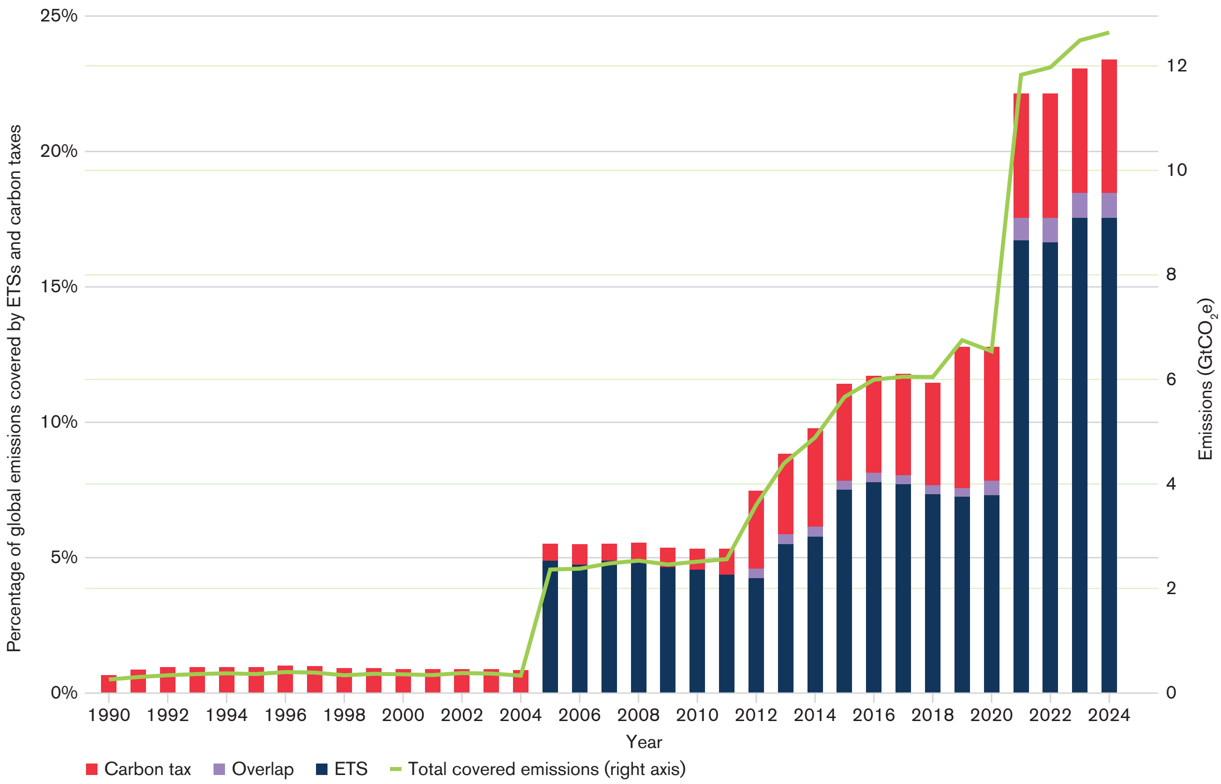
Source: Nachtigall et al. (2022).
Note: Climate action is measured as a combination of policy adoption and policy stringency on a scale from 0 (no climate action) to 1 (strong climate action). The figure displays the global average over 56 policies measured in 52 countries.

Figure 1.3: Map of carbon taxes and ETSs around the world



Source: World Bank State and Trends of Carbon Pricing 2024.
Note: ETS = emissions trading system; RGGI = Regional Greenhouse Gas Initiative.

Figure 1.4: Global greenhouse gas emissions covered by explicit carbon pricing policies



Source: World Bank State and Trends of Carbon Pricing 2024.
Note: ETS = emissions trading system; $GtCO_2e$ = gigatons of carbon dioxide equivalent.

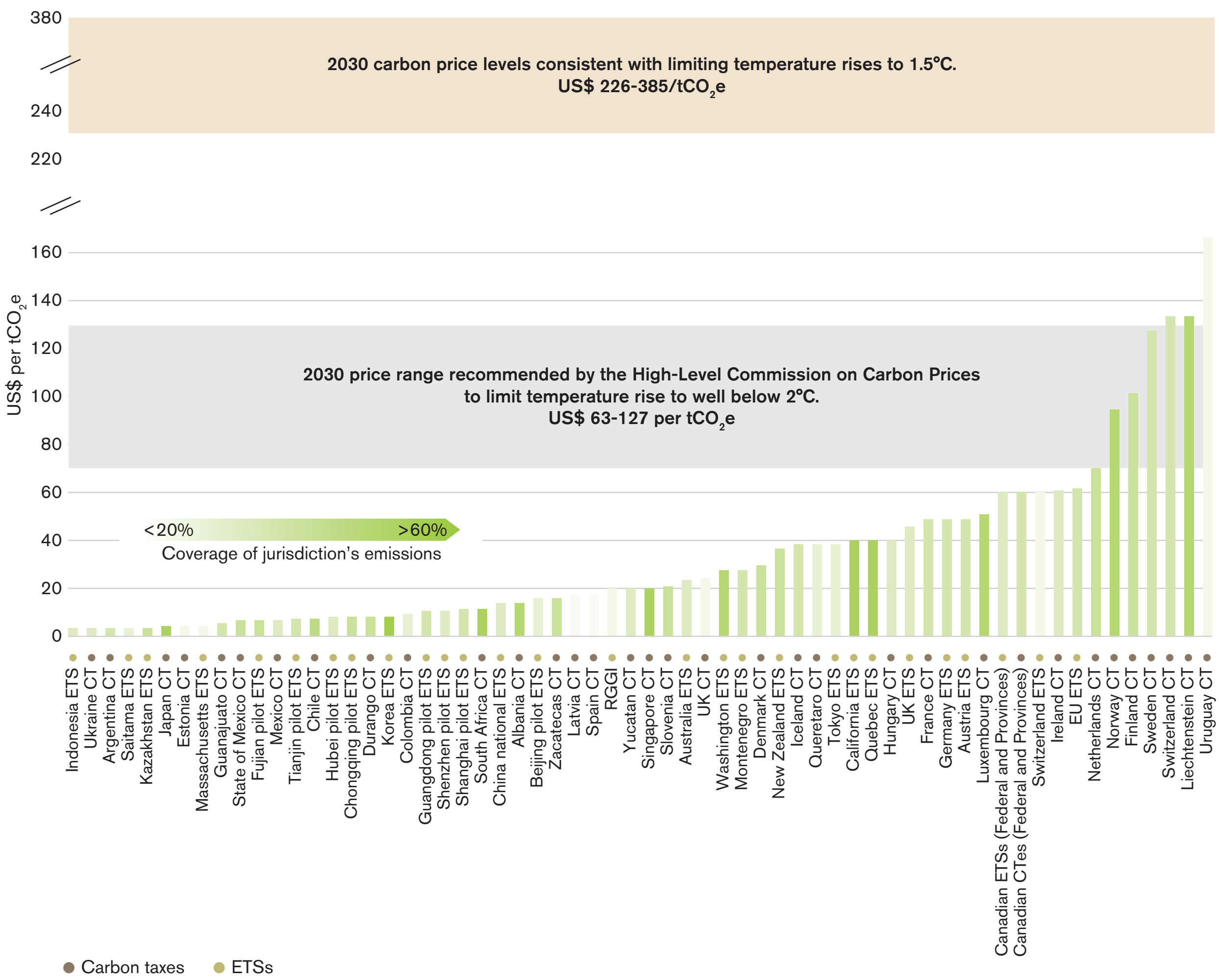
For example, leaving aside that carbon pricing can be combined with other policies, it is worth noting that only seven explicit carbon pricing instruments (which cover less than 1 percent of global greenhouse gas emissions) reached price levels high enough to limit temperature rises to well below 2°C, and that no existing carbon prices are ambitious enough to limit warming to 1.5°C (Figure 1.5).

1.3 Resilient low-emission development pathways deliver many benefits and can help promote economic growth, supporting the achievements of various SDGs

Reducing GHG emissions has several important benefits. Even in the short term, the World Bank's Country Climate and Development Reports suggest that low-emission development pathways can generate similar or even higher economic growth by 2030 compared with current development trajectories, provided that policies are well-designed, synergistic, and take place within a supportive enabling environment (World Bank, 2023b). For instance, promoting energy efficiency and the deployment of low-cost green technologies, such as solar power and e-mobility, can expand access to energy services and improve air quality. Shifting from carbon-intensive to carbon-sequestrating practices can maintain or increase agricultural productivity while reducing emissions and increasing ecosystem services. However, carbon-sequestration practices may not apply universally across all farming types. In a scenario consistent with the Paris Agreement mitigation objectives, the phasing out of explicit fossil fuel subsidies and increasing prices to internalize fossil fuel–related externalities, are estimated to raise 3.6 percent of GDP in revenue by 2030 (Black, Parry, and Zhunussova, 2023). These reforms also have valuable short-term health benefits, such as reducing local air pollution fatalities by 1.6 million per year. In the long run, climate action can contribute to keeping the potentially large costs of climate change limited.

Carbon pricing can be an effective economic instrument that incentivizes reductions and generates government revenue that can be used to support a just transition in

Figure 1.5: Prices and coverage across explicit carbon pricing policies



Source: World Bank State and Trends of Carbon Pricing.

the medium term, such as for funding sustainable and resilient infrastructure and green technologies, and investing in retraining or compensating affected groups and regions. According to economic assessments on carbon pricing that the World Bank Group, the IMF, and the OECD have conducted in both developed and developing countries, a carbon charge can significantly reduce emissions and promote structural change and diversification while forming part of a sustainable growth strategy.[5] Moreover, by pairing carbon pricing with fiscal policies which reduce taxes on labor and capital through the increased revenues of carbon pricing, low-carbon structural changes and diversification away from fossil fuels can be combined with increased national economic development.

ENDNOTES

1 According to the IPCC (2022) in model pathways with no or limited overshoot of 1.5°C, global net anthropogenic CO_2 emissions decline by about 45 percent from 2010 levels by 2030 (40–60 percent interquartile range), reaching net zero around 2050 (2045–5555 interquartile range). For limiting global warming to below 2°C, CO_2 emissions are projected to decline by about 25 percent by 2030 in most pathways (10–30 percent interquartile range) and reach net zero around 2070 (2065–8080 interquartile range). Non-CO_2 emissions in pathways that limit global warming to 1.5°C show deep reductions that are similar to those in pathways limiting warming to 2°C.

2 Black, Parry, and Zhunussova (2023). In these IMF estimates, unconditional and conditional NDCs are averaged.

3 The CAPMF provides information on climate action measured as a mix of the adoption and the stringency of a wide range of climate actions and policy instrument. Figure 1.1 shows the relative contribution of different instrument categories on countries' climate action.

4 Although climate action is not a measure of climate impact, there is a positive association between climate action and emission reductions (Nachtigall et al., 2024).

5 Relevant research by the World Bank Group is found in its CCDRs, which can be accessed at: https://www.worldbank.org/en/publication/country-climate-development-reports. Relevant global, regional, and national research by the IMF can be accessed at: https://www.imf.org/en/Topics/climate-change#indepth. Relevant research by the OECD on cross-country studies on climate change can be accessed at: https://www.oecd.org/en/topics/policy-areas/climate-change.html.

The menu of policy tools

The policy tools used to mitigate climate change must navigate market failures, fiscal implications, cross-border spillovers, distributional and political economy aspects, and other considerations such as implementation and enforcement costs. To this end, decarbonization requires a balanced and integrated policy mix with an important role for carbon pricing, national circumstances permitting. Achieving just transitions to a low carbon economy requires additional measures, such as social and redistribution policies.

2

2.1 The choice of mitigation instruments is ultimately guided by climate and non-climate goals, multiple market failures, fiscal implications, and other criteria

Carbon pricing addresses the primary market failure relating to the social cost of GHGs. Pollution is a byproduct of production processes and fuel consumption that causes real damages, which markets do not take into account on their own. Prices that do not reflect the social costs of emissions are a key impediment to mitigation (UNCTAD, 2022; Fouré et al., 2023). Carbon pricing is the only incentive-based policy that directly tackles this market failure and implements the polluter pays principle.[1] This policy promotes cost-effective abatement and levels the playing field for clean alternatives. Various other policy instruments, however, are necessary to address other market failures and barriers to mitigation.

Even with pricing policies creating incentives to invest in emission reducing technologies, other pervasive market failures can hinder innovation and diffusion of clean technologies. For instance, knowledge spillovers and adoption externalities can hinder optimal investment in new technologies (Jaffe, Newell, and Stavins, 2005). Innovating firms cannot fully capture the benefits of their new technologies due to the public-good nature of knowledge. Early adopters create positive externalities by generating information about the technology for others. And long-term investments in green technologies depend on expectations on long-term carbon prices: since governments cannot commit over the long term and because of the presence of perceived risks of policy reversal, additional incentives for projects with long-run returns are sometimes necessary. Imperfect information and the high initial costs of some new technologies can also slow their adoption, further exacerbating the underinvestment problem. Addressing these market failures can require technology-specific approaches and well-designed subsidies. However, governments are unlikely to conceive of all the technologies and opportunities to subsidize, and they may not be able to afford large enough subsidies for abatement. Carbon pricing has a role to play in overcoming these problems and facilitating the creation of markets for innovative clean technologies. This can magnify the impact of other specific policies in addressing market failures that hamper innovation.

Unaddressed market failures, infrastructure constraints, and other barriers can hinder the effectiveness of carbon pricing. For example, slow permitting processes for installing renewable energy infrastructure and other problems related to land use and zoning, compounded by lack of adequately trained labor can undermine mitigation efforts. Lack of affordable and long term financing complicate the financing of profitable investments in low-carbon technologies (Stiglitz, 2019). Demand-related market failures can also contribute to non-efficient market outcomes. Insufficient information about energy efficiency and product carbon footprints hinders the uptake of low-carbon goods. Behavioral biases can lead actors to favor status quo and traditional solutions and technologies, even in the presence of better alternatives. Finally, there are co-benefits of reducing emissions, such as improved health and biodiversity in addition to reduced congestion and road accidents, which are often also unpriced.

Non-carbon-pricing policies can usefully complement carbon pricing by dealing with other market failures, which can make carbon pricing more efficient and acceptable politically. These policies include coordinating network effects, building necessary infrastructure, managing noncompetitive markets, and supporting R&D and new technology adoption.[2] By providing alternatives and lowering abatement costs over time, technology-oriented policies can enhance the responsiveness of emissions to pricing, thus increasing carbon pricing effectiveness. As a result, the same level of reduction in emissions will require a lower carbon price than would have been needed otherwise[3] and non-price policies can be mobilized to start the transition and pave the way toward explicit carbon pricing (Rozenberg, Vogt-Schilb, and Hallegatte, 2020) A balanced policy mix can distribute the administrative burden among different levels of governments, thus improving overall feasibility (OECD, 2022a, 2022b). However, policy combinations can be complex to design and administer.

Standards and regulations are particularly useful when price signals alone are insufficient to drive the necessary changes. Potential users of a new technology need time to be convinced of its advantages, test it, and adapt it to their circumstances. This is the case, for instance, for energy efficiency in the residential sector for which support is needed to deploy new technologies (e.g., heat pumps) due to lack of information and capacity, lack of affordable and long-term financing, high risk aversion, and preference for the status quo. Innovators are making investments based on expectations of future market demand for clean products. Given uncertainties, carbon pricing alone may not generate sufficient confidence to accelerate this learning process enough to meet emission reduction goals. Standards and regulations can complement carbon pricing by mandating specific actions and helping overcome coordination failures.

Distributional effects across countries, regions, industries, communities, workers, and consumers are important in designing an effective mix of mitigation instruments. Also, the political economy context and public acceptability are critical elements of successful policy design. Policies that align with public values and priorities will be more durable.[4] Additional considerations include the instrument's ability to lower abatement costs in the short and medium-to-long term, the administrative costs involved in its implementation, its capacity to manage uncertainty affecting technological progress and other trends, as well as trade and environment agreements and other multilateral agreements.

The effectiveness of climate policies to reduce emissions also depends on non-climate policies and regulations. For instance, a lower interest rate makes renewable energy and high-efficiency technologies more competitive because those technologies are more capital intensive and have lower operational costs than fossil-fuel based technologies. The carbon price needed to make zero-carbon technology more competitive than fossil fuels is thus lower in low-interest rate environments. As a result, a capital market reform leading to a lower interest rate will increase the efficiency of carbon pricing, even if it is not motivated by a climate-related agenda.

A country's appropriate policy mix varies depending on the strength of market failures, industrial structures, social preferences, and administrative and political constraints. National circumstances significantly influence the effectiveness and acceptability of different policy instruments. In more advanced economies, explicit carbon pricing instruments might be more effective in sectors with high responsiveness to price signals. In sectors like agriculture, where emissions are harder to monitor and respond less to price signals and regulatory measures, changes to existing government policies might reduce emissions more. Furthermore, countries differ in administrative and institutional capacity, tolerance to taxation, and the degree of concerns regarding reallocation and distributional issues. Navigating political realities may require compromises and gradual implementation to build support and ensure successful policy adoption. A balanced climate policy mix will address the aforementioned challenges. Different policies play different roles in this mix and can be sequenced to build political support for an increasingly ambitious climate strategy (Meckling, Sterner, and Wagner, 2017; Pahle et al., 2018; Hallegatte et al., 2023).

2.2 Decarbonization calls for a package of coordinated and strategically sequenced climate change policies in which carbon pricing can play a central role

Carbon-pricing instruments are best suited for addressing the negative externality of GHG emissions because they can influence decisions of producers and consumers. This instrument creates an incentive to capture all opportunities to reduce emissions throughout an economy or a supply chain without requiring policymakers to foresee and target all those opportunities individually. These incentives encourage the uptake of low-carbon technologies and the utilization of clean infrastructure, increasing the return to public investments supporting them, but also affecting consumption baskets to reduce their carbon content.

Carbon pricing is the only abatement instrument that implements the Polluter Pays Principle. However, as the only abatement instrument that would ask polluters to pay for unabated emissions, carbon pricing can generate larger cost increases for polluters and, depending on the market structure and pass-through to consumer prices, lead to larger consumer and competitiveness concerns than alternative policies. This potential impact complicates its use, especially in trade-exposed sectors and for essential goods (e.g., fuel for residential heating). Different design options are available to address these challenges, such as targeted rebates or production subsidies, but some may reduce the effectiveness of carbon pricing. Compared to carbon pricing, targeted subsidies, standards, and regulations often enjoy a higher level of social acceptability, because their impacts on energy prices and household costs are less immediately apparent (Dechezleprêtre et al., 2022). However, such perceptions may result from information barriers about the actual cost these instruments impose on producers and consumers via different channels, such as higher public expenditure limiting choices (Blanchard, Gollier, and Tirole, 2023).

Carbon pricing can be explicit or implicit. Explicit carbon pricing aims directly at the unpriced carbon externality. Implicit carbon pricing instruments, such as fuel taxes, create similar price incentives for decarbonization but do so indirectly and often while pursuing other public policy objectives such as revenue mobilization or reducing local air pollution, congestion, and road accidents (Parry, Black, and Zhunussova, 2022; Stavins, 2022).

Explicit carbon pricing can be implemented as a carbon tax or an ETS. A carbon tax sets a price on CO_2 emissions, influencing producers and consumers to determine the quantity of emissions. The central authority imposes the price, but the market determines the emission levels, leading to uncertainty in environmental outcomes due to factors like asymmetric information or consumer preferences. In a cap-and-trade system, the central authority sets the emission levels, and the market determines the carbon price. Other ETSs may set intensity standards or add flexibility mechanisms to the cap, including to stabilize emissions prices. Trading systems entail price volatility, and uncertainty can influence firms' long-term investment decisions. Emissions trading requires specific regulations and a dedicated administrative structure to manage emissions allowances, monitor compliance, conduct auctions, and prevent fraud. In a trading system, complementary policies to support emission reductions may depress carbon pricing and therefore the emission reduction incentive, requiring coordination across instruments.

Implicit and explicit carbon pricing can serve as efficient tools to generate revenues. Revenues from implicit and explicit carbon pricing can support various policy objectives, enhance fiscal space, and improve debt sustainability. These revenues are raised in a relatively efficient way, by taxing something bad for society, compared with alternative highly distortionary taxes on productive inputs (Marten and Van Dender, 2019; World Bank, 2019). They can also help fund complementary policies for the transition, such as incentives for green R&D or social policies like transfers to households negatively affected by mitigation policies (D'Arcangelo, Levin, et al., 2022) and lessen or neutralize the impact of mitigation strategies on public budgets (D'Arcangelo, Pisu, et al., 2022).

For a variety of reasons, carbon prices may differ across sectors. Targeting emissions reduction in the sectors that are the least expensive to decarbonize is often seen as the best initial strategy because it requires lower carbon prices or minimizes budgetary expenditures on complementary investments. However, considering the time and investment required for reducing emissions in long-lived goods and assets, the best strategy may also call for immediate action in sectors with the highest abatement costs. This approach may involve investing in higher-cost options rather than opting only for the alternatives with the lowest abatement costs (Vogt-Schilb, Meunier, and Hallegatte, 2018). Also, differences in the strength of knowledge spillovers and the potential for learning-by-doing across sectors—when not addressed separately—can be a reason for differences in carbon prices.

2.3 Achieving just transitions to a low-carbon economy and maintaining political support requires additional policies

Policies to address the broader economic and social dimensions of decarbonization are needed. Such policies can be identified in the context of a just transition that aims to ensure that the advantages and costs of moving to a decarbonized and green economy are shared fairly nationally and internationally. This approach involves providing support to those who may face economic challenges during the transition, including countries, regions, industries, communities, workers, and consumers.[5] For example, carbon-pricing policies may affect relatively smaller firms more severely if they face financing constraints for investment in clean technologies and production processes.

Additional economic, social, and labor policies are also needed to manage adverse distributional and regional effects of mitigation policies. At a national level, policies such as cash transfers and progressive tax shifts can counteract distributional impacts of mitigation measures fostering social and political support for decarbonization efforts.[6] Labor market and reskilling policies are essential for assisting workers in transition. These policies can help mitigate the impact of decarbonization on jobs in emission-intensive industries and regions while facilitating hiring and expansion in low-carbon sectors.[7] Assessing and anticipating emerging skill needs is key to sustaining and accelerating the green transition, helping households and individuals to transition from highly polluting to less polluting jobs, and building public support for the green transition.[8] For developing countries with limited fiscal and institutional capacity, these options are limited and will require international cooperation and climate finance, to ensure ambition in the context of the CBDR-RC.

Supporting people and firms can also minimize the macroeconomic costs and maximize the benefits from the transition. Emission reductions will eliminate jobs in carbon-intensive sectors, such as coal mining, but also create new employment opportunities in other sectors, such as renewable energy or forestry. The ability of workers to shift from carbon-intensive sectors to the sectors that will benefit from the transition is one of the key drivers of the macroeconomic costs of the transition. Many developing countries dependent on fossil fuels will be disproportionally affected both in terms of exports and job losses. Investment in reskilling or labor market policies can enhance efficiency and generate large macroeconomic and fiscal gains, above and beyond the distributional or fairness objectives (Hallegatte et al., 2024). Similar benefits would be expected from policies that facilitate the reallocation of assets and productive capital across sectors to avoid stranding assets and ensure their productive use.

Socially responsive program design and effective communication campaigns are critical to increase public understanding and acceptance of incentive-based climate policies. Despite empirical evidence, many people are not convinced of the incentive mechanism of carbon pricing and its ability to reduce emissions on its own, rather than primarily through the use of its revenues.[9] Combining emission pricing with other policy interventions, such as strengthening public transport and public infrastructure, can bolster the public acceptability of emission pricing.[10] Making benefits visible—such as an identifiable “climate dividend” check or compensatory cash transfer—can also strengthen social support for carbon pricing and fuel subsidy reforms (Calvin et al., 2023). Evidence shows that support to policy reforms, including fossil fuel subsidy reform and carbon pricing, can increase over time as the benefits of the reform materialize, making it essential to design reforms such that they generate visible early benefits (World Bank, 2023b).

More generally, clear, transparent, and independent governance can help build trust, coordinate policy choices, monitor progress, and adjust strategies as needed. This type of governance includes conducting regulatory impact assessments, pilot projects, and consultations with experts and stakeholders. Phasing in carbon pricing coverage and levels can aid social learning (Carattini, Carvalho, and Fankhauser, 2018). Active engagement with stakeholders, including businesses, trade unions, civil society, and the public, ensures that policies are well-informed and broadly supported. Active engagement can help mitigate opposition and build trust in the policy process.

ENDNOTES

1 Principle 16 of the Rio Declaration on Environment and Development (1992).

2 This approach follows the Tinbergen (1952) rule, emphasizing the need to align the number of policy goals with the number of policy instruments. This ensures that each issue receives adequate attention, without relying on a single instrument to address multiple and possibly conflicting problems concurrently.

3 D'Arcangelo and others (2022) offer illustrative simulations on the effects of emission prices on emissions assuming different level of responsiveness to emission prices.

4 For a discussion of political acceptability of climate policy and approaches to align climate and other policy objectives, see Hallegatte et al.(2023) and Dechezleprêtre et al. (2022).

5 Katowice Committee on Impacts (KCI), 2022 offers a conceptual discussion and practical country experiences. See also OECD et al. (forthcoming).

6 Carattini et al. (2019) and Dechezleprêtre et al. (2022) use international surveys spanning several countries to show that emission charges could gain popularity if the revenues were returned to citizens.

7 ILO (2022) offers a detailed assessment of skills at risk and in demand. Causa and others (2024) use individual-level labor force data for a large sample of European countries to describe the distribution of green and high-polluting jobs across socioeconomic groups and rural/urban areas.

8 OECD (2023a) offers an in-depth review of practices in five countries (Australia, Austria, France, Norway, and Sweden) to identify best practices on how to feed information on changing skill needs into policies, notably in the areas of employment, career guidance, education, and adult learning.

9 Several studies (Ewald, Sterner, and Sterner, 2021; Douenne and Fabre, 2020) have shown that there was a lack of conviction about the Pigouvian mechanism of carbon taxes. This lack of conviction is an important motivation for protesters' opposition to the policy instrument.

10 Dechezleprêtre et al. (2022) offer empirical evidence based on surveys in several countries.

Carbon pricing metrics

Carbon pricing metrics inform on the extent and scale at which explicit and implicit carbon pricing shift incentives toward decarbonization and inform cross-country variation in average carbon price levels, which determines their competitiveness effects. They measure the price that people and firms who emit GHG have to pay for these emissions, either in the form of a tax or fee or by buying permits. They can measure average or marginal prices, and can consider only explicit carbon pricing or also implicit or indirect pricing. More granular data at the product level and embedded carbon pricing metrics are needed to determine competitiveness effects more accurately. Metrics measuring the impact of pricing policies and broader climate policies on emissions are helpful in scaling up climate action. These metrics consider the behavioral responses of pricing and non-pricing policies and thus require assumptions on these responses.

3

3.1 The task force builds on existing metrics introduced by its participating international organizations, leveraging commonalities across the metrics

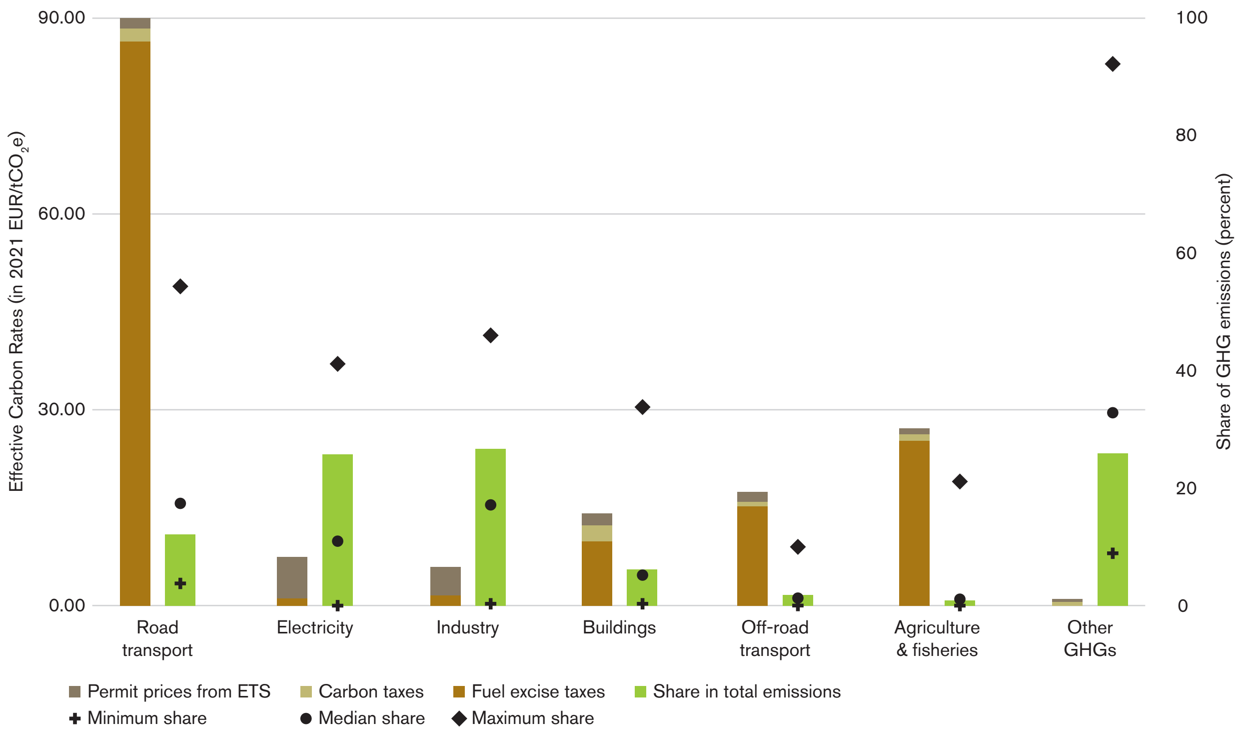
Carbon pricing metrics can focus on explicit carbon pricing instruments or incorporate implicit carbon pricing (such as fossil fuel taxes and subsidies). Explicit (or direct) carbon pricing measures include carbon taxes and permit prices in ETSs.[1] Explicit carbon prices are directly applied to (or to a unit proportional to) CO_2, and sometimes other GHGs, in terms of a monetary unit per ton of CO_2 (or CO_2-equivalent in the case of non-CO_2 GHGs). The carbon tax rate and the ETS permit price reflect the marginal carbon price of the instrument. Other policy design aspects, such as the extent of free permit allocation in ETSs or other rebates will effectively reduce the average carbon price of an instrument, creating a wedge between marginal and average prices (OECD, 2023b). Explicit carbon pricing metrics are particularly important in power and industrial sectors, as they are the dominant carbon pricing instruments in those sectors and sectors exposed to international spillovers (Section 4).

Incorporating implicit carbon pricing is relatively simple and provides a more comprehensive assessment of the carbon price incentive. Implicit (or indirect) carbon pricing measures, such as fuel excise taxes and fossil fuel consumption subsidies (which may include preferential value-added tax rates), also influence the carbon price signal in an economy. Positive implicit carbon prices via fuel excise taxes and negative implicit carbon prices via fossil fuel subsidies can be easily integrated into carbon pricing measures and can be converted in straightforward ways as they are often related to a fuel base that is directly proportional to GHG emissions. Even though implicit carbon pricing policies may be driven by other policy objectives (for example, revenue-raising or to address other externalities like air pollution or sector funding needs), they can help achieve climate (and fiscal, economic, and development) objectives. Several jurisdictions implement carbon taxes as part of their fuel excise tax systems, creating a strong link between the two instruments. Translating implicit carbon pricing measures, such as a fuel excise tax, into a carbon price is a straightforward unit conversion, using emission intensity factors based on the carbon content of various fuels. The translation of other implicit carbon pricing policies is also conceptually straightforward but requires more data. For instance, fossil fuel subsidies that lower pre-tax prices can require additional information on the budgetary transfers induced by such measures, which is not available in all countries.

Current data availability poses some challenges and trade-offs for calculating carbon pricing. Estimates of the components of carbon pricing may follow top-down or bottom-up approaches. The bottom-up approach uses official documents within a jurisdiction, including laws and policies, to determine and record the official carbon tax rates, fossil fuel tax rates, and tradable permit prices. A top-down approach infers carbon prices from differences between supply costs and retail prices (price-gap approach). While less accurate than a bottom-up approach, a top-down approach can help produce carbon pricing estimates for jurisdictions, fuels, and sectors for which resources are not available to collect data using a bottom-up approach. A top-down approach can also more easily provide estimates over a longer time frame, which can provide useful insights to policymakers and more easily allow time series analysis. Bottom-up and top-down approaches are complementary, with the appropriate approach dependent on data availability since observed or legislated taxes and prices in a jurisdiction are not always readily available, creating a trade-off between precision and resource requirements.

Explicit and implicit carbon pricing measures are not always uniform across fuels and sectors, but can be aggregated using emissions-based weighting to calculate an average carbon price. These metrics can be calculated within and across specific sectors or fuels. This calculation entails using data from the legal bases and quantifying the specific emission coverage of each carbon pricing instrument across sectors and fuels in each country. However, carbon pricing metrics aggregated to the national or global level should be treated with caution when making comparisons between countries, for two reasons. First, they mask the heterogeneity in effective (or total) carbon pricing across fuels, sectors, activities, and products (Figure 3.1). In particular, differences between countries' average effective carbon price could reflect differences in fuel shares as much as the differences in prices applying to each fuel.[2] Sector and fuel specific average effective carbon prices can reveal this heterogeneity across countries and thus may be preferred indicators of the economic incentives for decarbonization. Second, carbon pricing metrics aggregated to the national level cannot be employed as a measure for the emission reduction potential of carbon pricing policies of countries.

Figure 3.1: Carbon pricing instruments and share of greenhouse gas emission by sector



Source: OECD Effective Carbon Rates 2023.
Note: The left vertical axis shows Effective Carbon Rate (ECR) components by sector. Together, emissions from the road transport, electricity, industry, buildings, off-road transport, and agriculture and fisheries sectors make up CO_2 emissions from energy use. Other GHG emissions cover CH4, N2O, and F gas emissions and CO_2 emissions from industrial process. The right vertical axis presents shares of emissions from these sectors in total emissions, and their country-level variation. "Minimum share" (resp. "Maximum share") indicates the minimum share this sector may represent in a country's total GHG emissions. "Median share" is the median of such shares across countries. For instance, the median share in the road transport sector indicates that half of the countries in the sample have a road transport sector that accounts for more than 17.5 percent of national GHG emissions. Other GHG emissions data are from CAIT (Climate Watch, 2022) while the data on CO_2 emissions from energy use are based on the International Energy Agency (IEA) World Energy Balances (IEA, 2024).

The existing metrics have commonalities in scope and approaches. Several international organizations track carbon pricing initiatives across countries. Table 3.1 provides an overview of the different carbon pricing metrics, highlighting similarities and differences in scope and methodology. The World Bank's Carbon Pricing Dashboard covers only explicit carbon prices in the form of carbon taxes and ETS permit prices thus far implemented across 89 jurisdictions, of which 50 are at the national level. The OECD has calculated effective carbon rates (ECR), with bottom-up reviews of explicit carbon prices and fuel excise taxes, including reduced rates and exemptions. The OECD's net ECR adds fossil fuel subsidies that lower pre-tax fuel prices. Both OECD metrics are provided for 2012 2015, 2018 2021 and soon for 2023 at the sector and fuel level for almost 80 countries (OECD + G20 less Saudi Arabia and 35 developing economies), covering 82 percent of global GHG emissions.[3] The total carbon price (TCP) elaborated in Agnolucci et al. (2023) also accounts for value-added tax differentials, since different tax rate reductions on specific fuels amount to important price reductions in certain countries. Using alternative data sources to infer policy interventions (drawing on IMF work on fossil fuel pricing), over 140 countries can be covered for the 30-year period from 1991–2021. While each indicator covers a different set of instruments, areas of overlap highlight opportunities for greater convergence across the indicators and inter-operable data collection.[4]

The task force proposes unifying data collection focusing on the commonalities across existing metrics but recognizes the need for flexibility and pragmatism. The carbon pricing metrics discussed above include explicit and implicit pricing instruments that put a price directly on GHG emissions or indirectly via a base that is proportional to GHG emissions (for example, liters of diesel or tons of coal): carbon taxes, ETSs, fossil fuel taxes, and fossil fuel subsidies that lower pretax fuel prices. These metrics can either be calculated using a bottom-up methodology (which aligns with the OECD's ECR), a top-down methodology (similar to the World Bank's total carbon price using the IMF's price-gap approach), or a combination of the two (Figure 3.2). In this way, results can be comparable across methodologies, allowing for the use of more accurate observed data but adopting a pragmatic approach to infer or estimate the carbon pricing metric where observable data is not readily available or not feasible. Importantly, these carbon pricing metric approaches can provide country-sector or subsector (when feasible) level averages using information on emissions coverage of included instruments. However, while the resulting metrics are useful, further disaggregation would be needed for assessing the level and coverage of carbon prices applied to specific subsectors or products.

3.2 More granular data are needed to improve the accuracy and coverage of carbon pricing metrics and evaluate the international competitiveness impacts of carbon pricing

Carbon pricing metrics are needed at a granular level since competitiveness effects occur at the level of narrow sectors (such as steel, aluminum, cement) or even at product levels. Product-level carbon pricing metrics are especially useful when calculating the amount of payment required to comply with border adjustments, such as the European Union (EU) and United Kingdom (UK) Carbon Border Adjustment Mechanisms. Necessary information for such a calculation includes the following: quantity of imports, nomenclature code of the products, country of origin of the products, firms (or facilities) where the goods were produced, production methods, direct and indirect embedded emissions pertaining to the goods imported, and the carbon price due in the country of origin, including the quantity of emissions covered by any free allocations, rebates, or other forms of compensation.

Embodied carbon pricing measures consider the full extent of carbon prices paid at a product level, including on imported goods. They measure the extent to which the carbon costs of embodied emissions are imposed and passed through to product prices, giving an indicator of the degree of competitiveness and leakage pressure that the pricing policies create.

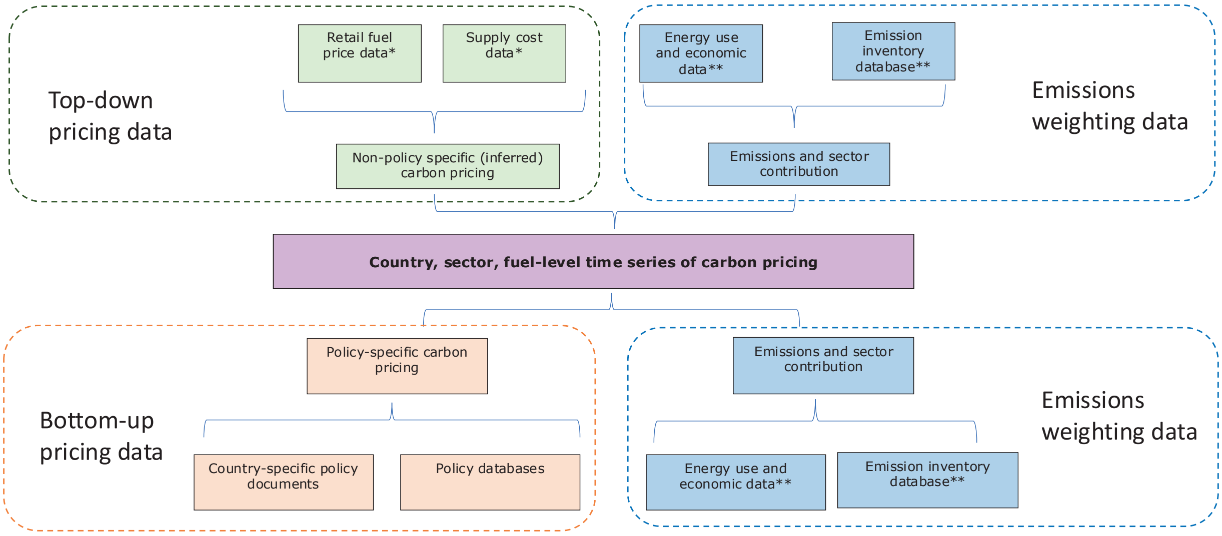
Calculating embodied carbon pricing requires a measure of embodied emissions at the product level and measuring the relevant carbon prices paid, net of free allocation. Specific BCAs will look for comparable carbon pricing policies and coverage. For instance, if the BCA includes indirect emissions, the measure of embodied carbon pricing should include carbon prices in the electricity sector that affect the costs of products produced using electricity. Unlike measures of marginal carbon prices, which measure the incentive to reduce emissions, embodied carbon pricing measurement also requires data on average free allocation, which reduces the net carbon payments to be passed along. For example, a cap-and-trade system with auctioned allowances requires producers to pay for all of their emissions; by contrast, a tradable performance standard can lead to a common marginal price for emissions across producers, but the benchmark allocations reduce the average carbon payments by producers, often to zero. The OECD ECR already collects information on free allowances to calculate an effective average carbon rate (EACR), which accounts for free allowances.

In some circumstances, a broader metric of embodied carbon and embodied carbon pricing can be useful, such as to understand and compare lifecycle carbon costs. In this case, carbon prices charged in the production of upstream intermediate inputs (for example, steel) used in downstream production (such as cars) should also be accounted for in the embodied carbon pricing of the downstream production. In some instances, the inputs and energy in the upstream sectors are provided across borders, which implies measuring carbon prices linked to consumption-based emissions to reflect emissions embodied in final demand as opposed to territorial emissions (using environmentally extended input-out tables). The OECD is developing relevant indicators of consumption-based embodied carbon prices to reflect the value chain effects of carbon prices (Smith, et al., forthcoming).

3.3 Other metrics measure the impact of carbon pricing and other policies on emissions

The impact of carbon pricing on emissions can be gauged ex post employing econometric approaches or ex ante based on modeling approaches that consider behavioral responses. The econometric approach shows varying estimates of the impact on emissions. One recent OECD study based on its effective carbon rate measure reports

Figure 3.2: Methodology for data collection of carbon pricing instruments and calculation and aggregation of carbon pricing metrics



Source: *own elaboration by* staff of the IMF, OECD, UNCTAD, WB, and WTO.
Note: *The top-down approach infers the tax rate based on the gap between supply costs and retail prices as a substitute for actual rates included in policy documents. The Total Carbon Price (TCP) largely uses a top-down approach, but incorporates bottom-up explicit carbon pricing data. The bottom-up approach uses official documents within a jurisdiction, including laws and policies, to determine and record the official carbon tax rates, fossil fuel tax rates, and tradable permit prices. This is the OECD's (net) Effective Carbon Rates approach. ** Energy, economic, and emissions data must include policy coverage information to allow pricing data to be appropriately allocated to sectors and fuels and aggregated to a country-level.

that a EUR 10 increase in carbon pricing decreases CO_2 emissions from fossil fuels by 3.7 percent on average in the long term. Carbon-related government revenues would triple on a global level, although over time they are expected to dwindle as additional increases in carbon pricing result in further reductions in emissions. Broadening carbon pricing to currently unpriced emissions contributes to two-thirds of the effects on emissions and revenues (D'Arcangelo, Pisu, et al., 2022).

Calculations based on estimated elasticities or economic models can be employed to assess the emissions impact of pricing policies ex ante. Calculations based on estimated elasticities can take into account explicit and implicit carbon prices and other climate policies that are usually considered "price-based policies," such as feed-in tariffs (FiTs) or tradable renewable portfolio standards. They calculate the emissions impact of pricing policies employing estimated elasticities derived from econometric analysis, which vary by country, sector, fuel, and time frames and depend on the nature and magnitude of the price change (for example, geopolitical shock versus policy-driven). A second approach is based on economic models, which simulate ex ante impacts of planned or proposed future climate policies (price and non-price policies) based on a consistent model considering changes in behaviors and technologies, and sometimes general equilibrium effects. Both approaches necessarily rely on assumptions, models, and unobservable responses to be able to project emission effects, implying that they are necessarily uncertain.

The projected emissions impact of climate policies can be expressed as emissions reduction or as a homogeneous carbon price generating the same emissions reduction. An example of an elasticities-based approach generating a homogenous economywide metric of the effects of price-based mechanisms is the IMF's Effective Carbon Price (ECP). The ECP calculates the explicit carbon pricing level required to generate the same degree of emissions reductions delivered by all pricing policies in place (for instance, including explicit and implicit, but also other price-based policies such as FiTs, tradable renewable portfolio standards, and low-carbon fuel standards). To facilitate such conversions, a range of additional data and assumptions are required. For example, to estimate the impact of subsidies to support decarbonization, such as FiTs and renewable energy certificates, and convert these policies into an equivalent carbon price requires information on the renewable energy certificates' prices and FiTs price premiums and the emission intensity of power generation at the country level. Furthermore, such estimates also require assumptions on the behavioral responses to measure the responsiveness of economic activity to pricing policies. For example, responses are assumed to be linear and elasticities constant.

Other metrics can be used to express the estimated impact on emissions of a combination of carbon pricing with other pricing and non-pricing policies and measures. Climate policies other than carbon pricing also reduce emissions, which is particularly relevant because in many countries, non-pricing policies are the dominant mitigation policy. To assess the total effect on consumers' and firms' choices and investments incentives that consumers and firms face to switch from GHG-emitting energy sources, these other policies need to be considered. They may not directly influence the net prices of fossil fuels but nonetheless increase the relative costs of carbon-intensive production and consumption through imposing compliance costs.

Metrics comparing the emission reduction potential of climate policies across countries offer valuable additional information over simple average carbon pricing metrics. However, they need to be treated with some caution. Their estimates of reduction (or carbon pricing equivalence) rely on the validity of the model underlying the metric and are less transparent than carbon pricing metrics based on observable data. Any model requires assumptions and calibration. The employed elasticities may be based on empirical estimates that are uncertain or unavailable for all countries, fuels, and sectors. The extent to which models capture secondary (general equilibrium, macroeconomic, or trade) effects of pricing policies on behavior can vary. It can be challenging for economic models to represent the details of non-pricing policies and the other market failures and barriers they may be designed to address. Sensitivity analysis can help users understand the robustness of the comparisons.

Multiple approaches exist to estimate the emissions impact of climate policies using empirical and modeling approaches, including:

- The OECD's IFCMA approach links bottom-up sectoral models with a computable general equilibrium model to estimate the net economy-wide effects of mitigation policy instruments or policy packages on emissions. In the IFCMA approach, sectoral models are used in an initial step that allows a detailed assessment of the direct impacts of various policy instruments. In a second and final step, the general equilibrium analysis allows one to pull together effects in various sectors and also consider indirect effects throughout the economy. Overall, the IFCMA approach allows one to calculate the effects of climate policy instruments and packages on emissions, net of indirect effects throughout the economy.
- To capture the nonmarginal nature of ambitious climate policies, the role of technologies, and the interaction across climate and non-climate policies, the World Bank Group's CCDRs have adopted a hybrid modeling approach explained in detail in Hallegatte et al. (2024). Specifically, sectoral techno-economic models are employed to construct (resilient and) low-emission development trajectories in key sectors. The macroeconomic and emissions implications of these sectoral transitions are then assessed with macroeconomic models. This approach allows one to consider multiple market failures, beyond the emissions externality; analyze price and nonprice policies and their interactions; represent explicitly the replacement of assets and infrastructure; and assess the macroeconomic feasibility of the transition. This approach is then used to simulate the impact of policy packages, including carbon pricing, on GHG emissions and on broader development goals. One of the key findings is the role of carbon pricing as an efficient tool for domestic resource mobilization, which helps fund the required investments and additional spending to facilitate the transition and protect the poor and vulnerable. Results are expressed as GHG emissions over time and also key macroeconomic and microeconomic variables (for example, GDP, consumption, distributional impacts, and public debt).
- The IMF's Carbon Price Equivalent (CPE) is aimed at estimating the equivalent explicit carbon pricing level required to generate the same amount of emissions reductions that is expected to be delivered by all climate mitigation policies (Black et al., 2022). The calculation relies on modeling and can accommodate projections of future policy commitments. Importantly, this metric does not measure "carbon pricing," but rather the broader set of climate policies (expressed in the form of an equivalent carbon price). The CPE differs from the ECP since it considers all climate policies and not only pricing policies.

Table 3.1: Overview of existing carbon pricing and climate policy impact metrics by international organization, scope, granularity, approach and methodology

		Scope									Methodology
		Explicit carbon pricing		Implicit carbon pricing			Other climate policies				
Indicator	Hosting institution/ initiative	Carbon tax	ETS permit price	Fuel excise taxes	Fossil fuel subsidies	Value-added tax differentials	Feed-in tariffs, and so on.	Regulations, investments, non-climate policies	Granularity (product, sector, aggregate)	Approach (observed, modelled)	
Explicit carbon price	IMF, World Bank	√	√						Aggregate	Observed	Collection of explicit carbon price as reflected in carbon tax or ETS permit prices
Effective carbon rates	OECD	√	√	√					Sector, subsector, fuel	Observed	Bottom-up approach based on legal and policy documents stipulating rates and base. Conversion based on emission intensity
Net effective carbon rates	OECD	√	√	√	√				Sector, subsector, fuel	Observed	Bottom-up approach based on legal and policy documents stipulating rates and base. Conversion based on emission intensity
Total carbon price	World Bank	√	√	√	√	√			Aggregate, sector, fuel	Observed	Top-down approach using differences between market and economic prices (price-gap approach). Top-down approach to increase coverage for low- and middle-income countries without bottom-up data Conversion based on emission intensity
Emission reductions	OECD/ IFCMA	√	√	√	√	√	√	√	Sector and aggregate	Modeled	Bottom-up approaches, done country per country. Hybrid modeling
Emission reductions	World Bank/ CCDR	√	√	√	√	√	√	√	Sector	Modeled	Bottom-up approaches, done country per country. Hybrid modeling
Emission reductions	IMF/Article IV reports	√	√	√	√	√	√	√	Aggregate	Modeled	Top-down approaches using CPAT and other models
Estimated effective carbon price	IMF	√	√	√	√	√	√		Aggregate	Modeled	Top-down approach using global databases and elasticities
Carbon price equivalent	IMF	√	√	√	√	√	√	√	Aggregate	Modeled	Top-down approach using global databases and elasticities

Source: Own elaboration by staff of the IMF, OECD, UNCTAD, WB, and WTO.
Note: This table provides an overview of metrics calculated by the international organizations part of the joint task force. Academic studies also discuss carbon pricing metrics based on econometric estimates of emission effect of carbon policies. IFCMA = Inclusive Forum on Carbon Mitigation Approaches; IMF = International Monetary Fund; OECD = Organisation for Economic Co-operation and Development; CCDR = Country Climate and Development Reports.

ENDNOTES

1 ETSs consist both of mass-based ETSs, including cap-and-trade systems with different allocation mechanisms, and rate-based ETSs, including tradable emission performance standards and output-based pricing systems.

2 For example, Country A and Country B may both tax road fuels relatively high and coal relatively light and thus have similar tax rates across fuels (for example, road fuel and coal). However, the average effective rate for Country A could be far higher than for Country B if road fuels (highly taxed in both) represent a relatively larger share of total emissions than coal (lightly taxed in both) given that Country A uses less coal than Country B.

3 The OECD Carbon Pricing and Energy Taxation database with 2023 net Effective Carbon Rates will be released in Q4 2024.

4 Other carbon pricing data repositories exist including International Carbon Action Partnership (ICAP), Carbon Barometer, and the World Carbon Pricing Database.

Spillover effects of climate policies

Climate policies generate a number of cross-border spillover effects on the climate and economic outcomes beyond the jurisdiction where they are implemented. A distinction can be made between generic cross-border spillover effects of all types of climate change policies—such as the development and dissemination of green technologies to other countries—and the spillover effects of cost-increasing carbon policies (for example, carbon pricing) and cost-reducing policies (for example, subsidies to foster decarbonization). Cost-increasing carbon policies can lead to carbon leakage, which countries are increasingly looking to address with policies like BCAs.

4

4.1 A country's climate change policies generate five generic types of cross-border spillovers on other countries with mixed effects on their economic and climate outcomes

The first positive cross-border spillover of climate policies is the primary objective of such policies, that is, reduced GHG emissions and less global warming. This positive spillover occurs for all climate actions and its size depends on the effectiveness of policies in reducing emissions. The positive spillover will be most pronounced in countries facing the largest projected losses from climate change, including many middle- and low-income countries.

A second positive spillover is that climate policies promote the development and dissemination of green technologies, reducing climate transition costs in other countries. Climate change policies ranging from carbon pricing to green research and development (R&D) can foster the development of green technologies in the economy implementing these policies. Other countries can benefit from these efforts by reducing the costs of their climate transition, either through the direct transfer of technologies or through the imports of technology embodied in intermediates and capital goods. As an example, recent evidence shows that trade in wind turbines provides access to technologies with a level of efficiency that cannot be replicated domestically in importing countries (Garsous and Worack, 2021). Furthermore, a simulation study indicates that cutting trade barriers on solar cells and modules by half could reduce global emissions by 4–12 gigatons between 2017 and 2060, a cumulative reduction of global emissions of 0.3–0.9 percent (Wang et al., 2021). This spillover is particularly important for low-income countries not at the technology frontier and thus importing most of the new green technologies.

A third positive spillover is that climate policies in one country can make the introduction of climate policies in other countries more likely. For example, countries building experience with climate policy approaches can inspire other countries to follow the example and implement their own policies. Empirical research shows that the likelihood of increasing carbon pricing in trade-exposed sectors in a country rises if trading partners and countries close to them raise their carbon prices (Linsenmeier, Mohommad, and Schwerhoff, 2023).

A fourth spillover is that climate policies shift demand from fossil fuels and emission-intensive goods to low-emission goods and energy-related environmental goods. Climate change policies of all types will reduce the demand for fossil fuels and raise the demand for raw materials and intermediates employed in the production of renewable energy (energy-related environmental goods). Furthermore, these policies will lead to a demand shift from emissions intensive goods to low-emission goods that will affect economic, climate, and environmental outcomes in other countries. The shift will have mixed environmental effects—reducing local pollution from the extraction of fossil fuels, but raising environmental pressures because of the mining of critical raw materials needed to produce equipment employed to generate renewable energy. While mining for critical raw materials will remain much smaller in aggregate than mining for fossil fuels, it can nevertheless cause large local damage.[1] However, the economic effects will also be mixed between and within economies and time horizons.

The shift in demand away from fossil fuels will also alter trade patterns and reduce the amount of energy traded, with the extent depending on decarbonization scenarios. Trade in raw materials will shift from fossil fuels to critical raw minerals needed for clean technologies (and digital transitions). As energy reliance shifts toward increased electrification, produced with renewable sources of energy, aggregate trade in energy goods (fossil fuels and electricity) will also decline because electricity is less traded. Meanwhile, trade in renewable energy technologies and certain low-carbon fuels, such as green hydrogen, could take a more prominent place in the future (Yilmaz et al., forthcoming). However, this trade is difficult to predict due to the uncertain outlook for future demand and cost declines. The extent of the shift in trade away from fossil fuels depends upon decarbonization pathways. For instance, Yilmaz et al. (forthcoming) project that trade in fossil fuels declines from 11 percent of global trade in 2022 to 3 percent in 2050 under ambitious climate scenarios and, even with limited additional climate policies, falls by about one-third.

The shifts in demand are projected to reduce the trade to GDP ratio with variation across countries reflecting initial specialization patterns. Trade volumes are projected to contract more substantially than GDP because renewable sources of energy rely more on domestic energy sources (World Bank staff estimates). Exports are projected to fall less in high-income countries—in a range of 0.7-2.9 percent in 2050. This range can be compared to low- and middle-income countries—in a range of 1.6-5 percent—due to the current trade structure, with low- and middle-income countries being more reliant on exports of fossil fuels and energy intensive trade exposed (EITE) goods.[2]

Falling demand for fossil fuels because of global decarbonization will be a major negative economic shock but provides opportunities for diversification. Global decarbonization policies will reduce the demand for fossil fuels and can thus adversely affect fossil fuel producers, especially in the short run. However, it also provides opportunities to diversify the economic structure away from sectors with a high degree of price volatility toward more sophisticated sectors with more growth potential, which can help promote economic development (Yilmaz et al., forthcoming). Policy interventions to promote diversification can help to make it more likely that this shift is growth-promoting (Peszko et al., 2023). Economies producing critical raw materials employed in renewable energy equipment, such as batteries, solar panels, and wind turbines, can benefit from increased demand for their exports, which can be particularly beneficial if they manage to add domestic value added before exporting the raw materials.

Global climate policies provide opportunities for producers of low-emission goods. Regions with a natural comparative advantage in equipment for renewable energy and greener energy grids can benefit from the increased global demand for renewable energy. Further, producers able to comply with regulations to limit emissions can extend market shares. Empirical evidence shows that the stringency of environmental regulations positively affects countries' specialization in environmental goods and services meant for preventing and abating pollution (Sauvage, 2014).

Generally, the introduction of decarbonization policies creates opportunities to exploit the benefits from specialization according to green comparative advantage. Such specialization occurs when producers that are relatively better at producing with low emissions gain market share relative to more polluting producers (Rosenow and Mealy, 2024). Trade can deliver a sizeable contribution (up to one-third) to emissions reductions when carbon pricing is introduced through specialization according to green comparative advantage (Le Moigne et al., forthcoming). Examples of countries specializing according to green comparative advantage are those with low-cost availability of wind or solar energy gaining market share in energy and energy intensive products.

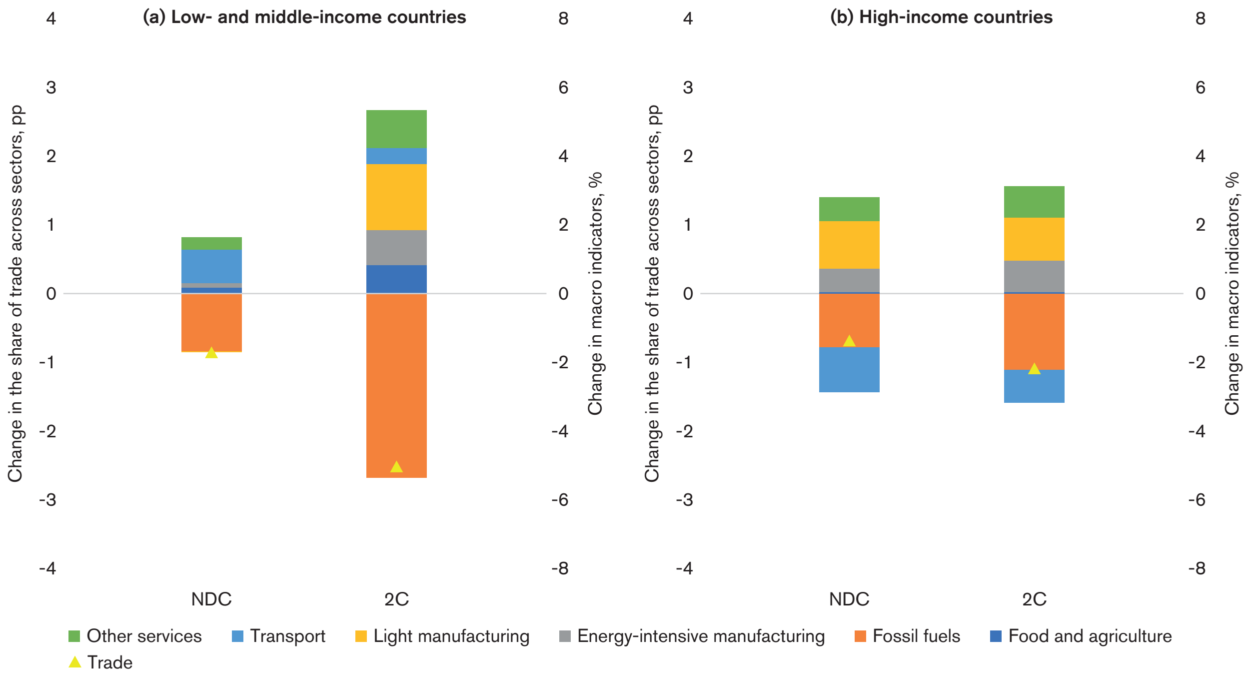
The biggest changes in specialization patterns are projected on average for low- and middle-income countries due to their higher average reliance on fossil fuel exports. In the most ambitious climate mitigation scenario in World Bank staff calculations, the shares of fossil fuels in total trade are projected to fall by 0.8-3.7 percentage points (Figure 4.1), while the shares of exports of transport, light manufacturing, and other services increase. In general, looking across countries and scenarios, impacts on trade are more substantial under higher mitigation ambition.

A fifth spillover of climate policies is related to the potential national security effects of climate policies. Climate change policies affect the way energy is produced. Since energy can be considered an essential good, many jurisdictions consider the repercussions for national security of climate policies. For example, multiple jurisdictions have introduced policies, such as local content requirements, to secure and diversify the production of inputs for renewable energy to limit dependency on one or a limited number of producers of such goods, increasing the resilience of supply to shocks. These policies can affect national security in other countries by limiting or creating dependencies. However, these policies are not further considered in this report.

4.2 Cost increasing climate policies, such as carbon pricing, generate both positive and negative cross-border spillover effects, depending on their design

The cross-border spillover effects outlined in this section can hold for all types of climate change policies. However, specific cross-border spillovers occur for cost-increasing climate change policies. A distinction can be made between production-related policies, which increase the costs only for domestic polluters, such as carbon pricing and producer-related regulations, and consumption-oriented policies, which drive up costs for domestic and foreign polluters—for example, global supply-chain standards. Carbon pricing accompanied by BCAs is another example. Import-based BCAs seek to impose the same carbon price per ton of CO_2 on imported goods as domestic goods. As such, the introduction of BCAs leads to a shift from production-based carbon pricing towards consumption-based carbon pricing (Kortum and Weisbach, 2017). This shift is only partial though, as BCAs generally do not provide rebates for

Figure 4.1: Changes in total trade for various mitigation scenarios and country groups and the reallocation of export shares across sectors in 2050 (deviations from baseline)



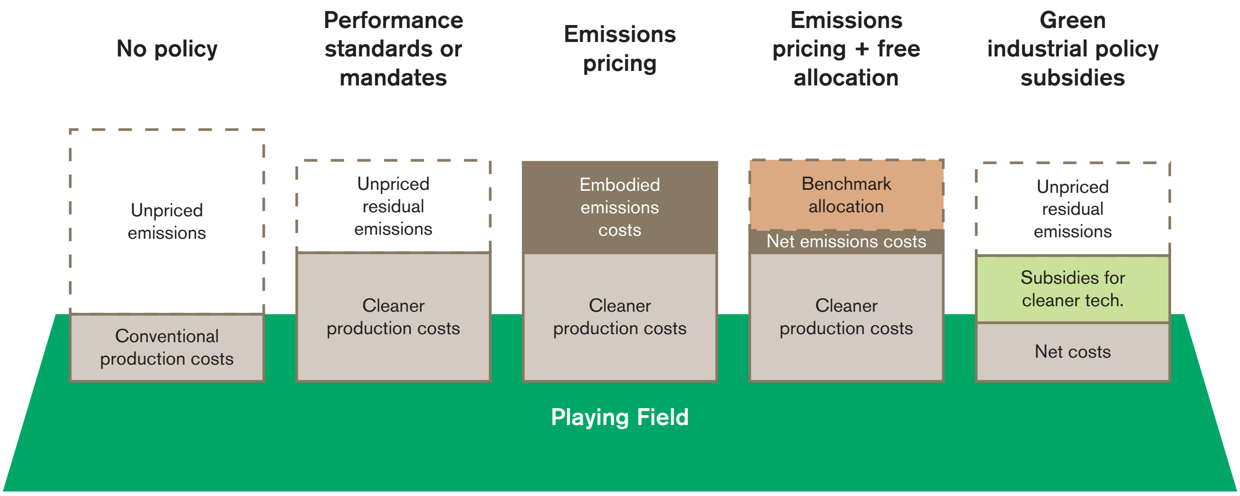
Sources: World Bank staff calculations.
Note: The nationally determined contribution (NDC) scenario includes a translation of unconditional NDCs into regional emission reduction requirements for 2030 relative to the baseline in 2030. Carbon pricing assumptions are applied post-2030.
Scenario 2C—Regional-specific emission reduction targets for 2030 based on NDCs and a ramping up of mitigation ambitions post-2030 with a harmonization of global carbon prices consistent with limiting global warming at 2oC by 2050.
pp – percentage points.
Changes in the share of sectoral exports in total exports are measured relative to the baseline (no action) scenario and reported in percentage points using stacked bars on the left vertical axis. Changes in total trade are reported on the right vertical axis. Analysis relies on version 10 of GTAP database and do not explicitly include critical minerals.

carbon pricing paid on exports, do not cover indirect ("scope 2") emissions on imports in all sectors, and only cover selected industries.

Cost increasing production- and consumption-oriented climate policies generate different spillover effects on foreign producers through changes in relative competitiveness. Foreign competitors producing a good subject to a domestic cost-increasing policy, such as carbon pricing, can benefit from this policy since they do not have to pay the carbon price and thus gain a competitive advantage. This cross-border spillover effect changes for consumption-based policies that drive up the costs for both domestic and foreign producers. In such cases, foreign producers also face the cost-increasing effect and thus could gain or lose competitiveness, depending on the relative emission intensity of their production process (if the policy differentiates accordingly) or their ability to cope with regulations that the domestic country imposes. The same holds for regulations imposed on both domestic and foreign producers.

Different production-based policies lead to different cost increases and competitiveness pressures. Figure 4.2 offers a stylized comparison of common policies for direct emissions in EITE sectors. Unregulated producers continue producing with conventional, low-cost technologies; they have a significant degree of emissions that remain unpriced. Producers regulated with policies like performance standards may be required to adopt cleaner technologies and production processes that increase their production costs. However, while emissions are reduced, they remain unpriced. Under full emissions pricing, producers not only adopt the higher-cost clean approaches, they also must pay for their embodied emissions, yielding the strongest signals to consumers but also the largest cost pressures (and possibly a drop in demand). Free allocation or benchmarking effectively reduces this embodied emissions pricing. Finally, producers incentivized to adopt the cleaner technology with subsidies do so if it lowers their costs; their residual emissions are also reduced but unpriced, leaving them with a net competitive advantage, even

Figure 4.2: Cost increases and competitiveness effects of different climate policies



Source: Fischer (2024).
Note: The figure illustrates the different components of costs per unit of product for an emissions-intensive firm, depending on the climate policy approach. Total private costs for the firm include production costs and embodied emissions payments net of free allocation or subsidies. Production costs with cleaner processes or technologies are assumed to be higher than those with conventional methods. Total social costs include the unpriced value of residual embodied emissions, here depicted at the illustrative carbon price. Higher competitiveness is associated with lower private costs.

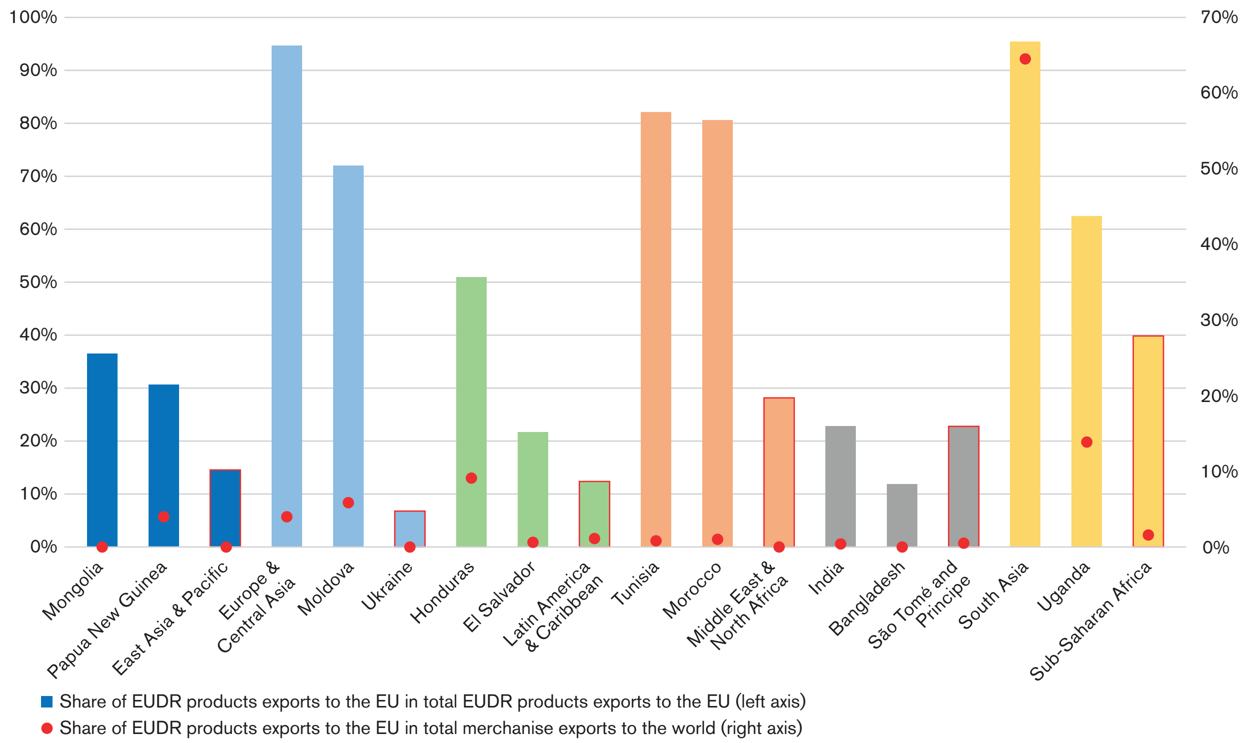
when compared to unregulated producers. Note that production cost differences are difficult to document and measure transparently; clean production may also require fixed investment costs but may raise or lower operating costs. BCAs are focused on adjusting for differences in embodied emissions costs.

Consumption-oriented policies can help limit emissions and reward more ambitious firms and countries, but pose compliance costs especially for developing countries' exporters. Several public and private deforestation-free measures and policies require importers of listed commodities to undertake due diligence processes (that is, conducting risk assessments) to ensure their products are not contributing to deforestation and thus to increased emissions. These policies can help to address some of the emissions linked to consumption choices and improve transparency and traceability on environmental and climate impacts of consumed products. Importers must often provide evidence that shipments comply not only with national laws of the country of production, including land use rights, environmental protection, forest use, third parties' rights, labor protections, international human rights protection, tax rules and laws, but also that no direct (and sometimes indirect) land-use change occurs to produce crops. These additional compliance and monitoring and reporting costs are especially burdensome for small producers, in particular in developing countries.

An example of a consumption-oriented policy is the European Union's Deforestation Regulation (EUDR). This policy will impose increased compliance costs related to due diligence requirements on many exporters, with impacts more pronounced in Latin America and the Caribbean, sub-Saharan Africa, and East Asia and the Pacific (World Bank, 2024).[3] In these respective regions, the commodities targeted by the EUDR (for example, cocoa and coffee) represent a significant share of the countries' exports of these products to the world—and in the case of economies such as São Tomé and Príncipe, Uganda, Cameroon, Burundi, and Honduras—of countries' overall exports (Figure 4.3). At the same time, such regulations can create opportunities for improved market access for exporters that can demonstrate compliance and an added incentive to reduce deforestation by giving an advantage to firms and countries that invest in limiting deforestation.

Product-based regulations create challenges when firms (especially SMEs), farmers, or their governments, do not have the resources to invest in deforestation prevention. Furthermore, there is a risk that these regulations could also lead to a consolidation of exporters in a market, creating more monopsony power vis-à-vis farmers. Managing these challenges in the context of a just transition requires specific design and complementary measures to support the transition, especially for the poorest countries (see Section 6). On top of these challenges,

Figure 4.3: Top low and lower-medium income countries with the highest share of the EUDR products in total merchandise exports to the eu, by region



Source: World Bank staff calculations based on 2022 data from the World Bank's WITS.
Note: The figure shows the exposure to the European Union's Deforestation Regulation (EUDR) and does not provide information on what share of the exporters are or will be compliant with the requirements of the new regulation. EU = European Union. The figure displays total EUDR exports to the EU exceeding $1 million.

the complexity of these policies and their reporting requirements may generate transaction costs that could lead to increased trade costs, especially for SMEs or firms in countries with limited data and institutional capacity potentially leading to the emergence of two-tier markets in some goods, with green markets driven by leading countries and brown markets for other countries.

4.3 Climate policies such as carbon pricing can lead to carbon leakage, which some jurisdictions are looking to limit through the introduction of BCAs

Climate policies, like carbon pricing, which raise costs for domestic producers can shift industrial activity to economies with less costly policies, thus generating carbon leakage. This shift can reduce the positive climate change spillover of these climate policies and can thus be seen as a negative cross-border spillover.[4] A second channel for carbon leakage is through the reduction of global demand for fossil fuels because of the introduction of carbon pricing in a region, driving down the global price of fossil fuels thus raising demand for fossil fuels in other regions.[5]

Ex ante modeling studies project carbon leakage rates of 5-60 percent from economy-wide carbon pricing policies. Böhringer et al. (2012) provide an overview of ex ante studies on carbon leakage. The carbon leakage rate is defined as the ratio of the increase in emissions in other regions relative to the decrease in emissions in regions introducing or raising carbon prices. Estimated leakage rates are highly sensitive to energy elasticity assumptions. They are higher for smaller, cleaner, and more ambitious coalitions of implementing countries (Böhringer, Fischer, and Rosendahl, 2014), higher for the EITE sectors (see Monjon and Quirion (2011) for steel and cement) and in an environment of monopolistic competition with firm entry and exit (Balistreri, Böhringer, and Rutherford, 2018).

Ex post empirical evidence for carbon leakage has been limited and mixed. A range of empirical studies have found mostly small (and both positive and negative) impacts of carbon pricing on different indicators of competitiveness (Ellis, Nachtigall, and Venmans, 2019; Dechezleprêtre and Sato, 2017), and few have been able to study leakage directly (Naegele and Zaklan, 2019). Many were focused on the years of the EU ETS when prices were relatively low and policies for compensating industries were present, meaning cost pressures were limited. Some recent studies (Misch and Wingender, 2021; Teusch et al., 2024) found average leakage rates of 25 percent for policy-related energy cost changes in the EU and 13 percent for steel and cement from the EU ETS over 2005-20, respectively. As the differences in climate ambition across countries increase and carbon leakage safeguards, such as free allowance allocation to EITE producers, disappear, carbon leakage rates could increase.

Governments are increasingly considering BCAs to address carbon leakage turning carbon pricing into a demand-side policy affecting domestic and foreign producers. To confront the risk of carbon leakage, some economies have historically provided special treatment to EITE sectors (for example, free allowances and carbon tax exemptions). However, as differences in the ambition of climate policies grow and some economies attempt to achieve deep emissions cuts in EITE sectors, governments increasingly are relying on or plan to rely on alternative measures, such as BCAs or subsidies, to support decarbonization (sometimes including local content requirements) and reduce the risk of carbon leakage. A meta-analysis of simulation work indicates that BCAs reduce the carbon leakage rate from an average of 14 percent to 6 percent (Branger and Quirion, 2014).

BCAs can be understood in light of the fact that carbon pricing could shift economic activity to jurisdictions with less costly climate policies. While climate policies aim to achieve lower global GHG emissions and encourage innovation in green technology, they may be difficult to implement if domestic impacted industries deem them to be too costly (OECD, 2020). One way to interpret the introduction of BCAs is that they play a role in making ambitious climate action in politically sensitive and highly visible sectors (such as steel) politically more feasible.

Economic analysis finds that BCAs can shift some of the incidence of carbon pricing to economies facing BCAs. While countries with low-emission intensive production could benefit by gaining market shares, emission intensive exporters stand to lose. Like conventional tariffs BCAs on imports of emission-intensive goods drives down their prices globally, reducing export revenues for exporters to BCA regions and raising terms of trade for the BCA region, which will be able to purchase imported goods at a lower price. Hence, to the extent that BCAs are imposed by rich industrialized countries, they can affect lower income countries with emission-intensive exports (although lower income countries importing these goods may stand to gain). Some scholars observe that this burden shifting may be at odds with the principle of CBDR-RC if BCA revenues are not used to benefit developing countries (Böhringer et al., 2022).

BCAs can disproportionately affect lower income countries due to the presence of transaction costs and the relative emission intensiveness of low-income economies. BCAs raise transaction costs for exporting firms that have to report and verify their emission intensities. They generate additional transaction costs that are particularly costly for smaller firms exporting from countries with less administrative and monitoring capacity. These transaction costs could decrease over time as efficient monitoring, verification and reporting infrastructures are developed. However, some countries—especially those with lower incomes—face specific barriers to decarbonize their production processes, finance the needed investment, acquire knowhow, or manage certain costs and thus lack resources to decarbonize swiftly. Furthermore, since production is on average more emissions intensive in lower income countries, the costs are expected to be higher in these countries.

BCAs could create improved opportunities for exporters with cleaner production technologies and access to clean energy. However, this is predicated on firms or governments having the resources or capacity to invest and act on emissions or to measure, report and verify the carbon content of production. This underscores the need for international cooperation to accelerate decarbonization efforts and increase the deployment of sources of renewable energy and clean technologies in developing countries. Capacity building, technical and financial assistance to lower the cost of compliance with BCAs could help limit their adverse impact (See Section 5).

Depending on their design, BCAs could provide incentives for third parties to introduce carbon pricing to capture carbon tax revenues. By introducing a carbon price, tax revenues can be raised that would otherwise go to the country introducing a BCA on its imports. This effect only holds under a design with the revenues of BCAs going to the importing country. If revenues from BCAs were to be allocated to decarbonization and mitigating the adverse side effects of BCA, as proposed by Baršauskaitė and Tipping, 2023, the incentive to introduce a carbon measure would be reduced. Simulation work indicates that for some exporters it would be optimal to introduce carbon pricing in response to BCAs, whereas others would be better off paying the BCA charges (Böhringer, Carbone, and Rutherford, 2016). The World Bank observes that in response to CBAM various countries such as India, Indonesia, Morocco, Türkiye, Ukraine, Uruguay, and countries in the Western Balkan, have implemented, adjusted, or are considering implementing direct carbon pricing to reduce CBAM compliance costs and capture revenue that would otherwise be paid to the EU (World Bank, 2024).

The size of BCAs' effects depends on product coverage, the product's nature, existing trade patterns, the carbon intensity of production, and domestic carbon pricing policies. A host of studies analyze the effects of BCAs on international trade, competitiveness, and income. Some of the studies zoom in at the sector level. Box 4.1 describes some of the opportunities and challenges that BCAs are creating for the steel and fertilizer industries and the potential of standards in measuring GHG emissions to reduce trade costs, increase interoperability, and contribute to the sector's decarbonization. These analyses also depend strongly on the counterfactuals and contexts chosen, including on assumptions about increases in carbon prices accompanying the BCA and whether phasing out free allowances is taken into account.

Summarizing, BCAs come with advantages and disadvantages. On the upside, such policies can help manage carbon leakage risks and buttress domestic support for climate action, contribute to positive international innovation spillovers, and stimulate domestic greener industries. They also create incentives for emission reductions in other countries exporting to countries introducing a BCA and could provide incentives to introduce carbon pricing depending on the allocation of the revenues of BCAs. On the downside, BCAs shift the incidence of carbon pricing from industrialized countries to lower income countries through changes in the terms of trade, to the extent that they are introduced by the former. The higher carbon intensity of developing countries' production of BCA covered goods and their lower financial and institutional capacity could make them more affected, with the risk of adversely affecting their position in global trade, thus potentially hampering efforts to come to a just transition. Some of these policies might be seen as unduly trade restrictive, especially in short and medium term. As a result, they risk inciting tit-for-tat trade actions, with negative global repercussions.

Carbon pricing is part of the mix to increase climate ambition, and BCAs are increasingly joining that mix. Each country must assess the optimal policy mix to its own situation to advance mitigation. The design of BCAs should seek to maximize mitigation and adaptation impacts and minimize negative spillovers on sustainable development. This is especially so for less advanced economies with less productive capacity, infrastructure to monitor, verify and report, and fiscal space. International cooperation is needed to support the decarbonization efforts in developing countries trade partners and reduce compliance costs of BCAs.

The European Union's Carbon Border Adjustment Mechanisms (CBAM) is a prominent example of a BCA policy. The EU CBAM is being progressively introduced—commencing with a transitional phase from 2023 that only requires reporting of emissions. Financial obligations begin to be phased in from 2026. This gradual phase-in of CBAM financial obligation aligns with the gradual reduction of freely allocated allowances under the EU ETS. With its implementation, importers of a select set of carbon-intensive goods are required to report the emissions associated with the production of these goods and purchase CBAM certificates that correspond to those emissions. The CBAM will initially apply to a selected group of industrial products with high carbon intensity, such as cement, electricity, fertilizers, aluminum, iron, steel, and also hydrogen. The EU will assess whether more goods are added in 2027. The introduction of CBAM along with the phaseout of free allocation of allowances will allow a fuller pass-through of carbon costs to consumer prices, meaning relatively clean competitors can benefit from the shift to CBAM, while relatively dirty ones lose competitiveness.

Other countries are exploring the introduction of BCAs. In late 2023, the United Kingdom announced that it would introduce a CBAM in 2027 (GOV.UK, 2023). Australia and Canada have also been exploring similar BCA measures, among other countries (WEF, 2022; Canada Department of Finance, 2023; DCCEEW, 2024). Even some countries without explicit carbon pricing are considering border measures, such as proposed legislation in the U.S. Congress calling for a carbon intensity fee on certain traded goods.

The exposure of third countries to CBAM can be estimated by the Relative CBAM exposure index developed by the World Bank.[6] This index measures the potential cost burden of CBAM allowance purchases for exporters compared with the average EU producer, adjusted by the proportion of exports to the EU market (figure 4.4). This index highlights the countries most affected by the CBAM and those that could benefit from domestic and international support to reduce their carbon footprint and maintain competitiveness in the EU market. Consider Zimbabwe, which is the most highly exposed exporter of iron and steel to CBAM, because it sends 92 percent of its ferroalloys exports to the EU in 2019, produced with an emission intensity of around 7 times higher than the average EU producer. Kazakhstan, Ukraine, and Belarus are the most exposed exporters of aluminum, fertilizer, and cement, respectively. The CBAM is expected to have limited macroeconomic impacts in most economies. Nevertheless the impact on producers of specific products can be large, as in Zimbabwe's example. Furthermore, there is uncertainty about the products covered which can be extended in the future.

Simulation studies project that CBAM would substantially reduce carbon leakage. Various ex-ante modelling studies assess the potential effects of CBAM on international trade, CO_2 emissions, and income. UNCTAD (2021) focuses on developing and vulnerable countries, showing that introducing CBAM along with a domestic carbon price of $88 per tonne of CO_2 in the EU, compared to introducing only carbon pricing would reduce carbon leakage by about two-thirds—from 15.1 percent to 6.9 percent—by returning some production to the EU. Bellora and Fontagné (2023) project a reduction in leakage by more than one third. Analyzing policies announced by the EU (including existing free allowances) and other countries, they project that carbon leakage would fall from 54 percent to 32 percent.[7]

CBAM is projected to reduce global emissions modestly, although such projections do not consider the potential impact on political support for more ambitious policies. While CBAM could help enable the continued increase in EU ETS price, it is estimated that alone it would deliver only a modest (less than 0.3 percent) contribution to reducing global emissions, relative to a benchmark with the same carbon price, according to several studies (UNCTAD, 2021). This projection does however not account for how BCA affects the political economy considerations and influences the feasibility of and support for more ambitious domestic action, or the incentive created for exporters with the capacity to reduce their own emissions.

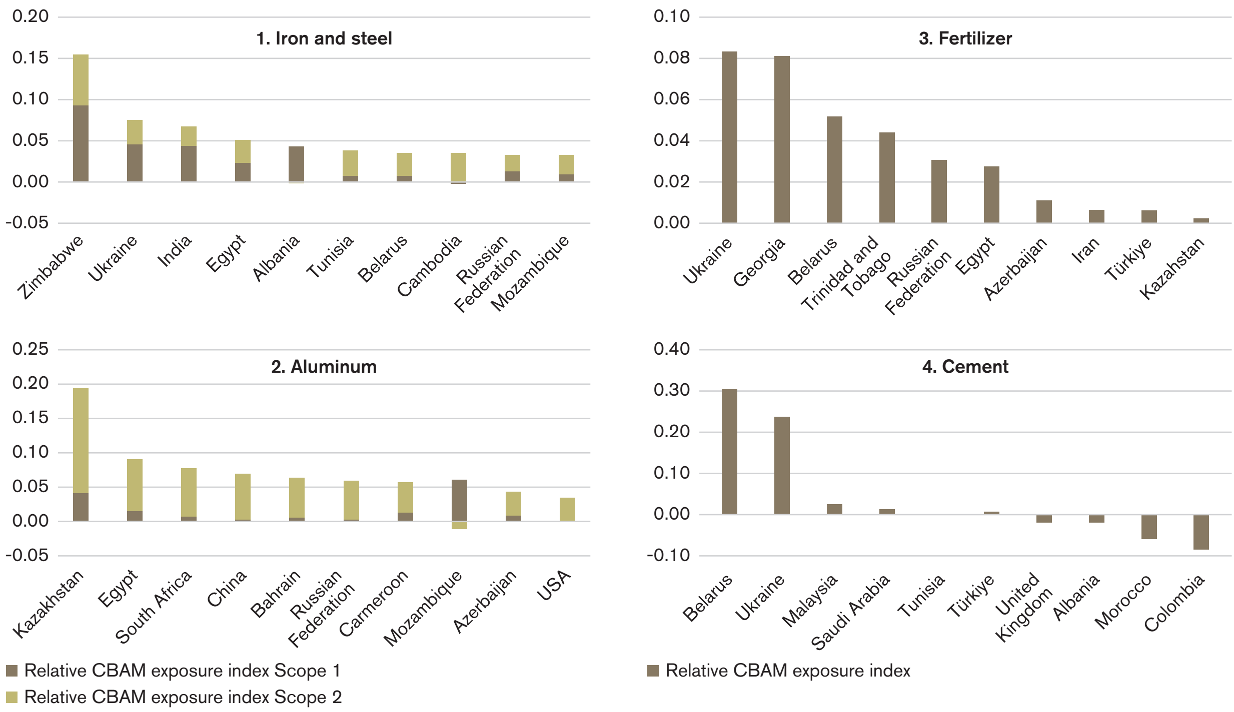
Simulation studies project that CBAM would reduce exports of carbon intensive producers and those unable to report on emissions in specific emission intensive sectors. UNCTAD (2021) finds that introducing CBAM compared to introducing carbon pricing only would result in changes in international trade patterns. More specifically, the study projects that in emission intensive trade exposed sectors (EITEs) exports from developing countries would fall in favour of developed countries, which tend to have less carbon-intensive production processes.

4.4 Cost-decreasing climate change policies, such as subsidies to foster decarbonization, generate a mix of positive and negative cross-border spillover effects.

Countries may introduce cost-decreasing climate change policies to stimulate the development of renewable energy and foster energy efficiency. As with cost-increasing policies, a distinction can be made between production-related subsidies benefiting only domestic producers and consumption-related subsidies potentially benefiting both domestic and foreign producers. Consumption-related subsidies accompanied by local content requirements tend to limit access of foreign producers to subsidies, depending on their design.

Policies reducing the costs for domestic and/or foreign producers generate positive and negative cross-border spillovers. Climate policies reducing costs for domestic and/or foreign producers can generate positive spillovers by reducing prices of low carbon goods globally due to learning by doing and innovation. This reduction can lower the price of low-carbon technologies in other economies, thus helping to reduce emissions. However, they can also generate positive and negative economic cross-border spillover effects. Downstream foreign consumers of subsidized goods and upstream foreign sellers of intermediates to a subsidized sector benefit from domestic subsidies, whereas (non-subsidized) foreign competitors producing the same good tend to suffer from production subsidies or demand subsidies accompanied by local content requirements. The opportunity costs of subsidies in terms of domestic

Figure 4.4: Relative carbon border adjustment mechanism exposure index



Source: Maliszewska et al., (2023).
Note: Underlying data for relative Carbon Border Adjustment Mechanism (CBAM) exposure index includes carbon emissions intensity data in 2014 and trade data in 2019 (WITS mirror statistics). The formula of the Aggregate Relative CBAM Exposure index can be found at https://www.worldbank.org/en/topic/trade/brief/technical-note-for-the-cbam-exposure-index.

spending are also important—especially if subsidies do not help create competitive markets but serve to limit new entrants, raising costs for consumers and limiting innovation over time.

Many economies turn to subsidies to foster decarbonization in light of the acceptability challenge of climate change policies. The number of government subsidies aimed at spurring green technologies and the green transition—from solar panels to electric vehicles—is increasing, according to the World Bank's new Green Subsidies Database (Signoret, 2023). An example is solar panels, whose production has been the most subsidized industrial sector relative to its size over 2005-2022 according to the OECD's firm-Level MAGIC database, with covered firms benefitting significantly from grants, tax concessions and below-market borrowings. A prominent example is the United States (US) Inflation Reduction Act (IRA). The IRA provides a suite of tax credits and grants designed to promote clean energy production and consumption, and also aims to promote the use of electric vehicles through rebates and tax credits. The legislation has raised concerns in other economies related to potentially trade restrictive components, for example, related to the implementation of local content requirements in subsidies for electric vehicles and the fact that scarce climate change investment funds might be diverted from other regions.

The incentives provided under the IRA are expected to have a significant global impact. The IRA is expected to reduce prices for low carbon goods, by learning by doing and innovation, and reduce CO_2 emissions (Bistline et al., 2023; Fournier et al., 2024). This innovation is expected to benefit the rest of the world if new technologies are made available. It is also likely to reduce international oil prices by shifting demand from oil to renewable energy sources while simultaneously driving up prices of critical minerals for the transition as demand surges for essential components in green technologies, such as solar panels, wind turbines, batteries, and high-efficiency appliances. These dynamics could intensify challenges for fossil fuel exporters.

Subsidies to promote decarbonization can have substantial spillover effects. Some of their positive spillover effects are undermined by policies such as local content requirements The same holds for subsidies provided only to domestic firms. The result could be a subsidy race in sectors considered strategic. Although such a subsidy race could have positive effects because of the positive environmental spillovers through reduced emissions, a risk exists that economies—in particular low- and middle-income countries—with less fiscal space do not have the resources to promote green sectors financially. Local content requirements introduce distortions that lead to an inefficient use of resources and can undermine efforts to diversify (Stone, Messent, and Flaig, 2015). Furthermore, they can create trade policy responses that raise trade barriers.

Box 4.1 Steelmaking and fertilizers

Increased demand for "low-emission steel" comes with opportunities while raising implementation challenges. Climate policies will create incentives for steelmakers to adopt more environmentally friendly production methods, including hydrogen-powered direct reduced iron production or electric arc furnace production using scrap steel (OECD, 2023c; IEA, 2023b; WEF, 2023). This shift could reshape global steel trade, creating new supply chains and potentially offering new opportunities for developing countries (for example, by supplying green hydrogen) (WTO, 2022c). However, as these changes will be implemented incrementally, a risk exists that exporters will ship their low-emission steel to markets with BCAs and divert high-emission steel to markets without carbon fees (OECD, 2020).

Steelmakers will bear additional compliance costs to comply with complex regulation. To comply with CBAM regulation, exporting steelmakers will need to gather emissions data following specific guidelines to ensure consistency and comparability over time, and transparency and accuracy in the calculations.[8] While these investments will be important in helping reduce emissions, to meet these requirements, steel producers will likely need to hire additional staff and invest in training and new software for tracking and documenting carbon emissions accounted for by all production stages—from raw material extraction to finished steel. In addition, independent verification of a steel producer's carbon emissions data will be required under CBAMs regulation, which can be expensive. Most steelmakers tend to be large companies which often operate across multiple jurisdictions, implying that they might already be familiar with dealing with regulations cutting across borders.

Initiatives to respond to these new challenges have been fragmented so far. This new context has led to a proliferation of definitions for "green", "near-zero", or "low-emission" steel, with no commonly accepted methodology to measure carbon emissions generated at each stage of the steel production process (WTO, 2022c). Such fragmentation of initiatives creates uncertainty for producers and additional trade frictions, such as a multiplication of verification requirements at the border, leading to increased transaction costs. Minimizing these costs requires international co-operation to establish definitions, measurement standards, and the mutual recognition of standards and conformity assessment results from trading partners (WTO, 2022c).

CBAMs would benefit domestic producers of fertilizers in the short term, depending on the phasing out of free allowances. Twelve countries (including Russia, Egypt, Algeria, Morocco, and Belarus) account for more than 90 percent of EU imports of fertilizers. The EU CBAM will likely increase the price of imported fertilizers in the EU and affect competitiveness of these trading partners as none of them have carbon pricing in place while they have relatively high GHG emission intensities (Vidovic et al., 2023; Marcu, Cosbey, and Mehling, 2021). In the short run, EU fertilizer producers will benefit from this non-EU exporters' loss in competitiveness and profitability.

In the long term, producers in countries with cleaner energy sources should gain a competitive edge over those in regions with higher emissions intensity. Developing countries with a comparative advantage in renewable energy generation could invest and move up the value chain and specialize in those, including green hydrogen production, to gain competitiveness in the EU and other markets. Ammonia, a key component for nitrogen-based fertilizers, is produced through a process involving hydrogen, which is the most energy-intensive phase in specialized production (IFA, 2014; Vidovic et al., 2023).

High-emission fertilizers could be exported to countries with lax climate policies. Due to varying levels of ambition in countries' climate policies, producers of high-emission fertilizers could redirect their exports to jurisdictions that do not implement BCAs or similar trade-related climate measures. At the same time, EU producers—which produce low-carbon emission fertilizers—may face increased production costs as result of the phasing out of free allocation of ETS allowances (Boulamanti and Moya, 2017; Vidovic et al., 2023).

Sectoral initiatives have proposed standardized frameworks for consistent CO_2 emissions measurement and reporting. In the steelmaking sector, one such example is the Climate Action Data Collection Programme of the World Steel Association (World Steel Association, 2024), which aims to establish a globally accepted standard methodology, striking a balance between harmonizing methods while allowing the promotion of more accurate and comparable emissions data (OECD, 2024a). In the case of fertilizers, one such initiative is the Carbon Footprint Calculator, which has established a certification program relying on a standardized tool for calculating carbon emissions, thereby fostering greater transparency and consistency in assessing the environmental impact of fertilizer production (Fertilizers Europe, 2023).

ENDNOTES

1 IEA projections suggest that mining of fossil fuels is orders of magnitude larger than mining of critical minerals. For example, in 2021 over 7.5 billion tons of coal were extracted from the ground and in 2030 expected coal demand is still 5 billion tons, while the IEA projects that the total amount of minerals needed for clean energy technology by 2040 will be under 30 million tons (IEA, 2023a).

2 World Bank staff calculations explore the trade effects of decarbonization, assuming carbon pricing is used to achieve countries' NDCs and more ambitious scenarios. Hence, the results hold under a scenario where variation in climate ambition in NDCs implies variation in carbon prices. Some of the results should therefore be interpreted cautiously.

3 The EU Commission has proposed to postpone the implementation of the EUDR to end of 2025 for large companies and end of 2026 for small companies.

4 In the long run the effects could be more nuanced since carbon pricing could also lead to cost reductions through learning by doing and increased innovation in the countries introducing them.

5 This channel has little to do with sectoral competitiveness and thus cannot be addressed by carbon border measures. This channel also explains why computable general equilibrium models find that the largest spillover impacts from climate policies (and from border measures) tend to fall on fossil fuel exporters (and benefit fossil fuel importers). From an empirical perspective, however, this channel is particularly difficult to estimate, and modeling results should be interpreted with appropriate caution and sensitivity analysis.

6 Assuming a carbon price of $100 per metric ton, the index measures the additional cost of CBAM certificates for exporters compared to the average EU producer, adjusted by the proportion of exports to the EU market. The index measures exposure to the EU CBAM, assuming removal of free allowances in the EU ETS, as opposed to the current EU ETS with free allowances. It recognizes cost changes in the EU market, where EU producers also bear emissions costs, enabling relatively clean exporters to gain competitiveness despite the requirement to purchase certificates.

7 The leakage rates in Bellora and Fontagné (2023) are larger than in UNCTAD (2021) since the former study focuses on projected outcomes in 2040 with larger carbon prices and differences in carbon prices, whereas the latter study uses a comparative static approach for the baseline year 2014.

8 For examples of such requirements see Annexes of the EU CBAM implementing regulation: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_228_R_0006#d1e32-113-1

Coordination to maximize positive spillovers and limit negative cross-border impacts

Promoting the positive spillover effects of climate action, while limiting the negative spillover effects, will require enhanced international coordination. Building on existing international rules and norms, a common understanding of cross-border spillovers, including better evidence on carbon leakage, and the impact on third countries, greater alignment of carbon intensities and product-specific emission metrics or benchmarks would improve transparency and help reduce transaction and compliance costs for firms engaged in international trade. A common understanding of the implementation of trade-related climate measures can avoid excess compliance costs and reduce the risk of trade tensions. Cooperation and coordination on technological development and deployment (from basic R&D and technology transfers to industrial policies and deployment subsidies) could increase efficiency, and accelerate and ensure a just transition.

5

5.1 Enhanced international coordination among countries is essential to maximize positive cross-border spillovers and minimize negative spillovers

A lack of coordination makes enhancing ambition, such as introducing carbon pricing, more difficult. The resulting, growing reliance on cross-border measures risks exacerbating trade tensions and expanding compliance burdens for developing countries and small and medium enterprises. Coordination is key to increase the scope and implementation of carbon pricing policies, which in turn would decrease the perceptions of unfair international competition.

Coordination and capacity building can help with the implementation of climate policies in countries with limited resources and institutional capacity. In the long run, developing countries will benefit from global mitigation efforts due to their greater vulnerability to climate risks. However, they often lack the necessary funds to invest in emission reductions and may lack affordable access to technologies essential for the transition. Additionally, they may have limited institutional capacity to implement explicit carbon pricing policies like ETSs. Coordination and capacity building can help lower the implementation costs for these economies (for example, through peer-learning, lower compliance costs, mutual recognition, and investment promotion and attraction).

Coordination can help to reduce trade tensions, especially if based on commonly accepted frameworks and data-based approaches. Past experiences with global economic coordination to addressing transboundary environmental challenges[1] may offer useful, even if anecdotal, examples of efforts to develop frameworks for collective action and addressing economic spillovers. While the Paris Agreement's bottom-up, nationally determined approach to climate action means that at least a certain degree of fragmentation is a natural feature of the policy landscape, plenty of opportunities still exist for coordination on some key policy metrics and common understandings. To help address spillovers and ensure just transitions, enhanced coordination could start by covering several key policy areas discussed in following subsections.

5.2 Developing a common understanding of cross-border spillovers and their impacts, including better evidence on actual leakages, helps countries better cope with spillovers

Structured policy information can help inform indicators of leakage risk, streamline compliance with border measures, and contribute to positive policy spillovers. Common information about climate policies—particularly carbon pricing mechanisms—can render them more transparent, allowing for better evaluation of the likely spillovers and of opportunities for better coordination and the reduction of negative spillovers. In the case of BCAs, having consistent measures of embedded carbon pricing can help discussions around interoperability of carbon pricing measures and adjustments to carbon charges that importers pay. Growing evidence reveals that climate policy evolves over time and is strongly influenced by the experience of neighbors and close trading partners. Increased transparency could thus also help lead to future harmonization and convergence, further reducing compliance costs.

Leakage risk starts but does not end with changes in competitiveness. The relative cost increase due to climate policies is the initial impulse for shifting competitiveness, as defined in Section 4, but the emissions response depends on a variety of factors and interdependent markets. Evaluating a sector's exposure to carbon leakage risk requires a simultaneous assessment of the cost impact of the climate policy on that sector, its exposure to international competition, and the potential for cost changes to cause foreign production to expand, and the likely emissions associated with that expansion. Ideal measures for these components are often unavailable, so policy makers rely on proxy indicators that can be measured with reasonable transparency, providing useful information for comparison, but they are often proxies and need to be supplemented with empirical evidence (see Table 5.1).

Leakage risk because of carbon pricing is determined by product cost increases, trade sensitivity, and emission responses abroad. Jurisdictions with explicit carbon pricing (like for example, the EU or California) identify sectors at risk of leakage for eligibility for free allocation or BCA. To do so, they typically use high historical emissions intensity as a proxy for carbon cost exposure and trade intensity for the sensitivity of international responses. While embodied emissions costs can be straightforward to estimate, true relative cost changes depend on other compliance costs that are difficult to observe, such as the cost and effectiveness of cleaner production techniques adopted, and the effects of complementary non-pricing policies and other compensation offered. Trade sensitivity depends on elasticities of substitution between products, which can depend on the time frame under consideration, as well as industrial organization. Fortunately, some empirical evidence indicates a close correlation between trade intensity and sensitivity (Fischer and Fox, 2018). The final link—the extent to which increased production abroad may increase emissions—is proxied by the emissions intensity of competing products, but in actuality would depend on general equilibrium effects (how other markets and supply chains respond) and how those emissions are themselves regulated. For example, if foreign firms in that sector are covered by an emissions cap, reductions elsewhere may offset increases in their emissions. Because of general equilibrium effects, an ETS covering certain emissions-intensive sectors may reduce that country's competitiveness in those goods but increase its comparative advantage in other goods. Advancing common understandings and metrics would help economies find mutually agreeable solutions in the future.

The positive spillover effects of different technology-oriented policies, including green industrial policies, require further study. Technology policies that make clean alternatives more affordable and widely available, have a potential for positive international spillovers. Emerging evidence suggests that clean R&D has larger knowledge spillovers than untargeted R&D, and the international spillover benefits of clean innovations are substantial (Verhoeven and Martin, 2024). Developing common understandings on how to measure and evaluate such spillover and technology-related policies would help justify further cooperation on technology development and dissemination to achieve global climate goals.

5.3 Greater alignment of carbon intensities and product-specific emission metrics or benchmarks can help reduce compliance costs for firms engaged in international trade

With the growing diversity in emissions pricing policies, non-price regulations and cross-border measures globally and emerging policies based on carbon intensity metrics, more countries are developing sophisticated Measurement, Reporting and Verification (MRV) systems in line with the administration and compliance requirements for such policies. The tiered approach of the Intergovernmental Panel on Climate Change's (IPCC) Guidelines for National Greenhouse Gas Inventories (directly or indirectly) forms the basis of most existing MRV systems, yet considerable variation still exists across jurisdictions (IFCMA, 2024). Under these guidelines emissions are estimated at the national level pragmatically, by using a 'tiered' approach employing an increasing level of accuracy and granularity. There are three tiers. First, a simple first order approach based on default values corresponding to large spatial regions employing globally available data, enabling calculations by any country. Second, a more accurate approach employing a similar calculation method to Tier 1 though based on country- and region-specific data. Third, higher order methods based on the use of countries' own detailed modelling, inventory measurements systems and data at a greater level of granularity (IFCMA, 2024).

Sources of differences include the scope and coverage of activities, methods used for calculating emissions from production processes, and default versus measured values. In most cases, only information on absolute emissions is required for reporting purposes and policy implementation. A growing role exists, however, for emission intensity metrics, which combine emissions data with production data, and are used directly to inform emissions reductions targets and the design of climate change mitigation policies.

The Intergovernmental Panel on Climate Change's Guidelines are designed for parties of the UNFCCC for reporting National Greenhouse Gas Inventories. These are mandatory commitments for some countries and regions, and voluntary in other cases. The guidance provides a pragmatic approach to reporting nationally aggregated emissions, with flexibility for inclusion of better data where available, and industry-specific guidelines where relatively more granular or complex data and calculations are needed. The guidelines' tiered approach is based on an increasing level of accuracy and granularity in response to the varying levels of reporting capacities across countries and regions (IFCMA, 2024).

Currently, sector-level carbon intensity metrics are better established than product-level metrics due to the availability of national emissions and output data at the sector-level. Sector-level details are available, for example, in data reported to UNFCCC (IFCMA, 2024). However, these metrics most often use indirect measurement approaches based on estimated energy use and corresponding emissions factors, largely relying on default values and limited primary data. Even with opportunities to enhance sector-level metrics through more granular installation-level data or novel data collection technologies (for example, satellite imaging), ultimately, product-level metrics are needed for modern applications in climate change mitigation policy.

Site and supplier-specific primary data generally yield the highest accuracy for product-level carbon intensity metrics. However, there is a trade-off between accuracy and resource requirements (IFCMA, 2024). Firms and authorities responsible for monitoring and verification of emissions data need to balance limited capacities for emissions measurement and reporting with demands for product-level measurements that sometimes require complex and large volumes of data. The verification and sharing of data along the supply chain faces various economic, technical, legal, and regulatory barriers. Computing product-level carbon intensity metrics becomes increasingly complex for more downstream goods that require information from several stages of the supply chain, especially when these cross multiple jurisdictions. Moreover, developing countries and small and medium enterprises with limited capacities for complex data reporting face their own challenges in advancing carbon intensity metrics, which merit targeted support and a tiered approach for SMEs, especially in developing countries.

The Inclusive Forum on Carbon Mitigation Approaches (IFCMA) is the OECD's flagship initiative designed to help optimize the global impact of emissions reduction efforts. This initiative is achieved through better data and information sharing, evidence-based mutual learning and better mutual understanding, and inclusive multilateral dialogue. The IFCMA is identifying and addressing challenges related to the calculation of sector- and product-level carbon intensity metrics, relevant to the design and evaluation of mitigation policies, and to steer firms' and consumers' decisions toward lower-emission products. This work supports better international coordination to avoid the proliferation of different standards, helps minimize compliance costs for businesses, and avoids disruptions to trade. For instance, it recommends principles such as ensuring proportionality (balancing accuracy with resource requirements for measurement), promoting innovation of new data sources or techniques, and fostering interoperability, for more accurate, timely, and granular carbon intensity measurement (OECD, 2024a). In particular, fostering interoperability involves developing processes, methods, and infrastructure for carbon intensity measurement in different countries, sectors, or products that share common foundations and can "speak" with each other to prevent conflicting or duplicative requirements. A common approach and understanding of best practices can reduce the complexity and cost of emissions reporting and risk of fragmentation arising from the use of different carbon intensity metrics within policies (IFCMA, 2024).

International coordination, multilateral dialogue, are crucial for leveraging the growth in MRV systems, spurred by new climate change mitigation policies relying on this data. Governments, industry bodies, and other organizations have made efforts to provide sector- or product-specific guidance for emissions measurement and reporting, yet considerable variation in methodologies remains across sectors and jurisdictions.[2]

Interoperability of emissions pricing, scope, and reporting can similarly streamline compliance with heterogeneous measures. As with carbon intensities, the prices for emissions, resulting from ETSs and other pricing instruments, can vary significantly across jurisdictions. The OECD and the World Bank produce cross-country measurements of carbon prices (OECD, 2023b), which includes carbon pricing derived from ETSs, carbon taxes, and consumption taxes, as well as subsidies, on fossil fuels (Section 3). Intensified discussions around carbon leakage and BCAs have raised awareness of the need to progress on the interoperability of emissions measurement and reporting. This can enable entities to report to multiple jurisdictions, while containing costs to do so. Interoperable approaches can help address differences in economic and institutional systems and reduce costs of compliance of developing countries and SMEs while reducing distrust.

Reporting of indirect emissions (Scope 2 and Scope 3) which are difficult to integrate into systems for administering emission pricing, can benefit from international coordination. In many cases, only the direct emissions under the control of the installation or entity located within the jurisdiction (Scope 1) are included in explicit emissions pricing and accounting systems. Indirect emissions from consumption of electricity (Scope 2) and the emissions embodied from material inputs sourced from other entities (Scope 3)—especially those imported from other jurisdictions—are generally more difficult to integrate into the reporting systems used to administer emissions pricing. Pricing of direct and indirect emissions, without duplication of reporting requirements and without creating separate and different requirements for companies depending on the location of their production, clearly requires inter-jurisdictional coordination between their emissions accounting systems.

Reporting is further complicated by fragmentation in the design of carbon pricing instruments raising costs for firms active across multiple jurisdictions. Carbon pricing instruments differ in other aspects of their design, ranging from fuel-based versus emissions-based carbon taxes, to the use of carbon intensity metrics for benchmarking in ETS. Moreover, in the face of complex, globalized supply chains, many entities are subject to emissions measurement and reporting across several jurisdictions with differing requirements related to carbon pricing measures in a jurisdiction. For example, multinational enterprises involved in production across borders or trade (in inputs or final products) may be subject to emissions reporting and associated carbon pricing payments to various jurisdictions. The OECD IFCMA carbon intensity workstream is conducting studies to assess similarities and differences in emissions reporting and verification across these various forms of pricing systems and assess possibilities for their interoperability.

5.4 Focused technology dissemination can accelerate the climate transition

Generally, R&D efforts can be coordinated to expand market reach, enhance the return on investments and increase the impact on climate action. Meeting the Paris Agreement targets will require significant efforts in both the development and deployment of current and new low-carbon technologies. IEA analysis indicates that about 85 percent of global CO_2 emissions reductions out to 2030 (relative to 2020 levels) on a pathway to net zero emission by mid-century might be achieved from commercially proven (though not necessarily cost-competitive) technologies (IEA, 2021). By 2050, however, almost half of the required emissions reductions will need to come from technologies that are either unproven or not yet developed.

The global development of low-carbon technologies (such as green cement, steel, hydrogen, aluminum, shipping, aviation, and agricultural technologies and processes) needs to be scaled up significantly. This scale-up needs to extend productive capacity and to include the transfer of these technologies, especially to developing countries, through trade, foreign direct investment, and patent licensing at affordable rates.

Potential opportunities for international coordination exist at each of the four main stages of technology development and adoption, building on existing platforms:[3]

1. *Basic research*: Globally, about $30 billion a year is currently spent on basic research into clean energy technologies, mostly in high-income countries and China (IEA, 2020). However, analysts consistently call for a gradual and sustained ramp-up of these efforts (Armitage, Bakhtian, and Jaffe, 2023; Cervantes et al., 2023; Dechezleprêtre and Popp, 2017; Newell, 2015). International coordination could pool resources, reduce the risks of duplicating efforts, and help ensure that funds are well-directed and efficiently used.

2. *Applied research and development (R&D):* Even with a strong carbon price, firms tend to underinvest in clean technology R&D due to challenges in preventing other firms from copying or using the knowledge embodied in new technologies. Applied R&D can be promoted through several measures of international cooperation, including:

   - International coordination on patents to provide robust protections for innovators licensing their technologies in different countries, while preventing abuse and addressing concerns on affordable access.

   - International coordination on R&D subsidies to support clean energy R&D while managing the global tax base.

   - Other less commonly deployed instruments such as a one-off prize for developers of specific new technologies or advanced purchase agreements could be coordinated internationally to pool resources, limit duplication and attract a diverse range of innovators.

3. *Demonstration projects*: These projects involve first-of-a-kind facilities to prove the viability of major newly developed technologies at commercial scale, such as the use of green hydrogen in sectors that are difficult to decarbonize. Public support of a limited number of well-designed demonstration projects could generate substantial new knowledge. International coordination could help avoid duplication of efforts.

4. *Technology deployment*: Internationally coordinated support, including subsidies and capacity building, could accelerate progress down the learning curve, although incentives should be temporary and technology-specific. Deployment could also be promoted through agreements to lower tariffs on low carbon technologies[4] and harmonize standards.

Technology policies involve more than just R&D and trade-related policies are also key for the dissemination of green technologies. The dramatic fall in costs of solar panels, for example, arose over time through a sequence of R&D support, market creation, and subsidies across multiple countries (Nemet, 2019) . A recent study estimates that prices of solar panels would be substantially higher without globalized supply chains (Helveston, He, and Davidson, 2022). Ongoing discussions are occurring, however, about industrial capacity concentration in the sector, related energy security concerns, and an increase in the adoption of trade-distortive measures. Better understanding of the impact of trade-related measures, including Aid for Trade on the further development of low-carbon technologies and their deployment to ensure just transitions could help inform these ongoing discussions.

5.5 Common understandings for implementation of trade-related climate measures can avoid unjustifiable discrimination, excess compliance costs, and the risk of trade tensions

A growing number of economies are adopting trade-related climate measures. The WTO's Environmental Database (EDB) shows that WTO members from all regions and stages of development are increasingly adopting trade-related climate policies. From 2009-2022, members notified to the WTO more than 5,500 measures with climate-related objectives. About 40 percent were from developing members. In 2009-2010, an average of 263 of such measures were notified per year. By 2021-2222, this number had more than doubled to 550 per year.[5] While such growth indicates the recognition of governments that trade and trade policy can be a key part of their toolkit to achieve climate objectives (WTO, 2023), by their very nature trade-related climate measures generate trade impacts and compliance costs (WTO and UNEP, 2009).

Ongoing discussions at the WTO, OECD, UNCTAD, UNFCCC, and other bodies indicate the appetite of governments to better understand such impacts and find solutions. Discussions are ongoing in WTO Committees, the OECD IFCMA and relevant Committees, the UNFCCC Forum on the Impact of Response Measures, United Nations Conference on Trade and Development Board, G20/G7, and other bodies. Common understandings on a range of issues often complex and technical can help ensure such trade-related tools are effectively leveraged for climate action and do not disproportionally affect less developed countries. The relevant issues include the extent of the impacts of trade-related climate measures, best practices and guidelines on the best use cases, design and implementation of such measures to maximize efficiency and reduce frictions, and principles and common rules to avoid creating unnecessary barriers to trade and arbitrary or unjustifiable discrimination.[6]

International rules and norms already exist and remain relevant and applicable—for example, WTO agreements, the UNFCCC provisions, and the Paris Agreement. Past trade disputes settled at the WTO, in particular, offer four general, non-exhaustive considerations to take into account when adopting trade-restrictive measures for environmental objectives:

- Coherence. The trade restriction or difference in treatment between domestic and imported products provided by the measure is justified by the legitimate objective and not to protect domestic sectors.
- Fit-for-purpose. The measure can efficiently contribute to the legitimate objective in a balanced way or is part of a national conservation policy also restricting domestic production or consumption.
- Mindful and holistic. The measure is part of a holistic environmental policy and considers the impact on other countries, and on other national, regional, and international efforts on the same topic.
- Flexibility. The measure is result-oriented and takes into account alternative measures to address the same challenge as effectively, albeit through different methods, including due to national and regional environmental conditions (WTO, 2020).

Opportunities exist for further discussions and development of new guidelines and norms. This is particularly the case when applied to the specific circumstances and considerations raised by the different types of trade-related tools used. Furthermore, uncertainty can be reduced, and trade frictions prevented by seeking agreement among countries on how to implement trade-related climate measures. For example, there is considerable uncertainty about the introduction of BCAs and their design and a common understanding between jurisdictions about their application and design would limit economic uncertainty and raise trust of market participants.

Of the more than 5,500 climate-related measures notified to the WTO in the 2009-2222 period, about half are regulatory in nature. Extensive work has been developed at the WTO Committee on Technical Barriers to Trade (TBT) to generate relevant guidelines for the adoption of regulatory measures.[7] The TBT Agreement itself contains numerous useful provisions covering issues such as transparency, early notification of draft measures and the opportunity for comments to be provided; reasonable interval between adoption of a measure and its entry into force for producers to adapt and effectively comply; even-handed application of regulations to imported products (of any origin) and domestic products; recognition that regulatory prescriptions should be based on performance rather than design or descriptive characteristics; mutual recognition of regulations, certifications, and performance evaluation when possible; and harmonization with international standards.[8]

2,366 climate-related non-tariff measures cover 26.4 percent of world trade according to UNCTAD's Trade Analysis Information System database. These measures are applied to the most traded and CO_2 intensive sectors, such as the automotive sector. Consequently, 26.4 percent of world trade is regulated through these measures, representing trade worth $ 6.5 trillion annually (UNCTAD and ESCAP, 2023).

Ample space still exists for further work in this field—identifying opportunities for interoperability, harmonization, and peer-learning. This can help ensure that regulatory policies are fit-for-purpose, efficient in achieving their objectives, and based on tiered approaches reflecting differences among countries and regions. For example, with the COP28 announced goal to triple resource efficiency and double energy efficiency by 2030, clear opportunities exist for enhancing coherence among different energy efficiency labels and policies.[9]

As discussed in Section 1, a growing number of measures in the form of price-based mechanisms, such as carbon taxes, ETSs, and other policies are being adopted. While the common understandings on measurement discussed previously will be key, guidelines and best practices on the design, development, and implementation of such measures are also important including to ensure just transitions. For instance, better understanding of the direct or indirect tax nature of such carbon policies, including border adjustment, could help clarify their implication for applicable trade rules and norms.

Common understandings on a host of issues related to BCAs could help address concerns over arbitrariness, climate efficiency, and protectionism.[10] Examples of such issues include the economic and climate implications of different emission scopes, carbon intensity benchmarks, product and country coverages, technical requirements to demonstrate carbon intensity and deviate from the benchmark, equivalent internal taxation, measurement of carbon price levels in countries exporting to regions introducing BCAs, allocation of BCA and carbon pricing revenues, and impacts on market concentration and developing countries and repercussions for development and achievement of the Paris Agreement.

Renewed interest in green industrial policy and sustainable agriculture offers an opportunity to further the debate, identify common concerns, and find potential solutions. According to the WTO EDB, more than 2,400 measures were notified to the Committee on Subsidies and Countervailing Measures from 2009-2022 on topics such as low-carbon technologies, reforestation, and low-carbon agriculture. The issue of the use of supportive measures to prop up specific industrial sectors is not new, and important insights from past experiences could be usefully revisited and re-discussed to help guide the adoption of effective measures and reduce negative impacts.[11] In particular, it is important to take into account the impact of such policies on developing economies, in particular those with little fiscal space and high levels of debt, especially in the face of high adaptation costs.[12] For instance, estimates by UNCTAD show that in 2019, developing countries spent more on interest payments than on health or education, leaving little for climate investments (UNCTAD, 2024).

Current trade rules do not easily accommodate certain types of subsidies, implying an opportunity to have a holistic discussion on the topic. [13] This includes discussions on how to maximize positive environmental externalities spilling over to other economies while minimizing negative trade impacts. Discussions would need to address topics, such as how to correctly measure and verify positive externalities, how to assess the impact of subsidies—in particular on the weakest players in the global economy—and the role unilateral and multilateral trade responses could play. At the WTO 13th Ministerial Conference held in February 2024, trade ministers for the first time held dedicated deliberations on the nexus between trade, industrial policy, and sustainability. Several members have also put forward specific proposals to discuss the topic.

ENDNOTES

1 Examples include the multilateral alignment of conservation measures under the Convention on the International Trade of Endangered Species of Fauna and Flora or the coordinated reduction in production, consumption, and trade of ozone depleting substances under the Montreal Protocol. While transboundary trade and economic consequences and tensions have certainly arisen from the implementation of these agreements, economies have continued to coordinate their efforts on these topics.

2 One example of sectoral effort is the Steel Standards Principles. Launched at COP28 and endorsed by standard setting bodies, international organizations, steel producers, and industry associations, these principles aim at aligning how GHG emissions are measured in the steel sector. Entities involved have continued to cooperate and are expected to present further developments at COP29 in Baku, Azerbaijan.

3 The Breakthrough Agenda is an example of technology development–focused effort. Launched at COP26 in 2021 among governments representing over half of global GDP, it includes various initiatives to help make clean technologies cheaper and more accessible for power, road transport, steel, hydrogen and agriculture. See https://climatechampions.unfccc.int/breakthrough-agenda.

4 Current tariffs are mostly not that large, averaging between 2 percent in advanced countries to 8 percent in low-income countries (Black, Parry, and Zhunussova, 2023). See also Pigato et al. (2020). However, there might be larger imbalances between tariffs applied to lower and higher-carbon technologies. For instance, while fossil fuels, such as crude oil and coal, face average applied tariffs of 0.8 and 1.6 percent, respectively, in the top 10 importing markets, renewable energy equipment faces average tariffs of 3.2 percent, with some economies applying tariffs as high as 12 percent (WTO, 2023).

5 For a general overview of such notifications, see WTO (2022a). The OECD IFCMA database on climate mitigation measures is expected to be delivered by the end of 2025.

6 See WTO (2022c) and UNFCCC (2019), in particular, the consideration that "international cooperation plays an important role in fostering economic diversification by contributing to the identification and sharing of best practices and experience of countries that have successfully diversified their economies; identifying non-domestic barriers to economic diversification, such as trade barriers; identifying ways in which the international community could facilitate increased foreign investment in non-traditional sectors; and facilitating assistance, in the form of technology transfer, technical assistance and financial support, for the difficult task of diversification."

7 For example, see the TBT Committee Decision on Principles for the Development of International Standards, Guides and Recommendations – G/TBT/9 ("six principles"); Guidelines on conformity assessment procedures – G/TBT/54.

8 See WTO (2022b). At COP28, around 40 institutions, including from the private sector, standardizing organisms, and international organizations, endorsed the Steel Standards Principles, indicating their common understandings on the need to further develop commonly agreed low-carbon standards.

9 See for example efforts under the UNECE "Group of Experts on Energy Efficiency" such as the "draft Industrial Energy Efficiency Action Plan (United Nations Economic and Social Council, 2020).

10 See, inter alia, OECD (2020); Marcu, Cosbey, and Mehling (2021).

11 See, inter alia, WTO (2006), OECD (2024b).

12 See UNCTAD (2021), Climate change, green recovery and trade.

13 See IMF, OECD, WB and WTO (2022).

Coordination to scale up climate action

International coordination can help to close the climate action gap identified in Section 1 by addressing the transparency gap, the implementation gap, and the ambition gap. International organizations already support climate action through technical assistance, capacity building, analytical work, and climate finance. Various options are discussed to go further, including enhanced reporting on climate policies to close the transparency gap; sectoral, regional, or policy-specific cooperation (including on explicit or total carbon pricing, but also on steel, aviation or shipping, for example) to close the implementation gap; and enhanced ambition in the next round of NDCs through open international coordination arrangements embedded in, or aligned with, the multilateral Paris Agreement and aligned with its principles and objectives, such as CBDR-RC.

6

6.1 International organizations help countries raise climate action by supporting the use of climate policies

The Paris Agreement encourages all parties to elevate their ambition through regular stocktakes of their climate action and a ratcheting mechanism through revision of their NDCs coupled with appropriate means of implementation, such as climate finance, trade, investment, technologies, and capacity building. International organizations can help countries to implement a variety of climate policies realizing planned emission reductions through multilateral and bilateral policy advice and analysis, technical assistance, guidelines, and increased access to climate finance, investment, knowhow, and technology.

Support can be provided through technical assistance, capacity building, and analytical work. This support identifies opportunities for countries to increase their climate ambition without compromising their development and economic objectives (for instance, through the World Bank's CCDRs, IMF diagnostic missions, OECD Extended Producer Responsibility and Economic Surveys, and UNCTAD's upcoming guidelines on using trade and investment policies to support NDCs). Similarly, IOs offer technical assistance and capacity building, sometimes in a coordinated manner. For instance, all the international organizations have been modeling the implications of the EU CBAM for developing countries, the UNCTAD has been offering technical assistance to developing countries to develop National Green Export Strategies to capture trade opportunities and diversify their economies, and the Action on Climate and Trade—a joint program between the World Bank, the WTO, and the World Economic Forum—helps developing countries identify opportunities and use trade as a tool to achieve their climate goals. International organizations can provide support with the introduction of policies, including carbon pricing to reap the mentioned benefits while tackling their distributional, competitiveness, political feasibility, and spillover effects.

Concessional climate finance is provided to support ambitious, effective, and credible mitigation policies and emissions reductions in developing countries. These policies will have powerful effects in incentivizing green investment domestically and abroad. Climate finance support is provided through multilateral development banks (MDBs), such as Development Policy Operations and other policy financing, the IMF (through the Resilience and Sustainability Trust, RST), and other development partners, including bilateral development agencies. For instance, the World Bank Group delivered $38.6 billion in climate finance in FY23 and committed to grow the share of its financing with climate co-benefits to 45 percent of its annual commitments in FY24. In 2023, MDBs collectively financed $74.7 billion of climate action in low-income and middle-income economies, with 67 percent of this total for climate change mitigation finance and 33 percent for climate change adaptation. The amount of mobilized private finance in low-income and middle-income economies stood at $15.7 billion. The same year, $50.3 billion of MDB climate finance was allocated for high-income economies, with 94 percent for climate change mitigation. The amount of mobilized private finance stood at $23.4 billion. The RST is the IMF's first long-term lending instrument for climate vulnerable countries, with $8 billion committed so far to 18 countries to help them mitigate and adapt to climate change. This support helps countries design and implement stronger macroeconomic and climate policies. This has the potential to promote green investments by supporting strong reforms, improving transparency and regulatory certainty, and reducing information asymmetries for climate-conscious investors.

Developed economies have reached the $ 100 billion UNFCCC goal for climate finance for the first time in 2022, but more funding is needed for a just transition. The OECD's seventh assessment of progress toward the UNFCCC goal finds that in 2022, developed countries provided and mobilized a total of $115.9 billion in climate finance for developing countries, exceeding the annual $100 billion goal for the first time. This achievement occurred two years later than the original 2020 target year. However, much larger amounts of climate financing are needed to help catalyze total investments in the trillions needed for the just transition.

6.2 Modalities for international coordination mechanisms can vary and aim at closing gaps in (1) transparency, (2) implementation and (3) ambition

No single modality defines global, regional, or sectoral initiatives for enhanced ambition. Different options face different levels of feasibility and challenges, including the metric used to measure action or ambition and the definition of minimum thresholds for participants. Three broad categories of possible coordination mechanisms are identified that can contribute to mitigation aiming to close the transparency gap, the implementation gap, and the ambition gap. The task force does not recommend a specific approach; rather, it encourages exploration of all possible options.

Multilateral fora exist to scale up coordination of climate action, such as the UNFCCC, the WTO CTE, and UN, but also additional fora for dialogue. These fora include the relevant working groups in the G20 or the G7, the Coalition of Finance Ministers for Climate Action, the Glasgow Financial Alliance for Net Zero, Network for Greening the Financial System, Coalition of Trade Ministers on Climate, Africa Climate Summit, Baku Initiative for climate finance, investment, and trade dialogue, IFCMA, Steel Standard Principles, ISO/IEC/other international standard making institutions, regional trade agreements, such as the recently concluded Agreement on Climate Change, Trade and Sustainability; the Trade and Environmental Sustainability Structured Discussions trade-related climate measures working group; the UN Sustainable Stock Exchange Initiative; and the Climate Club.

1. **To close the transparency gap, countries could agree on enhanced reporting and transparency of the policy and economic environment related to mitigation.**

   As discussed in Section 3 a range of initiatives already exist to identify the full set of climate policies and measure their impact on emissions. Examples are the World Bank's CCDRs, the IMF's calculation of the CPE, IMF's country diagnostics (such as IMF's Article 4), OECD's IFCMA, the UNEP Emission Gap report, the UNFCCC's Stocktake and Biennial Transparency Reports (BTRs), multiple initiatives from think tanks or academic institutions (such as various databases of climate policies, including the WTO Environmental Database). These processes aim to provide information on various countries' ambitions and efforts but are not reporting their results with a common metric. Building on and contributing to existing initiatives such as BTRs, enhanced transparency would improve accountability and self-discipline, for instance, by making more visible the level of subsidies attributed to various energy sources or technologies. Enhanced transparency would also facilitate the identification and cooperative management of cross-border spillover effects, for instance, when subsidies have trade distortive effects as discussed in Section 5.

   Sharing detailed information about the design of policy instruments could be an important step toward greater coordination. By providing comprehensive insights into the various elements of policy design, countries can better align their strategies, including the potential to move toward a unified approach to carbon pricing metrics. As discussed in Sections 3 and 5, a unified approach can standardize how carbon pricing metrics are measured and applied. Standardizing metrics, in turn, can lower the compliance burden for firms operating in multiple jurisdictions. Given the diversity of policy packages across countries, transparency-enhancing mechanisms are essential. These mechanisms can facilitate peer exchange and learning by allowing countries to understand the successes and challenges experienced by others.

2. **To close the implementation gap, countries could agree to implement certain policies, sectoral measures, or a policy mix leading to a certain estimated emission reduction.**

   Sectoral and broad-based initiatives already exist, i.e., on emissions in specific sectors (aviation, maritime), of a specific type (methane) or from specific fossil fuels (coal). For example, there have been broad-based commitments on coal phase-down, a tripling of renewables globally by 2030, and doubling of energy efficiency, but without specifics on how these commitments would be operationalized or the allocation of efforts across countries. Such sectoral approaches could facilitate the transition in key sectors where abatement costs are high, or technologies are not mature and where competitiveness concerns are largest. Further coordination could also build off the Global Methane Pledge (signed by 155 countries) that seeks to reduce global methane emissions 30 percent by 2030. Furthermore, international coordination could focus on fossil fuel subsidy reform. Another possibility is an agreement for countries to create a market for green goods, for instance, aiming that a certain percentage of steel used in the countries is zero-carbon steel or that a certain share of purchase of green goods is from developing countries. Globally coordinated policies are needed for international aviation and maritime emissions due to the mobility of the tax base and are practical given that UN agencies supervise the industries and collect the needed data on fuel use.

Enhanced coordination might initially focus on a limited number of sectors as a first step toward more comprehensive emissions coverage. This coordination can target, for example, emissions from power and industry that are already subject to explicit carbon pricing in over 40 countries. Sectoral initiatives are in line with collaborative efforts of variable geometry under the Paris Agreement and the UNFCCC (often including a mix of countries, private sector, civil society, and international organizations) to coordinate focused efforts on specific topics or sectors (for example, on methane leakage or around battery development).

Additionally, regional coordination policies could emerge that could be a steppingstone to more comprehensive international action. These coordination policies could occur, for example, among neighboring countries moving ahead with carbon pricing policies or in a South-South, South-North or triangular context. Regional coordination could also focus on power sector pools where countries trade energy surpluses or on a specific sectors such as green steel. Or it could focus on coordinated support to R&D, including enhanced technology transfers or the provision of specific treatment, such as in south-south trade under the Global System of Trade Preferences.

Sectoral and regional coordination could also be complemented by coordination on specific instruments, including carbon pricing. Numerous proposals among academics and policymakers exist for coordinated minimum levels of carbon prices across groups of likeminded countries (sometimes referred to as "climate clubs"), but none have yet come to fruition.[1]

Coordination on specific policy instruments has advantages and disadvantages. The advantage is that it focuses on a common policy intervention, which can facilitate transparency and limit the dispersion of cost and competitiveness impacts underlying spillover concerns. The disadvantage is that it is not flexible with respect to the policy instrument chosen, which may reduce participation and make it harder to design consistent and context-specific policy packages.

Coordination on a mix of climate policies as actually implemented, as opposed to a commitment for future policies, would require transparent reporting of all policies. This coordination includes the policies that may not be primarily implemented for climate change reasons but have an impact on emissions. Coordination on the effects of these policy mixes (as opposed to monitorable outcomes, such as emissions) would require an additional assessment of their expected impact on emissions. An advantage of targeting the full mix of climate policies is that synergies of sectoral measures and specific policies can be leveraged. A challenge is providing a transparent and consistent measure of the relative contributions when the assessment requires model-based approaches relying on assumptions and counterfactuals. Metrics to measure the effects of a policy mix could include observing absolute emission levels (possibly per capita), calculations of the absolute or relative emission reductions compared to either historic levels or estimates of "business as usual" emissions pathways, or other metrics relying on estimation or simulation methods (such as a carbon price equivalent calculated as discussed in Section 3).

Several options also exist to further scale up climate action with climate finance through existing institutions. For example, through increases in grants, concessional finance for climate action, blended finance, 3Ps (private-public-philanthropical) sources, debt-for-climate swaps, and increasing the capacity of MDBs to support countries to manage climate change and other global challenges. Linked ETSs and high environmental integrity carbon markets can also promote financial flows from high- to low-income countries while facilitating greater carbon price alignment. Such markets can be practically developed and operated using existing market infrastructure (for example, stocks exchanges and derivative exchanges) but many developing countries will require technical assistance to do so, especially LDCs.

3. **To close the ambition gap, countries could coordinate on an enhanced level of ambition in their next NDCs, ideally along with the policies to meet this enhanced ambition.**

   The next round of updated NDCs for COP30 provide a key opportunity to increase climate ambitions and make it consistent with the Paris Agreement temperature goal. As discussed in Section 1, failure to significantly curb emissions in the near term will put this vital goal out of reach. The next NDCs are to be submitted in early 2025 and could benefit from experiences with the First Global Stocktake, such as better interlinkages between enhanced NDC ambition and implementation, stronger connection between NDCs and mid-century low-emission development strategies or Long-Term Strategies (LTSs), emphasis on means of implementation, strengthened NDC processes, information, transparency, a role for peer exchange and mutual learning, and a role for outside actors, including support from the five international organizations in this task force (OECD, 2024a). The next round also needs stronger means of implementation.

NDCs need to provide short-term goals to ensure the short-term actions are embedded in and consistent with the longer-term emission reduction pathways. The Paris Agreement invites countries to submit LTSs, which can set the direction of travel for the next half a century and help countries chart low emission development pathways toward resilient and a net zero future. To date, 72 countries plus the EU have submitted their LTSs. Initiatives, such as the joint MDB LTS program, provide technical assistance and capacity building to help countries formulate their own LTSs. Since countries are still developing LTSs, World Bank's CCDRs are also used to inform the enhancement of NDCs and development of LTSs. High level leadership is critical to achieving country ownership, driving higher ambitions, and integrating the enhanced ambitions in NDCs and implementation. This leadership can be at a ministerial or higher level, in consultation with sectoral ministries.

Initiatives by a subgroup of countries, consistent with the Paris Agreement, could take the lead with enhanced ambition. Such a subgroup (ideally representing a critical mass of global emissions) could coordinate through defining and preparing "high-ambition NDCs" meeting certain criteria regarding ambition and implementation. These NDCs should ideally include fully articulated and verifiable policy plans to meet the emissions commitments. Initiatives by a smaller group of countries could take the form of open international coordination arrangements embedded in, or aligned with, the multilateral Paris Agreement and aligned with its principles and objectives, such as CBDR-RC. The initiatives should also respect principles and norms of other multilateral systems, such as those of the WTO. The process to come to such initiatives must remain open, transparent and nondiscriminatory. In general, any initiatives that result in greater ambition and climate action would be expected to have strong positive spillovers through their effect of reducing global temperatures. However, it is important to identify and minimize any negative spillovers effects on nonparticipants, including through engagement with all relevant parties to ensure nonparticipants (especially lower income countries that face specific barriers to enhanced climate action) share in the climate benefits but are not disadvantaged economically.

A key challenge is that agreeing to criteria for "high ambition NDC" is difficult as it relies on capturing the complexities of the local context. Also difficult is meeting specific challenges and opportunities to reduce emissions and to appropriately reflect climate action principles (for example, CBDR-RC) and the principles and norms of other multilateral systems, like those of the WTO. This difficulty is a key reason why the Paris Agreement shifted from a top-down (applied under the Kyoto Protocol) to a bottom-up approach, in which countries determine their own contribution to emission reductions. International organizations can provide evidence-based research on options. In addition, this challenge may be easier to overcome in coordination within single sectors (like steel or maritime transport), specific policies (such as carbon pricing), or among smaller groups of countries (embedded in the Paris Agreement).

One possibility to coordinate increased climate action would be to implement carbon prices or equivalent policies consistent with achieving Paris Agreement goals. Ambition levels can differ by income level and potentially other economy level criteria reflecting the Paris Agreement principles. While carbon pricing could be used, the choice of mitigation instruments could be flexible. A measure of carbon price equivalence makes it possible to realize the same emission reduction as with a carbon price but employing also alternative mitigation instruments. Because of the flexibility to employ various instruments, such coordinated efforts do not automatically promote carbon pricing convergence or reduce or eliminate the risks of carbon leakage. Such approaches also present challenges as they require significant assumptions to convert policies into a carbon price equivalent. IMF research on an International Carbon Price Floor (Black, Parry, and Roaf, 2021) or the WTO Secretariat on a Global Carbon Pricing Framework (Bekkers et al., 2024) could help inform discussions on efforts to further scale up ambition, while addressing cross-border trade spillover effects.

The choice of a metric capturing the emissions effect of all policies depends on the purpose

of the exercise, involving trade-offs between transparency, simplicity and relevance. Emission levels (or emissions per capita) are easily measurable and the most transparent but may be less relevant for some purposes given differences in country conditions. Emission reductions relative to a baseline year can also easily be observed while emission reductions relative to a baseline path cannot be directly observed because they depend on the baseline. However, they can be transformed into absolute emissions once a baseline is agreed upon. The level of climate ambition could also be measured as a carbon price that would be equivalent to certain emission reductions, although as discussed in Section 3 this approach requires further modelling assumptions and introduces abatement cost considerations.

6.3 Further joint work by international organizations can help fill the knowledge gaps identified in this report

The report has identified a range of areas where more knowledge, analysis and information can enhance the role of international coordination in scaling up climate action and addressing the cross-border spillover effects of climate policies. For example, there is a need for more granular and better data on embedded carbon prices, further analysis of the costs across different countries and regions of fragmentation of climate policies, a detailed analysis of border adjustment policies and their interoperability, their impact on trade patterns and just transitions, as well as solutions to promote and facilitate green technology and knowhow diffusion. Future work can also focus on a comprehensive analysis of different approaches to address the spillover effects of climate policies, scale up climate action and ensure a just transition, compatible with a universal, rules-based, open, transparent, predictable, inclusive, non-discriminatory and equitable multilateral trading system.

Table 6.1: Opportunities for coordination to close the transparency, implementation, and ambition gaps

Coordination On	Gap to Close	Proposed Metric and Thresholds	Advantages	Challenges
Reporting	Transparency gap	Criteria for reporting	■ Easier to reach consensus, support other coordination mechanism, encourage efforts through accountability. ■ Can build on existing reporting and collection efforts (WTO transparency obligations, BUR and Stock Take, IFCMA, CCDRs, CMAP, and so on)	■ Data intensive process, challenge for constant updating of the data. Difficulties to define the scope (which policies are included in the reporting?) and to garner country buy in. Data sharing could raise confidentiality concerns.
Specific policy action	Implementation gap	Policy- and sector-specific (for example, subsidy for green steel, kerosene tax)	■ Easier to coordinate at sector or regional level. Simple to design metrics for specific sectors	■ Creation of multiple regional and sector agreements, which would create consistency and coordination challenges
Specific policy action: carbon pricing	Implementation gap	Explicit (S&T) or Explicit and Implicit pricing (net effective carbon rate or total carbon price)	■ Simple and directly observable metric ■ Encourage consistent policy approach, reducing trade-related distortion	■ Possible to manipulate the metric (for example, increased carbon price compensated with other subsidies or tax breaks). ■ Inefficient in sectors unresponsive to prices (for example, SOE-led energy system) and poor proxy of total ambition ■ Thresholds are to define with countries' specificities and Paris Agreement (CBDR-RC) and WTO principles. High thresholds and international coordination can create additional barrier to implementation of carbon pricing.
Coordination on current full policy mix	Implementation gap	Estimated impact on emissions (for example, compared with given date or a baseline) or estimated equivalent carbon price	■ Can encourage more ambitious policies ■ Flexibility for countries to implement their preferred policy package	■ Different policy mixes still lead to distortive effects, even if equivalent in terms of emission reduction or carbon price equivalent. Unclear how to measure negative costs opportunities (which still need policy action) ■ Rely on the identification of all relevant policies and modeling to estimate impact on emissions (and equivalent carbon price) ■ Thresholds are to define with countries' specificities and Paris Agreement (CBDR-RC) and WTO principles. High thresholds and international coordination can create additional barrier to implementation of carbon pricing.
Coordination on "high ambition" NDCs	Ambition gap	Estimated impact on emissions or estimated equivalent carbon price	■ Can encourage more ambitious commitments, necessary to realize goals of Paris Agreement ■ Flexibility for countries to their preferred policy package	■ Unclear value added compared with existing Paris Agreement framework. ■ Hard to determine criteria for "high ambition" NDC while taking into account countries' specificities and Paris Agreement (CBDR-RC) and WTO principles.

ENDNOTES

1 A sensitive question is whether and under what circumstances trade measures might be used to enforce the "club," and if those could be applied to non-members. Given that this would be at odds with a global approach, such approaches should be treated with caution.

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Working together for better climate action

The report of the Joint Task Force on Climate Action, Carbon Pricing, and Policy Spillovers, with participation by the IMF, OECD, UNCTAD, World Bank, and WTO, makes four main contributions. First, it reflects on a common understanding of carbon pricing metrics which inform on the incentives to decarbonize and on cross-country variation in carbon prices, a key determinant of international spillover effects and competitiveness concerns. Second, the report analyzes the appropriate mixes of climate change mitigation policies, emphasizing the pivotal role of carbon pricing as the only policy implementing the polluter pays principle while generating revenues. Third, it analyzes how international organizations can support the coordination of policies to maximize positive and limit negative cross-border spillovers from climate change mitigation policies. Finally, it discusses how such coordination can help to scale up climate action by closing the transparency gap, the implementation gap, and the ambition gap.

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