CLIMATE CLUB

Summary report of the Strategic Dialogues on causes and relevance of spillovers from mitigation policies

Pillar 1, Module 2 - Strategic dialogue on causes and relevance of spillovers from mitigation policies

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Disclaimers

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- the technical meeting on the draft results of the first Issue Note (14.03.2024)
- the first Body of Members meeting (23.04.2024)
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- the third Body of Members meeting (26.09.2024)

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Table of contents

FIGURES

1 Introduction

1. Climate change mitigation policy (climate policy hereafter) packages across countries differ significantly in their composition and their stringency. Since 2020, the Paris Agreement requires countries to outline and communicate their national climate action plans, known as nationally determined contributions (NDCs) and update them every five years. NDCs present mitigation targets and pathways to reach these targets using different approaches and scopes, reflecting countries' common but differentiated responsibilities and respective capabilities, as recognised under the Paris Agreement (Net Zero Tracker, 2024[1]; OECD, 2023[2]).

2. Countries use a mix of policies, with differing emphases on certain policy types and varying levels of intensity and coverage. Policies may be market-based, e.g. carbon pricing or green subsidies, and may be of a regulatory nature, imposing technology or performance standards, for instance. Within policy types, the asymmetries in levels of intensity (e.g. rate for a tax or subsidy, price for an emissions trading permit) and coverage (i.e. the amount of emissions a regulation or carbon tax applies to) also add significantly to the differences in climate policies across countries. Policy packages are shaped both by differences in country circumstances and the different market failures that need to be addressed along the climate transition path (D'Arcangelo et al., 2022[3]). Figure 1, focusing on explicit and implicit carbon pricing, a commonly used mitigation instrument, shows that carbon prices vary across countries, in terms of levels, coverage, and the instruments used (OECD, 2023[4]; OECD, 2022[5]).[1]

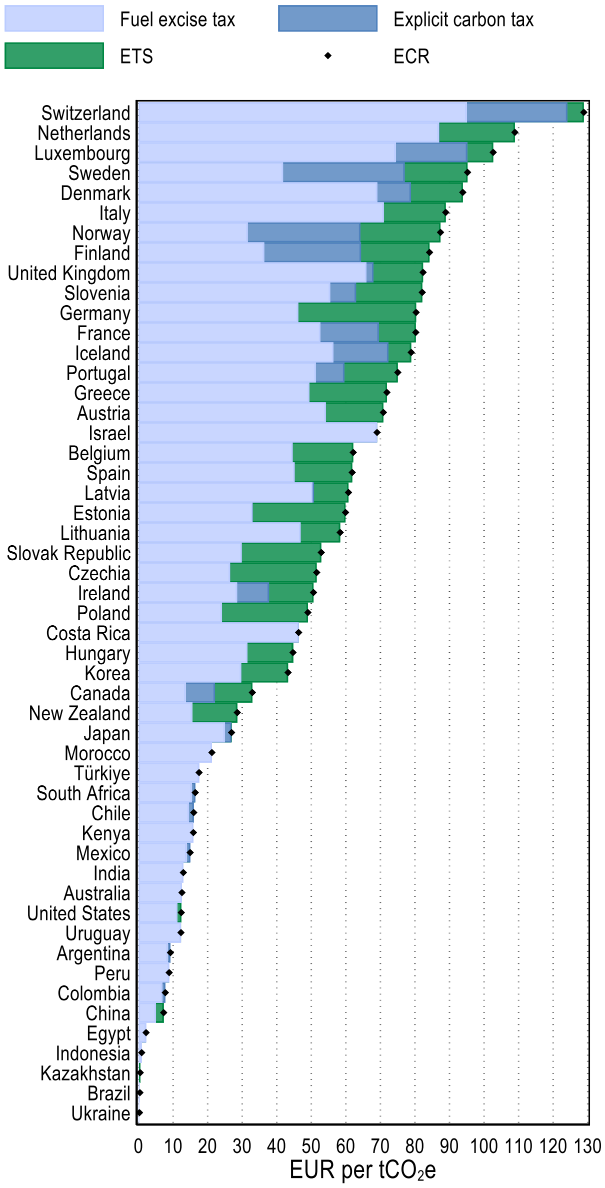
3. While the variety of policy instruments tailored to national circumstances enhances the resilience of the global climate policy architecture, this diversity also leads to collateral effects on other countries, known as international 'spillovers'. Such spillovers can offer opportunities for an accelerated transition, synergies, and deepened co-operation, but if not well managed, they can also undermine global mitigation outcomes and pose economic and technological risks.

4. The Climate Club's objective is to support accelerating industry decarbonisation and increasing ambition to achieve global net zero greenhouse gas emissions by or around mid-century. Mindful of the need to accelerate the green transition and manage carbon leakage and other risks to mitigation efforts in this context, Climate Club members have agreed to engage in a series of strategic dialogues to (i) share their assessment of causes and relevance of risks such as carbon leakage as well as other risks, (ii) discuss their strategies to mitigate such risks, and (iii) to identify possible ways to deepen their co-operation.

[1] Note that the differences in carbon pricing levels and coverage may be due to countries' differences in climate mitigation ambition, but they may also be due to low use of carbon pricing as part of the climate mitigation policy package.

Figure 1. The use of carbon pricing instruments and their levels differ widely across countries

Effective carbon rates, 2021, 51 Climate Club, G20 and OECD countries



Note: Effective carbon rates are averaged at the country-level across all GHG emissions (excl. LUCF - Land Use Change and Forestry) and by instrument type. If for instance two ETSs apply in a single country (as in the case of Germany with the EU Emissions Trading System (ETS) and the national ETS), these are combined under the unique heading “ETS”. Given that rates are averaged across country-level GHG emissions including those emissions that are not covered by any carbon pricing instrument, two countries which are covered by the same ETS (e.g. the EU ETS) and whose firms hence face the same permit prices, may present a different national average permit price (depending on the share of national emissions covered by the ETS in the respective countries). All rates are expressed in 2021 EUR using the latest available OECD exchange rate and inflation data. Prices are rounded to the nearest eurocent. Other GHG emissions data are from CAIT (Climate Watch, 2022[6]) while the data on CO_2 emissions from energy use are based on the IEA World Energy Balances (IEA, 2023[7]). The figure covers 44 OECD and G20 countries (all OECD countries and all G20 individual countries excluding Russia and Saudi Arabia). All Climate Club individual country members as of 14 March 2023 that are covered in the 2023 OECD Effective Carbon Rates database are also included here (the database covers Argentina, Australia, Austria, Belgium, Canada, Chile, Colombia, Costa Rica, Denmark, Egypt, Finland, France, Germany, Indonesia, Italy, Ireland, Japan, Kazakhstan, Kenya, Korea, Luxembourg, Morocco, the Netherlands, Norway, Peru, Spain, Sweden, Switzerland, Türkiye, Ukraine, the United Kingdom, the United States, and Uruguay; it does not cover Mozambique, Singapore, Thailand and Vanuatu).

Source: OECD (2023[4]).

5. The *Summary Report* provides a summary of the series of Issue Notes that were prepared to inform the Strategic Dialogues under Pillar 1 of the Climate Club Work Programme, *Advancing ambitious and transparent climate change mitigation policies*. Each chapter of this report corresponds to a Strategic Dialogue held with member countries and reflects the evidence base used for the discussions. The *Summary Report* discusses evidence on the causes and relevance of carbon leakage, both positive and negative, and explores both domestic measures and international co-operation strategies to address it.

6. The key findings of the *Summary Report* are outlined in the following points:

- **Differences in climate policies can entail international spillovers.** These spillovers can be positive or negative and manifest in differential outcomes, along three main dimensions: 1) the geographical distribution and total level of emissions (carbon leakage); 2) differential impacts on economic outcomes across countries, through compliance costs for businesses leading to effects on the broader macroeconomy; and 3) differential impacts on technology costs and technology diffusion.
- **Carbon leakage is one of the most discussed and studied international spillovers from climate change mitigation policy.** It occurs when foreign emissions increase because of the introduction or intensification of domestic climate policies, thus offsetting partly or totally their reduction impacts on domestic emissions. While existing ex-post evidence finds that carbon leakage has been limited so far, estimates of carbon leakage rates are generally higher in ex-ante studies, due in part to the ability of ex-ante analyses to model higher prices than the historical ones. Recent evidence on carbon price increases over the last years in some parts of the world suggests potential for significant leakage in some sectors under persistent policy asymmetries.
- **Meeting climate targets while managing international spillovers (i.e. minimising negative spillovers and amplifying positive ones) requires innovative policy solutions, synergies, and collaborative approaches**. Countries can deploy a range of policies that address carbon leakage. However, domestic measures (e.g. free allowances in ETSs, subsidies for low-carbon technologies, border carbon adjustments) generally offer only partial solutions to the challenge at hand since each instrument has certain inherent limitations (e.g. their fiscal cost, administrative complexity, trade impacts) and differences in approaches could lead to further fragmentation. Combining some of these approaches could help alleviate some of these limitations. Simultaneously, it is crucial to ensure coherence among instruments.
- **International co-operation holds significant potential to improve the effectiveness of countries' policies to reduce global emissions, including by mitigating carbon leakage risks.** An in-depth understanding of how international co-operation supports unilateral policies is key to leveraging synergies between them. By integrating both domestic and international co-operation approaches, policymakers can ensure that climate targets are met effectively and equitably.

2 Spillovers from climate policies

1. Evidence of differences in climate mitigation policies

7. **Climate mitigation policy packages differ across countries.** Policy packages are shaped both by country circumstances and by the different market failures that need to be addressed along the path to net-zero emissions (D'Arcangelo et al., 2022[3]).

8. **Country-specific circumstances impact the composition of climate policy packages**. These include the public acceptance for climate-related reforms, sectoral composition of the economy, administrative capacity, fiscal constraints, level of development, and natural resource endowment. For instance, sectoral composition matters, as it encompasses the importance of emission intensive sectors in an economy, their main emission sources (energy or industrial processes, CO_2 or other greenhouse gases), trade exposure, abatement costs, and availability of low-carbon alternatives. Another example is administrative capacity, since, for instance, some measures, such as emissions trading systems, rely on detailed monitoring, reporting, and verification systems of emissions at the facility level that may be administratively challenging to put in place.

9. **The path to net-zero emissions requires addressing several market failures, which influence the composition of climate policy packages.** The nature of market failures and other barriers in countries and sectors requiring decarbonisation involve different policy instruments, including those that reduce negative externalities, such as climate change and amplify positive ones such as technology spillovers. Path-dependence, knowledge spillovers, network effects, or learning-by-doing require instruments such as direct research and development (R&D) support or support for infrastructure and technology adoption and deployment.

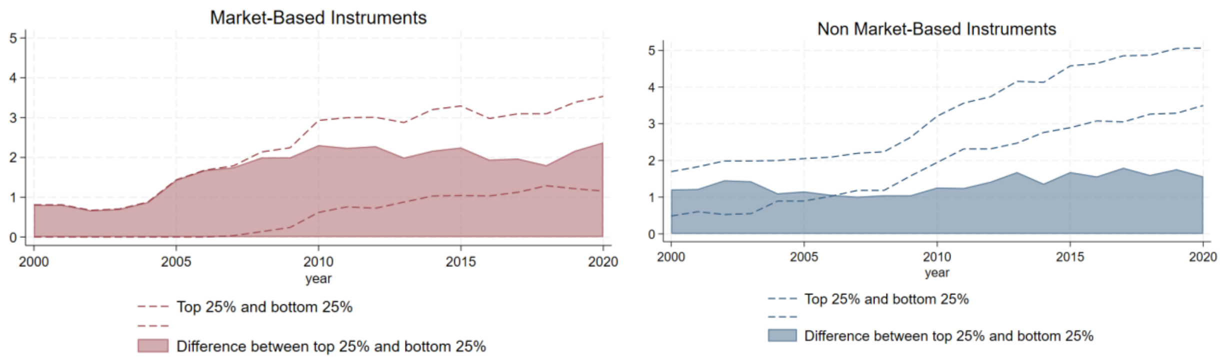
10. **Within policy types, intensity values and coverage vary across countries**. The asymmetries in levels of intensity (e.g. rate for a tax or subsidy, price for an emissions trading permit) and coverage (i.e. the amount of emissions a regulation or carbon tax applies to) also add significantly to the differences in climate policies across countries as they imply different outcomes for emissions reductions.

11. **The diversity in climate policy packages makes cross-country comparisons challenging, including with regards to the costs induced by polices.** As noted, there is growing awareness that well-designed mitigation strategies span a variety of policy instruments tailored to country specific circumstances and addressing multiple market failures (Blanchard, Gollier and Tirole, 2023[8]; D'Arcangelo et al., 2022[3]). However, the use of multiple policy instruments makes the comparison between countries' climate policy approaches difficult. Nevertheless, some attempts have been made to compare policies across countries (Aldy and Pizer, 2016[9]). This can be done by restricting the scope to a narrow set of policies (e.g. carbon pricing instruments), or by using composite indicators synthesising several policy types (e.g. the IMF's proposal for a country-level Carbon Price Equivalent (Black et al., 2022[10]) and recent calculations based on the OECD's Climate Actions and Policies Measurement Framework (D'Arcangelo, Kruse and Pisu, 2023[11])).

12. **Investigating the dynamics of a broader range of climate policies reveals that rising asymmetries in climate policy approaches across countries are mostly attributable to market-**

based policies. Despite starting from a similar level of stringency in 2000, the dispersion of market-based and non-market-based policies evolved differently over the following 20 years. Regarding market-based policies, the top quartile rose significantly (indicating that a group of countries implemented significantly more stringent policies) whereas the bottom decile hardly moved (suggesting little change in stringency). The same is not true for non-market-based policies as the top and bottom deciles moved nearly in parallel, as countries gradually adopted non-pricing policies at similar pace (Figure 2). This is complemented by evidence that carbon prices are increasing most in countries where they were initially higher (Figure 3).

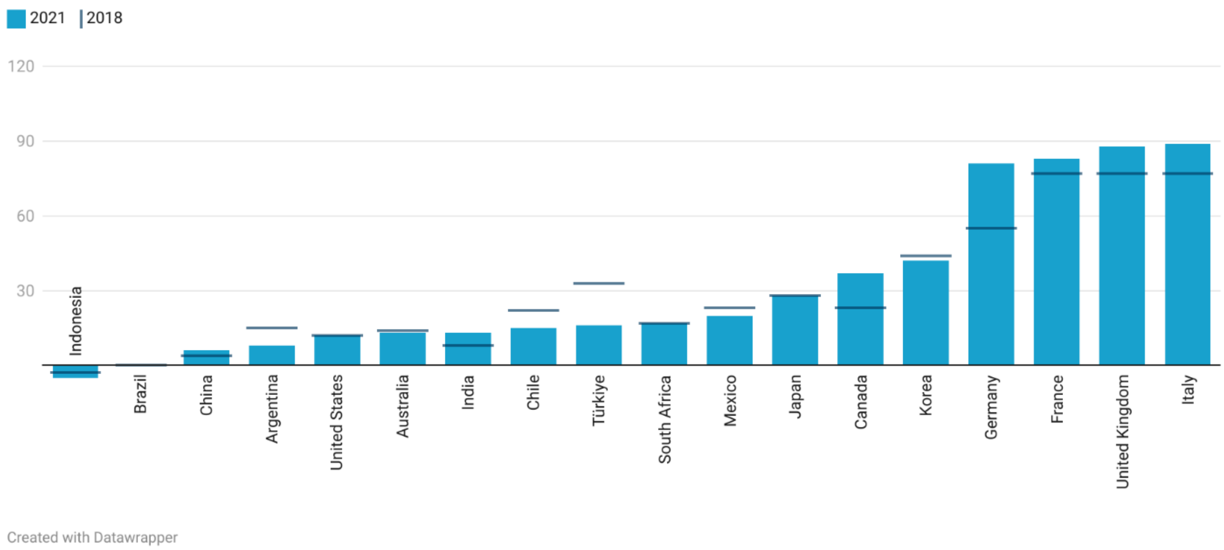
Figure 2. The dispersion of market-based policies' stringency increased whereas it remained overall stable for non-market-based policies



Note: Vertical axis represents stringency levels with 5 being the highest stringency level and 0 the lowest stringency level.
Source: OECD's computation based on CAPMF.

Figure 3. Carbon prices increased the most in countries where they were already the highest

Average Net ECR in 2021 EUR per tonne of CO_2e, 2018-2021



Note: Emissions-weighted net effective carbon rates, by G20 country (excluding Saudi Arabia). Carbon pricing here is measured according to the OECD Net Effective Carbon Rates methodology (Garsous et al., 2023[12]). Net Effective Carbon Rates (ECRs) are defined as the sum of carbon prices resulting from emissions trading systems, carbon taxes, and fuel excise taxes, net of fossil fuel subsidies.
Source: OECD (2022[5])

13. **The diversity of climate policy packages and the asymmetries in intensities and coverage of different policies call for broad policy inventories.** One such inventory is currently being developed and will be delivered by the OECD Inclusive Forum on Carbon Mitigation Approaches (IFCMA). This is an initiative designed to help optimise the global impact of emissions reduction efforts around the world through effective data and information sharing, evidence-based mutual learning and inclusive multilateral dialogue on climate mitigation strategies and mitigation and mitigation-relevant policy instruments.

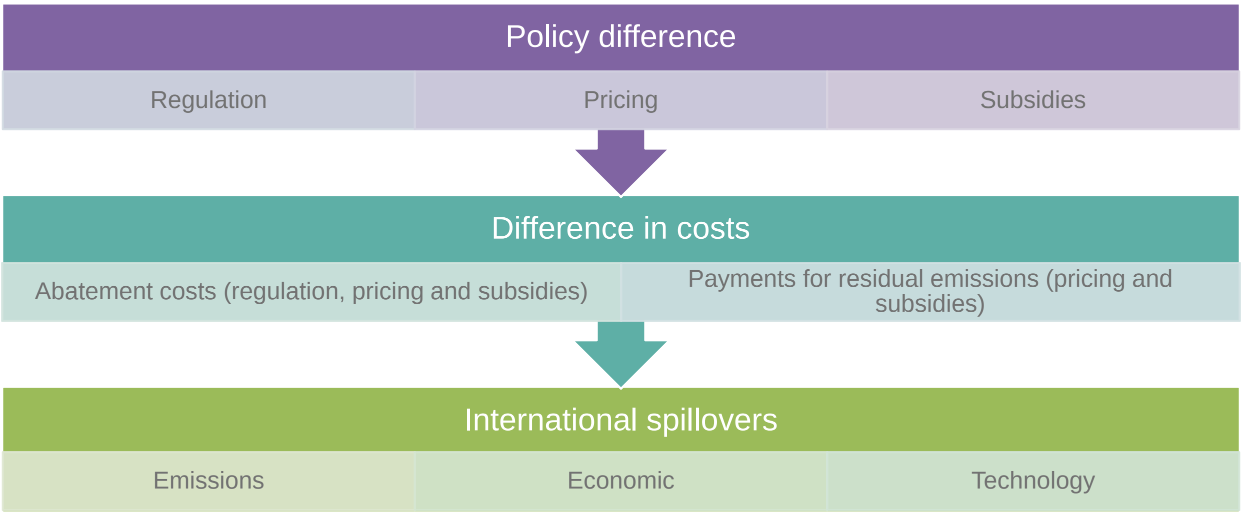
2. Spillovers from differences in climate policies: conceptual framework

14. **Differences in climate policies can lead to international spillovers**. These spillovers can be positive or negative and manifest in differential outcomes across countries, along three main dimensions: (i) the geographical distribution and the total level of **emissions** (carbon leakage); (ii) differential impacts on **economic outcomes,** through compliance costs for businesses leading to effects on the broader macroeconomy; (iii) differential impacts on **technology** costs and technology diffusion (Figure 4). The initial driver of spillovers lies in the changes in production costs that policies bring for firms.

15. **Cross-country differences in coverage and intensities of climate policies lead to differences in costs.** While both regulatory and pricing policies increase costs for firms, subsidies have the opposite effect.[2] Compliance with regulations increases costs when the regulations are binding and result in abatement effort. Pricing measures, in addition to triggering costly abatement, imply payments for unabated emissions. Firms in jurisdictions with climate policies that impose higher compliance costs will incur higher total costs. Subsidies reduce compliance costs related to regulatory and pricing policies. The cost differentials can lead to carbon leakage by impacting the location of emissions and their total level, they can impact the competitiveness of firms and can also affect technological progress over the longer run.

[2] Climate policies also impact households. However, given that these effects do not drive the spillover impacts from climate policies discussed on this note, they are not further discussed here.

Figure 4. Mechanisms through which climate policy differences can induce international spillovers



Source: Authors' elaboration.

Effects on compliance costs and economic outcomes

16. **The effect of climate mitigation policies on domestic firms' compliance costs and returns to investment can cause competitiveness concerns for internationally exposed firms – and loss of competitiveness of domestic firms can, in turn, impact domestic growth and employment.** In the short term, a climate policy-induced loss in competitiveness might result in reduced domestic output, but also in investment being redirected abroad. In the long term, this could lead to the closure of existing facilities or the relocation of production of the same products overseas. For example, firms might undertake foreign direct investment to produce similar goods at lower costs, exporting them back to their original markets or foreign firms producing similar or the same products may gain a comparative advantage and increase exports. When businesses relocate to countries with laxer climate policies and higher carbon intensities, this is referred to as the "pollution haven hypothesis" (Dechezleprêtre and Sato, 2017[13]).

17. **Climate mitigation policies may also enhance the competitiveness of firms.** This may take place through subsidies, which directly decrease businesses' compliance costs, or indirectly, through the longer-term productivity-enhancing effect of regulation or pricing. This latter effect is the more positive view of the link between competitiveness and climate policies, known as the Porter hypothesis (Porter and Linde, 1995[14]). According to this view, more stringent environmental policies such as higher carbon prices can trigger domestic investment in the development of new cleaner technologies. By gaining international leadership in clean technologies as first movers, they can increase their market share internationally and hence enhance their competitiveness (Dechezleprêtre and Sato, 2017[13]). Evidence completes this theoretical argument, as carbon pricing has been found to spur innovation and investment in low-carbon technologies (Hicks, 1963[15]; Aghion et al., 2016[16]; Calel and Dechezleprêtre, 2016[17]). Subsidising the adoption of green technologies is also a way to reduce emissions and improve long-run competitiveness while limiting short-run downside competitiveness risks – even though this comes with fiscal costs.

Effects on technology costs and diffusion

18. **Climate mitigation policies can result in lower technology costs and in technology diffusion over the long run.** As businesses increase their investments in clean technologies and gain experience developing and commercialising them at scale, the costs of these technologies decrease over time (Kavlak,

McNerney and Trancik, 2018[18]; Nemet, 2019[19]). Eventually, other countries could benefit from these cleaner technologies at lower costs if technology diffusion is not impeded by barriers such as regulatory or border barriers. Capacity building and foreign direct investment in developing countries can facilitate the diffusion of clean technologies (Choi and Kim, 2023[20]).

Effects on emissions: carbon leakage

19. **Differences in climate policies can affect the geographic distribution of emissions.** In a globalised economy with global value chains and international investment flows, domestic policies can impact the location of emissions as production and trade patterns shift across countries. One aspect of this phenomenon can generate the so-called carbon leakage effect, whereby foreign GHG emissions increase because of the introduction or intensification of domestic climate policies (OECD, 2020[21]; Fowlie and Reguant, 2018[22]). This may increase global emissions – if emissions shift to countries with higher carbon intensities – but could also decrease global emissions – if emissions shift to countries with lower carbon intensities. Negative carbon leakage could also occur, whereby foreign emissions decrease because of domestic climate policy.

20. **Carbon leakage can occur through multiple channels, both in the short and longer term. The trade and investment channel** impacts the level and geographic distribution of emissions via firms' costs. In the short term, a climate policy-induced loss in competitiveness might result in reduced domestic output, but also in investment being redirected abroad. In the long term, by increasing firms' costs, domestic climate policy can induce geographical shifts in production through relocation of firms altogether or through changes in the supply chain. **The international energy prices** channel occurs when a jurisdiction's demand for fossil fuels declines due to stricter climate policies. This can lead to a decrease in global fossil fuel prices, thus incentivising higher fossil fuel consumption (hence emissions) in foreign countries. Finally, **clean technology progress** induced by climate policies (such as clean technology subsidies) **and the international diffusion of such technologies** may result in negative carbon leakage, whereby foreign emissions decrease because of the introduction or intensification of domestic climate policies. This can occur through direct technology transfers to foreign countries and the expansion in the global market share of cleaner foreign firms.

21. **Mitigation policies aimed at addressing carbon leakage can impact trade, growth, and employment in countries to which carbon "leaks".** While competitiveness concerns relating to the relocation of production and losses of market share and carbon leakage concerns may be more relevant for economies with higher climate policy induced costs, the impact of measures that aim at addressing leakage is more relevant to countries with less stringent policies.

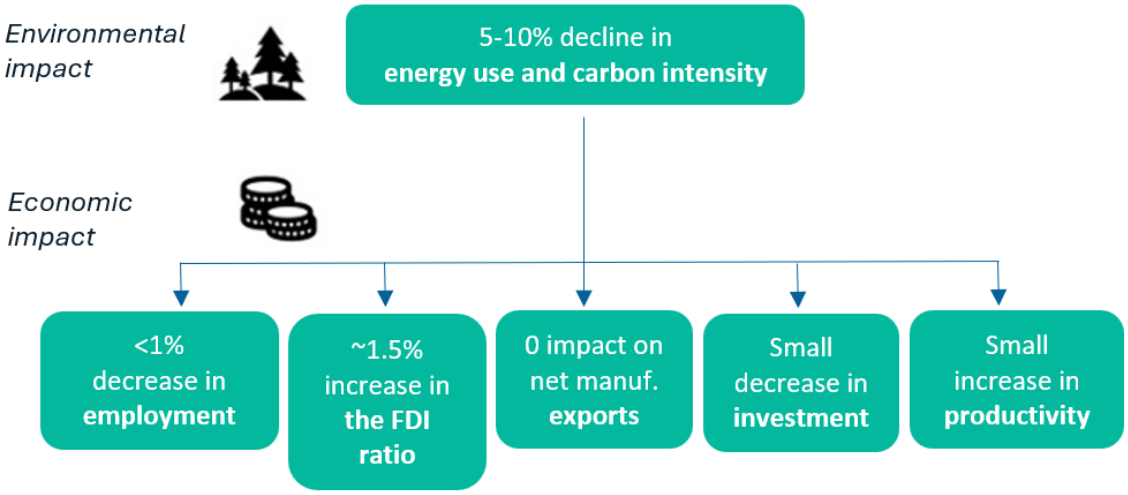
22. **Carbon leakage is one of the most discussed and studied international spillovers from climate mitigation policy.** The rest of the report concentrates on the issue of carbon leakage.

3. Evidence on carbon leakage

23. **Evidence on carbon leakage and its channels relies on both ex-ante and ex-post analyses.** Ex-ante analyses are model-based and enable the simulation of reforms in a forward-looking manner. The analyses are generally based on computable general equilibrium (CGE) models but may also rely on partial equilibrium models that enable a more detailed evaluation of sectoral heterogeneity. Ex-post analyses provide evidence based on past data and assess the effects of policies already in place. The available evidence focuses mostly on ex-ante analyses of carbon leakage occurring through differences in carbon prices.

24. **The ex-post evidence finds that carbon leakage has been limited so far** (OECD, 2020[21]; Ellis, Nachtigall and Venmans, 2019[23]). Ex-post models generally focus on the trade and investment channel and a decade of evidence from OECD studies (OECD, 2021[24]) finds no statistically significant or economically large effect of carbon pricing policies on factors that would feed into this channel, such as on employment, FDI, exports, investments, or productivity (see Figure 5). Studies have tended to find a positive effect of carbon prices on domestic environmental outcomes, especially a decrease in domestic energy use and carbon emissions and minor but statistically significant and positive effects on outward foreign direct investment (FDI), primarily in energy-intensive trade-exposed (EITE) sectors (e.g., Garsous and Kozluk (2017[25]); Borghesi, Franco and Marin (2019[26])). Looking at relocation decisions overall, other determinants than climate policies – such as labour costs – appear to have been more important so far in explaining trade and investment location decisions (Dussaux, Vona and Dechezleprêtre, 2020[27]).

Figure 5. Expected average domestic effects from a 10% increase in energy prices on manufacturing



Note: This figure illustrates average expected effects from a 10% increase in industry energy prices on environmental and economic outcomes in manufacturing sectors. It shows effects from across several OECD studies, which cover different samples, time periods and methods. Effects may differ across countries depending on country-specific policy contexts, macro-economic effects, and the time horizon.
Source: OECD (2021[24]).

25. **The low level of carbon prices to date and the pervasiveness of mechanisms such as the free allocation of allowances shielding industries from strong cost increases may help explain these findings.** Going forward, the scope for free allocation of allowances is set to become increasingly limited with plans to lower emissions caps in emissions trading systems (ETS) and to adopt more stringent emission-intensity benchmarks. This will result in fewer permits and less scope for free permit allowances. For firms, this will eventually mean shifting from payments for residual emissions to incurring abatement costs i.e. increasing their efforts to make their production less carbon intensive. This could affect production costs significantly and hence increase carbon leakage risk. Already recent empirical evidence finds higher rates of carbon leakage than previously identified (see below).

26. **Estimates of carbon leakage rates are generally higher in ex-ante studies than in ex-post ones.** This is mainly due to the ability of ex-ante analyses to model higher prices than the historical ones and to account for the international energy price channel. Additionally, ex-ante models do not consider various sources of inertia that may reduce the responsiveness to climate policies. Branger and Quirion (2014[28]) perform a meta-analysis of 25 ex-ante models and estimates carbon leakage rates ranging

between 5% and 25% in scenarios without any policy aiming at addressing this phenomenon. Ex-ante analysis has tended to find that the international energy price channel dominates (Boehringer, Fischer and Rosendahl, 2010[29]). In contrast to studies that examine emission reductions driven by carbon price increases, a recent study by Larsen et al. (2023[30]) analyses the impact of emission reductions achieved through the U.S. Inflation Reduction Act (IRA). Using a CGE model, the study finds that the IRA's cost reductions for low-carbon technologies also contribute to emissions reductions beyond U.S. borders.

27. **In recent years, carbon prices have increased strongly in some parts of the world, whereas they remained low in others** (OECD, 2023[4]). Teusch et al. (2024[30]) test the effect of these developments on domestic emissions and carbon leakage for cement and steel. These two sectors alone account for more than 40% of industrial greenhouse gas emissions. Over the observed period the average plant-level carbon price for these sectors increased by a factor of seven from USD 1.4 per tonne of CO_2-equivalent (tCO_2e) in January 2015 to USD 11/tCO_2e in December 2021.The paper finds that higher carbon prices have reduced plant-level emissions and that rising carbon price asymmetries have affected international trade patterns and led to carbon leakage. The empirical results suggest that on average, a USD 1 per tonne of CO_2e increase in carbon prices reduces cement and steel plants' domestic emissions by 1.3%. The effect is driven by both carbon intensity improvements and output reductions.

28. **Calculations of average leakage rates based on estimated elasticities suggest that carbon leakage through international trade offset around 13% of these domestic emission reductions**. Results suggest that as the carbon price difference between the importing county and exporting country rise, countries' imported emissions increase. One explanation for the relatively moderate leakage effect is that these sectors still receive free allocation in many countries and other forms of government support (Garsous, Smith and Bourny, 2023[31]; OECD, 2023[4]), which reduce the carbon leakage risk.

29. **One recent study points to the long-term effect of climate legislations on technology diffusion, greener investments, and consumption abroad**. Eskander and Fankhauser (2023[32]) explore this phenomenon by analysing the impact of national climate legislation on international carbon emissions from 1996 to 2018. Unlike more granular studies focusing on specific products or industries, their research evaluates the aggregate impact of climate policies across economies, providing a macro-level assessment. They find that climate legislation leads to significant reductions in both territorial emissions and imported emissions, with no evidence of trade-related carbon leakage. They also identify a significant negative long-term effect on domestic emissions from climate laws passed by major trade partners. This suggests that climate policies can induce clean innovation and promote greener consumption internationally through technology spillovers.

3 Domestic policies addressing carbon leakage

30. **Countries can deploy a range of policies that address carbon leakage.** This section describes policies explicitly designed to mitigate carbon leakage and policies that indirectly address this phenomenon. For instance, while free allowances and border carbon adjustments (BCA) most likely include carbon leakage mitigation as one of their policy objectives, domestic subsidies for low-carbon technologies, while not explicitly targeting carbon leakage, may still help address it by supporting technology diffusion and innovation . The list of policies discussed in this section is not exhaustive but presents the main instruments used or potentially applicable in this area.

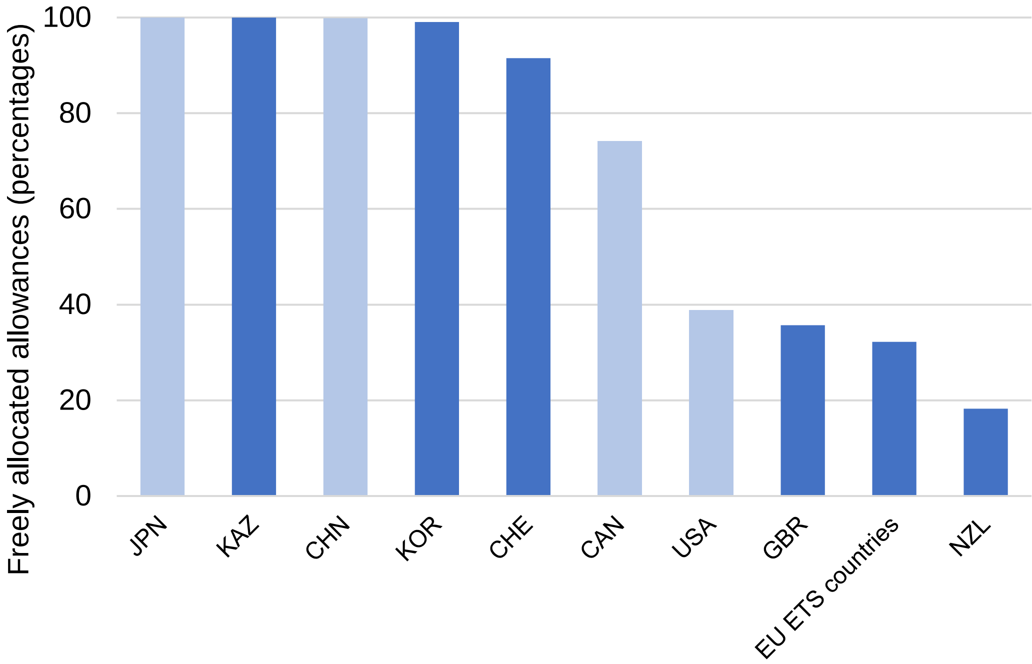
1. Free allowances within emissions trading systems

31. **To date, many countries have addressed the concern of carbon leakage caused by asymmetrical carbon prices via emissions trading systems (ETS) by freely allocating emission allowances to firms instead of auctioning them** (see Figure 6). Free allowances allocations are highly heterogeneous across jurisdictions. Most ETSs use a mass-based approach with an absolute emissions cap that typically declines over time according to national carbon mitigation plans (e.g. the EU ETS, the California Cap-and-Trade system). Alternatively, ETSs can also be rate-based, relying on measures of emissions per unit of product rather than total emissions for allocation (e.g., the Australian Safeguard Mechanism, the Chinese National ETS).[3] Further, free allowances can vary based on several factors, including the targeted sectors, their benchmark setting and dependence on historical emissions, or specific conditions for entering firms. As illustrated in Figure 6, differences in free allocations coverage across countries reflect differences in scope, sectoral composition, and adjustments rates for EITE sectors (OECD, 2023[4]).

[3] This approach offers greater flexibility by preventing excessively high permit prices during economic booms and mitigating severe price drops during downturns. However, it has drawbacks, such as its ineffectiveness in reducing production for compliance, as permits decrease with output, potentially undermining the system's cost-effectiveness.

Figure 6. Share of free allocation in verified ETS-covered emissions, by country with positive permit prices, 2021

Countries with national level or supra-national ETS (dark blue) and countries with sub-national level ETS (light blue)



Note: The EU ETS applies to all EU countries as well as Iceland, Liechtenstein, and Norway. The 2023 ECR database does not cover Bulgaria, Croatia, Liechtenstein, Malta, and Romania, so these are not presented in this figure and the overall share over EU ETS countries does not include them either. Mexico's pilot ETS is not presented here, because prices were null in 2021. Canada, China, Japan, and the United States each have sub-national ETSs (along with the national ETS for China), and for each of these countries, it is the resulting country-level share of free allocation of allowances in total verified emissions that is presented here. Total verified emissions refer to the sum of the ETS covered emissions.
Source: OECD (2023[4]), Effective Carbon Rates 2023: Pricing Greenhouse Gas Emissions through Taxes and Emissions Trading, OECD Series on Carbon Pricing and Energy Taxation, OECD Publishing, Paris, https://doi.org/10.1787/b84d5b36-en.

32. **Free allowances support firms' competitiveness while maintaining incentives to reduce emissions at the margin** (OECD, 2020[21]; Zaklan, 2023[33]). By reducing the total cost of emissions (and then firms' average costs), free allowances provide support to domestic firms, thus helping mitigate the risk of carbon leakage taking place through the trade and investment channel. At the same time, free allowances do not change marginal carbon prices and hence preserve incentives to reduce emissions at the margin, since firms face an opportunity cost of using the allowances instead of selling them at market price. Incentives vary across different ETSs based on the design and the stringency of the cap, the free allocation rules and the benchmark used to determine the output-based allocations.

33. **In practice, there are several drawbacks to free allowances, including overallocation, reduced incentives to abate, windfall profits and forgone government revenue which may impact the incentives to move to net-zero** (OECD, 2020[21]). The overallocation of free allowances tends to

occur more when grandfathering is used as an allocation method, wherein firms receive emission allowances according to their historical emissions. Overallocation may also be due to outdated or insufficiently granular benchmarks, or limited responsiveness to macro or technology shocks, with little output-based corrections (Dechezleprêtre, Nachtigall and Venmans, 2018[34]). Free permits weaken abatement incentives, in particular by weakening incentives to invest in low-carbon production technologies (Flues and van Dender, 2017[35]; Dechezleprêtre, Nachtigall and Venmans, 2018[34]). Further, the opportunity costs created by free allowances may be passed through to output prices, which can increase profits for the firm – a phenomenon known as windfall profits (Dechezleprêtre, Nachtigall and Venmans, 2018[34]). This degree of marginal cost pass-through depends on many factors, including the allocation regime, the level competition in the sector, demand and supply elasticities, carbon intensity of production, and international trade exposure of the sector. Evidence for high windfall profits has generally mostly been found in the power sector as pass through of ETS costs is high (OECD, 2023[4]). Lastly, free allowances represent foregone revenue for domestic governments (see e.g. OECD (2022[5])). Therefore, the use of free allowances could hinder progress toward achieving net-zero emissions. Free allowances are decreasing in many ETSs, through an increase in the share of auctioned allowances, a decrease in ETS caps or in the benchmark emission intensity in the case of rate-based systems. Indeed, the tightening of a cap implies less room for free permits, so even if the share of free allocation of allowances does not change, its level does (OECD, 2023[4]). Equivalently, a tightening of the benchmark emission intensity implies a greater need for trading allowances or credits. Firms complying with ETS having a decreasing cap (or benchmark) would need to eventually abate as opposed to relying on free allocation of allowances.

34. **In addition to free allowances, countries with ETSs can compensate producers for input-price increases resulting from carbon pricing** (OECD, 2020[21]). This aims to prevent potential leakage from indirect cost increases. For example, in several EU countries, firms also receive compensation due to the ETS-induced increases of electricity costs.

2. Preferential carbon tax rates and other preferential tax treatment for energy use

35. **Preferential carbon tax rates or other preferential tax treatment for energy use through reduced or zero tax rates for specific sectors or products may be another measure to address carbon leakage** (OECD, 2020[21]), especially if applied to EITE sectors. Such preferential rates may increase political support from actors that find it hard to quickly reduce their emissions through the adoption of new technologies or behavioural change.

36. **Jurisdictions can offer exemptions, reduced tax rates, or rebates on carbon tax payments akin to providing free allowances to firms covered by an ETS**. For example, operators in emission intensive sectors whose international competitiveness could be significantly compromised may be exempted from the CO_2 levy in Switzerland. In exchange, these firms must commit to reducing their greenhouse gas emissions by entering into an agreement with the government.[4]

Preferential rates have drawbacks, including reduced abatement incentives and foregone government revenue (OECD, 2020[21]; OECD, 2023[36]). Preferential rates, similar to free permits, lower domestic policy stringency for trade-exposed domestic firms. However, unlike free permits, preferential carbon or energy tax rates also reduce marginal incentives to lower emissions for firms benefiting from these preferential rates. Furthermore, preferential rates may weaken incentives for foreign firms to invest in clean production. Changes in fossil fuel prices relative to other goods and services significantly influence

[4] https://www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/co2-levy/exemption/step-by-step.html

production and consumption decisions. These support measures can alter investment returns in specific sectors, favouring fossil fuel production and intensive use over cleaner energy alternatives. This distortion can lock in polluting technologies for decades, delaying the transition to a low-carbon economy and increasing the risk of stranded assets as environmental and regulatory conditions evolve (OECD, 2015[36]). Since 2012, the OECD monitors government support that confers preferential treatment to fossil fuel production and consumption across 50 OECD, G20, and EU Eastern Partnership countries (OECD, 2023[36]).

3.

4. Border Carbon Adjustments (BCAs)

37. **Border carbon adjustments (BCAs) are gaining interest in the policy community as a way to reduce the risk of carbon leakage**. The EU has recently introduced a Carbon Border Adjustment Mechanism (EU CBAM) effective from October 2023 and with a transition period until December 2025. The CBAM will be gradually phased in, replacing free allowances, which will be completely phased out for sectors covered by the CBAM by 2034. The United Kingdom is planning on introducing its own CBAM from January 2027. Several other countries – including Australia (DCCEEW, 2023[38]),– are considering similar mechanisms.

38. **The objective of most BCAs is to ensure that imports face the same carbon price as a comparable good produced domestically.** BCAs may be designed in various ways. The most discussed variants to date generally consist in levies on imported products based on the carbon price they would have incurred if produced domestically. BCAs may also generate revenue for domestic governments, which can be used e.g. to advance the green transition and address equity concerns (domestically or internationally). But as BCAs also create incentives for producers abroad to decarbonise, revenues raised may be limited. Given the strong link between climate and trade considerations, through their potential effect on the competitiveness of both domestic and foreign industries, one important condition for BCAs is their compatibility with World Trade Organisation (WTO) rules (OECD, 2020[21]).

39. **Designing an effective and feasible BCA might be challenging. BCAs comprise a wide variety of possible design features, with different variations and trade-offs** (OECD, 2020[21]). This includes whether the BCA is applied to either just imports or also exports. Applied only to imports, BCAs decrease carbon leakage risks by subjecting imports to the same carbon price as comparable domestically produced goods. However, to achieve similar effects internationally, these measures may need to address carbon costs for exporting firms to jurisdiction with lower or no carbon pricing in place. A critical concern regarding export rebates is potential compatibility with WTO rules (OECD, 2020[21]). Another design feature that could be considered is whether or not to couple the BCA with carbon pricing or other mitigation policies.

40. **BCAs can also vary in terms of sectoral coverage, and scope of emissions covered – the resulting choices induce trade-offs between complexity and administrative costs versus accuracy**. Relatedly, verification and certification costs may vary depending on the carbon intensity metric used. BCAs based on carbon prices not only require measurement of carbon intensity of products but adjustments of the BCA liability for carbon prices paid abroad. To date, no product-level carbon pricing system exists, adding to the implementation challenges of such a system. Collecting product-level data on carbon intensity with credible third-party verification could be feasible for direct emissions but poses significant challenges and costs for indirect emissions (OECD, Forthcoming[39]; OECD, 2024[40]). Precise legal verification of emissions streams would increase implementation costs and create technical barriers to trade. BCAs generally have to rely on carbon intensity estimates of products. They could rely on national

sector-level emission intensities or technology-specific estimates to reflect the overall domestic policy ambition. However, this approach risks penalising firms that have a low emission intensity compared to other firms in the same country and sector and reducing abatement incentives. Using national benchmarks could also be discriminatory towards foreign producers and thus runs in conflict with trade rules. One potential response to these issues is to allow producers to prove that they outperform the benchmark. However, this approach risks encouraging the 'reshuffling' of emissions, where lower-carbon production is directed toward export markets subject to BCAs, leaving higher-carbon production for domestic or other markets (Böhringer et al., 2022[41]). Moreover, BCAs come with high administrative costs, relating to the interoperability of emissions-intensity monitoring, verification, and reporting.

41. **Despite the potential issues linked to BCAs, ex ante modelling exercises suggest that BCAs can effectively reduce carbon leakage** (Branger and Quirion, 2014[28]; Nachtigall and Ellis, 2021[42]) **and can also be expected to promote more ambitious climate policies in other countries.** Following the introduction of the CBAM, countries including India, Indonesia, Morocco, Türkiye, Ukraine, Uruguay, and Western Balkan countries, have implemented, adjusted, or are considering implementing direct carbon pricing to reduce CBAM compliance costs and to capture revenue that would otherwise be paid to the EU (World Bank, 2024[43]). The degree of effectiveness of BCAs in preventing leakage depends on the extent to which BCAs cover EITE products, the treatment of exports (inclusion of export rebates), and the precision of the measurement of embodied carbon emissions (using foreign-specific criteria rather than default domestic-based factors). BCAs have also been found to be relatively more effective in reducing carbon leakage than free allowances based on the grandfathering approach, wherein firms receive emission allowances according to their (historical) emissions (OECD, 2020[21]).

5. Excise taxes on the domestic consumption of carbon-intensive goods

42. **Excise taxes on the domestic consumption of both locally produced and imported carbon-intensive goods can be another policy tool to address carbon leakage**. Currently, carbon-content related excise taxes are not widespread for carbon intensive industrial goods. The rates of excise taxes could generally be based on the average carbon content of the goods (or on product benchmarks). With sufficiently granular product categories and the availability of carbon intensity metrics at this level of detail, low-carbon goods become cheaper than their high-carbon counterparts. Excise taxes are levied on both domestic and imported goods, reducing the risk of WTO challenges. Further, excise taxes also generate revenues for the domestic government, which can be used to accelerate the green transition or for other public policy goals.

43. **However, unlike more sophisticated but administratively more complex BCAs based on product-level carbon intensities, excise taxes, when based on average intensities, price the average emissions or benchmark emissions of goods**. They are thus amenable to a wide product coverage and provide flexibility for rate adjustments over time. However, this average intensity-based approach, while easier to implement, may not create strong incentives to switch to a cleaner production method for a given good (OECD, 2020[21]). Therefore, using more granular carbon intensity metrics to set excise tax rates can strengthen emission abatement incentives (OECD, 2020[21]; Neuhoff and et al., 2016[44]; OECD, 2024[40]). While excise taxes may not directly incentivise foreign countries to introduce carbon pricing mechanisms as BCAs do, they could still encourage cleaner production processes in the longer term provided they are adopted widely or in large markets.

44. **Feebates, a policy with some similarities to excise taxes, use a sliding scale of taxes on products or activities with above-average emissions and a sliding scale of rebates for products or activities with below-average emissions** (OECD, 2020[21]; Parry, van der Ploeg and Williams, 2012[45]). This policy incentivises consumers to shift to less polluting technologies to benefit from the rebate and

avoid the tax. In general, feebates are designed to be revenue neutral. The “carrots (i.e. the rebate) and sticks (i.e. the fee)” feature may increase the public acceptability of this instrument as compared to excise taxes alone. Currently, feebates are primarily used in the transport sector, such as for vehicle registration and circulation taxes. The availability of granular data on emissions at product level could drastically expand the range of applications of this policy.

6. Domestic subsidies for low-carbon technologies

45. **Some climate change mitigation policies, even when not explicitly introduced to address carbon leakage, may help to reduce the risk of carbon leakage and even lead to negative carbon leakage, whereby emissions abroad are reduced due to domestic technological progress**. Domestic subsidies for low-carbon technologies are an example of such a policy.

46. **If well designed, subsidies for low-carbon technology drive innovation, leading to cost reductions that enhance the competitiveness of low-carbon technologies compared to their high-carbon counterparts**. Several jurisdictions are deploying large support packages for low-carbon technologies, including under the US Inflation Reduction Act (The White House, 2023[46]), the EU LIFE (L'Instrument Financier pour l'Environnement) programme (European Commission, 2024[47]), Japan’s Green Transformation Plan (Japanese Ministry of Economy, Trade and Industry (METI), 2024[48]), and Australia’s Hydrogen Headstart program (Australian Government, 2024[49]). Evidence suggests that experience (i.e. learning-by-doing) is a major determinant of new technologies’ cost reductions (Way et al., 2022[50]). Support for the development and deployment of clean technologies can accelerate learning-by-doing and the accumulation of experience, thus reducing their costs. The resulting cost reductions further foster the deployment and diffusion of low-carbon technologies, both domestically and internationally, including in developing countries through international technology diffusion and knowledge spillovers (Cervantes et al., 2023[51]; Dressler and Warwick, Forthcoming[52]).

47. **Different barriers to clean technological deployment exist that may justify government intervention**. Subsidies can be an important policy tool for addressing market failures and emergencies (such as vaccine development in the context of Covid-19). Well-designed subsidies for low-carbon technologies can, for instance, relieve credit constraints; support innovation through research and development as well as demonstration, create knowledge spillovers through learning-by-doing or address information asymmetries. Realising these benefits in practice requires careful policy design (Dressler and Warwick, forthcoming[53]).

48. **Subsidies come with certain drawbacks, including their fiscal costs and their potentially counterproductive effects if not carefully designed** (Millot and Rawdanowicz, 2024[54]). Policymakers must consider the potentially large fiscal costs associated with domestic subsidies. Further, targeting support for clean technologies and energy sources is crucial. Untargeted government support risks creating conditions that lead to economic and environmental inefficiencies (Garsous, Smith and Bourny, 2023[31]).

7. Mandatory product standards

49. **Another policy approach to address carbon leakage involves implementing mandatory product standards on emission intensity (or other environmental performance indicators such as resource efficiency) for domestic products and imports** (OECD, 2017[55]; OECD, 2020[56]). Mandatory product standards that set product-level carbon intensity ceilings can help lower emissions and mitigate carbon leakage risks (OECD, Forthcoming[39]). They can foster the development of the market for low-

carbon goods. Applied to domestic production and imports, they can help achieve domestic emissions reductions while reducing the risk of carbon leakage.

50. **Several factors can enhance their effectiveness, fairness, and feasibility** (OECD, Forthcoming[39]). International action to coordinate standards can help mitigate carbon leakage risks while promoting decarbonization globally. To be perceived as fair and safeguard market competition, such standards would need to recognise the compliance challenges of SMEs and developing countries. Additionally, such standards also should comply with a country's bilateral, plurilateral, and multilateral agreements (including those under the WTO).

51. **However, standards may have several disadvantages, including their potentially high administrative costs and potential mismatches with climate and trade goals**. Standards may generate administrative costs, including expenses to establish comparable methodologies to ensure compliance with the standard as well as verification and certification expenses (OECD, 2015[57]; OECD, Forthcoming[39]). Moreover, mandatory product standards may be set at a level that is politically or economically feasible rather than the optimal level required to achieve long-term climate objectives. Consequently, they can sometimes be misaligned with climate goals and be designed to favour domestic industries, potentially leading to disputes within the WTO (OECD, 2015[57]). In any case, setting effective ceilings is challenging. Ceilings set too low risk being unattainable and negatively impacting competition whereas ceilings set too high risk being ineffective (OECD, Forthcoming[39]). One possible to solution is to combine ceilings with flexibilities, so that over-performers receive credits, which can be sold to under-performers. Similar to BCAs, another concern is related to resource reshuffling, whereby lower-carbon production is directed toward export markets subject to standards, leaving higher-carbon production for domestic or other markets. Lastly, unlike carbon taxes or ETSs, mandatory product standards do not generate revenues.

52. **Mandatory product standards based on emission intensities are not yet widely implemented, but the United Kingdom (UK) government has considered their potential**[5]. In a 2023 consultation, the Department for Energy Security and Net Zero and HM Treasury explored a range of policies, including voluntary product standards, mandatory product standards, product labels, and an embedded emissions reporting framework. While the UK plans to consult on detailed voluntary product standards proposals in 2024, it will continue to assess the possible role of mandatory product standards in addressing carbon leakage in the late 2020s or early 2030s.

8. Summary

53. **The effectiveness of domestic policy instruments in mitigating carbon leakage risks while sustaining incentives for emissions reduction varies significantly depending on contextual factors and the specifics of their design** (OECD, 2020[21]). Table 1 summarises the characteristics of each reviewed instrument. Domestic measures generally offer only partial solutions to the challenge at hand since each instrument has certain inherent limitations and differences in approaches could lead to further fragmentation. Ultimately, the effectiveness of each policy in addressing the risk of carbon leakage will depend on its specific design features. For instance, the extent to which free allocations may mitigate carbon leakage depends on how the policy is structured and on the covered sector's characteristics. The same principle applies to other measures.

54. **Combining approaches could help limit some of their associated shortcomings** (OECD, 2020[21]). For example, a jurisdiction with a broad-based Emissions Trading System (ETS) might also implement additional excise taxes on carbon-intensive products like steel, cement, and bulk chemicals to

[5] https://www.gov.uk/government/consultations/addressing-carbon-leakage-risk-to-support-decarbonisation

encourage a shift towards cleaner alternatives, while mitigating risks of leakage by levying a uniform tax between domestically produced and imported goods. In addition, it could provide targeted subsidies to low-carbon innovation and investments to ensure that carbon leakage mitigation reinforces incentives to decarbonise. Simultaneously, it is crucial to avoid inconsistencies between instruments. For instance, introducing a BCA alongside free allowances could undermine the credibility of the ostensible goal of reducing emissions, as both measures aim at mitigating carbon leakage, but free allowances provide weaker incentives to decarbonise (OECD, 2020[21]).

55. **Meeting climate targets while managing international spillovers requires innovative policy solutions, synergies, and collaborative approaches** (OECD, 2020[21]; OECD, Forthcoming[39]). The next chapter outlines some possible approaches.

Table 1. Main features of selected policies addressing or affecting carbon leakage

Instrument	Maintains domestic abatement incentive	Avoids carbon leakage related to asymmetric cost increases for domestic producers	Generates revenues for domestic governments	Incentivises foreign countries to invest in clean production or in pricing carbon emissions	Administratively within reach
Free allowances	Weak to moderate (depending on extent and design)	Moderate to strong (depending on share of free allocation)	No (foregone revenue)	No	Strong
Preferential carbon tax rates and other preferential tax treatment for energy use	Weak (depending on size of discount)	Moderate to strong (depending on size of discount)	Weak (foregone revenue, depending on size of discount)	No	Strong
Border carbon adjustments	Strong	Moderate	Yes	Moderate to strong	Weak
Excise taxes on consumption of specific carbon-intensive goods	Moderate	Moderate	Yes	Moderate	Strong
Domestic subsidies for low-carbon technology	Variable (depends on design)	Moderate to strong	No (Fiscal cost and potential foregone revenue)	Variable (depends on technology diffusion across countries)	Variable (depending on design)
Mandatory product emission intensity standards	Variable (depending on design)	Moderate to strong	No	Variable (depends on harmonisation in standards)	Weak

Source: (OECD, 2020[21]) “Climate Policy Leadership in an Interconnected World: What Role for Border Carbon Adjustments?”; (Dressler and Warwick, Forthcoming[52]) “Corporate income tax, investment, and the net-zero transition: Issues for consideration”; OECD/IEA/NEA/ITF (2015), “Aligning Policies for a Low-carbon Economy”

4 Options for international co-operation

56. **As governments increasingly adopt measures to manage carbon leakage risks and enhance the acceptability of climate policies, it is likely that diverse approaches will emerge.** Many of these domestic policies depend on assessing the carbon content of products. Carbon intensity metrics can help track carbon emissions associated with producing outputs, either at the country, sector, or product level (OECD, 2024[40]). Default reference values based on sector or subsector averages, for example, can be useful complements and could potentially reduce compliance costs. If the measurement of carbon intensities and the design of the policies that use carbon intensity metrics are not consistent across jurisdictions, firms' compliance costs and governments' administrative costs can increase, increasing the costs of trade. Currently, the monitoring, reporting and verification (MRV) systems underpinning carbon intensities metrics differ across jurisdictions. Establishing interoperable MRV systems helps to lower administrative costs and firms' compliance costs.

57. **Co-operative approaches can facilitate the interoperability of carbon intensity measurements and policy approaches (e.g. carbon prices, regulations, green subsidies) and could pave the way to better alignment where relevant**. Interoperability allows diverse carbon intensity measurement systems or policy approaches to be compatible and consistent. In doing so, it enables different methods or policies to work together effectively, supporting co-operative efforts in achieving goals like emission reductions. This can help to reduce firms' compliance costs, policy uncertainty, and governments' administrative costs. Co-operation may entail exchanging information on carbon emissions embedded in trade (preferably at subsector or product level) and climate change mitigation policy design, developing interoperable greenhouse gas accounting, reporting, and verification systems, developing mutually recognised carbon accounting methodologies, and designing international (plurilateral or multilateral) solutions based on common mitigation policy approaches.

58. Table 2 **presents a non-exhaustive list of options for mitigating carbon leakage through international co-operation, ranging from the least to the most integrated forms of co-operation.** These can be seen as complementary actions to existing multilateral efforts, such as the Paris Agreement, with regards to contributing to the global emissions reduction efforts and WTO trade rules, in terms of securing the efficient and fair functioning of open markets and avoiding trade distortions.

59. **To engage fully in the more integrated forms of co-operation, emerging markets and developing economies will require support, in the form of technical or financial assistance**. Examples of such forms of support are the Partnership on Transparency in the Paris Agreement (PATPA) providing support for countries for the compilation of their Biennial transparency reports (BTR) under the UNFCCC[6]; and the efforts of the Global Matchmaking Platform under Pillar 3 of the Climate Club aiming to match support needs for industry decarbonisation efforts of developing and emerging economies with

[6] For more information on the PATPA BTR guidance tool, see https://transparency-partnership.net/publications-tools/btr-guidance-and-roadmap-tool.

existing international technical and financial assistance offers and private finance instruments (Climate Club, 2024[58]).

Table 2. Options for addressing carbon leakage through international co-operation

Option	What does it imply?	Why can it help to address carbon leakage?	Requisite level of international co-operation	Examples
Information exchange on carbon emissions and policy design for purposes of analysis and peer learning	Information exchange of data, in particular granular carbon emission and intensity data, as well as of climate policy design.	- Increases transparency and enhances understanding of countries' diverse mitigation approaches and their possible international spillovers. - An increased understanding of policies can assist countries in prioritising policy instruments for evaluation and reform, highlighting overlaps or interactions among policies that can affect their effectiveness and efficiency.	Low to moderate	- IFCMA carbon intensity workstream & stocktaking of policies - Biennial transparency reports (BTRs under the UNFCCC - Exchanges in the context of the Strategic Dialogue of the Climate Club as well as under Pillar 2 of the Climate Club on definitions and measurement standards - Emissions Measurement and Data Collection for a Net Zero Steel Industry (IEA (2023),
Interoperability of monitoring, reporting and verification (MRV) systems and of carbon intensity measurement and policy instrument design	Interoperability of MRV systems and carbon intensity measurement methodologies assures different carbon intensity metrics are compatible and consistent. In turn, this ensures that different policies (i.e. different through their design, emission/ sectoral coverage, and intensity) may be interoperable.	- Can prevent increased reporting costs for businesses and minimise trade frictions. - Interoperability of policy approaches fosters greater alignment in carbon pricing and regulatory standards across different jurisdictions.	Moderate	- IFCMA carbon intensity workstream - Embedded carbon emission measurements within the Australian Guarantee of Origin Scheme, EU and UK CBAM, US Task Force on Climate and Trade - Climate Club's Pillar 1, Module 1 and Pillar 2 Module 1 2024 Work Program
Mutual recognition of carbon intensity measurement and polices based on them	Countries accept that third countries' national rules, emission measurements, conformity assessment procedures adhering to or developed through pre-defined and internationally agreed standards or processes are equivalent to their	- Fosters greater consistency and alignment in regulatory standards across jurisdictions. - Ensures that firms in countries of the mutual recognition agreement are not	Moderate to high	- "Mutual Recognition Principle" within the European Union - Mutual recognition agreements among trade partners - ISO standards - Environmental Product Declaration

	own (e.g. technical alignment).	discriminated abroad and face similar costs for carbon emissions. - Facilitates the development of international markets of low-emission products though certification (i.e. lowering asymmetric information problems).		
International solutions	International solutions refer to policy approaches to address carbon leakage that are undertaken plurilaterally or multilaterally	- Can ensure broad consistency and alignment in carbon pricing or regulatory standards across different jurisdictions. - Effectiveness depends on the degree of commitment by governments.	High	Initiatives to raise ambition: - International Maritime Organization (IMO) Strategy on Reduction of GHG Emissions from Ships - Global Methane Pledge Common procedures: - Industrial Deep Decarbonisation Initiative (IDDI) Common policies: - IMF proposal on carbon price floors - Linking of ETSs - Nordhaus climate club proposal

Source: Authors' elaboration.

1. Information exchange on carbon emissions and climate change mitigation policy design

60. **One avenue for international co-operation is the exchange of information and data to support analysis and peer learning**. This includes exchanging granular carbon emissions data, emission intensity metrics, and the detailed aspects of climate policies. Sharing such data and information enhances transparency, deepens the understanding of diverse climate mitigation approaches across countries and provides clearer insights into the importance and drivers of carbon leakage risks. At the domestic level, it can also assist governments in prioritising policy instruments for evaluation and reform by identifying overlaps or interactions among policies that may influence their effectiveness. Ultimately, such information exchange could drive greater convergence towards more effective mitigation policy mixes.

61. **A variety of policy initiatives already facilitate sharing information on emission measurements and climate policies**. Examples include the work of the Climate Club under Pillar 1.1. and Pillar 2 (Climate Club, 2024[58]), IEA work on Emissions Measurement and Data Collection for a Net Zero Steel Industry (IEA, 2023[59]), OECD work on the measurement of carbon intensity and the stocktaking of available climate policies under the IFCMA (OECD, Forthcoming[60]; OECD, Forthcoming[39]), the UNFCCC's Global Stocktake and Biennial Transparency Reports (BTR)[7], the World Bank's Country

[7] For further information on the BTR, see https://unfccc.int/biennial-transparency-reports.

Climate and Development Reports (CCDRs)[8], the IMF-World Bank Climate Policy Assessment Tool (CPAT) (Black et al., 2023[61]), IMF and OECD country diagnostics (such as Article IV consultations[9] and OECD Economic Surveys[10]), as well as databases from thinktanks and academic institutions.

62. **Ongoing OECD work under the IFCMA carbon intensity workstream provides a high-level overview of the key methods and challenges in calculating product-level carbon intensity metrics** (OECD, 2024[40]). Carbon intensity metrics can enable the tracking of the carbon emissions associated with producing outputs, either at country, sector, or product-level (OECD, 2024[40]). Carbon intensity metrics are crucial to inform discussions on carbon leakage risks and how to manage them (IEA, 2022[62]). Sector and product-level carbon intensity metrics can help to pinpoint where and how carbon leakage risks may manifest, thus helping to prioritise and guide policymaking (Yamano and Guilhoto, 2020[63]). Additionally, policy tools such as mandatory product emission standards and BCAs require the reporting of carbon intensity metrics (OECD, 2020[56]).

63. **The IFCMA is conducting a systematic stocktake of mitigation policies currently in place** (OECD, Forthcoming[60]). This stocktake based on a standardised typology includes economic instruments, such as taxes, trading systems and subsidies, regulatory tools, such as standards and other regulatory policies, as well as other instruments, such as government investment and consumption, information instruments, and voluntary approaches. Mitigation policies are characterised via a set of attributes and mapped to their emissions base to identify the share of greenhouse gas emissions they cover. This unified data structure allows for comparability, enhances transparency, and facilitates co-operation around policy approaches.

64. **The UNFCCC transparency arrangements ensure regular data availability on GHG emissions, climate policies, progress toward targets, impacts, adaptation efforts, and support needs**. Under the Paris Agreement's Enhanced Transparency Framework, Parties must submit biennial transparency reports (BTRs) starting by December 31, 2024 (UNFCCC, Conference of the Parties (COP), 2018[64]). These BTRs will include national inventory reports (NIRs), progress on NDCs, details on policies and measures, climate impacts and adaptation, as well as information on financial, technological, and capacity-building support.

65. Information exchange is a crucial prerequisite for interoperability of carbon intensity measurement and policy approaches, discussed in the next section.

2. Interoperability of carbon intensity measurement and policy approaches

66. **A second option for international co-operation is to move towards the interoperability of monitoring, reporting and verification (MRV) systems, carbon intensity measurement, and policy instrument design.** Interoperability goes beyond simply exchanging information; it requires that data from different sources can be seamlessly integrated and made compatible. Interoperability ensures the compatibility of different systems based on a shared understanding of data, methodologies, and standards, which do not have to be the same. This is a more ambitious form of co-operation than information exchange

[8] For further information on the CCFRs, see https://www.worldbank.org/en/publication/country-climate-development-reports.

[9] For more information on the IMF Article IV Consultations, see https://www.imf.org/en/Publications/SPROLLs/Article-iv-staff-reports#sort=%40imfdate%20descending.

[10] For more information on the OECD Economic Surveys, see https://www.oecd-ilibrary.org/economics/oecd-economic-surveys_16097513.

(discussed above) and might involve higher administrative costs initially but would eventually facilitate information exchange and the implementation of policies to address carbon leakage.

67. **Achieving interoperability builds on the detailed understanding of the reporting rules used to collect the data necessary for the computation of carbon intensity metrics and developing rules and processes to make them compatible**. Compatible methodologies, through MRV systems, are critical for the collection of harmonised emission data within the required reporting framework. An MRV system comprises the guidelines, standards, and procedures for monitoring, reporting, and verifying GHG emissions, which can be used for carbon intensity measurements. In general, an MRV system establishes the specific rules, methods, and tools, alongside the legal and technical framework, needed for standardised emissions monitoring, reporting and verification. Achieving interoperability requires MRV systems to be well documented and structured, such that information collected under on MRV system can be translated in to the rules, methods and tools of another MRV system.

68. **To ensure interoperability of product-level carbon intensity metrics, it is essential to establish consistent measurement of emissions and product volumes throughout the value chain** (OECD, 2024[40]). Emission monitoring can differ depending on whether it is via measurement or calculation, with methodologies varying across different accounting frameworks. Moreover, there are important discrepancies in data availability (relating to the previous section on information exchange), granularity, and scope. Similarly, production data must also be interoperable, addressing issues arising from different product classification. Further, misalignments persist among data approaches with some systems defining output in physical terms, such as tonnes, and others using monetary values, like value added. Achieving interoperability across these dimensions is crucial for accurate and effective carbon intensity measurement across different countries. This does not necessarily require the establishment of a single monitoring methodology, but rather the possibility to get from one metric to another in a consistent manner.

69. **Interoperability can promote compatible reporting mechanisms for both measurement of embedded emissions in traded products and policy inventories**. In doing so, interoperability can reduce compliance costs and administrative burden for businesses conductive activities across different jurisdictions, thereby minimising the risk of creating trade barriers (OECD, 2024[40]).

70. **Initial findings from the current OECD work under the IFCMA carbon intensity workstream** (OECD, 2024[40]) **highlight the absence of standardised GHG accounting and reporting methods**. Instead, there is a proliferation of measurement approaches, especially for product-level carbon intensity metrics. These approaches differ in system boundaries (e.g. production technology and emission scope) and the use of “default” values instead of primary data from monitoring, reporting, and verifications (MRV) systems from facilities. This may lead to high transaction costs and operational inefficiencies. Such challenges are particularly burdensome for firms in global value chains, especially small and medium-sized enterprises (SMEs), which often lack the financial resources and expertise needed to invest in data collection systems.

71. **Interoperability of carbon intensity metrics is also central to the Climate Club's Pillar 1, Module 1 and Pillar 2, Module 2 of its 2024 Work Programme** (Climate Club, 2024[58]). Pillar 1, Module 1 aims to identify common obstacles across sectors and products that hinder the computation and use of emissions intensity metrics, with the goal of developing a common understanding of methodologies for calculating the emission intensities of cement and steel products. Pillar 2, Module 2 seeks to promote international co-operation in developing consistent, comparable, and interoperable standards to avoid the proliferation of conflicting standards. It encompasses emissions accounting methodologies and definitions for 'near zero emissions'. The programme aims to align standards internationally and establish markets for near-zero-emissions materials. Both modules build on existing work by amongst others the IFCMA, the International Energy Agency Working Party on Industry Decarbonisation (IEA WPID). International

Monetary Fund (IMF), Breakthrough Agenda (BA), Clean Energy Ministerial Industrial Deep Decarbonisation Initiative (CEM IDDI), as well as ongoing efforts in some EU members states and Climate Club members.

72. **The growing interest in the nexus between climate and trade has prompted countries to explore more standardised approaches to measuring carbon intensities of trade exposed goods**. This is evident amongst others in policy initiatives such as the Australian Guarantee of Origin (GO) Scheme, the EU and UK CBAM, and the US Task Force on Climate and Trade. The Australian GO Scheme (Australian Government Department of Climate Change, Energy, the Environment and Water, 2023[65]) tracks and verifies emissions and other attributes across the value chain of Australian clean energy products, including hydrogen and renewable electricity on a voluntary basis. By increasing transparency for consumers, the GO Scheme aims to provide participating producers with a competitive advantage both domestically and internationally. Similarly, the EU[11] and UK[12] CBAM rely on measuring embedded carbon emissions to price carbon emissions emitted during the production of certain carbon intensive goods entering the EU, or the UK. In April 2024[13], the US Task Force on Climate and Trade was launched to develop detailed carbon intensity data, enhancing the effectiveness of climate and trade policies. The Task Force will collaborate with trade partners to standardise the measurement of embodied emissions. Additionally, the US announced its intention to promote common measurement practices and high standards for embodied emissions globally. These initiatives share the ambition to create globally interoperable standards for embodied emissions. Enhanced international co-operation is crucial to advance these objectives.

73. **Interoperability extends beyond carbon intensity measurement**. Policies can vary in their design, including their sectoral and emission scope, facility size thresholds and other eligibility criteria and technical parameters. To foster better interoperability across policy instruments, countries must ensure a clear understanding of these diverse attributes, including sectoral coverage, ambitions, and other design features, such as the size of regulated facilities, emission caps or carbon intensity baselines. Interoperability in policy approaches could foster greater alignment of carbon pricing and regulatory standards across different jurisdictions.

3. Mutual recognition of carbon intensity measurement and policy approaches

74. **Another option for international co-operation to address carbon leakage risk is mutual recognition**. Countries accept that third countries national rules, emission measurements, conformity assessment procedures adhering to or developed through pre-defined and internationally agreed standards or processes are equivalent to their own. This approach promotes greater consistency of and alignment across jurisdictions of emissions measurement approaches and climate policies, compared to interoperability, where methodologies and policies can differ but could be broken down into comparable components, such as sector and emission scope. It ensures that firms within mutual recognition agreements face comparable reporting and compliance procedures and costs. Mutual recognition across jurisdictions facilitates international trade in low-emission products and helps to mitigate carbon leakage.

[11] https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en

[12] https://assets.publishing.service.gov.uk/media/65fc11fef1d3a0001132ac6f/Introduction_of_a_UK_carbon_border_adjustment_mechanism_from_January_2027.docx.pdf

[13] https://www.whitehouse.gov/briefing-room/speeches-remarks/2024/04/16/remarks-as-prepared-for-john-podesta-columbia-global-energy-summit/

75. **Mutual recognition is a more ambitious and integrated strategy to mitigate carbon leakage risks than information exchange and ensuring interoperability**. It requires the development of internationally agreed and auditable standards and processes and the presence of accredited auditors that can certify if firms have adhered to such standards and processes. Certification is automatically recognised in third countries that are part of the mutual recognition agreement. Mutual recognition is particularly relevant under multilateral trade rules, such as the WTO's non-discrimination principle for "like" products, and within regional trade agreements (Yamaguchi, 2021[66]).

76. **Mutual recognition is already applied in other contexts, such as the "Mutual Recognition Principle" within the European Union** (Regulation (EC), No 764/2008[67]) **or under mutual recognition agreements among trade partners**. Under the EU "Mutual Recognition Principle," Member States recognise that the technical rules of imported goods provide the same level of public interest protection as their own domestic regulations. Consequently, products marketed in one Member State can be sold in other Member States. Another example relates to mutual recognition agreements through bilateral or multilateral trade agreements which enhance trade in goods between countries by improving market access and benefiting industry through simplified conformity assessment processes. A common example included in mutual recognition agreements are good manufacturing practices (e.g. inspection capability) and certifications for medicinal products. The EU has signed several mutual recognition agreements with third countries, including Australia, Canada, Israel, Japan, New Zealand, Switzerland, and USA (European Commission, 2024[68]). Incorporating recognised certifications of embedded emissions or mutually accepted verification processes into trade agreements could enhance the effectiveness of unilateral policies, such as BCAs or excise taxes based on embedded emissions, to address carbon leakage.

77. **In the area of emission measurement, examples for mutual recognition are ISO standards and the Environmental Product Declarations (EPDs)**. The International Organization for Standardization (ISO) creates technical standards covering various areas, including quality, safety, technology, and environmental impact, such as emissions accounting and reporting (International Organization for Standardization, 2024[69]). These standards offer detailed guidance that addresses technical complexities and product-specific factors, aiming to harmonise emissions accounting within and across sectors. Although ISO does not collect data from reporting entities, its standards are widely adopted by industry and governmental initiatives. EPDs are certified reports of the environmental data of a product, in accordance with the ISO 14025 standard (Environmental labels and declarations — Type III environmental declarations — Principles and procedures) (The International EPD System, 2024[70]). EPDs provide highly transparent reporting of this impact through comparable, objective, and third-party verified data.

4. International solutions

78. **Among the reviewed options for international co-operation, the most ambitious effort involves the introduction of common approaches**. These can be categorised into three main types: initiatives to raise ambition, common procedures, and common policy approaches.

79. **Initiatives to raise the ambition of climate mitigation policies and address carbon leakage can take various forms.** They can comprise of international sectoral agreements involving commitments by governments or the private sector, either bilaterally or multilaterally, to regulate collaboratively emissions within a specific sector (OECD, 2020[21]). Even if these initiatives do not directly address carbon leakage, they decrease the risk of carbon leakage due to a higher alignment of the ambition and pace of emission reductions across jurisdictions.

80. **Sectoral agreements may be a viable approach** (OECD, 2020[21]). The effectiveness of such approaches depends on the degree of commitment by governments, the willingness of the sector, and

broad country coverage, including both developed and developing countries. Sectoral agreements should also take into account country circumstances, including access to resources and technology for decarbonisation (OECD, 2023[72]). An example of an international sectoral agreement is the International Maritime Organization (IMO) Strategy on Reduction of GHG Emissions from Ships (OECD, 2020[21]; IMO, 2023[71]). In 2018, the IMO adopted a climate change strategy for international shipping, aiming to reduce GHG emissions from the sector by 50 percent by 2050 compared to 2008 levels. This strategy provides a framework to reduce both the carbon intensity of ships and the GHG emissions from international shipping activities. Another example of an international initiative is the Global Methane Pledge (GMP), with 158 participating countries as of March 2024. The GMP encourages participants to undertake voluntary actions aimed at collectively reducing global methane emissions by at least 30 percent from 2020 levels by 2030. Participants commit to adopting good practice inventory methodologies and improving the quality and transparency of greenhouse gas reporting (United Nations Environment Programme/Climate and Clean Air Coalition, 2022[72]; Global Methane Pledge, 2023[73]).

81. **Common procedures to address carbon leakage risks could involve international agreements on standardised methods for collecting and calculating emission intensity data**. This could be implemented through sector-specific or cross-country MRV systems. Beyond ensuring the interoperability of carbon intensity metrics, common procedures would require the consistent application of these methods across different countries. An example for sector-specific common procedures is the Industrial Deep Decarbonisation Initiative (IDDI). The IDDI seeks to boost the adoption of green public procurement policies among member countries by providing various levels of commitment with progressively stringent carbon intensity benchmarks, standardising carbon accounting standards, and creating industry guidelines. Currently, these efforts focus on cement and steel. Launched in November 2021, the initiative now includes 10 member countries: Canada, Germany, India, Japan, Saudi Arabia, Sweden, UK, the United Arab Emirates and the United States. The initiative aims to promote the purchase of low-carbon steel and cement by governments.

82. **Common policy approaches go beyond indicative commitments and can range from a direct linkage of unilateral policy instruments to plurilateral policy instruments**. They can also include non-pricing carbon pricing instruments. Common non-pricing policy approaches to address carbon leakage risks include implementing mandatory product standards on emission intensity across different countries. Such standards would require the interoperability and mutual recognition of product-level carbon intensity metrics. Suggestions for common pricing approaches to mitigate carbon leakage risks include the IMF proposal of an international carbon price floor (Parry, Black and Roaf, 2021[74]) and the concept of a climate club proposed by Nordhaus (2015[75]). The international carbon price floor involves a negotiated agreement among a small number of major emitting countries to set a (differentiated) minimum carbon price for their CO_2 emissions. The proposal suggests flexibility provisions for emerging market economies, e.g. through differentiated carbon price floors (which might lower the effectiveness in addressing carbon leakage). The conceptual proposal for a climate club by Nordhaus (Nordhaus, 2015[75]) includes a border carbon adjustment (BCA) agreement among several countries. Participating countries agree to set a minimum domestic carbon price and impose a levy on imports from non-participating countries, aligning with the domestic carbon price within the club. While both these proposals remain at a conceptual level, the linking of carbon markets (OECD, 2020[21]; Wetterberg, Ellis and Schneider, 2024[76]) is a concrete example of cooperation on pricing. Linking carbon markets tends to align carbon prices between jurisdictions, significantly reducing the risk of carbon leakage for the sectors and trading partners involved. Examples of linked carbon markets include the link between the California and Quebec Cap-and-Trade systems, and between the European Union Emissions Trading System (EU ETS) and the Switzerland ETS. Conceptually, international solutions can ensure broad consistency and alignment in carbon pricing and regulatory standards across different jurisdictions. While some common regulatory approaches have already been implemented, common approaches related to an international carbon price floor or BCAs remain largely conceptual proposals.

5 Summary and conclusions

83. **International spillovers from climate policy asymmetries need to be well identified and understood**. This allows to deepen collaboration, create win-win situations on positive spillovers and reduce adverse effects resulting from negative spillovers. Indeed, positive spillovers such as negative carbon leakage resulting from progress of green technologies driven by climate policies should be strengthened, while negative spillovers such as carbon leakage and its harmful collateral economic effects should be reduced.

84. **The current divergence in climate mitigation policies may be due to differences in policy sequencing across countries**. Given the diversity in national circumstances, countries have different starting points for their climate transitions, which translate into international policy asymmetries. As countries progress along their transition pathway, in the longer run, climate mitigation policies across countries may eventually converge in their design and measurement approaches.

85. **The feedback from international spillovers to domestic policy could either accelerate convergence in climate action or further entrench climate policy differences and thus reinforce climate policy fragmentation dynamics.** Policies introduced as a response to carbon leakage (e.g. price-based border carbon adjustments such as the EU CBAM) in one jurisdiction could encourage other jurisdictions to introduce carbon pricing measures or similar border adjustments. Australia's carbon leakage consultation and the introduction of the UK CBAM are examples of these recent dynamics. Other countries, such as Türkiye, are considering introducing an ETS for their trade-exposed industries. Such developments could translate into enhanced convergence across policy approaches. A possible scenario is the persistence of a highly diverse international climate policy landscape. In this context, addressing carbon leakage through both unilateral measures and international co-operation is crucial for aligning climate policies globally and ensuring that climate targets are met.

86. **Meeting climate targets while managing international spillovers requires innovative policy solutions, synergies, and collaborative approaches** (OECD, 2020[21]; OECD, Forthcoming[39]). Focusing on carbon leakage, this paper reviewed the main unilateral measures and international co-operation strategies that may address it. While there is a range of domestic policies that address carbon leakage, their effectiveness in mitigating carbon leakage risks while sustaining incentives for emissions reduction varies significantly depending on contextual factors and the specifics of their design (OECD, 2020[21]). Domestic measures generally offer only partial solutions to the challenge at hand since each instrument has certain inherent limitations and differences in approaches could lead to further fragmentation. Combining some of these approaches could help alleviate some of these limitations, provided that they maintain abatement incentives (OECD, 2020[21]).

87. **International co-operation can strengthen the effectiveness of domestic policies in reducing global emissions and mitigating carbon leakage risks**. Having an in-depth understanding of how international co-operation supports domestic policies is key to leveraging synergies between them. By integrating both approaches, policymakers can ensure that climate targets are met effectively, given country circumstances.

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