Cross-border spillovers at the intersection of climate and trade: the US Inflation Reduction Act and the EU Carbon Border Adjustment Mechanism

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Introduction

Humanity is currently navigating an "in-between" era of the ecological transition in which significant commitments have been made and crucial mitigation pathways have been sketched. Indeed, almost all countries in the world have ratified, in 2015, the Paris Agreement, the landmark international treaty which have set in stone our commitment to keep warming from exceeding 2°C. Moreover, in the sector at the foundation of all our polluting activities -the energy sector- renewable solutions have started to make a dent, driven by their incredible cost reductions. Yet, in this interregnum, institutions have also started thinking about how to cut emissions in hard-to-abate industries and how to cushion the social impact of more stringent climate policies. Perhaps the most important lesson we have come to understand is that achieving deep decarbonisation will require a truly systemic transformation, not just piecemeal improvements.

In such a context, the increasing heterogeneity of policy measures, especially in their scope and level of ambition, is sparking tensions between the biggest players, with potential adverse effects for the global momentum towards decarbonisation. Measures at the intersection of climate and trade -like tariffs, export controls, border carbon adjustments, or domestic content requirements- have been singled out as particularly controversial, breaking with a past of unfettered globalisation. They are characterised by their multi-dimensional objectives and their interlinkages with, on the one hand, the resurgence of industrial policies and, on the other, geopolitical and geostrategic concerns. Their complexity makes traditional analyses, typically grounded in a single discipline and focused solely on linear outcomes, ill-suited for accurately assessing their potential impacts.

This paper takes a different approach and employs the concept of "spillovers" to examine causal linkages and unintended effects of climate policies with a cross-border dimension. Spillovers are often overlooked in policy design, largely due to the challenges in clearly identifying and measuring them, but especially for trade- and climate-related measures, they are now proving fundamental in assessing potential policy implications. It also the case that the proliferation of policies containing protectionist elements is amplifying the chance that negative spillovers prevail over positive ones. Using spillovers in a "forward-looking" way, this paper analyses two pivotal trade- and climate-related policies implemented across the two sides of the Atlantic: the US Inflation Reduction Act and the EU Carbon Border Adjustment Mechanism. These two case studies are instrumental to shed light on the various trade-offs involved and demonstrate how cross-border spillovers are just as important, if not more so, than the related domestic effects.

After a literature review on the nexus between climate and trade, a conceptual framework based on 4 types of cross-border spillovers is presented. The paper then employs the conceptual framework to analyse the two case studies, and, lastly, concludes with a discussion and some policy recommendations.

Literature Review (optional)

Climate and trade nexus

The share of global emissions linked to international trade has been estimated to be around 20-25% (Mehling, 2024). Given this significant feature of our globalisation, scholars have long asked whether trade is an enabler or a constrainer of environmental outcomes in the presence of various policies or agreements. For instance, it has been found that trade openness generally coincides with lower firms' emission intensities, as exporting companies tend to invest more in abatement – even if the mechanisms that generate this outcome are not yet perfectly clear (Felbermayr et al., 2024). Ricardo taught that trade can enhance comparative advantages: in the case of climate, more advanced countries with higher innovation potential and technological know-how could specialise in clean goods and services, whereas countries with more renewable potential could instead focus on the production of energy-intensive basic materials (Jakob et al., 2022). Until recently, the benefits of free trade have proved substantial in the energy transition realm, many boasting the spectacular cost reduction in solar PV panels imported from China. Trade, however, might also function as a constraint. For instance, tariff and non-tariff barriers have found to be higher for finished products than for upstream materials, which tend to typically be more carbon-intensive – revealing an

environmental bias in trade patterns (Shapiro, 2021). Moreover, scholars who have tried to estimate quantitatively the "carbon embodied" in trade have found that territorial production emissions are substantially different than emissions related to consumption, also known as a country's carbon footprint, signalling that emission reductions by advanced climate leaders may be less profound than thought (Felbermayr et al., 2024). The extent to which emissions have "leaked out" of more ambitious jurisdictions (so-called carbon leakage), albeit still statistically disputed, is widely believed to be inevitable in a future in which emission targets are set tighter (Jakob, 2022). While these aspects will continue to be relevant and worth investigating, this paper focuses more on the effects that policies at the intersection of climate and trade can potentially have in this novel *geostrategic* context, characterised by a resurgence in industrial policies and an increasing securitization of low-carbon supply chains. What Figure 1 suggests is that climate- and trade-related measures must be appropriately contextualised and seen as interlinked with these other aspects.

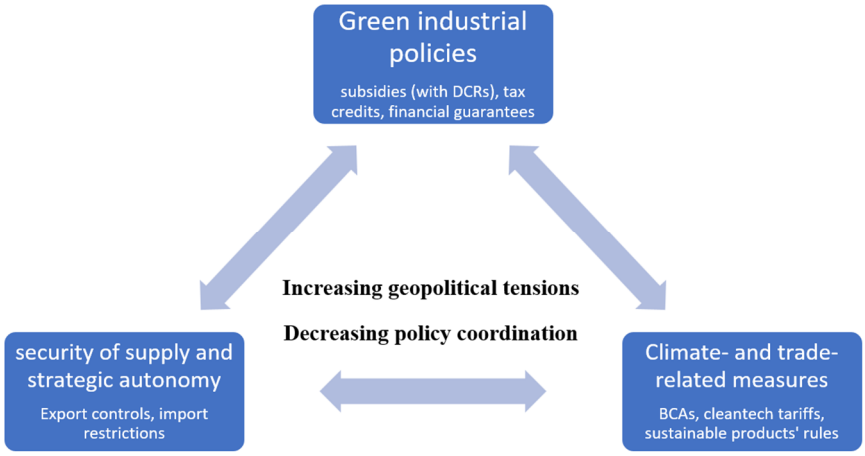

Figure 1. Own elaboration

Multi-objective, interlinked policies in the current geostrategic context

Why do trade- and climate-related policies are embedded in this broader geostrategic context? De Ville et al. (2023) convincingly offer some explanations on the key drivers which have brought about this turn towards strategic autonomy and unilateralism in trade-related measures. On the one hand, businesses regularly faced with competitors benefitting from -often opaque- state support have started to voice their concerns for their fading competitiveness in world markets. On the other, simultaneously, they have progressively lamented the burdens of new domestic -often environmental- regulations, this latter point being part of a broader trend of increasing sustainability ambitions, especially in the EU. The adverse effects of ambitious climate policies, increasingly at odds with the voluntary spirit of the Paris Agreement, have thus started to come to the fore for frontrunners. Together with a WTO, once the arbiter of trade and subsidy disputes, in total paralysis (Bown & Clausing, 2023), unilateral measures like border carbon adjustments (BCAs) have been the kind of responses put forward to mitigate competitiveness and leakage risks in a world of deteriorating cooperation. But "levelling the playing field" has not been the only objective. In an effort to spur climate laggards to follow the lead of climate vanguards, "make-it-my-way" interventions like the EU Deforestation Regulation have also represented a tool for influencing third countries' climate actions (Hoekman & Sabel, 2025). This dimension related to exporting decarbonisation abroad have generated many criticisms, and accusations of "green protectionism" have proliferated from developing countries (Meyer, 2024).

In parallel, decarbonisation has become enmeshed with geopolitical considerations, especially along the US-China axis of power competition. Supply chains of critical materials see nowadays China undisputably at the helm, controlling the production of more than 50% of wind turbines' components, more than 80% of solar PV's components, and even more in some crucial parts of batteries (Mehling, 2025). Far from being passive about its outsized role, China has also extensively used export restrictions as economic coercion against countries with foreign policies it disliked (Bown & Clausing, 2023). For its part, the US has not been idle

either, explicitly targeting China as a security threat and erecting 100% tariffs on Chinese EVs and batteries (Mehling, 2025). Further, the EU, after an anti-subsidy probe on Chinese EV manufacturing, has recently imposed more proportional trade measures in the form of countervailing duties applied to Chinese imports[1]. These increasingly strategic and geopolitical behaviours are well encapsulated in concepts such as "friend-shoring" and "de-risking", now at the forefront of the current political debate.

The comeback of industrial policy, that is the selective promotion and protection of certain industries, technologies, or sectors, has also converged with the green transition, and not by chance. Beyond shoring up manufacturing, "green" industrial policies have responded to two crucial (interconnected) questions previously left unanswered. First, as we begin to understand that the transition to low-carbon economic societies will require a *systemic* transformation, it has become clear that industrial policies contribute more decisively to create the infrastructure, technologies and markets undergirding the transformation (Mehling, 2024). There is indeed a growing intellectual consensus that public support and interventions beyond carbon pricing are not only needed to correct market externalities, but also, more fundamentally, to help laying the foundations for the experimentalist behaviour that firms can then adopt, creating the conditions for innovation and thus deep decarbonisation (Sabel & Victor, 2022)(Victor & Carlton, 2023). Secondly, in a world in which taking ambitious climate actions depend on domestic distributive conflicts between winners and losers (Aklin & Mildenberger, 2020), industrial policies crucially contribute to entrench and expand the political coalitions necessary to enact the policies. This can also initiate a virtuous cycle of "policy sequencing", starting with "carrots" rewarding the few (industrial policies) and ending with "sticks" penalising the many (carbon prices) (Meckling et al, 2017).

Green industrial policies are inextricably linked to trade. This is because, in light of what said above about competition, de-risking and re-shoring, and by their intrinsic trait of "picking winners", industrial policies providing incentives for domestic industries will unavoidably contain protectionist elements – one key example being Domestic Content Requirements (DRCs). These protectionist elements might thus be the key ingredient for policy uptake but, simultaneously, they might also pose challenges when considered from a globalist standpoint. As a result, scholars have described green industrial policies as "double-edged swords" (Kaufman et al., 2023). Nevertheless, and as this paper argues, while the resurgence of industrial policies risks exacerbating their negative trade-related international spillovers, these can in fact be managed with careful design and cooperation. Conversely, positive spillovers -such as policy-induced technological innovation- can and should be recognised and considered in order to maximise their impacts.

Conceptual framework: policy-analysis through spillovers effects

This paper builds on the work of Mehling (2024) and WTO et al. (2024), which both recognise spillovers as crucial side-effects of climate policies. *Spillovers* are defined as incidental developments, repercussions, by-products that are manifest across space ("elsewhere") and time ("later"). The analysis carried out by Mehling (2024) shows how the concept of spillover has been employed in a range of different disciplines and has thus somewhat lacked conceptual clarity[2] . Importantly, in policy analysis, difficulties in measurements and in establishing causal relationships have hindered the successful application of the concept. Spillover effects are indeed often *unintended*, not only resulting from deliberate policy design but also due to complex system interactions.

However, this paper precisely uses spillovers in merit of their ability to capture the chains of contingencies that are influencing the present and that could shape the future. This "forward-looking" policy analysis exercise finds its intellectual origins in the work of Levin et al. (2012), who argue that we ought to be ".. interested in other possible and likely futures than the linearly predicted ones, and in determining the ways in which our actions and the actions of others contribute sometimes via unintended effects and consequences". This approach has already been employed for analysing how institutions can catalytically bring about change

[1] *Center for European Reform*. https://www.cer.eu/insights/eus-drive-china-what-ev-tariffs-mean-europe.
[2] Different types of spillovers: "from concrete physical flows and changes in observable behaviour to more abstract notions, such as socioeconomic or political spillovers" (Mehling, 2024)

(Hale, 2020) and how lock-ins and path-dependencies can be broken for transformations to ensue (Bernstein & Hoffmann, 2018). Given the focus on trade, this paper investigates the positive and negative effects of spillovers *across borders* along four dimensions (*economy, technology, policies, norms*), trying to embody this forward-looking approach and thus reasoning on the pros and cons of the two measures described (IRA and CBAM) in terms of their *repercussions* and *potential consequences* in time.

The spillovers identified for climate- and trade-related measures are displayed in Figure 2. The first, *carbon leakage*, is the proportional increase of emissions abroad after a reduction in emissions domestically because of a climate policy like carbon pricing. Leakage manifests through relocations of production abroad and a rerouting of trade flows, with the implementing jurisdiction importing more embodied carbon from abroad and thus maintaining (or even worsening) its carbon footprint. More total emissions or, worse, demise of the domestic industrial base can have adverse effects on the implementing countries, with concerns coming from both industries and environmentalists. Reducing leakage is therefore seen as imperative, not least to convince that far-reaching decarbonisation is possible without deindustrialisation.

Secondly, policies that lower technological costs and support clean manufacturing can generate innovation and learning-by-doing, much like what has happened for the solar PV industry from feed-in-tariffs in Germany (Mehling, 2024). These *technological learning effects* can propagate across borders if the industrial policies supporting them retain a level of openness. However, this openness often conflicts with domestic demands for protection, which must be in some way accommodated for the policy to gain political support. Dissemination of technology and knowledge, especially in developing countries, may be the most important spillover of all, given that the majority of green energy deployment will need to happen in those regions (Lewis, 2024).

Thirdly, take up of policies domestically can cause *policy diffusion*, a mechanism which can occur in many ways: through *policy coercion*, third countries adopt similar measures for continuing to reap the benefits of trading with the implementing country ("make-it-my-way" policies) or to capture revenues they would otherwise forego (as in the case of BCAs); through *policy competition*, rivals respond with comparable interventions to avoid losing competitiveness; and through *policy learning*, countries emulate the innovative climate policies of others. This policy diffusion effects can positively induce the "ratcheting-up" mechanism hoped by the architects of Paris, triggering a virtuous race to the top, but they can also provoke beggar-thy-neighbour dynamics where less equipped countries inevitably lose.

Lastly, policies supplemented with protectionist or outright punitive elements[3] (unilateral tariffs are primary examples), in addition to distort trade flows, can undermine shared norms and lead to pervasive zero-sum uncooperative mindsets, further fuelling geopolitical tensions. Minimising these *green "shockwaves"* is thus crucial to avoid retaliation and trade wars. Cooperating to cushion negative impacts on other countries, especially developing ones, often goes a long way to mitigate this type of spillover.

[3] Nowadays, increasingly justified by geopolitical and security considerations. The US tariffs on China's batteries and EVs, among other reasons, respond to the perceived Chinese threat (Mehling, 2025).

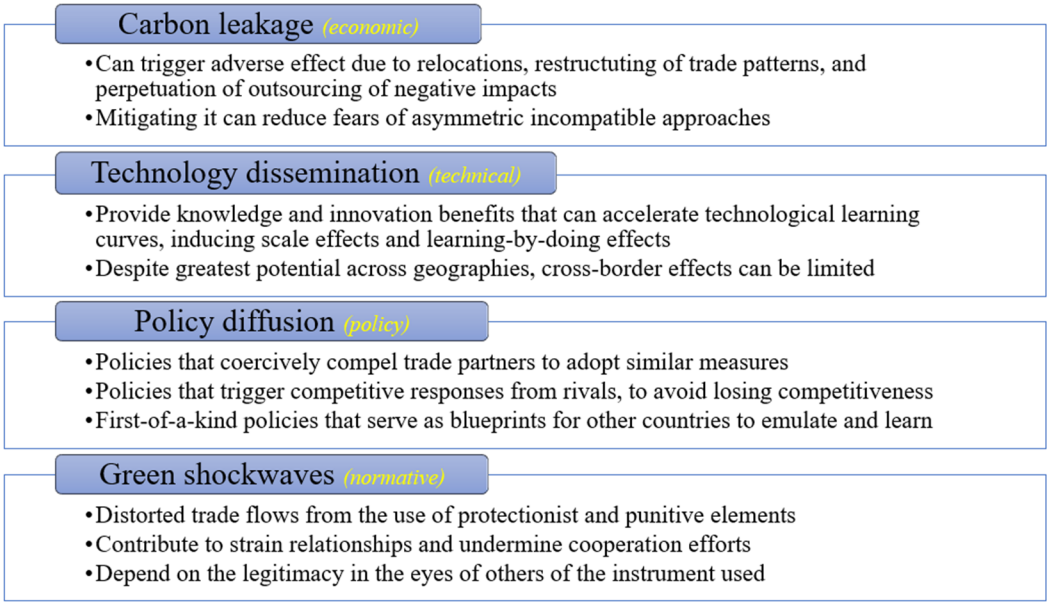

Figure 2: Cross-border spillover effects resulting from climate policies, manifesting along different dimensions (in yellow). Own elaboration

Armed with these conceptual lenses, this paper examines the spillover effects of two policies at the forefront of the climate and trade nexus: the US IRA and the EU CBAM.

Case study 1: the IRA

Description

Persistently failing to introduce some form of carbon pricing[4], the US, in the last two decades, has resorted mostly on regulations, vehicle efficiency standards and some State and federal incentives for clean energy (Elkerbout et al., 2024). With the Biden administration determined to alter the emissions trajectory of the country, what was initially proposed as the Build Back Better Plan morphed into a new infrastructure bill (the Bipartisan Infrastructure Law) and a climate one, reframed as Inflation Reduction Act to increase political support and to picture it as necessary for the Covid recovery (Bang, 2024). The IRA is essentially a mix of carrots in the form of direct subsidies, financial guarantees and, especially, tax credits, to revive the renewable energy sector and to guarantee a credible supporting framework for clean manufacturing. The monetary size of the bill estimated by Congress is shown in Figure 3, but these sums are *uncapped*, as objectives are in the form of intensity targets[5]. Totalling almost 400 billion$[6], the IRA stands as the largest climate legislation is US history, with incentives spanning the entire energy sector, from producers of raw materials to manufacturers and end-use consumers, and the EV entire supply chain (Bistline et al., 2023).

Importantly, the support mechanisms come with various *domestic content requirements* (DCRs) which make the credits more generous or even conditional on domestic manufacturing. For example, in order to qualify for a full EV tax credit, at least 40% of the materials used in the vehicle's battery must be sourced in the US, and the battery itself must also be manufactured and assembled domestically (Lewis, 2024). As further example, "bonus credits" are provided if clean energy technologies are indigenous (ibid.). Moreover, the IRA generally limits sourcing of materials and components from "foreign entities of concern", a list of countries which includes, notably, China. Section 30D EV Tax Credit even explicitly prohibits sourcing

[4] Such as the cap-and-trade system proposed with the Waxman-Markey Bill of 2009.
[5] For instance, provision of tax credits for clean energy continues until electricity emissions fall to 20% of 2022 levels.
[6] Although there is considerable uncertainty related to the estimation, many sources predict could be much more (Kleimann et al., 2023), especially credits for clean manufacturing.

critical materials or battery components from firms anywhere in the world *if they have Chinese ownership*. These provisions unveil not only the protectionist features of the IRA, but also its geopolitical objective to de-risk strategic sectors from China, lending credibility to the tripartite nexus outlined in Figure 1.

TAX CREDITS	
Investment and Production Tax Credits for Clean Electricity Generation and Storage	$131
Production Tax Credit for Carbon Capture and Sequestration	$3
Nuclear Power Production Tax Credit	$30
Clean Fuels	$19
Clean Energy and Efficiency Incentives for Individuals	$37
Clean Vehicles	$14
Clean Energy Manufacturing	$37
SUBTOTAL	**$271**
DIRECT EXPENDITURES	
Agricultural & Forestry Conservation and Sequestration Projects	$21
Energy Loans	$17
Energy Efficiency	$11
Industrial Decarbonization	$5
Other (e.g., Green Bank)	$66
SUBTOTAL	**$121**
TOTAL	**$392**

Figure 3: Estimated entity of the IRA's tax credits and direct expenditures, per item. Source: Bistline et al. (2023)

Spillovers

The IRA undoubtably generates benefits for local American industries and will contribute to substantial job creation, especially in disadvantaged communities and regions. The "domestic-first" agenda was a vehicle to make the measure politically feasible, but in rejuvenating green industries domestically it is also bringing together decarbonisation coalitions in Republican States, now become backers of the credits (Noll et al., 2024). Nonetheless, if one sets aside these positive effects for the domestic economy and transition and looks at cross-border spillovers through the taxonomy developed in this paper, the picture looks quite different. The main channels are impaired technological learning effects, policy competition and strained trade relationships.

From the perspective of *technology dissemination*, the IRA localisation provisions significantly restrict this positive spillover. In a country which has always been at the forefront of innovation, propelled by some of the most renowned technological hubs, massive support is surely expected to lower technological costs, to drive key discoveries in clean manufacturing[7], and to trigger learning-by-doing dynamics[8]. However, particularly for the EV sector where US companies significantly lag behind, relocation of supply chains implies higher future costs for US consumers, with US firms missing key opportunities for cooperation with

[7] Just to mention some examples, US startups like QuantumScape (solid-state batteries for EVs) or Sublime Systems (low-carbon cement) are already pushing the technological frontier ahead.
[8] This is true for wind power, for example, as technological design profits from a stable home market and feedback from users more than other technologies like solar PVs (Noll et al., 2024).

foreign auto- and battery-makers[9]. Despite keeping collaboration open with a few neighbours[10], the trade restrictions embedded in the IRA could lead to geographical isolation and slower learning processes as foreign knowledge is not harnessed, slowing down the overall transition.

The *policy diffusion* spillover has forcefully operated through competition, with many foreign officials battening down the hatches as soon as the IRA was announced[11]. The spillover effect in the EU has been the plainest to see. In March 2023, the EU put forward its Critical Raw Materials Act (CRMA) and its NetZero Industry Act (NZIA), outlining a strategy to prevent its manufacturers to shift to US territory. The NZIA has so established targets for EU domestic manufacturing in specific technologies by 2030, has accelerated permitted procedures, and has unleashed national subsidies loosening state aid rules with the Temporary Crisis and Transition Framework (TCTF), already stocking fears in more fiscally constrained EU countries about being left behind (Veugelers et al., 2024). The "matching aid" provision in the TCTF essentially rings as a direct IRA response, allowing "*the amount of support the beneficiary could receive for an equivalent investment in the alternative location, or the amount needed to incentivise the company to locate the investment in the EU*"[12]. The reactions triggered by the IRA, dubbed by many as a global subsidy race, have overall contributed to a spurt of green industrial policies in the name of competitiveness which, albeit answering domestic concerns, could result in a much costlier green transition.

Lastly, the tenuous outreach by the Biden administration[13] has, euphemistically, just not been enough to alleviate tensions among trade partners. *Strained relations* with allies can dilute shared norms and lead to a zero-sum mindset, where each country prioritizes its own economic self-interests, and contribute to worsen the geopolitical environment, further decreasing prospects for multilateral cooperation (Mehling, 2024). Moreover, the DCRs in the IRA are seen as in breach of the subsidy rules of the WTO[14], signalling to the rest of the world that, once more, the US will disregard them. As the US prioritises its own interests, other might do the same. Above all, this undermines the international frail governance of climate change, especially if a country which should be seen as a leader defects from cooperation so manifestly[15].

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[9] There are many instances of transnational joint-ventures and partnerships in the sector, like BMW and Volkswagen with the Chinese battery giant CATL. It is no coincidence that the ties between Ford and CATL have been investigated: https://www.reuters.com/business

[10] Within the scope of the DCRs are included countries with which the US has a free-trade agreements, but these partners are not many and, crucially, the EU and other traditional allies are not among them.

[11] For example, Korea has changed its consumer tax credit eligibility, Britain and Canada have proposed green industrial plans and China has denounced the policy at the WTO (Bown & Clausing, 2023)(Lewis, 2024).

[12] The case of Northvolt, the Swedish battery-maker, perfectly illustrate the situation at the time, with EU institutions desperate to create an EU domestic battery champion: https://rhomotion.com/news/what-can-we-learn-from-northvolt

[13] Biden's words: "when you write a massive piece of legislation … there's obviously going to be glitches in it and [the] need to reconcile changes in it … there's tweaks that we can make that can fundamentally make it easier for European countries to participate and/or be on their own … I never intended to exclude folks who were cooperating with us" (Bown & Clausing, 2023). Unfortunately, other than starting negotiations of free-trade agreements and the unsuccessful Global Agreement on Sustainable Steel and Aluminium (GASSA) with the EU, not much else have been accomplished.

[14] Two types of subsidies are prohibited under the Agreement on Subsidies and Countervailing Measures (ASCM): export subsidies and subsidies contingent on the use of domestic over imported inputs (Bown & Clausing, 2023)

[15] Now, Trump's second term has obviously worsened the outlook, having exited altogether from the Paris Agreement.

IRA's spillovers	
Technology	• ⊕ Provides substantial domestic incentives to innovate both in terms of new technologies and capacity of deployment • ⊖ Localisation provisions and geographic isolation could cause higher domestic costs for green technologies • ⊖ The same provisions limit cooperation opportunities with more advanced competitors (especially Chinese EV and battery makers)
Policy	• ⊕ Massive domestic incentives have triggered policy competition abroad, leading up to new green investments in other countries • ⊖ Uncoordinated policy diffusion means less developed regions will lose from a global subsidy race
Norms	• ⊖ Outright protectionist elements impair cooperation and strain relationships with trade partners • ⊖ Discriminatory elements worsen geopolitical tensions with both friends and foes

Case study 2: the EU CBAM

Description

Due to concerns of carbon leakage and relocations abroad, allocation of free allowances to energy-intensive trade-exposed (EITE) sectors were envisioned in the EU ETS since its birth, effectively shielding industries like steel and cement from the burden of the carbon price. With the announcement of the European Green Deal in 2019, however, a Carbon Border Adjustment Mechanism was proposed, in the words of Von der Leyen, to "make sure a price is paid for the embedded carbon emissions generated in the production of certain goods imported into the EU" (Hancock, 2023a). The CBAM is therefore a *carbon equalising tariff* which aims to apply the same internal carbon price to dirty imports, reestablishing a level-playing field in EITE sectors[16]. While expressively focused on mitigating leakage, a largely unappreciated nuance of the CBAM is that it allows to progressively phase out the old anti-leakage remedy (free allowances), thus pricing the carbon externality for the first time in historically protected sectors. In this respect, it constitutes the logical development of the EU ETS system.

In terms of design, the CBAM weighs on EU importers, who must register at the EU CBAM platform and declare the carbon embodied in their imports. Importantly, an EU-conceived methodology is provided to report the embedded emissions[17], according to which default values based on the 10% worst EU players are used if foreign firm-level emissions are not retrievable. Moreover, the price of the surrendered CBAM allowances tracks the EU ETS one, but with a caveat: the carbon price already incurred by producers abroad can be "deducted" from the price if importers demonstrate so[18]. In this way, the EU tries to avoid imposing its carbon price unconditionally across the board, accounting for foreign mitigation efforts – albeit only if these are carbon pricing initiatives expressed numerically. While the CBAM applies to imports, no rebate mechanism is yet envisioned for EU exports, even though the Commission has acknowledged the problem for exporting firms, susceptible to lose market share from the current final design (Jakob & Mehling, 2024).

The multifaceted nature of the CBAM has been subject to considerable debate. For instance, Pirlot (2022) has unmasked how the CBAM objectives can be linked to contradictory "stories". If, on the one hand, there is the fair competition story, by which CBAM contributes to restore the level-playing field for EU players, on the other there is the Paris story, according to which the EU wants to beat non-cooperative countries not showing the "highest possible ambition". The explicit reference to the Paris Agreement is problematic

[16] Sectoral coverage includes iron & steel, cement, aluminium, fertilisers, electricity and hydrogen.
[17] All direct (Scope 1) emissions are included, while emissions from the electricity used in the production of the imported goods (Scope 2) are required only for cement and fertilisers. The EU emission accounting methodology has been mandatory from 2025. https://taxation-customs.ec.europa.eu/carbon-border-adjustment-mechanism_en
[18] CBAM Regulation, Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023R0956

because CBAM's implicit instruction to adopt a carbon price stands in stark contrast to the voluntary spirit of climate commitments under Paris. There is also a climate leadership story professed in the CBAM text, according to which countries should follow the EU lead and over time form a de facto climate club in which BCAs would not be necessary anymore. Even the unambiguous fair competition story, others have emphasised, does not necessarily coincide with minimising leakage (Marcu et al., 2022). These stories created for justifying the policy reveals how CBAM's potential spillovers are not straightforward and could change depending on which story is prioritised in CBAM's exact design.

Spillovers

The CBAM, by itself, aims to correct the negative spillover of *carbon leakage*, but the potential effectiveness of the measure has been disputed (EU Parliament, 2023). There are several possible channels through which leakage reduction could be significantly diluted. One is resource shuffling, whereby, for example, foreign exporters redirect their carbon-intensive steel to other markets while reserving for the EU the greenest steel. This reshuffling effectively creates a two-tier system, with lower-carbon steel earmarked for the EU, resulting in a net negative impact on the climate. Moreover, one other key challenge is whether to extend the sectoral coverage to prevent leakage further down the value chain. Indeed, third countries may try to avoid the policy costs by directly exporting intermediate or final products not included in the CBAM's scope, in so doing harming European competitiveness[19] (Elkerbout et al., 2024). These potential spillovers suggest that CBAM's ability to mitigate both leakage and the adverse effects on competitiveness created by the carbon price may not be straightforward. Ultimately, design tweaks could reduce these risks[20], but the EU will have to strike a balance between leakage spillovers and administrative complexity.

From the *policy diffusion* perspective, the CBAM has so far operated through policy coercion and emulation. Firstly, already in the introductory phase (2023-26), foreign producers are being pushed to keep track of their emissions, otherwise paying an administrative fine (Hancock, 2023b). Secondly, the deduction mechanism of Article 9 has compelled other countries to adopt carbon pricing systems, if only for collecting themselves the revenues. As Figure 4 shows, carbon pricing initiatives have proliferated around the world in recent years. These CBAM policy spillovers, it must be pointed out, are not necessarily negative, as countries are increasing their ambitions to comply. Rather, what could be more worrying is a proliferation of BCAs without coordination, which would create a context in which trade, instead of getting greener, would be increasingly fragmented. Several other countries have indeed already ventilated proposals for their BCAs[21]. If the EU CBAM is the example, there is the risk that countries will not come to agree on common reporting methodologies and standards for low-carbon products, seriously hindering the development of new international lead markets (Marcu et al., 2022). In the literature, climate clubs have been heralded as potential solutions to unilateral initiatives. However, it is unlikely that carbon pricing and BCAs will constitute the club good that makes participation worthwhile, suggesting that positive incentives ("carrots") to encourage industrial decarbonisation might be a better pathway (Jakob, 2023).

[19] Luca de Meo, chief executive of Renault, has stated that European carmakers have already "..seen a rise in the price of steel, which is probably 8-10% the cost of the car in Europe", putting them at a disadvantage against cheaper cars manufactured abroad (Hancock, 2023a). Other industries such as construction, packaging and consumer appliances could be at risk, analysts say (EU Parliament, 2023).

[20] The Commission, for instance, has already declared that CBAM's scope will be extended to downstream sectors, but it is yet unclear how this will be done in practice. The steel sector, in particular, already entails a high degree of complexity, with different production routes and numerous product categories associated to more than 100 custom codes (Hancock, 2023a).

[21] In late 2023, the United Kingdom announced that it would introduce a CBAM in 2027. Australia and Canada have also been exploring similar BCA measures, among other countries. 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 (WTO et al., 2024)

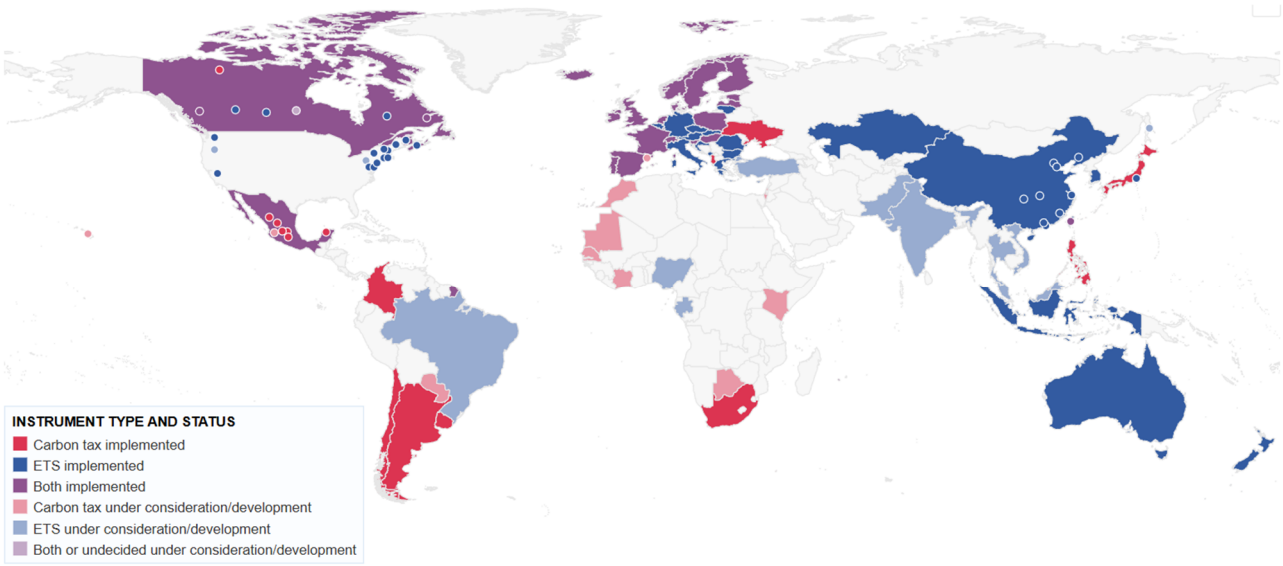

Figure 4: Carbon pricing tracker, 2024. Source: World Bank. https://carbonpricingdashboard.worldbank.org

Finally, the EU CBAM has been accused by many developing countries of being "yet another green trade barrier" (the other most controversial measure being the EU Deforestation Regulation), symbol of an EU seen as imposing its climate policies on others. This confrontational stance stems from the approach chosen by the CBAM to account only for monetary measures, criticised for interfering with the sovereign right of countries, under the Paris Agreement, to choose their own policy mix (Mehling et al., 2024). Even though EU lawyers have repeatedly reassured about CBAM's compliance with WTO laws, China and India, among others, have lodged official complaints and threatened retaliation (Hancock, 2023a). Moreover, countries much dependent on exports to the EU in CBAM sectors have reiterated how a level-playing field with equal emissions costs is inherently unfair to them, being at a completely different stage of development than EU countries (Zhong & Pei, 2022). Indeed, CBAM's unconditional application with no exemptions runs counter to Paris' Common-But-Differentiated-Responsibilities (CBDR) principle. To improve CBAM's legitimacy and mitigate the *green shockwave* spillover, many authors have suggested how its revenues could be used to support the transition in CBAM's so-called "significant others" (Smith et al., 2024). This would also benefit those countries via technology transfer and capacity building, maximising the technology dissemination spillover. Yet, in adopting this solution the EU must carefully balance it with the need to support industrial decarbonisation at home, something that some consider a valid remedy for the export leakage problem (Jakob & Mehling, 2024). All these considerations shed light on how minimising negative spillovers crucially depends on how CBAM, the most foreign-policy oriented measure of the Green Deal, is viewed by others. In other words, CBAM's legitimacy will be crucial for its success.

CBAM's spillovers	
Leakage	• ⊕ Potentially reduce leakage by applying carbon costs to dirty imports in EITE sectors • ⊖ Resource shuffling from foreign exporters hinders leakage reduction • ⊖ Limited sectoral coverage could hinder leakage reduction and impair EU's competitiveness, although extending CBAM entails more administrative complexity
Policy	• ⊕ Requirements to monitor and verify emissions create and improve MRV systems abroad • ⊕ Deduction of foreign carbon prices compel third countries to adopt carbon pricing systems • ⊖ Proliferation of unilateral BCAs could slow down efforts to agree on common methodologies and standards for green products, potentially limiting trade beneficial effects
Norms	• ⊖ CBAM's deduction mechanism is in contrast with CBDR principle • ⊕/⊖ Depending on how CBAM's revenues are used, legitimacy of the measure and technological spillovers may improve

Discussion and the way forward

This exercise of mapping potential spillovers and reasoning on how they are unfolding -or might unfold- helps to draw some important considerations.

Firstly, the analysis has shown that domestic-first climate policies almost inevitably come with negative spillovers. Trade restrictions mean higher costs for green technologies and a drag on technology dissemination and potential learning effects. Moreover, massive domestic disbursements of subsidies and other support mechanisms, deployed either plainly or opaquely[22], contribute to dilute shared norms of fair international practices and often generates tit-for-tat dynamics which destruct trade and cooperation. This is clearly the case of the US IRA, which, compounding protectionist and discriminatory elements with a distinct geopolitical flavour, risks to more than offset the positive domestic effects it creates.

Secondly, as Mehling (2024) argues, even though the current geostrategic environment necessarily force countries to, on the one hand, protect domestic players and, on the other, make sure that trade does not amplify existing supply chain dependencies, the consequent cross-border negative spillovers can be minimised with attentive policy design. For example, the use of CBAM's revenues for supporting the transition in less-developed trade partners could crucially contribute to sharing existing green technologies where are desperately needed to avoid locking in carbon-intensive development pathways, to create new green value chains for the EU itself[23], and to improve the international acceptance of BCAs. Other design tweaks could be the use of *average sectoral* emissions to avoid reshuffling loopholes and the extension of CBAM's sectoral coverage only to those high-emitting subsectors not yet included in the scope.

Thirdly, from the analysis it can be noticed that, while carbon leakage (negative), technology dissemination (positive) and green shockwaves (negative) are mostly unidirectional spillovers – they either should be minimised or maximised, the policy diffusion spillover may result in bifurcated outcomes, leading either to races-to-the-top or to-the-bottom. This speaks to the utmost importance of considering policy implications. Both the case studies analysed in this paper are nuanced. The IRA, on the one hand, has prompted countries like the EU to reflect on their lack of a green industrial policy; on the other, it has reduced the efficiency of the rapid-response measures taken to counter its forceful entry into force. The EU CBAM, conversely, while spurring other countries to consider adopting carbon prices, has also started a wave of BCAs announcements

[22] "Opaquely" refers mainly to China, which in the last decades has provided massive support to local industries through a range of measures at different vertical levels, with some (like land leases) often going unnoticed.
[23] For example, in the iron and steel sector, countries with natural renewable energy endowments could specialise in the production and export of hydrogen-based Hot Briquetted Iron (HBI) which could then be shipped to developed countries for further processing into electric-arc furnaces for steelmaking (Vogl et al., 2021).

around the world which, if unilaterally implemented, could hinder substantially international markets for green materials.

Finally, and perhaps most importantly, cross-border spillovers are best managed if cooperation efforts are pursued. This relates directly to the green shockwaves spillover, but also indirectly to all the others. For example, countries like the US employing green industrial policy strategies could tie these to climate finance commitments for developing countries, already pledged but not yet fully provided. In the case of BCAs, efforts to share best practices in relevant international fora could help improving design and combating unilateral implementation. More generally, international cooperation efforts should move to build mechanisms that nudge countries towards more *policy alignment* rather than policy fragmentation (Lewis, 2024). International guardrails for subsidies, common reporting methodologies, or jointly set standards for green lead markets are, in this respect, incredibly valuable actions that can only be agreed upon cooperatively.

Recommendations

- Assessing and calculating spillovers from climate policies should be institutionalised and carried out more rigorously, with mixed-methods analyses based on both empirics and models, and on scenarios, storylines, forward-looking approaches, and the like (Mehling, 2024)
- Green industrial policies should retain a degree of openness, employing a "portfolio" approach rather than excluding trade partners a priori to prioritise exclusively the domestic context (Noll et al., 2024)
- Cooperation efforts on BCAs should be linked to discussions around inclusive climate clubs for sectoral decarbonisation, up to date the most innovative institutional vehicles to bring countries and firms together for supporting global transition pathways of hard-to-abate and trade-exposed industries[24]
- Coupling more explicitly trade- and climate-related unilateral policies to international partnerships on technologies[25] and just transitions[26] is crucial to reap the benefits of clean trade and enhance these measures' legitimacy (Lewis, 2024)

[24] The G7 Climate Club for industry decarbonisation created in December 2022 is a paramount example, even though recent political developments like the trade vicissitudes sparked with the Trump administration have stifled its impact and put its continuation into question. https://climate-club.org/

[25] New Zealand, Costa Rica and Iceland have signed an open plurilateral agreement to slash tariffs on products like solar panels and electric vehicles. https://www.reuters.com/world/europe/new-zealand-signs-environmental-tradedeal-with-switzerland-costa-rica-iceland-2024-07-02/

[26] The EU Just Transition Partnerships (JTPs), like the one stipulated with South Africa, are an example. https://climate.ec.europa.eu/news-your-voice/news/joint-article-just-energy-transition-partnerships-2025-01-20_en

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