Emissions trading systems with different measures for carbon leakage prevention: implications for linking

Report for the Carbon Market Policy Dialogue

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1. Introduction

Climate policies that regulate energy-intensive industries are normally accompanied by measures for limiting the risk of carbon leakage; specifically, the risk that increased production costs result in market share losses and, therefore, in increased emissions abroad. In an emissions trading system (ETS), the free allocation of emission allowances is a built-in lever that is typically used for preventing carbon leakage due to competitiveness deterioration. There are also other, external levers that can be used for the same purpose, notably border carbon adjustments and policies promoting low-carbon innovation. Free allowance allocation alone offers several options that differ from one another in the rules governing allocation and in related incentives for allowance recipients. Similarly, border carbon adjustments and policies for low-carbon innovation can come in many forms. All in all, there are multiple tools that can be used for preventing carbon leakage and many variants of these tools that policymakers can choose from. This abundance of options is reflected in the different anti-leakage approaches observed in existing ETSs.

Different measures for carbon leakage prevention across ETSs, regardless of whether the same ETSs are linked or not, may potentially distort economic competition. This is true of competition between firms, but also of competition between jurisdictions if decisions on the location of production plants are directly concerned. If two or more ETSs are linked together, the differences in question – if any such difference persists after linking – generally become more significant and visible. This is because a convergence in allowance prices, upon linkage, reduces or eliminates the risk of carbon leakage between linked ETSs (while price differentials remain *vis-à-vis* third jurisdictions). The harmonisation of free allocation rules, and possibly of other anti-leakage measures, is indeed a particularly relevant topic in the context of linking. More generally, however, the need to raise ambition in climate change mitigation has meant that carbon leakage prevention *per se*, independent of linking, is becoming increasingly important. The recent initiative of the EU regarding the possible introduction of a border carbon adjustment – an unprecedented measure – is emblematic in this sense.

The purpose of this report – like that of the preceding three (FSR Climate, 2020; Verde et al., 2020; and Galdi et al., 2020) and of the two that will follow – is to inform the Carbon Market Policy Dialogue (CMPD).[1] With regard to differences in carbon leakage prevention between ETSs and the implications for linking, the report does four things: a) it provides a conceptual framework; b) it summarizes the scientific literature; c) it describes the current status of the six ETSs represented in the CMPD, namely those of California, China, the EU, New Zealand, Quebec and Switzerland; and d) it offers up a few ideas for discussion. The hope here is to stimulate the CMPD and, also, to provide relevant contents that will be taken up in the subsequent capacity building and dissemination activities within the DICET project – Deepening International Cooperation on Emissions Trading.[2]

The report is structured as follows: Section 2 outlines the conceptual framework; Section 3 summarises the literature; Section 4 reports on the state-of-play and on the relevant experience of the six ETSs represented in the CMPD; and Section 5 offers a discussion and conclusions.

1 https://lifedicetproject.eui.eu/carbon-market-policy-dialogue/

2 https://lifedicetproject.eui.eu/

2. Conceptual framework

2.1 Carbon leakage: definitions, channels, and risk assessment

Definitions

In this report, 'carbon leakage' is intended as the phenomenon whereby emissions reductions achieved in a jurisdiction are to some extent offset (potentially, even more than offset) by an increase in emissions abroad.[3] This version of carbon leakage, which refers to emissions effectively shifting across jurisdictions, is the most commonly considered.[4] In an opposite way, 'negative' carbon leakage arises whenever emission reductions attained in a jurisdiction lead to further emission reductions elsewhere. Furthermore, a leakage 'rate' measures the portion (percentage) of a given cut in emissions that corresponds to a consequent change in emissions abroad, with a positive number indicating leakage and a negative one indicating negative leakage.

Channels

Carbon leakage across jurisdictions may take place via three main channels: a) firm competition, a.k.a. competitiveness channel, b) global energy markets; and c) technology spillovers, which are specifically relevant to negative leakage. The three channels are not mutually exclusive: in principle, they could all be active at the same time.

The competitiveness channel hinges on the mechanism whereby more stringent climate policies than in other jurisdictions affect the competitiveness of domestic firms. The simple logic is that higher production costs reduce competitiveness, thus resulting in both increased production and increased emissions of competing firms subject to less stringent policies. Within the competitiveness channel, a key distinction is that between operational and investment leakage. Operational leakage relates to negative effects on short-term competitiveness and, as such, it is reflected in reduced output and immediate loss of market share; investment leakage, by contrast, relates to negative effects on long-term competitiveness, resulting in the shutdown of existing plants or in the investment in new production capacity abroad. Importantly, there are also arguments which diminish the competitiveness channel's relevance. According to the Porter Hypothesis (Porter and van der Linde, 1995), more stringent market-based climate policies may induce regulated firms to be, in fact, more competitive.[5] Another argument is that carbon costs are only one of many variables determining investment decisions.

Competitiveness deterioration is not the sole channel through which carbon leakage can occur. If a jurisdiction, or a set of jurisdictions, adopting more stringent climate policies makes up a significant share of global demand for fossil fuels, carbon leakage may materialise in other parts of the world as a result of reduced fossil fuel prices. An important aspect of this mechanism is that, absent international policy coordination, governments do not readily dispose of instruments to intervene on global energy markets and limit carbon leakage. In other words, there are no obvious unilateral measures to prevent carbon leakage occurring via global energy markets.

Finally, emissions reductions achieved in a given jurisdiction could result – unlike in the two previous cases – in additional reductions elsewhere, i.e. negative leakage. Transboundary spillovers from development and use of low-carbon technologies explain the mechanism in play here. In brief, more ambitious climate policies, while reducing domestic emissions, may also induce lower emissions in other jurisdictions via learning, reduced abatement costs, and related spillovers.

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3 For our purposes, a distinction between national and sub- or supra-national jurisdictions is not relevant.

4 Carbon leakage could also refer to emissions shifting across economic sectors or across time, as with intertemporal leakage.

5 The Porter Hypothesis posits that market-based environmental policies may improve firm competitiveness by spurring new production processes and products.

Risk assessment

Assessing the risk of carbon leakage, as a consequence of possible adverse competitiveness effects, is important for preserving the environmental effectiveness of unilateral climate policies while not giving regulated firms unjustified compensations. A proper assessment of leakage risk is particularly important in the context of a fixed-cap ETS if the free allocation of emission allowances is a key anti-leakage measure. This is because the total volume of free allowances decreases with the cap over time and, therefore, allowance allocation needs to be well-targeted. In theory, leakage risk is determined by the extent to which climate policy drives up domestic production costs and the consequent change in emissions outside that jurisdiction. In practice, it has become standard to assess leakage risk on the basis of two criteria, namely a sector's emission intensity and trade intensity. Emission intensity metrics capture the potential significance of carbon costs meaning the maximum impact that carbon pricing could have on a sector; trade intensity metrics proxy for the (in)ability to pass-through additional costs without loss in global market share. Sectors at risk of carbon leakage are usually identified based on a combination of these metrics and corresponding threshold values. Sometimes (as with, for instance, California's and Quebec's ETSs), multiple thresholds are considered to distinguish between different levels of risk. In general, this approach strikes a compromise between accuracy in assessing leakage risk and administrative complexity. The growing scarcity of free allowances induces ETS regulators to seek greater accuracy in allocating those. However, while marginal improvements may, here, be imagined and achieved, simple 'definitive' solutions do not seem to exist.

2.2 Approaches to carbon leakage prevention

In an ETS, the free allocation of emission allowances is the canonical approach for preventing carbon leakage. However, free allocation is not the only approach for leakage prevention. Nor is it even necessarily the best one, especially when thinking of future, deep emission reduction targets like those already set by several ETSs around the world. Free allocation responds to a logic of carbon costs compensation imposed on regulated firms, insomuch as those would otherwise result in market share losses and, therefore, in carbon leakage. Other anti-leakage approaches, which may or may not accompany an ETS, aim at: a) levelling the playing field between domestic firms and their competitors in other jurisdictions; or b) fostering low-carbon innovation as a way of enhancing the competitiveness of domestic firms.

Compensatory measures: free allocation[6]

In an ETS, different rules can govern the free allocation of emission allowances to regulated firms. There are three 'archetypal' methods of free allocation (variants of which may co-exist and evolve over time in a given ETS): grandfathering; fixed base-period benchmarking; and output-based allocation. Under grandfathering, firms receive free allowances according to their historical emissions multiplied by an emission factor. Allocations are, thus, lump-sum transfers proportional to historical emissions. The application of product-specific benchmarks (expressed in terms of emissions per unit of output) in the calculation of allocations, characterises both fixed base-period benchmarking and output-based allocation. The purpose of benchmarks is to strengthen incentives for increasing emission efficiency, as well as to reward early action. Under fixed base-period benchmarking, however, allocations are proportional to activity levels in the given base period. With output-based allocation – this is the key difference between the two methods – allocations are proportional to current activity levels. Crucially, adjusting (or 'updating') allocations to current output means that, in effect, firms receive an output subsidy. This implicit subsidy entails that product prices increase by smaller amounts and that, therefore, the prevention of market losses and carbon leakage is more effective. The size of the subsidy depends on the stringency of the benchmark, as well as on other ETS parameters, such as the assistance factor and (in a fixed-cap ETS) the cap decline factor.

6 For a comprehensive analysis of different free allocation methods, see Acworth et al. (2020). For a direct comparison of free allocation rules in force in different ETSs, see Dobson and Winter (2018). For a detailed illustration of output-based allocation, see Fischer (2019).

Levelling the playing field: border carbon adjustment[7]

Border carbon adjustment (BCA) is another instrument that can be used to prevent carbon leakage via the competitiveness channel. To date experience with BCA is very limited.[8] However, the serious consideration of BCA recently, both in the EU and the US, means that the future diffusion of this approach has become a real possibility. BCA is supposed to level the playing field between domestic and foreign producers by equalising carbon prices faced by domestic firms and lower or higher carbon prices abroad. In theory, price adjustments would make up for any such differences in carbon prices. In practice, different BCA designs can be considered and evaluated according to multiple criteria. These include technical feasibility, environmental effectiveness, administrative costs and, most importantly, compatibility with international trade law.

When combined with an ETS (rather than a carbon tax), a BCA could require that importers pay a fee based on the market price of emission allowances: alternatively, it could require that importers buy allowances equivalent to what the ETS requires of domestic producers. In both cases, just as free allocation in the importing jurisdiction should be accounted for, carbon prices and free allocation in the exporting jurisdiction should be accounted for too. Further, one may consider a BCA that also offers relief to exports by rebating the associated domestic carbon payments. This would ensure that domestic exporters are not disadvantaged in international markets. However, scholars have warned that – at least in the case of a BCA-ETS combination – export rebates would "very likely be considered prohibited export subsidies" under World Trade Organisation (WTO) rules (Cosbey et al., 2019).9 In general, a de-facto requisite for the compatibility of any BCA with WTO rules is a strong and provable environmental rationale, i.e. emissions reduction.10 Also, it must be equally clear that the implementation of a BCA is neither arbitrary nor carried out in a way that is aimed at protecting domestic interests. Last but not least, a BCA needs to reconcile compliance with the principles of non-discrimination, under the GATT, and that of Common but Differentiated Responsibilities and Respective Capabilities, under the United Nations Framework Convention on Climate Change (UNFCCC)..

Fostering innovation[11]

Instruments that complement an ETS by directly promoting low-carbon innovation in energy intensive industries may also play a key role in preventing carbon leakage. Increasingly, various forms of public subsidies are considered or are already used for just this purpose. In the EU, the EU ETS Innovation Fund, which provides financing to the commercial demonstration of innovative low-carbon technologies, is a case in point. Moreover, a number of new proposed instruments have been gaining traction. Carbon contracts for differences (CCfDs) are probably the novelty that has generated greatest interest. Essentially, CCfDs promote investment in innovative low-carbon projects by guaranteeing a fixed price for emissions reductions below the best available technology. Depending on the contract price level and thanks to reduced revenue uncertainty (and hence reduced financing cost), CCfDs can spur deep-decarbonisation projects that would not be viable otherwise under current market conditions and expectations.[12]

Beyond CCfDs, other instruments that have been proposed to promote low-carbon innovation in industrial sectors include product carbon requirements and consumption charges. Product carbon requirements are emission-intensity standards for industrial products. Proponents of this instrument often

7 For an in-depth analysis of border carbon adjustments, see Cosbey et al. (2019).

8 California's ETS features a BCA mechanism for the electricity sector.

9 Cosbey et al. (2019): "The WTO Agreement on Subsidies and Countervailing Measures (SCM Agreement) disciplines the use of subsidies to domestic producers and delineates permissible responses to imports that are subsidized in violation of the agreement. The SCM Agreement prohibits any subsidies that are conditioned on the export of goods, and therefore may limit the ability to apply BCA to exports."

10 The "conservation of exhaustible natural resources" is one of the exceptions that allow a nation to violate the non-discrimination principles of the General Agreement on Tariffs and Trade (GATT), namely National Treatment and Most Favoured Nation.

11 For a detailed analysis of the instruments for deep decarbonisation, see Chiappinelli et al. (2020).

12 On CCfDs specifically, see Richstein (2017).

suggest that the standards could be voluntary in a first phase, and subsequently become mandatory once there is enough capacity to produce low-carbon materials. The logic of consumption charges is different. Consumption charges are intended to complement output-based allocation by providing demand-side incentives for low-carbon innovation. The idea is that the sum of the two forces, namely output-based allocation for producers and stronger carbon price signals to consumers, would give producers greater incentives for investing in low-carbon innovation.13

2.3 Carbon leakage prevention, competitive distortions, and linking

Any instrument for carbon leakage prevention could produce, depending on its own specific design, competitive distortions that are illegitimate under WTO law or under other applicable trade regimes (e.g. the European Single Market in the case of the EU ETS). Specific designs of free allocation, BCA, and any instrument promoting low-carbon innovation could all qualify, for example, as prohibited or actionable subsidies under WTO law.[14] Any anti-leakage instrument or measure that a jurisdiction may wish to use needs to be compatible with the broader relevant trade regimes. This is always true: whether an ETS is linked to another ETS or not.

Now, consider linking. On the one hand, by inducing partial or full convergence of allowance prices, ETS linking reduces (under partial linking) or removes (under full linking) any internal competitive distortion due to differences in carbon prices. On the other hand, given pre-existing (i.e. pre-link) differences in carbon leakage prevention between linked ETSs, price convergence can highlight or even exacerbate potential competitive distortions. This eventuality is most clear in the case of differences in free allocation. Imagine more generous free allocation in one ETS than in another linked ETS as reflected, for example, in laxer parameters for eligibility to free allocation or in less stringent benchmarks. This would entail different production costs for competing businesses in different jurisdictions. While there can be such distortions regardless of linking, they can also arise with linking if differences in carbon leakage prevention are not adjusted after price convergence. Moreover, linking could exacerbate competitive distortions if output-based allocation is used in one ETS but not in the other(s). For example, there could be a case in which bilateral linking determines a large price increase in the ETS that uses output-based allocation and only a small price decrease in the ETS that uses fixed base-period benchmarking. Firms in the output-based allocation ETS will then benefit from a significant increase in the implicit output subsidy that they receive. By contrast, competing firms in the fixed base-period benchmarking ETS will only see a modest reduction in the carbon price they face.

An increased focus on competitive distortions and, possibly, on the expectation of exacerbated competitive distortions may generate resistance to ETS linkages whose anti-leakage measures are not harmonized. A linkage may still take place, as the differences in question do not preclude linking in a technical sense. However, with time, some harmonization may prove necessary for the political sustainability of the linkage.

3. Literature review

The literature specifically relevant to the topic of this report is not huge. Relevant contributions are scattered in studies – more often reports or book chapters rather than journal articles – that cover several aspects of ETS integration in the context of the existing international climate change regime or in the context of a hypothetical one. A second feature of this literature is that it focuses on potential competitive distortions due to differences in allowance allocation between ETSs. Differences in other anti-leakage measures, again as causes of potential competitive distortions, are largely ignored. The focus on heterogeneous allocation approaches is explained, in part, by the allocation method itself being a necessary element of any ETS. But there is also the fact that certain allocation rules may determine com-

13 On consumption charges specifically, see Neuhoff et al. (2016).

14 Under WTO's Agreement on Subsidies and Countervailing Measures two types of subsidies are prohibited: subsidies that require recipients to meet certain export targets, or to use domestic goods instead of imported goods. Even where a subsidy is not prohibited, it can be actionable if it causes injury to other countries.

petitive distortions by interacting with linking. Accordingly, our summary of this literature is structured into three topics: a) potential competitive distortions caused by different allocation rules, regardless of linking; b) potential competitive distortions caused jointly by linking and different allocation rules; and c) the harmonisation of allocation rules.

3.1 Potential competitive distortions caused by different allocation rules, regardless of linking

Baron and Bygrave (2002) is one of the first studies to consider the possibility that differences in allocation method between ETSs produce competitive distortions; that is, the possibility that differences in the way emission allowances are distributed distort competition between firms in different ETSs, thus affecting market shares. An example: in one ETS emission allowances are distributed through auctions, while, in another, they are given for free, based on historic activity (i.e. grandfathered). Firms under the first ETS face real carbon costs. Firms, instead, under the second face opportunity costs – these being equal to the revenue that would be earned if emissions were reduced and the allowances sold. On the one hand, the assumption whereby rational, profit-maximising firms fully value the opportunity cost of using free allowances for compliance, in the same exact way as if it was a real cost, suggests that competitive outcomes are not affected by whether some firms have to buy allowances while their competitors get them for free; or, more generally, by whether some firms receive fewer free allowances than their competitors. On the other hand, the (presumed) irrelevance of the allocation method with respect to operational decisions does not negate obvious asymmetric effects on short-term profits, namely greater production costs for firms that have to buy relatively more allowances than their competitors. For this reason, Baron and Bygrave (2002) state that differences in (real) compliance costs raise competitiveness concerns. Similarly, Haites (2003) acknowledges that free allocation may have wealth effects which influence competitiveness. Jaffe and Stavins (2007) further specify that “if a firm faces constraints on its ability to raise capital at typical market rates, differences in allocation approaches can competitively disadvantage a firm that must purchase more allowances than its competitors”.

A more specific, but no less important example of how differences in allowance allocation may cause competitive distortions arises with ETSs in which allowances are distributed for free based on current output. In an ETS that uses output-based allocation, regulated firms receive an implicit output subsidy, which, by definition, may distort competition in a given market (Haites, 2003; Jaffe and Stavins, 2007). Santikarn et al. (2018) also comment on possible competitive distortions related to how fixed base-period benchmarking (see Section 2.2) and output-based allocation respond to the economic cycle. That is, during economic downturns, firms with predetermined allocations receive excess allowances, while firms whose allocation is based on output see a reduction in allocations; during economic booms, the opposite is true.

Differences in certain allocation rules may also directly affect decisions regarding the shut-down of production plants and – what is more relevant from a competition perspective – the location of new plants. Specifically, this is the case of differences in the rules for new entrants and closures within the scope of an ETS. As Blynth and Bosi (2004) explain, a firm will have an incentive to shut down production in jurisdictions that continue to allocate to closed plants (in other terms, pre-allocated allowances are not withdrawn upon closure), and start up or expand new production capacity in jurisdictions that will allocate allowances free of charge to new entrants. One may say that differences in new-entrant and closure provisions can distort competition between jurisdictions (competition for investments), rather than competition between firms.[15]

3.2 Potential competitive distortions caused jointly by linking and different allocation rules

When two (or more) ETSs are linked together, the respective allowance prices should converge as a consequence of trading. Under full linking, prices should, in fact, fully convergence at some intermedi-

15 In the first two EU ETS trading periods, heterogeneous new-entrant and closure provisions across Member States were questioned as illegitimate sources of competitive distortions by EU State aid rules. See Section 4.3.2 for more details.

ate level.[16] In principle, by inducing price convergence, a linkage on its own reduces or, with full linking, eliminates any potential competitive distortion due to carbon price differentials within the linked ETSs (Baron and Bygrave, 2002). Of course, in levelling the playing field through price convergence, linking does initially produce competitiveness effects: negative effects for the firms facing a price increase relative to the pre-link situation, and positive effects for those facing a price decrease. The impacts of these price changes on the competitiveness of firms, in the different ETSs, will ultimately depend on, *inter alia*, a firm's ability to pass on allowance costs and on the recycling of auction revenues, if such mechanisms are in place (Flachsland et al., 2008).

While linking reduces or eliminates competitive distortions due specifically to carbon price differentials between ETSs, it does not address other potential distortions due to differences in allocation rules, i.e. those described in the previous paragraph (Section 3.1). As a matter of fact, it is possible to think of cases where changes in allowance prices caused by linking accentuate or attenuate competitive distortions due to different allocation methods. Haites (2003) illustrates how these interactions may come about. One first needs to recall that output-based allocation gives firms an implicit output subsidy. Consider two ETSs, 'A' and 'B', which are linked together: the pre-link allowance price in 'A' is lower than the pre-link price in 'B'; plus, 'A' uses output-based allocation. After linking, the allowance price will rise in 'A' and, hence, the implicit output subsidy with it. Now, if output-based allocation was already a cause of competitive distortions before linkage, the price increase after linkage would amplify those distortions. Conversely, if the pre-link price in 'A' were higher than that in 'B', then the price decrease in 'A' after linkage would attenuate any pre-existing distortion due to output-based allocation. However, even in this kind of situation a linkage may encounter resistance. Jaffe and Stavins (2007) consider precisely this scenario: firms in the lower-price ETS ('B') may object to a link because, for them, that would entail facing the same allowance price as competitors in the other ETS ('A'), without receiving the benefit of output-based allocation that their competitors enjoy.

As these examples show, output-based allocation stands out as being potentially problematic when it comes to linking. However, in general, the actual significance of any competitive distortion always depends on the extent to which firms compete in a market. And the extent to which firms compete with each other can only be established empirically, on a case-by-case basis. Furthermore, as Jaffe and Stavins (2007) observe, it is possible that, in some cases, the opportunity to establish a linkage could eliminate the need for the use of output-based allocation.

3.3 The harmonisation of allocation rules

Given two or more ETSs, differences in their approaches to carbon leakage prevention, notably differences in allocation rules, do not represent an impediment to linking in a technical sense, i.e. to the exchangeability of allowances (Tuerk et al., 2009). Yet, as noted above, such differences can potentially distort competition between firms across jurisdictions, whether independent of linking or, if output-based allocation is used, in combination with linking via price convergence. What is more, differences in anti-leakage measures that are not adjusted after a linkage and price convergence can become (more) significant and, if so, potentially controversial. All these considerations lead to the same general conclusion: harmonisation or 'alignment' of anti-leakage measures and especially allocation rules should be pursued, so that a level playing field is achieved, not only in terms of carbon prices, but also in terms of actual carbon costs. In the real world, however, the extent to which harmonisation is needed to facilitate linkage will depend – experience demonstrates – on circumstances specific to each ETS and to each linkage (Jaffe and Stavins, 2007). Also, some differences between ETSs may remain without undermining the case for linking. Another aspect of harmonisation which is worth mentioning is that the risk of leakage, while is normally reduced between harmonised ETSs, could potentially increase *vis-à-vis* third jurisdictions (Kachi et al., 2015).

In their innovative study on linking processes, Burtraw et al. (2013) analyse the harmonisation of numerous design elements of ETSs that consider linking, including those pertaining to allowance allocation and carbon leakage prevention more generally. Table 1 is the relevant section of a much more

16 This level depends, in the first place, on the relative size of the ETSs and the respective abatement costs.

extensive table which, for any given design element (here: allowance allocation), summarises the authors' evaluation of harmonisation along three criteria: a) importance of harmonisation for the proper functioning of the linked ETSs (*'Important for functioning of markets?'*); b) the administrative difficulty of harmonisation (*'Difficulty to align?'*); and c) the importance of harmonisation for political-economy reasons (*'Important for political economy?'*), which mainly relates to the minimisation of distributional effects.

Table 1: Evaluation of allocation alignment (Burtraw et al., 2013).

	Important for functioning of markets?	Difficulty to align?	Important for political economy?
Allocation method	Maybe	Hard	Yes
Treatment of entrants and exits	No	Easy	Maybe
Measures to address leakage	No	Hard	Maybe
Use of auction revenues	No	Hard	Maybe

The argument put forward by the authors whereby differences in allocation method may affect the very performance of linking relates, again, to a scenario in which output-based allocation is used in one of the ETSs. In such a case, it is explained that "one might expect to see allowances and emissions flow to the program using output-based allocation even if the two programs are in every other way identical". We interpret this sentence as to mean that costs savings from linking may not be maximised. Beyond 'allocation method', other design elements that are contemplated include: a) the allocation treatment of entrants and exits; b) measures to address carbon leakage (to third jurisdictions); and c) the use of auction revenues. Harmonisation seems not to be important for the functioning of linked markets (first column) with any of these elements. As regards the ease of harmonisation, three out of four design elements are deemed to be hard to align, the exception being the allocation treatment of entrants and exits. However, alignment may be important for political-economy reasons, mainly related to distributional effects and equity considerations. Specifically, alignment is more convincingly considered important in terms of the allocation method – as stressed by many authors (Sterk and Schule, 2009, Hausotter et al., 2011, among others) – and it is potentially important for the other design elements. On the use, for example, of auction revenues, Mace et al. (2008) note that the acceptability of linking may be called into question if industrial sectors perceive that their competitors in a partner ETS receive additional support.

4. Data from the ETSs in the Carbon Market Policy Dialogue

This section reports on the state-of-play and the relevant experience of the six ETSs represented in the CMPD.

4.1 California-Quebec

4.1.1 State of play

Regulated sectors identified as being at risk of carbon leakage

The California and Québec cap-and-trade programs were developed following the recommendations of the Western Climate Initiative (WCI) partner jurisdictions. In 2008, WCI released recommendations that included program design features to address emissions leakage based on the point of regulation and allocation of allowances.[17] By design, the WCI recommendations are intended to ensure that implementing a cap-and-trade system does not shift economic activity, and GHG emissions, to jurisdictions without carbon pricing. This emissions leakage could erode cumulative global emission reductions. The

17 https://wcitestbucket.s3.us-east-2.amazonaws.com/amazon-s3-bucket/documents/en/wci-program-design-archive/WCI-DesignRecommendations-20090313-EN.pdf

recommendations also focus on maintaining incentives for efficient production in regulated sectors, reducing carbon emissions. In the electricity sector, grids interconnect across neighboring jurisdictions. California and Québec followed the WCI recommendation to place the regulatory requirement for the carbon content of imported electricity on the first jurisdictional deliverer. This is the entity that brings electricity to the grid. With the first jurisdictional deliverer serving as the point of regulation, all electricity consumed in a jurisdiction is regulated under the cap-and-trade system, whether imported or generated inside the jurisdiction.

The WCI recommendations also addressed emissions leakage from the industrial sector as covered entities may not be able to pass carbon costs to consumers due to national and international competition - resulting in a shift of production and emissions to jurisdictions with less stringent climate policies. Both California and Québec have implemented methodologies to identify sectors at risk for leakage and minimize leakage for energy intensive and trade exposed (EITE) sectors through output based allocation of allowances. California and Québec follow a similar approach to identifying sectors at risk for carbon leakage but are not bound by linkage requirements to follow the same protocol in determining the quantity of distribution of freely allocated allowances to prevent carbon leakage. The approach of each jurisdiction is outlined below.

EITE allowance allocation in Québec

To ensure the competitiveness of entities in Québec, the cap-and-trade system contains provisions to provide allowance allocation for EITE sectors at risk for carbon leakage as defined using two metrics, a trade exposure ratio and an emission intensity calculation. Trade exposure measures a sector's ability to pass carbon costs to consumers, while emissions intensity captures the impact of carbon pricing on a sector's total production costs. These metrics are calculated as follows:[18]

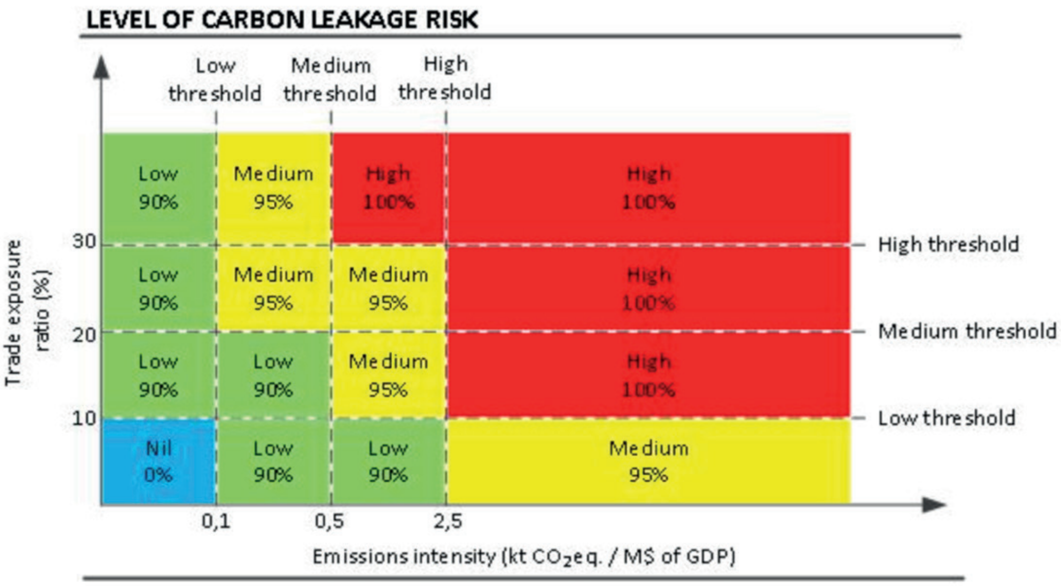
$$Trade\ Exposure\ Ratio\ (\%) = \frac{(exports + imports)}{(domestic\ production + imports)}$$

$$Emissions\ Intensity\ \left(\frac{KtCO2e}{Million\ \$}\right) = \frac{GHG\ emissions}{GDP}$$

The EITE metrics generate a carbon leakage risk that classifies sectors (defined by North American Industry Classification System or NAICS code) and regulated entities and is used to determine which entities require allowance allocation to maintain competitiveness. Figure 1 details the carbon leakage risk classifications.

18 https://www.environnement.gouv.qc.ca/changements/carbone/entreprises-fieeec-en.htm

Figure 1 - Québec Carbon Leakage Risk Classifications[19]



The number of free allowances provided to entities to prevent carbon leakage is a function of carbon leakage risk (or assistance factor), production data, and a declining GHG intensity target.[20] Intensity targets are assigned at the facility level except in the aluminium, cement, and lime sectors, where sector specific targets are applied. Thus:

$$Free\ allowance\ allocation = Assistance\ factor\ x\ Intensity\ target\ x\ Output$$

The quantity of freely allocated allowances or emissions units provided to each entity is based on production data that predates the annual free emissions unit calculation. When production data for the year of the emissions calculation are received, modifications are made, ex-post, to account for changes in production volume, ensuring that entities are compensated for their leakage risk appropriately in a given year. From 2012 to 2020, the assistance factor for all EITE emitters was set at 100%. For the current 2021-2023 compliance period, assistance factors will vary from 90% to 100% based on the carbon leakage risk outlined in Figure 1.[21] From 2012 to 2020, the fixed process emissions intensity target was set at 100%. For the current compliance period, 2021-2023, intensity targets for process emissions decline 0.5% each year. The intensity target for combustion emissions and other emissions fell by 1% to 2% each year from 2015 and 2020 and will decline 1.5% and 3% annually from 2021-2023.

In 2021, 77 entities (including steel mills, cement plants, paper and pulp facilities, and aluminium smelters) in Québec, just over half of all regulated entities, received allowance allocation to prevent carbon leakage.[22] For the post-2023 period, Québec has not determined assistance factors that may depend on the global uptake of climate regulation and carbon pricing that will level national and international competitiveness.

19 https://www.environnement.gouv.qc.ca/changements/carbone/entreprises-fieeec-en.htm

20 https://www.environnement.gouv.qc.ca/changements/carbone/methode-calcul-en.htm

21 An assistance factor of 60% is also provided for certain electricity producers. Those with fixed-price contracts prior to 2008 or entities that produce off-site electricity and steam.

22 https://www.environnement.gouv.qc.ca/changements/carbone/ventes-encheres/allocation-gratuite/Qte-unites-versees.pdf

EITE allowance allocation in California

California's cap-and-trade program provides freely allocated allowances to sectors at risk of leakage. In addition to following WCI partner recommendations, California is legislatively required to minimize leakage under the Global Warming Solutions Act of 2006 (AB 32).[23] The California cap-and-trade program classifies leakage risk by sector as defined by six-digit NAICS codes. California identifies the trade exposure of sectors using a trade share calculation and calculates emissions intensity using sector value added as follows:[24]

$$Trade\ Share\ (\%) = \frac{(imports + exports)}{(shipments + imports)}$$

$$Emissions\ Intensity\ \left(\frac{CO2e}{Million\ \$}\right) = \frac{GHG\ emissions}{Value\ added}$$

California classifies sectors into three categories for trade share (high, medium, and low) and four categories for emissions intensity (high, medium, low, and very low) based on trade share and emissions intensity. Similar to Québec (Figure 1), California combines these metrics to establish leakage risk thresholds of high, medium, or low, which are used to calculate the allocation of allowances for leakage prevention. Figure 2 outlines the California leakage classifications.

Figure 2 - California Carbon Leakage Risk Classifications[25]

Leakage Risk	Emissions Intensity	Trade Exposure
High	High	High
		Medium
		Low
	Medium	High
Medium	Medium	Medium
		Low
	Low	High
		Medium
Low	Low	Low
	Very Low	High
		Medium
		Low

California calculates the number of allowances provided to industrial entities based on leakage risk (or assistance factor), a declining cap adjustment factor that decreases each year in proportion to the overall emissions cap (between 2-4% a year), production data, and a product benchmark that establishes a representative GHG emissions factor for a unit of product produced.[26] That is:

$$Free\ allowance\ allocation = Assistance\ factor\ x\ Benchmark\ x\ Cap\ decline\ factor\ x\ Output$$

23 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=200520060AB32

24 https://www.arb.ca.gov/regact/2010/capandtrade10/capv4appk.pdf

25 https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/meetings/073012/emissionsleakage.pdf

26 When product benchmarks are not available allocation can be determined using an energy benchmark which relies on energy consumed over a period of time. In 2020, less than 2% of allocation was calculated using an energy based formula.

Similar to Québec, allowance allocation is based on the most recent available production data, which will precede the annual allowance allocation calculation. Once annual production data is verified for the year of the allowance allocation calculation, there is an adjustment or true up of allowances to correspond to differences in production.

For the first three compliance periods (2013-2020), the assistance factor for all industrial entities in California was set to 100%, irrespective of their leakage risk classification. All industrial entities, therefore, received allowance allocation to prevent leakage. Legislation passed in 2017 (AB 398) keeps the assistance factor for all industrial entities at 100% from 2021 through 2030. Thus, free allowance allocation will change over time for industrial entities based on changes in output, the cap decline factor, and any changes in product benchmark. The cap decline factor will ensure that free allowance allocation declines in line with the cap, 4% for the current compliance period through 2030.

4.1.2 Relevant experience

Analysis of carbon leakage within the cap-and-trade system

Preventing leakage and maintaining competitiveness has been a central tenet in reviewing the California Québec cap-and-trade system. External researchers and policymakers have analyzed the impact of carbon pricing on emissions leakage and resource shuffling, substituting lower GHG emissions power for higher GHG emission power when importing electricity into a jurisdiction. Both the California Air Resources Board (CARB) and the Ministère de l'Environnement et de la Lutte contre les changements climatiques (MELCC) that implement cap-and-trade programs for their jurisdictions actively monitor the reporting of emissions across regions to ensure that emissions leakage and resource shuffling of electricity do not occur. To date, there has been no evidence of resource shuffling or emissions leakage in the electricity sector.[27]

In California, the Economic and Allocation Advisory Committee (EAAC)[28], the Market Simulation Group (MSG)[29], and the Independent Emissions Market Advisory Committee (IEMAC)[30] have analyzed the potential impact of emissions leakage and resource shuffling in the cap-and-trade program and made recommendations for regulatory consideration. The EAAC provided feedback on California's approach to emissions leakage mitigation and recommended either a border carbon adjustment – which was explored in California but never implemented – or output based allowance allocation. The MSG analyzed the potential for resource shuffling and the potential impact on the cap-and-trade allowance market and emissions. More recently, in 2019, the IEMAC provided recommendations on strengthening provisions of the cap-and-trade program to reduce the potential for emissions leakage.[31]

Modifications to leakage mitigation

Over time, modifications have been made to the leakage mitigation in both the California and Québec cap-and-trade programs. In Québec, in the current compliance period, the assistance factor has declined and intensity targets have become more stringent, reducing the number of freely allocated allowances received by entities in Québec. There is discussion regarding the level of leakage mitigation required in the post-2023 compliance period as other jurisdictions implement stringent GHG reduction targets requiring entities worldwide to incorporate carbon costs into their production decisions.

Regulatory modification and legislative mandates have also changed the level of leakage mitigation in the California cap-and-trade program. As outlined in the 2010 Cap-and-trade Regulation, the assistance factor for medium and low leakage risk sector was set to decline in the second (2015-2017)

27 https://ww2.arb.ca.gov/sites/default/files/classic//cc/capandtrade/guidance/resource_shuffling_faq.pdf

28 https://www.arb.ca.gov/regact/2010/capandtrade10/capv4appk.pdf

29 https://ww2.arb.ca.gov/our-work/programs/cap-and-trade-program/market-monitoring/market-simulation-group

30 https://calepa.ca.gov/climate/iemac-independent-emissions-market-advisory-committee/

31 https://calepa.ca.gov/wp-content/uploads/sites/6/2018/09/6e.-IEMAC_Meeting_Materials_9-21-18__Fowlie_and_Cullenward_Report_on_Emissions_Leakage.pdf

and third (2018-2020) compliance periods. In 2011, a Board resolution required CARB to re-evaluate leakage risk for all industrial sectors.[32] This Board action led to regulatory modification in 2013, which delayed the planned reduction in assistance factor until the third compliance period to allow for the completion of external research on leakage risk. Academic researchers re-evaluated the leakage risk for all industrial entities but a 2017 legislative mandate, AB 398, required the assistance factor for all industrial entities to be set at 100% from 2021 through 2030.[33] To prevent market disruptions, CARB passed regulatory changes that kept the assistance factor at 100% for all compliance periods through 2030.

As the California cap-and-trade program matures, there are continued discussions about the competitiveness of California industry and the need for leakage mitigation. Recently, discussions related to border carbon adjustments or non-allocation based approaches are being discussed to ensure that in-state entities are not disadvantaged by facing a carbon price.

California and Québec are not dominant trade partners and do not share a physical border. However, the two programs' approach to minimizing leakage, as developed under WCI recommendations, allows each jurisdiction flexibility to ensure that their covered entities remain competitive in the global market and that global emissions fall due to the joint cap-and-trade system.

4.2 China

4.2.1 State of play

On 3 April 2019, the Ministry of the Ecology and Environment of the People's Republic of China drafted the Interim Regulations on the Administration of Carbon Emission Trading (Draft for comments). On 30 March 2020, the Ministry publicly solicited opinions on the Interim Regulations on the Administration of Carbon Emission Trading (Revised Draft). But there is no detailed information mentioned or related to carbon leakage in these documents. At present, carbon leakage in China's carbon market is mostly discussed in academic circles and in terms of overall design principles for coverage and allowance allocation. The authorities have not officially identified the sectors that are at significant risk of carbon leakage, nor have they identified a strategy for adjusting the allowance allocation method to these sectors. There follows a summary of the sectors that are currently regulated and of the allowance allocation methods in pilot carbon markets and the national ETS.

Coverage and allowance allocation method in pilots

The eight pilot carbon trading markets have covered more than twenty industries. In general, all the pilots cover high energy consumption and high emission industries, such as thermal electric power, cement, petrochemicals, and steel. In terms of the emission sources covered, the carbon markets of all pilot provinces and cities covered direct emission sources and indirect emission sources from heat and electricity.

Free allocation is the main allocation method used in all the pilots. In the pilot schemes, almost all allowances have been allocated free of charge to enterprises. Some pilot schemes have designed or implemented auctions, but with different purposes and procedures. Only a small share of total allowances are auctioned in Shanghai and Guangdong; Beijing, Tianjin and Hubei use auctions as a tool for facilitating price discovery and trading; Shenzhen has considered both aspects; Chongqing and Fujian are still studying the issue. The pilots mainly aim at addressing two possible market issues: first, excessively high allowance prices; and, second, the 'reluctance to sell' of businesses, resulting in insufficient market liquidity. Auctions have, to date, taken place in Hubei, Guangdong, Shanghai and Shenzhen. Table 1 shows the sectors covered and the allowance allocation methods in the pilots.

32 https://ww3.arb.ca.gov/regact/2010/capandtrade10/res11-32.pdf

33 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180AB398

Table 2: Covered sectors and allowance allocation method.

Pilot	Covered sectors	Allowance allocation method
Beijing (2020)	Power, heat, cement, petrochemical, other manufacturing, services, transportation (including civil aviation)	Free allocation. A temporary auction is triggered when the price is too high, or the regulator may decide whether to call for a temporary or for a periodic auction.
Tianjin (2020)	Power, heat, building materials, papermaking, iron and steel, chemical, petrochemical, oil and gas exploitation, aviation	Free allocation. Auctions or fixed price sales are used to stabilise the market price in cases of large fluctuations
Shanghai (2020)	Industry: electric power, iron and steel, petrochemical, chemical, non-ferrous, building materials, textile, paper, rubber and chemical fibres Non-industrial industries: aviation, airports, ports, shopping malls, hotels, office buildings and railway stations	Free allocation. According to the carbon market, the allowances to be paid in 2020 will be issued through temporary or periodic bidding.
Hubei (2019)	Sixteen sectors: electric power, heat and cogeneration, steel, cement, chemical, petrochemical, non-ferrous, paper making, textile, glass, ceramics, medicine, automobile manufacturing, equipment manufacturing, food and beverage, water production and supply	Free allocation. Government reserve allowances are mainly used for market regulation and price discovery.
Guang-dong (2020)	Six sectors: electric power, cement, steel, petrochemical, paper, civil aviation	The main parts are free and some parts are paid. 95 percent are free of charge for power companies. 97 percent for steel, petrochemical, cement and paper companies, and 100 percent for aviation companies
Chongqing (2020)	Industrial enterprises with annual carbon emission of more than 20,000 tons of carbon dioxide equivalent. These cover the chemical industry (calcium carbide, synthetic ammonia, methanol), building materials (cement, plate glass), steel (crude steel), non-ferrous (electrolytic aluminium, copper smelting), paper making (pulp manufacturing, machine-made paper and paperboard), electric power (pure power generation, cogeneration of heat and power) and other industries	Free allocation. Draft for soliciting opinions. When the market supply and demand is out of balance, the reserve allowances will be issued through payments.
Shenzhen (2020)	Enterprises and public institutions with an annual carbon emission of 5,000 tons; or single public buildings with a construction area of more than 20,000 square meters; or single public buildings of state organs with a construction area of more than 10,000 square meters. These cover power, water, gas, manufacturing, construction, public transportation, airports, docks, etc.	Allowances for pre-allocation, new entrants and adjustment are all free. Paid allowances includes those for auction allocation and allowances sold at a fixed price for the purpose of suppressing the price.
Fujian (2020)	Nine sectors: petrochemical, chemical, building materials, steel, non-ferrous, papermaking, electric power, aviation and ceramics.	Free allocation. The intention is to study and establish a paid allocation mechanism and to implement a paid allocation mechanism at the appropriate time.

National coverage and allowance allocation method

In the national ETS, the power industry is chosen for launching the national carbon market. It is taken as the first sector to be covered in the construction of the national ETS for two main reasons. First, carbon emissions from the power industry are the most significant in terms of volume. Second, the quality of carbon emissions data and related data is higher compared with other sectors. The national carbon emission trading market is one of the core measures for achieving the goal of peaking carbon dioxide emissions and the vision of carbon neutrality in China. Its construction will be accelerated in the future. Energy-intensive industries such as petrochemicals, chemicals, building materials, steel, non-ferrous metals, papermaking and aviation will gradually be included.

Currently, China's electricity market reform is still in progress. The electricity price and power dispatching mode have not yet been determined by the market. Most electricity prices are regulated by the government. Therefore, carbon prices for the electricity sector cannot, as yet, drive electricity savings and related emission reductions as they do in the EU. Since a pass-through of carbon costs is not possible, consumers do not face increased costs and may therefore not save electricity. In addition, about 70% of China's electricity is used in the industrial sector. When determining the targets for carbon emissions in the industrial sector, we should consider not only the direct on-site carbon emissions from the burning of coal, oil and natural gas (as the EU does). China needs also to take into account indirect carbon emissions associated with electricity use by industrial businesses.

On the basis of international experiences and the pilot schemes in eight provinces and cities in China, it can be said that the free allocation of all or of most allowances is generally the rule in the initial stage of a given operation. Over time, the share of allowance auctioning progressively increases. With reference to the current (first) trading period of the national ETS, output-based allocation is applied. That is, allowance allocation is based on the actual output of the enterprise in the year of performance.

4.2.2 Relevant experience

The risk of carbon leakage is closely related to industry characteristics. The trade intensity, emission reduction potential and emission reduction cost of different industries vary significantly. Carbon pricing has the potential to affect the competitiveness of high-carbon industries and, hence, to induce carbon leakage. Tan et al. (2018) adopted a multi-region CGE model to simulate carbon leakage from the Hubei pilot ETS via different channels. Competitiveness effects turn out to be the main source of carbon leakage. By contrast, carbon leakage occurring through the energy channel is modest due to limited energy price falls.

In the early days of the pilot carbon markets, some researchers studied the effects of carbon markets or carbon prices on different industries. Zhao (2012) proposed an analytical framework for the impact of carbon trading on industrial competitiveness under an imperfect competitive market structure. Fu and Zhang (2014) studied the impact of trading on carbon leakage, and found that there was no leakage problem in low-carbon manufacturing sectors based on the industry panel data from 1996 to 2010. However, leakage occurred in high carbon manufacturing sectors: including paper and paper products, oil processing and coking, chemical raw materials and chemical products, chemical fibre, non-metallic mineral products, ferrous metal smelting and rolling processing industry, non-ferrous metal smelting and rolling processing. Li et al. (2014) found that for a carbon price of 100 yuan/tCO_2 in China, the output of most energy supply industries will decrease by 6%-7%, the output of industries will decrease by 1%-2%, and the export of most energy intensive industries will decrease by 4%-14.5%.

With the development of China's carbon market, researchers have paid more attention to the eventuality of carbon leakage between China and other countries, but also between pilot and non-pilot regions, ETS and non-ETS industrial sectors, industrial sectors and other sectors, and so forth. Using a general equilibrium model, Li et al. (2019) consider a 'Linking ETS+' scenario. In this scenario, China's national ETS and the EU ETS are fully linked, and total emissions covered by the two ETSs combined are reduced by an extra 5% compared to the 'Independent ETS' scenario. A scenario is designed in which China and the EU reduce emissions by the same amount in their respective ETS caps in order to achieve an overall 5% reduction target for the two systems combined. In the Linking ETS+ scenario, though more stringent constraints on caps can reduce emissions from the ETS sectors in China and the EU, emissions from sectors and regions that are not covered increase. Thus, carbon leakage partly negates the mitigation benefits brought about by linking. In a 'Restricted Linking ETS+' scenario, restricted linking can reduce emissions from non-ETS sectors in China compared to full linking, but it results in increased emissions from the EU non-ETS sector and from the rest of the world.

Comparing pilot and non-pilot regions, Zhou et al. (2020) developed a difference-in-difference-in-differences econometric model. Interestingly, the authors found that emission trading pilots led to reverse carbon leakage, that is, a shift in emissions from the non-pilot region to the pilot region. Reverse leakage may be explained by excessive allocation of emission allowances in the pilot region. Gao et al. (2020) evaluated the effectiveness of China's pilot schemes in reducing emissions. The authors found that emissions trading encouraged the outsourcing of emissions from pilot to non-pilot areas, thus resulting in carbon leakage. This aggravates the imbalance of emissions transfers in China's provinces.

From the perspective of ETS vs non-ETS industrial sectors, Wang et al. (2018) showed that with both a carbon tax in the non-ETS sectors and a regulated power market in place, the risk of carbon leakage is insignificant if the average auctioning factor of ETS is lower than 60%. Also, ETS expansion can help prevent carbon leakage to non-ETS sectors as well as make allowance auctioning more attractive and acceptable. Zhang et al. (2020) evaluated, instead, the distortionary effects of emissions trading on intra-sector competition and carbon leakage. The share of non-ETS emissions to total emissions of the sector is used to express the impact of the production shift in terms of carbon leakage. For all the six unregulated sectors, market shares increase compared with regulated emission sources. This suggests that emissions trading would bring a significant competitive advantage to unregulated emission sources. Significant differences are observed, with the non-ferrous industry being the least affected, and cement and steel, two industries with severe overcapacity, being most significantly impacted.

From the perspective of industrial sectors and other sectors, Pan et al. (2020) studied carbon leakage in the energy/forest sectors using meta-analysis. It was shown that average carbon leakage in the forest sector stood at 39.6%, which is higher than leakage in energy-related sectors. For example, a climate policy designed to reduce deforestation may cause an increase in (forest product) price in the world market which may, in turn, cause changes in land use and in third country demand. Local economic conditions are key drivers of carbon leakage.

Meanwhile, some researchers focused on the impact of the carbon market on the competitiveness of industries. Xia and Tang (2017), for example, found that China's seven pilot carbon markets (excluding Hubei province) are net importers of embodied emissions, and that pilot trading schemes in China could lead to carbon leakage toward other non-trading regions and sectors. Lin et al. (2019) analyse the impact of the carbon market on the competitiveness of China's steel industry in terms of price, output, trade, as well as carbon leakage by constructing a partial equilibrium model. Under current scenarios, the carbon market would have a limited impact on the steel industry. If the carbon price reaches \$10/ CO_2 and 20% of the allowances is auctioned, carbon leakage is 0.49%. If the carbon price reaches \$30/ CO_2 and the allowance is auctioned at 100%, the carbon leakage rate can increase up to 4%. Qi et al. (2020) pointed out that the marginal impact of carbon prices on the trade competitiveness of covered industries was diminishing. There were large differences in the export value of covered industries affected by carbon prices. This was because of the differences in energy costs, mapping coefficients34 and the export size of these industries. From smallest to greatest, the proportion of the export value decline is affected as follows: petroleum, chemicals, non-ferrous metals, ferrous metals, non-metals and paper.

Finally, since the start of the ETS, there has not been much detailed discussions around carbon leakage prevention. However, with the gradual improvement in the carbon market and the expansion of industry coverage, carbon leakage deserves more attention. In fact, national authorities have now some projects underway to study the impact of the carbon market on industrial competitiveness and trade.

34 Emissions per unit of standard coal consumed by different industries are different. Therefore, the same carbon price can map differently to energy prices of different industries.

4.3 European Union

4.3.1 State of play

Regulated sectors identified as being at risk of carbon leakage

In January 2021, the EU ETS entered Phase IV (2021-2030), its fourth trading period. As in Phase III (2013-2020), the economic sectors deemed at risk of carbon leakage are identified according to a formula that combines emissions-intensity (EI) and trade-intensity (TI) indicators. The EI indicator is emissions (both direct and indirect) per unit of Gross Value Added, whereas the TI indicator measures extra-EU trade (i.e. the sum of imports and exports) as the share of production and imports together. However, the formula was modified for Phase IV in such a way that a sector cannot qualify as being at risk if it is only high emissions-intensive or only trade-exposed. To some extent, the sector needs to be both. Specifically, (4-digit NACE[35]) sectors for which the product EI x TI exceeds 0.2 are considered to be at risk of carbon leakage. In addition, if, for a given sector, the same composite indicator falls between 0.15 and 0.2, then a qualitative assessment based on abatement potential, market characteristics and profit margins will determine whether that sector is considered to be at risk. The resulting 'carbon leakage list', which was adopted in 2019 and which will apply to Phase IV, counts 63 sectors, covering about 94% of industrial emissions (European Commission, 2019a).[36]

Free allowance allocation

In Phase IV, 57% of the total number of allowances will be distributed through auctions, while the rest (43%) will be allocated free-of-charge. As a rule, 100% auctioning applies to electricity generation, with an optional derogation for the modernisation of the electricity sector in ten Member States whose GDP *per capita* was below 60% of the EU average in 2013.[37] Beyond electricity generation, any regulated firm (more precisely: installation)[38] whose emissions exceed its allocation of free allowances has to buy allowances that cover the difference in order to be compliant. The method for the allocation of free allowances is fixed base-period benchmarking. Specifically, 54 benchmarks (52 product-specific, and 2 so-called fallback approaches based on heat and fuel inputs) are used, which are calculated based on 2016/2017 data (for Phase IV) and set at the average of the 10% most efficient installations.[39] Different assistance factors apply to installations in sectors at risk of carbon leakage and to all other industrial installations: throughout the trading period, the former receive allowances at 100% of the benchmark, the latter at 30% of the benchmark (0% after 2030, with the exception of district heating). As to the aviation sector, a reduction in the assistance factor, which currently stands at 82%, is expected in the near future. Importantly, in the calculation of allocations, the relevant benchmark (number of allowances per tonne of output) is multiplied by the installation's historical production level (not current output). However, as of Phase IV, to better align allocations with actual output levels, allocations will be adjusted in case of variations of output (rolling two-year average) exceeding +15% (increases) or -15% (decreases) relative to historical levels.[40] Finally, as in Phase III and as in the vast majority of Member States during the first two trading periods,[41] free allowances are set aside to assist new entrants (meaning both new installations and significant capacity expansions of incumbent installations). Allowances, meanwhile, that have already been allocated are forfeited upon installation closure.

35 NACE is the statistical classification of economic activities in the EU.

36 Coverage of industrial emissions was 98% under the previous carbon leakage list for the period 2015-2020.

37 Only three out of ten eligible Member States actually make use of the derogation (ICAP, 2021).

38 In the EU ETS, regulated entities are installations, not firms.

39 The benchmarks will be recalculated in 2024. Moreover, to account for technological progress, an annual reduction rate (0.2% to 1.6%) will be applied to each benchmark. The most recent benchmarks are found in European Commission (2021a).

40 Historical production levels are those considered for determining initial allocations.

41 In the first two trading periods, Member States had significant freedom in both setting their national cap and distributing allowances, which included rules for new entrants and closures.

Measures addressing indirect emissions leakage

In the EU ETS, higher costs incurred by regulated firms due to carbon price signals passed on in electricity prices – thus potentially exposing some firms (electricity-intensive ones) to carbon leakage – are not covered by free allocation. However, Member States can (in fact: "should") provide partial compensation of indirect emission costs to firms in at risk sectors. In 2020, revised State aid guidelines aimed at enabling Member States to provide compensation while avoiding competitive distortions in the Single Market, were adopted for Phase IV (European Commission, 2020). In this context, State aid is considered an appropriate instrument independently of the form in which it is offered, direct grants included. The revised guidelines set a maximum stable compensation rate of 75% (i.e. up to 75% of the indirect emission costs incurred). Moreover, in the calculation of maximum aid payable, the application of electricity consumption efficiency benchmarks ensures that support to inefficient production processes remains limited and maintains the incentive for dissemination of most energy efficient technologies. To illustrate, the maximum aid payable to an eligible installation (i.e. in one of the sectors at risk) is calculated by the following formula:

$$Amax_t = Ai \times C_t \times P_{t-1} \times E \times AO_t$$

where: Ai is aid intensity (0.75 being the maximum);

C_t is the applicable CO_2 emission factor (or market-based CO_2 emission factor)[42];

P_{t-1} is the EUA forward price at year t-1;

E is the applicable product-specific electricity consumption efficiency benchmark;

AO_t is the actual output in year t.

As the formula shows, compensations for indirect emission costs are based on current output, not on historical output as with free allocation (except for output variations in excess of 15%: see above).

Low-carbon innovation policies for regulated sectors[43]

Introduced with the reform for Phase IV and replacing the previous NER 300 funding programme[44], the Innovation Fund (IF) provides financing for the commercial demonstration of innovative low-carbon technologies in energy-intensive industries, as well as in renewable energy and energy storage (European Commission, 2019b). The IF itself is funded through the auctioning of 450 million allowances from 2020 to 2030. Thus, assuming an average carbon price of €40/tCO_2 over Phase IV, about €18 billion would be made available. The IF is not, however, the sole nor even probably the main source of public funding that will be used to support the deep-decarbonisation of regulated sectors, including energy-intensive industries. In the face of the Covid-19 pandemic, exceptional levels of public economic support have been required. Crucially, the economic stimulus has been geared toward serving the ecological transition and the objectives of the European Green Deal. The Recovery and Resilience Facility (RRF), which is the cornerstone of the Next Generation EU recovery package, provides Member States with €672.5 billion in loans and grants: 37% of the money used by each Member State should be allocated

42 As an alternative to a country's standard CO_2 emission factor (measuring the CO_2 intensity of generated electricity), Member States may request that the applicable CO_2 emission factor be established based on a study of the CO_2 content of the actual margin-setting technology in the electricity market.

43 For a comprehensive overview of the various funding programmes assisting the deep-decarbonisation of energy-intensive industries, with a focus on steel, see European Commission (2021b).

44 NER 300 was focused on carbon capture and storage projects and on innovative renewable energy technologies. NER 300 itself was funded through the auctioning of 300 million allowances from the New Entrants' Reserve – hence its name – set up for Phase III.

to investments and reforms that foster the ecological transition. In addition to the IF and the RRF, the InvestEU Fund will mobilize public and private investments in the area of sustainable infrastructure through an EU guarantee of €9.8 billion. Moreover, under Horizon Europe, which is the EU's main funding programme for research and innovation, the European Commission recently proposed ten new partnerships between the EU, Member States and/or the industry, including Clean Hydrogen, Circular Bio-based Europe, Clean Aviation and Europe's Rail, among others (European Commission, 2021c). The goal of the partnerships is to "speed up the transition towards a green climate neutral and digital Europe, and to make European industry more resilient and competitive". The EU will provide almost €10 billion of funding that partners will match with at least an equivalent amount of investment. Also relevant, albeit on a different level, is the fact that State aid rules are being revised, including the rules specifically relevant to aid for environmental protection and energy. In a recent decision, the European Commission approved a Dutch scheme that provides aid via CCfDs (see Section 2.2) for renewable energy production, low-carbon hydrogen production, low-carbon electric boilers, CCS and waste heat recovery.[45]

Border carbon adjustment

As part of the strategy to achieve climate neutrality by 2050, the European Commission is preparing a legislative proposal for the adoption of a WTO-compatible Carbon Border Adjustment Mechanism (CBAM). The proposal should be published by July 2021.[46]

4.3.2 Relevant experience

Evidence on competitiveness effects and carbon leakage

A large and growing econometric literature assesses the impact of the EU ETS on the competitiveness of regulated firms and related carbon leakage. To the best of our knowledge, Verde (2020) is the most recent in-depth review of these studies. The main conclusion of the investigation is that, to date, there is no evidence of the EU ETS having had widespread negative or positive effects on the competitiveness of regulated firms, nor is there evidence of significant carbon leakage. Both low to moderate carbon prices and generous free allocation likely explain this outcome. However, there are three important caveats here. First and most importantly, the evidence available remains largely limited to the first two trading periods, i.e. Phases I and II. Second, some heterogeneity of estimated effects is observed, but patterns, notably sectoral patterns, hardly emerge. Third, the question of whether the EU ETS has had long-term effects on the economy via investment leakage or firm dynamics has been very little explored.

What has been learnt about carbon leakage prevention

The allocation method has changed considerably over the life of the EU ETS. Looking back, one can recognise a continuing process of policy learning in the evolution of allocation rules and of the EU ETS more generally. Phase III, in particular, broke strongly with the previous trading periods in terms of: a) the harmonisation of allocation rules across Member States; b) the adoption of fixed base-period benchmarking in lieu of grandfathering; and c) the adoption of auctioning as the default allocation method, especially 100% auctioning for the electricity sector. With Phase IV, allocation has been further improved through: a) the more accurate identification of the sectors at risk of carbon leakage; b) allocation adjustments in response to large sustained output variations; and c) revised state aid guidelines for the compensation of indirect carbon costs. Policy learning is also recognisable in the Innovation Fund, and promises to be a more effective funding programme for innovative low-carbon projects than the previous NER 300.

45 https://ec.europa.eu/commission/presscorner/detail/en/ip_20_2410

46 For a discussion of the desirable characteristics of the CBAM, should the EU adopt it, see Delbeke and Vis (2020).

Harmonisation of anti-leakage measures as part of linking processes

So far, the EU ETS has been directly linked with only two other ETSs: Norway's and Switzerland's. In both cases, the disparity in size meant that the design characteristics of the EU ETS generally prevailed when it came to ETS alignment. In fact, more useful insights may be drawn from other relevant experiences. The literature offers examples which concern: a) heterogeneous allocation rules within the EU ETS both in Phase I (2005-2007) and Phase II (2008-2012); and b) heterogeneous allocation rules in the failed linkage with Australia's Carbon Pricing Mechanism (CPM) – a transitory scheme leading to the national ETS.

The first two EU ETS trading periods are of interest in that they can be viewed as representing the implementation of a multilateral full linkage involving many national ETSs (Jaffe and Stavins, 2007; Ellerman, 2010). Ellerman et al. (2007) and Ellerman (2010) provide the most detailed analyses of the processes and the outcomes of allowance allocation in Phases I and II. While the European Commission played a key coordinating role, the Member States had ample discretion in allocation decisions. Governments could auction up to 5% and 10% of the total number of allowances in, respectively, Phase I and Phase II. However, the vast majority of allowances were given away for free and many countries ended up not auctioning any allowances at all. "There was of course much lobbying" is a telling comment in Ellerman et al. (2007). Allocation rules for new entrants and closures were the object of competitive pressures too, though at the level of governments rather than of firms. Almost all Member States opted for different new-entrant and closure provisions whereby new installations were granted free allowances and closing installations forfeited theirs. These rules were much debated at the time, both because they could distort investment decisions (affecting the cost-effectiveness of the EU ETS) and because cross-country heterogeneity could distort competition in the EU's internal market. Then, with Phase III, the competitive tensions described were defeated through the centralised harmonisation of allocation rules.

Considering a different episode in the history of the EU ETS, namely the failed linkage with Australia's CPM (2014), de Lemos Pinto Aydos (2017) focuses on the competitive distortions that would have likely resulted from different allocation rules in the two schemes. While the EU ETS used, and indeed continues to use, fixed base-period benchmarking and benchmarks reflecting the top 10% performers, the Australian scheme used output-based allocation and industry average benchmarks. Yet the European Commission and the Australian government did not negotiate even basic provisions for free allocation under the linking agreement. For the author, it is possible that minimum levels of harmonisation across the allocation systems would have been necessary over time, had the linkage been successful. This would have been similar to the harmonisation process adopted by the EU ETS in its Phase III.

4.4 New Zealand

4.4.1 State of play

Regulated sectors identified as being at risk of carbon leakage

In the NZ ETS, industrial allocation is targeted to specific activities that are considered to be emission-intensive and trade-exposed (EITE). There are 26 eligible EITE activities, all of which were made eligible for allocation in 2009 and 2010, when NZ ETS obligations were first being applied to the industry sector.[47] There is provision in the legislation for new types of industrial activity to be considered, but no such new activities have appeared and been made eligible for allocation since that time.

All economic sectors that produce internationally traded products were considered. The first step in the assessment was to identify and define activities that could be at risk of emission leakage. Typically, an eligible activity is an industrial process that makes internationally tradable products and that involves significant emissions. More than half of the units allocated each year go to the three largest EITE activities: steel making, methanol production, and aluminium smelting.

Each activity is defined by its inputs and outputs, for example making alumina into aluminium. This means that in principle it is technology neutral. A firm that makes a specified product, from the same inputs, with less emission-intensive technology benefits from the same allocation as others.

Once an activity had been identified as being potentially eligible, the government required all firms that carried out the activity to submit data for assessing eligibility. To be emission-intensive, the average emissions associated with the activity must be more than 800 tonnes CO_2-equivalent for every one million NZD of revenue from sale of the product. Emission and financial data used for this assessment was the average for the activity in New Zealand during a recent three-year period between 2006 and 2009. To be trade-exposed, an activity simply needs to be producing a product that is traded across oceans. Eligible activities are divided into "highly emission-intensive" and "moderately emission-intensive" and receive different levels of assistance as indicated in the table below.

Table 3: Eligibility and emission intensity of trade-exposed activities

	Eligibility	Level of assistance (LA) 2010-2020
Emission intensity < 800	Ineligible	Not applicable – no allocation
800 < Emission intensity < 1600	Moderately emission-intensive	0.60
Emission intensity > 1600	Highly emission-intensive	0.90

47 The 26 eligible activities and their baselines are listed in Schedule 2 of the relevant regulations: https://legislation.govt.nz/regulation/public/2010/0189/latest/DLM3075101.html

Free allowance allocation

A benchmark level of emissions, referred to as an “allocative baseline” in the ETS legislation, was calculated for each eligible product and was set down in regulations. The baseline is the average emissions per tonne of a product made by carrying out the activity, in the same historical period used for assessing eligibility.[48]

Allocations are indexed to current output. Any firm that carries out an eligible activity may register and apply for an allocation each year, calculated as:

$$A = LA \times \sum (PDCT \times AB)$$

where: A is the allocation in New Zealand Units (NZUs) for a compliance year;

LA is the level of assistance that applies for the activity for that year;

PDCT is the tonnes of an eligible product made in the year;

AB is the allocative baseline for the product.

The levels of assistance remained at 0.60 and 0.90 for the first ten years of the NZ ETS. Allocation is now being phased down, starting with the 2021 calendar compliance year, so that the LAs used for this year are 0.59 and 0.89. They will be reduced by a further 0.01 each year until 2030. In addition, the legislation provides for:

- More rapid reductions for all sectors from 2031, with some ability to slow these if there is an ongoing risk of emission leakage;
- More rapid reductions for individual sectors at less risk from 2026.

In principle, this means that if a firm carries out a highly emission-intensive activity and emits the average amount for its sector, its allocation for 2021 covers 89% of its relevant NZ ETS cost, leaving 11% as the net cost. This net cost will increase to at least 20% by 2030. However, for each activity the baseline represents average emissions between 2006 and 2009, and has not changed since that time. Actual emissions are likely to be lower now because of ongoing improvements in efficiency, technological changes, and structural change in some industries.

The government decided in late 2020 to start a review of industrial allocation policy, with a view to potentially updating the baselines to make them more representative of current emissions. The review was started with a mandatory data collection for a sample of four sectors, which indicated that there may be scope for reductions in some sectors.

Measures addressing indirect emissions leakage

The emissions used to calculate allocative baselines include indirect emissions related to electricity generation. Although most of New Zealand’s electricity generation is renewable, the ETS has a significant effect on wholesale electricity prices. Geothermal generation has significant emissions, and coal and gas are used for periods of high demand.

48 All significant products are large-scale commodities that are sold in tonnes. A few small-scale products use other units. Some activities make more than one product.

To calculate baselines, electricity emissions are calculated using an "electricity allocation factor" (EAF) currently set at 0.537 tCO_2-equivalent per MWh. Although the EAF is expressed as an emission factor, it is not based on actual emissions. It is derived from estimates of the effect of the ETS on electricity prices, using models that simulate the operation of the electricity market. The EAF was set in 2010, at 0.520 tCO_2-equivalent per MWh, and has been updated once since that time. Setting an EAF was a challenging process, with joint working groups that represented the EITE industries, the electricity sector, and the government working to achieve consensus on the methods and ultimately on what the number should be. They were required to make projections on the future of the wholesale electricity market, in order to fix the EAF for five or more years ahead. For some activities, e.g. mechanical pulp production, essentially all of the allocation is attributable to electricity. Overall, about a third of the units allocated relate to electricity. Aluminium smelting is treated separately, and receives allocation at lower rates, because long-term contracts limit the pass-through of ETS costs to the aluminium smelter.

Low-carbon innovation policies for regulated sectors

New Zealand has a history of providing assistance to business for energy efficiency and emission reductions, mainly on a basis of co-funding.[49] The government has recently announced a ban on new coal boilers in industry from the end of 2021, and it is consulting stakeholders on a proposal for a mandatory phase-out of all existing coal boilers by 2037. There is also a new competitive fund for decarbonisation in industry, which allocated its first funding in April 2021. These initiatives focus on industries that use steam boilers, most of which are not eligible for allocation.

4.4.2 Relevant experience

Evidence on competitiveness effects and carbon leakage

One of New Zealand's two cement plants closed in 2015, and a significant proportion of the country's cement requirements are now supplied by imports. In early 2020 the Marsden Point oil refinery reduced output because of the nationwide lockdown in response to Covid-19, which reduced gasoline and aviation fuel use to very low levels. The refinery company announced in June 2020 that they would not return the plant to full output, and the plant is now being run at reduced capacity. The future of the Bluff aluminium smelter is also in doubt. Some smaller industrial plants have also closed recently or are at risk of closing. None of these developments appears to be clearly attributable to carbon leakage. The factors that have led to these industries' competitiveness problems include:

- Over-capacity in competing countries, for example in steel and oil refining, leading to low commodity prices;
- The cost of electricity in New Zealand, particularly transmission cost;
- Low levels of investment in earlier decades leading to obsolete plant and equipment in some sectors.

Emission pricing through the ETS may be a factor in discouraging investment in emission-intensive industrial activities. Currently, however, product price issues and other input costs are more material for competitiveness than the relatively low net cost that the ETS places on an eligible activity.

49 Support programmes are provided by the Energy Efficiency and Conservation Authority: https://genless.govt.nz/running-a-business/co-funding-and-support/business-co-funding-and-support-programmes/

Issues or lessons learnt about carbon leakage prevention

The use of a legislated and objective test for emission intensity was helpful in limiting the scope for the eligibility of specific sectors to become contentious or to be politicised. The threshold of 800 tCO_2-equivalent per million NZD may appear arbitrary, but it is broadly in line with cost levels that, at expected emission prices, would be a material factor in the profitability of a typical industry.

The apparently technical matter of setting and adjusting an accurate EAF has been challenging and occasionally contentious for EITE industries. Accuracy will be even more important and potentially contentious in the future, as New Zealand's electricity sector approaches 100% renewables and its emissions continue to decline. At the time of writing, the government is consulting stakeholders on options for updating the EAF in future, including a proposal to update it every year based on *ex-post* data rather than on projections.[50] This would remove a significant source of inaccuracy, but may make allocations more variable year to year.

The issue that EITE industries raise more often than any other is the tension between removing over-allocation and incentives for reducing emissions. Reducing allocations in response to lower emission intensity over time, it is argued, undermines the incentive for firms to invest in emission reductions. In general, the policy response to this issue is to phase down allocation by reducing the level of assistance in a pre-determined way – such a phase-down is not a response to any reductions that firms make and would not undermine any incentive to reduce emissions. However, there is a strong case now for reviewing and adjusting all allocation baselines on a one-off basis because there has been no phase-down in the first ten years of the ETS.

4.5 Switzerland

4.5.1 State of play

Regulated sectors identified as being at risk of carbon leakage

The list of sectors considered to be at risk of carbon leakage are defined as those identified by the EU-ETS: the Swiss CO_2-Ordinance explicitly refers to the Commissions Delegated Decision (EU) 2019/708[51]. This reference to EU regulation is not a consequence of the recent linking with the EU ETS: already the first versions of the CO_2-Ordinance from 2013 referred to corresponding EU decisions. Any considerations concerning selection criteria for identifying these sectors are thus identical to the EU ETS. No differentiation is made between different risk levels.

Free allowance allocation

Free allocation follows the EU ETS approach and is primarily based on product benchmarks applied to historical output levels. The future years of the current trading period (2022-2030) will see yearly adjustments of the yearly allocations based on changes in activity rates of more than 15% of each participant. This approach closely follows the European Commission's[52], with minor adjustments accounting for the low volume of the Swiss carbon market (about 55 installations in Phase III) and the small size of the participating installations.

A distinction is made between sectors which are at a risk of carbon leakage and those which are not. At-risk sectors benefit from the free allocation of allowances according to the respective cascade of benchmarks, as in the EU ETS. For installations not deemed to be at risk a carbon leakage exposure factor smaller than 1 is applied. In line with EU ETS regulations[53], this factor decreased from 0.8 in 2013

50 These options are set out in a consultation document: https://consult.environment.govt.nz/comms/proposed-nz-ets-changes2021/

51 Annex 9 no 3 of the Swiss CO_2 Ordinance 641.711 (status as of 10 February 2021), footnote 355

52 Guidance Document n°7 on the harmonised free allocation methodology for the EU ETS post 2020

53 Guidance Document n°2 on the harmonised free allocation methodology for the EU ETS post 2020

to 0.3 in 2020 and will decrease from 0.3 to 0 between 2026 and 2030 for non-district-heating installations (constant 0.3 between 2021 and 2025).[54]

The total number of permits available for free allocation and auctioning during the 2021-2030 period is calculated from historic permit numbers and emissions (annex 8, Swiss CO_2 Ordinance). Of this total, up to 10% of permits allocated during the previous year can be auctioned off. This is much lower than in the EU ETS and mirrors the lack of fossil fuel-based power generation in Switzerland, which would rely on auctioning. For permits allocated to aircraft operators, the share of auctioned allowances amounts to 15%, in line with the EU ETS[55].

Measures addressing indirect emissions leakage

Indirect emissions are not eligible for free allocation. The exchangeability of electricity and fuels is handled much as in the EU ETS: the allocation to industrial processes which can rely on both fuels and electricity as an energy source are adjusted proportionately to only reflect the share of the activity enabled by the use of onsite fuels or heat. Electricity-use emissions are calculated using the same factor 0.376 as in the EU ETS Guidance Document n°2 (European Commission, 2019c).[56] Financial compensation to electricity-intensive installations is not part of the Swiss CO_2 legislation. Since Swiss domestic electricity production is nearly CO_2-free, the CH ETS does not have direct impacts on the electricity prices.

Low-carbon innovation policies for regulated sectors

In a broader context, Swiss CO_2 legislation provides some dedicated support for innovation from small and medium-sized businesses (which are not obliged to participate in the CH ETS). Instead of paying the CO_2 levy, these companies can make a reduction commitment, either by agreeing to a binding quantitative emissions reduction path or – in the case of smaller companies – agreeing to the implementation of specific technical efficiency measures.[57] To reach these agreements and hence to be exempt from the CO_2 levy, companies can call on the support of two private sector agencies commissioned by the federal government to inform installations about energy efficiency potentials and to develop targets and measures: EnAW – the Energy Agency of the Swiss Private Sector – and act Cleantech Agency. The rationale of this option is the protection of the companies' international competitiveness, which might be undermined by the Swiss CO_2 levy (currently at 96 CHF/t).[58] The quantitative reduction targets are audited by independent verifiers.

The fully revised CO_2-Act, which is supposed to be put into force in 2021, introduces a climate fund for the financial support of low-carbon investments and innovations[59]. It is fully financed through certain earmarked fractions of the revenues generated through CO_2 policy instruments:

a) sanctions and permit auctions of the CH ETS scheme;

b) the share of CO_2-taxes not reimbursed to the public and companies; and

c) a CO_2 tax on airplane tickets.

Certain shares of the climate fund are earmarked for the support of innovative companies exploring low-carbon methods and products. This includes, for example, the development of low-carbon building

54 Annex 9 no 3 of the Swiss CO_2-Ordinance 641.711 (status as of 10 February 2021)

55 Art. 48 of the Swiss CO2-Ordinance 641.711 (status as of 10 February 2021)

56 Annex 9 no 4.1 of the Swiss CO_2-Ordinance 641.711 (status as of 10 February 2021)

57 www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/co2-levy/exemption.html

58 www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/co2-levy/exemption.html

59 www.bafu.admin.ch/bafu/de/home/themen/klima/dossiers/klimaschutz-und-co2-gesetz/klimafonds-investitionen-in-die-zukunft.html (available in German, French, and Italian)

materials or biodegradable packaging.[60] The details of the Swiss climate funds' funding instruments are currently under development.

The climate fund replaces two existing support mechanisms, which were linked to the past CO_2-Act and which were financed exclusively through earmarked revenues from the CO_2 levy: a) the Technology Fund, through which the Swiss Confederation provided solvency guarantees to companies "offering innovative products or processes that are likely to become the market standard"[61], and b) the federal and cantonal buildings programme, which financed the canton measures for the support of energy efficiency and renewable energy in the building sector[62].

Border carbon adjustment

Swiss authorities have not defined any intention or plans concerning the implementation of a border carbon adjustment. However, considering the integration with the EU ETS, the EU's plan to implement such an instrument (CBAM)[63] would necessitate analogous measures in Switzerland.

Albeit not primarily related to CO_2-emissions, Switzerland is currently gaining experience with sustainability-related border adjustment mechanisms in the context of the recently approved EFTA-Indonesia free-trade agreement (CEPA). In order for the partial import tax reduction to be granted, certain sustainability standards for palm oil must be met (WBF, 2020).

4.5.2 Relevant experience

Evidence on competitiveness effects and carbon leakage

No analyses of the Swiss ETS's leakage effects are available. However, many of the features of the Swiss CO_2-Act counteract potential competitiveness issues by design. In the context of the Swiss ETS, this notably includes the large fraction of freely-allocated permits: during the period 2013-2018, the share of emissions covered through freely allocated permits stood at 99.3 % (across all sectors). While an under-allocation of free permits did occur for some sectors (e.g. 81.2% for the chemical and pharmaceutical industry), this was mitigated by low permit auction prices (CHF 5.15 to 12 per tCO_2 during the period after 2015) and the option to offset some emissions using cheap international emission reduction certificates from the Kyoto mechanisms (FOEN, 2019).

The high share of freely allocated allowances is poised to persist for the 2021-2025 allocation period. Despite the close alignment of the Swiss ETS with the EU ETS, the share of auctioned permits remains much smaller in the former. It is limited to 10% in Switzerland by law, while it is anticipated that it will reach 57% in the EU ETS (see Section 4.5.1). In addition to free allocation, the linkage between the EU ETS and the Swiss ETS, as of 1 January 2020, naturally acts as an additional mechanism against carbon leakage. This is because a large share of the Swiss companies' main competitors are located in the European Union.

Issues or lessons learnt about carbon leakage prevention

In the Swiss ETS, the free allocation of most permits counteracted any risk of leakage from the start. Furthermore, the list of sectors subject to a risk of carbon leakage is identical to the EU ETS and rather comprehensive. For instance, the Swiss cement industry, which accounts for almost half of emissions under the Swiss ETS, is considered to be exposed to a significant risk of carbon leakage. However, the cement used in Switzerland is mainly of domestic origin, with imports amounting to only 13.9% in 2020 (Cemsuisse, 2021).

60 www.bafu.admin.ch/bafu/de/home/themen/klima/dossiers/klimaschutz-und-co2-gesetz/klimafonds-investitionen-in-die-zukunft.html (available in German, French, and Italian)

61 www.kmu.admin.ch/kmu/en/home/concrete-know-how/finances/financing/public-aid/technology-fund.html

62 www.bafu.admin.ch/bafu/en/home/topics/climate/info-specialists/reduction-measures/buildings/buildings-programme.html

63 www.europarl.europa.eu/news/en/press-room/20210201IPR96812/carbon-levy-on-eu-imports-needed-to-raise-global-climate-ambition

Harmonisation of carbon leakage measures as part of linking processes

Since 2013 the Swiss carbon market has been designed with a future linkage with the EU ETS in mind. Because of this, most design choices were adopted from EU regulations. This notably includes the list of sectors at risk of carbon leakage and the benchmark values for permit allocation based on historic activity rates. The full linkage between the two ETS became effective on 1 January 2020. Due to the close alignment and harmonization between the two markets, the linkage can be expected to further reduce leakage effects, rather than to act as an additional risk factor.

5. Discussion and conclusions

At the time of writing (May 2021), the six ETSs represented in the CMPD continue evolving in significant ways. Particularly striking is the price rally observed in the EU ETS, which has seen EUA prices increase from around €20/tCO_2 to well over €50 in the space of one year. Regarding the drivers of this escalation, it seems safe to assume that a change in expectations played a key role following political agreement over the EU's climate neutrality goal and a more ambitious emissions reduction target for 2030.[64] Major developments have taken place in China, as the national ETS officially started on 1 February 2021 – the day the regulations creating the ETS entered into force – and actual trading of emission allowances is expected to commence by the summer. 2021 is also the first year of operations for New Zealand's radically reformed ETS. At a more general level, an increasing number of governments have committed to achieving net-zero GHG emissions by around mid-century.[65] What is more, the impact of the Covid-19 pandemic on the economy has led many governments to gear their expansionary interventions toward an acceleration of the ecological transition.

Within this dynamic context, the question of how to deep-decarbonise the economy while avoiding carbon leakage has become more important than ever in a practical, concrete sense. The fact that the EU is currently working on the introduction of a WTO-compatible border carbon adjustment (BCA) – an unprecedented measure at the international level – reflects the perceived urgency of this issue. Considering the implications of a BCA for the linking of ETSs, a well-designed mechanism could facilitate the establishment of linkages, as no (or reduced) price adjustments would apply upon price convergence between the ETSs that are linked together. However, any BCA would firstly need to be recognised by the trading partners as a genuine environmental measure, and not as a protectionist one. Secondly, avoidance of carbon price adjustments as the sole additional incentive to link may not suffice. In this regard, casting linking agreements into broader preferential trade agreements could give the parties involved further incentives to establish a linkage. Arguably, the history of the EU ETS, which currently covers the 30 States of the European Economic Area (the 27 EU Members States plus Iceland, Liechtenstein and Norway), lends support to this hypothesis (Ellerman, 2010).[66] However, facilitating linkages is not normally the ultimate purpose of a BCA. Also, given the many complexities and implications of linking, it is possible that a BCA would induce carbon prices to converge across ETSs without a linkage. Clearly, this would still be a desirable outcome from an economic efficiency perspective.

Back to our six ETSs, a difference that emerges from their comparison concerns the method of allocation of free allowances to the industries at risk of carbon leakage. In California's, Quebec's, New Zealand's and China's ETSs, output-based allocation is employed. In the EU's and Switzerland's, fixed base-period benchmarking is used, or primarily used, instead. The fact that output-based allocation was chosen for China's brand-new ETS, for New Zealand's recently reformed ETS and, to some extent, also

64 The EU has committed to reducing its overall net GHG emissions by 55% below 1990 levels, by 2030. A revision of the EU ETS is expected in July 2021 which (among other things) will reduce the cap accordingly.

65 Colleagues at the International Carbon Action Partnership have calculated that net-zero targets are currently enshrined in law or proposed in legislation in jurisdictions accounting for about 12% of global emissions. Besides, net-zero targets appear in policy documents and pronouncements in jurisdictions covering another 40% of global emissions.

66 In the lead-up to the 2009 UNFCCC conference, in Copenhagen, Ellerman (2010) addressed the question of whether the EU ETS could be considered a proto-type global system. Today, in the Paris Agreement era, Ellerman's question has partly lost relevance for its reference to a new potential Kyoto-type regime. The analysis remains relevant, however, as its insights can be transferred to bottom-up processes of ETS linking.

for the current trading period of the EU ETS[67], suggests that this type of allocation – more effective in preserving market shares given its implicit output subsidy – has gained popularity in the last few years. Interestingly, the literature summarised in Section 3 stresses how output-based allocation alone can distort business competition, as well as how, in a linking context, it may amplify or attenuate competitive distortions by interacting with post-link changes in allowance prices. These conclusions are the results of thought experiments, however, meaning that they derive from pure theoretical reasoning. In the real-world, the significance of these distortions will depend on the circumstances of a specific linking situation. The degree to which firms under different ETSs compete with each other in markets, is critical in this sense. The EU ETS experience again suggests that differences in allocation rules more likely become problematic from a competition perspective if the linked ETSs are part of a deeply-integrated economic area.

In the first two EU ETS trading periods, differences in allocation rules across Member States, especially those for the treatment of new entrants, produced some controversies. These frictions were subsequently overcome through the tight harmonisation of allocation rules implemented as of Phase III. The linking arrangements between the ETSs of California and Quebec provide another relevant piece of experience. After over six years, the linkage continues to work successfully despite differences in free allocation between the two ETSs. Both California and Quebec use output-based allocation, but their allocation rules are not identical. Taken together, these two experiences suggest that the harmonisation of allocation rules is not strictly necessary for a linkage to take place. However, they also suggest that, first, the importance of harmonisation is directly related to the intensity of competition between firms under different ETSs; and that, second, harmonisation is likely to be increasingly asked for with the increasing scarcity of emission allowances. In the case of the EU ETS, the whole harmonisation process was led by the European Commission as a central coordinating authority: something quite natural, given the many parties involved. In the case of the California-Quebec link, partial harmonisation has been managed bilaterally, within the framework of the Western Climate Initiative.

67 As of Phase IV of the EU ETS, maximum State aid addressing the risk of indirect emissions leakage is based on current output. Moreover, allocations are adjusted in both cases: output increases exceeding +15% and output decreases exceeding -15% relative to historical levels (see Section 4.3.1).

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