ETS Alignment: a price collar proposal for carbon market integration

Report for the Carbon Market Policy Dialogue

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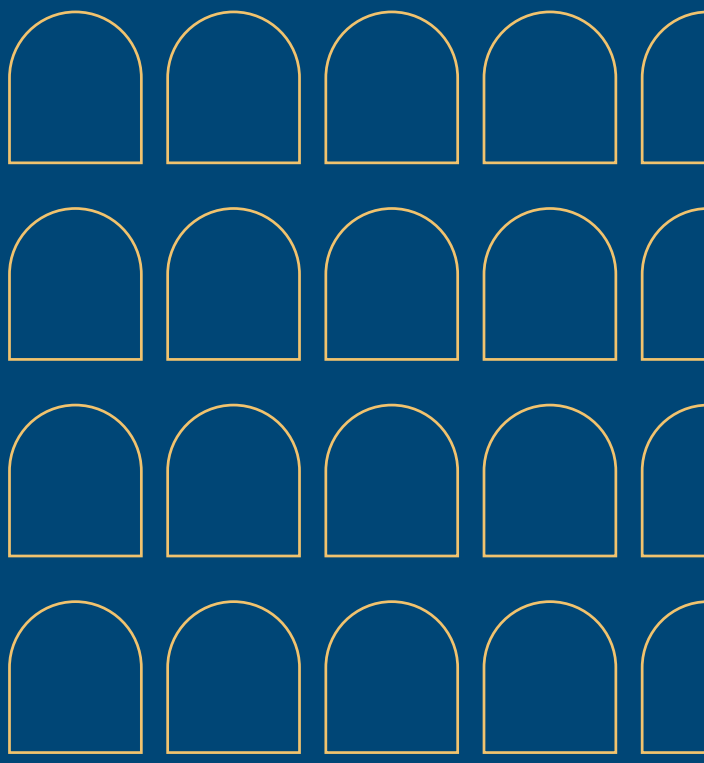

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1. Introduction

Carbon markets have become an increasingly important policy instrument in implementing the targets expressed in the Nationally Determined Contributions (NDCs) of many Parties to the Paris Agreement. The recently concluded discussions on the Article 6 of the Agreement in Glasgow is likely to make this tendency even stronger. Provided they are well-designed and internationally coordinated, carbon pricing instruments, including carbon markets, can facilitate the achievement of the ambitious goals of the Paris Agreement cost-effectively within individual jurisdictions as well as globally. A patchwork of mandatory emissions trading systems (ETSs) and carbon taxes, covering more than a quarter of global greenhouse gas (GHG) emissions, are now operational in jurisdictions including the EU, Switzerland, Germany, China, South Korea, and New Zealand as well as in several US states and Canadian provinces and many more are in the pipeline (World Bank, 2022). These have existed alongside a host of domestic and international crediting mechanisms and voluntary carbon markets. However, carbon prices arising from these initiatives vary in a wide range undermining the cost effectiveness of the instruments.[1] The possibility to link them (Bodansky et al. 2016; Mehling et al. 2018a & 2018b among others) and the potential benefits of doing so (Doda et al, 2019; Edmonds et al, 2021 among others) have long been recognised. At the same time, there have been few instances of linking.

Against this backdrop, the LIFE DICET project[2] has sought to better understand the reasons behind the apparent scarcity of links and help policymakers enhance international cooperation for the development and possible integration of carbon markets. The purpose of this report is to inform the Carbon Market Policy Dialogue (CMPD)[3] of this project. Four previous reports have investigated the implications of different ambition levels (Verde et al, 2020), price control mechanisms (Galdi et al, 2020), leakage prevention measures (Verde et al, 2021), and offset provisions (Galdi et al, 2022), for linking ETSs. This fifth and final report under the project synthesises the earlier findings, identifies specific ETS design elements requiring specific degrees of alignment/harmonisation and discusses how this can be achieved in linking negotiations. Moreover, with a view to finding ways to facilitate the establishment of direct linkages between ETSs, a proposal regarding the management of allowance prices in the form of a "price collar for the linked system" is presented.

State of play and outlook for carbon markets

At the beginning of 2022, there were 25 mandatory ETSs operating around the world with 22 more under development or consideration. ETS were in force at the city (e.g. Beijing, Shenzhen, Tokyo); province or state (e.g. California, Guangdong, Quebec); national (e.g. China, Switzerland, the UK); and supranational (i.e. EU members states plus Iceland, Liechtenstein, and Norway) levels and covered approximately 17% of global GHG emissions. There are examples where multiple ETSs operate in the same jurisdiction but cover different emissions (e.g. Germany and China).[4] Linkages have been established between ETSs and are operating between California and Quebec, between the US states participating in RGGI, Tokyo and Saitama, and the EU and Switzerland (ICAP, 2022). Alongside these, there are many national and international crediting mechanisms which supply the offset demand generated in some of the compliance systems. These mechanisms also supply a growing voluntary carbon market demand and are likely to increase in prominence following the conclusion of the negotiations on Article 6 rulebook of the Paris Agreement as well as in the context of the net-zero-target announce-

1 S&T2022 price range, for ETS and CT separately.

2 https://lifedicetproject.eui.eu/

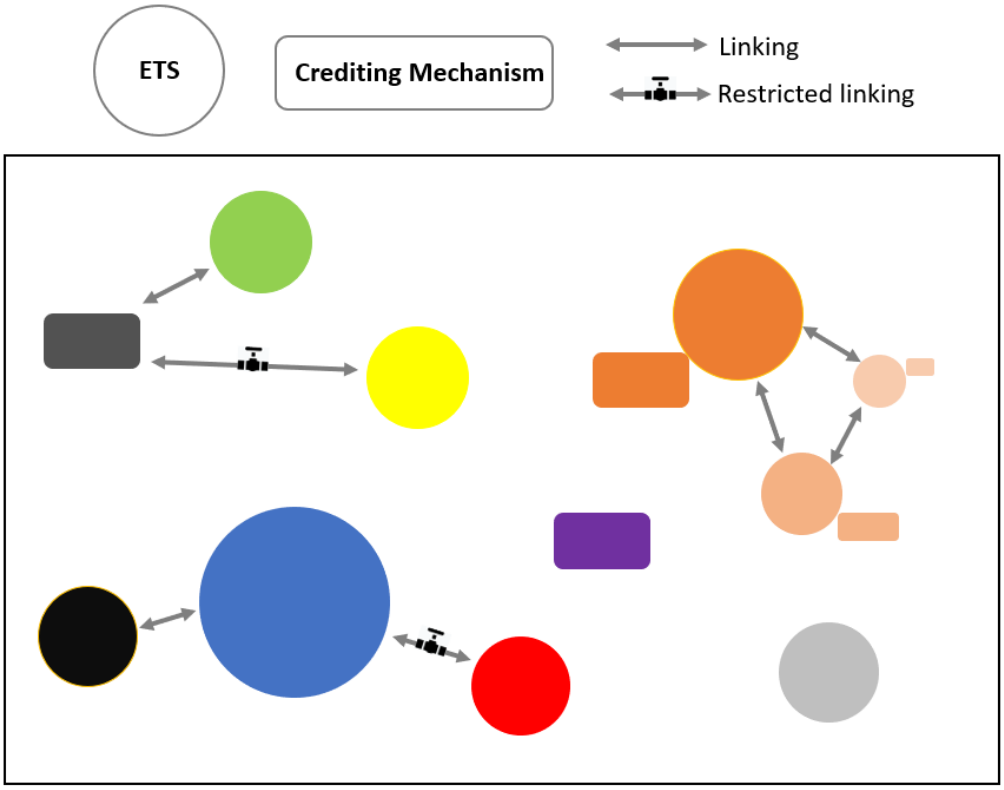
3 https://lifedicetproject.eui.eu/carbon-market-policy-dialogue/

4 In the case of Massachusetts two distinct ETSs cover the same emissions namely those from the power generation sector.

ments and the growing need to remove GHGs from the atmosphere. That said, it is still early days for the developments in the voluntary carbon market space post-Glasgow and much caution is necessary (Fearnehough et al., 2020; Bassam and Maino, 2022; World Bank, 2022).

Taken together these recent developments imply a complex landscape of international carbon markets going forward. This is illustrated in Figure 1 albeit in a highly stylised manner. The circles in the figure identify the ETS; rectangles are the crediting mechanisms, and colours distinguish between different jurisdictions. The arrows that may connect different types of carbon markets indicate the possibility of international allowance or credit transactions that may take place (freely or with some restrictions) under a linking arrangement. For example, the ETS in the light grey jurisdiction is in autarky and the crediting mechanism in the purple jurisdiction does not provide offsets for any compliance systems but only serves (inter)national voluntary demand (not illustrated). The three jurisdictions in different shades of orange have domestic crediting mechanisms that supply their respective ETSs. These ETSs are multilaterally linked without any restrictions so one would expect allowance prices to be equalised between them.

Figure 1: Stylized Carbon Market Landscape.



The ETSs in black and red jurisdictions are *in*directly linked with each other through their bilateral links to the ETS in the blue jurisdiction. In the absence of any restrictions on the link between the blue and black jurisdictions' ETSs, the respective prices of allowances would converge. However, this resulting common price could differ from the allowance price in the red jurisdiction's ETS depending on the nature and stringency of the restrictions on the link between red and blue jurisdictions ETS. Another *in*direct link can be observed between the ETSs in green and yellow jurisdictions through their link to the grey crediting mechanism. In this constellation, the prices of allowances and offsets in the green and dark grey markets would be equalised, but the common price would likely differ from the allowance prices in the yellow ETS if the restriction on credit flows is binding. Note that the dark grey jurisdiction could be interpreted as representing a supranational body, like the UN, so that the crediting mechanism can be viewed as that envisioned under Article 6.4 of the Paris Agreement.[5]

5 In the future, several ETSs could be linked to the Article 6.4 crediting mechanism. For the sake of visual simplicity, this plausible scenario is not pictured in the diagram.

This is of course a very simplified figure with a limited number of jurisdictions, carbon market types and linkages between them; unspecified restrictions on unit flows between linked systems; and assuming that each allowance or credit precisely represents a tonne of GHG. Moreover, the figure does not illustrate the voluntary carbon market demand which is relevant for the determination of the prices of credits. Regardless, there could be up to 10 different carbon prices despite all markets being in equilibrium, no uncertainty, and all units having the same high quality. It is this difference that motivates further carbon market integration. Specifically, provided certain key conditions are met, further integration could achieve the same level of emissions reductions but at a lower cost than implicit in the figure; or a greater level of emissions reductions at the same cost as in the figure; or a mixed outcome in between.

Conditions for linking to be successful

The key conditions for linking to be successful can be grouped under three headings.[6] First, there are some conditions that need to be satisfied *before linking negotiations* can start in earnest. For example, there must be **general and mutual trust** between the would-be partners that go well beyond the domain of climate policies. By its very nature linking creates exposures to unexpected developments in partners' economic, social and political circumstances as a consequence of linking but also more broadly. Trust in their ability to respond to these developments without undermining the principles of cooperation is crucial. Moreover, all partners must expect to gain not only in terms of reduced compliance costs, but also in aggregate economic and political terms, considering the broader, and often politically challenging, general equilibrium effects triggered by the expected changes post-linking. These may relate to a general political preference for domestic abatement action as well as general political preference against large financial flows financing abatement action elsewhere, even if it is cost effective to do so. Despite this, the **mutual net benefits due to linking** are generally positive and can be large. However, this does not mean there will be no losers if the link goes ahead, a point regarding which there must be a common understanding prior to linking negotiations.

There must also be broad acceptance of the level of partners' climate policy ambition, particularly in the ETSs to be linked.[7] For an individual system, this is reflected in the scope of emissions covered, flexibility provisions such as offset use, banking and borrowing, etc., and the range of prices that in each jurisdiction is deemed acceptable (implicitly or explicitly) by the regulator. The latter aims to balance between the need to ensure adequate incentives for mitigation today and in the future, and the need to ensure that the high cost of compliance does not compromise the political acceptability of the ETS. Without at least some **overlap between the ranges of acceptable carbon prices**, it is unlikely that the parties will come to the table to negotiate a linking arrangement where unit flow is unrestricted. In Section 3, this report discusses how a price collar for the linked system can help build trust, enhance benefits and provide an enforcement mechanism for the set of mutually acceptable prices for jurisdictions. In this context, it is also important that the would-be partners consider the balance between emissions trading and other climate policies in delivering the other jurisdictions' climate targets because this balance can have significant implications for the prices prevailing in the ETSs to be linked.

Second, assuming the would-be partners have agreed to come to the negotiation table, another set of conditions relating to the **alignment of core design features** of ETSs must be met *during the linking negotiations*. Many previous studies have identified design features requiring strict alignment; those that should lead to comparable outcomes without necessarily requiring full alignment; and those that

6 These three headings relate to the genesis, negotiation and implementation phases of a linking agreement discussed in ICAP (2018). The rest of the section on conditions draws on insights in Grubb (2009), Tuerk et al (2009), Flaschland et al (2009) and Burtraw et al (2013), ICAP (2018), Gulbrandsen et al (2019), Evens and Wu (2021).

7 Report 1 of LIFE DICET project emphasizes three dimensions of ambition in an ETS: coverage, stringency and determinacy.

would benefit from coordination and mutual understanding which in turn would contribute towards the smooth operation of the linked systems. In Section 2, the report provides further details on the reforms and revisions that need to be negotiated for a successful link. Negotiations should start by clarifying the objectives each jurisdiction wishes to achieve by linking; build further trust by focusing on elements that are easy to harmonize and gradually move on to more contentious features which may be more difficult to align. Those who have been involved in actual linking negotiations or followed them closely, highlight the importance of this phase for strengthening the trust and understanding among future partners.

Third and *after the successful completion of linking negotiations*, another set of conditions become relevant to ensure that linking remains beneficial and fit-for-purpose over time. Economic and political circumstances inevitably change. Innovations in climate science, in abatement and removal technologies or in MRV and registry methodologies may render core assumptions and features of individual ETSs outdated which in turn may compromise the linked system. Many such changes are difficult to plan for in advance. Therefore, **built-in reviews and broad-based consultations**, as well as **mechanisms for revision and dispute resolution** are critical to identify emerging issues and respond to them rapidly and effectively. The linking partners should also have a shared understanding regarding the process for adding other ETSs to the linked system. Conversely, if the built-in review, revision and dispute resolution mechanisms are not sufficient to dissuade a partner from terminating the linking agreement, each partner should have the confidence that there is a **robust de-linking protocol** in place that will protect the interests of all parties.

The rest of this report takes a closer look at how deeper carbon market cooperation can be achieved despite the current fragmented carbon market landscape, increasingly complex outlook, and the panoply of conditions that need to be satisfied before, during and after linking negotiations. We start with the issues relating to the alignment of key ETS design features. This is followed by a proposal that aims to reduce price uncertainties post-linking. We conclude with a (preliminary) set of conclusions and recommendations to facilitate carbon market integration in the future (to be revised in light of the CMPD meeting).

2. Reforms and revisions to align ETSs

It is helpful to consider the extent of reforms and revisions that would prepare the ETSs of the would-be partners for a successful link from two distinct viewpoints. First, taking the set of ETSs to be linked as given, an assessment of the existing degree of alignment between the systems is crucial. At one extreme, ETSs may be designed with linking in mind already. For example, the ETSs of US states participating in RGGI were designed and launched as systems which were linked from the outset using a Memorandum of Understanding (MoU) and the Model Rule. Moreover, the program explicitly identifies a path for future participants to follow if they wish to link to existing system currently consisting of ETSs in eleven US States. In other words, the reforms and revisions that would be required to align systems is very much part of the system design.[8] At the other extreme are systems like the EU ETS and the (now defunct) Australian Carbon Pricing Mechanism (CPM) which were designed as independent systems prioritising within-jurisdiction emissions reductions and without detailed and explicit provisions for linking in the future. Regardless, the European Union and the Australian government were able to negotiate a bilateral cooperation agreement to link EU ETS and CPM (Evans and Wu, 2021). In practice, ETSs, regardless of whether they are linked or not, fall somewhere in between these extremes. The discussion in the rest of Section 2 is particularly relevant for those systems that were independently designed but are willing to consider linking.

8 For further details, see State Statutes and Regulations; the MoU and Model Rule; and the path for new states to join RGGI on the RGGI website.

Second, taking an ETS design feature as given, it is important to consider the degree of alignment that would be appropriate for linking to work well considering the **robustness of the linked system, overall environmental ambition, and possible undesirable side effects i**ncluding automatic propagation as well as issues related to fairness, competitiveness and leakage. For example, misalignment in the provisions regulating offset use and price containment mechanisms (PCMs) in different ETSs may have significant implications along all three with possible side effects including automatic propagation of one system's approach to others. They therefore **require compatibility** in design with the attendant reforms and revisions when they are not; other key design elements do not require compatibility so long as they lead **to comparable outcomes;** and still others would **benefit from coordination and mutual understanding** for improved operation of the linked system. These issues are discussed in more detail below considering the previous reports under the LIFE-DICET project; Burtraw et al (2013); Borghesi et al. (2016), particularly Chapter 4; ICAP (2018) particularly Chapter 4; ICAP and PMR (2021), particularly Chapter 9; and references therein. For simplicity, we focus here on linking without restrictions.[9]

Design features requiring compatibility

Key ETS design features, particularly those that have a bearing on system robustness and ambition, require compatibility across ETSs. Failure to ensure compatibility on these features could later lead to major challenges and could preclude a linking agreement or compromise the functioning of the linked system.

The most critical element of any ETS is the level of emissions allowed under the system, namely the cap, and its evolution over time. The stringency of the cap and the methods used for determining it directly impact the level of environmental ambition in the ETS. Most existing ETSs place a fixed limit on emissions from the covered sectors and announce in advance how it will change over time, in what is known as the absolute cap approach. An alternative approach is to use an intensity-based cap, where the number of allowances is determined based on the level of activity at the regulated-entity level or using a more aggregate measure like the GDP. In this approach, the level of the cap is not known in advance because it changes in proportion to the level of activity and, also, its stringency is determined in part by the selected benchmark (i.e. factor of proportionality). While it is theoretically possible to link systems with absolute and intensity-based caps, the uncertainty introduced by the latter in the expected overall ambition of the linked system is likely to prove too big a barrier to overcome in negotiations. A similar uncertainty arises when ETS participation is voluntary through opt-in and opt-out provisions for many entities in an ETS. Failing to restrict the extent of opt-in/out provisions or to agree on a common approach to cap adjustments necessitated by the voluntary participation decisions of during the linking negotiations could be detrimental to their success. Moreover, if there is any doubt about a would-be partner's temptation to set a less stringent cap due to linking (for example in order to increase allowance sales to linking partners), negotiations are unlikely to succeed.[10] As a consequence, very close alignment regarding cap setting approaches and revisions is required for successful linking.

ETS design features that provide additional flexibility through offset use; banking and borrowing; and approach to linking with new and additional systems also require compatibility. These can have significant implications for system robustness and environmental ambition through their effect on the set of units which are acceptable for compliance, when and by whom. Moreover, they propagate across linked systems, overriding the domestic preferences and constraints that may have led to the adoption of different provisions in different jurisdictions in the first place.

9 Restricted linking is a potential and general response to many of the issues discussed below, albeit at the cost of reduced benefits from linking. Indeed, autarky can be interpreted as an extreme form of restricted linking. We focus on linking without restrictions to illustrate the main arguments for alignment and refer the reader to Schneider et al. (2017), Quemin and de Perthuis (2019), Borghesi and Zhu (2020) for additional discussion of restricted linking.

10 See section 3.2 of Report 1 on ambition under the LIFE DICET project for additional details and references.

The type and number of offsets that are allowed as well as the monitoring, reporting and verification (MRV) standards ensuring their quality and environmental integrity affect the ambition and robustness of the linked system. This is because every time an offset credit is used for compliance in a given ETS, an allowance is freed up for use in any ETS of the linked system, even in those that do not allow offsets. Put differently, the same incentive that may tempt a would-be partner to set a less stringent cap mentioned above exists for being less stringent when it comes to the number, or perhaps more importantly the quality, of offsets that are allowed into its system. Revisions to offset rules of ETSs considering linking to adopt a common approach and minimum MRV standards that are acceptable to all is therefore essential. These minimum standards must ensure that allowed offsets correspond to real, additional, permanent and verified emissions reductions. Moreover, a robust tracking system must be in place to ensure the same offset is not used more than once to avoid double-claiming and double-counting.[11]

While banking of allowances is typically permitted in practice, borrowing is almost never an option or severely restricted to small quantities and to short-term. Alignment of these temporal flexibility options is vital because they propagate across systems. For example, if regulated entities in one ETS are allowed to borrow from future compliance periods, they can sell these allowances (or the present vintage allowances they free up) to regulated entities elsewhere. In turn, this would cause concern for the regulators in those systems who may have restricted borrowing to minimize delay in abatement or to incentivise early investment for low-carbon technologies. They may also be concerned about the creditworthiness of the borrowers in the system allowing borrowing, which in turn can call into question the ambition and robustness of the entire linked system.

Last but certainly not the least, an important design feature that requires careful consideration and close alignment is price control. A host of PCMs, in force in virtually every operating ETS, exist to protect against price of allowances from falling too low or rising too high.[12] Because linking provides all market participants with access to the most favourable price anywhere within the linked system, the effectiveness of an individual ETS's PCMs become diluted. There is even the possibility of perverse interactions between PCMs. For example, an auction reserve price in one system cannot be effective if there are enough allowances available for sale at a lower price in the secondary market, which is now deeper and more liquid by virtue of linking. This is intimately tied to the question of what happens to the allowances that remain unsold and the foregone revenues for the government if they are to be taken off the market permanently. Similarly, the reserves associated with soft price ceilings in smaller jurisdictions are likely to be depleted much more quickly when there is sustained increases in demand implying potentially large financial flows, particularly if the unexpected demand originates in larger jurisdictions. Conversely, a hard price ceiling in a small jurisdiction under autarky is unlikely to survive in linking negotiations, as jurisdictions that did not opt for this PCM will likely be strongly opposed to the possibility that the PCM undermines the ambition and robustness of the linked system as a whole. At a higher level of abstraction, the approach to PCMs itself can provide a stumbling block in linking negotiations. For example, it may be difficult to reconcile the differences between rule-based and discretionary PCMs, or those that feature a price rather than a quantity trigger.

Many of these complex issues were investigated in much greater detail elsewhere, including under this project.[13] Here it suffices to note that close alignment of PCMs is critical for the successful negotiation of the linking agreement and operation of the linked system. Indeed, the close alignment of PCMs is a core feature of the existing links between California and Quebec as well as the US States participating in RGGI. In Section 3, our proposal to use price collars in linking arrangements builds on the experiences in these linked systems as well as on the theory of price-triggered, rule-based PCMs.

11 See section 3.2 of Report 4 on offset use under the LIFE DICET project for additional details and references.

12 See ICAP (2020) which explores different market stability mechanisms (MSMs) used in ETSs around the world.

13 See Report 2 on PCMs under the LIFE DICET project as well as Vivid Economics (2020) for additional details and references.

Finally, the joint and individual approaches of linked jurisdictions to linking with new jurisdictions because all the preceding features above, and subsequent ones below need to be aligned with the newcomer's ETS. Therefore, it is not surprising that would-partners must be closely aligned on a clear position regarding if, how and when new members are admitted to the linked system either as a joint decision, or what conditions an individual jurisdiction, say X, must satisfy to link its system to an ETS in another jurisdiction, say Y, bilaterally. Needless to say, in the latter case, the systems in X's partners in the existing arrangement are indirectly linked to Y, through their common link to X.

Design features requiring comparable outcomes

Certain ETS design elements and features do not need to be identical or strictly compatible when negotiating linking. However, they must lead to comparable outcomes despite differences in their structure and parameters. Reforms and revisions to these design features agreed during the negotiations will affect the operation of the linked system and therefore need to be considered carefully by policymakers.

Under the assumption that there is general and mutual trust between the jurisdictions, and a common understanding regarding the design features requiring compatibility, there is not an a priori need to strictly align the stringency of the caps in the respective ETSs. However, all would-be partners must find the set of cap stringencies broadly acceptable.[14] Insomuch as these differences in stringency are reflected in allowance price differences across systems, they are in fact the very source of "effort-sharing gains" due to linking (Doda et al, 2019). These gains accrue to all linking jurisdictions without undermining the achievement of the aggregate cap in the linked system. However, it is also important to note that when cap stringencies differ by too much, it becomes much harder to maintain political acceptability because the redistribution of abatement effort, co-benefits, financial flows etc. generate much greater economic and political implications under these circumstances, despite the potential for large cost-savings. Therefore, linking negotiations should aim to arrive at a comparable set of cap stringencies to facilitate linking.

Without robust MRV systems it is impossible to operate an ETS that meets its environmental and economic objectives. Lack of confidence about the robustness of any one of the would-be partners' MRV systems will call into question the robustness of the entire linked system. At the same time, different MRV systems built around different internationally accepted standards exist and can be, and often are, adapted to circumstances of the individual jurisdictions. In other words, when all would-be partners have the confidence that emissions are monitored accurately, reported truthfully, and verified by independent, competent, and accredited verifiers, a tonne in any one ETS will be equal to a tonne in any other linked ETS. Achieving this goal in linking negotiations is feasible even when the particularities of MRV rules and regulations differ from jurisdiction to jurisdiction.

A closely related issue is the stringency of enforcement of all aspects of ETS regulation. A robust MRV system may be in place in each ETS, but if enforcement efforts are lacking in some, confidence in the robustness of the entire system will be undermined. Moreover, strictly enforced MRV rules is by itself not enough. Each jurisdiction must ensure that the required number of compliance instruments are surrendered on time against the obligations of each regulated entity. There must be transparent rules that specify what to do in case of missed deadlines. Penalties should be high enough to deter noncompliance with any aspect of the ETS regulation. There is also an argument for aligning the penalties for noncompliance across jurisdictions because significant differences might create an incentive for noncompliance to move to the jurisdiction with less stringent penalties. The structure and responsibilities of local competent authorities, the legal basis for issuing penalties and any dispute resolution mechanisms

14 Assessing cap stringency in ETS depends on many factors (e.g. abatement options, development status, political-economy considerations, etc) and complex interactions between them.

may differ across systems but the standard of enforcement must be acceptable to all and established as such in the linking negotiations.

Linking does not require that the linked ETSs share a common registry but timely and secure flow of information will be necessary should the jurisdictions opt to operate independent but linked registries. In this case, there is a need to align the processes and procedures that regulate the flow of information into and out of individual registries to prevent fraud and manipulation. Moreover, any market sensitive announcements must be coordinated across jurisdictions. Operating a common registry for all the linked systems can help reduce coordination costs and facilitate the application of a common set of processes and procedures throughout the linked system.

ETSs in operation today are much more complex than the version described in textbooks where compliance entities exchange permits among each other to discover a price that ensures the demand for permits is exactly equal to the supply determined by the government. Instead, contemporary markets for allowances exhibit characteristics of commodity markets and markets for financial instruments and conducted largely through exchanges. In addition to compliance entities, market participants can include brokers, private citizens, NGOs as well as financial actors trading not only allowances but also a variety of derivative instruments. As such, they require sophisticated regulation and oversight to contain and minimize risks of misconduct. Jurisdictions should therefore agree on how different approaches to the treatment of allowances under financial market regulation can be reconciled and establish processes for cooperation post-linking.

Design features that would benefit from coordination and mutual understanding

The ETS design features which would benefit from coordination and mutual understanding but do not need to be aligned for a link to function include scope, allocation methods, phases and compliance periods. Greater coordination and understanding on these aspects would improve the functioning of the linked system and enhance trust.

Differences in the scope of coverage may well persist beyond implementation of a link and may even be beneficial as the bring cost saving opportunities to the linked system that would not be available under autarky. However, it is important to ensure that the differences in coverage of activities/gases, point of regulation and thresholds for inclusion in the ETS do not give rise to competitiveness, leakage, or fairness concerns. associated with a given activity, while a would-be partner's scope also covers process emissions, the regulated entities could raise concerns regarding competitiveness, leakage and fairness. Similar concerns may arise if one system covers all installations regardless of size while the other covers only medium and large installations and excludes small ones. However, assuming that the ETS would be in operation in both jurisdictions even in the absence of linking (i.e. under autarky), it is worth noting that linking in fact reduces the severity of these concerns.

Differences in the point of regulation may remain post linking but when they relate to the emissions in the same sector (e.g. upstream and downstream coverage of emissions from the power sector, where both power and allowances are traded across jurisdictions), care must be taken to avoid double coverage or gaps in coverage by making accounting adjustments to surrender obligations of regulated entities as needed.

Linking leads a convergence of allowance prices. It should therefore assuage any leakage and competitiveness concerns, at least among the linking jurisdictions, relative to autarky. Moreover, in a well-functioning ETS, the allocation method is not a determinant of the allowance price nor the ambition of the system, at least in theory. Consequently, many jurisdictions have used free allocations to minimise carbon leakage risk and to obtain buy-in from energy intensive and trade exposed sectors. Many juris-

dictions also aim to reduce the share of freely allocated allowances in the cap over time. More recently, this has been supported by a policy debate as well as concrete policy proposals regarding border carbon adjustments.

Although neutral with respect to environmental ambition and allowance price, differences in allowance allocation methods have implications for the distribution of rents between the government and regulated entities. This in turn affects the profitability of regulated entities that receive free allocations in one jurisdiction versus those in the same sector but in a different jurisdiction that must obtain them in auctions or secondary markets. For example, where free allocations levels are determined by grandparenting, there is the risk of windfall profits; and where free allocations are based on benchmarks, the specific value of, and the updating process for, benchmarks will inevitably be subject of linking negotiations. Alignment of free allocation methods, while not necessary in the strict sense, would therefore help make the link more resilient to political pressure.[15] Where allowances are auctioned, the distribution of revenues across jurisdictions may change after linking, creating a need for agreement on how they will be divided. A related question is whether to hold joint or separate auctions. While examples of both joint and separate auctions exist and have functioned well so far, there may be economic and administrative benefits from holding joint auctions (e.g. economies of scale; reduced risk of market manipulation).

The synchronisation of trading phases and compliance periods is not a necessary part of a linking agreement. However, to the extent that different phases of an ETS present an opportunity to revise and update core components of the ETS, alignment of phases among partners can reduce uncertainty, coordinate reviews and consultations, and help with communication of upcoming revisions. The alignment of compliance periods can have benefits in terms of reduced cost of program administration, particularly if there is greater alignment of MRV systems, and jurisdictions use a joint registry. However, asynchronous compliance periods could also be beneficial by generating different peaks in allowance demand and therefore improve market liquidity.

Table 1: Different degrees of alignment for ETS design features

Features requiring compatibility	Features requiring comparable outcomes	Features that would benefit from coordination and mutual understanding
· Mandatory versus voluntary participation · Type of the cap (absolute versus intensity-based) · PCMs · Banking and borrowing · Use of offsets · Linking with new and additional partners	· Stringency of the cap · Financial market regulation · Enforcement stringency · Robustness of MRV registry operation	· Scope of coverage · Point of obligation · Compliance period · Allocation methods · Phases

The analysis above, summarized in Table 1, shows that varying degrees of alignment is called across different design features. Moreover, many different conditions need to hold for a linkage to take place. Recognition of this complexity and of the fact that linkages between ETSs are still only few leads to the question: *how could linkages be facilitated?* We take up this question in the next section, where we propose an approach to linking ETSs that reduces risk for would-be partners.

15 See Report 3 on carbon leakage prevention under the LIFE DICET project for additional details and references.

3. Linking with a price collar - a proposal

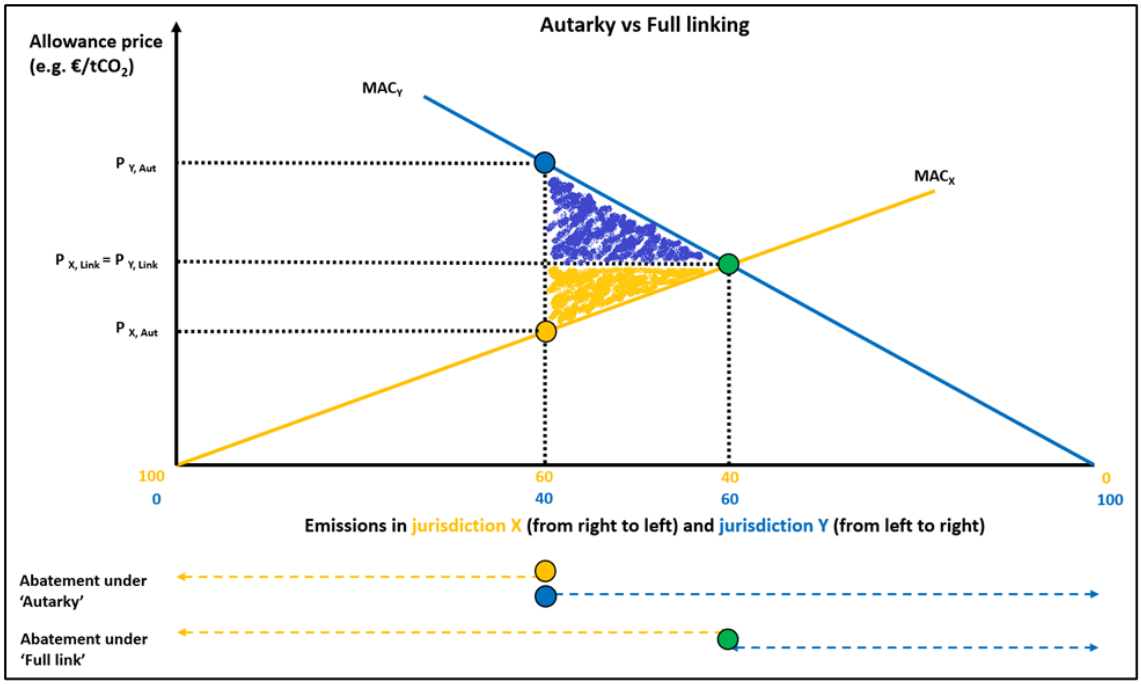
Little doubt, the consequences of linking for the prices of emission allowances play a crucial role in determining linking decisions. From the perspective of a jurisdiction that is considering linking its ETS with another ETS, or multilaterally with other ETSs, the consequences in question are: first, the immediate impact on the price of domestic allowances and, second, the risk that the same price will be affected in the future by shocks or policy changes in the linked ETS(s). The 'price impact of linking' and the 'price risk of linking', which is how we refer to these two phenomena, may partly explain why only few linkages have been observed to date. On the bright side, facilitating new linkages may be possible if these price-related barriers are better understood and adequately addressed. Notably, in situations where establishing a full linkage is of potential interest for all the jurisdictions involved, the price risk of linking could be constrained by enforcing a price collar (i.e. a minimum price and a maximum price) for the linked system. Both the boundaries and the operational rules of such price collar would be central elements of the linking negotiations and agreement. Price collars would facilitate the establishment of new linkages and, if successful, they could improve international coordination of carbon prices. In the following, the underpinnings of this proposal are illustrated.

The price impact of linking and its acceptable range

The first step of our analysis focuses on the impact of a linkage on the price of emission allowances in each of the participating ETSs. Whenever n (≥ 2) ETSs are linked together, n allowance prices are affected by the international trade of allowances. Prices in a net-exporter ETS will increase, while those in a net-importer ETS will decrease. In the case of full linking, meaning allowance trading is free from any regulatory intervention, the efficiency gains from trade are maximised as allowance prices converge to an intermediate level.

For simplicity and without loss of generality, Figure 2 compares equilibrium prices and emissions for two (n = 2) ETSs, in jurisdictions X and Y, under autarky and full linking scenarios. In the graph, these jurisdictions have business as usual emissions of 100 units and their marginal abatement cost (MAC) curves are represented by orange and blue respectively. Emissions in Jurisdiction X decline moving from left to right along the horizontal axis, and its MAC increases as depicted by the orange MAC curve. Similarly, emissions in Jurisdiction Y decline moving from right to left along the horizontal axis, with analogous implications for its MAC shown in blue. Under autarky, jurisdiction X caps emissions at 60 units, issues 60 allowances, and allows domestic regulated entities to trade allowances freely among themselves. Jurisdiction Y caps emissions at 40 units, issues 40 allowances, and allows domestic regulated entities to trade allowances freely among themselves. When the two ETSs are linked together, emission reductions take place where they are cheapest to deliver in the linked system. As a result, abatement of 20 units shifts from jurisdiction Y to jurisdiction X. Total emissions, and hence total abatement, are unchanged compared to autarky. However, efficiency gains are achieved. The gains from trade, in passing from autarky to full linking, correspond to the shaded area. Specifically, net savings in abatement costs are the efficiency benefits accruing to jurisdiction Y, whereas net revenues from sold allowances are the efficiency benefits accruing to jurisdiction X.

Figure 2: Autarky vs Full linking: gains from trade and price impacts.



Depending on the relative size of the ETSs and more generally depending on the difference in the respective marginal abatement costs, price changes caused by linking can be markedly asymmetric. ETSs with steeper marginal abatement cost curves will see greater price changes, and vice versa. Accordingly, other things equal, smaller ETSs will see greater price changes.

Predicting the direction and the general magnitude of the effects of linking on allowance prices is relatively easy and any jurisdiction contemplating a linkage will assess its impact on domestic allowance prices. How, then, would this calculation inform the decision as to whether pursuing the linkage or not? Plausibly, the expected price impact would be evaluated against a range of values that are considered acceptable, e.g. [-€5,+€5], [-€10,+€10], etc. For a given jurisdiction, X, the width of the acceptable range, $AR_{X,}$ can depend on many different factors. These may relate to anticipated general equilibrium effects of higher or lower carbon prices (e.g. expected impacts on the jurisdiction's trade balance or on employment), as much as to the policymaker's preferences about a greater or diminished role of carbon pricing in the domestic policy mix, or to her attitudes toward international transfers or toward domestic distributional effects – all consequences of linking determined through changes in allowance prices (Flachsland et al., 2009; Doda and Taschini, 2017).

For our purposes, we do not need to know why a jurisdiction's AR for the price impact of linking is wide or narrow. We can take the width of an AR as given.[16] Nor do we account for political or other non-economic considerations that may inhibit a linkage between ETSs in the real world. We simply establish that a jurisdiction will remain open to the possibility of linking, or discard this option, depending on whether the expected price impact falls in a predetermined acceptable range.[17] A corollary of this condition is that a linkage between n ETSs could only materialise if the n expected price impacts are considered acceptable by the n respective jurisdictions. That is, in formal terms, if $\widehat{\Delta P_i} \in AR_i, \forall i = 1, 2, \ldots, n.$

16 The fact that the width of AR is taken as given in our discussion does not imply that it is independent of any PCMs that exist prior to linking, an issue we revisit in section 4.

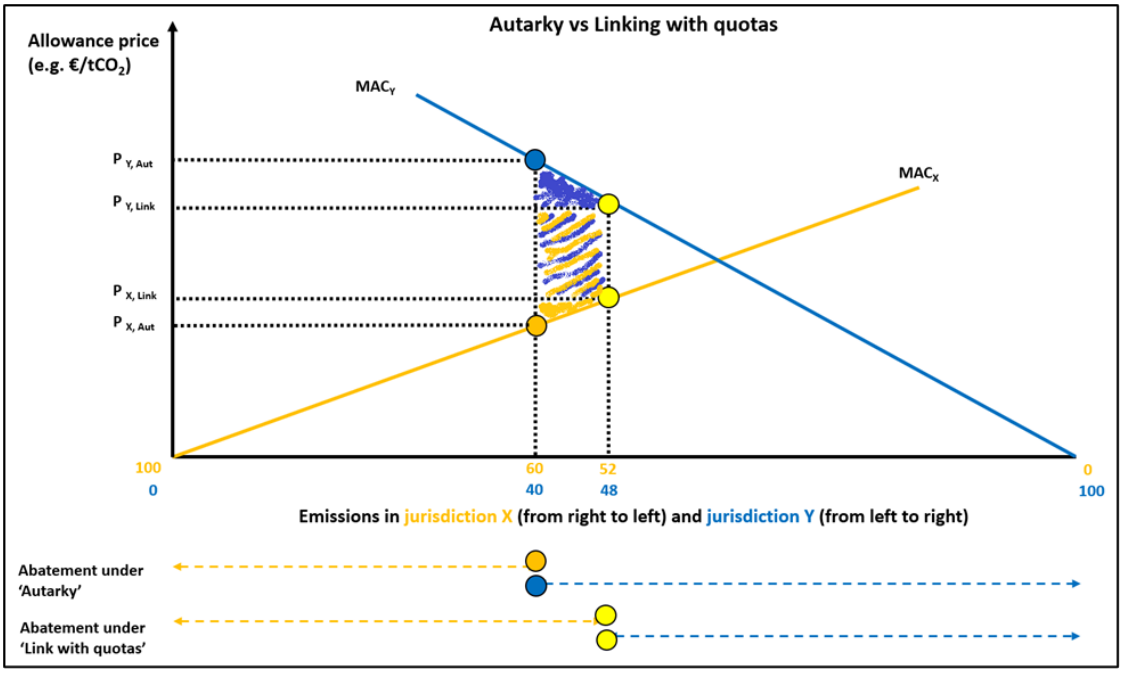
17 It is possible that a jurisdiction is not indifferent between all prices within its AR even if all prices in the range are considered acceptable.

Price impacts and types of linkages: full linking vs linking-with-quotas

For a given ETS, the expected impact of a linkage on the price of domestic emission allowances mainly depends on: a) the price level and the size of the potential partner ETS(s) relative to the own price level and size, and b) the type of linkage that is being contemplated. With reference to the type of linkage, a fundamental distinction is between full linking and restricted linking. The former indicates free trading of allowances between ETSs without any regulatory intervention; the latter refers to various ways in which the flow of allowances among jurisdictions can be limited or altered. In the literature, forms of restricted linking that so far have been considered include: border taxes on allowance transfers, exchange rates, discount rates, and quotas (expressed as a percentage of an ETS' total number of allowances) on allowance transfers (see e.g. Lazarus et al., 2015, Borghesi and Zhu, 2020, Schneider et al., 2017, Quemin and de Perthuis, 2019). Of these approaches, transfer quotas stand out as being the most practical and, today at least, the most plausible alternative to full linking. Just as many existing ETSs impose a quota on emission offsets that can be used by regulated entities for compliance purposes, similar quotas could be imposed on the volume of allowances imported/exported from/to other linked ETSs.

Full linking will normally lead to perfect convergence of domestic and foreign allowance prices to some intermediate level between the respective pre-link levels. And again, to the extent that allowance prices reflect marginal abatement costs, price equalisation across ETSs implies achievement of a maximum efficiency gain – maximum savings in total abatement cost – through trade. Linking-with-quotas, by contrast, will not normally result in perfect price convergence or deliver a maximum efficiency gain as a consequence, unless pre-link prices are very close to each other or the limits to allowance transfers are sufficiently lenient. Still, however big or small the efficiency gain is, it is an improvement over autarky. Figure 3 shows the gains from trade and the price impacts under linking with-quotas. The hatched area represents scarcity rents, which are captured by jurisdiction Y or jurisdiction X depending on whether the quota applies to X's imports or Y's exports.[18]

Figure 3: Autarky vs Linking-with-quotas: gains from trade and price impacts.



18 As explained in Schneider et al. (2017), the distribution of the gains from trade depends on how the transfer quota is implemented. If it is a quota on imports of the higher-price jurisdiction, the price for transfers would likely settle at the allowance price in the lower-price jurisdiction (i.e. X). As a result, the higher-price jurisdiction would capture the scarcity rent. If it is a quota on exports of the lower-price jurisdiction, the price for transfers would likely settle at the allowance price in the higher-price jurisdiction (i.e. Y). As a result, the lower-price jurisdiction would capture the scarcity rent.

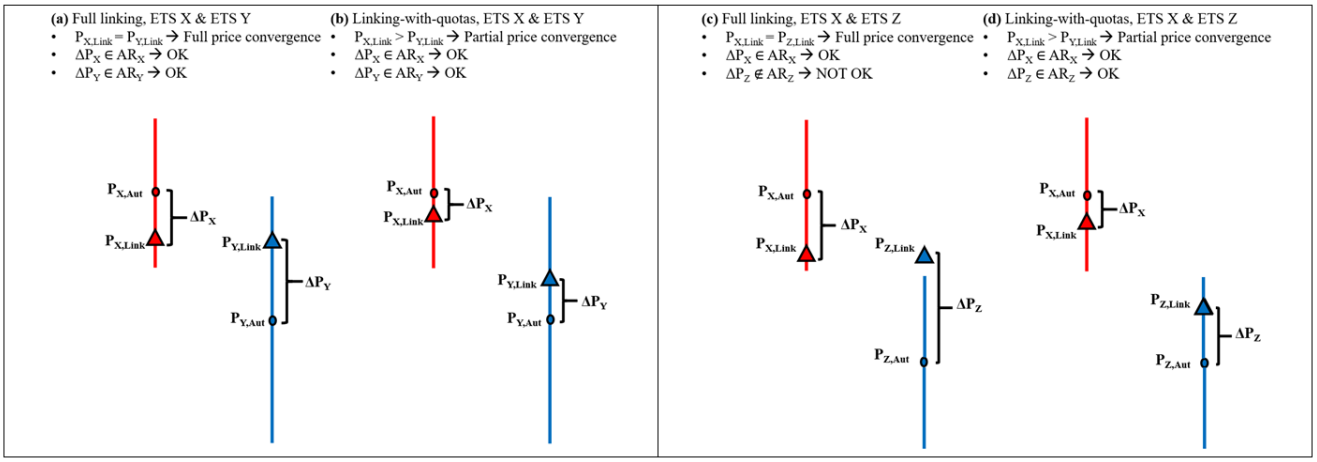
Let us now recall the condition that we have established: any linkage is only viable if the n expected impacts on allowance prices are acceptable for the n respective jurisdictions, i.e. $\widehat{\Delta P_i} \in AR_i, \forall i = 1, 2, \ldots, n.$

With full linking, perfect convergence of allowance prices implies that for this condition to hold a) pre-link prices must be sufficiently close to each other, or b) the acceptable ranges for the price impacts must be sufficiently wide. In situations where the condition is not met with full linking, linking-with-quotas can be a valid alternative.[19]

In Figure 4, graphs (a) and (b) depict a situation, involving ETS X and ETS Y, in which the condition about the expected price impacts is met with both full linking and linking-with-quotas. In both cases, each of the two expected price impacts falls in the respective AR ($\widehat{\Delta P_X} \in AR_X$ and $\widehat{\Delta P_Y} \in AR_Y$).

By contrast, graphs (c) and (d) show a situation, involving this time ETS X and ETS Z, where the same condition is not met for full linking ($\widehat{\Delta P_Z} \notin AR_Z$), but is met for linking-with-quotas ($\widehat{\Delta P_X} \in AR_X$ and $\widehat{\Delta P_Z} \notin AR_Z$)

Figure 4: Acceptable price impacts as a condition for linking.



To sum up, full linking maximises the gains from trade in emission allowances through equalisation of abatement costs across ETSs. However, perfect convergence of domestic allowance prices may entail impacts that are not acceptable for all the jurisdictions involved. If so, a full linkage between the same ETSs is not viable. In principle, linking-with-quotas can be a valid option precisely in situations where full linking is not viable because the condition about the expected price impacts is not met. Quotas on allowance transfers can then be set, and adjusted if needed, so as to limit the impacts on allowance prices within the given acceptable ranges.

Full linking with a price collar: why and how

Even when a full linkage would determine changes in allowance prices that are acceptable for all the potential linking partners, a variety of barriers may inhibit a full linkage or any linkage for that matter. Overcoming some of these barriers, such as a lack of trust or insufficient expected benefits at a macro-economic level, may require extensive intervention by governments and a long timeframe. By contrast, where the expectation of a loss of control over domestic allowance prices is a barrier to linking, enforcing a collar for the post-link allowance prices may be a practical remedy.

19 While not used in existing ETS linkages, constraints on the volume of transactions is common for domestic or international offsets and is more likely to be discussed when considering linking with significantly different autarky prices. However, the distribution of rents associated with binding constraints on volume might be challenging to address from a political perspective.

More specifically, major variations in domestic allowance prices caused by shocks or policy changes in linked ETS(s) represent a risk for a jurisdiction pursuing a full linkage. Shocks that may originate in an ETS and affect, as a result, allowance prices in a linked ETS include: economic recessions, strong unanticipated growth, and technological leaps that lower the abatement cost of emissions. Also, changes in other climate policies that affect the level of regulated emissions must be considered. Whether driven by opportunism or not, greater push by partners on countervailing, companion or complementary policy levers can reduce allowance prices with the result of both increased allowance imports in and capital outflows to linked ETSs. As such, the price risk of linking – as we call it – can be a disincentive for the establishment of new linkages. However, the same risk can be eliminated by negotiating a price collar in the linking agreement and implementing it thereafter.

For the sake of simplicity and without loss of generality, let us consider two ETSs, ETS X and ETS Y. A feasible collar would be identified by the intersection between the two respective intervals representing acceptable post-link allowance prices. The two jurisdictions would commit to keeping post-link allowance prices within the collar. Using the same notation as above, the intersection of acceptable post-link allowance prices would be the price levels falling in both intervals $P_{X,Aut}+AR_X$ and $P_{Y,Aut}+AR_Y$ (where P_{Aut} is the autarky, or pre-link, allowance price and AR is the acceptable range for the price impact of linking). The width of the intersection and, hence, of the collar, would vary from case to case. In general, the wider is the collar, the smaller are the chances that the floor or the ceiling would be activated. Moreover, so long as the collar bounds are not activated, full linking with a price collar is equivalent to full linking tout court. Both in Figure 5 and Figure 6, the green marker identifies a situation of this kind.

Crucially, both equilibrium prices and total emissions (total abatement) deviate from those that would be realised under full linking tout court if either the floor or the ceiling is activated. Figure 5 shows the case where the floor is triggered by an unexpected reduction in marginal abatement costs in jurisdiction X. The activation of the floor prevents the system from reaching a new ‘full linking’ equilibrium identified by the red marker. With the floor activated, regulated entities in both jurisdictions do extra abatement, the sum of which corresponds to the distance between the yellow markers (10 extra units abated in X and 5 extra units abated in Y). As a result of the extra abatement, an equal number of allowances is ‘freed’, which could either be cancelled (hence a permanent reduction in the aggregate cap) or stored in a cost containment reserve to be used in the opposite case where the price ceiling is triggered.

Figure 5: Linking with a price collar, activated floor.

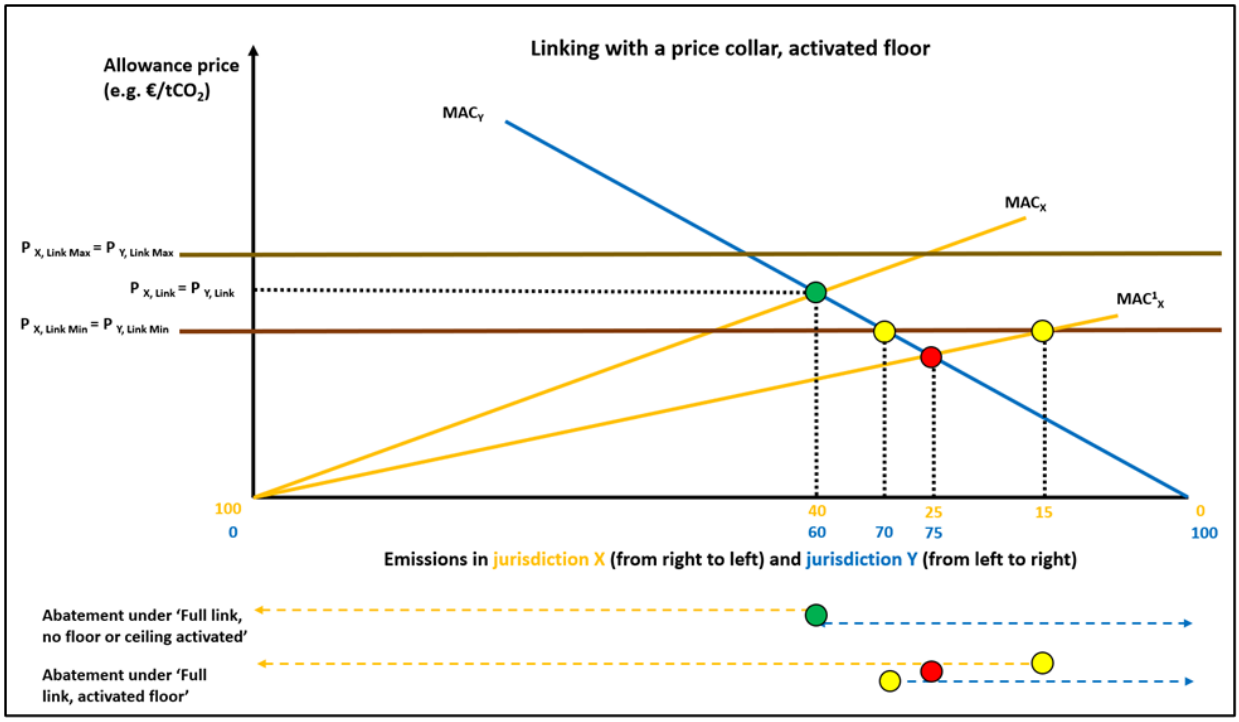
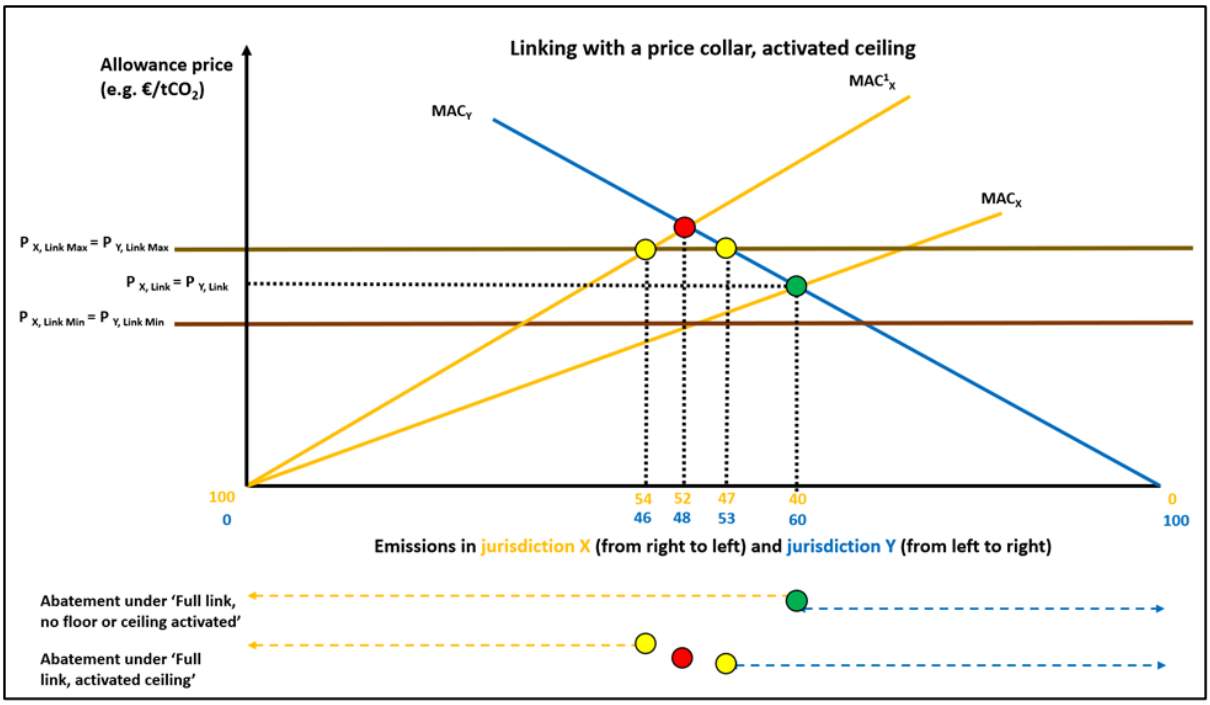


Figure 6: Linking with a price collar, activated ceiling.



By the same token, Figure 6 shows the case where the ceiling is triggered by an unexpected increase in marginal abatement costs in jurisdiction X. Here too, the activation of the ceiling prevents the system from reaching a new 'full linking' equilibrium identified by the red marker. With the ceiling activated, however, regulated entities in both jurisdictions do less abatement. The overall increase in emissions, under the linked system, corresponds to the distance between the yellow markers (2 fewer units abated in X and 5 fewer units abated in Y).

A price collar of the kind just described could be enforced by linked ETSs in different ways. Specifically, options for enforcing a ceiling include the following: a) allowances from a joint cost containment reserve are sold to regulated entities at a price equal to the ceiling; and b) if and when the cost containment reserve is exhausted, top-quality emission credits (including potentially carbon removal certificates) which are real, measurable, verifiable and additional are sold to regulated entities at a price equal to the ceiling. The rationale for selling emission credits, as opposed to issuing more allowances, is to preserve the environmental integrity of the linked ETSs (global net emissions would be unaffected). As to the options for enforcing a floor, they include the following: a) allowances are distributed through auctions with a reserve price equal to the floor (unsold allowances could then feed the cost containment reserve); and b) a 'top-up' carbon tax is applied to allowances that are auctioned at a price below the floor. The rate of the carbon tax would be equal to the positive difference between the floor and the auction sale price of allowances (Wood and Jotzo, 2011). In all cases, it is essential that due consideration is given to the interactions between the price collar for linking and PCMs that may continue to exist in linked ETSs to preclude adverse impacts.

4. Concluding remarks

This fifth and final report under the LIFE DICET project offers two main contributions. First, the report reviews the conditions that need to be satisfied for linking to be successful. The review is based on previous work under the project as well as on the broader academic and policy literature. Three critical stages of negotiations, and corresponding conditions, are identified. Before the jurisdictions even start negotiations to link their systems, there must be sufficient trust between potential partners; the prices expected to emerge in the linked system must be acceptable to all; and each partner must expect to receive positive net economic and political benefits in aggregate. Provided these conditions are satisfied, during the linking negotiations jurisdictions need to agree on revisions and reforms to affect various degrees of alignment for different ETS design elements for the link to work effectively. Finally, after a linking agreement is reached and implemented, built-in reviews and mechanisms for revision and dispute resolution will need to function well so emerging issues are identified and addressed quickly.

The second contribution of the report is a proposal whose purpose is to facilitate the establishment of new linkages between ETSs. Specifically, the price collar mechanism for the linked system described in Section 3 can reduce the uncertainty surrounding the allowance prices after linking and bring about stability to the system. Agreeing on whether the price collar mechanism is permanent or a temporary measure for the initial years of the linked system's operation, its parameters (e.g. the price floor and ceiling levels), evolution over time (e.g. to reflect changes in inflation and exchange rates) and enforcement rules (e.g. how to intervene when the price collar is triggered) at the negotiation stage could provide many benefits by reassuring a diverse set of stakeholders simultaneously.

For example, regulators can rest assured that the price risk of linking due to developments in other jurisdictions is reduced. Regulated entities will know that compliance costs will not skyrocket which can help with industry buy-in. Investors in low-carbon technologies and environmental NGOs will be reassured that the allowance prices will remain above a certain level enhancing the public acceptability of linking. Moreover, by making the jointly acceptable price range of jurisdictions participating in the linked system explicit, the price collar can also act a reference for new members who may be willing to join the system in the future or when linking the linked system with other linked systems elsewhere.

Despite these benefits, the agreement on the parameters and rules of a price collar in the linked system can be difficult to achieve. For example, jurisdictions may not be willing or able to make the prices they deem acceptable public and explicit because this may be interpreted as going against the very nature of a quantity instrument they opted for under autarky. In the absence of explicit acceptable price

ranges, jurisdictions can gather information using modelling exercises in the systems to be linked or by analysing the properties of the observed historical price distributions. The specific rules of intervention when the price collar is triggered will have distributional implications which are inherently political. For example, if developments in one jurisdiction come to be seen as triggering the price floor more frequently than those in other jurisdictions, political acceptability of the linked system may be undermined. This is more likely if these developments relate to changes in other climate policies or are perceived as undermining the environmental integrity of the whole system. Moreover, if the overlap between the jurisdictions' acceptable ranges for allowance prices is narrow, the price collar will be triggered frequently with all the attendant inefficiencies.

These difficulties notwithstanding the political and economic benefits due to linking are large and growing as the mitigation effort around the world ramps up, low-cost abatement opportunities become scarce in many jurisdictions and low liquidity can become a challenge in ETSs under autarky. Put differently, even if the linking with a price collar is likely to encounter political economy obstacles in the near-term during negotiations, starting the conversation and developing the proposal further will be beneficial in the long term.

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