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TRANFORMATIONAL CLIMATE CLUBS FOR STEEL DECARBONISATION

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List of abbreviations:

ASEAN: Association of Southeast Asian Nations

BCAs: Border Carbon Adjustments

BF: Blast Furnace

BOF: Basic Oxygen Furnace

CBAM: (EU) Carbon Border Adjustment Mechanism

CBDR: Common but differentiated responsibilities

CCSU: Carbon Capture Storage and Utilisation

DRI: Direct Iron Reduction

EAF: Electric Arc Furnace

EITE: energy-intensive trade-exposed (industries)

ETS: Emission Trading System

GASSA: General Agreement on Sustainable Steel and Aluminium

GSD: Green Steel Deal

IRA: Inflation Reduction Act

LeadIT: Leadership Group for Industry Transition

MEF: Major Economies Forum on Energy and Climate

MENA: Middle East and North Africa

NDCs: Nationally Determined Contributions

PCRs: Product Content Requirements

PPCA: Powering Past Coal Alliance

PPP: Public-Private Partnerships

UNFCCC: United Nations Framework Convention on Climate Change

WTO: World Trade Organisation

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Introduction

"Transformational" climate clubs have been heralded as a potential solution to circumvent the limitations of climate multilateral negotiations, scale up ambitions within a group of like-minded countries and, over time, entice other countries to join. Originally envisioned as coalitions of actors providing excludable club goods, transformational clubs have also been envisioned to sanction non-members, particularly after the controversial proposal by the economist William Nordhaus (Nordhaus, 2015). Fundamentally, they seek to resolve the "free-riding" problem associated with public goods, which occurs when nations are reluctant to bear the costs of mitigation hoping instead to benefit from the actions of others. The traditional top-down approach of broad international agreements, such as the Kyoto Protocol, has often faltered due to the failure to overcome this fundamental collective action problem.

With the Paris Agreement, independent climate action has been bolstered by a contribution-and-review process through which countries now "pledge" their ambitions, in the hope that positive climate leadership will ratchet up climate efforts worldwide. While opening the door to a new era of bottom-up initiatives and a "polycentric" system of governance, Paris has also resulted in differing levels of ambition in climate policies which have heightened fears among frontrunners of an uneven playing-field, whereby production risks relocating to where the cost of polluting is lower. This risk of "carbon leakage" has been particularly acute for energy-intensive trade-exposed (EITE) industries such as steel. Being essentially spared of the imposed carbon costs due to leakage concerns, the steel industry has so far lacked comprehensive commitments and sufficient levels of international coordination to reduce its carbon footprint.

To shield members from leakage, climate clubs have figured prominently in recent discussions. Yet, materials like steel are also "locked-in" in carbon-intensive processes which derive from complex interplays between technological, economic, social and geographical forces. Crucially, "de-carbonising", that is breaking this carbon lock-in and unlocking a new low-carbon pathway, responds to different logics than gradually reducing atmospheric emissions. If not geared towards mustering support for disrupting carbon lock-ins, a cross-sectoral club exclusively focused on addressing free-riding and leakage may be of questionable political utility. Therefore, it has been suggested that, without overlooking the need to minimise leakage risks, industrial decarbonisation should instead take centre-stage in discussions around climate clubs. This dissertation focuses specifically on steel, and asks:

- *How and to what extent could a transformational climate club enhance cooperation and accelerate decarbonisation of the steel industry?*

To this end, this dissertation builds on the theoretical framework proposed by Levin et al. (2012), which emphasizes three key policy features to trigger incremental changes which can ultimately set off new transformative path-dependencies: stickiness, entrenchment, and expansion. In the context of a club, stickiness refers to the immediate attractiveness of policies which can lock in the initial support of club members;

entrenchment involves fostering sustained member support over time; and expansion pertains to offering incentives to enlarge the coalition of members. By applying this framework to climate clubs, this dissertation unveils why some interventions adopted by a club might be incrementally transformative for steel decarbonisation, why others may be unfeasible initially but could become more viable once preconditions are met, and, further, why others may just prove counterproductive. In doing so, it sheds light on crucial debates involving clubs and climate cooperation.

The dissertation is organised as follows. The first chapter reviews the literatures on climate action and cooperation, the nexus between climate and trade, and climate clubs. Specifically, it aims to: untangle why unilateral action and cooperation occur for climate mitigation and decarbonisation; explain the relevance of carbon leakage and how it is currently being addressed; and draw relevant lessons from outlining the main features of the plethora of climate clubs proposed in the literature.

The second chapter links the theoretical framework of Levin et al. (2012) with the key concepts of a club. Moreover, it illustrates the methods employed respectively in the two empirical chapters: deductive thematic analysis and case-study analysis.

The third chapter seeks to develop a hypothetical ideal climate club for steel. Firstly, thematic analysis is used to catalogue and discuss the potential governance functions of a club based on the challenges of transitioning to low-carbon steel production, and, secondly, findings are linked back to the conceptual framework. It contends that the club should adopt an inclusive approach, prioritising "carrots" to reward prospective green steel producers and support developing countries, expected to account for the bulk of future steel production. Conversely, at present, employing "sticks" could be either counterproductive or practically unfeasible before stickier foundational actions are taken.

Finally, the fourth chapter, mindful of previous findings, analyses comparatively the General Agreement on Sustainable Steel and Aluminium (GASSA) between the US and the EU and the G7 Climate Club, climate clubs which have been deemed to have transformative potential. The inconclusive negotiations of the GASSA reveals the drawbacks of focusing almost exclusively on trade sticks in the case of different domestic political-economic conditions. In contrast, the G7 Climate Club shows potential to be truly transformative after having recognised the sticky, entrenching and expanding actions to prioritise.

Chapter 1: Literature review

1.1 Climate action and cooperation

The earth's climate presents the characteristics of a global public good in that no individual can be excluded from benefitting from it and can diminish the benefits others enjoy from it (Chin, 2021). Preserving this public good is a tremendously costly endeavour, since burning fossil fuels has been and still is the cornerstone of economic development. Moreover, while costs are generally concentrated, benefits are mostly diffused and distributed over time. It is exactly this imbalance of costs and benefits which deters countries from acting, or rather pushes them to rely opportunistically on mitigation actions by others – so-called "free-riding" (Cooper et al., 2017). Climate change thus represents the quintessence of a collective action problem (Ostrom, 2009).

Because of free-riding, actors cooperate *only if* others reciprocate their efforts (MacKay et al., 2015). This view purports an understanding of climate policymaking as fundamentally reciprocal, for which action by the pivotal players, more than anyone, is constrained by what others do. Collective action theory recommends an externally enforced set of rules to prevent free-riding – a treaty (Barret, 2016). Yet, no such set, nor the authority to enforce it, have been successfully put in place so far. The Kyoto Protocol was historically the top-down attempt to set targets and timetables to achieve them, but weak enforcement led to defection and ultimately demise. Despite a gloomy record of international diplomatic cooperation, many economists have continued asserting the importance of free-riding and advocating for one-pack global solutions like a global carbon price (Cooper et al., 2017) or treaties sanctioning noncompliance (Barret, 2016).

Due to the failure of Kyoto's coordination commitments, climate governance has spread out beyond the UNFCCC (Asselt&Zelli, 2012). This ramification of non-hierarchical centres of decision-making at multiple levels have spurred scholars, first and foremost Elinor Ostrom, to focus on the advantages of such a polycentric governance system (Ostrom, 2010). Agreeing on a global agreement, she argues, albeit vital, must not be the only effort pursued. Ostrom's followers have thus focused on bottom-up initiatives and their potential for experimentation and learning (Sabel&Victor, 2022), transnational and multi-level networks (Bulkeley, 2014) and the building of trust as catalyst for cooperation (Dorsch&Flachsland, 2020). They have also acknowledged the weaknesses of a polycentric system, such as the incapacity to address free-riding, still looming large, and the risks of uncoordinated inconsistent policies (Ostrom, 2010).

A true polycentric system, as envisioned by Ostrom, characterized by cooperation and competition between centres at levels tailored to match their functions is not yet existent. Surely, there is evidence of polycentric dynamics; but polycentricity's hallmarks, which are the overarching orchestration and monitoring of these initiatives to build trust and foster learning, may not be evident yet (Bernstein&Hoffmann, 2018). Notwithstanding, this reveals how early literature on polycentricity did not abstain from the idea that a collective action or *system*, such as polycentric governance, was needed.

Another strand of literature, evolving from polycentricity, radically breaks with approaching climate cooperation as a collective action problem, or a dilemma of governing the "commons". Instead, it views actors as unconditional cooperators and contends that climate policies, cooperative or not, are adopted based on distributive conflicts (Aklin&Mildenberger, 2020). Climate policies create winners and losers, and, over time, the power imbalances change because of empowered interest groups, new emerging shared norms and, critically, the presence of catalytic institutions (Hale, 2020). The Paris Agreement is, in theory, one such catalytic institution: Nationally Determined Contributions (NDCs), which are flexible, stimulate early movers without limiting them to a least common denominator outcome and spur incremental action through stocktaking of progress over time.

Similarly, other scholars emphasise the importance of breaking out from carbon lock-ins, conceptually defined as the intricate interplays between technological, institutional and social factors that generate resistance to climate mitigation (Unruh, 2000). Bernstein and Hoffmann argue that the carbon-intensive modes of production in which we are locked-in require prioritising deep decarbonisation instead of general emission reductions, and that, crucially, decarbonisation responds to different logics than public goods (Bernstein&Hoffmann, 2018). Levin et al. focus on those logics, examining how positive path dependencies can be generated to trigger low-carbon trajectories through incremental actions and reinforcing feedback (Levin et al., 2012). They emphasise the importance of identifying interventions to entrench support for decarbonisation policies and to expand support coalitions over time. Eventually, when "tipping points" are reached, decarbonisation actions unravel in a series of cascading processes (Sharpe&Lenton, 2021).

This dissertation is driven by the belief that the "commons" metaphor utilised by those who prioritise free-riding risks misdiagnosing the roots of the problem. Other than being of dubious political feasibility, collective solutions like a global carbon price, alone, do not address the fundamental challenges of disrupting lock-ins, overcoming obstructionism, and entrenching low-carbon pathways (Bernstein&Hoffmann, 2018). If these are the roots of the problem, focusing only on lowering emissions is insufficient, as such reductions could only yield efficiency gains too minor to significantly shift the balance in favour of clean technologies. Such focus would also overlook the multitude of entry points where decarbonisation pathways can be entrenched (Bernstein&Hoffmann, 2019). Polycentric governance recognises this multitude of path-breaking initiatives and their interdependencies, but, crucially, does not seek to explain their emergence (Ostrom, 2010).

1.2 Leakage, trade and climate

In a fragmented climate regime, emissions can "leak out" of the more ambitious jurisdictions when carbon-intensive firms relocate to regions with laxer emission targets, causing a negative net-effect for the climate. This so-called "carbon leakage" also undermines the competitiveness of, more than any other, EITE industries, undercut by dirty imports coming from less ambitious countries (Frankel, 2009). Debates are ongoing on whether leakage is statistically significant, but it is widely believed that, as emission targets are set tighter, the leakage problem will become more prominent (Jakob, 2021; Böhringer et al., 2022). Addressing leakage is paramount because the ratcheting up of independent climate policies, one of the promises of the Paris Agreement, can only work if actions are not deterred by artificial comparative advantages of reluctant countries.

Historically, leakage has been addressed by compensating businesses at risk of relocation with free emission permits. However, this approach conflicts with the goal of reducing polluting consumption, because firms are essentially spared of the carbon cost (Jakob, 2022). Accordingly, policymakers have long discussed border carbon adjustments (BCAs), measures aimed at creating a level-playing field to equalise the carbon price borne domestically with equal tariffs on dirty imports. To the extent that they protect domestic players, BCAs can muster political support for more ambitious policies at home. And insofar as foreign exporting firms are compelled to find cleaner production methods to be less burdened, BCAs are also part of a climate leadership story to increase ambitions abroad (Pirlot, 2022).

However, BCAs face substantial practical challenges, mostly related to the calculation of imports' "embodied carbon" (Böhringer et al., 2022: *23-24*), and there is a lively legal debate about their compatibility with WTO law (Dobson, 2023). Politically, they may be even more controversial. First, equalising carbon prices, insofar as it partly shifts the mitigation burden on trade partners, runs squarely counter to historical responsibilities, encapsulated in the common-but-differentiated responsibilities (CBDR) principle (Eckersley, 2010). Second, domestic lobbies may advocate for a BCA designed more to damage their competitors than to achieve effective climate change mitigation, disguising protectionist purposes (Meyer, 2024). Thirdly, and because of these reasons, trade partners could retaliate with sanctions of their own, triggering tit-for-tat dynamics which might result in a trade war detrimental to climate cooperation. Accordingly, accusations of unilateral standard-setting and green protectionism have often featured in the rhetoric of countries affected by the newly introduced EU Carbon Border Adjustment Mechanism (CBAM) (Hancock, 2023).

Many authors have argued that some design details might be key to resolving these tensions, such as the use of revenues to compensate who is burdened the most (Mehling et al., 2019). Both economists (Jakob, 2021) and political scientists (Sabel&Victor, 2022) agree that penalties are economically optimal and normatively just only when the weakest are enough supported. Jakob (2023) also mentions how BCAs, if framed as instruments to enable joint climate action by members of a club, might prove more acceptable than when used as means to impose climate policy on trade partners.

Nevertheless, BCAs and their potential adverse effects oblige us to reflect how leakage can be addressed rather through cooperation, and how regions in which climate policy is still incipient can be supported. If climate change is a fragmented "regime complex" (Keohane&Victor, 2016: *574*), trade policy is one of its building blocks and has in this respect immense potential, from curtailment of fossil fuel subsidies to cooperation on support schemes for green technologies (Jakob et al., 2022). Much like climate policy, multilateral trade negotiations at the WTO have foundered, instead morphing into preferential trade agreement or sector-specific accords (Sabel&Victor, 2022). It does not come as a surprise that, in this context, trade has featured centrally in debates around climate clubs.

1.3 Climate clubs

In response to the shortcomings of climate *grand* multilateralism, new innovations in global governance have arisen under the umbrella concept of polycentricity. Among these, climate clubs have been proposed to harness the advantages of initiatives undertaken in smaller forums (Victor, 2011). Involving fewer countries, or focusing on specific sectors could, using the vocabulary of Keohane and Victor, foster narrow-but-deep instead of broad-but-shallow cooperation (Keohane&Victor, 2016). Yet it is difficult to give an exact definition of climate clubs because they have come to signify different things to different people. From extensive review of the literature, it appears that different conceptualisations of climate clubs derive from how one tries to resolve the tensions around their key features – *membership* and *design.* A typology is shown below based on this understanding.

Criteria / ***Type***	*Objective*	*Examples*	*Membership*	*Design / Club goods*	*Drawbacks*
Transformational	Increase ambition changing members' incentive structure	*Nordhaus (2015), Weischer et al. (2012), etc.*	Open-ended but with binding requirements	Excludable club goods or sanctioning mechanisms for non-members	Political feasibility and legitimacy
Bargaining	Facilitate more effective negotiations in minilateral fora	G7, G20, MEF	Closed (strictly based on invitation)	Rule-setting but without club goods	Lowest-common-denominator outcomes
Normative	Advance normative commitments to certain climate policy objectives	PPCA, LeadIT	Loosely open-ended (voluntary commitment)	Reputational benefits	Only symbolic actions
Pseudo-Voluntary	Provide public goods, often in the form of standards	GG and ISO Protocols	Loosely open-ended (adherence to standards)	Reputational benefits	Lack of enforcement

Table 1: *Typology of climate clubs. Source: author.*

Normative clubs adhere on a climate objective, like a coal phase-out, more to rally members towards a normative commitment than to enact binding rules to reach it (Falkner et al., 2021). They aim to include as many countries as possible, on the premise that members commit to the objective. Bargaining clubs, instead, restrict membership to the most powerful to facilitate compromise-seeking between countries with diverging normative ambitions (ibid.). They are thus at the opposite sides of the membership spectrum. Other scholars also recognise pseudo/voluntary climate clubs, aimed at creating shared standards to improve transparency and provide reputational benefits for firms (Green, 2017; Pratash&Potoski, 2007). All these club arrangements can have considerable political utility; yet they do not represent that friendly or competitive alternative to the UNFCCC to switch gears in mitigation efforts. Many authors thus argue that "no credible climate club yet exists" (Hovi et al., 2016; *3*).

Transformational clubs, instead, intend to directly alter actors' incentive structures, and as such are inextricably linked with theoretical debates on climate cooperation. A group traces its intellectual roots to the economic theory of clubs devised by Buchanan (1965). He argued that a club focused on the public good of climate mitigation inherently encourages free-riding due to the non-excludable nature of the public good. His concern was instead on private "club goods" which are, by definition, excludable, and which, in the case of climate change, can produce climate mitigation as a co-benefit (Hovi et al., 2016). Scholars have proposed, for instance, joint government-led R&D clubs protected by intellectual property rights, or clubs providing preferential terms of trade or investment (Weischer et al., 2012; Stewart et al., 2013). Nonetheless, especially as far as trade is concerned, clubs based on such benefits have not been feasible due to competing political interests (Falkner, 2016), although, even for trade, there have been exceptions[1].

Excludability can be achieved not only providing benefits which accrue solely to members, but also through sanctioning non-members – a differentiation often referred in the literature as *carrots* versus *sticks*. The club proposed by Nordhaus, which has been the most widely discussed in the literature, employs sticks – in the form of uniform trade tariffs – to penalise non-members while, internally, obliges members to adopt a uniform level of carbon pricing (Nordhaus, 2015). In the words of Falkner et al., "this elegant simplicity explains why it is the least politically feasible of all club models" (Falkner et al., 2021; *483*). Indeed, the proposal scores poorly in terms of feasibility not only because of all the problems arising from trying to harmonise different carbon pricing regimes, but also in terms of its sociological legitimacy – how other countries view it, especially in light of the CBDR principle (Hall, 2024). It also belies a purely economic understanding of the climate mitigation conundrum, viewing it as a collective action problem requiring above all else a global solution like a carbon price. Similar proposals, inspired from Nordhaus, have circulated with BCAs instead of punitive trade sanctions (Tagliapietra&Wolff, 2021).

Other authors, conscious of the political drawbacks of transformative clubs *a' la Nordhaus*, have adopted more nuanced approaches for devising clubs, combining voluntary commitments with transformative elements. For example, Victor suggests how like-minded countries could kickstart a club based on "conditional commitments", making mitigation contingent to other countries' mitigation efforts or to financial assistance (Victor, 2011, 2016). Moreover, Luepke et al. envision linking clubs with just transition partnerships for

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

developing countries (Luepke et al., 2024). Approaches structured only on mutually reinforcing positive cooperation, though, can be undermined by free-riding, which is why Nordhaus proposed penalties and Buchanan originally prioritised private excludable goods.

What the many club conceptions in the literature ultimately suggest is that sticks and carrots must be carefully calibrated for a club to be both effective and feasible (Agora, 2022). The Montreal Protocol to combat the depletion of the ozone layer, albeit being multilateral in nature, provides one good example: the threat of punishment was combined with technical support to facilitate compliance (Sabel&Victor, 2022). Moreover, trying to alter unilaterally the incentive structures of extremely heterogeneous countries would probably prove ineffective. Clubs would more likely succeed if constructed as "coalitions of the willing" or based on specific sectors where interests of members are more aligned (Falkner, 2016: *97*).

1.4 A sectoral approach

A cross-sectoral climate club focused on reaching diplomatic agreements would probably end up mirroring the negotiations full of insurmountable hurdles at the UNFCCC. If international cooperation is pursued to truly advance decarbonisation forward, some scholars argue, it should be articulated across sectors (Kumar et al., 2022; Luepke et al., 2024; Geels et al., 2019). Energy-intensive industries, like steel or cement, are still at the early-medium stages of decarbonisation, where technology trajectories are not clearly defined. Establishing a low-carbon trajectory will require fundamental transformations involving technologies, infrastructures, economic incentives and institutions, elements which all vary across sectoral systems (Oberthür et al., 2021). Moreover, as mentioned, these EITE industries, competing internationally, tend to be particularly affected by carbon leakage, so policies will unavoidably have international ramifications.

EITE industries therefore present a clear case where a climate club could make a difference (Otto&Oberthür, 2022). This is why this dissertation adopts a sectoral approach, aiming to evaluate the potential of a climate club to foster decarbonisation specifically in the steel industry. A steel club has already received substantial academic attention (Hermwille, 2019) and, importantly, two recent club-like initiatives have interested the sector: the G7 Climate Club proposed by the German presidency in 2021, and the negotiations on a "General Agreement on Sustainable Steel and Aluminium" (GASSA) between the EU and US. While both possess the potential to become transformational clubs, the degree to which they can drive steel decarbonisation remains an empirical question—one that this dissertation seeks to explore.

Chapter 2: Research Design

2.1 Framework

The theoretical framework employed builds on Levin et al. (2012: *129*), who argue that, in order to trigger progressive incremental changes capable of addressing the "super-wicked" problem of climate change, characterised by an inherent inability to "discount the future rationally", policies choices need to:

- *Stick* immediately, making reversibility difficult;
- *Entrench* support over time;
- *Expand* progressively their reach.

Scholars of punctuated equilibrium suggest that policies tend to remain stable, until punctuated change to a new equilibrium occurs by way of paradigmatic shifts or progressive incremental steps (Cashore&Howlett, 2007). In the case of decarbonisation, breaking the carbon-intensive dominant modes of production in which industries like steel are locked-in is tantamount to shifting to a new equilibrium, but, crucially, the shift is unlikely to happen through big one-shot paradigmatic solutions (Wiener, 2007). Decarbonising means also that efficiency-improving and emission-reducing policies, albeit politically feasible, are inadequate to trigger the required transformational change (Sharpe&Lenton, 2021).

Levin et al. (2012), therefore, argue that focusing on the three policy features aforementioned facilitates the identification of political mechanisms which may, progressively, build conditions to foster deep decarbonisation. Such mechanisms encompass building capacity, nurturing coalitions and creating logics of appropriateness to plant seeds for new path-dependencies (Bernstein&Hoffmann, 2020; Hale, 2020). This view is shared by scholars who perceive that climate actors are unconditional cooperators driven by distributive conflicts (Aklin&Milderberg, 2020), and that pathways to decarbonisation follow a logic of increasing returns and reinforcing feedback (Sharpe&Lenton, 2021).

A steel decarbonisation club involves forming a low-carbon coalition of countries committed to implement policies to accelerate the sector's global transition. The policy prescription identified by Levin et al. (2012) appear particularly advantageous to inform the club's actual design. Firstly, stickiness refers to a policy intervention's capacity to draw in and retain the support of initial club members by offering immediate benefits and minimising short-term costs. Secondly, entrenchment pertains to a club's design logic that fosters internal member support over time, leading to the onset of low-carbon lock-ins. Finally, expansion means that club's members should try to expand the club further, prospectively offering sufficient incentives for non-members to join. Expansion, in the context of a club, is thus connected, in addition to its design, to its membership.

While Levin et al. (2012) place particular focus on policy change at different levels, policy levers may be also easier to change over time after stickier actions create novel conditions, laying the groundwork for more ambitious interventions later. Meckling et al. (2015) document, for instance, how green industrial policies, like feed-in-tariffs, have historically paved the way for more sweeping carbon pricing in the electricity sector. Focusing on strategically identifying those stickier actions can facilitate the implementation of more radically entrenching policies later, like the use of club sticks to induce non-members to participate or, at least, to try to catch up. This *sequencing* dimension is therefore included in the conceptual framework (Figure 1).

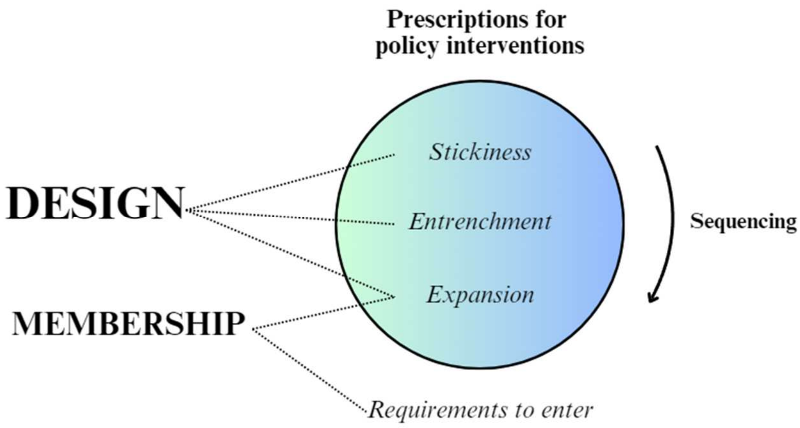


Figure 1*: Conceptual framework. Source: author*

Using this conceptual framework enables approaching the research question from a unique angle, allowing for a more nuanced analysis of why certain steps are not feasible and why others could be incrementally transformative. In so doing, it helps to shed light on debates regarding climate cooperation through transformative climate clubs, such as whether to prioritise carrots or sticks, or if certain members' constellations may need to be expanded.

The main limitation of the framework as outlined is that it does not evaluate the institutional potential of the club in the context of a polycentric "fractal" system, in which lock-ins have a multilevel and interdependent nature (Bernstein&Hoffmann, 2019). In other words, it does not assess the extent to which it could spur decarbonisation actions in sectors other than steel. As such, it could be considered "reductionist" in overlooking interdependencies and interlinkages between sectors and undervaluing the importance of the bigger picture. Notwithstanding, a small cohort of scholars has already evaluated the potential for a climate club to exploit existing governance gaps and achieve a better institutional fit in the "sectoral institutional complex" of energy-intensive industries (Otto&Oberthür, 2022). Discussions are therefore supported in light of those authors' notable findings.

2.2 Methodology

The rest of this dissertation is divided in two parts: the first section aims to create a hypothetical ideal climate club for steel based on the sector's challenges and needs; the second assesses and compares two real-world case studies of climate clubs which have identified steel, among others, as a pilot sector.

2.2.1 Deductive Thematic Analysis

In Chapter 3, the research method employed for the construction of the ideal-type club was a *deductive thematic analysis*. Thematic analyses are flexible methods for identifying, analysing and reporting patterns or themes from qualitative data, allowing researchers to explore complex phenomena and to derive meaningful insights from it (Braun&Clark, 2006). Deductive thematic analyses, specifically, are characterised by an encoding process in which the relevant qualitative data are fit into pre-existing frames, which can be derived from analytical preconceptions or from literature reviews (ibid.). The deductive thematic analysis employed in this dissertation enabled the identification of the possible governance functions a club could supply to accelerate steel decarbonisation.

The first step involved grouping the barriers and challenges of steel decarbonisation into four sets of uncertainties within the sector – *supply*, *demand, political* and *international* uncertainties. In so doing, the geographical articulation of present and future production and demand of steel was also found particularly important from the point of view of an international club. This industry-distinct analysis was carried out through extensive review of primary (export reports and international organisations' outputs) and secondary literature. The second step entailed mapping systematically and then discussing the governance functions and related policy interventions that a club could provide – the themes of the analysis. The criteria for choosing the themes were guided by the lens of the theoretical framework, focusing on their potential for stickiness, entrenchment, or expansion. For this second step, a review of all available academic and expert proposals for climate clubs was conducted, with findings cross-referenced against those from scholars of "sectoral institutional complexes" (Otto&Oberthür, 2022). Finally, results of the thematic analysis are linked back to the conceptual framework in a discussion about the actual shape of the hypothetical ideal club.

2.2.2 Case-study analysis

In Chapter 4, a case-study approach was used to assess and compare the potential to accelerate steel decarbonisation of existing club initiatives, thereby bridging discussions from the hypothetical proposal to real-world applications. Accordingly, the analysis was primarily informed by official outputs, in addition to academic and experts' analyses. The GASSA and the G7 Climate Club were chosen for three reasons. Firstly, both can be considered as sectoral clubs relevant for steel (even though the G7 Climate Club, cutting across several sectors, plays an important orchestration function). Secondly, both can be regarded as "transformative", in the sense that they both aim to change members' incentive structures and to address the issue of carbon leakage. Finally, they present the necessary institutional strength (prospectively, in the case of GASSA) and governmental authority which many other sectoral initiatives lack. The two clubs allow for the analysis to be comparative, providing concrete examples of how prioritising certain actions over others translate in true decarbonisation potential or political deadlock.

Chapter 3: a hypothetical club for the steel sector

3.1 Steel decarbonisation: barriers and challenges

Reaching net-zero in the steel industry involves a diverse array of solutions and implementation challenges. Reducing energy and materials demand and moving towards enhanced circularity, key elements of the equation according to the IEA (2023a) and IPCC (2022) reports, require the involvement of wide range of actors beyond the steel industry across highly complex value chains, so will not be considered. The focus is here on transitioning to lower-emission production processes, the crucial challenge of deep decarbonisation and, in fact, a more pragmatic focus for a steel club (Hermwille, 2019).

Steel can be produced in two main ways, as shown in Figure 2. The primary route, highly carbon-intensive, involves reducing iron ore to "pig iron" in a coal-powered blast furnace (BF), then converting it into steel in a basic oxygen furnace (BOF). Although Carbon Capture Utilisation and Storage (CCUS) can reduce emissions from this BF-BOF route, the technology is costly and does not discourage new coal-based production investments (Agora&Wuppertal, 2023). A smaller percentage of plants use Direct Iron Reduction (DRI) to produce "sponge iron", which is then smelted in electric arc furnaces (EAFs) powered by electricity. Green-hydrogen-based DRI, coupled with EAFs, represents the main decarbonisation pathway, but its adoption is complicated by the availability of green energy and hydrogen infrastructure (IPCC, 2022). Other decarbonisation technologies are either still in development (electrowinning) or alone cannot be comprehensive (biocharcoal) (Somers, 2022). Currently, there is thus not a silver bullet clean technology for producing virgin steel, which makes up about 71% of global steel production[2]. Steel is also produced secondarily in EAFs using recycled scrap, which is much cleaner than the BF-BOF route, depending on the electricity's carbon intensity. While recycled steel is important, it cannot be the sole solution, especially in developing regions where steel demand is rising, and scrap supplies are finite (Swalec&Grigsby-Schulte, 2023).

[2] https://worldsteel.org/data/world-steel-in-figures-2024/#crude-steel-production-by-process-2023

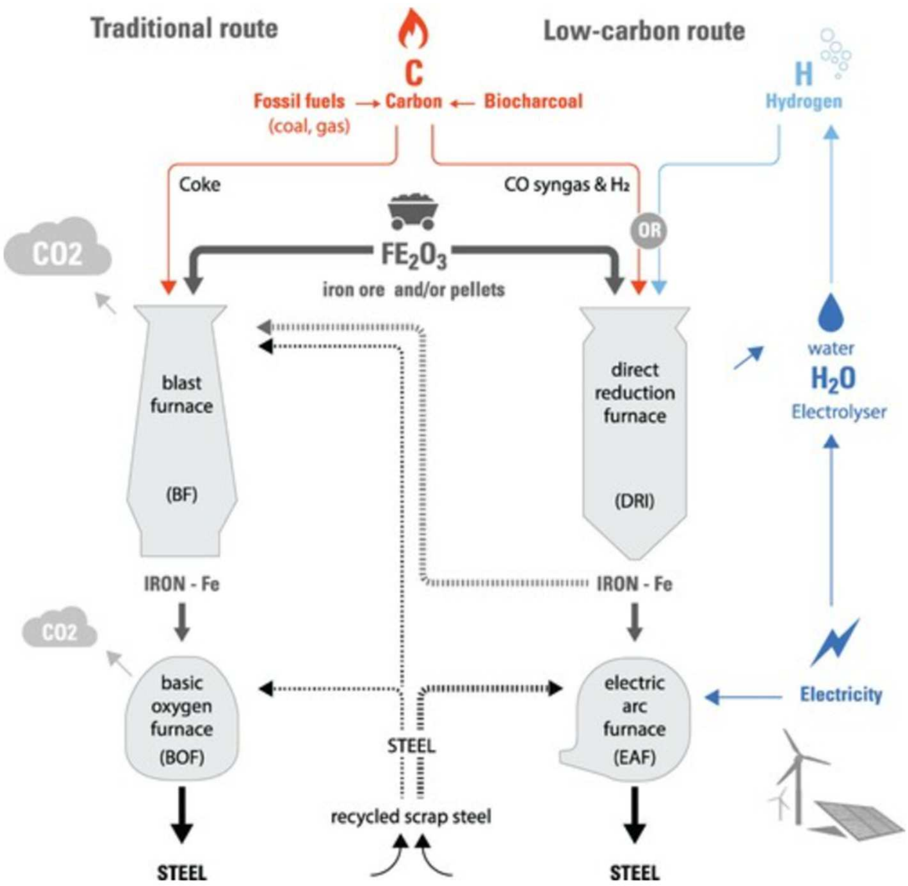
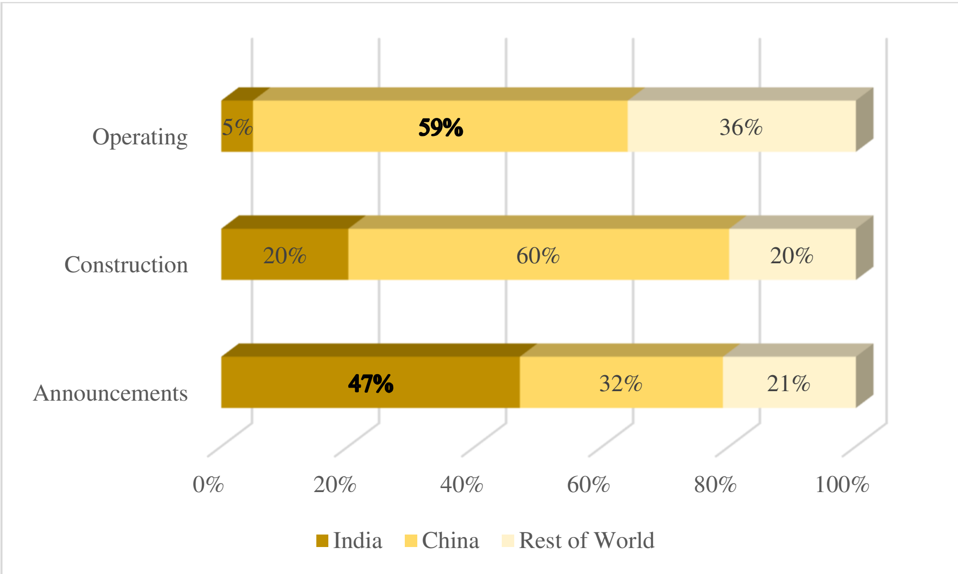


***Figure 2**: Steel production routes. From (Trollip et al., 2022)*

Several barriers confront decarbonisation beyond these *technological (supply) uncertainties*. Firstly, steel plants are characterised by high up-front investments which take a long time (up to 45 years) to be recouped (Wesseling et al., 2017). Therefore, changing completely modes of production is very costly and risky, and, consequently, corporate R&D is often only aimed at incremental innovation of existing processes, resulting in technological inertia. Secondly, near-zero emission steel, while providing no integral co-benefits, is estimated to cost 20-40% more than steel produced from conventional steel plants (IPCC, 2022). Thirdly, this competitive disadvantage is compounded by the fact that steel is an internationally traded commodity, subjecting producers operating on miniscule margins to fierce competition (Swalec&Grigsby-Schulte, 2023). Finally, comprehensive policy frameworks to infuse trust for future low-emission producers are either lacking or are not articulated enough (Oberthür et al., 2021). The combination of these sectoral features results in *demand* and *political uncertainties* which hamper incipient green steel markets.

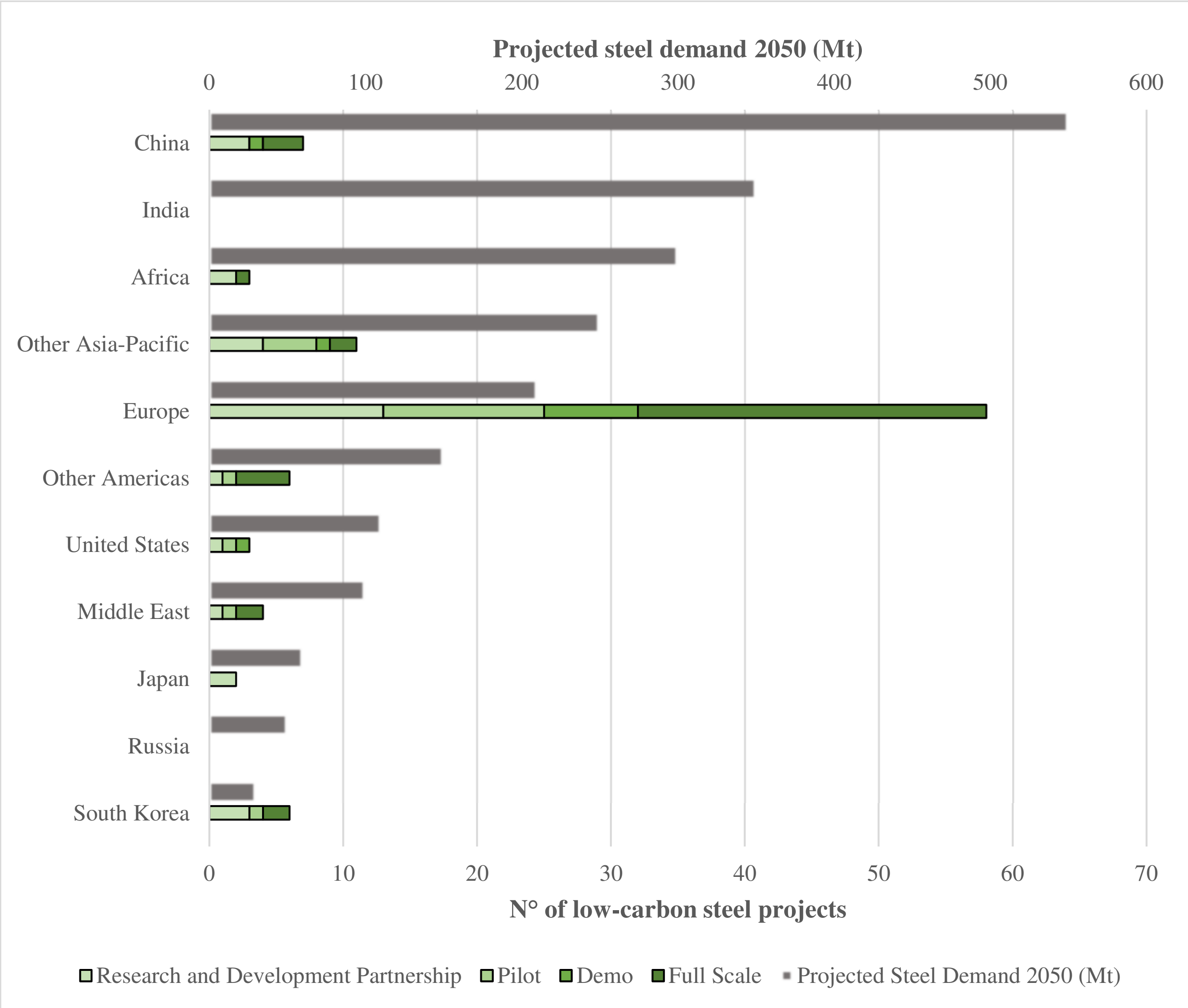
As already mentioned, the international nature of the sector means that different levels of stringency of climate policies increase the risk of carbon leakage. Moreover, inefficient producers have often been kept in business by lavish government subsidies or other market-distorting mechanisms, resulting in so-called "non-market excess capacity". Overproduced cheap steel flooding international markets has not only dampened prices and profitability but has also historically contributed to exacerbate trade relations (GFSEC, 2024). These issues create *international inconsistencies* in trade, climate, and domestic industrial policies within the sector, collectively contributing to hinder investments in low-emission steel production (Swalec&Grigsby-Schulte, 2023).

Geographical aspects of steel decarbonisation are also worthy of consideration. As can be seen from Graph 1, 59% of global current BF-BOF capacity, the dominant mode of production, is based in China, which is by and large the largest world producer and exporter. Yet, crucially, India, in pursuit of its economic and industrial development, has recently overcome China in new announced unmitigated BF-BOF plants, accounting for 47% of the share (about 150 new Mt). These additions will come along this decade, bringing on a new cycle of carbon lock-ins which risks consuming the remining carbon budget (Algers&Ahman, 2024). There is a silver lining to this: it has been found that opportunities to embed low-carbon technologies in blast furnaces occur fairly often throughout their operational lifespan—approximately every 19, 16, and 10.5 years (Vogl et al., 2021). Especially for countries like India, exploiting these windows of opportunities will be key.



***Graph 1**: India and China share of global **BF-BOF** capacity, by stage of development. Source: (Swalec&Grigsby-Schulte, 2023)*

As countries like India ratchet up their industrialising efforts, it is paramount to spread green technologies to where the bulk of new demand will emerge. Graph 2 depicts the projected steel demand by 2050 assuming a net-zero scenario and compares it with current low-carbon steel projects. Whilst developing regions with currently below-needs capacity will account for the bulk of future demand (India, Africa, ASEAN), most green projects are in leading European countries (Hermwille et al., 2022). This significant disparity must be bridged if global emissions are to be reined in.



Graph 2*: Steel decarbonisation technology gap. Own elaboration from (Hermwille et al., 2022) & Green Steel Tracker (LeadIT)*

Shifting from coal-based production to hydrogen DRI and EAFs is also expected to alter the comparative advantages of steel manufacturing countries, benefitting those with low-cost renewable electricity (Devlin et al., 2023). This phenomenon, called by Samadi et al. the "renewable pull" (Figure 3), will pressure older steel regions in the EU and US to reduce their capacities and invest more in secondary steel production with EAFs, while favouring countries like Australia, South Africa or the MENA regions to become leading exporters of green iron (Samadi et al., 2023).

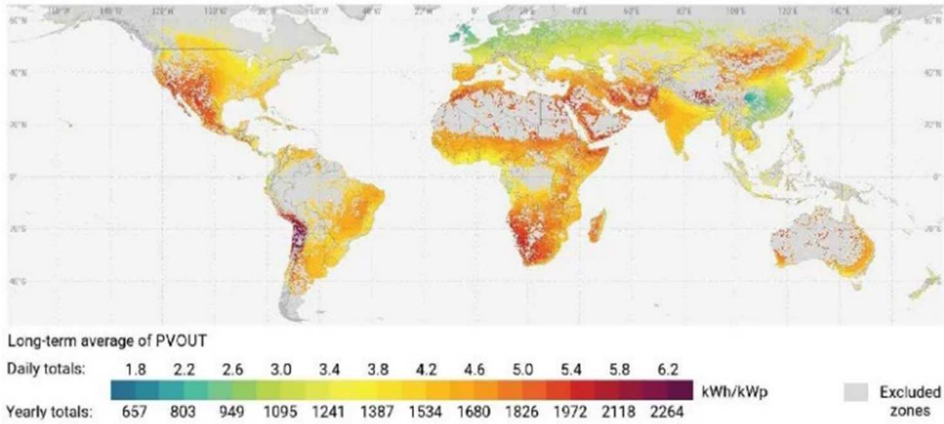


***Figure 3**: Solar potential. From (ESMAP, 2020)*

All in all, these geographical features of steel decarbonisation are likely to increase frictions between countries but, at the same time, hold incredible potential for more efficient inter-regional decarbonisation strategies, for coordinating phase-in and phase-out policies and for addressing global overcapacity (Algers&Ahman, 2024).

3.2 Thematic analysis: governance potential for a steel club

Political, supply and *demand uncertainties,* and *international inconsistencies* currently confront the decarbonisation of virgin steel. Below is shown a table with the results of the thematic analysis through which, from the sector's challenges, the policy functions of a hypothetical climate club have been catalogued. The policy interventions connected to them are hereby analysed through the lens of the theoretical framework, assessing their stickiness and their potential for entrenchment and expansion.

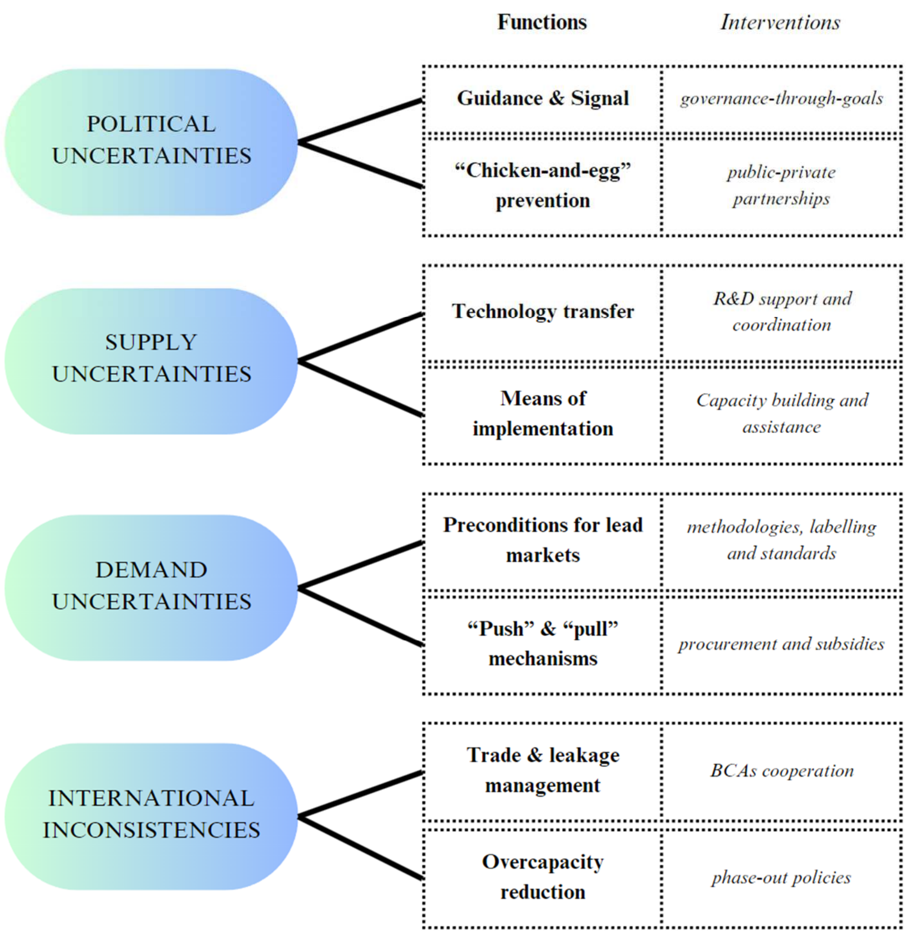


***Table 2**: schematic results of thematic analysis*

An internationally oriented sector like steel requires guidance at the international level to align stakeholder expectations with a low-carbon future and detailed roadmaps on how to achieve the paradigmatic shift. International institutions like Agenda Breakthrough or the UNFCCC-coordinated Climate Action Pathways already provide policy direction and industry-specific roadmaps, but what lacks is an authoritative decarbonisation vision (Otto&Oberthür, 2022). A clear signal from a coalition of ambitious, like-minded countries would encourage efforts in the right direction. Industry leaders would be driven to invest in capturing emerging green markets and to prevent their assets from becoming stranded due to the anticipation of stricter climate policies (Maier et al., 2024). "Governance-through-goals" therefore represents a no-lose *sticky* option which could attract and lock-in the first club members at arguably no short-term political costs (Ahman et al., 2022).

Political uncertainties stem also from a "chicken-and-egg" problem: steel producers refrain from overhauling their production systems without certain political backing, whereas policymakers tend to hesitate to set ambitious targets if industry players lack "plug-and-play" technology strategies (Hermwille, 2019). This problem is exacerbated in a sector in which industrial leaders are mostly "weak" or incremental innovators. Public-Private Partnerships (PPP) sponsored by club members could effectively resolve this problem.

Countries could even take on an entrepreneurial role and become active investors together with private innovators, sharing the risks but also the eventual profits (Mazzucato, 2015). Of the top 50 global steel producers, LeadIT estimates that only one third have publicly committed to achieve net-zero emissions by 2050 (Swalec&Morales, 2023). Just like for countries, "decarbonisation-through-goals" must become a *sticky* option also for firms.

Support for and coordination of R&D efforts are essential for successful technology transfer and adoption (Leitner et al, 2024). Indeed, decarbonising steel production is akin to a large-scale transformation experiment and, as such, is more likely to succeed if lessons from pilot and demonstration projects are shared or even directly implemented in centres of growing steel demand. A club could facilitate technology transfer while at the same time guaranteeing intellectual property rights of innovators to preserve internal competition, *entrenching* support of club members (Hermwille, 2019). In doing so, it could foster new decentralised steel value chains, "pulled" upstream by low-cost renewables and vast iron ore supplies in emerging countries and downstream in developed countries equipped with EAFs (Trollip et al., 2022). The South Africa-EU Strategic Partnership represents one example of effective technology transfer which, importantly, could be coupled with and sponsored by sectoral decarbonisation clubs (Luepke et al., 2024).

Financial assistance concern exclusively emerging economies, which will require a combination of private, blended and bilateral/multilateral financing to lower the cost of capital and achieve full commercialisation of green steel projects (Leitner et al, 2024). Otto and Oberthür (2022) report a plethora of institutions already responsible for scaling up means of implementation[3]. Notwithstanding, a decarbonisation club could offer additional benefits, for example fostering more efficient practices among participating stakeholders. This is often harder to achieve when financial and technical assistance spans multiple sectors (Agenda Breakthrough, 2023). Provided that is linked to membership, capacity building would help members enjoy "finance-readiness status" (Ahman et al., 2022: *12*) and would constitute a key carrot for non-members to join. The urgency of decarbonisation necessitates for *expanding* interventions of this sort to engage in deep cooperation beyond what would be needed under normal circumstances.

Nowadays consensus lacks for what defines "green" steel. For instance, many feel that virgin steel producers are disadvantaged to achieve green certifications since slashing emissions from primary steel production is way more burdensome, raising issues of comparability between the two production routes (Muslemani et al., 2021). Disagreements over both emission reporting methodologies and certified standards represent non-price barriers that hamper the creation of green steel markets. While complete harmonisation of current approaches may be politically unfeasible and even unnecessary, too much diversity is undesirable and could have unintended consequences – like the greenwashing already experienced by other sectors (Agenda Breakthrough, 2023; Agora, 2022). In this context, a club of like-minded countries could build on recommendations by expert

[3] Particularly relevant for steel are the Industrial Deep Decabonisation Initiative (IDDI), LeadIT and Mission Innovation

revisions (IEA, 2023b) and endorse a credible steel certification that would be difficult (*sticky*) to reverse, helped by the proactive contribution of frontrunner companies.

Credible standards for green steel set by the club would then be the basis for specifying conditions of public procurement contracts ("pull") and limited but dynamic subsidies ("push") (Muslemani et al., 2021: *7*). Although numerous institutional initiatives already promote public procurement[4], a club could effectively coordinate those efforts to send a stronger international signal (Otto&Oberthür, 2022). Moreover, facilitating dialogues on subsidies could avoid a race to the bottom and be a part of wider discussions about fair industrial policies (Ahman et al., 2022). Overall, these policy-driven lead markets for green steel would both *entrench* members' support and provide incremental benefits as the markets are *expanded* to new members, representing the other key carrot of the club.

Finally, the challenge of excess capacity continues to feed instability in the sector and contributes to increase the competitive gap between cheap carbon-intensive and expensive green steel (Leonelli, 2022). As now global steel demand stagnates due to declining demand in China, risk of overproduction is even greater (Algers&Ahman, 2024). Developed countries have already activated sanctioning mechanisms individually[5]. But given how politically risky implementing a common set of tariffs would be, a club could instead focus on discussions around phase-out policies which, albeit themselves politically difficult, must be considered alongside phase-ins to *entrench* support for low-carbon coalitions. As already mentioned, BF phase-outs need not wait until low-carbon steel reaches full commercialisation (Vogl et al., 2021). Moreover, they do not only interest countries struggling against overcapacity like China, but also Global North countries which will transfer their upstream parts to renewable-cheap locations (Algers&Ahman, 2024).

3.4 The thorniest governance function: trade and leakage management

Academic proposals for a climate club have mostly been conceived as "Nordhausian" vehicles to implement internal carbon pricing and BCAs at the border to address carbon leakage (Tagliapietra&Wolff, 2021; Vidigal, 2023). While these options may become more politically feasible in the longer term, they now face substantial hurdles.

First, the current polycentric web of carbon pricing systems, characterised by the history and politics of each country, would make their coordination quite difficult (Biedenkopf&Wettestad, 2018). A climate club is unlikely to overcome those domestic distributive conflicts (Aklin&Milderberg, 2020). Looking at Figure 4, the only plausible club with harmonised internal carbon prices could include mainly European countries, but that is hardly the solution for an internationally oriented industry like steel where major polluters are

[4] Chief examples are IDDI, SteelZero and the First Movers Coalition (FMC)
[5] For instance, "Section 232" tariffs by the US in 2018 and the steel "probe" mandated by the EU in 2023 (Kleimann, 2023)

developing economies. Second, implementing a common BCA for club members with different carbon prices would risk falling foul of WTO non-discrimination rules, which command that all external impositions must mirror domestic ones[6]. Third, and relatedly, if non-members retaliated on grounds of protectionism, the club good – avoidance of the border tariff – would no longer be there (Martini&Görlach, 2022).

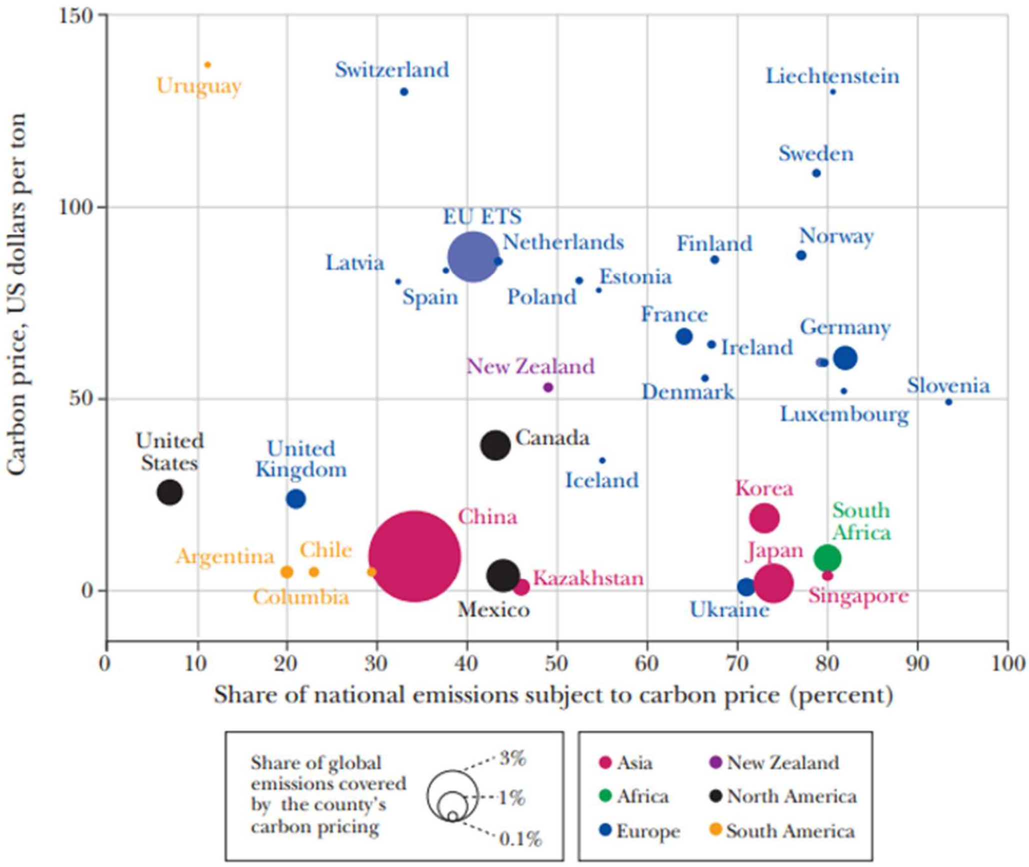


Figure 4*: carbon pricing coverage and price level, by jurisdiction. From (Clausing&Wolfram, 2023)*

A club logic could be informally activated with "deduction mechanisms." For instance, the EU CBAM deducts the carbon price already paid in the country of origin from its tariff calculations[7]. If other countries matched the EU's carbon pricing level, they would effectively join a *de facto* climate club (Szulecki et al., 2022). However, this approach is limited to carbon pricing, an explicit, monetised measure. Accounting for all implicit foreign regulatory burdens is not only complex but could risk wasting precious political capital (Agora, 2022). The steel sectoral analysis has just shown how a club only based on sticks and internal carbon pricing is unsuitable for a systemic transition which urgently require a multitude of different policies – a policy mix.

The EU CBAM is proof that enacting unilateral BCAs is naturally much easier than agreeing on common ones, and has now sparked reactions around the world, with countries like the UK, Canada and Japan with

[6] GATT Article III
[7] Article 9. https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023R0956

forthcoming BCAs of their own (Hancock, 2024). A proliferation of unilateral divergent approaches, potentially escalating trade tensions, is naturally not desirable (Mehling et al., 2024). Whilst now fraught with difficulties, the need for cooperation and the conditions it requires will nevertheless grow in the longer term. A club could facilitate discussions on comparability of policy approaches and best practices for BCAs, coexisting with independent initiatives like the EU CBAM while offering a platform to resolve trade disputes (Vangenechten&Lehne, 2022).

3.5 The ideal steel club

How would the key salient characteristics of a hypothetical club be shaped in practice? This section, mindful of the above discussions, sketches it out, recognising and addressing trade-offs where possible. In so doing, it addresses key academic debates related to clubs and, more broadly, to climate cooperation.

If the objective of the club was to advance global decarbonisation of steel, the requirements for entering could not be legally binding obligations to adopt carbon prices, because they would essentially exclude all countries which do not have the implementing capacity and those that have chosen different policy solutions. In particular, excluding *a priori* countries who weight the most on total present and future emissions and whose transitions can only be kicked off with the help of others would be unwise, and would make the club look like an unduly protectionist project. Therefore, I argue that the club should be open and inclusive in nature but with clear commitments as membership requirements. Full decarbonisation by 2050 would be the foremost priority, but pledging to certain levels of green public procurement or agreeing on phase-outs of unmitigated BFs could be included as requirements. Moreover, members' constellation will need to balance advantages of operating in smaller numbers and the need for a certain degree of legitimacy. This means that a club would start with the most ambitious "vanguards", but with a view of pulling "rearguards" along (Sabel&Victor, 2022: *159*). Finally, as discussed, membership should also be broadened to steel corporations which would actively collaborate with public authorities, for example in the form of PPPs.

Regarding the design, stable and detailed frameworks for decarbonisation of virgin steel and the development of accepted emission reporting methodologies are sticky preconditions for successive actions. Members' support would be progressively entrenched with technology transfer through R&D coordination and joint demonstration projects. Further entrenching actions, like creating green steel demand and providing technical and financial assistance would also function as carrots to expand the club. "Helping thy neighbour" policies should not be seen as competition concerns but rather as strategic actions by a catalytic institution (Hale, 2020) to incrementally build a low-carbon coalition whose size will ultimately be crucial to trigger a paradigmatic shift and entrench a new positive lock-in. Accordingly, nurturing low-carbon coalitions providing economic benefits to the few may work better than penalising the many (Meckling et al., 2015).

Nordhaus-type tariffs would also entrench members' support but, at the same time, would crucially conflict with the positive feedback logic of expansion. Their prospective avoidance would probably not be the reason for joining. Rather, they pose risks of retaliation which would essentially nullify the club good of trading freely without tariffs. BCAs might be less contentious given their alleged objective of levelling the playing-field rather than directly coercing others with tariffs (Vidigal, 2023). Nevertheless, WTO-compatible BCAs necessarily depend on internal carbon pricing, which is why they are proliferating unilaterally (EU CBAM) rather than through a club. Overall, trade-related club sticks seem therefore doomed by political unfeasibility in the short-term and, even if implemented, do not provide the comprehensive answer to industrial decarbonisation that scholars principally concerned with free-riding assume they would (Jakob, 2023).

This new era of dealing with carbon leakage ushered in by the EU CBAM, however, has illuminated the sticky options to prioritise for, in the longer term, enact innovative club policies at the intersection of climate and trade. The crucial one seems to be emission reporting, which is the basis for creating standards and, eventually, implementing trade bans for products not respecting those standards. While the EU CBAM has already compelled many steel producers to start monitoring their emissions (Hancock, 2023), a club approach would ensure a more harmonious development of reporting methodologies and lower risks of a patchwork of divergent approaches (Mehling et al., 2024).

Chapter 4: Case studies

4.1 GASSA

GASSA's origins trace back to 2018, when the Trump administration raised 25% tariffs on both products based on national security grounds (so-called Section 232 tariffs) and the EU retaliated with comparable sanctions of its own (Hall, 2024). In 2021, the two powers reconciled and retired the respective WTO disputes, while committing to negotiate a transatlantic transformative agreement to "restore market-oriented conditions and address carbon intensity" (EU-US Joint Statement, 2021: *1*). Stated core elements of the agreement were developing common methodologies to assess the embedded emissions of traded steel and aluminium and the use of trade policies to restore market-oriented conditions and encourage low-carbon intensity production (ibid.).

Agreement was supposed to be reached in October 2023, but as of today talks have been put on hold, revealing irreconcilable differences of how to proceed despite the two blocs sharing the same underlying objectives. Disagreement derived firstly from two fundamentally different starting points. One pertains to structural conditions of production: the US mostly produce steel secondarily through EAFs (69% against a 31% still produced primarily) whereas in the EU the BF-BOF primary production route is predominant (56% against a 44% of EAFs-based output), making the US, on average, the cleaner producer (Unger&Quitzow, 2024). The other relates to the respective climate policy mixes: the EU has long prioritised carbon pricing with its flagship ETS system, now coupled with the CBAM to counter leakage, whereas the US, after many failed attempts to adopt a carbon price, has passed its landmark green industrial policy, the Inflation Reduction Act (IRA), powered by fiscal and financial incentives (Mehling et al., 2024). Based on these premises, two very different positions were brought forward following the 2021 Joint Statement.

The US stance draws heavily from a paper called "the Green Steel Deal" (hereby GSD) by Tucker and Meyer, which emphasized the need for the US and the EU to have internal flexibility in their domestic decarbonisation policies due to their differing political and economic contexts (Tucker&Meyer, 2021). Externally, the GSD argued for "harvesting an early win" through the application of a common carbon tariff (ibid.: *3*). Resembling the GSD paper, the US proposal imposes domestic requirements only vaguely - "greenings steel production within 10 years" - but foresees common club tariffs expected to "ultimately supersede the EU CBAM, at least on a bilateral basis" (Kleimann, 2023: *8*). Tariffs are calculated based on the average industry intensity of countries compared to that of the US, without differentiating between production routes (ibid.). The US proposal, therefore, seems to be devised to satisfy US needs. Kleimann, among others, has strongly criticised the proposal for being designed exclusively to shield the US domestic industry which, as said, is characterised by the prevalence of less polluting EAFs (Kleimann, 2023). Criticism has also been addressed to the tariffs' calculation method which takes into account only country averages without distinguishing cleaner from more polluting producers, thereby failing to create any incentive to individual firms to decarbonise (Leonelli, 2022).

The EU has instead placed more emphasis on operationalising joint ambition for industrial decarbonisation, foreseeing intermediate targets by 2030 and 2040 detailed with roadmaps, and vouched for technology-specific methodologies to calculate average production emissions (Rimini et al., 2023). Moreover, the EU proposal insists on coordinating product-based BCAs instead of using nation-based tariffs, in line with the path undertaken with the EU CBAM (ibid.). While BCAs function more as equalising measures than straightforward penalty tariffs, and at least retain the possibility of being compatible with WTO law if thoroughly designed, the EU seems here to ignore the fact that implementing a BCA would imply having domestic carbon prices. Playing by the EU terms would therefore arguably leave the US with no leakage prevention measure. Table 3 summarises the two conflicting club ideas.

US	**EU**
Structural preconditions	
Prevalence of secondary EAF-based steel	Prevalence of primary BF-BOF-based steel
Fiscal-powered regulatory policies (IRA)	Carbon pricing (EU ETS)
Conflicts of interest	
Tariffs as main club instrument	No tariffs but BCAs (in line with EU CBAM)
Internal flexibility for decarbonisation policies	Flexibility but implicit pressure on implementing carbon prices
Vague domestic requirements	Interim targets and roadmaps
Technology-neutral standards	Technology-specific standards

Table 3*: GASSA's negotiation conflicts. Source: author*

From these findings, it seems clear how both the U.S. and the EU are unlikely to easily abandon their chosen approach, given deep-rooted entrenched preferences for the respective climate policies. The precipitated GASSA negotiations also reveal the difficulties of any club arrangement focused predominantly on trade sticks, especially if modelled as punitive tariffs like the US proposal. But scholars agree that GASSA's destiny is not doomed, and glimpses of hope lies in those pragmatic stickier action already being taken (Unger&Quitzow, 2024). Many argue, for example, that the growing knowledge of steel emission intensity, if combined with a shared installation-based approach, could eventually assist, through a *sequencing* logic, the introduction of Product Content Requirements (PCRs) – product-based maximum emission standards based on best available technologies (Marcu et al., 2023; Leonelli, 2022). PCRs could represent a new transparent and non-discriminatory way of addressing trade issues like carbon leakage and could also accommodate different domestic mitigation approaches and industrial structures.

Yet, the GASSA might still not represent the best available fora to agree on sticky priorities like product standards. Its underlying objectives to "restrict market access for non-participants that do not meet conditions of market orientation [and] standards for low-carbon intensity" denote an exclusive membership, with an implicit reference to Chinese carbon-intensive excess capacity (Joint Statement, 2021: *1*). Given that three-quarters of global steel production is already in Asia and the Global South, focusing solely on traditional allies is risky (Unger&Quitzow, 2024). An effective decarbonisation club more inclusive in nature will have to integrate emerging economies to truly foster that *expanding* logic capable of engendering new positive path-dependencies in the steel sector globally.

4.2 G7 Climate Club

The idea of a climate club based on the Nordhaus model was originally floated by the German finance ministry in 2021 (Federal Ministry of Finance, 2021). While purporting to tackle a list of different policy priorities (like standards, public procurement and green hydrogen), the proposal stressed the centrality of a uniform minimum carbon price and a common BCA to address the leakage problem, essentially mirroring the EU stance on climate mitigation (ibid.). Accordingly, for years harmonisation of carbon prices figured prominently in the German narrative on clubs (Kumar et al., 2022). However, the plan struggled to garner political resonance in the G7 because the economic club approach conflicted with the national mitigation strategies of member countries, as previously analysed for the EU and the US.

Recognising the political unfeasibility of the Nordhaus approach was pivotal. A top-down harmonisation of carbon prices would have clashed with the regulatory approach of the US and, consequently, that impossibility would have precluded the implementation of a common BCA. In parallel, exemptions from the EU CBAM for members of the club would not have been permissible under WTO law, undermining the EU willingness to play by international rules. This unfeasibility in practice proves how overambitious club proposals are erroneous in disregarding the domestic political economic contexts. For instance, the EU CBAM was born out of intensive lobbying from industry and climate groups (Wettestad, 2023), and was crafted not as a template to address the decarbonisation of heavy industry but as a targeted domestic measure to protect the effectiveness of the EU's carbon pricing system (Baron&Lee, 2021). Establishing it as foundation for a climate club would fail to account for the diversity of club members and would overlook the complexity of decarbonisation challenges.

The Climate Club was then announced in December 2022, and from its Terms of References it was presented as an "open, cooperative and inclusive Climate Club" with particular focus on "unlocking potential for the decarbonisation of hard-to-abate industrial sectors" (G7, 2022: *1*). Membership requirements were extended to countries "committed to the full implementation

of the Paris Agreement" willing to "accelerate actions to this end" (ibid.: *3*). Three pillars were listed: "advancing ambitious and transparent mitigation policies", "transforming industries" through development of standards and promotion of green industrial markets, and "boosting international climate cooperation and partnerships" with the aim of developing a matchmaking platform between funders and recipients focused on enabling the conditions for industry decarbonisation projects (ibid.: *1-3*).

Based on what agreed on these pillars, not only have signatories of the Club broadened the focus beyond the central concerns of leakage, binding requirements and club sticks, but they also seem to have recognised which are the policy priorities for industrial decarbonisation based on what is politically possible. Accordingly, most elements correspond to the design features of the hypothetical club for steel devised in Chapter 3. For instance, focusing on methodologies and standards are, in the case of steel, the most probable "quick wins" (Kumar et al., 2023). Moreover, strategic coordination of demand-side policies and improved conditions for technical and financial assisting programs respond to an *expanding* logic (non-members are attracted to the potential gains) which also *entrench* members' support (members benefit from larger green markets and more efficient funding).

All the while, leakage has not been overlooked by the Club's initiators. Pillar one specifies "working towards a common understanding [of mitigation policies] through comparative analysis of the effectiveness of such policies, including price-based and non-priced-based mitigation instruments" (G7, 2022: *1-2*). In the document describing in more detail the Programmatic Work, among the objectives is included the assessing of "the causes and relevance of leakage and other such risks such as possibility of fragmentation of climate action, as well as on experiences and strategies to mitigate and avoid such risks and identifying possible ways to cooperate in this regard" (Climate Club, 2023: *9*). Crucially, instead of the requirement to impose a common BCA to prevent competitive losses for members, the focus is on discussing best practices to enable, at least, potential coordination of inevitably unilateral BCAs. The G7 Climate Club, therefore, appears to have shifted away from punitive measures, positioning itself as a discussion forum complementary to the EU CBAM while concentrating on more enduring actions that could gradually lead to a more coordinated approach to counter leakage.

Officially launched at COP28 in 2023, the G7 Climate Club now comprises of 42 members[8], including many developing countries which do not yet produce steel, but which could hasten their economic development exporting hydrogen or green iron to developed countries. The club could thus be particularly helpful for reducing trade barriers for green materials (Jakob et al., 2022) while also scaling up and coordinating initiatives like the G7 Just Transition Partnerships, which have already supported countries such as South Africa, Indonesia, and Vietnam (Barbier, 2023). The development of these new steel value chains would be mutually beneficial for countries in the Global North and South, constituting another quick win. Membership could still be widened especially to India, the elephant in the room of the group of next future big steel producers (see Graphs 1-2) which could benefit enormously from international cooperation.

Nonetheless, an excessive large number of countries in the club could disproportionately increase internal transaction costs and lead to suboptimal outcomes, trading input legitimacy with effectiveness (Falkner, 2016; Victor, 2016). Recognising this trade-off is particularly important for a cross-sectoral club of which steel represents only one pilot sector. To this end, Kumar et al. (2023) suggests that, within the Climate Club, a sub-

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[8] https://climate-club.org/

set of ambitious countries would be better positioned to make more binding commitments, like national steel decarbonisation pledges to be included in the respective NDCs. A differentiation of membership tiers and commitments has also been highlighted to be a first step to weave the principle of CBDR into the club architecture (Hall, 2024).

Conclusions

As argued throughout this dissertation, the logics through which decarbonisation occurs are a far cry from simply reducing emissions through gradual efficiency gains. A climate club that treats solutions for free-riding and carbon leakage as panaceas risks misdiagnosing the roots of the climate change problem, which is, at its core, not one of collective action but more one of carbon-intensive path-dependencies. The case of steel testifies how switching to low-emission production methods requires overcoming a series of technological, economic and political uncertainties through a mix of different policies.

How could steel decarbonisation be advanced by a club? This dissertation has shown that by focusing on sticky, entrenching, and expanding policy interventions, a club can successfully prioritise avenues for cooperation with the potential to be incrementally transformative. For instance, signalling clear political commitments and agreeing on what green steel is represent sticky interventions virtually free of charge. Entrenching measures, like coordinated green public procurement and financial assistance for emerging economies, can build long-term support of club members but can also function as carrots to entice others to join, whose potential for becoming future green iron exporters should not be underestimated. Expanding the coalition of low-carbon producers is also pivotal to spread green technologies to countries in which demand for steel will increase the most. The G7 Climate Club, originally conceived as a club *a' la Nordhaus*, has recognised the importance of prioritising these actions and, after one year from its official launch, is already showing promising potential to help fostering a truly global steel transition.

Conversely, the dissertation has also highlighted the importance of moving beyond punitive measures which could alienate potential members and provoke retaliatory actions that undermine global cooperation. Moreover, implementing trade sticks such as club tariffs or a common BCA as main design instruments might prove politically unfeasible in light of different political-economic contexts. The case of the GASSA has unveiled these dynamics in practice, with negotiations between the two sides of the Atlantic now having reached an impasse due to conflicting political interests. The case study has also shown how resolving domestic distributive conflicts, for example in relation to the adoption of carbon pricing in the US, falls beyond the capacity of a club.

Meanwhile, international inconsistencies like excess capacity and carbon leakage, which constitute important obstacles to the sector's transition, are not currently being ignored, but are rather being dealt with unilaterally, as in the case of the EU CBAM. In this regard, it has been argued that a club could still play a "softer" role than what originally thought, providing a discussion platform for avoiding a conflictive fragmentation of different approaches. Moreover, harmonising methodologies for emission reporting has emerged as a critical sticky priority to, over time, implementing more innovative solutions at the nexus of trade and climate. Through a sequencing logic, the growing knowledge of emission measurements is now informing standards for multiple green steel products which, then, could become trade bans in the form of Product Content

Requirements (PCRs). Jointly implementing PCRs as a club could benefit immensely green trade and leakage management, potentially serving as the first feasible stick of a transformational club.

In conclusion, this dissertation contributes to the growing body of literature on innovative climate governance by having illustrated the potential of a sector-specific climate club as catalyst for deep decarbonisation. While academic efforts must continue to navigate the political complexities at the intersection of climate, trade and industrial policies, the findings underscore that, with the appropriate design and membership requirements, climate clubs can be powerful instruments for change. As the world continues to grapple with the urgent need to decarbonise heavy industries, the lessons from this research highlight the value of collaborative and targeted approaches to climate cooperation. The future of steel decarbonisation, and indeed broader climate action, may well depend on the continued evolution and refinement of these innovative governance models.

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