# Enforcing cooperation using issue linkage:

# Theory from the intersection of climate change and trade

Sam S. Rowan*

This version: May 26, 2022

## Abstract

Many proposals advocate linking climate and trade policy to improve climate cooperation. Since climate mitigation is non-excludable, mitigation cannot be enforced through issue-specific reciprocity, but linking mitigation with trade penalties on non-participants could incorporate trade's reciprocity into an enforceable climate club. However, this perspective has overlooked the relationship between climate policy preferences and existing trade flows. Using a model of issue linkage in climate and trade informed by domestic political economy, I show that an effective climate-trade club requires members with high levels of climate policy ambition, export leverage over laggards, and insulation from trade retaliation. I illustrate that these three attributes do not necessarily co-occur empirically. States that support the club's goals on one dimension may undermine them on another. The findings provide insights into institutional design, climate politics, and the constraints on issue linkage in international cooperation.

**Keywords** international cooperation; institutional design; reciprocity; climate change; international trade; climate tariffs; carbon border adjustments; sanctions;

---

[*] Assistant Professor, Department of Political Science, Concordia University, sam.rowan@concordia.ca

# 1. Introduction

How to enforce cooperation between states is one of the most important topics in global politics. States may defect from agreements because the international system lacks an overarching mechanism to enforce agreements. Nonetheless, sometimes states do manage to govern effectively. One of the key mechanisms that enables cooperation is direct reciprocity, where states reciprocally reform their policies on the same issue and maintain these reforms so long as their counterparts do as well. Given a set of complementary conditions—such as, low transaction costs and a long shadow of the future—reciprocity can enforce cooperation and improve welfare. Direct reciprocity works because if a state were to violate an agreement, its counterpart could subsequently withdraw its own policy concessions, which would nullify any advantages the violator gained from defection (Keohane 1986). International trade is the archetypal example of direct reciprocity, where parties agree to reciprocally reduce barriers to each other's trade, but maintain the ability to raise them on partners who renege.

However, many issues in global politics cannot be enforced through direct reciprocity. In a human rights treaty banning torture parties accept an international legal obligation prohibiting torture. Yet, if one party were to torture its citizens, it is unlikely that the other parties would be able to induce the violator to comply with its treaty obligations by threatening to torture their own citizens. Direct issue-specific reciprocity is not appropriate here (Mitchell and Keilbach 2001; Hafner-Burton 2005).

But because reciprocity can be a powerful enforcement mechanism, states may attempt to bundle an issue that cannot be enforced through direct reciprocity with one that can be (Sebenius 1983; Poast 2012; McKibben 2016). By expanding the scope of an agreement beyond a non-reciprocal issue to include a reciprocal one, states can incorporate the enforcement powers of the latter into the former (Koremenos et al. 2001; Jinnah 2011). Though there is a strong theoretical rationale for linking issues, issue linkage seems under-utilized or weak in practice.

In this paper, I argue that issue linkage depends on how states' interests and leverage manifest across the reciprocal and non-reciprocal issue. I consider trade as an illustrative reciprocal issue. One important reason why issue linkage with trade fails is that existing trade flows may be misaligned to leverage greater cooperation on these non-reciprocal issues. Issue linkage can only improve cooperative outcomes if the new institution can uphold strong internal policy obligations for members and wield a credible trade penalty over non-participants. But when states that support strong collective action on the non-reciprocal issue have weak leverage over the exports of states that do not support collective action—or worse, when they are themselves highly dependent on export markets in the latter states—they cannot link issues productively.

Linking international trade to climate change mitigation in a climate club exemplifies this challenge. Consider the case where states have preferences for stronger or weaker climate action but hesitate to decarbonize unless their peers do so as well. Mitigation cannot be enforced through direct reciprocity because mitigation is a non-excludable good, which non-participants can enjoy by definition. If a state attempts to reciprocate a counterpart's defection by withholding its own mitigation, these punishments cannot be targeted to affect only the defector and will also harm counterparts in good standing. However, linking climate change to trade brings trade's reciprocal enforcement powers into climate mitigation, and gives teeth to a climate agreement (Nordhaus 2015; Hovi et al. 2019). A climate club with common mitigation obligations could raise trade penalties on states that refuse to mitigate. By using trade penalties to offset gains from free riding, the climate club creates new incentives to mitigate. An extensive literature analyzes climate clubs with different configurations of membership and incentive structures (Victor 2011; Eckersley 2012; Nordhaus 2015; Falkner 2016; Hovi et al. 2016; Green 2017; Hovi et al. 2019; Colgan 2021; Rowan 2021).

However, the effectiveness of a climate club depends on states' preferences for climate action and the actual pattern of trade flows across states. Strong climate clubs must have core club members that (1) are ambitiously committed to decarbonization, (2) have leverage as key export markets for climate laggards, and (3) export mostly to other climate leaders, thereby insulating the club from retaliatory pressure. The club needs to uphold strong internal climate policy obligations to reduce emissions. At the same time, the club needs to have trade leverage over climate laggards to enact meaningful penalties that induce them to mitigate. Trade penalties require asymmetric trade flows. The climate club's core members need to be important export markets for non-members, so that trade penalties have teeth. And finally, the climate club's core members need to be insulated from retaliation by exporting mostly to each other, such that they are not dependent on export markets in non-members. The club's trade penalties help protect their domestic industries from unregulated foreign firms (Genovese 2019), but non-club countries may retaliate and restrict their markets to exports from the club (Kim and Margalit 2021). Domestic industries in club countries, therefore, pull their governments in both directions—to protect them from foreign competition through carbon tariffs and to keep export markets open without retaliatory tariffs. If the climate club is not insulated from tariff retaliation because club members export mostly to non-club states, then the club will not be able to uphold a strong external trade penalty.

Issue linkage in climate and trade depends on the interaction of willingness to act on climate and willingness to sanction on trade. However, climate and trade preferences can be misaligned. A climate club must uphold high climate policy standards and trade penalties that shift recalcitrant states to join. But in setting policy across two dimensions, negotiators must satisfy states' constraints along both climate and trade. The states that prefer the most stringent climate action do not necessarily have the trade leverage over climate laggards and may in fact be dependent on those markets. Similarly, states with well-aligned trade flows may not support strong climate policy. In selecting the core membership of a climate–trade club, institutional designers face tradeoffs along each dimension. That interests within climate and trade can be misaligned may help explain why, despite myriad calls for climate clubs over the past decade, no formal club has been established.

I develop this argument with a model of membership in a linked climate and trade club. Following recent work emphasizing preference heterogeneity in climate politics (Genovese 2019; Aklin and Mildenberger 2020; Colgan et al. 2021; Rowan 2021), I build a model where state preferences over the depth of climate action vary. Then I add a trade dimension characterized by each state's dyadic trade relationships. I conceptualize a climate club as an exogenous common climate policy standard that members must uphold, akin to a carbon price. States whose pre-existing climate preferences exceed that standard join, and then set the club's common external trade penalty. States bring their pre-existing trade relationships with them into the club, which end up capping the level of the trade penalty that the club can adopt.

I consider three types of relationships between climate and trade preferences. First, states' climate preferences can be *unrelated to* (or, independent of) their trade export flows. This is the textbook issue linkage scenario (Sebenius 1983), and here I show that linking climate to trade can induce some states with moderate climate preferences to join and pursue emissions reductions. Second, climate preferences can be *positively related* to trade exposure, such that states with moderate climate preferences export heavily to states with high support for climate action. In this best case scenario, the climate and trade dimensions reinforce each other, and induce an even greater number of states to join. However, in a third scenario, if states' climate preferences are *negatively related* to export flows into climate club, then the club has very weak leverage over climate moderates and linking climate to trade will not increase participation. This climate–trade club cannot uphold strong trade penalties because core club members are dependent on export markets outside the club and therefore fear tariff retaliation.

I apply the insights from this model to consider three hypothetical climate–trade clubs, as well as sectoral climate clubs and the European Union's 2021 carbon border adjustment mechanism. Emphasizing either of the club's internal climate policy depth or its external trade penalty depth suggests different climate club ideal types. First, a climate–trade club could select core members on the basis of their strong climate policy preferences, and then see how these states' trade relationships could induce other, less ambitious, states to join the climate club. Second, a climate–trade club could select core members to maximize the club's leverage over low ambition countries, and then see whether these core states' climate preferences could support sufficient internal climate policy depth to drive decarbonization. Finally, it could select on insulation, where members trade mostly with each other. To assess the effectiveness of a climate club that imposes trade penalties on non-members, it is paramount to understand the patterns of imports and exports across states, and how these covary with climate preferences.

Given this, the European Union resembles a most likely case for linking climate to trade. EU states export mostly to each other, but EU states are major export destinations for third parties. This insulates EU states from retaliatory trade pressure, and provides leverage over non-members. While EU states' climate policies are not necessarily the most ambitious globally, compliance with existing policies has been costly enough to lead domestic industries to lobby for protection from competition with unregulated foreign firms. As a response in July 2021, the European Commission proposed a set of tariffs in five energy-intensive trade-exposed sectors to equalize climate policy costs across jurisdictions. I analyze the relationship between trade leverage and insulation within each of these sectors compared to other high carbon sectors and other randomly selected sectors. I find that the EU extends trade protection in keeping with the opportunities and constraints that leverage and insulation provide.

This paper contributes to a growing literature on the relationship between climate change and international trade (Harrison 2015; Aklin 2016; Morin and Jinnah 2018; Genovese 2019; Mehling et al. 2019; Colgan 2021). I study a model of climate club formation with trade penalties (Nordhaus 2015) and heterogeneous preferences (Hovi et al. 2019). The model integrates ideas about domestic trade protection (Genovese 2019), tariff retaliation (Kim and Margalit 2021), and enforcement (Nordhaus 2015). My argument helps to account for the weakness, or "untapped potential" (Morin and Jinnah 2018), of existing environment and trade linkages by highlighting the constraints from institutional design and domestic political economy. This paper also addresses debates in international cooperation around issue linkage and enforcement (Sebenius 1983; Hafner-Burton 2005; Poast 2012; McKibben 2016). I build on insights from longstanding debates over interdependence to consider how pre-existing asymmetric relationships between states in one issue-area can be used to achieve foreign policy ends in others, particularly when direct reciprocity is challenging (Keohane and Nye 1977; Farrell and Newman 2019). I suggest that the relationship between states' preferences on a reciprocal issue and a non-reciprocal issue conditions whether linkage enables or collapses cooperation, and offer a theoretical model for exploring these dynamics in other issue-areas. Importantly, this holds for the economy as a whole and within economic sectors.

## 2. CLIMATE AND TRADE CLUBS

Climate change mitigation is characterized by some of the most important and difficult cooperation problems in global politics. Many observers have noted that the public goods characteristics of mitigation create an incentive for states to free ride on the contributions of others (Barrett 2003; Keohane and Victor 2016). Scholars are also increasingly sensitive to the intense preference heterogeneity in climate politics that creates distributional conflict across states (Genovese 2019; Aklin and Mildenberger 2020; Colgan et al. 2021; Rowan 2021). Coordinating mitigation multilaterally, among a large number of states, aggravates these problems (Hovi and Sprinz 2006; Victor 2011). The existing UN climate treaties only partially address these issues, if they do so at all (Depledge 2006). As a result, climate governance is often considered ineffective and scholars have advocated for institutional reforms (Hale et al. 2013).

Perhaps the most prominent alternative design for achieving greenhouse gas emissions reductions is the climate club (Victor 2011; Eckersley 2012; Nordhaus 2015; Falkner 2016; Hovi et al. 2016; Green 2017; Hovi et al. 2019; Colgan 2021; Rowan 2021). While proposals vary, the climate club's core idea is to jumpstart mitigation in a small group of states. Networking minilaterally could facilitate negotiations by reducing their dimensionality, fostering small group dynamics that encourage deliberation, and narrowing the range of interests represented. Some proposals go further and advocate new kinds of issue linkage that could build greater reciprocity into climate politics. The key here is that doing so in a club framework would create excludable private benefits for club members that act as select incentives to contribute to the non-excludable public benefits of mitigation. Linking climate mitigation to international trade—either further trade liberalization among club members or new trade penalties applied to non-club members—forms the basis of many climate club proposals. Club proposals have been critiqued in terms of their consistency with key norms of the UN-led climate process (Eckersley 2012) and their possibility of fragmenting climate governance (Biermann et al. 2009), but most commentators are optimistic about their mitigation effectiveness.

William Nordhaus' work is a particularly clear example of this climate club proposal, and I build my discussion from this (Nordhaus 2015; Nordhaus 2020). There are two primary features of his club design: (1) a common climate policy target, and (2) a trade penalty applied to non-participants. Conceptually, the key task is selecting the level of each that maximizes total emissions reductions.

First, climate club members coordinate to enact a harmonized policy target. For Nordhaus, club members target a single minimum carbon price, though a club could target another policy objective, such as an emissions reduction or a spending goal. The club faces a broader–deeper tradeoff in selecting this policy level: because states have different levels of support for climate action, fewer states will be willing to join as the common policy targets become more demanding (Downs et al. 1998; Gilligan 2004; Hovi and Sprinz 2006; Thompson and Verdier 2014). Public goods models often assume that states have the same preferences because the classic under-provision result arises even with this seemingly benign simplifying assumption. Previous research has shown that preference heterogeneity can ameliorate public goods provision (Snidal 1985), and this perspective is increasingly present in climate research (Milkoreit 2019; Hale 2020). The club design works with this preference heterogeneity. It structures cooperation around the most ambitious states, and in doing so, its proponents argue, can build a climate regime with deeper policy targets than could be agreed to at the universal membership UN climate negotiations which proceed by consensus and must appease the global lowest common denominator (Hovi and Sprinz

2006). The harmonized target could be adjusted by development levels to accord with the UN climate treaties' norm of common by differentiated responsibilities and respective capabilities. Of course, the climate club achieves this policy depth at the expense of its breadth of membership, leaving the overall effect on emissions ambiguous.

Furthermore, because governments have already begun regulating climate change domestically with a mix of targets, prices, standards and other regulation that are difficult to evaluate on a common metric (Cullenward and Victor 2021), the climate club faces second-order bargaining challenges over allocating the costs of adjustment to a common policy standard. It is beyond the scope of this paper to address how different varieties of climate policy interact with the club design, but regulatory divergence between the United States and the European Union has been a stumbling block in climate negotiations historically and in the present (Colgan 2021).

Second, the climate club imposes a trade penalty on countries that do not participate. The trade penalty changes the cost-benefit calculation of enacting strong climate policy, by raising the costs of inaction. It also works to equalize regulatory stringency across jurisdictions, and thereby protect domestic industries from unregulated competition. Nordhaus' design raises a simple uniform tariff on all imports from non-club members—and on club members who fail to comply with their membership obligations. The import tariff penalty could, instead, be adjusted to match the carbon intensity of particular countries, sectors, or goods—and some research suggests that targeted tariff rates might be more consistent with existing trade law (Mehling et al. 2019)—but calculating product-level rates raises many non-trivial accounting choices and data limitations, so I set this aside.

Domestic polluters have frequently opposed climate policy over concerns about international competitiveness and leakage (Genovese 2019). If domestic industries are regulated to a higher (i.e., costlier) standard than foreign firms, then these unregulated foreign firms may outcompete regulated ones or firms may simply relocate to pollution havens, nullifying the effect of domestic climate regulation (Aklin 2016). The climate club's trade penalty levels the playing field between regulated domestic firms and unregulated foreign ones by extra-territorializing climate regulation. It imposes new costs for non-participation that outweigh the benefits of free riding and makes the agreement "binding" in cost-benefit terms. The trade penalty can help build domestic support for decarbonization in political contexts where climate policy is not sustainable without protection for domestic interest groups.

## 3. Aligning ambition, leverage and insulation

The previous section presents a strong rationale for linking climate and trade to improve climate mitigation. However, linking climate with trade does not inherently introduce a credible external enforcement device into climate politics. Instead, this issue linkage interweaves states' climate preferences with their pre-existing trade relationships. This trade dimension can be characterized by each state's trade, or more specifically export, flows to club and non-club members. Linking climate politics to trade politics makes the climate club negotiations multidimensional because now negotiators need to accommodate states' participation constraints along both climate and trade. I argue that the actual pattern of trade flows between countries can either amplify or dampen climate cooperation depending on how they intersect with states' support for climate action.

The design of any institution must reflect members' preferences and their policy constraints. In a linked climate–trade club, negotiators consider these constraints along both climate and trade dimensions. Along the climate dimension, setting more ambitious policy targets may herald quicker emissions reductions, but more demanding targets may be too costly and price some states out of the club, thereby limiting the club's effectiveness. The climate constraint resembles the broader–deeper tradeoff, where choosing more demanding climate policy targets will shrink the number of states willing to accept them (Downs et al. 1998).

The trade penalty is intended to correct for this tradeoff. A higher trade penalty should induce more recalcitrant states to join the club and mitigate rather than remain outside. However, club members may struggle to raise a high trade penalty. The club must set the trade penalty at a level that satisfies the participation constraint of the most constrained state. This trade participation constraint depends on states' pre-existing trade relationships, and reflects the share of goods that a member exports to other club members relative to non-club members. Existing models of climate clubs tend to assume that trade penalties (or opportunities) affect all states equally (Hovi et al. 2019), but trade relationships vary across states. Some members will have much greater exports outside the club than others. Non-club countries may even be more important export destinations than other club members. As core club members negotiate their common external trade penalty, export-exposed core club members will push for weaker trade penalties because they fear non-members will retaliate with reciprocal tariffs.

The dominant perspective in international political economy of climate change argues that trade adjustments are necessary to protect regulated domestic industries from more competitive unregulated foreign firms (Genovese 2019). I argue that a retaliatory trade policy dynamic binds as well (Kim and Margalit 2021): raising tariffs on non-participating countries will create new costs for domestic exporters when foreign countries retaliate for climate tariffs. Retaliatory tariffs will be particularly costly for climate tariff-sending countries that export heavily to countries targeted by climate tariffs. Enacting high trade penalties may not be credible if they make the enforcing countries worse off (Thompson 2009). Existing export relationships, therefore, place an upper limit on the level of the trade penalty that the climate–trade club can adopt. The rise of global value chains should further constrain tariff levels, since tariffs raise costs for domestic firms sourcing foreign goods for export (Bown et al. 2021). Insisting on a high tariff may preclude even climate leaders from participating if climate laggards are important export markets. At the same time, accepting the tariff constraint of the most export-exposed club member may not provide enough of a penalty to induce laggards to participate. Tariff retaliation constrains the club's ability to raise adequate trade protection for domestic industries, and in doing so, undercuts the original rationale for issue linkage. The domestic distributive politics of climate change and trade cut both ways—leading interest groups to seek protection and to minimize retaliation.

Domestic governments are cross-pressured in the climate–trade club. From the climate side, they face pressure to enact strong policy. On the trade side, import-competing industries lobby for protection via offsetting climate tariffs. At the same time, exporting industries lobby for low tariffs to prevent a retaliatory trade war that constricts access to foreign markets. Governments may struggle to find the right balance between these competing interest groups. Domestic political institutions that structure interest group access to policymaking will inform which sets of interests win out.

Here, we can see how the exact membership of a climate club matters for its ability to uphold stringent climate policy obligations and enforce trade penalties on non-members. Distinguishing between climate policy depth and trade penalty depth implies that states that would be valuable club members based on one dimension may be impediments along the other. Some countries may support strong climate action, but have no leverage because they are not important export markets for climate laggards. Worse yet, they may be dependent on exports to climate laggards. Other countries may be the reverse. They may be crucial export markets for climate laggards, giving them high leverage, but they may also have relatively low support for climate action themselves, which will weaken the level of common climate policy that the club can uphold.

Taken together, the strongest climate–trade club will be one where core club members support strong climate policy, have strong leverage over the exports on non-club members, and export mostly to each other. These attributes may be in tension. Linking climate to trade can only improve cooperative outcomes if the club can actually uphold strong climate standards and credibly threaten large trade penalties. If climate ambition, trade leverage, and trade insulation are misaligned, then a climate–trade club will struggle to induce greater climate action from laggards. These considerations suggest opposing principles for selecting core members of a climate–trade club: either selecting (1) on the basis of climate ambition, (2) on leverage over laggards' exports, or (3) on insulation from trade retaliation.

## 4. Designing for climate and trade

### 4.1. Modelling membership in a climate–trade club

Here, I focus on states' preferences over the level of climate policy coordination in a climate club, as well as their preferences over trade with members of that climate institution. Begin by assuming that states $i \in \{1, \ldots, I\}$ have preferences over internationally-coordinated climate mitigation that are uniformly distributed $x_i \in (0, 1)$.[1] Higher values of $x_i$ indicate that a country prefers to coordinate at more stringent mitigation. To fix ideas, this dimension could correspond to the level of a carbon

---

[1] I set the number of states $I = 150$ in this exercise; the number of states ends up mattering because preferences are sampled from a distribution and larger samples (e.g., $I = 500$) will eventually find the most extreme values that challenge the specification of the model in ways that are not relevant to climate policy.

price that a country is willing to adopt in an international climate agreement, with higher values of $x_i$ indicating that a country prefers a higher carbon price. Most traditional models of climate policy do not assume that states have different levels of support for climate action (Barrett 2003; Nordhaus 2015), but some increasingly do (Hovi et al. 2019; Hale 2020). Consider $x_i$ to reflect the dynamics of domestic climate policy battles between winners and losers from climate policy, informed by a country's vulnerability to climate impacts, its dependence on fossil fuels, access to clean electricity, and other relevant inputs. The particular source of a country's climate preferences are unimportant for this exercise, but the fact that they vary across countries is crucial. I also set aside preferences over the choice of policy instrument—such as, whether to price or directly regulate carbon.

Next, states begin creating a new climate club $j$, where members must set their climate policies equal to or greater than $\theta_j \in (0, 1)$. This could be conceptualized as that minimum carbon price that all members of the climate club must adopt. Instead of bargaining over the climate target, I assume it is exogenous. For example, an exogenous climate target could arise as a proposal from an existing international organization, such as the carbon price floor that has been proposed in recent International Monetary Fund working papers (Parry et al. 2021), or it could reflect the state of existing science about the necessary carbon price to reach temperature goals written into existing treaties (Hänsel et al. 2020). Taking this climate dimension on its own, states' utility for coordinating climate policy at this level is given by a standard spatial loss function $U_i(\theta_j) = -|x_i - \theta_j|$. To clarify the exposition, I refer to states with $x_i \geq \theta_j$ as the "core club members", who will decide on the trade penalty that follows.

Trade flows are the climate club's other dimension. States' trade preferences reflect their share of exports into the climate club. Let states' trade preferences $y_i \in (0, 1)$ summarize this export exposure to core club members, where higher values of $y_i$ indicate that a country exports more to core club countries. Begin by assuming that trade flows are independent of climate preferences. Draw $y_i$ from a truncated normal distribution independent of climate preferences $y_i^{\perp} \sim N(0.5, \sigma^2, 0, 1)$, where $^{\perp}$ denotes that trade and climate preferences are independent. States with higher values of $y_i$ export more to core club members and the trade penalty will affect these states the most, as explained below.

The climate club sets a trade penalty $\lambda_j \in (0, 1)$ to apply to non-members (and members out of compliance). Trade penalties are intended to worsen non-members' terms of trade, decreasing their utility from non-participation, and increasing their incentives to join the climate club and set their climate policy equal to $\theta_j$. Domestic interest groups demand protection from uneven cross-national regulatory pressure when climate policy is tightened in home markets. The trade penalty acts as this protection, and could be conceptualized as a percentage tariff applied to imports from non-members that reduces the value of trade. Contra Nordhaus (2015), I assume non-club members will contest the climate club's trade restrictions as unfair trade discrimination and raise offsetting retaliatory tariffs. Upholding tariffs against non-participating countries requires club members to forego some benefits from trade with those countries and domestic exporters lobby for lower tariffs. Core club members will be unevenly exposed to these other states through their pre-existing trade flows. Very high trade penalties will lead some core club members to exit the club, as the trade obligations are too onerous. Ultimately, the climate club must set $\lambda_j$ to accommodate the export exposure $y_i$ of the club member with the lowest intra-club exports, or equivalently the highest extra-club exports. Since $y_i$ summarizes exports into the club, this is the lowest value of $y_i$ for states with $x_i \geq \theta_j$: $\lambda_j = \min(y_i | x_i \geq \theta_j)$. Domestic governments straddle the competing domestic political demands of protecting domestic firms from carbon leakage while also preserving access to differentially-valuable export markets, potentially in countries with weak support for climate action. If the trade penalty falls relative to the climate policy target, then domestic industries are only weakly protected from regulatory divergence, and club members will be averse to large discrepancies between these two targets.

States' utility from membership in the climate club is then a function of a climate term relating a state's climate ideal point $x_i$ to the club's climate target $\theta_j$; two trade terms that reflect their trade flows into the club $y_i$ and out of the club $1 - y_i$, re-weighted by the trade penalty $\lambda_j$; and, for members, an aversion to large discrepancies between the climate policy target and the trade penalty applied to non-members. Let states' utility from membership in the climate club be given by the following:[2]

$$U_i(\text{Join}|\theta_j, \lambda_j) = -|x_i - \theta_j| + y_i\beta + (1 - y_i)(1 - \lambda_j)\beta - (\theta_j - \lambda_j) \tag{1}$$

And states' utility from not joining the climate club be given by the following:

$$U_i(\text{Not join}|\theta_j, \lambda_j) = -x_i + y_i(1 - \lambda_j)\beta + (1 - y_i)\beta \tag{2}$$

States have policy preferences in two dimensions, climate and trade, akin to a two-dimensional spatial model. Let $\beta$ be a weight for the trade dimension relative to climate. Values of $\beta > 1$ indicate that states care more about trade than climate.[3] Following the logic of spatial models of choice, a climate–trade club can be conceptualized as a line cutting through a two-dimensional climate and trade space, whose position reflects the weight for trade relative to climate $\beta$, the climate policy demand $\theta_j$, and the trade penalty $\lambda_j$. States join the climate club when their utility from

---

[2] In order: a climate term, a club trade term, a non-club trade term, and an aversion term.

[3] In the exposition below, I set $\beta = 1$, so it drops out.

joining exceeds that from not joining.

States that join the climate club set their climate policies equal to $\theta_j$, and derive utility from that choice relative to their preferred coordination point $x_i$. States that do not join do not enact climate policies and they bear a cost $-x_i$ that depends on their domestic level of support for climate action. The climate club's trade penalty helps protect domestic industries and unlock greater climate policy stringency, in line with existing research on the difficulty of setting strong climate policy without protection for domestic industries (Genovese 2019; Colgan et al. 2021). Future work could consider how this model relates to the current structure of nationally determined contributions (NDCs) under the Paris Agreement, where states set their own international climate targets. One interpretation could be that states' NDCs are less ambitious than their preferred level of internationally-coordinated climate action $x_i$, such that international cooperation and trade protection support stronger climate policy than could be enacted otherwise.

Note that the model is static and built on decision-theoretic foundations. It takes the climate policy standard to be exogenous and uses a fixed rule for determining the trade penalty. States decide to join or not based on their utility for this combination of climate and trade rules. For $n = 150$ countries, it is not computationally feasible to assess each of the $n! = 5.7e + 262$ combinations of possible members. Instead of evaluating these as interdependent strategic choices, I evaluate the model in decision-theoretic terms using exogenous climate policy obligations that builds on existing spatial models of international cooperation and a rule for setting the trade penalty based on well-established domestic political economy considerations about protection and retaliation. I assess the model's sensitivity in simulations by drawing new combinations of climate and trade preferences, and I consider accession dynamics in the appendix. More details about the modelling procedure are provided in the appendix.

The most important substantive question with this institutional design is whether the trade penalty can actually induce more states to join for a given climate policy target, and therefore increase greenhouse gas mitigation. Intuitively, states whose ideal points are just below $\theta_j$ and states with high trade exposure $y_i$ will be the most sensitive. I take a draw of climate ideal points $x_i$ and trade exposure $y_i^{\perp}$ for 150 states, and calculate net utility from membership as above. In figure 1, states are positioned based on their underlying climate policy preferences $x_i$ and their pre-existing trade exposure to club members $y_i^{\perp}$, where trade exposure remains independent of climate preferences. The shading reflects each state's net utility from membership in the climate club, with higher utility shaded green, negative utility shaded red, and the break-even point in white. The vertical dashed line is $\theta_j$ and the horizontal dashed line is $\lambda_j^{\perp}$, which reflects the extra-club export exposure of the club member with the lowest export share into the club. Because trade preferences are independent of climate preferences—trade exposure is drawn from a distribution independent of climate preferences by construction—$\lambda_j^{\perp}$ will be low in expectation. This low trade penalty induces only some countries to join. In this simulation, 43 of 150 countries join the climate club; across 500 simulations, the median simulation also yields 43 members (29%). By comparison, 37.5 countries have ideal points greater than $\theta_j = 0.75$ on average. When trade preferences are independent of climate preferences, issue linkage hardly induces greater participation. Low trade penalties motivate few states to overcome their climate hesitancy.

If the trade penalty were higher, it could be a more effective lever, but this can only be achieved if club members trade mostly among themselves. This corresponds to a situation where climate preferences are *positively related* to trade exposure. In practice, trade flows are not independent of climate preferences. Climate preferences reflect levels of GHG emissions, vulnerability to climate impacts, and other factors which also correlate with economic size and trade flows. This suggests

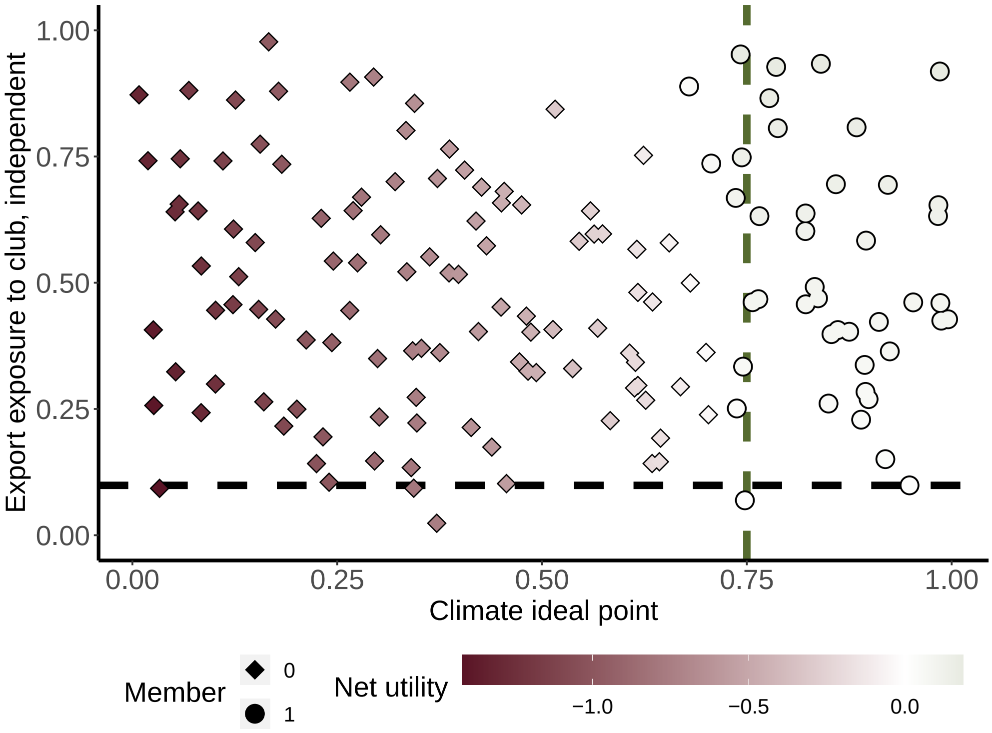

Figure 1: Membership in a climate-trade multilateral, when export exposure to club members is independent of climate preferences

modelling trade exposure as a function of climate preferences. Now, draw a state's trade exposure from a truncated normal distribution centered on its climate ideal point: ${y_i}^+ \sim N(x_i, \sigma^2, 0, 1)$, with $^+$ denoting the positive correlation between trade and climate preferences. Under this framework, states with ambitious climate policy preferences trade mostly with other states with ambitious climate policy preferences, which has the effect of insulating them from retaliatory pressure from non-members. They now set $\lambda_j^+ = \min(y_i^+ | x_i \geq \theta_j)$, and the utility to membership changes.

The positive relationship between climate preferences and exports into the club has two effects, shown in the left panel of figure 2. First, it raises the value of the trade penalty that the club can sustain because more of its club members trade internally, including crucially the lowest common denominator. Second, states whose climate policy preferences are not sufficient in and of themselves to be core club members are now more exposed to club members: they export more

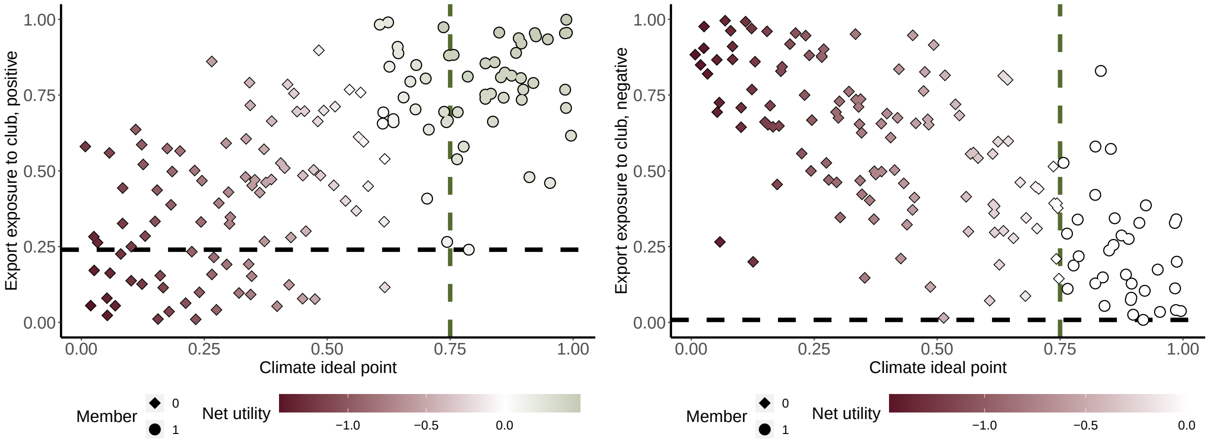

Figure 2: Membership in a climate-trade multilateral, when export exposure to club members is positively (left) and negatively (right) correlated with climate preferences

to climate club states making them more sensitive to the higher trade penalty. Accordingly, the number of states that have positive net utility for joining increases compared to when climate and trade preferences are independent. The left panel of figure 2 shows these two effects. However, the increase in membership is also modest. Now, 57 of 150 countries join; across 500 simulations, the median simulation yields 63 members (42%).

However, trade preferences could also be *negatively related* to climate preferences. In this scenario, states that support the most ambitious climate policy export mostly to states with the lowest support for climate policy. This approximates a pollution offshoring or pollution haven thesis, where the greenest countries are such precisely because they export raw materials to be processed and the pollution associated with their import consumption occurs elsewhere (Harrison 2015; Aklin 2016). Now consider a climate club when trade preferences are negatively associated with climate preferences. Draw states' export exposure from a truncated normal distribution centered on the inverse of its climate ideal point: $y_i{}^- \sim N(1 - x_i,\ \sigma^2,\ 0,\ 1)$, with $^-$ denoting the negative correlation between trade and climate preferences. Set $\lambda_j^- = \min(y_i^- | x_i \geq \theta_j)$, and re-calculate utilities.

The right panel of figure 2 plots the ideal points, export exposure, and utilities for this this model. The negative association undermines climate club membership for two reasons. First, some states with high climate ideal points now export mostly outside the club, constraining the trade penalty to be very low. Second, this low trade penalty is an ineffective lever over intermediate states, because the states with climate ideal points just below the climate club's obligations now export very little to the club, so they are not very sensitive to the trade penalty. In this scenario, only 35 of 150 countries join; across 500 simulations, the median simulation yields 38 members (25%). This simulation shows that linking climate policy to trade does not necessarily create a new zone of possible agreement if the preference heterogeneity on climate is high and inversely related to trade leverage. Figure APP-1 gives the distribution of membership for each simulated relationship between climate and trade.

Clearly, the underlying relationship between states' climate and trade preferences matters for the effectiveness of a climate–trade club. When states that support stronger climate action also have trade leverage over climate laggards, they are able to induce greater participation in a climate-trade multilateral. But the climate club's trade leverage is attenuated by the most trade-exposed core club member. A negative relationship between climate preferences and trade exposure implies that some of the most progressive climate states will be strongly dependent on export markets in states with weaker climate preferences. These latter states will require a high export penalty to join the club, but climate progressives will struggle to adopt such a penalty because the lowest common denominator at the intersection of trade and climate will seek to water this down. Linking climate change to trade does not create a new enforcement tool out of thin air because it also smuggles states' underlying trading relationships into the climate negotiations. In some cases, the issue linkage can expand the club's leverage over laggards, but in others it will not.

### *4.2. Climate–trade clubs and emissions reductions*

In the positive correlation model, the climate club can induce greater participation even while holding the climate club's climate obligations constant at a high level (e.g., $\theta_j = 0.75$); the climate club can increase the breadth of participation while holding the depth of cooperation constant. Here, the broader-deeper tradeoff within climate change is solved by linking climate to trade, so long as trade exposure is positively correlated with climate preferences.

The theoretical literature on the broader-deeper tradeoff also makes a second claim about the depth of cooperation in a multilateral. One of the insights from Gilligan (2004)'s contribution to the broader-deeper debate was distinguishing between depth as (1) the policy level that an institution demands members uphold (e.g., a deeper GHG target for countries; call this policy depth; depth for Downs et al. (1998)), and (2) the total gains from cooperation (e.g., a greater aggregate GHG reduction; call this cooperative depth). These two quantities are related because the total gains from cooperation (cooperative depth) reflect both the number of participating actors (breadth) and the policy contribution that each makes (policy depth). A large aggregate reduction of GHG emissions could arise from a small number of actors making large reductions, or a large number of actors making smaller reductions.

If we fix a distribution of GHG emissions across countries and map this to a function $f$ where emissions fall for higher levels of $\theta_j$, then we can select $\theta_j$ to achieve the highest total mitigation for each underlying relationship between climate preferences and trade exposure. Assume for now that emissions $\text{GHG}_i$ are (unrealistically) evenly distributed across states, implying that they are also (unrealistically) unrelated to climate preferences or trade exposure. Emissions reductions globally $G$ for any given climate–trade club are then the sum of mitigation contributions from states whose

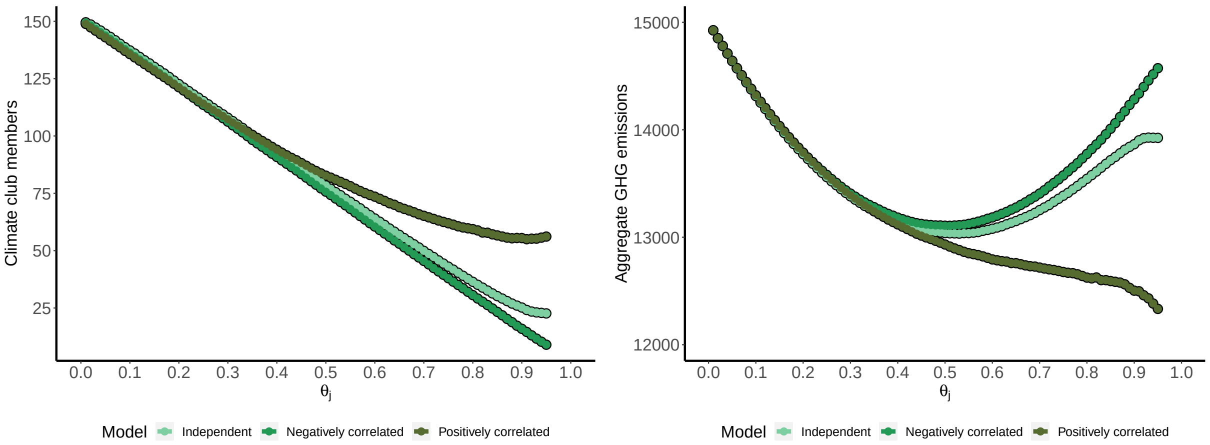

Figure 3: Broader–deeper tradeoff conditioned by the model linking climate preferences to trade exposure. $I = 150, \mathrm{GHG}_i = 100$. Marker points are mean membership and emissions over 500 simulations per model and value of $\theta_j$.

utility to joining exceeds that of not joining ($U_i(\mathrm{Membership}_i \geq 0)$):

$$G(\theta_j, \lambda_j) = \sum_{U_i(\mathrm{Membership} \geq 0)}^{I} f(\theta_j \times \mathrm{GHG}_i) \tag{3}$$

Higher values of $\theta_j$ end up excluding some states, but the remaining ones work harder, and the total emissions reduction depends on the shape of this tradeoff. The broader-deeper tradeoff, ultimately, implies a U-shaped relationship between values of policy depth $\theta_j$ and cooperative depth $G$.

Figure 3 shows the relationship between the climate policy target level, membership, and aggregate emissions. As the climate policy target becomes more demanding, membership decreases (left panel). This is especially pronounced when climate and trade preferences are negatively correlated, but the trend is consistent for all models linking climate to trade. In the case where climate preferences and trade flows are positively correlated (darkest green), however, the membership loss flattens at higher levels of $\theta_j$, where the more homogenous set of core club members are able to uphold a higher trade penalty $\lambda_j$.

In the right panel, we see that emissions fall as the climate policy target increases—intuitively, asking club members to undertake stronger mitigation decreases total emissions. But we see the strong U-shaped relationship, where total emissions fall, then begin to rise again as the climate policy target becomes more demanding. Linking climate to trade only yields stronger emissions reductions when climate and trade preferences are positively correlated. Indeed, in the positive correlation case, increasing the climate policy target consistently decreases emissions, and membership is roughly constant for high values of $\theta_j$.

The broader-deeper tradeoff arises when climate preferences and export exposure to the climate club are independent or negatively related: higher values of $\theta_j$ shrink membership (left panel), and beyond intermediate levels, the more stringent policy reforms of the remaining states achieve fewer and fewer aggregate reductions (right panel). Issue linkage does not unlock greater cooperation automatically. Linking climate to trade only enables greater policy depth, cooperative depth, and breadth of membership when trade exposure to club members is positively correlated with climate preferences or even independent of climate preferences. Under this scenario, pro-climate action states can use their trade ties to induce greater participation. Taken together, the membership and emissions considerations create a broader-deeper frontier across values of $\theta_j$, rather than a strict tradeoff.

The left panel of figure 3 shows that not all states join, even with the favourable relationship between climate and trade preferences. States with very low levels of support for climate policy are difficult to shift in these models. In the positive correlation case, the worst climate laggards are not dependent on export markets in club countries, so the trade penalty is ineffective. In the negative correlation case where climate laggards export heavily to the club (right panel of figure 2), the club cannot raise high tariffs on laggards because it fears retaliation from states with intermediate levels of support for climate policy but that are important export markets for the club. Here, the club's high leverage over the exports of climate laggards is nullified by the club's dependence on export markets in intermediate states. Thompson and Verdier (2014) have shown that tailoring institutional rules to match the participation constraints of individual states could improve cooperative outcomes, but also that states have incentives to misrepresent their preferences to get more favourable exemptions. The common external tariff wastes some of the club's leverage, but attempting to bargain over each non-member's tariff rate would collapse back to the single uniform tariff rate.

## 5. Theoretical cases

The discussion above demonstrates that the underlying relationship between climate preferences and trade exposure determines whether linking climate to trade can improve cooperation. In the above, all states have the same GHG emissions, but for climate governance in practice, the distribution of GHG emissions across states varies with states' underlying climate preferences and with their trade profiles. The export profiles of core members and non-members are key for both setting the level of the trade penalty and understanding how sensitive non-members are to the trade penalty. To assess the efficacy of a real world climate–trade club, climate preferences and trade exposure need to be evaluated on a case-by-case basis because it matters whether the climate club members support strong climate action, have high trade leverage over high emitting climate laggards, and insulation from retaliation.

Despite the fact that states have created many different climate governance institutions (Rowan 2021), none of these correspond to the design principles of Nordhaus' club (Green 2017). Instead of testing the model empirically on an existing climate–trade club, I consider how the model suggests three different ideal types of climate–trade clubs: one that selects members based on their climate policy ambition, another that selects members based on their trade leverage over climate laggards, and finally one that selects on insulation. In some respects, this matches Nordhaus (2015)'s empirical strategy of first positing a hypothetical club membership then modelling the external tariff that would stabilize it, as well as Hovi et al. (2019)'s strategy of simulating how clubs could evolve from different hypothetical initial memberships. This paper builds on this existing work by grounding the analysis in actual dyadic trade flows.

### *5.1. Selecting on climate: The NDC club*

Consider first the example of selecting core club members on the basis of their climate policy preferences. Climate policy preferences $x_i$ are not observed directly, and researchers have struggled to create a reliable index of climate policy preferences for all states. An intuitive way to proxy for states with the most ambitious climate policy preferences is to select states whose 2015 Nationally Determined Contributions (NDCs) in the Paris Agreement are consistent with less than 2°C of warming. Using data from climate scientists (Robiou du Pont et al. 2017), I flag these countries and define them as the NDC club.[4] I calculate each club member's intra-club trade concentration—what share of their exports are to other NDC club members—and each non-club member's export exposure to club members' markets. This operationalizes trade exposure $y_i$ as in the theoretical model presented above, using their average dyadic trade flows between 2015 and 2019 (United Nations 2022).

Figure 4 plots the relationship between GHG emissions and trade exposure by club membership. The $x$-axis is an index of GHG emissions taken by multiplying national aggregate emissions by

---

[4] These countries are listed in the appendix.

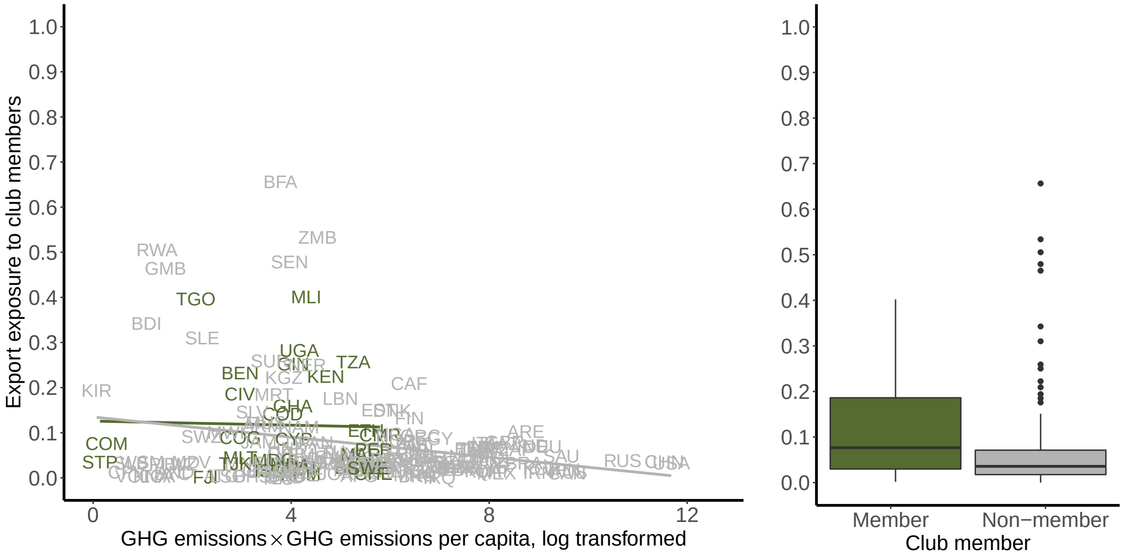

Figure 4: Core NDC climate club membership (green) defined as states with 2015 Paris Agreement NDCs consistent with ≤ 2C of warming. $y$-axis is states' share of exports into the NDC–climate club.

emissions per capita, and logging this, such that countries can score "high" through large values of either component. The GHG emissions index is an imperfect proxy for climate policy preferences, but does highlight the largest emitters. The $y$-axis gives countries' trade exposure to the NDC club. NDC club members are marked in green. From theory in the previous section, for the NDC club to be effective it needs to be a key export market for non-members giving the club leverage, and have high intra-club trade, where members export mostly to other members, giving the club insulation from trade retaliation from non-members.

Figure 4 shows that the NDC club in fact has low trade leverage over the largest emitters. The largest emitters are not dependent on export markets in countries with strong NDCs. At the same time, many club members with strong NDCs also have relatively low trade concentration within the club ($y$ values near 0), such that they export mostly to countries with weak NDCs. The box plot on the right shows the lack of insulation and leverage for the ambition club. These states will constrain the capacity of the NDC club to raise high trade penalties on non-members. By selecting core members on climate policy stringency, what the NDC club gains in terms of internal climate policy depth it loses in external trade depth. The 2019 Agreement on Climate Change, Trade and Sustainability signed by Costa Rica, Fiji, Iceland, New Zealand, Norway, and Switzerland could be considered an embryonic version of the NDC club—but as these countries represent a tiny fraction of world trade, it is difficult to see how their agreement could scale.

### *5.2. Selecting on trade: The leverage club*

An alternative club selects core members on the basis of their export market leverage over states with relatively weak climate policy. I first define the 10 countries with the worst climate policy performance using Germanwatch's Climate Change Policy Index: the United States of America, Saudi Arabia, Iran, Canada, Taiwan, Malaysia, Kazakhstan, Australia, South Korea, and Russia, in order.[5] I then select the 5 countries that receive the most exports from each of these 10 worst climate performers, as the countries with the highest leverage over these climate laggards: Mexico, the United Kingdom, Netherlands, France, Germany, Italy, Turkey, China, Japan, India, Thailand, Vietnam, and Singapore.[6] As before, I then calculate each states' trade flows into and out of the leverage club.

Figure 5 plots the relationship between the GHG emissions index and trade exposure by club membership. Begin by noting that the scale of the $y$-axis has changed considerably compared to figure 4, as the leverage club has much stronger export relationships than the NDC club. The major emitting-laggards are now much more dependent on exports into the climate club than before.

---

[5] The CCPI ranks the 60 largest emitters, so this index does not overlap directly with the NDCs; furthermore, many of these countries submitted non-quantifiable NDCs, so their consistency with the 2C warming target cannot be directly assessed. Burck et al. (2021).

[6] Note that the United States, Canada, Russia and South Korea (4 of the countries with the lowest climate policy performance) are actually among the states with the highest export leverage over climate laggards, and have been excluded from core membership of the leverage club.

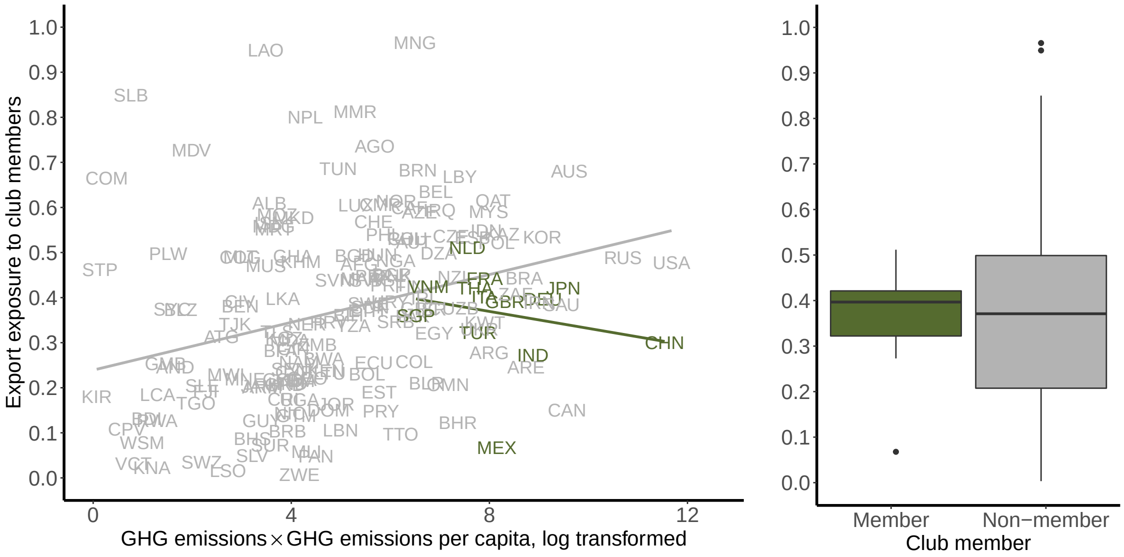

Figure 5: Core climate club membership (green) defined as states with the highest export leverage over climate laggards. $y$-axis is states' share of exports into the leverage–climate club.

Nonetheless, the level of the trade penalty that the leverage club can uphold will be constrained by the export exposure of Mexico, the leverage club members with the least intra-club trade. As roughly 90% of Mexico's exports are out of the club, it is unlikely that a high trade penalty will be adopted. On the whole, the leverage club members have only middling levels of intra-club export concentration, such that they will be vulnerable if targeted states retaliate with offsetting tariffs. The box plot on the right shows that the leverage club accounts for a large share of exports from non-club members, but that leverage club countries lack insulation, as they are dependent on export markets outside the club.

Now consider the level of climate policy commitments that club members will be able to enforce amongst themselves $\theta_j$, and which will serve as the price of admission to the leverage club. All leverage club members are relatively large emitters themselves, and they have adopted highly varied negotiating positions in international climate politics to date. Some members—the UK, France and Germany—have been core members driving strong EU climate diplomacy. At the same time, Japan recently declined to augment its already poor NDC target at the 2021 Glasgow climate summit, Mexico weakened its NDC, and Turkey has sought to leave Annex I of the UN Framework Convention on Climate Change to lessen its international obligations. The leverage club is by no means uniform in its support for stringent climate policy. Much of the preference heterogeneity over the pace of decarbonization that has characterized international climate negotiations is reproduced in the leverage club, suggesting they will struggle to adopt a high $\theta_j$ that can drive decarbonization. The leverage club's challenges demonstrate that shifting institutional forums does not necessarily resolve the bargaining problems that characterized existing forums, even if new forums may include stronger enforcement mechanisms.

### *5.3. Selecting on insulation: The EU as climate–trade club*

An insulation club selects members who have strong pre-existing trade ties to each other, with relatively little trade dependence on export markets outside the club. The European Union could be a candidate insulation club. Figure 6 demonstrates the relationship between GHG emissions and exports for an EU-based climate club. Note first that the EU club members have very strong intra-club trade ties. Most club members export primarily to other club members, meaning that they are relatively insulated from trade retaliation by non-members compared to the other hypothetical clubs. The most export-exposed EU members are Cyprus, Malta, and Greece. Malta and Cyprus are small countries, and Greece is still roughly five times less exposed than Mexico, the most export-exposed member of the leverage club, or fifty times less exposed than some members of the NDC club. An EU club could use this insulation to achieve relatively deep external trade policy depth $\lambda_j$ by raising relatively large trade penalties on non-members.

Compared to the leverage club, an EU-led climate club would be able to maintain relatively

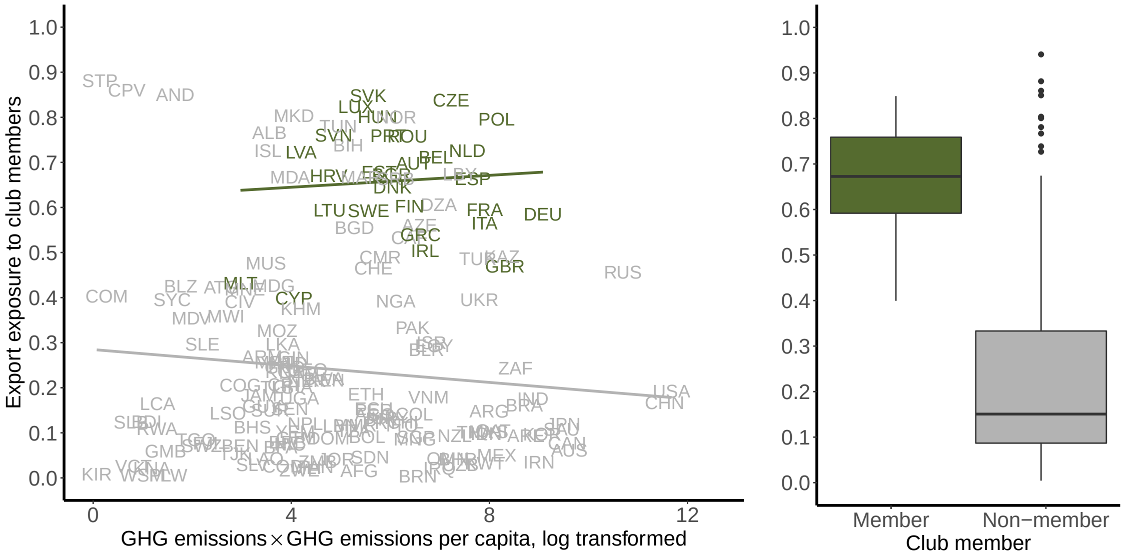

Figure 6: Core climate club membership (green) defined as EU member states, including the UK. $y$-axis is states' share exports into the EU.

deep internal climate policy depth $\theta_j$ by building on the relatively broad support its members already have for stringent climate action. The EU has developed a credible internal GHG emissions trading scheme—the EU ETS—that could form the backbone of a common climate policy target for new club members.

However, figure 6 shows that an EU club would still have relatively low leverage over major emitters. Of the ten largest emitters in terms of GHG emissions multiplied by GHG emissions per capita, only Russia has a large export exposure to EU club members. China and the USA export roughly 18% and 15% by value to the EU, respectively, but most others send fewer than 10% of their exports to the EU. For example, an EU club may struggle to induce policy reforms in countries where climate policy has been weak, like Australia, because the EU accounts for less than 5% of Australian exports. I consider accession in the appendix, but find that a relatively small amount of world trade is shifted by countries acceding to the club. Even when a climate club could maintain *both* relatively stringent internal climate policy depth and external trade policy depth, the climate club could still fail to induce meaningful mitigation reforms in targeted states if the latter are not highly vulnerable to export restrictions into the club. Narrowing club membership to reduce preference heterogeneity and linking climate mitigation to international trade is not a panacea.

### *5.4. Sectoral climate–trade clubs*

Given the persistent challenges with creating effective institutions that target all GHG emissions—"economy-wide" targets—there has been a growing interest in climate policy coordination at the sector level (Cullenward and Victor 2021). The primary focus of sectoral climate policy has been on energy-intensive trade-exposed sectors—steel, cement, aluminium, and fertilizer. Here, large industrial processes generate disproportionate emissions and international trade in these goods produces competitive pressures to harmonize regulations across countries. I argue the same dynamic between climate policy preferences, trade leverage, and trade insulation holds within sectors. States attempting to establish sectoral climate–trade clubs confront the same tension between upholding strong internal decarbonization targets and wielding credible trade leverage over the exports of climate laggards. However, by downscaling climate policy into sectors, the relationship between climate and trade preferences will be shuffled. New states will have within-sector trade leverage, and any club may be more or less insulated from within-sector retaliatory pressures as well.

I develop this analysis in the appendix. In figure APP-3, I illustrate the relationship between trade insulation and leverage over the largest steel exporting countries for a hypothetical EU climate—trade club in steel. Besides Malta, every EU member exports over half of its steel to other EU countries. This would provide an EU club with a high level of insulation from retaliatory pressure from non-club countries. However, the EU has weak leverage over the world's largest steel exporters. None of China, South Korea, Russia, the United States, or Brazil exports more than

30% of their steel to the EU, and the average export exposure to the EU of the top 15 non-EU steel producers is only 16%. Given the EU's relatively strong domestic climate policy, an EU climate–trade club in steel would likely be able to uphold high decarbonization goals and high tariffs on non-club members, but the club would nonetheless struggle to induce policy reforms in the largest steel exporters (i.e., emitters) because those countries are not highly dependent on the European market.

In July 2021, the European Commission took initial steps toward creating a climate–trade club by proposing to add a carbon border adjustment mechanism (CBAM) in these energy-intensive trade-exposed sectors to the EU emissions trading scheme, effectively extra-territorializing the EU's carbon pricing regulation to foreign exporters. In figure APP-4, I illustrate the relationship between trade insulation and leverage for each of the CBAM sectors. For each sector, I calculate the share of intra-EU trade as trade insulation, and for the top 15 non-EU sectoral exporters, their export dependence on the EU as the EU's export leverage. The trade relationships vary across sectors, reflecting the idea that moving from total trade flows to sectoral flows scrambles export insulation and leverage. In general, states are more insulated within the CBAM sectors than for total trade. Cement is a notable exception, where a minority of countries export primarily outside the EU. EU states often have relatively low leverage over the largest exporters within these sectors. Only within aluminium and electricity does sectoral leverage exceed leverage in total trade. Comparing the CBAM sectors to non-CBAM sectors suggests that the CBAM sectors were selected more based on trade insulation than leverage (table APP-1). Given this relatively low leverage, it is unlikely that the EU can compel many recalcitrant states to adopt strong climate policies by raising carbon border adjustments, even if it may be possible to offset some of the costs of domestic climate policy.

# 6. CONCLUSION

States have struggled to enact collective mitigation sufficient to prevent dangerous climate change. Free riding—where countries decline to participate in mitigation—and distributive conflict—where implementing climate policies creates new winners and losers—have been considered two of the key constraints. Linking climate mitigation with trade regulations in a new international institution has been proposed as a means of addressing both of these problems. Trade penalties reduce the incentive of non-members to shirk, and harmonizing policies across jurisdictions reduces competitiveness concerns about unequal regulatory burdens. This style of issue linkage—using the enforcement powers of a reciprocal issue, like trade, to improve governance of a non-reciprocal issue, like climate mitigation—has a long history in institutional design.

In this paper, I explain a new constraint on issue linkage that stems from the alignment of states' interests along each linked issue. A successful climate–trade club must maintain three related policy pillars. The conditions that support these are not guaranteed to co-occur empirically. First, the club needs to uphold strong climate policy demands. Second, the club needs to impose high trade penalties that nullify the benefits of free riding. Trade penalties address both the enforcement problem in international cooperation and the distributive conflict in domestic political economy related to carbon leakage and uneven regulatory competition. However, and third, the club must also possess very strong intra-club trade ties that insulate club members from retaliatory tariffs. The club will struggle to maintain high enough tariffs to deter free riding when climate club members export primarily outside the club. Just as domestic industries seek protection from carbon leakage, they also seek access to export markets abroad. Essentially, interests for decarbonization, leverage over climate laggards, and insulation from retaliation all need to be aligned for this issue linkage to be effective. In analyzing different ideal type clubs, I find that these conditions do not hold in current global politics.

I develop this argument using climate change and trade, but the argument can be extended to other issues where direct reciprocity is difficult to enforce, such as human rights, labour standards, and other environmental problems. On the non-reciprocal side, institutional designers need a core set of ambitious states to build the regime. On the reciprocal side, asymmetries alone are not sufficient to link issues productively. Here, states need both leverage and insulation. High levels of interdependence may simply produce offsetting relationships, where states may be important trading partners in both directions. Offsetting asymmetries can act as veto points that prevent states from using interdependence as a source of bargaining power. This helps to explain the appeal of the new interdependence approach's emphasis on finding elements of hierarchy and asymmetry within seemingly symmetric relationships (Farrell and Newman 2019).

Future work might consider these relationships dynamically. I have taken a static approach, where the value of existing trade relationships are affected by new trade distortions. This is appropriate for considering the short-term effects of policy changes. These trade distortions affect importers, exporters, intermediaries in global value chains, and ultimately the welfare of consumers. Whether climate clubs are enacted will depend, in part, on which of these groups are empowered by political institutions in key states. However, weaponizing interdependence also creates incentives for exposed states to lessen their dependence on sanctioners' markets. Climate tariffs could, therefore, have feedback effects that lead them to obsolesce over time if penalized states can find alternative export markets for their goods. As such, states may need to find new incentives, outside the trade regime, to spur decarbonization.

# REFERENCES

Aklin, Michaël (2016). “Re-exploring the trade and environment nexus through the diffusion of pollution”. *Environmental and Resource Economics* 64.4, pp. 663–682.

Aklin, Michaël and Matto Mildenberger (2020). “Prisoners of the wrong dilemma: Why distributive conflict, not collective action, characterizes the politics of climate change”. *Global Environmental Politics* 20.4, pp. 4–27.

Barrett, Scott (2003). *Environment and Statecraft: The Strategy of Environmental Treaty-Making*. Oxford University Press.

Biermann, Frank et al. (2009). “The fragmentation of global governance architectures: A framework for analysis”. *Global environmental politics* 9.4, pp. 14–40.

Bown, Chad, Aksel Erbahar, and Maurizio Zanardi (2021). “Global value chains and the removal of trade protection”. *European Economic Review* 140, p. 103937.

Burck, Jan et al. (2021). *The Climate Change Performance Index*. Germanwatch e.V. URL: `https://ccpi.org/download/the-climate-change-performance-index-2021/`.

Colgan, Jeff D. (2021). *Partial Hegemony: Oil Politics and International Order*. Oxford University Press.

Colgan, Jeff D., Jessica F. Green, and Thomas N. Hale (2021). “Asset revaluation and the existential politics of climate change”. *International Organization* 75.2, pp. 586–610.

Cullenward, Danny and David G. Victor (2021). *Making Climate Policy Work*. Polity.

Depledge, Joanna (2006). “The opposite of learning: Ossification in the climate change regime”. *Global Environmental Politics* 6.1, pp. 1–22.

Downs, George, David Rocke, and Peter Barsoom (1998). “Managing the evolution of multilateralism”. *International Organization* 52.2, pp. 397–419.

Eckersley, Robyn (2012). “Moving forward in the climate negotiations: Multilateralism or minilateralism?” *Global Environmental Politics* 12.2, pp. 24–42.

Falkner, Robert (2016). “A minilateral solution for global climate change? On bargaining efficiency, club benefits, and international legitimacy”. *Perspectives on Politics* 14.1, pp. 87–101.

Farrell, Henry and Abraham Newman (2019). “Weaponized interdependence: How global economic networks shape state coercion”. *International Security* 44.1, pp. 42–79.

Genovese, Federica (2019). “Sectors, pollution, and trade: How industrial interests shape domestic positions on clobal climate agreements”. *International Studies Quarterly* 63.4, pp. 819–836.

Gilligan, Michael (2004). “Is there a broader-deeper trade-off in international multilateral agreements?” *International Organization* 58.3, pp. 459–484.

Green, Jessica F. (2017). “The strength of weakness: Pseudo-clubs in the climate regime”. *Climatic Change* 144.1, pp. 41–52.

Hafner-Burton, Emilie (2005). “Trading human rights: How preferential trade agreements influence government repression”. *International Organization* 59.3, pp. 593–629.

Hale, Thomas N. (2020). “Catalytic cooperation”. *Global Environmental Politics* 20.4, pp. 73–98.

Hale, Thomas N., David Held, and Kevin Young (2013). *Gridlock: Why Global Cooperation is Failing when We Need It Most*. Cambridge: Polity Press.

Hänsel, Martin et al. (2020). “Climate economics support for the UN climate targets”. *Nature Climate Change* 10.8, pp. 781–789.

Harrison, Kathryn (2015). “International carbon trade and domestic climate politics”. *Global Environmental Politics* 15.3, pp. 27–48.

Hovi, Jon and Detlef Sprinz (2006). “The limits of the law of the least ambitious program”. *Global Environmental Politics* 6.3, pp. 28–42.

Hovi, Jon et al. (2016). “Climate change mitigation: a role for climate clubs?” *Palgrave Communications* 2, p. 16020.

— (2019). “The club approach: A gateway to effective climate co-operation?” *British Journal of Political Science* 49.3, pp. 1071–1096.

Jinnah, Sikina (2011). “Strategic linkages: The evolving role of trade agreements in global environmental governance”. *The Journal of Environment & Development* 20.2, pp. 191–215.

Keohane, Robert O. (1986). “Reciprocity in international relations”. *International Organization* 40.1, pp. 1–27.

Keohane, Robert O. and Joseph Nye (1977). *Power and Interdependence: World Politics in Transition*. Little, Brown and Company.

Keohane, Robert O. and David G. Victor (2016). “Cooperation and discord in global climate policy”. *Nature Climate Change* 6.6, pp. 570–575.

Kim, Sung Eun and Yotam Margalit (2021). “Tariffs as electoral weapons: The political geography of the US–China trade war”. *International Organization* 75.1, pp. 1–38.

Koremenos, Barbara, Charles Lipson, and Duncan Snidal (2001). “The rational design of international institutions”. *International Organization* 55.4, pp. 761–799.

McKibben, Heather Elko (2016). “To link or not to link? Agenda change in international bargaining”. *British Journal of Political Science* 46.2, pp. 371–393.

Mehling, Michael et al. (2019). “Designing border carbon adjustments for enhanced climate action”. *American Journal of International Law* 113.3, pp. 433–481.

Milkoreit, Manjana (2019). “The Paris Agreement on Climate Change—Made in USA?” *Perspectives on Politics* 17.4, pp. 1019–1037.

Mitchell, Ronald and Patricia Keilbach (2001). “Situation structure and institutional design: Reciprocity, coercion, and exchange”. *International Organization* 55.4, pp. 891–917.

Morin, Jean-Frédéric and Sikina Jinnah (2018). “The untapped potential of preferential trade agreements for climate governance”. *Environmental Politics* 27.3, pp. 541–565.

Nordhaus, William D. (2015). “Climate clubs: Overcoming free-riding in international climate policy”. *American Economic Review* 105.4, pp. 1339–70.

— (2020). “The climate club: How to fix a failing global effort”. *Foreign Affairs* 99.3, pp. 10–17.

Parry, Ian, Simon Black, and James Roaf (2021). *Proposal for an international carbon price floor among large emitters*. IMF Staff Climate Notes.

Poast, Paul (2012). “Does issue linkage work? Evidence from European alliance negotiations, 1860 to 1945”. *International Organization* 66.2, pp. 277–310.

Robiou du Pont, Yann et al. (2017). “Equitable mitigation to achieve the Paris Agreement goals”. *Nature Climate Change* 7.1, pp. 38–43.

Rowan, Sam (2021). “Does institutional proliferation undermine cooperation? Theory and evidence from climate change”. *International Studies Quarterly* 65.2, pp. 461–475.

Sebenius, James (1983). “Negotiation arithmetic: Adding and subtracting issues and parties”. *International Organization* 37.2, pp. 281–316.

Snidal, Duncan (1985). “The limits of hegemonic stability theory”. *International Organization* 39.4, pp. 579–614.

Thompson, Alexander (2009). “The rational enforcement of international law: solving the sanctioners’ dilemma”. *International Theory* 1.2, pp. 307–321.

Thompson, Alexander and Daniel Verdier (2014). “Multilateralism, bilateralism, and regime design”. *International Studies Quarterly* 58.1, pp. 15–28.

United Nations (2022). *United Nations Commodity Trade Statistics Database (Comtrade)*. URL: `http://comtrade.un.org`.

Victor, David G. (2011). *Global Warming Gridlock: Creating More Effective Strategies for Protecting the Planet*. Cambridge University Press.

# Supporting information for:

# “Reciprocity, protection and retaliation: Issue linkage in climate change and trade”

This version: May 31, 2022

**Appendix table of contents**:

## *I. Climate club membership algorithm*

This section describes the steps taken to calculate utilities in the decision-theoretic model. The procedure involves drawing climate preferences and trade preferences, setting an exogenous climate policy standard, having club members define the trade penalty, and then calculating each state's utility for joining that particular climate–trade club. For $n = 150$ countries, it is not computationally feasible to assess each of the $n! = 5.7e + 262$ combinations of possible members, nor to do some for different random draws of climate and trade preferences. It is also, therefore, not feasible to calculate each $n!$ club's d'Aspremont stability for every country's incentive to exit or join for every possible combination of members. Instead of evaluating these as interdependent strategic choices, I evaluate the model in decision-theoretic terms using exogenously-defined climate policy standards and a rule for setting the trade penalty based on well-established domestic political economy considerations about protection and retaliation. I simulate the model 5,000 times by drawing new combinations of climate and trade preferences to assess the sensitivity of the model's assumptions about membership.

1. Draw climate ideal points $x_i$ from uniform distribution
2. Draw trade exposure $y_i$ from truncated normal distribution. Depending on the model, this is calibrated to be independent $y_i^{\perp}$, positively correlated $y_i^{+}$, or negatively correlated $y_i^{-}$ with climate ideal points
3. Define the weight of trade relative to climate $\beta = 1$
4. Set an exogenous level of the climate standard $\theta_j \in \{0, 1\}$
5. Core club members ($x_i \geq \theta_j$) set the trade penalty $\lambda_j = \min(y_i | x_i \geq \theta_j)$
6. Calculate each state's static utility for joining and not joining, following equations 2 and 3 in-text
7. States join or not based on these utilities
8. Assess the sensitivity of this membership result by re-drawing $x_i$ and $y_i$ and running steps 1–7 again

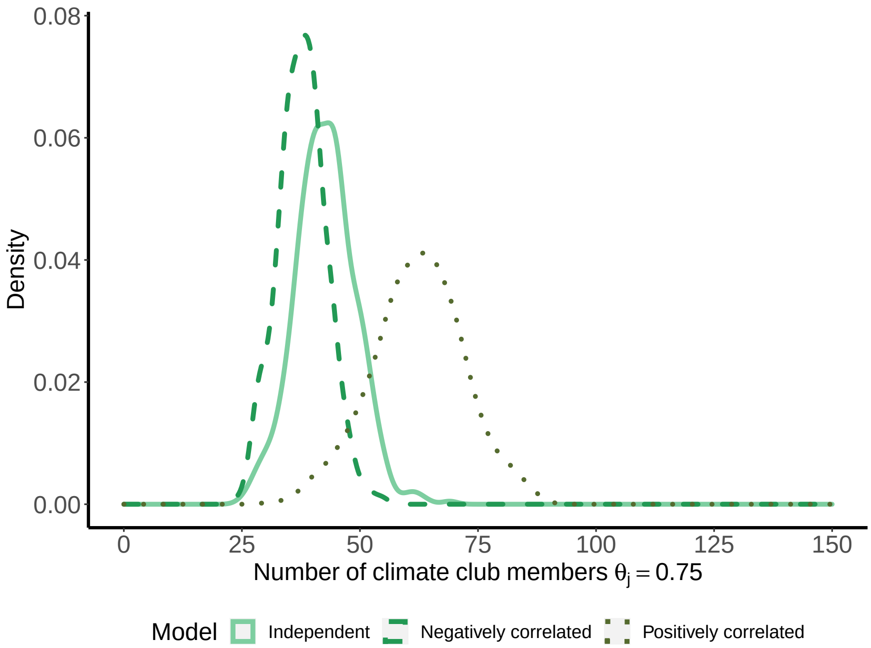

Figure APP-1: Distribution of membership in a climate–trade club, for 500 simulations of $\theta_j = 0.75$, when climate preferences and trade flows are independent versus positively and negatively correlated.

## *II. Accession*

One of the key characteristics of the climate–trade club is its ability to draw in new members. By raising trade penalties on non-members, states re-evaluate joining's cost-benefit calculus. In moving from theory to illustrative cases, the ability to cleanly measure climate preferences and institutional design parameters is reduced. In the ideal type clubs described in-text, we do not observe $\theta_j$ or $\lambda_j$ (or $x_i$), which limits our ability to measure utility as given by the membership equations in-text.

However, we can observe trade flows into and out of the club, as well as a proxy for climate preferences. Define an accession rule for states not already in the club:

$$Accede_i = \begin{cases} 1, & \text{if } 0.1 \times GHG_i \geq y_i \\ 0, & \text{if } 0.1 \times GHG_i < y_i, \end{cases}$$

where $y_i$ is a state's share of exports into the climate club. In practice, this is a diagonal line cutting through the climate–trade space. For these states, the net benefits of joining the climate–trade club outweigh the costs of not joining.

Now, the composition of the climate–trade club changes. Assume following the exposition in-text that the climate policy targets remain constant. With a larger membership, the accession club now has more mass in global trade and potentially new leverage over non-members. Re-calculate trade flows into and out of the accession club.

I outline these dynamics building from the insulation/EU club. Figure APP-2 illustrates how the enlarged club changes all states' trade exposure to the climate–trade club. The original core club members are in dark green, the countries that accede based on the rule above are in light green, and the remaining non-members are in grey. Country labels represent their trade flows into the club, and these are linked by vertical lines to their original trade exposure to the club before accession.

Membership doubles from the 28 core members to 56 members. All states now trade more with the climate–trade club than before, but some states' trade is more affected than others. However, the states that accede do not bring large trade flows with them and have relatively low leverage on remaining non-members. Core members now trade 4.2% more within the club than before, and accession members now trade 6.7% more into the club than before. However, the average non-member's trade with the club only increases by 2.4%, which using the same accession rule as above would only bring three new members into the club. Accession stalls out.

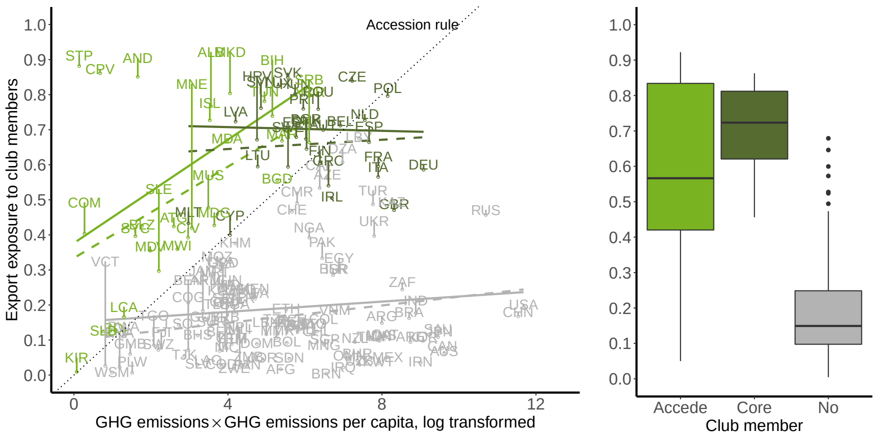

Figure APP-2: Illustrating accession dynamics in the insulation/EU club. Core members (darkest green) are EU member states, including the UK; non-core members accede to the club (light green) following the membership rule outlined above (dotted line); and states that never join are in grey. *y*-axis denotes export exposure to the insulation club (open circles), and the insulation club with accession (country labels); vertical lines shows country-level increases in export exposure after countries accede. Dashed lines are OLS regressions for the original insulation club for illustrative purposes; solid lines are for the club with accession.

### *III. Sectoral climate policy*

Given the persistent challenges with creating effective institutions that target all GHG emissions—"economy-wide" targets—there has been a growing interest in climate policy coordination at the sector level (Cullenward and Victor 2021). The primary focus of sectoral climate policy has been on energy-intensive trade-exposed sectors, where large industrial processes generate disproportionate emissions and international trade in these goods produces competitive pressures to harmonize regulations across countries. These sectors—steel, cement, aluminium, and fertilizer—are crucial for effective mitigation, but also raise complex domestic political economy challenges over harmonizing policy standards across jurisdictions.

I argue the same dynamic between climate policy preferences, trade leverage, and trade insulation holds within sectors. States attempting to establish sectoral climate–trade clubs confront the same tension between upholding strong internal decarbonization targets and wielding credible trade leverage over the exports of climate laggards. However, by downscaling climate policy into sectors, the relationship between climate and trade preferences will be shuffled. New states will have within-sector trade leverage, and any club may be more or less insulated from within-sector retaliatory pressures as well.

I illustrate these dynamics in global steel trade. Steel is heavily traded in international markets and one of the most carbon-intensive industrial processes in the modern economy. Creating steel requires superheating iron ore, and high carbon coke is a more economical energy source for this process than clean energy. While cross-national technological differences lead to different carbon intensities of steel, this is more of a difference in degree than in kind, as no jurisdictions are close to zero-carbon steel production at scale. Consider an example where the EU decides to act as a climate–trade club in steel, raising tariffs on imported steel to offset the costs of climate regulation on domestic steel manufacturers. The EU's emissions trading scheme already covers the European steel industry, where scarce emissions permits create a market price for emitting. The EU ETS spot price has risen dramatically from roughly €20 per tonne of $CO_2$ during the 2018–2020 period to over €80 in December 2021, leading the European steel industry to lobby for protection.[1]

In figure APP-3, I illustrate the relationship between trade insulation and leverage over the largest steel exporting countries for a hypothetical EU climate–trade club in steel. The horizontal axis gives the (logged) total export value of steel by country, and the vertical axis gives the percentage of a country's steel exports into the EU. Besides Malta, every EU member (in green), exports over half of its steel to other EU countries. This would provide an EU club with a high level of insulation from retaliatory pressure from non-club countries.

At the same time, the EU has weak, or at least uneven, leverage over the world's largest steel exporters. None of China, South Korea, Russia, the United States, or Brazil export more than 30% of their steel to the EU, and the average export exposure to the EU of the top 15 non-EU steel producers is only 16%. Given the EU's relatively strong domestic climate policy, an EU climate–trade club in steel would likely be able to uphold high decarbonization goals and high tariffs on

---

[1] Sheppard, David, Harry Dempsey, and Peggy Hollinger (2021). "EU industry calls for urgent carbon border tax as prices soar". *Financial Times*. 29 April 2021.

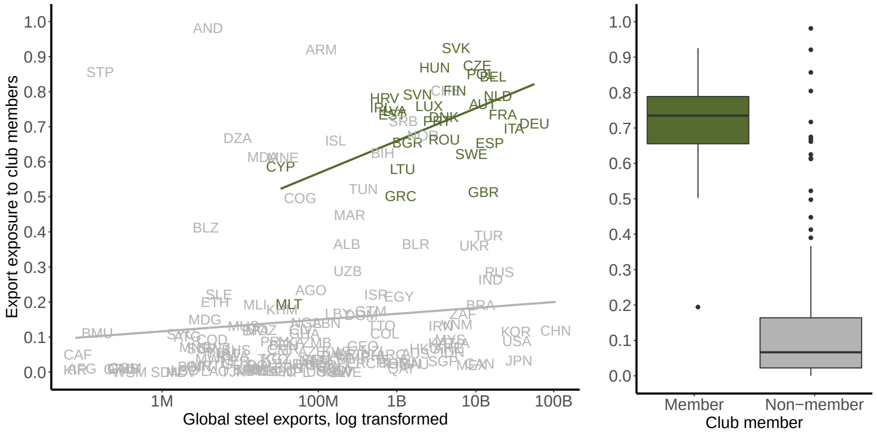

Figure APP-3: EU club members in green, non-members in grey; total global steel exports (logged) on *x*-axis, versus export share into the EU on *y*-axis

non-club members, but the club would nonetheless struggle to induce policy reforms in the largest steel exporters (i.e., emitters) because those countries are not highly dependent on the European market. Here, an EU climate–trade club in steel reflects the broader opportunities and constraints that the EU's global trading relationship create for enforcing decarbonization with trade sanctions.

### *IV. The EU Carbon Border Adjustment Mechanism*

In July 2021, the European Commission took initial steps toward creating a climate–trade club by proposing to add a carbon border adjustment mechanism to the EU ETS, effectively extraterritorializing the EU's climate regulation to foreign exporters.[2] The CBAM would apply to five energy-intensive trade-exposed sectors—iron and steel, aluminium, cement, fertilizer, and electrical energy. If the mechanism takes effect, foreign firms exporting into the EU will need to pay a carbon price equivalent to the prevailing price in the EU ETS to adjust for differences in climate policy stringency across jurisdictions, analogous to a climate–trade club's tariff penalty on non-members. How does this proposal reflect the constraints of insulation and leverage?

In figure APP-4, I illustrate the relationship between trade insulation and leverage for each of the CBAM sectors. For each sector, I calculate the share of intra-EU trade as trade insulation (*x*-axis), and for the top 15 non-EU sectoral exporters, their export dependence on the EU as the EU's export leverage (*y*-axis). Marker labels indicate the mean EU member's export insulation and the mean of the top 15 non-EU exporters' dependence on the EU market. Vertical whiskers summarize the interquartile range of sectoral EU export leverage over non-EU exporters from the mean. Horizontal whiskers highlight the sectoral export exposure of the most exposed EU members, and range from the mean level of export insulation (label) to the 10th percentile of within-sector

---

[2] European Commission proposal, COM(2021) 564 final.

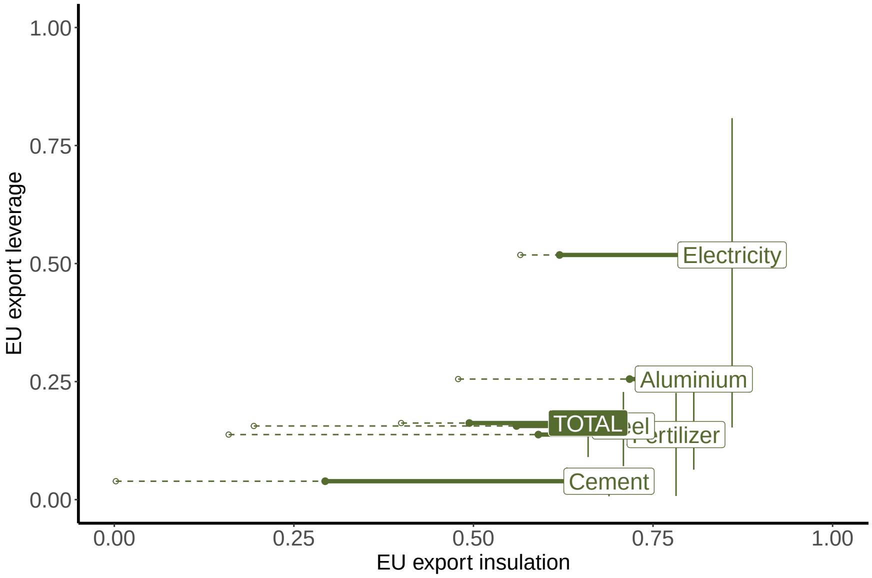

Figure APP-4: Export insulation and leverage for 5 CBAM sectors. Marker labels placed at the mean within-sector insulation and leverage. Vertical whiskers indicate the interquartile range of within-sector leverage over the 15 largest non-EU sectoral exporters; horizontal whiskers show decreasing levels of within-sector EU export insulation—at the 10th percentile of insulation (thick line, closed point) and the minimum level of insulation (dashed line, open point).

insulation (closed point) and the lowest insulation (open circle). Low insulation values indicate that a country exports primarily outside of the EU in that sector, and should therefore prioritize keeping export markets open.

The trade relationships vary across sectors, reflecting the idea that moving from total trade flows to sectoral flows scrambles export insulation and leverage. In general, state are more insulated within the CBAM sectors than for total trade. Cement is a notable exception, where a minority of countries export primarily outside the EU. EU states often have relatively low leverage over the largest exporters within these sectors. Only within aluminium and electricity does sectoral leverage exceed leverage in total trade.[3] These patterns suggest the CBAM sectors were selected more based on trade insulation than leverage. Given this relatively low leverage, it is unlikely that the EU can compel many recalcitrant states to adopt strong climate policies by raising carbon border adjustments.

Finally, I consider trade patterns across a range of CBAM and non-CBAM sectors. The CBAM sectors are energy-intensive and trade-exposed, but they are not the only high carbon sectors of the global economy. This prompts a consideration of why these sectors were chosen rather than others. I measure the EU's export insulation and leverage in six other high carbon sectors,[4] and

---

[3] The largest electricity exporters relying overwhelmingly on fossil fuels for electricity generation.

[4] Coal, oil and gas; cows and sheep; refrigerants and air conditioning; plastics; paper; and motor vehicles.

twenty randomly sampled sectors. If the CBAM proposal is targeted to sectors where the EU is relatively insulated from retaliatory pressures and has high leverage over the largest exporters, then this should be reflected in the choice of sectors.

Table APP-1 summarizes mean leverage and insulation for total trade and within the CBAM, other high carbon, and randomly sampled sectors. The average state in CBAM sectors is highly insulated from retaliatory pressure, and more so than for the other sectors. However, the lowest common denominators in EU cement, fertilizer, and steel exports stand out as unusually exposed to non-EU markets. The CBAM sectors appear to have slightly better leverage and insulation (at the mean and 10th percentiles) than non-CBAM sectors and total trade, even if the least insulated states are often highly dependent on non-EU markets. Nonetheless, across all of these sectors, the EU has relatively low leverage over the largest non-European exporters. This goes to the heart of the tradeoff in club design, where climate–trade clubs that may be able to uphold relatively strong internal climate policy standards and raise relatively high tariffs on climate laggards may nevertheless have weak influence on global climate policy if they also have weak leverage over those laggards. Insulation and leverage cannot be the only reason why some sectors are protected rather than others, and future work could consider how the carbon intensity of EU industries and their ability to mobilize through European political institutions affect linked climate and trade policy.

Table APP-1: Leverage and insulation of an EU climate–trade club across sectors

| Sectors | Leverage (mean) | Insulation (mean) | Insulation (10th percentile) | Insulation (min.) |
|---|---|---|---|---|
| Total trade | 0.162 | 0.660 | 0.494 | 0.399 |
| CBAM ($n = 5$) | 0.221 | 0.769 | 0.556 | 0.280 |
| Aluminium | 0.255 | 0.807 | 0.717 | 0.479 |
| Cement | 0.039 | 0.689 | 0.294 | 0.002 |
| Electricity | 0.518 | 0.860 | 0.620 | 0.565 |
| Fertilizer | 0.138 | 0.782 | 0.590 | 0.159 |
| Steel | 0.156 | 0.709 | 0.560 | 0.194 |
| Other high carbon ($n = 6$) | 0.161 | 0.724 | 0.530 | 0.305 |
| Randomly sampled ($n = 20$) | 0.123 | 0.348 | 0.187 | 0.057 |

## *V. Supplementary tables and figures*

Table APP-2: Members of the NDC and leverage clubs

| NDC club | Leverage club |
|---|---|
| Bangladesh | China |
| Benin | France |
| Bhutan | Germany |
| Cambodia | India |
| Cameroon | Italy |
| Chad | Japan |
| Comoros | Mexico |
| Congo - Brazzaville | Netherlands |
| Congo - Kinshasa | Singapore |
| Côte d'Ivoire | Thailand |
| Cyprus | Turkey |
| Djibouti | United Kingdom |
| Equatorial Guinea | Vietnam |
| Eritrea | |
| Ethiopia | |
| Fiji | |
| Ghana | |
| Guatemala | |
| Guinea | |
| Iceland | |
| Kenya | |
| Liberia | |
| Madagascar | |
| Mali | |
| Malta | |
| Moldova | |
| Morocco | |
| Peru | |
| São Tomé & Príncipe | |
| Sweden | |
| Switzerland | |
| Tajikistan | |
| Tanzania | |
| Togo | |
| Uganda | |

Table APP-3: List of sectors in CBAM, selected high carbon, and sampled sectors

| Commodity | Assigned sector | HS code |
|---|---|---|
| Total trade | Total | “Total” |
| Iron and steel | CBAM | 72, 73 |
| Cement | CBAM | 2523, 6810 |
| Fertilizer | CBAM | 3102 |
| Aluminium | CBAM | 76 |
| Electricity | CBAM | 2716 |
| Fossil fuels: coal, oil and gas | Selected high carbon | 2701–2715 |
| Cows and sheep | Selected high carbon | 0102, 0104, 0201, 0202, 0204 |
| Refrigerants | Selected high carbon | 8415, 2903, 382471–382479 |
| Plastics | Selected high carbon | 39 |
| Paper | Selected high carbon | 48 |
| Motor vehicles | Selected high carbon | 87 |
| Cereals | Sampled | 10 |
| Cork | Sampled | 45 |
| Straw | Sampled | 46 |
| Staple fibers | Sampled | 55 |
| Nickel | Sampled | 75 |
| Metals | Sampled | 81 |
| Railway parts | Sampled | 86 |
| *Overlap with selected carbon, dropped* | Sampled | 87 |
| Arms | Sampled | 93 |
| Toys | Sampled | 95 |
| Cooking oils | Sampled | 1508 |
| Silica fossils | Sampled | 2512 |
| *Overlap with selected carbon, dropped* | Sampled | 4818 |
| Artificial staple fibers | Sampled | 5507 |
| Blouses | Sampled | 6106 |
| Knitwear | Sampled | 6113 |
| Waterproof footwear | Sampled | 6401 |
| Safety glass | Sampled | 7007 |
| Turbines | Sampled | 8410 |
| Aircraft landing gear | Sampled | 8805 |