Effective climate clubs require ambition, leverage and insulation:

Theorizing issue linkage in climate change and trade

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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 enforcement powers into a 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 motivated by findings from the domestic political economy of international trade, I show that the necessary conditions for climate clubs are exacting. Effective climate–trade clubs require members with high levels of climate policy ambition, export leverage over laggards, and insulation from trade retaliation. However, I show that these three attributes do not necessarily co-occur theoretically or 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; climate change; international trade; carbon border adjustments; climate tariffs; sanctions; issue linkage; reciprocity;

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Data availability statement The datasets analyzed in this paper can be accessed as follows: (1) Data on bilateral trade flows are collected by UN Comtrade (United Nations 2022); (2) data on greenhouse gas emissions are collected from the World Bank's World Development Indicators (World Bank 2022). Transformed data will be made available on a public repository upon publication.

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1. Introduction

Governments have struggled with multilateral cooperation on climate mitigation. The conventional explanation emphasizes that mitigation creates non-excludable benefits and is not directly enforceable (Barrett 2003; Keohane and Victor 2016). This diagnosis generates a common prescription for states to add enforcement powers to climate governance through an issue linkage with international trade, where trade's reciprocal structure would allow governments to punish non-cooperation (Nordhaus 2015; Hovi et al. 2019). A new climate club would enact ambitious common mitigation targets for members and raise trade penalties on states that refuse to mitigate to offset incentives to free ride. However, advocates have proposed linking climate and trade since the early 2000s, but no such climate club has been created in practice.

Linking climate and trade is an example of the broader concept of issue linkage in international cooperation. Many global problems cannot be resolved individually because key actors have divergent preferences. In these situations, states can facilitate a mutually beneficial agreement by linking issues because this expands the bargaining space and allows states to trade concessions (Sebenius 1983). Existing research has emphasized whether two issues are inherently related, such that linking them is substantively important, or whether the issues are linked opportunistically for a tactical negotiation advantage (Haas 1980; Aggarwal 1998). A tactical linkage could be particularly useful when it brings the enforcement powers of one issue (e.g., international trade) to bear on a second issue that cannot be enforced through issue-specific reciprocity (e.g., climate mitigation) (Keohane 1986). Although theory presents a strong rationale for issue linkage, it seems under-utilized in practice (Poast 2013; Morin and Jinnah 2018).

I argue that part of the explanation for this missing issue linkage is that it requires a specific

alignment of interests along both issues. To fix ideas, I build my argument using climate mitigation and trade. Existing work has examined the central role of trade agreements that states have linked human rights, environmental protection, and security arrangements to (Davis 2004; Hafner-Burton 2005; Jinnah 2011; Poast 2013; Milewicz et al. 2018). I consider linking climate and trade a form of tactical linkage (Haas 1980), where a sender attempts to exert power to shape a target's behaviour. Senders may have *leverage* over a targeted trade partner when the sender is an important export market, such that restricting market access would impose costs on a target. But this restriction will be weak if the sender is a minor export market for the target. And this threat will not be credible if the target is an important export market for the sender because trade penalties will trigger tariff retaliation and the sender's domestic exporters will mobilize to oppose measures that limit their access to global markets. Therefore, senders need to be *insulated* from retaliation by exporting mainly to non-targeted markets. Finally, obtaining high degrees of leverage in a multilateral setting, where several states coordinate to enact trade penalties, may increase senders' preference heterogeneity and limit their ability to achieve deep cooperation. As a result, issue linkage is constrained by existing trade flows and domestic political economy.

I focus on the alignment of interests along both linked issues to explain under what conditions issue linkage can be effective. Existing work on the climate–trade linkage has been broadly optimistic that it can improve mitigation (Victor 2011; Nordhaus 2015; Falkner 2016; Hovi et al. 2019; Tagliapietra and Wolff 2021), but has paid little attention to actual trade ties between countries. International trade lawyers have noted clubs may fall foul of the World Trade Organization's rules on trade discrimination, but nonetheless trade penalties can be designed to comply with these rules (Mehling et al. 2019). Other scholars have questioned whether the enforcement (Aklin and Mildenberger 2020) and broader–deeper problems (Farias and Roger 2023) that provide the

theoretical rationale for clubs are binding constraints in climate politics. By contrast, my argument emphasizes dynamics internal to the climate–trade linkage and can be applied to diverse instances of issue linkage.

I argue that states' existing trade relationships and their preferences over climate action create a novel constraint on climate clubs' effectiveness for reducing global greenhouse gas emissions. Specifically, effective climate clubs must have core club members that (1) are committed to ambitious 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 strong climate policy obligations to reduce emissions and it needs strong trade penalties that compel laggards to mitigate.

Trade penalties require asymmetric trade flows. The climate club's core members must be important export markets for non-members to use trade penalties as leverage for policy reforms. Core members must also be insulated from retaliation, so that they can maintain high trade penalties. Members have insulation when they export mostly to each other and are not dependent on exporting to non-members. The club's trade penalties protect domestic industries from unregulated foreign firms (Genovese 2019), but if trade penalties trigger tariff retaliation, then domestic exporters will mobilize to keep global markets open (Kim and Margalit 2021). Interest groups in club countries, therefore, pull their governments in both directions: to raise carbon tariffs that protect them from unregulated foreign competition and to attenuate carbon tariffs to avoid retaliation in export markets.

I demonstrate this argument with a model of climate–trade clubs. I build a model where state preferences over climate action vary. Then I add a trade dimension that reflects dyadic trade relationships. States bring their pre-existing trade relationships into the club negotiations, which cap the club's trade penalty. 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 worst case 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.

I apply the model to examine three hypothetical climate–trade clubs, sectoral climate clubs, and the European Union's 2021 carbon border adjustment mechanism as comparative case studies. Emphasizing either of the club's internal climate policy depth or its external trade penalty depth suggests different climate club ideal types that select members based on their underlying ambition, trade leverage, or insulation. I find that selecting core club members on the basis of any of these attributes creates tradeoffs for the other dimensions. For example, building a climate club from countries with the highest levels of pre-existing support for climate action yields a club with no leverage or insulation. Similarly, building a club from countries with the highest leverage over large emitters yields a club that is too heterogeneous to agree on deep climate mitigation rules. Issue linkage in climate and trade depends on the interaction of willingness to act on climate and willingness to sanction on trade. However, these conditions only co-occur in very specific circumstances and do not co-occur empirically.

For scholars of climate clubs, this paper contributes to our understanding of the necessary conditions for effective clubs. These conditions are quite restrictive and depend on a favourable

alignment where states with pro-climate policy preferences have high leverage over laggards and low exposure to trade retaliation. I combine previous work that considers trade penalties (Nordhaus 2015), heterogeneous preferences (Hovi et al. 2019), and retaliation (Hagen and Schneider 2021), but underpin this with theory from the domestic political economy of trade.

This paper also contributes to a growing literature on the relationship between climate change and international trade. I integrate ideas about trade protection (Genovese 2019) and tariff retaliation (Kim and Margalit 2021) in modelling climate club formation. The model emphasizes states' pre-existing climate preferences and dyadic trade ties in contrast to other models where states have common preferences or trade measures affect all states equally. My findings help 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.

Finally, this paper contributes to debates on issue linkage and enforcement (Haas 1980; Sebenius 1983; Aggarwal 1998; Poast 2013; McKibben 2016). I build on insights from 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 (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.

2. Climate and trade clubs

Climate change mitigation is characterized by some of the most difficult international cooperation problems. Mitigation's public goods characteristics creates incentives for states to free ride (Barrett

2003; Keohane and Victor 2016). Preference heterogeneity creates distributional conflict across states over the pace of climate action (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 (Depledge 2006). As a result, climate governance is often considered ineffective and ripe for institutional reforms (Hale et al. 2013).

The climate club is perhaps the most prominent alternative design for achieving greenhouse gas (GHG) emissions reductions.[1] 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 and narrowing the range of interests represented. Some proposals go further and advocate linking issues to build more reciprocity into mitigation. A club creates excludable private benefits for members that act as select incentives to contribute to the non-excludable public benefits of mitigation. Linking climate mitigation to international trade—either trade liberalization among club members (Hovi et al. 2019) or trade penalties applied to non-members (Nordhaus 2015)—forms the basis of many proposals. Critics question whether clubs are consistent with key norms of the UN climate treaties (Eckersley 2012) or would fragment climate governance (Biermann et al. 2009), but many commentators are optimistic about their mitigation effectiveness (Victor 2011; Nordhaus 2015; Hovi et al. 2019; Tagliapietra and Wolff 2021). Nonetheless, most of this work is conceptual, since no climate club currently exists, though some work has examined which states participate in the variety of club-like climate institutions outside the UN climate process (Green 2017; Rowan 2021).

William Nordhaus' work is a particularly clear example of the climate club proposal, and

[1]For broad overviews, see Falkner 2016; Hovi et al. 2016.

I build my discussion from this (Nordhaus 2015; Nordhaus 2020). The two primary features of his club design are: (1) a common climate policy target, and (2) a trade penalty applied to non-participants. Club designers are tasked to select the level of each that maximizes global 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 (Downs et al. 1998; Gilligan 2004; Hovi and Sprinz 2006; Thompson and Verdier 2014). 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, leaving the overall effect on emissions ambiguous. The club design structures cooperation around the most ambitious states, and in doing so, its proponents argue, can enact deeper targets than could be agreed to under the UN climate negotiations' consensus rules.

Second, the climate club imposes a trade penalty on countries that do not participate. Nordhaus' design raises a simple uniform tariff on all imports from non-club members. Domestic polluters have frequently opposed climate policy over concerns about international competitiveness and leakage (Genovese 2019). If domestic industries are regulated to a higher 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 can help build domestic support for decarbonization in political contexts where climate policy is not sustainable without protection for domestic interest groups. Climate tariffs change mitigation's incentive structure by

imposing new costs for free riding, and therefore make mitigation "binding" in cost-benefit terms.

3. Aligning ambition, leverage and insulation

The previous section presents a strong rationale for using issue linkage to improve climate mitigation. However, I argue that 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 countries. Linking these politics makes negotiations multidimensional because now institutional design must accommodate states' participation constraints along both issues. 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. Setting more ambitious climate targets may reduce emissions more quickly, but fewer states are willing to accept more demanding targets (Downs et al. 1998). This broader–deeper tradeoff implies that the club's overall effect on emissions is ambiguous.

The trade penalty is intended to correct for this tradeoff. A higher trade penalty should entice recalcitrant states to join the club and mitigate. 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 (Thompson and Verdier 2014). This trade participation constraint stems from 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 measures 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 countries 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.

To see this, consider the political economy of international trade. The dominant perspective in the existing climate and trade literature emphasizes that trade adjustments are necessary to protect regulated import-competing domestic industries from unregulated foreign competition (Genovese 2019) and, failing this, carbon emissions will leak across borders (Aklin 2016). Here, carbon tariffs can equalize regulatory stringency.

But, other interest groups are also active in trade policy. Raising tariffs on non-club countries will create new costs for exporters when foreign countries retaliate for climate tariffs (Kim and Margalit 2021). Therefore, exporting industries should mobilize to attenuate carbon tariffs and prevent retaliatory tariff cycles. Exporting interest groups are stronger the more a state exports to non-club members relative to club members. Existing export relationships place an upper limit on the level of the trade penalty that the climate–trade club can adopt. Furthermore, other factors will also work against raising high import tariffs, such as geopolitical concerns about penalizing allies, their effects on consumer prices, and prices for intermediaries in global value chains (Meckling and Hughes 2017). Tariff retaliation adds to this and places an upper bound on the club's trade penalties.

Therefore, governments are cross-pressured in the climate–trade club. On climate, they face pressure to enact strong standards. On trade, 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. Domestic political institutions that structure interest group access to policymaking will inform which sets of interests win out. Governments may struggle to find the right balance between these competing interest groups.

International coordination builds legitimacy for penalties that governments struggle to enact unilaterally (Thompson 2009). But exporters in the most export-exposed club member constrain the trade penalty. As a result, climate tariffs may be too low to protect domestic industries and may not provide enough of a penalty to induce laggards to join the club. Tariff retaliation limits the club's ability to set high trade penalties, and in doing so, undercuts the original rationale for issue linkage. Insisting on a high tariff may preclude even climate leaders from participating if climate laggards are their important export markets.

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 on 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: crucial export markets with leverage over laggards, but uninterested in climate action.

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 on the basis of (1) climate ambition, (2) leverage over laggards' exports, or (3) insulation from trade retaliation.

I emphasize exports as constraints on climate–trade clubs. Exports are the main focus of the existing literature, generate clear predictions, and facilitate exposition. Imports could also place a ceiling on the climate club's ambition, because climate tariffs will raise prices of imported goods for consumers and firms in global value chains. However, the overall role of imports is more ambiguous. For countries that import mostly from club members, joining the climate club maintains existing import relationships. For countries that import mostly from non-club members, the climate club's trade penalty benefits import-competing firms, but hurts importers and consumers. Theoretically, either side could be more powerful, so I set imports aside in this paper to focus on exports.

4. Designing for climate and trade

4.1. Modelling membership in a climate–trade club

I model climate–trade clubs using the spatial model of international cooperation (Lupu 2013), with states' preferences emerging from their domestic politics that create participation constraints (Thompson and Verdier 2014), and with external penalties for non-participation (Barrett 2003). I examine how heterogeneous preferences over climate action intersect with pre-existing trade ties, which affect the capacity to use trade to enforce cooperation.

Begin by assuming that states $i \in \{1, \ldots, I = 150\}$ are identical except for their climate and trade preferences.[2] States have preferences over internationally-coordinated climate mitigation

[2]I set the number of states $I = 150$. This is a model assumption and reflects roughly the number of states in UN climate negotiations. The number of states in the model impacts the results because preferences are drawn from a distribution,

that are uniformly distributed $x_i \in Unif(0,1)$. Higher values of x_i indicate that a country prefers more stringent mitigation. To fix ideas, this dimension could correspond to the level of a national carbon price that a country is willing to adopt in an international climate agreement. Consider x_i to reflect the outcome 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 is unimportant for this exercise, and what matters is that they vary across countries. When climate preferences are uniformly distributed there is a larger number of climate leaders and climate laggards compared to normally distributed preferences. This larger number of leaders will help create the core membership of the climate club, which would collapse if very few states supported strong climate action.

Next, states begin creating a climate club j, starting with setting a common climate policy standard that all members must adopt $\theta_j \in (0,1)$. Consider θ_j as the club members' carbon price. To facilitate exposition, I assume the climate standard is exogenous rather than bargained over, and I demonstrate below how cooperation is affected by different target values.[3] Exogenous standards could emerge from focal points in existing policy proposals, such as the international carbon price floor proposed by the International Monetary Fund (Parry et al. 2021) or it could reflect the state of existing science about the necessary carbon price to reach the Paris Agreement's temperature goals (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 $U_i(\theta_j) = -|x_i - \theta_j|$. This formulation implies a state's utility peaks when the climate standard matches their ideal point and

large samples will tend to draw more extreme preferences, and the most extreme preferences on trade constrain the club's design.

[3]I discuss the implications of this assumption at the end of this section.

decreases symmetrically as the climate standard diverges from this point.

States that join set their climate policies equal to θ_j, while states that do not join do not enact climate policies and they bear a cost x_i, which reflects unmet domestic demands for climate action. This follows from the assumption that governments struggle to set climate policy equal to domestic demand for climate action because they also need to offer protection for exposed domestic industries, and governments struggle to offer these protections without the club's coordinated trade penalty, discussed below. Nonetheless, governments have adopted climate policies "unilaterally", or in the absence of a binding international agreement, so some may consider the assumption that non-members do not enact climate policy to be too strong. In practice, however, countries with carbon pricing often rebate energy-intensive, trade-exposed sectors when trade partners do not have equivalent prices, substantially watering down their policies (Mascher 2018). One reconciliation could be that each state's Paris target—their current unilateral policy because Paris is not binding—is less ambitious than its preferred level of internationally-coordinated climate action x_i, such that linking mitigation with trade protection would unlock stronger climate policy. This assumption affects the model by making non-membership costly and costs rise with domestic demands for climate action.

To simplify 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 ties 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 indicate a higher percentage of exports to club countries. Begin by assuming that trade flows are *independent* of climate preferences. Draw $I \times I$ dyadic trade flows from a normal distribution independent of climate preferences, then aggregate dyadic flows to measure each state's share of trade into the club,

and bound total trade to lie between 0 and 1 with the logistic function $y_i^{\perp} = \frac{1}{1+e^{(N(\mu,\sigma^2))}}$, where $^{\perp}$ denotes that trade and climate preferences are independent. This assumes that states trade with every other state and their share of trade with club countries varies.

The climate club sets a trade penalty $\lambda_j \in (0, 1)$ for non-members. The trade penalty is a necessary condition for import-competing groups that demand protection from uneven cross-national climate regulation. This could be conceptualized as an import tariff that worsens non-members' terms of trade and increases their incentives to join the climate club. 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. Domestic industries in core club countries that export primarily outside the club will lobby to attenuate tariffs and minimize retaliation. Core club members have different pre-existing export exposure to non-club members. Very high trade penalties could lead some core club members to exit the club if the trade retaliation is too onerous. Consistent with models where institutions must reflect the policy preferences of the most constrained member (Thompson and Verdier 2014), the climate club must set λ_j to accommodate the trade preferences of the club member with the highest dependence on export markets outside the club. Therefore, the club sets $\lambda_j = \min(y_i | x_i \geq \theta_j)$. As 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 obligations. Governments straddle the competing political demands of protecting domestic firms from carbon leakage while also preserving access to important export markets. Conceptually, excluding core club members that export mostly outside the club could raise the trade penalty and I develop this in the appendix.[4]

States' utility from membership in the climate club is, then, a function of a climate term

[4]Appendix materials are available at the journal's website.

relating a state's climate ideal point x_i to the club's climate target θ_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 λ_j; and, for members, an aversion to large discrepancies between the climate policy target and the trade penalty applied to non-members. The aversion term implies that governments prefer trade penalties to be at least equivalent to the climate standard, and thereby protect domestic industry. Let states' utility from membership in the climate club be given by the following:

$$U_i(\text{Join}|\theta_j, \lambda_j) = \underbrace{-|x_i - \theta_j|}_{\text{Climate}} + \underbrace{y_i\beta}_{\text{Club trade}} + \underbrace{(1 - y_i)(1 - \lambda_j)\beta}_{\text{Non-club trade}} - \underbrace{(\theta_j - \lambda_j)}_{\text{Aversion}} \tag{1}$$

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

$$U_i(\text{Not join}|\theta_j, \lambda_j) = \underbrace{-x_i}_{\text{Climate}} + \underbrace{y_i(1 - \lambda_j)\beta}_{\text{Club trade}} + \underbrace{(1 - y_i)\beta}_{\text{Non-club trade}} \tag{2}$$

States join when utility from membership exceeds that from non-membership. States have policy preferences in two dimensions, climate and trade, akin to a two-dimensional spatial model. The model allows for a β coefficient to weight the trade dimension relative to climate, where values of $\beta > 1$ indicate that states care more about trade than climate, though for ease of exposition, I set this to 1 so it drops out and mention it qualitatively in the applications below.[5]

The model provides insights into a tradeoff that arises when states try to link an issue like climate change, where states have varied preferences over the level of the common policy target, with an issue like trade, where states have relational preferences derived from their pre-existing ties

[5]Increasing β will lead the core club members with relatively low climate preferences and relatively high trade exposure to leave the club; decreasing β will lead some additional states to join the club when their climate preferences are near the club's standard and they trade less with the club than similarly placed peers.

with specific partners. In setting an exclusionary climate standard, the club necessarily partitions the existing trade network, re-configuring it into club and non-club blocs. Every value of the climate standard creates a different partition of the climate–trade space, and trade exposures then depend on this climate standard. In the exposition below, the model illustrates that effective climate clubs require a favorable relationship between climate preferences and trade ties in this newly partitioned space.

Interpreting this type of model requires fixed, exogenous rules, since it would be impossible to analyze the characteristics of the $I! = 150! = 5.7e{+}262$ combinations of possible club memberships. The model is static and built on decision-theoretic foundations. The content of these rules is taken from well-established existing research on the domestic political economy of trade protection and retaliation. However, a climate–trade club in practice is unlikely to emerge from a fixed rule—though they may coalesce around some focal policy proposals—which raises questions about the model's external validity. One key limitation is that it does not consider bargaining dynamics. Existing research shows that bargaining over institutional design tends to pull outcomes toward the preferences of powerful states, those with the best outside options, and those who benefit the most from the status quo (Gilligan 2004). Future work could consider this by adding country-level power terms into the model. In principle, core members could raise the trade penalty above the level preferred by the most exposed core member, but doing so would require another side payment and all states have incentives to misrepresent their participation constraints, which could make this infeasible (Thompson and Verdier 2014). I consider an extension in the supplementary materials where I exclude the most constrained core club country, but show that this has a very small effect on overall membership. In the discussion of ideal type clubs below, I discuss bargaining dynamics more qualitatively.

A key strength of the parsimonious model is that it demonstrates how the climate and trade dimensions tradeoff against each other for differently configured clubs. In simulations, it shows how this tradeoff varies for different realistic assumptions about the correlation between climate preferences and trade flows, as well as different levels of the climate policy standard. I assess the model's sensitivity by re-drawing combinations of climate and trade preferences. I consider accession dynamics in the supplementary information. More details about the modelling procedure are provided in the supplementary information.

4.2. Membership depends on climate and trade preferences

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 θ_j and states with high trade exposure y_i will be the most sensitive. I draw climate ideal points x_i and trade exposure $y_i^{\perp}$—where trade exposure is independent $^{\perp}$ of climate preferences—and calculate net utility from membership as above. In figure 1, states are positioned based on their climate policy preferences x_i and their pre-existing trade exposure to club members $y_i^{\perp}$. We see that some core club members send over 40% of their exports to club members, while others export only 5% to club members, leaving them very exposed to retaliation. The shading reflects each state's net utility from membership as taken from equations 1 and 2, with higher utility shaded green, negative utility shaded red, and the break-even point in white. The vertical dashed line is θ_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, $\lambda_j^{\perp}$ will be low in expec-

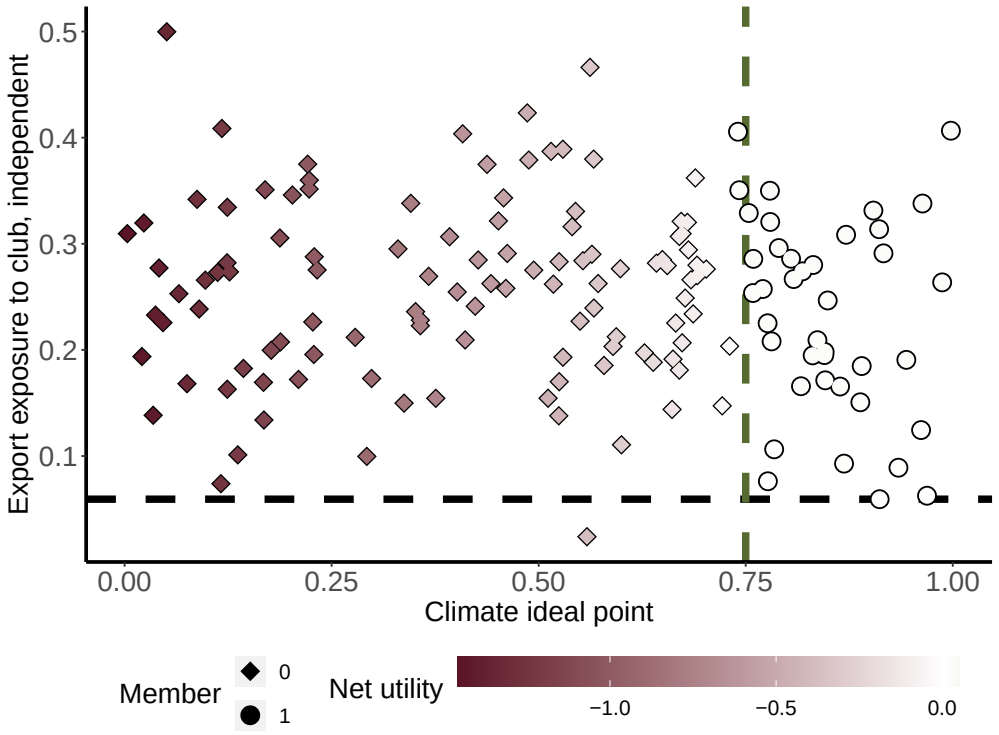

Figure 1: Membership in a climate–trade multilateral, when export exposure to club members is independent of climate preferences

tation. This low trade penalty induces only some countries to join. In this simulation for $\theta_j = 0.75$, only 40 of 150 countries join the climate club. Across 500 simulations—re-drawing x_i and $y_i^{\perp}$ 500 times—the median simulation also yields 40 members (27%). By comparison, 37.5 countries have ideal points greater than $\theta_j = 0.75$ on average. These membership statistics suggest that the climate–trade issue linkage has a very small effect on membership, since it only entices a handful of states to join. This suggests that when climate and trade preferences are independent, linking climate and trade may not be a productive strategy to drive mitigation. Calculating the median membership allows comparisons across different assumptions for how climate and trade preferences are linked, which I show next.

If the trade penalty were higher, then it could be a more effective tool, but this can only be achieved if club members were more insulated by trading 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 trade flows. Now I consider this situation where climate and trade preferences are positively correlated. I take the absolute distance between two states' (i and m) climate ideal points as a measure of their climate affinity, then draw their dyadic trade ties as a function of that affinity, such that countries with more similar climate preferences trade more with each other, and then I transform these trade ties to be bound between 0 and 1 with the logistic function $y^{+}_{i,m} = \frac{1}{1+e^{(N(1-|x_i-x_m|,\sigma^2))}}$. I finally aggregate dyadic trade ties to measure each state's share of trade with core club members $y^{+}_{i} = \Sigma^{x_m=1}_{x_m \geq \theta_j} y^{+}_{i,m}$. They now set $\lambda^{+}_{j} = \min(y^{+}_{i} | x_i \geq \theta_j)$, and the utility to membership changes. 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.

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 now export more 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, 54 of 150 countries join; across 500 simulations, the median simulation yields 53 members (35%). Linking climate and trade can increase participation when climate preferences and trade

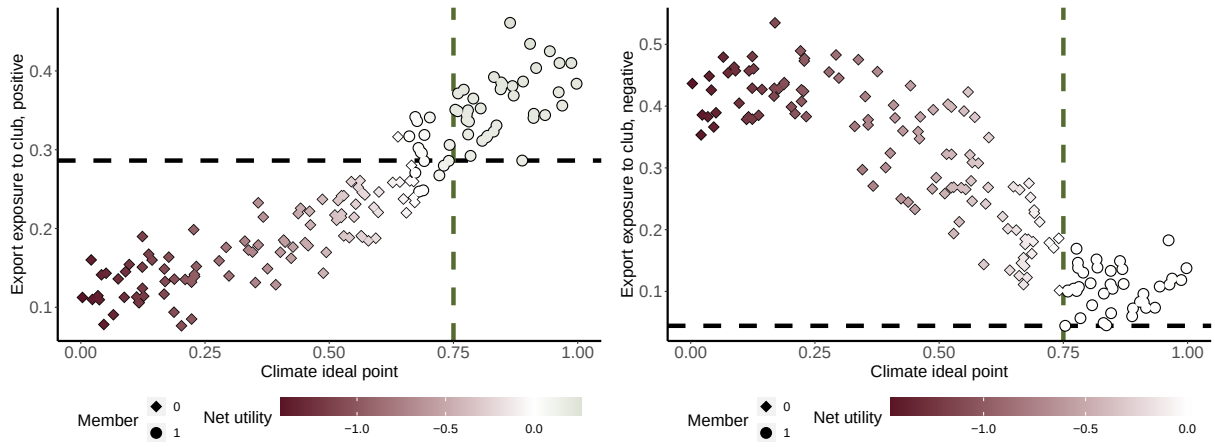

Figure 2: Membership in a climate–trade multilateral, when export exposure to club members is positively (left) and negatively (right) correlated with climate preferences

ties are positively related.

However, trade preferences could also be *negatively related* to climate preferences. In this scenario, states that support ambitious climate policy export mostly to states that oppose climate action. This reflects a pollution offshoring thesis, where countries are green because they displace the pollution associated with their consumption elsewhere (Harrison 2015; Aklin 2016). Now consider a climate club when trade preferences are negatively associated with climate preferences. I draw states' dyadic trade ties as in the positive correlation case above, but now make dyadic trade flows decrease as climate preferences become more similar $y^{-}_{i,m} = \frac{1}{1+e^{(N(|x_i - x_m|, \sigma^2))}}$, where $^{-}$ denotes the negative correlation between trade and climate preferences. I aggregate trade to core club members y^{-}_{i}; 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 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 38 of 150 countries join; across 500 simulations; the median simulation yields 38 members (25%). This 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 across draws.

The main implication of this exercise is that the relationship between climate and trade preferences influences membership in climate–trade clubs. When climate leaders have trade leverage over climate laggards, they are able to induce greater participation in a climate–trade club. This only arises when states with preferences for strong climate action export mostly to each other and are large export markets for states with intermediate levels of support for climate action. 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 states will be dependent on export markets in states that oppose climate action. The latter states will require a high trade penalty to join the club, but core club members will water this down. Linking climate change to trade does not necessarily create a new enforcement tool because it also smuggles states' underlying trading relationships into the climate negotiations.

4.3. 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. Gilligan (2004) distinguishes two kinds of depth: (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). Moderate aggregate reductions of GHG emissions could arise from a small number of actors making large reductions, or a large number of actors making smaller reductions. But large aggregate reductions require all actors to make large cuts.

If we fix a distribution of GHG emissions across countries and map this to a function f where emissions fall for higher levels of θ_j, then we can select θ_j to achieve the highest total mitigation for each underlying relationship between climate preferences and trade exposure. Begin by assuming that emissions 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 utility to joining exceeds that of not joining ($U_i(\text{Membership}_i \geq 0)$):

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

Higher values of θ_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 θ_j and cooperative depth G.

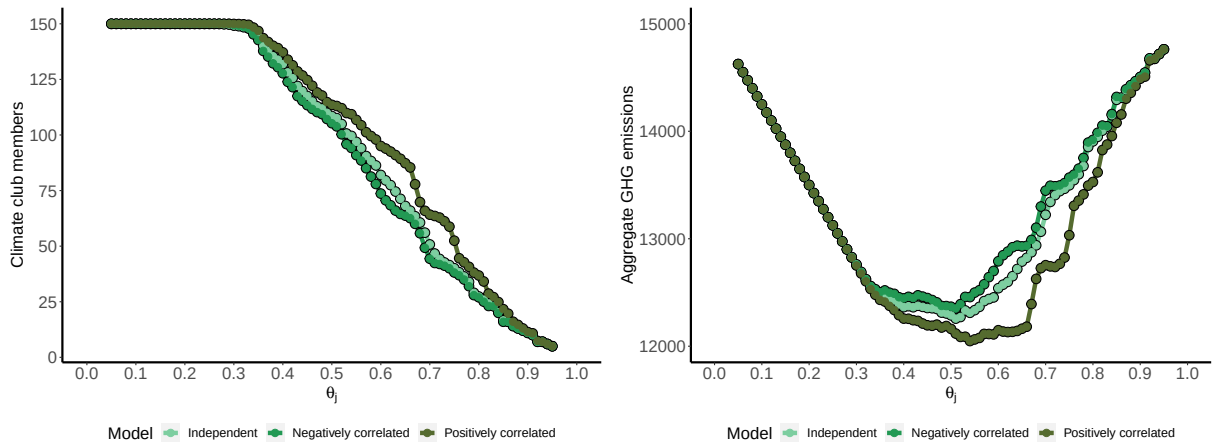

Figure 3: Broader–deeper tradeoff conditioned by the model linking climate preferences to trade exposure. $I = 150, \text{GHG}_i = 100$. Marker points are mean membership and emissions over 100 simulations per model and value of θ_j.

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. When climate preferences and trade flows are positively correlated (darkest green), the club is able to sustain larger membership only at intermediate values of θ_j. For very high values of θ_j, the core club membership is too small to have enough leverage over non-members.

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 U-shaped relationship, where total emissions fall, then begin to rise again as the climate policy target becomes more demanding and shrinks membership. The optimal climate policy level for the club to target to reduce emissions is around the average of states' climate preferences. However, linking climate to trade can increase membership and decrease emissions for values of θ_j between roughly 0.5 and 0.8. In the positive correlation case, core club members are able to uphold a strong

trade penalty and have high leverage over states with intermediate climate preferences. But as the club's climate standard becomes more demanding, the club shrinks, loses insulation and leverage, and is less effective at reducing emissions. Overall, this suggests that a climate–trade club will be most effective when it asks members to make intermediate mitigation contributions. This is true regardless of the relationship between climate and trade, but the overall effect on emissions is larger when climate and trade are positively related.

The broader-deeper tradeoff is stark when climate preferences and export exposure to the climate club are independent or negatively related: higher values of θ_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 substantively greater policy depth, cooperative depth, and breadth of membership only when trade exposure to club members is positively correlated with climate preferences. Taken together, the membership and emissions considerations create a broader-deeper frontier across values of θ_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 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, 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, as in the present model.

A related consideration is whether excluding a very exposed core club member from the climate club could enhance the club's effectiveness by allowing it to raise a higher trade penalty. However, the effect of excluding any individual state is ambiguous ex ante. Excluding one country necessarily re-partitions the entire climate–trade space. The club may gain some insulation if the most constrained member is substantially more exposed than the next. However, the club may also lose some insulation if remaining club members export to that excluded state. At the same time, the club necessarily loses some leverage by diminishing its share of global trade. Decisions over exclusion create their own tradeoffs because the effectiveness of tariffs as a policy instrument depends on their effect on multiple, non-independent policy goals—insulation and leverage. I consider this in the appendix, where I drop the most constrained core club member from club formation, and use the trade flows of the second most constrained state to set the trade penalty. Overall, this has a very minor effect on membership, increasing it by 1.7 members on average for the positive correlation case but only 0.8 members in the independent and 0.2 members in the negative correlation cases (figure APP-2).

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 model,

to ease exposition, states are all alike except for their climate preferences and dyadic trade flows. However, for climate governance in practice, we need to consider the distribution of national GHG emissions, as well as, states' underlying climate preferences and trade profiles, which all covary. 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.

No climate–trade club currently exists in global politics, therefore it is not possible to test the theory's expectations on real-world institutional designs. Instead, to illustrate the theory's logic and the tradeoffs involved in designing such a club, I consider three different climate–trade club ideal types: selecting members based on their (1) climate policy ambition, (2) trade leverage over climate laggards, and (3) insulation from retaliation. These cases demonstrate the model's insight that members that are useful for the club along one dimension may be impediments along another, such that linking climate and trade may not facilitate cooperation. Selecting on ambition undermines the club's leverage and insulation; selecting on leverage undermines ambition and insulation; though, in at least one empirical case, selecting on insulation may support ambition. I conclude by showing that the same logic holds for downscaling climate–trade clubs to the sector level.

5.1. Selecting on climate: The ambition club

Consider, first, selecting core club members based on strong pre-existing support for climate action. Climate policy preferences x_i are not observed directly, but an intuitive way to proxy for this is to select states whose 2015 Nationally Determined Contributions (NDCs) in the Paris Agreement are consistent with less than 2C of warming. Using data from climate scientists (Robiou du Pont

et al. 2017), I flag these countries and define them as the ambition club (Rowan 2021).[6] If these states were to form a climate–trade club, how much leverage would they have over the exports of climate laggards? I calculate each state's export exposure to the club—the share of their exports to ambition club countries using their average dyadic trade flows between 2015 and 2019 (United Nations 2022). This operationalizes trade exposure y_i as in the theoretical model, such that states with higher values export more to ambition club members than states at lower values.

Figure 4 illustrates how ambition trades off against insulation and leverage. The y-axis gives countries' trade exposure to the ambition club. Ambition club members are marked in green, non-members in grey. We see that club members export little to other club members, giving them low insulation. At the same time, club members are not key export markets for many countries, giving them low leverage. This is especially true with respect to the largest emitters. Countries are arranged on the x-axis using an index of their GHG emissions—defined as GHG emissions × GHG emissions per capita, logged—so that large aggregate emitters and large emitters per capita can be identified at high values (World Bank 2022). This highlights whether the club has leverage over relatively large emitters or smaller ones, if any. The ambition club would have low leverage over the largest emitters, as these states are not dependent on export markets in countries with the strongest climate policy. The box plot on the right shows the lack of insulation for members and leverage over non-members for the ambition club. These states will constrain the capacity of the ambition club to raise high trade penalties on non-members.

The intuition here matches the model. By setting a common climate policy target that is much more stringent than many states in the world would be willing to adopt, the core membership of the club will be narrow. A negative correlation between climate preferences and trade flows holds

[6]These countries are listed in the supplementary information.

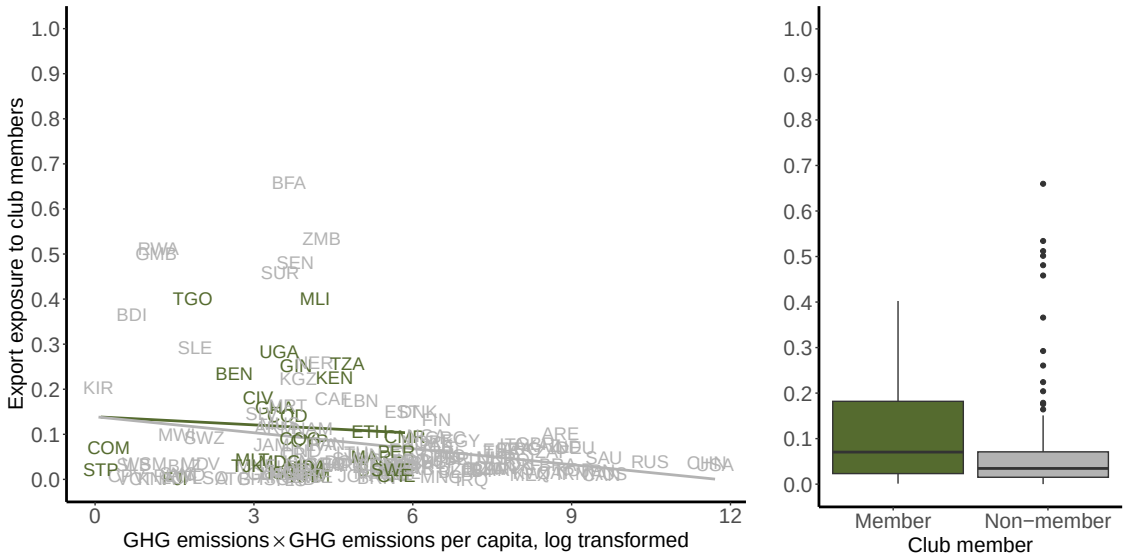

Figure 4: Core ambition climate club membership (green) defined as states with 2015 Paris Agreement NDCs consistent with ≤ 2C of warming. *y*-axis is states' share of exports into the ambition club.

for this core club membership, as core club members trade mostly outside the club, which weakens both their insulation and leverage. Lacking insulation and leverage, the ambition club will not be effective at recruiting members and reducing emissions. By selecting core members on climate policy stringency, what the ambition club gains in internal climate policy depth it loses in external trade depth.

5.2. Selecting on trade: The leverage club

A key task of the climate–trade club is to wield high trade penalties over the largest emitters to force them to decarbonize. This dimension, on its own, suggests selecting core club members based on their leverage as major emitters' key export markets. However, selecting core countries with high leverage does not necessarily imply that a leverage club would be able to adopt strong climate policy standards. In fact, empirically, the states with the most leverage over major emitters are often themselves also climate laggards, which limits the leverage club's ability to set strong internal

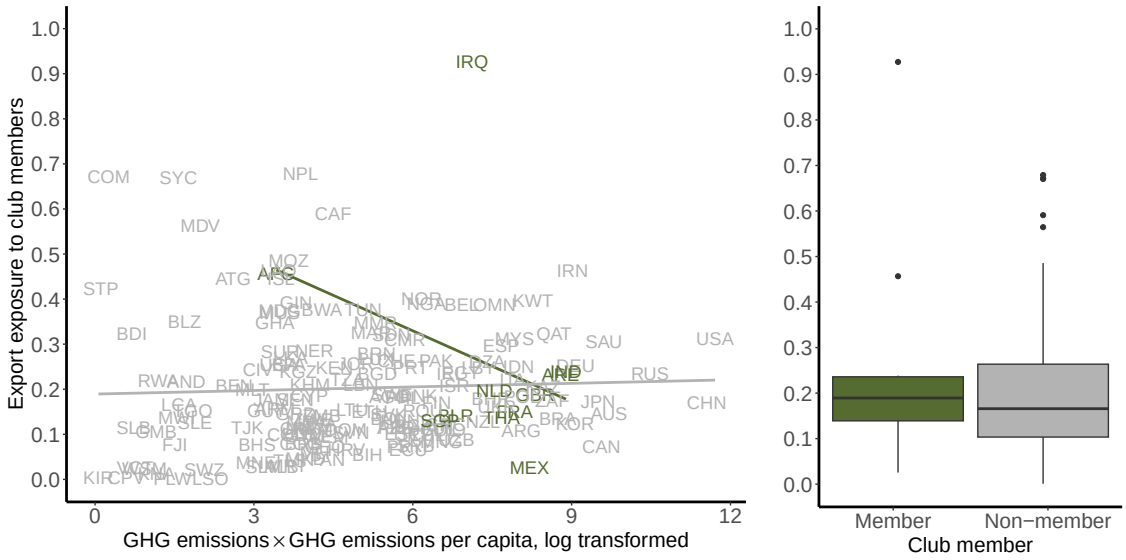

Figure 5: Core climate club membership (green) defined as states with the highest export leverage over climate laggards. y-axis is states' share of exports into the leverage–climate club.

climate targets. This illustrates the key tradeoff between climate preferences and trade flows that climate clubs struggle to resolve.

I illustrate this by building a hypothetical leverage club composed of the key export markets of the ten largest emitters taken from the multiplicative GHG index of aggregate emissions and emissions per capita. These emitters are: the United States of America, China, Russia, Australia, Saudi Arabia, Canada, Japan, Germany, South Korea, and Iran.[7] I then select the five countries that receive the most exports from each of these major emitters, as the countries with the highest leverage: Afghanistan, Belarus, France, India, Iraq, Mexico, Netherlands, Singapore, Thailand, Turkey, United Arab Emirates, United Kingdom, Vietnam.[8] I define the latter countries as the leverage club, and then calculate each state's trade flows into and out of it.[9]

[7]In extensions, I selected climate laggards using external rankings of climate policy and the results are similar.

[8]Note that Canada, China, Germany, Japan, South Korea, and United States are among the biggest emitters and the states with the highest export leverage over other large emitters. I exclude them from core membership of the leverage club.

[9]An alternative measure of leverage could re-weight export exposure by exports as a share of GDP. This would reflect that exports are more significant to some economies. Overall, the correlation between export exposure and exports as a share of GDP is 0.04 for non-club members, so should not affect the results systematically.

Figure 5 shows that major emitters are now more dependent on exports into the leverage club than for the ambition club. These median targeted large emitter exports roughly 24% of its goods to the leverage club, though this ranges from 8% to 54%. The major emitters actually trade extensively with each other, which insulates them from externally-imposed trade penalties. 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 member with the least intra-club trade. As over 95% of Mexico's exports are out of the club, Mexican exporters should mobilize to oppose high climate tariffs, and the Mexican government will not join unless the trade penalties are attenuated. The box plot on the right shows that the leverage club members have only middling levels of intra-club export concentration, such that they will be vulnerable, rather than insulated, if targeted states retaliate with offsetting tariffs.

Now consider the level of climate policy commitments that leverage club members will be able to enforce amongst themselves, and which will serve as the price of admission to the leverage club. Readers will notice immediately that this is a very mixed group of countries that is not unanimous in supporting strong climate policy. Many leverage club members are relatively large emitters themselves, and they have adopted divergent negotiating positions in international climate politics to date. Some members—such as France and the UK—have been active members driving strong global climate diplomacy. However, other leverage club members have been reluctant to enact strong climate policies, including major fossil fuel exporters, such as Iraq and the United Arab Emirates. Other leverage club members, such as Thailand and Vietnam, have recently weakened their climate pledges during the 2021 Glasgow ratchet process. Much of the preference heterogeneity that has characterized international climate negotiations is reproduced within the leverage club, suggesting it will struggle to adopt a high climate standard that can drive decarbonization. The

leverage club's challenges demonstrate that shifting institutional forums does not necessarily resolve the problems that characterize existing UN climate negotiations, even if new forums may include stronger enforcement mechanisms. What this ideal type club gains in leverage over large emitters it then loses in internal climate coherence.

5.3. Selecting on insulation: An EU-led 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 members of the European Union could be a candidate insulation club, as EU members have very strong trade ties amongst themselves. Figure 6 shows that the most export-exposed EU members are Cyprus, Malta, Ireland, 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-led club could use this insulation to achieve high external trade policy depth by raising relatively large trade penalties on non-members, at least compared to other ideal type clubs. Compared to the leverage club, an EU-led climate club would also be able to maintain relatively deep internal climate policy depth by building on the broad support its members already have for stringent climate action. The EU has developed a credible internal GHG emissions trading scheme that could form the backbone of a common climate policy target for new club members.

However, figure 6 shows that an EU-led club would still have relatively low leverage over major emitters. Of the ten largest emitters ranked along the x-axis, only Russia has a large export exposure to EU members. China and the USA export roughly 15% by value to the EU, respectively, but most others send less than 10% of their exports to the EU. For example, an EU-led club may

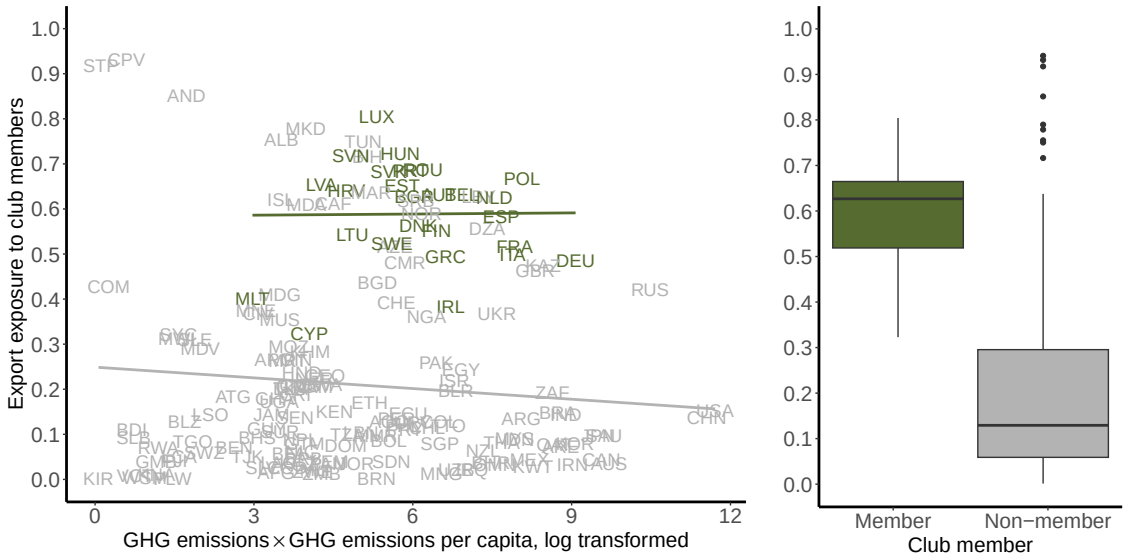

Figure 6: Core climate club membership (green) defined as EU member states, including the UK. *y*-axis is states' share exports into the EU.

struggle to induce policy reforms in countries where climate policy has been weak, like Australia, because the EU accounts for less than 4% of Australian exports.

I consider accession to an EU-led insulation club in the supplementary information, but find that a relatively small amount of world trade is shifted by countries acceding to the club (figure APP-3). 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 within

economic sectors (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. 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 supplementary information. In figure APP-4, I illustrate the relationship between trade insulation and leverage over the largest steel exporting countries for a hypothetical EU-led climate–trade club in steel. Nearly every EU member exports over half of its steel to other EU countries. This would provide an EU-led steel 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, Japan, or the United States exports more than 10% 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%. An EU steel club would have the most leverage over Russia, Turkey, India, Ukraine, and the United Kingdom. Given the EU's relatively strong domestic climate policy, an EU-led 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-5, I illustrate the relationship between trade insulation and leverage for each of the CBAM sectors. I calculate the sector-level 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 CBAM will compel climate laggards to adopt strong climate policies, 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 countries disagree over the pace of decarbonization—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 using climate clubs as a case study. 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 some domestic industries seek protection from carbon leakage, others 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.

Given this, a climate club built around the European Union's existing climate and trade rules 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 some 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 seven 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.

I develop my 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), though as Kim and Margalit (2021) note, countries can choose to retaliate in sectors that are politically sensitive to amplify costs.

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 is 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.

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Appendix for:

"Effective climate clubs require ambition, leverage and insulation Theorizing issue linkage in climate change and trade"

This version: December 14, 2023

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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

II. Distribution of membership

Figure APP-1 shows the distribution of the number of members in a climate and trade club across 500 random draws of trade ties and holding θ_j fixed at 0.75. We see that when dyadic climate ideal point distance and trade ties are independent of each other (uncorrelated), adding trade penalties has a relatively small influence on membership. Across 500 simulations, 40 states join this climate club on average. When dyadic climate and trade ties are negatively related—such that states that have more climate preferences trade less with each other and more with states they disagree with on climate—linking climate and trade is similarly not a very productive strategy. Across 500 simulations, only 38 states join this climate club on average. Only in situations where dyadic climate ideal point distance and trade ties are positively related—where countries trade more with other countries when they also see climate issues similarly—does linking climate and trade enhance climate club membership. Here, across 500 simulations, 53 states join the climate club on average. We can also see from the figure that in each of the 500 simulations, the number of club members when climate and trade ties are positively correlated is always larger than when climate and trade ties are independent or negatively correlated.

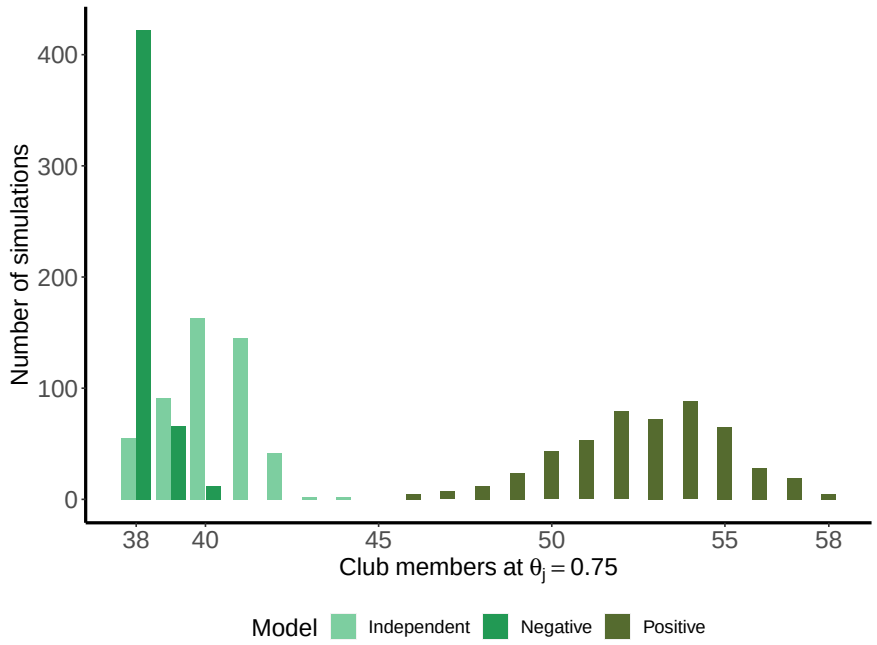

Figure APP-1: Distribution of membership in a climate–trade club, for 500 simulations of θ_j = 0.75, when climate preferences and trade flows are independent versus positively and negatively correlated.

III. Setting trade penalties

In the model, core club members $x_i \geq \theta_j$ set the trade penalty λ_j to match the trade preferences y_i of the most constrained core club member. In other words, the core club member who is the least insulated because it exports the most outside of the club sets a ceiling on how high the club's trade penalty can be. If the trade penalty could be higher, then it could be a more effective mechanism for forcing low climate types to join and mitigate. But raising the trade penalty impacts club members unevenly based on their pre-existing trade ties into and out of the club.

Conceptually, excluding a particularly exposed core club member from club formation and bargaining over λ_j could unlock a higher trade penalty. However, the overall effect on membership is potentially ambiguous. To see this, consider that removing any one state from the club also re-partitions the climate–trade space and all of the dyadic trade flows into and out of the club because this previously most constrained state is now outside the club. The remaining club members may now be less insulated and trade more outside the club than before because they trade with this excluded state. This could actually lower λ_j, leaving the club no better off than before.

To analyze these possibilities, I re-configure the membership algorithm to (1) exclude the most constrained core club member from club formation, (2) re-calculate each state's share of trade into and out of the new core club, (3) re-calculate the trade penalty using the second-most min$'$ exposed core club members' trade flows $\lambda_j = \min'(y_i | x_i \geq \theta_j)$, and (4) re-calculate all the utilities to membership and non-membership.

In figure APP-2, I show the change in membership from the exclusion for each of the 500 draws of trade ties shown in figure APP-1. In the independent and negative correlation cases, dropping the most constrained member hardly affects membership. Across 500 simulations, the independent case adds 0.8 members on average and the negative correlation case adds 0.2 members on average. In the positive correlation case, dropping the most constrained member adds 1.7 additional members on average, with a long tail. Overall, if the club can raise a higher trade penalty, this can increase membership, but simply excluding the most constrained member from initial bargaining will not transform a climate club to universal membership.

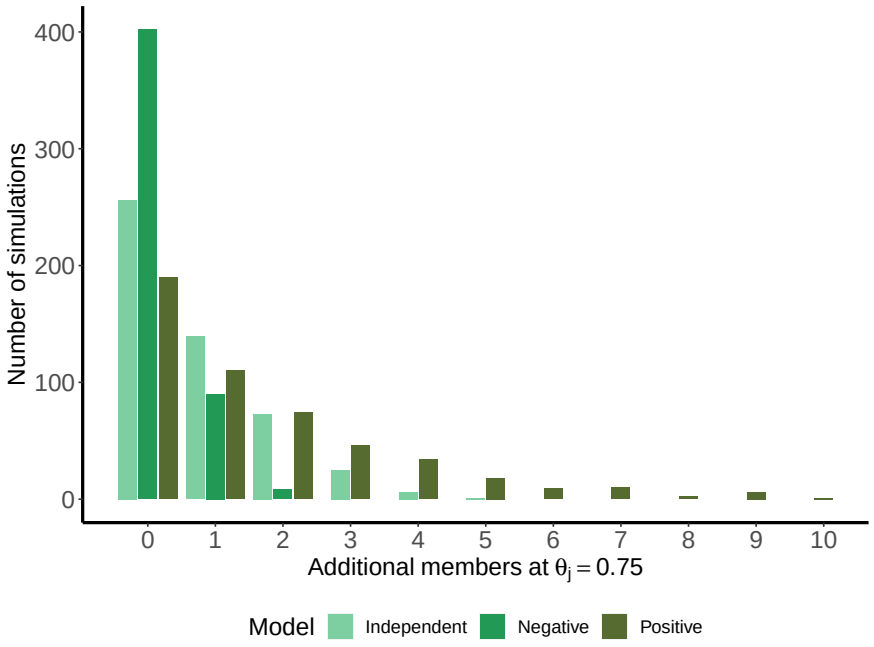

Figure APP-2: Number of additional members in a climate club when the most constrained core club member is excluded from initial bargaining over λ_j. The 500 simulations are the same as in figure APP-1, holding $\theta_j = 0.75$, and the result displayed here is the number of additional members in that simulation when the most constrained member is excluded. Models are for situations when climate preferences and trade flows are independent versus positively and negatively correlated.

IV. 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 θ_j or λ_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-3 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 nearly doubles, with the accession of 23 new countries. 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 only 0.6% more within the club than before, and accession members now trade 6.0% more into the club than before. However, the average non-member's trade with the club only increases by 0.8%, which using the same accession rule as above would only bring one further new member into the club. Accession stalls out.

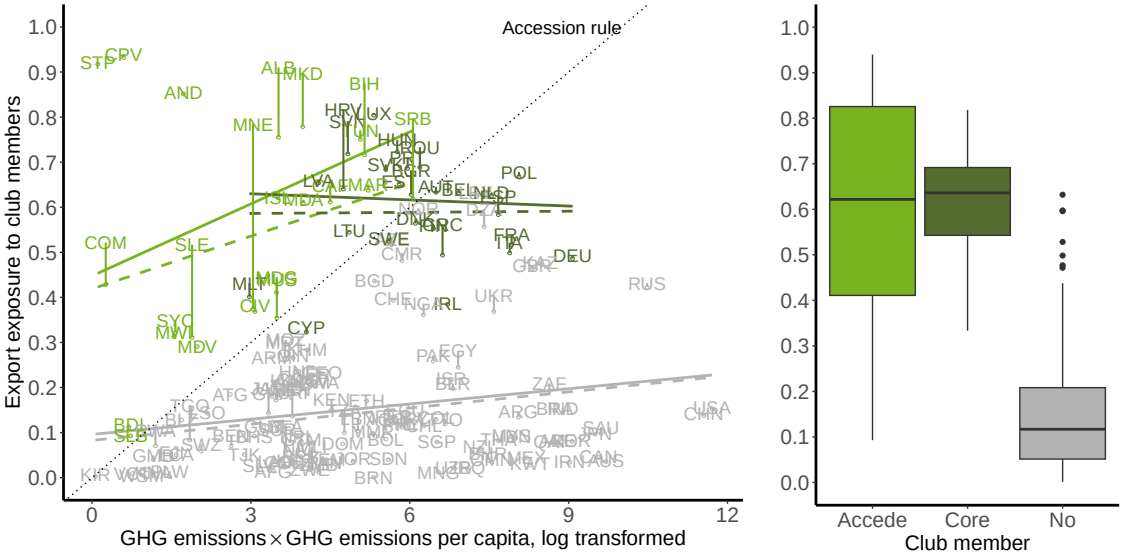

Figure APP-3: Illustrating accession dynamics in the insulation/EU club. Core members (darkest green) are EU member states, including the UK; non-core members accede to the club (light green) following the membership rule outlined above (dotted line); and states that never join are in grey. *y*-axis 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.

V. 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-4, 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. Nearly 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

[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.

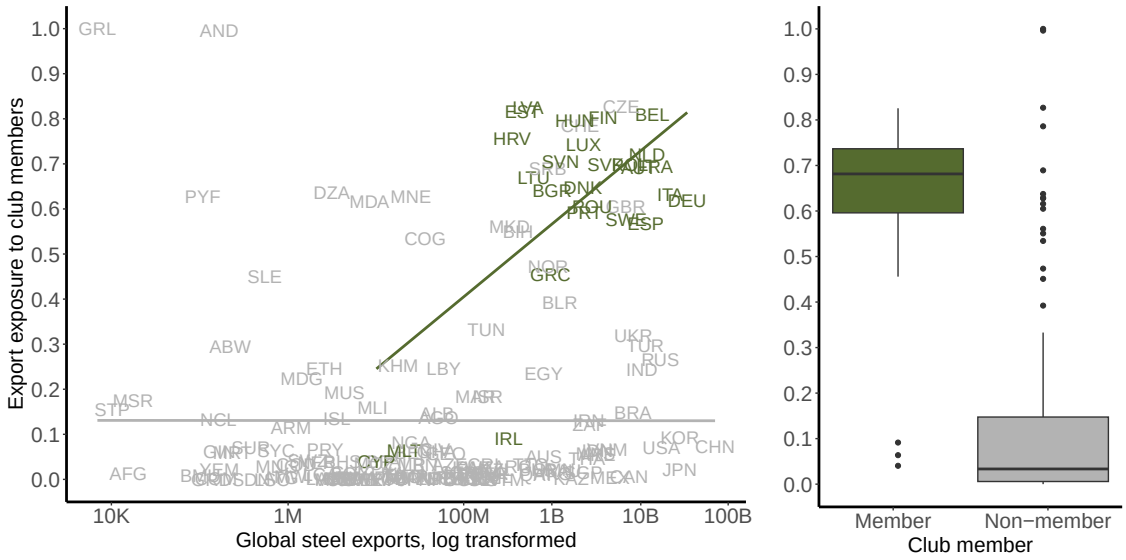

Figure APP-4: EU club members in green, non-members in grey; total global steel exports (logged) on x-axis, versus export share into the EU on y-axis

exporters. None of the top 5 non-EU exporters—China, South Korea, Japan, the United States, or Russia 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 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.

VI. 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 seven energy-intensive trade-exposed sectors—iron and steel, aluminium, cement, chemicals, fertilizer, electrical energy, and polymers. 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-5, 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 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

[2]European Commission proposal, COM(2021) 564 final, amended by the EU Parliament, 2021/0214(COD) in June 2022.

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

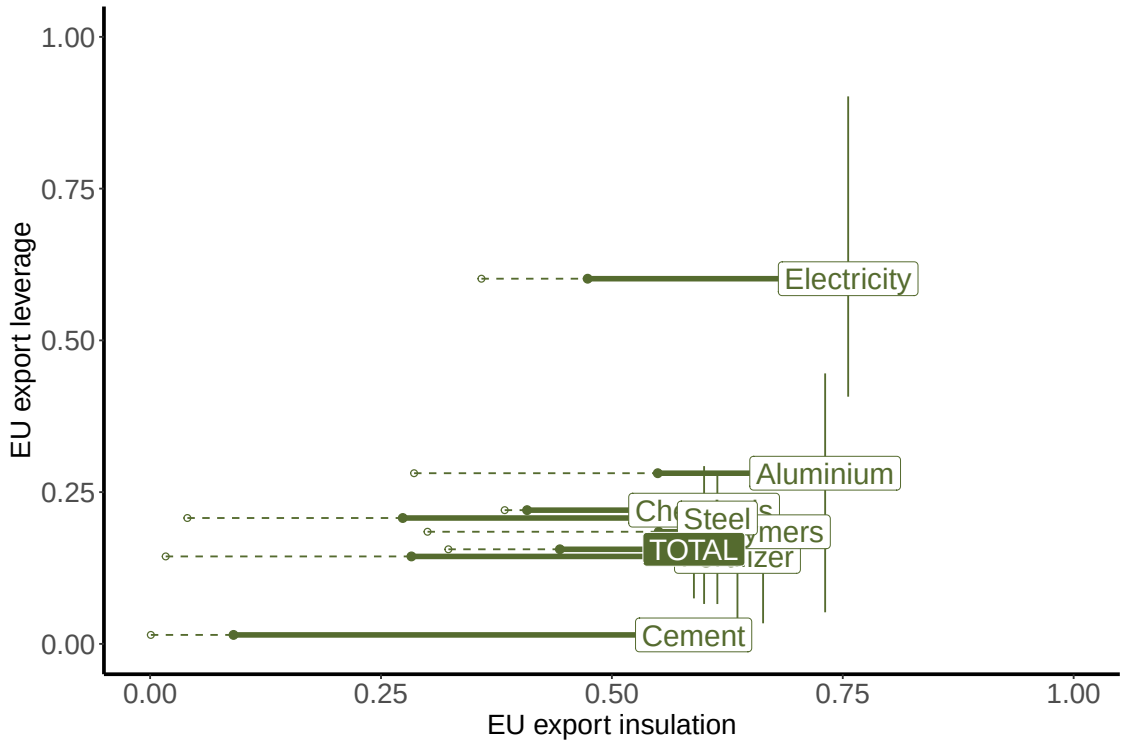

Figure APP-5: Export insulation and leverage for 7 CBAM sectors. Marker labels placed at the mean within-sector insulation and leverage. Vertical whiskers indicate the interquartile range of within-sector leverage over the 15 largest non-EU sectoral exporters; horizontal whiskers show decreasing levels 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).

others. I measure the EU's export insulation and leverage in six other high carbon sectors,[4] and 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

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

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	0.156	0.589	0.444	0.323
CBAM	0.236	0.656	0.376	0.198
Aluminium	0.281	0.731	0.550	0.286
Cement	0.015	0.589	0.090	0.001
Chemicals	0.220	0.600	0.408	0.384
Electricity	0.602	0.756	0.474	0.359
Fertilizer	0.144	0.636	0.283	0.017
Polymers	0.185	0.664	0.551	0.300
Steel	0.207	0.614	0.274	0.040
Other high carbon ($n = 6$)	0.204	0.629	0.422	0.160
Sampled ($n = 16$)	0.223	0.576	0.273	0.100

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

NDC club	Leverage club
Bangladesh	Afghanistan
Benin	Belarus
Bhutan	France
Cambodia	India
Cameroon	Iraq
Chad	Mexico
Comoros	Netherlands
Congo - Brazzaville	Singapore
Congo - Kinshasa	Thailand
Côte d'Ivoire	Turkey
Cyprus	United Arab Emirates
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"
CBAM codes listed in European Parliament 2021/0214(COD), 22 June 2022, Annex I.		
Aluminium	CBAM	8 codes, in 76∗∗
Cement	CBAM	252330, 252310, 252321, 252329, 252390
Chemicals	CBAM	29, 280410, 281410, 281420
Electricity	CBAM	271600
Fertilizer	CBAM	10 codes, in 28∗∗, 31∗∗
Iron and steel	CBAM	38 codes, in 72∗∗, 73∗∗
Polymers	CBAM	39
Fossil fuels: coal, oil and gas	Selected high carbon	2701–2715
Cows and sheep	Selected high carbon	0102, 0104, 0201, 0202, 0204
Glass	Selected high carbon	70
Refrigerants	Selected high carbon	8415, 2903, 382471–382479
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
Overlap with selected carbon, dropped	Sampled	7007
Turbines	Sampled	8410
Aircraft landing gear	Sampled	8805