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25-16 Global climate cooperation after 2024

A proposal for a heavy industry climate coalition

Kimberly Clausing, Joe Aldy, Dustin Tingley, and Catherine Wolfram

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ABSTRACT

We explore the future of global climate cooperation in light of US withdrawal from global climate agreements and the reversal of US federal climate policy. At present, the free-rider problem hampers global collective action; the world needs better mechanisms to incentivize bolder climate policy. Toward this end, we suggest a heavy industry climate coalition. Countries would "join" the coalition by committing to apply a carbon fee (or an equivalent emissions trading system) to emissions-heavy industries, and they would couple that fee with a carbon border adjustment mechanism. We suggest a tiered pricing approach that would be sensitive to countries' economic development levels to broaden coalition participation. The coalition would pair the carbon-pricing mechanism with other inducements for members, including market access, climate finance commitments, and technology transfer agreements. We estimate that a heavy industry climate coalition has the potential to reduce worldwide emissions substantially, acting as a stepping stone for further international climate cooperation.

JEL codes: F18, H23, Q56, Q58
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Kimberly Clausing, nonresident senior fellow at the Peterson Institute for International Economics, holds the Eric M. Zolt Chair in Tax Law and Policy at the University of California, Los Angeles.

Joe Aldy is the Teresa and John Heinz Professor of the Practice of Environmental Policy at the Harvard Kennedy School.

Dustin Tingley is the Thomas D. Cabot Professor of Public Policy with a joint appointment in the Harvard Kennedy School of Public Policy and Harvard Government Department.

Catherine Wolfram is the William Barton Rogers Professor in Energy and a professor of applied economics at the MIT Sloan School of Management.

CHAPTER 4

Global climate cooperation after 2024: A proposal for a heavy industry climate coalition

Kimberly Clausing,[a] Joe Aldy,[b] Dustin Tingley[b] and Catherine Wolfram[c]
[a]University of California, Los Angeles; [b]Harvard University; [c]Massachusetts Institute of Technology

With the election of Donald J. Trump in November 2024 for a second, albeit non-consecutive, presidential term, it has become clear that the United States will not take a leading role on global climate cooperation in the coming years. The Biden administration had reaffirmed the United States' commitment to the Paris Agreement, and coupled this symbolic action with substantial climate policy aimed at domestic decarbonisation through both tax and regulatory levers. In contrast, both the prior and incoming Trump administrations' disdain for the United Nations Framework Convention on Climate Change (UNFCCC) process reflects an explicitly dismissive attitude to climate change as a policy problem. The second Trump administration has withdrawn from the Paris Agreement and initiated the roll-back of US regulations on power sector and tailpipe emissions; upcoming Congressional action (still unresolved at the time of this writing in mid-May 2025) may also repeal some or all of the Inflation Reduction Act's clean energy tax subsidies.

This chapter explores the future of global climate cooperation in light of recent developments in the United States, making two key arguments. First, following the reversal of US federal climate policy and its withdrawal from global climate cooperation, US emissions progress will depend instead on state-level policy action as well as dynamics resulting from prior policy adoption and technical change.

Second, because the world is falling short of necessary climate policy action, it will be useful to develop mechanisms that incentivise bolder climate policy. While the Paris Agreement and UNFCCC process have made important strides, the free-rider problem hampers global collective action. Toward this end, we suggest a heavy industry climate coalition – where 'heavy' industry refers to aluminium, iron and steel, cement, and fertilizers – as an important step forward. In a heavy industry climate coalition, countries would 'join' by committing to apply a carbon fee (or an equivalent emissions

trading system) to emissions-heavy industries, and they would couple that fee with a carbon border adjustment mechanism. Coalition participants could also pair carbon-pricing sticks with carrots, including market access, climate finance commitments, and technology transfer agreements.

This coalition approach has key advantages. First, for coalition members, industrial carbon pricing can reap large emissions reduction benefits while raising fiscal revenues. We estimate that a heavy industry climate coalition based on a modest carbon price has the potential to reduce worldwide emissions by 1.5%, or 570 million tonnes (Mt) per year, if the 17 G20 jurisdictions that presently employ some form of carbon pricing participate, or as much as 2.7%, or 1030 Mt per year, if participation covers the vast majority of the world. Second, the coalition mechanism will encourage policy adoption momentum by giving coalition 'members' preferential market access and other benefits relative to 'non-members'. Indeed, this latter feature provides something that the UNFCCC process has so far lacked: an enforcement mechanism to counter the free-rider problem that stymies global collective action in tackling climate change.

The EU Carbon Border Adjustment Mechanism (CBAM) provides a useful starting point in countering free-rider incentives, but more work is needed for this approach to suit the rest of the world. First, the coalition could support harmonisation of measurement, monitoring, and verification criteria as well as administrative processes across jurisdictions to reduce compliance and administration costs. Absent coordination, global firms risk facing dozens of disparate regimes and are wary of revealing sensitive information to foreign governments. A more predictable, transparent, and administratively simpler approach would generate less opposition from the business community. Second, the 'common but differentiated responsibilities' principle central to the UNFCCC climate process can be more effectively honoured through a plurilateral approach. By agreeing on differentiated obligations for coalition membership that are based around commonly accepted metrics of economic development, a plurilateral agreement can better meet the needs of poorer countries, jurisdictions that have limited resources and that often bear little to no responsibility for climate change.

The European Union has been understandably loath to violate WTO principles regarding non-discriminatory trade measures. Yet, in the context of two international agreements, in which the principle of one (common but differentiated responsibilities) may be in tension with the principle of the other (non-discrimination), countries can find a sensible middle ground that encourages broad participation consistent with countries' capacities and the overall objectives of both the climate and trade treaties. Further, the WTO does contain special provisions that allow for members to treat developing countries more favourably.[1]

1 https://www.wto.org/english/Tratop_e/dda_e/status_e/sdt_e.htm

This chapter will describe how a heavy industry climate coalition can be negotiated and implemented, and how it can eventually serve as a stepping stone to the resolution of the world's biggest global collective action problem. While negotiation will not be easy, it is feasible. At present, the G20 jurisdictions account for about 80% of global carbon emissions, and most G20 countries are either utilising carbon pricing approaches or working towards that end (the exceptions are the United States, Saudi Arabia, and Russia, which together account for about 20% of G20 emissions).[2] Together, they can create a climate coalition that incentivises membership through both sticks (tariffs on carbon-intensive goods for non-members) and carrots (market access, technology transfer, and climate finance for members).

The Trump administration's stance on climate policy signals a retreat from US leadership in global efforts, leaving a vacuum for others to fill. Paradoxically, the absence of US involvement could facilitate coordination on price-based climate policies by reducing conflicts tied to US preferences. Still, nothing in our proposal precludes participation by the United States, and US heavy industry firms might have substantial incentives to participate if their competitors in markets around the world are part of the coalition.

US CLIMATE POLICY AFTER 2024

During the Biden administration, the US government built on prior tax and regulatory policies in passing and implementing the largest climate bill in US history, the Inflation Reduction Act (IRA). The IRA included more than $120 billion in public investment on climate projects, including conservation and carbon sequestration in the agriculture and forestry sectors, energy efficiency, industrial decarbonisation, and green lending. The IRA also provided extensive clean energy tax credits, intended to incentivise clean electricity production and investment, carbon capture, clean fuels, energy efficiency, electric vehicles (EVs), and clean manufacturing activity. The original estimate of the budgetary costs of these credits was about $270 billion, but Congressional scorekeepers have since more than doubled their estimates, and outside estimates are often even higher (Bistline et al., 2023; Goldman Sachs, 2023; Penn Wharton Budget Model, 2023).[3]

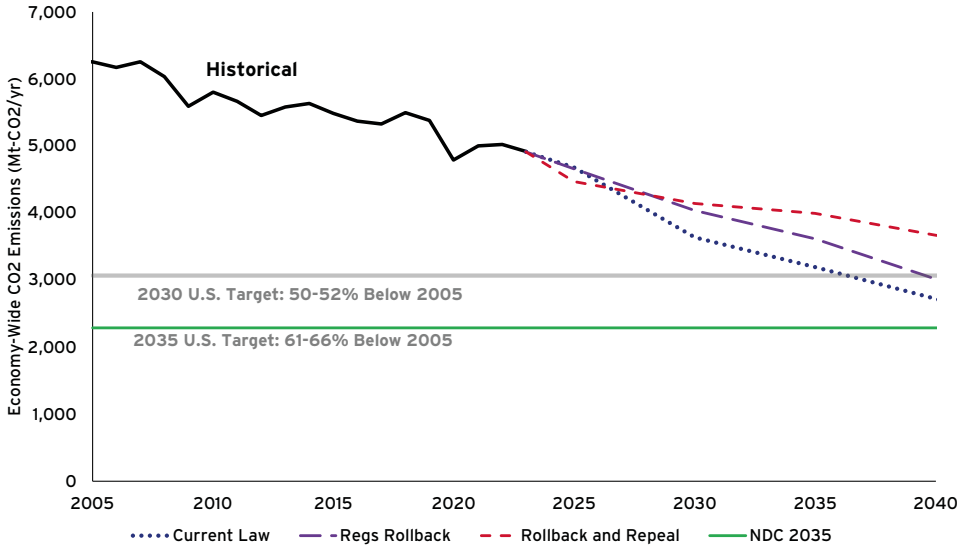
2 India and Brazil are implementing carbon pricing regimes; 15 other G20 members already use some form of carbon pricing. As of 2023, the G20 includes the African Union; the European Union is also a member of the G20. The European Union employs a carbon pricing regime, but most African Union nations do not. Our comparison of emissions is based on Climate Watch data for 2021. We consider carbon dioxide emissions including land use-change and forestry.

3 For a discussion of the evolution of these estimates, see Box 3-1 in Congressional Budget Office (2024). Outside estimates have some methodological differences relative to official scores.

Virtually all of the IRA clean energy tax provisions are uncapped; they are only time-limited, with most clean energy investments eligible for tax credits for as long as a decade after passage of the law.[4] In addition, major climate regulations can amplify the deployment of tax-favoured technologies, such as the Biden administration Environmental Protection Agency (EPA)'s standards on tailpipe CO_2 emissions standards for vehicles, fossil fuel power plants, and biofuels.[5] In March 2025, the Trump EPA initiated a review of these regulations, which could result in regulatory revisions that reduce their ambition.

The Biden-era tax and regulatory steps are forecast to reduce US emissions substantially relative to the prior status quo, or a scenario where such steps were reversed. Figure 1, drawing from analysis in Bistline et al. (2025), shows estimates of the US emissions path under three scenarios: the US current law scenario (which assumes Biden-era tax and regulatory policies continue); a regulatory rollback scenario (which assumes tax policies continue, but Biden administration power plant and tailpipe regulations are rolled back); and a regulatory and repeal scenario (which assumes regulations are rolled back alongside a full repeal of all IRA clean energy tax credits).

FIGURE 1 **US EMISSIONS UNDER THREE SCENARIOS**



Source: Bistline et al. (2025).

4 The IRA's main clean electricity provisions remain in place until an emissions target is achieved, which is projected to occur after 2040 (Bistline et al., 2023). Past experience with the investment tax credit for solar power, for example, illustrates how clean energy innovation can enable much greater deployment of a form of tax-favoured investment than initially projected by the scorekeeper – in the case of solar, about an order of magnitude more than initially projected (Aldy, 2025).

5 Layering regulation on the IRA tax provisions would double the investment in carbon capture technology in the power sector relative to the IRA subsidies alone (Aldy, 2025).

As is apparent from Figure 1, US emissions are on a declining trajectory, due to prior policy steps and technological progress. However, the downward trajectory is insufficient to meet US 2030 Paris Agreement emissions reduction goals, or the Biden administration's 2035 goals announced in December 2024, even under current tax and regulatory policies. Under other scenarios – either regulatory rollback, or rollback and repeal – US emissions reductions are more modest, falling even further short of US climate policy targets.

The Trump administration is likely to have far-reaching effects on US climate policy. The administration announced its plans to withdraw from the Paris Agreement and undertake a host of executive branch deregulatory actions in two day-one executive orders.[6] Indeed, regulatory rollback is likely, whereas a complete IRA credit repeal may be less likely, for two reasons.

First, the regulatory steps require only action by the executive branch, not Congress, and the Republican margins in Congress (53-47 in the Senate and, pending special elections, 220-213 in the House) are very tight, making Congressional action more difficult. With deregulation, the executive branch may act without Congress, but it must undergo a process of public engagement, which takes time, as evident in similar efforts in the first Trump administration (Aldy, 2017). Under some statutory authorities, such as for fuel economy standards, deregulation does not imply no regulation, but simply less-ambitious regulation. The Trump administration, however, has also increased uncertainty over the permitting of clean energy technologies, which could chill investment even before formal policy actions.

Second, the clean energy tax credits have benefited many Republican constituencies, and IRA investments have been disproportionately occurring in either 'red' (i.e., Republican) or 'swing' states, making it difficult for Congress to vote to reverse these large tax benefits.[7] For example, 18 Republican Members of Congress sent a 2024 public letter to the Speaker of the House of Representatives that noted: "Energy tax credits have spurred innovation, incentivized investment, and created good jobs in many parts of the country – including many districts represented by members of our conference".[8] There may even be room for some areas of bipartisan progress in Congress, including around issues like geothermal energy, nuclear energy, carbon capture, and permitting reform for energy infrastructure such as energy transmission and interconnection as well as pipelines for CO_2 and hydrogen.

6 https://www.whitehouse.gov/presidential-actions/2025/01/putting-america-first-in-international-environmental-agreements/; https://wci-inc.org/our-work/program-design-and-implementation

7 See, for example, https://www.ft.com/content/06fcd3dd-9c39-48d3-bb08-6d75d34b5ed1

8 See https://garbarino.house.gov/sites/evo-subsites/garbarino.house.gov/files/evo-media-document/FINAL%20Credits%20Letter%202024.08.06.pdf. Twenty-one Republican Members of Congress penned a similar letter in March 2025 to the Chair of the House Ways and Means Committee.

Still, the fiscal trade-offs will be stark in the 2025 tax debate, and changes to the tax code are nearly inevitable due to the looming expiration of much of Trump's 2017 tax legislation, the "Tax Cuts and Jobs Act". Indeed, the 2017 legislation was designed to permanently enact the less popular provisions (corporate tax cuts), while the more popular individual and pass-through business provisions were made explicitly temporary, reducing the scored budgetary costs of the legislation. Thus, the Republican-controlled Congress is expected to make every effort to extend the tax cuts, but the fiscal costs of extension are huge, approximately $5 trillion over ten years (Committee for a Responsible Federal Budget, 2024). Since IRA repeal could score as generating more than $700 billion, that revenue gain – alongside the inevitable attraction of undoing a signature Biden effort – may tempt legislators toward substantial or even full repeal (U.S. Department of the Treasury, 2024).

Even under a full 'rollback and repeal' scenario, however, there are still reasons to expect an ongoing decline in US emissions. First, some IRA investments have already occurred and those will continue to generate emissions reduction benefits into the future, as will prior investments under earlier clean energy tax credits. Second, technological change and business model development (both in the United States and abroad) will continue to drive clean energy adoption, as clean energy alternatives become less expensive relative to carbon energy sources. Indeed, these factors mitigated emissions rebound during the first Trump administration (Aldy, 2017).

Finally, there is an important role for US policy action by US states, cities, or tribal nations, and voluntary actions by US businesses can also be significant. For example, California has long been a leader in environmental regulatory efforts, and its policies have important spillover effects. Companies may not want to make a special 'clean' product for California alone, nor will they want to forsake such a large market (as California has the economic size of a large country), so they often choose to make products for the country (and the world) that meet California's higher standards. Other states may also follow California's regulatory standards; for example, the California zero-emission vehicle standards have been adopted by 17 states and Washington, DC, representing 37% of new, light-duty vehicle sales in the United States.[9] This dynamic was indeed responsible for important reductions in automotive pollution, and courts have recently upheld California's right to impose higher regulatory standards.[10]

9 This was calculated by the authors using data from the Alliance for Automotive Innovation (https://www.autosinnovate.org/resources/insights).

10 For one news story, see https://www.pbs.org/newshour/politics/court-upholds-californias-authority-to-set-nation-leading-vehicle-emission-rules. Related issues are currently before the US Supreme Court (see https://www.eenews.net/articles/supreme-court-spares-california-auto-emissions-waiver-for-now).

Climate commitments have also been affirmed in many US states. In 2024, California supported a $10 billion climate bond measure[11] and implemented new low carbon fuel standards,[12] the state of Washington upheld an emissions allowance system,[13] New York state continued to implement its 'cap-and-invest' programme,[14] and the Governor of Maryland introduced a sweeping climate executive order.[15] In prior years, US states and cities have formed coalitions, often alongside US businesses, committing to climate action. Some of these are even aimed at implementing carbon pricing, including the Western Climate Initiative[16] and the Regional Greenhouse Gas Initiative.[17] Thirteen states, representing about 20% of US electricity consumption, have cap-and-trade programmes covering the power sector with prices of at least $\$25/tCO_2$ by the end of 2024. Three of these states – California, Oregon, and Washington – extend these programmes to energy-intensive manufacturing industries, covering about 10% of US establishments in these industries.[18] A majority of US states implement renewable energy portfolio standards.[19] While some of these efforts are being challenged in US courts, they nevertheless demonstrate bottom-up state-level efforts.

THE FUTURE OF GLOBAL CLIMATE COOPERATION

Even though there are reasons to hope for continued progress in US emission reductions, the outlook for US leadership on the global stage is poor. Leaders from other countries will need to use existing incentives and institutions, or create novel institutional designs, to accelerate progress in addressing climate change. Progress to date has been woefully insufficient. By one measure, current policy action implies a warming of 2.7°C by 2100, well above the Paris Agreement goal of 1.5°C (Climate Action Tracker, 2024). Further, many indicators are worrisome, including ocean temperature increases, alerts about the collapse of key ocean currents that regulate climate,[20] and escalating tolls from climate-related disasters.

While the world community appears nearly unified in recognising the nature of the problem and the kinds of policy steps that are needed in response, other factors inhibit progress. Foremost, there is a free-rider problem. Climate change is a truly global externality, and action in any one jurisdiction benefits the entire world. Thus, when

11 https://www.kqed.org/news/12012256/californias-10-billion-climate-bond-ahead-with-a-strong-lead
12 https://ww2.arb.ca.gov/news/carb-updates-low-carbon-fuel-standard-increase-access-cleaner-fuels-and-zero-emission
13 https://apnews.com/article/washington-climate-law-repeal-initiative-vote-bbac4bb2601db447d783ba5c511c9cbd
14 https://nysfocus.com/2024/12/23/greenhouse-emissions-new-york-cap-and-trade
15 https://www.wypr.org/wypr-news/2024-06-05/maryland-governor-moore-mandates-statewide-climate-action-with-new-executive-order
16 https://wci-inc.org/our-work/program-design-and-implementation
17 https://www.rggi.org
18 Appendix A describes how we arrived at this estimate.
19 https://www.ncsl.org/energy/state-renewable-portfolio-standards-and-goals
20 https://www.euronews.com/green/2024/10/24/this-tipping-point-would-be-catastrophic-for-europe-but-scientists-are-unsure-when-well-re

individual jurisdictions contemplate the costs and benefits of climate action, they recognise that they bear the entire costs of their own policies but reap a tiny sliver of the policy's ultimate benefits. This reduces the incentive to act, and jurisdictions are instead incentivised to free ride on others' effort (Barrett, 1994; Nordhaus, 1994).

Further, there is no enforcement mechanism within the UNFCCC Paris Agreement process. Countries make their own nationally determined contributions (NDCs) to emissions reductions, and these are monitored and assessed, but countries that fail to make sufficiently bold policy commitments, or that fail to follow through on their commitments, face no penalty. The 'pledge and review' strategy of the Paris Agreement relies on naming and shaming, but the threat of reputational risk is an insufficient motivator for costly action, and it is undermined by the intermittent participation of the United States, the largest historical emitter.[21]

Another hindrance is the absence of leadership. While 'leadership' is a difficult element to pin down, it generally entails a subset of large, economically important countries (and their associated leaders) that are willing to expend diplomatic effort and resources for an extended period of time in order to further cooperation. At certain moments in history, countries have been able to work together to solve collective action problems. One formative example is the formation of the Bretton Woods institutions – the World Bank, the IMF, and the General Agreement on Tariffs and Trade (GATT) – in the wake of World War II to encourage reconstruction and development after the war, greater financial stability, and improved global integration. Another example is the Paris Agreement itself, which was reached after arduous diplomatic efforts as well as prior failures. And a third example is the international tax agreement of 2021 (now being broadly implemented), which includes about 135 jurisdictions representing about 95% of the world economy.[22] This agreement committed governments to transformative tax policy changes that seek to better tax mobile multinational company profits.

A HEAVY INDUSTRY CLIMATE COALITION

We propose a heavy industry climate coalition, arguing that it can help overcome the hurdles that impede international collective action. First, there are natural leaders in this space who would benefit from developing such a coalition. Second, and crucially, the coalition mechanism would help overcome the vexing free-rider problem by giving coalition members advantages relative to non-members, eventually incentivising broad policy action.

21 https://ourworldindata.org/grapher/cumulative-co-emissions

22 While the Trump administration issued a day one executive order withdrawing the United States, that order was toothless since Congress had already failed to implement the agreement, and a backstop provision will still extend the agreement to most large US multinational firms.

How would a coalition work?

Under the proposed heavy industry climate coalition, members would commit to charging a fee, or a carbon price, on the direct carbon emissions associated with the production of aluminium, iron and steel, cement, and fertilizer production (scope 1 emissions), as well as the associated electricity used in production (scope 2 emissions), affecting all production within their borders. The selection of these manufacturing industries reflects both their energy intensity and a desire for compatibility with EU and UK efforts. For these industries, members would also agree to impose carbon border adjustments (nondiscriminatory tariffs that apply domestic carbon price equivalents to imports) on non-member countries, but not to impose carbon border adjustments on other members.

Importantly, member countries would coordinate to develop common measurement, reporting, and verification standards as well as common administrative procedures. Metrics to assess and compare mitigation efforts should be comprehensive, measurable, replicable, and universal (Aldy and Pizer, 2016). The members would support a global scientific committee to refine methodologies and procedures on an ongoing basis. Setting such regulatory standards on a plurilateral basis is likely to generate more long-standing political support for the regulation; it can also counter the perception that the European Union is imposing its regulatory standards on others.

This effort would build on important work by the European Union on its Carbon Border Adjustment Mechanism (CBAM).[23] At present, the EU CBAM applies to scope 1 emissions in the aluminium and steel sectors, and both scope 1 and 2 emissions in the other CBAM sectors, but there is some thought of expanding the reach of the CBAM in the years ahead. Importantly, the EU CBAM credits exporting countries' carbon pricing in its tariff calculations. Thus, if an exporting country has a €20 per ton carbon price, and the European Union has a €80 per ton carbon price, the tariff will be based on the difference (€60 per ton). This regime rewards those countries with carbon prices with lower tariffs (and access to the European market, which offers a higher equilibrium price), and it also rewards cleaner production, as cleaner products naturally pay a lower carbon price, spurring decarbonisation efforts.

The EU CBAM represents an innovative solution to the problem of leakage. Absent border adjustment, countries may be reluctant to impose costs on their industries, since consumers may choose to import lower cost dirty products from abroad, or production may move abroad to avoid the cost-imposing regime. The CBAM is an answer to these concerns, albeit only a partial one.

23 We do not undertake a lengthy comparison with Nordhaus (2015), who proposes a climate club based on country climate policy ambition, using a uniform tariff on all goods as an incentive. For a discussion of that alternative, see Clausing and Wolfram (2023). A G7 climate club initiative put forward by Germany is described by Erbach and Scalamandrè (2023) through the European Parliamentary Research Service.

First, since carbon prices on exports are not rebated, EU firms may still face competitiveness issues in markets abroad. Second, most CBAM goods are inputs, not final products. If the carbon price becomes a sizable component of some final goods' costs, there will still be an incentive to move production offshore. This latter mechanism will be limited if the component carbon cost is small, or if the input goods are used in non-traded production such as domestic construction.

Our proposal builds on the EU CBAM, but recognises that a plurilateral (or even multilateral) process can improve the EU CBAM in several key respects. First, the EU CBAM has been criticised for being administratively burdensome, but a plurilateral agreement can act to address these concerns in an inclusive manner while ensuring that a complex web of different regimes does not proliferate, creating multiplied compliance and administrative costs. Second, a plurilateral process can better honour the principle of common but differentiated responsibilities.

Third, the EU CBAM, since it does not include export rebates and falls on input goods, still generates competitiveness concerns for EU firms. But a coalition would facilitate wider participation in the CBAM regime, reducing those concerns substantially. It would also enable a smoother extension of the CBAM to scope 2 emissions for all sectors, or eventually to other sectors beyond heavy industry. Finally, in general, a larger agreement creates stronger incentives for those outside the agreement to 'join', helping overcome the collective action problems that plague climate change mitigation and reducing remaining competitiveness concerns.

We believe that a focused, plurilateral approach could serve as a stepping stone to a more comprehensive, multilateral approach. However, as a matter of practicality, initial negotiations are likely to be limited to a more modest number of jurisdictions, such as a willing subset of either the G20 or the OECD. The convening body for such an agreement is discussed below.

How would the coalition encourage broad participation?

The biggest advantage of a plurilateral approach is that it can address the 'common but differentiated responsibilities' principle that lies at the heart of the UNFCCC climate cooperation process, and addressing that concern would build support for participation in the agreement. We suggest several key elements that would help drive broad participation.

First, and most important, the minimum carbon price commitments would be tiered, acknowledging different levels of economic development (and indeed different degrees of responsibility for the underlying problem of climate change). Following Parry et al. (2021), we suggest three pricing tiers for lower-, middle-, and higher-income countries,

perhaps at €25, €50, and €75 (inflation indexed over time).[24] This tiered design is intended to give lower-income countries stronger incentive to join and to address concerns that CBAMs would otherwise disproportionately harm them. Tiering also offers flexibility for negotiation, with several clear levers to adjust, such as the price levels assigned to different countries, the duration of price discounts, and the speed of adjustments for free allowances and variations in cap-and-trade market designs.

Members would commit to minimum carbon prices that reflect their tier, and they would not face CBAMs from other member countries if they are pricing at their committed level. Countries would apply CBAMs to non-member countries. Whether they charge a lower tariff for lower-income non-member countries (or vary that discount) depends on how members weigh the desire to incentivise membership versus the desire to recognise differentiated responsibilities.

Whether poorer countries are in fact harmed by policies such as the EU CBAM is an empirical question. As the European Union removes the free allowances for EU producers and phases in the CBAM, EU prices for covered goods will rise, benefiting exporters who sell into Europe. At the same time, such sellers will face a tariff, potentially harming sellers.[25] For the cleanest producers, the price increase should dominate the tariff effect, and producer surplus will increase. For the dirtiest producers, the opposite is the case, and producer surplus may fall and/or producers may choose to divert their production to other non-CBAM markets, where prices are lower.

Whether poorer countries' producers gain or lose will depend on the emissions intensity of their production. Early evidence from Clausing et al. (2025) suggests that there is not a strong relationship between emissions intensity and GDP per capita, indicating heterogeneous effects on lower-income country producers. Still, there is ample concern about negative effects on poorer countries (Eicke et al., 2021; Magacho et al., 2023).

24 One could also include a fourth tier of exemption for the poorest countries without affecting many emissions; the 26 countries that the World Bank classifies as low-income generate 2.2% of world carbon emissions, and less than 1% of emissions in the CBAM industries. Still, several low-income countries have relatively clean production in the heavy industries and export the vast majority of their output, so they stand to gain fiscal revenues from imposing their own carbon price on heavy industries (Clausing et al., 2025).

25 In many cases, the incidence of a tariff falls on consumers in the market that levies the tariff, and the same would be expected in markets that implement CBAMs, such that European consumers (directly or indirectly) pay higher costs for steel, iron, aluminum, fertilizers, cement, and electricity in the case of the EU CBAM. The consumer burden from tariffs arises because world supply to any particular country is close to perfectly elastic, so the consumer side of the market bears the entire tax burden. In theory, large countries can drive down the world price of goods when they levy tariffs, by lowering worldwide demand for such goods and raising worldwide supply of such goods. In practice, these 'terms-of-trade effects' have not been observed in the multiple studies that have considered the case of recent US tariffs on Chinese goods (see Clausing and Lovely, 2024). Still, the larger the coalition that is levying such tariffs, the more likely it is to generate such terms-of-trade effects that harm exporters.

Our approach will help guard against such negative effects in multiple ways. Both a tiered pricing structure and the promise of uniform measurement, reporting, and verification standards will make joining a heavy industry climate coalition far more attractive than otherwise, hopefully encouraging broadly inclusive coalition membership. A larger coalition increases the effectiveness of the coalition by increasing its market size; non-members may seek to join the coalition in order to secure tariff-free access to the coalition markets.

Membership will also come with other benefits. For governments, industrial carbon pricing will generate domestic revenue that can be used for any fiscal need, including investing in mitigation or offsetting any household cost increases. Household costs are likely to be very minor for industrial carbon pricing, particularly for lower-income countries that export the bulk of their production, but they could be more significant for countries that implement broader carbon pricing.

The coalition could also induce broad participation with other desirable incentives. For instance, in clean energy production, access to key inputs (such as critical minerals) and technologies is often a pressing issue. In joining the coalition, countries could commit to barrier-free trade in clean energy inputs and enhanced sharing of technologies. With respect to trade, members could commit to forgo export restrictions (often weaponised in the past), to forgo tariffs on clean-energy inputs (except when needed to countervail subsidies, following WTO norms), and to avoid local content provisions.[26] Countries would together agree on a list of inputs to zero- or low-carbon production that would qualify for the liberalised regime. Technology sharing could be facilitated by the regular reporting of decarbonisation efforts in these industries, which would highlight progress, identify barriers, and facilitate coordination to accelerate technology transfer and innovation. Finally, member countries could work with the World Bank, the International Finance Corporation, and other large lenders to support clean technology investments in these industries.

Clean technology leaders, many of whom have traditionally been located in higher-income countries, would also benefit from these open access rules, and heavy industry in high-income countries would benefit from the reduced leakage concerns that a large coalition would entail. Global companies will benefit from a more uniform set of standards and procedures among coalition members. Most importantly, higher income countries would benefit from the policy momentum (discussed below) that the coalition approach promises.

26 Unfortunately, recent progress in the WTO has been slow, including on these issues. The Doha round failed to lower tariffs on environmental goods and services, or to achieve its other aims (Solleder and de Melo, 2019). Bown and Clausing (2024) suggest plurilateral reforms along the lines suggested in the text.

However, one shouldn't be excessively optimistic about the generosity of higher-income countries when setting the parameters of the coalition. Richer countries may be wary about providing lower pricing tiers for poorer countries, and commitments of climate finance and technical assistance, while highly desirable, can be difficult to muster in a world of pressing fiscal constraints. Thus, the precise parameters of these features of the coalition would certainly be subject to negotiation and innovation. For example, technology transfer could be done via partnership models between rich country and poorer country firms, which could help foster political support throughout (Gaikwad et al., 2025). This insight builds on earlier work on the domestic political economy of foreign aid which highlights that participating donor country firms can be important advocates of overseas engagement, while also including important roles for firm expertise in recipient countries (Milner and Tingley, 2015).

Still, well-off countries can be reassured that there would be provisions in place to 'graduate' countries when they become richer. In addition, it may be useful to sunset elements of the tiered preferences over time, perhaps alongside greater flows of climate finance and the earmarking of CBAM revenues toward a fund for mitigation and technical assistance for poorer countries.

Such steps could reassure governments of well-off countries that their firms would not be at a permanent disadvantage relative to those in poorer countries. Even though a temporarily lower carbon price would provide a competitiveness benefit for lower-income producers relative to EU producers, a plan to sunset would leave the long-run price signals aligned, reducing the incentive to migrate production out of EU markets. Further, EU firms' competitiveness in outside markets would be enhanced by the broader adoption of carbon pricing among coalition countries. Even if there were temporary leakage of emissions toward lower-income countries under tiered pricing, the emissions and competitiveness benefits associated with encouraging broader carbon price adoption are likely to dominate such effects, assuring that the proposal works in the long-term interest of global collective action around climate change.

Indeed, perhaps the largest benefit to all coalition members, and to the world, would be a genuine set of incentives to encourage bolder climate policy action. Indeed, as documented in Clausing et al. (2024), the early days of the EU CBAM have encouraged many governments to contemplate or implement new carbon pricing regimes, and media mentions of both carbon pricing and decarbonisation have surged accordingly. These incentives are particularly large for countries that are dependent on exporting carbon-intensive products to the European Union, as they have the most to gain from tariff free access to the EU market. Even the US public appears sensitive to the diffusion effects of CBAM (Ingles et al., 2024).

But the EU CBAM alone will provide less of a motivation for carbon pricing adoption than the plurilateral coalition we describe here. By folding its CBAM into a plurilateral effort, the European Union will avoid ill will abroad. While the tiered pricing structure will provide competitiveness advantages to lower-price countries, these advantages will be temporary, and they will act to help enlarge the coalition in a way that ultimately makes EU policies more sustainable.

While it is too early to say whether such policy momentum and diffusion will be long lasting, a heavy industry carbon coalition would be an excellent way to build on the carbon pricing momentum generated in part by the EU CBAM, and with time there would of course be room to expand the scope of the coalition, reaching other sectors of the economy beyond heavy industry.

Still, even a focus on heavy industry can reap large emissions reduction benefits. We estimate that the industries covered by the proposal account for about 20% of global carbon emissions. Using standard elasticities from the literature, we calculate that the heavy industry climate coalition has the potential to reduce worldwide emissions by 1.5%, or 570 mt per year, if the 17 G20 countries that presently employ some carbon pricing participate, or as much as 2.7%, or 1030 Mt, if participation covers the vast majority of the world.[27] Accounting for emission reductions in the electricity sector with the coverage of scope 2 emissions from the heavy industries could increase these estimates substantially.

The emissions reduction progress from a heavy industry climate coalition compares favourably to other benchmarks. For example, EU and US emissions in 2021 were 130 MT and 380 MT lower than they were in 2011, respectively.[28]

27 Appendix B discusses how we arrived at the global carbon emissions share and these estimates. We apply a carbon price semi-elasticity of -0.3% per $1 t/CO2 in 2023 US dollars. This is informed by estimates for carbon price semi-elasticities for aggregate emissions across economic sectors, which range from -0.02% to -0.52% per $1 t/CO2 in 2023 US dollars (Best et al., 2020; D'Arcangelo et al., 2022; Rafaty et al., 2021; Sen and Vollebergh, 2018). We assume a carbon price of $50 per t/CO2 in 2023 US dollars. For the G20 countries, we assume an average carbon price of $10 per t/CO2, and thus estimate the reduction on an additional $40 per t/CO2 carbon price. For the rest of the world, we assume an average carbon price of $5 per t/CO2, and thus estimate the reduction on an additional $45 per t/CO2 carbon price. We estimate that the G20 countries excluding Russia, the United States, and Saudi Arabia account for 62% of carbon emissions, based on Climate Watch 2021 data. We implicitly assume that the industrial share of emissions in these countries and the rest of the world are the same. Total 2022 carbon emissions are 38.5 Gt according to the Emissions Database for Global Atmospheric Research (Crippa et al., 2023).

28 Data based on Climate Watch. Of course, the challenges for these sectors to decarbonise are not uniform. Cement, for example, might be more challenging and costly. Nevertheless, our proposal helps to incentivise innovation that will reduce these costs.

How would the heavy industry climate coalition be negotiated?

The year 2025 will be a delicate one for international cooperative efforts, to say the least. Disagreements surrounding Russia's invasion of Ukraine and conflicts in the Middle East have exacerbated underlying frictions, and relations between the world's two largest economies (and emitters) – the United States and China – are fragile, especially in the trade context. While both countries have invested heavily in clean energy technologies and capabilities, those efforts have also been in tension, as each seeks enhanced global competitiveness in these frontier industries.

Political events also imply challenges ahead. Under President Trump, the United States has stepped back from global climate leadership and has withdrawn from international collaborative efforts entirely. While most countries are quite unlikely to follow this lead, Argentina has seriously broached this possibility.[29]

The European Union could be a natural leader in this space, but recent European policy debates have revealed large differences among member nations in terms of energy policy, and governments in leading states are absorbed with boosting defence spending.[30] The situation of some key Asian partners is also politically fragile, with Korea facing a particularly challenging time[31] and Japan also facing political changes.[32] Canada and Mexico are especially vulnerable to the Trump administration's tariff policies, despite the recently renegotiated free trade agreement (USMCA). Canada, despite having a generally successful and well-designed carbon pricing regime, has also faced pushback on carbon pricing.[33]

It may therefore seem like a quixotic time to suggest increased international cooperation around climate. Still, several factors are reassuring. First, all negotiations take time, and technical and procedural progress can be made ahead of any ultimate political agreement. As one example, the international tax agreement came together swiftly in 2021, but only after years of convenings and a slow, arduous progress at the technical and bureaucratic levels of governance. Second, the salience of the climate change problem increases year after year in a dramatic fashion, so even recalcitrant governments may be willing to work on effective policy solutions. Third, politically volatile times can also create odd opportunities for progress. As just one example, while the Trump administration seeks to levy indiscriminate tariffs on most of the rest of the world, other governments may find it useful to explore areas of commonality where they can work collectively and isolate the United States while at the same time achieving broader climate policy goals. Fourth,

29 https://www.batimes.com.ar/news/argentina/milei-says-hes-considering-taking-argentina-out-of-paris-agreement.phtml
30 Still, Germany's recent constitutional amendment to allow higher government borrowing sets aside at least €100 billion for climate action.
31 https://www.bbc.co.uk/news/articles/c878rjgv7d2o
32 https://www.bbc.co.uk/news/articles/c8xpev42g78o
33 The current prime minister, Mark Carney, removed the consumer side carbon tax, but he remains committed to industrial carbon pricing and carbon border adjustments.

Brazil, a global leader in clean energy, will host the Conference of the Parties (COP) for the first time since the landmark 1992 Rio de Janeiro conference. This moment carries significant symbolic weight, presenting an opportunity for bold climate action and novel policy innovation and collaboration.

Finally, as noted above, both the EU CBAM and analogous efforts elsewhere (including in the United Kingdom) have helped spur new policy momentum around carbon pricing, and the vast majority of G20 jurisdictions (15, with two more in progress) have already enacted some form of carbon pricing.[34] China, meanwhile, which produces 50% of global steel and almost 60% of global aluminium, is expanding the scope of its carbon pricing program to cover three of the four heavy industry sectors (all but fertilizer).[35] By working together, countries forming a coalition can generate real incentives (both 'sticks' and 'carrots') that make cooperation easier by making it self-interested. Thus, one need not rely solely on international goodwill to make progress.

Our proposal is also naturally amenable to 'dials' that might facilitate negotiation. For example, the number of pricing tiers, and the gaps in prices between them, are both negotiable. Lower price tiers could be designed to slowly converge with higher price tiers, and countries hitting development benchmarks would 'graduate' to higher pricing tiers. The degree of climate finance, technical assistance, and dedicated revenues are all variables. Finally, the trade agreement component might help spur broad participation by providing joining countries with more security in their trading relationships, alongside greater market access. These factors can drive increased flows of trade and foreign direct investment while furthering the efficiency of the energy transition.

To enable greater participation in, and compliance with the terms of, a climate coalition, its design could leverage emerging institutions under the Paris Agreement. Article 6.2 of the Paris Agreement promotes various forms of bilateral cooperation to facilitate progress on countries' NDCs. The linking of domestic cap-and-trade programmes serves as one approach consistent with Article 6.2 (Mehling et al., 2018).[36] Fully linking domestic cap-and-trade programmes with unfettered cross-border trade in emission allowances can both ensure common carbon prices among linked systems and obviate the need to report and verify carbon prices. Compliance with coalition membership could be determined by reporting comparable carbon prices or by fully linking domestic carbon pricing programmes.

34 India is expected to launch a domestic compliance carbon market by mid-2026 (see https://icapcarbonaction.com/en/news/india-adopts-regulations-planned-compliance-carbon-market and https://carbon-pulse.com/365604).

35 https://carbonherald.com/china-expands-carbon-trading-market-to-heavy-industries-targeting-emissions-reduction

36 For example, the EU ETS has formally linked with the Switzerland ETS, while Norway formally participates in the EU ETS. In both cases, Article 6.2 rules guide the accounting of flows in emission allowances (Hynes and Schneider, 2023). In the design of the CBAM, the EU exempts Switzerland and Norway (as well as Iceland and Liechtenstein, which also participate in the EU ETS) from the border adjustment mechanism.

Article 6.4 establishes the Paris Agreement Crediting Mechanism, which enables a firm or government to invest in a project in another country that reduces emission reductions. Emission offset credits could be sold to other firms or governments to demonstrate progress on emission reduction goals. The design of a climate coalition could account for such offset credits in a variety of ways (Aldy and Halem, 2024), but such policies need to be designed carefully; carbon pricing should apply to emissions broadly, not just to exported emissions, or reshuffling could undermine the goals of the policy.[37]

By designing the coalition consistent with Article 6 of the Paris Agreement, this initial plurilateral effort would establish a legitimate foundation for broadening access and participation in a more comprehensive, multilateral agreement down the road. It would also spur market-oriented strategies that could enhance cost effectiveness, strengthen economic ties, and promote political alignment among nations combating climate change.

There are also likely to be technical issues that need to be addressed, including how to ensure equivalence between pricing and emissions trading system (ETS) regimes, how to ensure the phase-out of free allowances under ETS regimes, how to pace and unify countries' pricing commitments in an environment where existing policies are heterogeneous, and how to support countries with lower administrative capacity.

During the negotiation window, delegates would meet to discuss all outstanding issues, some at the technical level and some at the political level. Once an agreement is reached, meetings would continue, refining implementation of the agreement, expansion of the agreement to new members or sectors, and handling other matters as they arise.

In our proposal, we do not specify either the leadership or the convening organisation for such an agreement. The former would depend in part on political developments among potential member states, and the latter may depend in part on the interests of those key leaders. The OECD facilitated the international tax agreement (alongside the G20 and a larger 'inclusive framework' that included a wide array of other jurisdictions). However, early political negotiations often involved a much smaller subset of jurisdictions, and China's "key partner" status at the OECD would need to be elevated to make serious progress on climate issues. Beyond the OECD and G20, we could also envision a role for the World Bank, the IMF, the UNFCCC, and other multilateral forums. However, the

37 Consider three design options. First, the certified emission reductions reflected in an offset credit could be used by a firm covered by the CBAM. Second, the price paid for offset credits could be used to reduce the border adjustment (e.g., the difference between the €75/t CO2 price commitment and the offset credit price). Third, the expenditures for offset credit purchases (the product of offset price and the quantity of offset credits) could be used to reduce the total payments a firm must make to sell a good into the coalition (Sandler and Schrag, 2024). This could create another margin of compliance that could entice participation by more developing countries, although there are also political economy issues in richer countries. For example, firms covered by the EU ETS may want comparable access to international offset markets to demonstrate compliance with their ETS obligations if their foreign competitors can use offset markets to demonstrate CBAM compliance.

risk of beginning with a wide forum is that diffuse interests may make the initial push toward agreement more difficult. Thus, we find it most plausible to imagine progress through a 'coalition of the willing' among the G20 countries that presently have a carbon price.

CONCLUDING THOUGHTS

What would a heavy industry climate coalition mean for the United States? In the short run, the US government would likely react to this development in either a neutral or unproductive fashion, perhaps threatening its own tariffs in response. While such a coalition would entail a well-justified and negotiated departure from nondiscriminatory WTO norms, outsider countries could even choose to cite the discriminatory nature of carbon levies (which would fall more heavily on high-income emitters) as a justification for retaliation.

However, the larger the coalition membership, the more futile such retaliation would prove. For example, if the vast majority of G20 jurisdictions that have an existing or contemplated carbon pricing regime all band together, they would cover nearly 60% of world GDP and more than 60% of world carbon emissions, and would include every major economy beyond the United States and two petrostates (Saudi Arabia and Russia).[38] That coalition would have substantial weight in the international community.

Further, with the system of sticks and carrots included in the heavy industry climate coalition, many jurisdictions throughout the world would have a strong incentive to join, potentially driving up membership to even higher shares of world emissions and GDP. Down the road, joining such a coalition could easily become an attractive option for future US administrations that are more focused on the problem of climate change.

At the start, the heavy industry climate coalition we envision would reach 20% of world greenhouse gas emissions, leading to an estimated 1.5% reduction in emissions. Progress in these sectors is important, particularly since the included industries are difficult to decarbonise. But in the end, the most important role of coalition would be to demonstrate how the use of incentives – both the enforcement mechanism of tariffs and the inducements of market access, freer trade in clean energy inputs, and climate finance – can help overcome longstanding and vexing global collective action problems.[39] As such, the coalition could become a stepping stone to larger climate policy efforts in the time ahead.

38 https://www.imf.org/en/Publications/WEO/weo-database/2024/October/weo-report

39 The use of an enforcement mechanism was also key to progress in the international tax agreement, in the form of an 'undertaxed profits rule' which allowed adopting countries to protect their tax bases from the profit shifting of companies based in non-adopting countries. That mechanism helped ensure adopting countries that non-adopters could not free ride on their efforts, degrading the value of the agreement.

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APPENDIX A

This appendix describes how we reach the estimate that between 6% and 10% of US economic activity in heavy industries is or will be covered by a carbon pricing program.

Overview of applicable cap-and-trade/emissions trading schemes

California, Oregon, and Washington all have some form of carbon pricing, cap-and-trade, or emissions trading programs that apply to energy intensive trade-exposed (EITE) industries. The programs are at different stages of implementation and have different specifications.

Of the three, California has the oldest such programme, having launched its cap-and-trade programme in 2013.[40] It covers sources that emit at least 25,000 metric tons of CO_2-equivalent greenhouse gases a year. California allows for allowance trading, with the 2025 annual auction reserve price set at $25.87 per CO_2-equivalent of emissions.[41]

Oregon's Climate Protection Program has been reinstated starting 2025.[42] While it covers sources that emit at least 15,000 metric tons of CO_2-equivalent greenhouse gases a year, EITE industries are only expected to face compliance obligations starting in the second compliance period, which will run from 2028 to 2029.[43] For EITE sources Oregon will issue 'compliance instruments' in the second compliance period, where each compliance instrument represents one ton of covered emissions. Each source is expected to receive compliance instruments that are equal to its average emissions from 2022 and 2023 multiplied by the emission reduction target. These instruments are tradable, and, additionally, EITE sources can meet up to 20% of their compliance obligation through Community Climate Investment Credits (CCIs), which are expected to be priced at $129 as of 2025 (International Carbon Action Partnership, 2024b).

Washington's Cap-and-Invest programme, which started in 2023, applies to facilities or businesses that produce more than 25,000 metric tons of carbon emissions a year.[44] However, EITE industries are given no-cost allowances each year to cover most of their compliance costs until at least the end of 2034. For 2023-26, EITEs in Washington are given 100% no-cost allowances of baseline emissions, with allowances declining to 94% for 2031-34. Allowances in Washington's auction in March 2025 sold for $50.[45]

40 https://www.c2es.org/content/california-cap-and-trade/
41 https://ww2.arb.ca.gov/sites/default/files/2024-12/nc-2025_annual_reserve_price_notice_joint_auction.pdf
42 https://oregoncapitalchronicle.com/2024/11/21/oregon-commission-approves-redo-of-landmark-climate-program-after-lawsuit-derailed-it/
43 https://olis.oregonlegislature.gov/liz/2023I1/Downloads/CommitteeMeetingDocument/287454 and https://digitalcollections.library.oregon.gov/nodes/view/301548
44 https://ecology.wa.gov/air-climate/climate-commitment-act/cap-and-invest
45 https://washingtonstatestandard.com/2025/03/12/washington-carbon-auction-prices-rise-again/

While free allowances are given (or are planned to be given, in the case of Oregon) in these programs, EITE sources still face a carbon incentive to reduce their emissions. As Washington's Department of Ecology notes: "Though EITEs receive no-cost allowances, they still have an incentive to lower emissions in the short-term if they're in a position to do so. This is because EITEs that emit fewer emissions than their allocation of no-cost allowances can save those allowances for future use, or they can sell them to other program participants".[46]

Share of heavy industries' activity covered by California, Oregon, and Washington

We use releases from the 2022 Economic Census, which provides data at the state and industry (denoted by NAICS) levels on variables such as employment, total sales, and number of establishments.[47] To identify which NAICS industry codes to use, we look to analysis by Congressional Research Service (CRS) on Border Carbon Adjustments (Congressional Research Service, 2024). The CRS analysis of the Clean Competition Act, which is considered to be similar to EU's CBAM, identifies the following 6-digit NAICS codes which correspond close to our definition of heavy industries: 325311 (nitrogenous fertilizers), 327310 (cement), 331110 (iron and steel), 331313 (aluminium), and 331314 (aluminium) (Rasool et al., 2024; Congressional Research Service, 2024)

In an ideal world, for these five industry codes, we would look at the share of national economic activity (proxied by variables like sales or employment) covered by California, Oregon, and Washington. However, to preserve the confidentiality of respondents, the Economic Census suppresses data for certain cells if they span only a few establishments. Thus, we keep scaling up to the broader industry code until we have non-suppressed data for all three states:

- For 325311 (nitrogenous fertilizers), we use the broader 5-digit code 32531 (fertilizer and compost). The former granular industry code constituted about 50% of the latter's national sales.
- For 327310 (cement), we use the 4-digit code 3273 (cement and concrete product). The former granular industry code constituted about 15% of the latter's national sales.
- For 331110 (iron and steel), 331313 (aluminium), and 331314 (aluminium), we use the 3-digit code 331 (primary metal). The three granular industry codes account for about 44% of the code 331's total national sales.[48]

46 https://ecology.wa.gov/air-climate/climate-commitment-act/cap-and-invest/emissions-intensive-trade-exposed-industries
47 https://www.census.gov/EconomicCensus
48 Author's calculations, based on the Economic Census 2022.

For these three codes (32531, 3273, and 331) of US economic activity, we calculate the shares contributed to by these three states. Of the US sales, employment, and number of establishments in these three industry codes, we calculate the shares in the three states to be 6%, 9%, and 10%, respectively.[49]

APPENDIX B

This appendix describes the sources for our estimate that the heavy industry climate coalition sectors account for 20% of global carbon emissions.

For carbon emissions from the four CBAM-affected manufacturing industries (steel and iron, cement, aluminium, and fertilizer), we use data from Bataille et al. (2024), which provides sector-level breakdowns of 2021 CO_2 emissions.

According to Bataille et al. (2024), the share of CO_2 emissions for the CBAM-affected manufacturing industries are 10.2% for steel and iron, 7.9% for cement and lime, 1.2% for ammonia production, and 0.5% for nonferrous metals, suggesting that about 19.8% of the world's CO_2 emissions are attributable to these four industries.

This value should be taken as an estimate since the definition of industries in Bataille et al. (2024) does not comport exactly with CBAM industries: for instance, CBAM only covers aluminium, but Bataille et al. (2024) use the value for nonferrous metals instead. Further, the values in Bataille et al. (2024) include all dedicated onsite CO_2 emissions, including for heat and power. These exclude emissions from utility electricity used for industrial processes, which account for a significant share of industrial emissions. While direct non-energy industrial emissions account for 26.8% of world carbon emissions, an additional 11.8% is attributed to utility electricity production for industry, resulting in 38.6% of carbon emissions being attributed to industrial processes.

Indeed, we find that the industry emission shares in Bataille et al. (2024) compare well for iron and steel, cement and lime, and ammonia, but less well for aluminium, which sources electricity largely from utilities. For instance, Kim et al. (2022) report that the iron and steel industry accounts for 7-9% of global emissions; Cheng et al. (2023) report that cement accounts for 5-8% of global emissions. McKinsey & Company (2023) and The Royal Society (2020) cite the share of carbon emissions from ammonia production as 1.2% and 1.8%, respectively. Estimates from the International Energy Agency suggest aluminium accounts for 270 Mt of CO_2 emissions in 2022,[50] which represents about 0.7% of global emissions. Factoring in indirect emissions, aluminium represents nearly 1 Gt of CO_2 emissions in 2022, implying an emissions share of 2.7%, well above Bataille et al. (2024)'s value for non-ferrous metals.

49 Author's calculations, based on the Economic Census 2022
50 https://www.iea.org/energy-system/industry/aluminium

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