A WTO Compatible Climate Club that Solves the Free-Rider Problem in Global Climate Policy

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May 21, 2024

Abstract

The voluntary Paris Climate Agreement (and the Kyoto Protocol) has failed to halt the global growth of greenhouse gases since it does not address the free-rider problem in international climate agreements. Although there are proposals that address the free-rider problem (e.g., Nordhaus, 2015), the absence of WTO-compliance in existing proposals has impeded them from gaining support in policy circles. We propose a Climate Club in which member countries commit to net-zero carbon dioxide emissions by 2050 with intermediate goals, impose uniform penalty tariffs on imports of non-members, high tariffs on carbon-intensive products of non-members and progressive tariffs on members who do not meet intermediate targets. We propose an institutional structure like the Montreal Protocol including that rich country members voluntarily contribute to a Multilateral Fund for developing country members with low per capita emissions. This Climate Club meets the conditions of successful cooperative agreements on common resources since it contains reciprocal commitments and has penalties for non-compliance. Importantly, it is WTO compliant under the GATT Exception clause for the conservation of exhaustible natural resources and it can be implemented immediately.

To achieve net-zero emissions by 2050, model estimates indicate the world needs both rapid technological progress to lower the costs of clean energy as well as an effective Climate Club. We propose that all high-income countries devote 0.20 percent of their GDP to technologies that lower the relative price of green energy or alternatives to other greenhouse gas emissions.

Keywords: Climate Club; World Trade Organization, free-rider problem; net-zero emissions, green technological change.

JEL classification: Q3; Q5; F18; K32; K33

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Acknowledgements: The author thanks Carolyn Fisher, Bernard Hoekman, Maryla Maliszewska, Will Martin, Constantine Michalopoulos, Petros Mavroidis, Indra Overland and Charles Sabel for helpful comments. Parts of this paper draw on Tarr *et al*. (2023) in *Energy Economics*. The views expressed are those of the author and do not necessarily reflect the views of ISET, the World Bank or those acknowledged.

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> "The parties to the agreement will allow…for the optimal use of the world's resources in accordance with the objective of sustainable development, seeking both to protect the environment and to enhance the means for doing so…."
> Preamble to the Marrakesh Agreement Establishing the World Trade Organization.

1. Introduction

Given that global warming depends on the *cumulative* greenhouse gas (GHG) emissions in the atmosphere, the Intergovernmental Panel on Climate Change (IPCC, 2022) estimates the planet's remaining "carbon budget" for limiting temperature increases to 1.5 or 2 degrees Celsius, and the IPCC states, with high confidence, "that global CO_2 [carbon dioxide] emissions would need to decline to net-zero to halt global warming." In response to these estimates, in 2021, almost 200 countries agreed to the Glassgow Climate Pact with the goal of "reducing global carbon dioxide emissions…to *net-zero around mid-century*, as well as deep reductions in other greenhouse gases."[1] Further, 151 countries have pledged to reach net-zero emissions, 141 of which commit to net-zero emissions by 2050.[2] Notwithstanding these pledges, we observe a continuation of the long-run trend of growing global carbon dioxide emissions, which reached 37 billion metric tons in 2021. The United Nations Framework Convention on Climate Change (UNFCCC) states that the commitments are not adequate to meet climate objectives.[3]

A clean atmosphere is a global public good from which no country can be excluded. Since limiting GHG emissions is costly, many countries prefer to "free ride" on the abatement efforts of other nations, while continuing to emit GHGs. There is no global government with enforcement power to compel costly national abatement policy. The fully voluntary Paris Climate Agreement and its predecessor, the Kyoto Protocol, have been unsuccessful in arresting the growth of global carbon emissions. Overcoming free riding by autonomous governments is a fundamental problem in reducing global GHG emissions.

To address the free-rider problem, Nordhaus (2015) proposes a Climate Club of governments in which members: impose a minimum price of carbon emissions at home; and impose an import tax surcharge of up to ten percent on all imports from non-members. Nordhaus recognizes that the penalty tariff surcharge violates World Trade Organization (WTO) law and proposes an amendment. We summarize experience with WTO amendments that shows that an amendment is not a viable option, and, to our knowledge, no government has proposed a Nordhaus-style Climate Club.[4] We believe the lack of

[1] See: the Glasgow Climate Pact, para. 17 at https://unfccc.int/documents/310475.
[2] Calculated from data available at: https://zerotracker.net/. Accessed March 21, 2024. Stern and Lankes (2022) find that intermediate actions lag the long-term promise of nations.
[3] https://unfccc.int/news/climate-plans-remain-insufficient-more-ambitious-action-needed-now
[4] At its meetings in June 2022, the G7 countries agreed to form a *voluntary* Climate Club based on industrial decarbonization and international cooperation and partnerships.

a viable WTO option has significantly impeded the Nordhaus proposal from gaining support in policy circles.

Numerous model estimates (summarized in Browning *et al.*, 2023) find that to achieve net-zero CO_2 emissions by 2050, with average technological progress, carbon prices will have to rise to US$ 400 per ton or more. Nordhaus (2021) estimates that a well-structured international cooperative agreement on climate policy is needed, but it will still fall short of achieving net-zero emissions by 2050 without substantial technological advance that reduces the cost of clean energy. The second fundamental challenge is to achieve technological progress that substantially reduces the cost of reducing greenhouse gases.

The first research question we address is: how can we design an international cooperative agreement that (a) impacts the strategic decisions of countries such that all significant emitters of CO_2 will undertake significant abatement efforts and (b) is compliant with the existing laws of the World Trade Organization (WTO) and can be promptly implemented? The second question we address is how such an agreement can accommodate what the United Nations Framework Convention on Climate Change (UNFCCC) calls the "common but differentiated responsibility" of developing countries. Finally, we address the question of what the appropriate role of government subsidies for technological innovation is to lower the cost of alternatives to products that produce greenhouse gases.

For CO_2 emissions[5] we propose a Climate Club in which members:

(i) commit (with administrative plans and legislation) to net-zero CO_2 emissions by 2050 with intermediate goals;
(ii) impose a uniform tariff surcharge (of up to ten percent) on all the imports of all countries that are not members of the Climate Club, except products that lead to reduced GHG emissions, and possibly other environmental products;
(iii) impose high and progressive import tariffs and export taxes on trade in carbon-intensive products with non-members;
(iv) impose a progressive tariff on members who fail to meet intermediate goals.
(v) Rich countries will contribute to a Multilateral Fund to assist developing country members of the Climate Club in their transformation to net-zero emissions. To access these funds, developing country members must have per capita CO_2 emissions below an agreed threshold.

Our Climate Club contains commitments that are reciprocal, monitored and with penalties for non-compliance. Consequently, it meets the essential conditions of the economic research of multiple sub-disciples on how to obtain a sustainable cooperative agreement on common resources. Economic research shows that without reciprocity, the use of public goods will result in a tragedy of the commons. To impact the strategic decision of countries, this Climate Club provides substantial sticks and carrots to induce membership.

[5]In section 5.6, propose extensions of this Climate Club to control the most important other GHGs, namely, methane, nitrous oxide and hydrofluorocarbons.

Our case for WTO-compliance is based on GATT Article XX(g), known as the "Exception clause." It stipulates conditions under which WTO members may *immediately* apply trade measures for the "conservation of exhaustible natural resources" even if they violate their WTO commitments. To avoid a finding of WTO-illegal discrimination, a Climate Club must permit alternate regulatory regimes that achieve comparable conservation of the exhaustible natural resource. By focusing on the objective of reducing aggregate GHG emissions rather than requiring a specific regulatory approach, we believe this Climate Club avoids a "discrimination" finding by the WTO and bypasses the immensely complicated task of defining equivalents between alternate regulatory approaches at the micro level.

We recommend carbon pricing as a core component of *national* carbon policy, but since carbon pricing is a specific regulatory approach, it cannot be a requirement of an *international* cooperative agreement that is based on GATT Article XX. This implies that the Nordhaus-style Climate Club cannot appeal to GATT Article XX.

To meet the challenge of technological innovation, we propose that developed countries devote 0.2 percent of their GDP to subsidies for game-changing technologies that would provide cost competitive alternatives to products that produce greenhouse gases. Cheap clean energy would play an important synergistic role with emission reduction regulations in encouraging clean energy.

The accommodation for developing countries is that members of the Climate Club who have low emissions would obtain access to the Multilateral Fund. Further, developing countries are not responsible for subsidies to technology. Finally, for the poorer countries that are below an agreed threshold of per capita emissions, we propose to allow Climate Club membership with a slightly extended deadline for net-zero emission and lower penalty tariffs for non-members.

We provide the key data on GHG emissions in section 2. These data show that it is crucial to include all substantial emitters of GHGs in emission reduction, both in developed and developing nations. In section 3, we summarize the literature on how to design an effective cooperative agreement on common resources. The WTO experience with amendments and Dispute Settlement Body decisions under GATT Article XX(g) are discussed in section 4. In section 5, we elaborate the rationale for the rules of our Climate Club, a proposed institutional structure, how to accommodate developing countries and extensions of the Climate Club for other GHGs. In section 6, we provide a rationale and proposal for developed countries to subsidize game-changing technologies that are cost competitive alternatives to products that produce GHGs.

2. All significant emitting nations need to reduce carbon emissions.

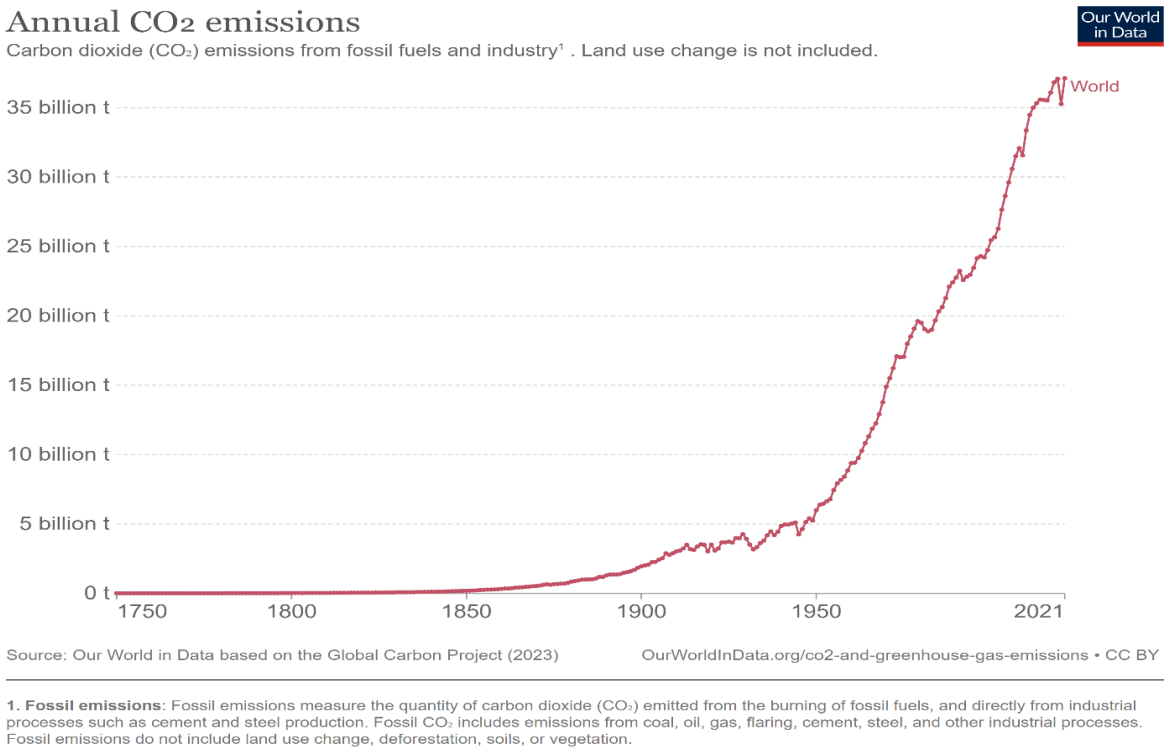
2.1 The growth of human-induced carbon emissions

Figure 1 shows the growth of human-induced carbon dioxide emissions since 1750. The growth accelerated after 1946. In billions of metric tons, these have grown from 1.85 in 1900, to 4.64 in 1946,

22.76 in 1990, 35.56 in 2015 and reached 37.12 in 2021. The Kyoto Protocol, which was designed to reduce emissions from a base year of 1990, succeeded in limiting emissions among many industrialized countries, but failed when measured in aggregate terms (Maamoun, 2019). The Paris Agreement was signed in 2015. The rate of increase in emissions has fallen, but global emissions have increased.

Figure 1. Annual Human-Induced Carbon Dioxide Emissions, 1750-2021.

In billions of metric tons



1. **Fossil emissions**: Fossil emissions measure the quantity of carbon dioxide (CO_2) emitted from the burning of fossil fuels, and directly from industrial processes such as cement and steel production. Fossil CO_2 includes emissions from coal, oil, gas, flaring, cement, steel, and other industrial processes. Fossil emissions do not include land use change, deforestation, soils, or vegetation.

2.2 The impact of cumulative carbon emissions on global surface temperatures.

The Intergovernmental Panel on Climate Change (IPCC) is the UN body responsible for assessing the science related to climate change and its impacts. With contributions from hundreds of scientists, it provides periodic "Assessment Reports" of the scientific basis of climate change and its impacts. We highlight three important estimates from its Sixth Assessment Report.

First, IPCC (2022, p. 59) estimates that "the likely range of human-induced change in global surface temperature in 2010–2019 relative to 1850–1900 is between 0.8° Celsius to 1.3° Celsius, with a central estimate of 1.07° Celsius." That is, the best estimate is that due to human-induced factors, the average temperature in the decade of 2010 to 2019 is 1.07 degrees Celsius higher than the average temperature of the second half of the 19th century.

Second, IPCC (2022, p.94) "reaffirms with high confidence… that there is a near-linear relationship between cumulative CO_2 emissions and the increase in global average temperature caused by CO_2 over the course of this century for global warming levels up to at least 2°C relative to 1850– 1900." The IPCC (2022, p. 94) estimates that the temperature response to *cumulative* carbon dioxide emissions likely falls within the range of 0.27° Celsius to 0.63° Celsius for each additional one trillion tons of carbon dioxide in the atmosphere, with a best estimate of 0.45° Celsius. The carbon dioxide emissions are global emissions, independent of the country of origin.

2.3 The carbon budget

The third important estimate of IPCC (20220 is the carbon budget, which is the estimated maximum amount of global carbon dioxide emissions that can be emitted to obtain a given probability of holding global temperature increases below a given temperature compared to the average temperature in 1850 to 1900.[6] We report key estimates in table 1. The IPCC estimates the carbon budget with a probability (we convert to likelihood percentages in the table).[7] The second line in table 1 shows that the estimated carbon budgets and likelihoods pairs to hold global temperatures to an increase of no more than 2 degrees Celsius above the average of temperatures in the second half of the 19th century. For example, that objective will be achieved with likelihood of 67% if the maximum cumulative global carbon dioxide emissions after 2020 are no more than 1,150 billion metric tons. The table shows that a decrease (increase) in carbon dioxide emissions will increase (reduce) the likelihood of holding the temperature increase to less than 2 degrees Celsius. For example, if the maximum cumulative global carbon dioxide emissions after 2020 are 900 billion metric tons, holding the temperature increase to less than 2 degrees Celsius will be achieved with likelihood 83%.[8]

[6] The literature uses the terms total carbon budget and remaining carbon budget. We are using the term "carbon budget" for the *remaining* carbon budget. The IPCC (2021, p. 2220) defines both concepts based on: "the maximum amount of cumulative net global *anthropogenic* CO_2 emissions that would result in limiting *global warming* to a given level with a given probability, considering the effect of other anthropogenic climate forcers. This is referred to as the total carbon budget when expressed starting from the *pre-industrial* period, and as the remaining carbon budget when expressed from a recent specified date."

[7] There is additional uncertainty in the estimate of the carbon budget since the estimates of the carbon budget take the median of the estimates of mitigation efforts of greenhouse gases (GHGs) other than CO_2 emissions but do not quantify the uncertainty of those estimates. The main GHGs and their share of carbon dioxide equivalent emissions in the U.S. in 2021 are carbon dioxide (79.4%), methane (11.5%), nitrous oxide (6.2%) and various fluorinated gases (3%). See: https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks

[8] The Global Carbon Project updated the IPCC estimates of the carbon budget from the beginning of 2020 to the beginning of 2023. With data from an additional three years of global emissions, they find that the carbon budget for 50% likelihood of retaining temperatures under 2 degrees Celsius fell to 1230 billion metric tons of carbon dioxide. They estimate that this is equivalent to 30 years at 2022 emissions levels. See Friedlingstein *et al*. (2022, p.814).

Table 1: Estimated (Remaining) Carbon Budgets from January 1, 2020

Likelihoods[a] depending on gigatons (billions of metric tons) of CO_2

Global Warming Relative to 1850-1900	Likelihood				
	17%	33%	50%	67%	83%
1.5°C	900	650	500	400	300
2°C	2300	1700	1350	**1150**	900

[a] Likelihoods are the probabilities (times 100) of holding temperatures within 1.5 or 2 degrees Celsius above the 1850 to 1900 average, based on **cumulative carbon emissions** after January 1, 2020.
Source: IPCC Technical Summary (2022, table TS.3, p. 98).

Table 2: Greenhouse Gas Emissions by Region and Major Countries, 1990-2019

In Billions of Metric Tons (Gigatons, Gt) of Carbon Dioxide *Equivalent* Emissions

					Change in Gt and %		Share of Global Emissions[a]	
	1990	1997	2015	**2019**	2019-1990	2019/1990		
World	**30.6**	32.9	46.1	**48.1**	17.5	157%	**1990**	**2019**
OECD (38)	14.2	15.4	14.9	**14.6**	0.4	103%	46%	30%
Upper Middle Income[b]	9.9	10.2	19.6	**20.9**	11.1	212%	32%	44%
Lower Middle Income[b]	4.5	5.0	8.2	**9.2**	4.7	205%	15%	19%
Low Income[b]	0.6	0.6	0.9	**1.0**	0.4	164%	2%	2%
The Leading Emitters								
China	3.2	4.3	11.8	**12.7**	**9.5**	**392%**	11%	26%
United States	5.8	6.6	6.1	**6.0**	0.2	103%	19%	12%
India	1.2	1.6	3.1	**3.4**	**2.2**	**278%**	4%	7%
European Union (27)	4.5	4.3	3.6	**3.4**	-1.1	76%	15%	7%
Russia	3.0	2.1	2.3	**2.5**	-0.5	82%	10%	5%
Japan	1.2	1.3	1.3	**1.2**	0.0	100%	4%	2%
Brazil	0.6	0.7	1.1	**1.1**	0.5	182%	2%	2%
Indonesia	0.5	0.6	0.9	**1.0**	0.5	211%	2%	2%

[a]The shares do not sum to 100, mainly because there are several rich countries that are not in the OECD, including Saudi Arabia and the other Gulf States.
[b]World Bank classification.
Source: Constructed from World Bank data available at:
https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE. Accessed May 16, 2023.

2.4 Global net-zero emissions

Net-zero emissions mean that all global emissions are either avoided or offset with activities that remove GHGs from the atmosphere, such as carbon capture from forests, oceans and other methods of carbon capture. IPCC (2022, p. 98) maintains "there is high confidence… that global CO_2 emissions would need to decline to net-zero to halt global warming."

Table 3 Greenhouse Gas Emissions (GHG) by Annex I[a] and non-Annex I Countries

GHG 2019 emissions in millions of tons of CO_2e (without LULUCF[b])

Annex 1 countries	GHG emissions	**Non-Annex I countries**	GHG emissions
USA	6,572	China	12,705
EU countries	4,044	India	3,395
Japan	1,210	Russia	2,123
Canada	738	Brazil	1,057
Australia	546	Indonesia	1,002
Turkey	508	Iran	894
United Kingdom	448	Saudi Arabia	723
Kazakhstan	360	South Korea	698
Ukraine	334	Mexico	653
Belarus	92	South Africa	555
New Zealand	82	Vietnam	450
Norway	51	Pakistan	432
Switzerland	45	Thailand	422
Iceland	5	Argentina	369
Liechtenstein	0.2	Egypt	351
Monaco	0.1	**Total of above**	25,829
TOTAL (Annex I)	15,035	**Rest of non-Annex I**	7,226
		TOTAL (non-Annex I)	33,055
	World Total	48,090	

[a]Annex 1 countries are the developed and transition countries that are parties to the UNFCCC treaty. Russia is an Annex 1 country but is included in the non-Annex I countries.

[b]LULUCF is land use, land use change and forestry.

Source: For Annex I countries: https://di.unfccc.int/time_series, accessed August 6, 2022. World Bank database for all other data, including total emissions reported at 46,288 million tons in 2019: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE, accessed August 11, 2023.

2.5 The majority share of global GHG emissions is from middle-income countries.

More than sixty percent of global GHG emissions now come from middle-income countries. Table 2, shows that, from 1990 to 2019, the share of global GHG emissions from middle-income countries increased from 47% to 63%, while the share of OECD countries fell from 46% to 30%. An important explanation for these changes is the growth of emissions in China. Table 2 reports carbon dioxide equivalent emissions from all countries with at least one gigaton of carbon dioxide equivalent emissions in 2019. China almost quadrupled its emissions from 3.2 billion tons in 1990 to 12.7 billion tons in 2019. China is now the world's largest emitter, alone accounting for 26% of global emissions in 2019. Relative to 1990, by 2019 India increased its carbon dioxide equivalent emissions by 278%, from

1.2 to 3.4 billion tons. Brazil and Indonesia approximately doubled their emissions. While Russia remains a substantial emitter, it reduced its emissions by 18%.

Among the upper income countries, the European Union reduced its emissions by 24%, while the United States and Japan showed little or no increase in their emissions. Maamoun (2019) shows that, collectively, high income countries did not increase their emissions after 1990.

In table 3 we provide a list of the most significant countries regarding their GHG emissions. We group countries based on the classification of the Kyoto Protocol negotiations, under which only Annex I countries took commitments to limit carbon emissions relative to 1990 levels. The share of global emissions from non-Annex I countries in table 3 is 64% excluding Russia and 69% including Russia.[9]

The data in tables 2 and 3 show that it is crucial to involve all significant emitters in the world in GHG reduction. The developed countries alone cannot solve global warning.

3. How to design an effective international agreement on climate change[10]

3.1 The crucial role for reciprocity

Evidence from multiple disciplines finds that the key to obtaining voluntary cooperation in common-resource problems is *reciprocity*, encapsulated in the phrase, "I will do more if you do more." Elinor Ostrom was awarded the Nobel Prize in economics for her seminal work on real-world experience on communities that use cooperative agreements to sustainably manage common resources such as pastures, forest resources and fishing rights. In numerous cases, these communities have sustainably managed common resources over centuries. Ostrom (1990) and others, including Kraft-Todd *et al*. (2015) and Bowles and Gintis (2013), find that reciprocity is central to cooperation and sustainable management of common resources. Similar results have been found in numerous laboratory experiments, summarized in Fehr and Gächer (2000), and in game-theory studies of free-rider situations (Fudenberg and Tirole, 1991). These studies indicate that, to save the commons, users must cooperate; cooperation requires trust that others will adhere to the rules of the agreement, and trust requires a reciprocal agreement that is monitored and enforced. Ostrom (2009, pp. 35-36) summarized the results by stating: "*trust and reciprocity* as a necessary central core associated with successful cooperative action…. A key problem is monitoring." Ostrom (1990, p.59) finds that surprisingly small penalties for violating the agreement are effective at stabilizing the cooperative agreement.

3.2 The need for a comparable commitment

The research on common resources indicates that to achieve a good outcome for climate change, international negotiations must lead to reciprocal commitments. Reciprocity implies that countries will

[9] Russia is included in non-Annex I countries even though it initially took commitments under the Kyoto Protocol, but later withdrew.

[10] This section draws on Cramton *et al*. (2017) where the reader may find a more extensive treatment of these issues.

incur the costs of making significant reductions in carbon emissions when they see other countries making comparable commitments.

Neither the Kyoto Protocol nor the Paris Agreement obtained comparable commitments among the countries negotiating the agreements. The negotiators of the Kyoto Protocol attempted to define a common commitment on quantities of emissions, but developing countries (including China, India, Brazil and Indonesia) refused to take any commitments.[11] The Kyto Protocol set binding targets for carbon emissions only for 37 industrialized and transition countries (known as Annex I countries). Global emissions rose by 37 percent in the fifteen years following the signing of the Kyoto Protocol (from 1997 to 2012), with most of the global increase coming from developing countries.[12] Disappointing experience with these agreements has confirmed that national commitments for limiting GHG emissions which are independent of each other will not work.

Under the Paris Agreement, there was no attempt to obtain reciprocal commitments. The "Nationally Determined Contributions (NDCs)" are voluntary, there is no penalty for setting under-ambitious national targets, and there is no penalty for noncompliance. Despite the NDCs, global CO_2 emissions have increased since the signing of the Paris Agreement in April 2016. Table 2 shows that the growth of carbon emissions between 2015 and 2019 is primarily due to the growth of emissions among middle-income countries. During this period OECD countries reduced their GHG emissions by 0.3 billion tons, while middle income countries increased their emissions by 2.3 billion tons.[13]

3.3. Why was the Montreal Protocol so Successful

The Montreal Protocol (1987) for the elimination of Ozone Depleting Substances (ODS) is hailed as the most successful international environmental agreement. Ultimately, the Protocol was ratified by all the member and observer states of the United Nations, making it the first universally ratified treaty in United Nations history . The treaty addresses the need to avoid depletion of the ozone layer in the stratosphere. As a result of actions taken under the Protocol, scientists predict a restoration of the ozone layer to its 1980 levels by sometime between 2040 and 2060. In 2003, United Nations Secretary General Kofi Annan, characterized the Montreal Protocol as "perhaps the single most successful international environmental agreement to date."[14]

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[11] For a discussion of the negotiations see Depledge (2000). For specific country commitments see: https://unfccc.int/sites/default/files/resource/docs/cop3/l07a01.pdf#page=24

[12] See Maamoun (2019) for analysis. Data from World Bank database at: https://data.worldbank.org/indicator/EN.ATM.GHGT.KT.CE (accessed April 15, 2023).

[13] The International Energy Agency reports that: while there was a decline in carbon emissions of the world outside of China in 2020 and 2021, the carbon emissions increase in China more than offset the aggregate decline in the rest of the world over the same period. In 2021, China's CO_2 emissions rose to 33% of the global total. See: https://www.iea.org/news/global-co2-emissions-rebounded-to-their-highest-level-in-history-in-2021. Accessed September 10, 2023.

[14] See: https://ozone.unep.org/sites/default/files/Key_achievements_of_the_Montreal_Protocol_2012_0_0.pdf.

The annual Meeting of the Parties is the governing body for the treaty. The Parties are assisted by the Ozone Secretariat, which is based at the U.N. Environment Program. The Protocol established quotas on production and consumption of ODS at the national level which led to a phaseout and eventual ban on the production and consumption of ODS. The parties were given the flexibility within their respective states to choose the regulatory method to achieve the required reductions. There were also explicit constraints on trade, including bans on trade with non-parties to the Protocol in ODS goods and in selected products that contain ODS.[15] Failure to meet the targeted reductions was subject to a variety of severe penalties, including trade, financial and technological penalties.[16] In practice, non-compliance was addressed with consultations and technical and financial assistance, then cautions; the penalties were never exercised.[17]

With its reciprocal and comparable commitments, penalties for non-compliance with monitoring, the Montreal Protocol meets the required conditions for a successful cooperative agreement. Beyond these requirements, there are two aspects of the structure of the Montreal Protocol that contributed to its success. First, the Protocol contained a Multilateral Fund (MLF) implemented by four international agencies.[18] The MLF was funded by developed countries to pay for *additional costs* associated with the reduction of emissions from ODS abatement efforts of "Article 5" countries. Article 5 countries are developing countries that are *Montreal Protocol members* with less than 0.3 kg of ODS emissions per capita per year. As of November 2023, the cumulative contributions of developed countries to the fund totaled US$4.7 billion.[19] DeSombre (2000) and Stiglitz *et al*. (2023) argue that the Multilateral Fund was crucial to the success of the Protocol since it provided powerful incentives to attract developing countries.

Second, the Parties to the Protocol established four Technical and Economic Assessment Panels that included business representatives. Sabel and Victor (2022) conclude that involving business representatives in the technical panels led to recommendations that were implemented more rapidly and to more rapid knowledge transfer.

4. WTO Rules for a Compliant Climate Club

The founders of the WTO declared that an important objective of the WTO is to protect the environment and provide for sustainable development (World Trade Organization, 1994). Nonetheless,

[15] For details of the import and export constraints, see: https://ozone.unep.org/treaties/montreal-protocol/articles/article-4-control-trade-non-parties

[16] See https://ozone.unep.org/treaties/montreal-protocol/meetings/fourth-meeting-parties/decisions/annex-v-indicative-list-measures-might-be-taken-meeting-parties-respect-non-compliance-protocol.

[17] See Stiglitz *et al*. (2023).

[18] The MLF had a Secretariat and Executive Committee to evaluate and approve or reject projects to be paid out of the MLF. The MLF is implemented by: UN Environment Program (UNEP), UN Development Program (UNDP), UN Industrial Development Organization (UNIDO) and the World Bank- as well as bilateral agencies of non-Article 5 countries.

[19] http://www.multilateralfund.org/default.aspx

a Climate Club must be crafted carefully to both address the free-rider problem in effective international agreements on climate change and to be consistent with WTO law. In our view, the WTO and its predecessor, the GATT, have provided an international rules-based framework that has facilitated the reduction of trade barriers and an international trade regime that has led to very substantial benefits to the global community, including poverty reduction. We believe it is valuable to work within the laws of the WTO to avoid weakening the institution. In this section we explain why we believe the Climate Club we propose is compliant with existing WTO law.

4.1 WTO Amendment: Delays and Concessions

Experience with WTO amendments shows that passing an amendment would entail an excessive amount of time given climate needs and the negotiation process to obtain the required consensus for an amendment to the most-favored nation principle would likely render the amendment ineffective.[20] There have been only two amendments to the World Trade Organization (1994) agreement: the Trade Facilitation Agreement amendment, and an amendment to the Trade Related Intellectual Property (TRIPS)[21] agreement. Both amendments took about twenty years to become WTO law.

In the case of the Trade Facilitation Agreement, there was significant resistance from many developing countries that delayed formal negotiations for eight years. Developing countries preferred recommendations and exemptions based on implementation capacity, as opposed to mandatory trade-facilitation rules. To obtain the agreement of developing countries, the Trade Facilitation Agreement allows developing countries to opt-out of the obligation to undertake a commitment if they lack adequate implementation capacity, Neufeld (2014).

Judging by the difficult negotiations on the Trade Facilitation Agreement, an amendment to accommodate a Climate Club could be expected to be very contentious and time-consuming and may necessitate allowing developing countries to opt-out if they determine that they do not have the capacity to implement the obligation. This means the amendment would lack the crucial "reciprocity" of a commitment from developing countries. The data on GHG emissions shows, however, that it is essential to include the substantial emitters among developing countries in firm, reciprocal, commitments. A lack of reciprocity will discourage emissions reduction in all countries.[22]

4.2 GATT Article XX: the WTO Exception Clause

We base our Climate Club on Article XX of the GATT (1947), known as the Escape clause.[23] The Escape clause refers to ten categories of "exceptions" that allow a member of the WTO to impose

[20] Amendments that relate to either MFN or bound tariffs must be adopted by consensus. See World Trade Organization (1994, Article X) for the rules and process for an amendment to the WTO.
[21] For details of the TRIPS Amendment see: https://www.wto.org/english/news_e/news17_e/trip_23jan17_e.htm
[22] We do not regard a WTO "Waiver" as an effective strategy. A Waiver to the rules of the WTO usually requires a vote of three-fourths of WTO members (WTO, 1994, Article IX.3) and is subject to annual review and voting for its extension. (A consensus is required in some cases.) Given implementation costs, negotiations within the WTO to obtain the required votes for a Waiver is likely to be difficult; and due to the annual voting requirement, it would not be a permanent solution.
[23] The World Trade Organization adopted Article XX and most of GATT (1947) in its statement regarding the GATT in 1994. See: https://www.wto.org/english/docs_e/legal_e/06-gatt.pdf

measures, including trade measures, that depart from the member's obligations.[24] Our Climate Club would appeal to paragraph (g) of Article XX that provides an exception for measures relating to the conservation of exhaustible natural resources. The precise text of paragraph (g) is that it allows measures (including trade measures):

> "*relating to the conservation of exhaustible natural resources if such measures are made effective in conjunction with restrictions on domestic production or consumption;"*[25]

The measures must also be consistent with the preamble ("chapeau") to Article XX which states:

> *"Subject to the requirement that such measures are not applied in a manner which would constitute a means of arbitrary or unjustifiable discrimination between countries where the same conditions prevail, or a disguised restriction on international trade, nothing in this Agreement shall be construed to prevent the adoption or enforcement by any contracting party of measures*:" (the ten exceptions follow)

In principle, application of the Escape clause by a WTO member is subject to the Dispute Settlement process. Currently, however, the Dispute Settlement Mechanism is not functioning; until it begins functioning again, the Dispute Settlement Body cannot rule for or against any measure.[26] Nonetheless, to minimize the chance of a trade war, it would be prudent for the Climate Club to establish rules that are consistent with the precedents of the WTO established under the Dispute Settlement procedure.

Based on the key rulings of the Dispute Settlement Body relevant to exceptions for the conservation of an exhaustible natural resource, our Climate Club would have to show that (briefly): (i) carbon dioxide or other GHGs threaten an exhaustible natural resource; (ii) the trade measures applied contribute to the conservation of the exhaustible natural resource ; (iii) the measures are applied comparably on domestic production or consumption; and (iv) the trade measures do not discriminate among countries.[27] We assess whether our Climate Club can pass these tests in the next four subsections.

4.2.1 Do GHG emissions threaten an exhaustible natural resource? In the dispute settlement case entitled "United States— Standards for Reformulated and Conventional Gasoline," the Dispute Settlement Panel found (World Trade Organization, 1996, para. 6.37) that "a policy to reduce the depletion of clean air was a policy to conserve an exhaustible natural resource within the meaning of Article XX(g)." It ruled that the United States has a right to establish regulations to protect its air quality.

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[24] See: https://www.wto.org/english/res_e/booksp_e/gatt_ai_e/art20_e.pdf

[25] Also relevant for Climate Clubs, paragraph (b) allows trade measures "*necessary to protect human, animal or plant life or health*."

[26] The WTO states that: "Currently, the Appellate Body is unable to review appeals given its ongoing vacancies. The term of the last sitting Appellate Body member expired on November 20, 2020." See: https://www.wto.org/english/tratop_e/dispu_e/appellate_body_e.htm

[27] Section 4.2 draws on the work of Vidigal (2023), where the reader may find an elaboration of these tests.

The ruling was strengthened by the Appellate Body and adopted by the Dispute Settlement Body.[28] In "United States—Import Prohibition of Certain Shrimp and Shrimp Products," (hereafter U.S. Shrimp) the Appellate report declared that: sovereign states may act together bilaterally, plurilaterally or multilaterally, either within the WTO or in other international fora, to protect endangered species or to otherwise protect the environment (World Trade Organization, 1998, para. 185).

Although the WTO has not ruled specifically on the impact of GHGs on clean air, there is substantial scientific evidence that excessive GHGs in the atmosphere reduce clean air. As we show in table 1, the IPCC estimates the maximum capacity of the atmosphere (the carbon budget) to absorb further CO_2 emissions. Exceeding these additional cumulative global emissions will increase the likelihood that temperatures will rise to levels that are not acceptable by international agreement. Our Climate Club is aligned with the IPCC estimate (with high confidence) that the world will have to achieve net-zero CO_2 emissions. These estimates indicate that clean air or a clean atmosphere is an exhaustible natural resource that is endangered by CO_2 emissions.[29]

4.2.2. Do the measures contribute to the conservation of an exhaustible natural resource? In Brazil – Retreaded Tyres, (World Trade Organization, 2007, para. 155) the Appellate Body concluded that even an extremely trade-restrictive measure (e.g., the import ban imposed by Brazil) is justifiable as a component contributing to the objective of a broader regulatory regime of conservation of an exhaustible natural resource. The Climate Club we propose is based on the achievement of emission reduction, which is directly the measure of conservation of the exhaustible natural resource. It allows carbon pricing and all other measures that are designed to achieve a reduction of CO_2 emissions toward net-zero emissions by 2050. Provided a country has an effective plan for CO_2 emission reduction that is codified in its laws and is implemented over time, its domestic policies meet the requirements for membership in the Climate Club. This type of Climate Club should pass the test of contributing to the conservation of the exhaustible natural resource.

4.2.3 Are the measures applied on domestic production and consumption? Our Climate Club should pass this test since the first rule of our Climate Club is that members apply domestic measures to limit CO_2 emissions with monitoring of progress toward net-zero emissions. The tariff surcharge on non-members will be eliminated with comparable domestic measures to reduce carbon emissions.

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[28] See: https://www.wto.org/english/tratop_e/envir_e/edis07_e.htm The WTO ruled against the United States, however, due to its determination that the measure imposed on imports was more restrictive than its domestic measure and therefore constituted unjustifiable discrimination. The U.S. modified its rule on imports to come into compliance with the WTO ruling.

[29] The WTO has ruled that countries have a right to require environmental measures outside of their jurisdiction when there is a "sufficient nexus" between the exhaustible natural resource and the member government, World Trade Organization (1998, para. 133). GHGs emitted anywhere impact all countries which should establish a "sufficient nexus" between the GHG actions of all countries in global warming.

4.2.4 Do the measures arbitrarily or unjustifiably discriminate between countries where the same conditions prevail? The "chapeau" or preamble of Article XX prohibits *discrimination* between countries where the same conditions prevail. The U.S. Shrimp case yielded multiple important rulings on WTO law regarding GATT Article XX. We provide an appendix with details. The United States applied restrictions on imported shrimp unless the shrimp were caught under conditions that the United States judged to be safe for sea turtles. The Dispute Settlement Body of the WTO ruled that when members apply measures under GATT Article XX(g), other WTO members must be permitted to establish their own regulatory regime provided that regulatory regime provides equivalent or comparable protection of the exhaustible natural resource. Trade measures cannot be used against WTO members to compel them to impose the same or identical regulatory regime. The application of trade measures under Article XX to compel an identical or essentially the same regulatory regime was ruled arbitrary or unjustifiable discrimination under the chapeau (preamble) of Article XX. In ruling against the United States, the report of the Appellate Body (World Trade Organization, 1998, paras. 163-165, 186) stated (emphasis added):

> The actual *application* of the measure… *requires* other WTO Members to adopt a regulatory program that is not merely *comparable*, but rather *essentially the same*, as that applied to the United States shrimp trawl vessels…Other specific policies and measures that an exporting country may have adopted for the protection and conservation of sea turtles are not taken into account....***It is not acceptable for one WTO Member to... require other Members to adopt essentially the same comprehensive regulatory program, to achieve a certain policy goal, as that in force within that Member's territory, without taking into consideration different conditions which may occur in the territories of those other Members*** [emphasis added]…. Although the measure of the United States in dispute in this appeal serves an environmental objective that is recognized as legitimate under paragraph (g) of Article XX of the GATT 1994, this measure has been applied by the United States in a manner which constitutes arbitrary and unjustifiable discrimination between Members of the WTO, contrary to the requirements of the chapeau of Article XX.

This ruling compels us to define the regulatory requirements for a GATT Article XX-compliant Climate Club in rather broad or flexible terms regarding the regulatory approach to CO_2 reduction. Suppose, on the contrary, we impose a finite set of specific regulatory requirements for membership in a Climate Club. This Climate Club might exclude the regulatory approach of some WTO member (country A) that is comparably reducing its CO_2 emissions. Since country A does not meet the rules for membership in the Climate Club, its trade with Climate Club members would be subject to the trade restrictions. Using the language of U.S. Shrimp, the application of trade measures in this situation would appear to "constitute arbitrary and unjustifiable discrimination between Members of the WTO."

Consequently, our proposed Climate Club allows any regulatory regime that is designed to achieve a comparable percentage reductions of CO_2 emissions toward net-zero. Only the progress toward net-zero emissions would be monitored and potentially penalized, not the specific regulatory approaches.

A special case of this conclusion is that the Nordhaus-style Climate Club cannot use GATT Article XX as a WTO-legal basis for its Climate Club since it requires carbon pricing, which is a specific regulatory approach. (We discuss numerous other regulatory measures to achieve net-zero emissions in section 5.5.) Since WTO members must be permitted to take regulatory measures that yield equivalent or comparable reduction of CO_2 emissions, the WTO rules that such a regime is "discriminatory."

Further, in the U.S. Shrimp case, the WTO ruled against the United States since it ruled that a country imposing the trade measure under GATT Article XX must negotiate a compliance agreement in good faith with any impacted WTO member, taking their conditions into account (World Trade Organization, 1998). To comply with the ruling, the United States conducted negotiations that led to the Indian Ocean-South-East Asian memorandum of understanding (MOU) and its associated conservation and management plan that comprehensively protects six sea turtles.[30] Malaysia did not sign this MOU and brought a non-compliance Dispute Settlement case. Ruling against Malaysia, the WTO Appellate Body ruled that the U.S. followed the rulings of the Dispute Settlement Body in 1998. It found that Article XX on requires the U.S. to negotiate with all WTO members in comparably good faith, not to conclude an agreement (World Trade Organization, 2001, para. 134).

5. A WTO Compliant Climate Club for Effective Climate Policy

The key requirement of our Climate Club follows from (i) the scientific evidence of the IPCC on the existence of the carbon budget and the need for net-zero global emissions near 2050, and (ii) the universal government endorsement of net-zero emissions near 2050. In 2021 at COP26, almost 200 countries agreed to the Glassgow Climate Pact. The Pact declares that it is the goal of all these nations to limit global warming and states that it requires "reducing global carbon dioxide emissions…to *net-zero around mid-century*, as well as deep reductions in other greenhouse gases."[31] Further, 151 countries have already committed to a net-zero emissions target, 141 of these by 2050. Regarding the largest emitters of GHG, the European Union, United States, Japan and Brazil committed to net zero by 2050; China, Russia and Indonesia by 2060; and India by 2070.[32] Medium-term actions, however, lag the long-term ambition, and only a minority of countries have either codified their net-zero pledge into national legislation or

[30] https://www.cms.int/iosea-turtles/en/page/mou-text-cmp
[31] See: the Glasgow Climate Pact, para. 17 at https://unfccc.int/documents/310475.
[32] See: https://zerotracker.net/. Accessed March 21, 2024.

formed action plans.[33] We take as a constraint on the rules of our Climate Club that all significant emitting countries commit to, and take measures to implement, net-zero emissions by 2050.[34]

5.1 A Timely, Effective and WTO-compliant Climate Club

We propose a Climate Club among countries that are willing to commit, codify and implement measures to achieve net-zero CO_2 emissions by 2050. The initial Climate Club membership would be a "coalition of the willing." Member countries would agree to the five conditions described in the Introduction on which we elaborate.

5.1.1 Members are Free to Choose their Regulatory Approach. The first rule of our Climate Club is that it allows all regulatory approaches, subject to the constraint of committing in legislation and administrative actions, to reach net-zero emissions by 2050, with intermediate goals. Since all WTO members can flexibly choose their regulatory approach to achieve net-zero emissions, and to negotiate and join the Climate Club, this Climate Club would avoid a discrimination finding under GATT Article XX(g) due to the imposition of a specific regulatory regime. To solve the free-rider problem among nations in climate policy, however, reciprocal commitments toward net-zero GHG emissions with monitoring and penalties would be core principles. The domestic commitments to net-zero emissions would make the members compliant with the requirement under GATT Article XX(g) to apply domestic measures on production and consumption.

5.1.2 What Trade Barriers should the Climate Club Employ? The primary purpose of the trade barriers on non-members is to induce membership in the Climate Club and thereby induce countries to make hard commitments to net-zero emissions. A Climate Club forces a country to make a strategic decision between (i) the costs of abatement as a member of the Climate Club and (ii) the costs of the trade barriers or loss of other benefits provided to members. A secondary objective of trade barriers of the Climate Club could be the reduction of carbon leakage.

The trade measures we propose on imports of non-members are informed by multiple modeling estimates. First, the Stanford Energy Modeling Forum assembled sixteen modelling teams to estimate the impacts of net-zero on the United States, Canada and Mexico. In their summary of this project, Browning *et al*. (2023) report that, in the moderate green technological progress scenario, eight of the eleven models that report estimates of carbon prices for the United States estimate carbon prices would rise over time reaching US$400 per ton or more in 2050; the remaining three models report carbon prices in 2050 at between US$100 and US$200 per ton. With more optimistic assumptions of green technological progress, the models estimates of carbon prices in 2050 are reduced by between 15 and 65 percent.

[33] Stern and Lankes (2022) and https://net0.com/blog/net-zero-countries.
[34] The Climate Club may permit trading in emission rights which would allow some countries to have net-positive emissions by purchasing emission permits from net-negative emission countries.

Second, Nordhaus estimates that his proposed Climate Club can attract a wide membership at a price of carbon of US$50 per ton. At minimum carbon prices of US$100 or more, however, membership drops very significantly, even at the maximum uniform tariff surcharge of ten percent. Membership declines with higher carbon prices because they impose greater abatement costs on members. Membership increases with higher penalty tariffs since they impose greater costs on non-members of the Climate Club. But members also bear the costs of restrained trade from high tariffs, which explains why Nordhaus suggests a maximum tariff of ten percent.[35] Nordhaus (2021) estimates that his proposed Climate Club contributes to the net-zero objective but cannot achieve that goal without an optimistic assumption of green technological progress. The second rule of our Climate Club is the Nordhaus (2015) rule that members will impose a uniform tariff surcharge of up to ten percent on all imports from non-member countries, (we except goods that reduce GHGs and possibly other environmental goods). The combined results of Nordhaus and Browning *et al*. (2023), however, indicate that a ten percent uniform tariff surcharge on all imports of non-members alone is insufficient to induce wide participation in a Climate Club at carbon prices that are necessary for net-zero. Consequently, we investigate how to provide more carrots and sticks to increase membership.

Given that high uniform tariff surcharges impose costs on all countries, including Climate Club members, we ask what other measures our Climate Club can usefully employ to induce membership. First consider border carbon adjustment taxes on the embedded carbon of carbon intensive imports. The European Union has begun to implement these where they are known as the carbon border adjustment mechanism (CBAM). The CBAM, in principle, is designed to be a carefully crafted instrument with variable border carbon taxes that depend on the carbon intensity of the imported good (possibly firm or plant specific) and the carbon prices in both the European Union and the exporting country. Its proponents contend it is WTO-complaint without reference to the Exception clause. Nordhaus (2015, p. 1348) and Bekkers and Cariola (2022, p. 33) independently find that, for countries that are not regulating carbon emissions, the CBAM imposes costs that are too low to induce a significant number of non-coalition countries to take on the domestic costs of GHG abatement. Böhringer *et al*. (2016, p.45) find similar results, except that they estimate that a European-wide CBAM will induce carbon pricing in China and Russia. Since China alone accounted for 31.7 percent of global CO_2 emissions from fossil fuels in 2021,[36] inducing China to participate in the Climate Club is an important advantage. Although these estimates suggest that a CBAM will fall well short of inducing global carbon reduction measures, a significant advantage of a CBAM is that, in countries planning to regulate carbon emissions, the CBAM contributes to the political acceptance and likely implementation of domestic measures to limit GHG

[35] Compared with the more commonly employed Armington models, models that incorporate the evidence of firm heterogeneity find there is much less scope for unilaterally increasing tariffs and reaping terms-of-trade gains. That is, the "optimal tariff" is lower in models with heterogeneous firms. See Balistreri and Tarr (2022) and Caliendo and Feenstra (2024).

[36] See: https://www.iea.org/countries/china/emissions

emissions. This is because the CBAM neutralizes the competitive advantage of imports from countries that do not regulate carbon emissions; and model estimates are that it will have some, albeit limited, impact in reducing carbon leakage.[37] On the other hand, Böhringer *et al*. (2022) note, that it is extremely difficult to monitor and calculate the embedded carbon in imports, which will limit the effectiveness of a CBAM.

Members of the highly successful Montreal Protocol employed a set of much stronger instruments on targeted sectors or products responsible for emissions of ozone depleting substances. In trade with non-member countries, members were banned from both importing and exporting ozone depleting substances and a set of products that contain ozone depleting substances. The bans are equivalent to prohibitively high import tariffs and export taxes that induce zero trade. Eventually, all countries of the world joined the Montreal Protocol so discriminatory trade restraints were no longer applied. Stiglitz *et al*. (2023) note, as more countries join a Climate Club with import penalties on non-members, it becomes progressively more costly to stay out of the Climate Club, and the import barriers become less extensive as membership increases. One must be cautious, however, about generalizing from the Montreal Protocol experience to the strategic value of import tariffs and export taxes in a Climate Club since the costs of implementing net-zero CO_2 emissions are orders of magnitude higher than the costs of implementing the Montreal Protocol.[38] Further, to provide proper incentives, sector panels composed of technical experts would have to carefully define when a good or plant is sufficiently decarbonized such that its output is not subject to the high penalty tariff on carbon-intensive goods, something that Böhringer *et al*. (2022) indicate is extremely difficult. Nonetheless, the Montreal Protocol experience suggests that high import tariffs and export taxes on trade with non-members in carbon intensive products could increase membership, so this is our third rule in our recommended Climate Club.

The commitments of members must be monitored and penalized for non-compliance. The fourth rule of our proposed Climate Club is progressive tariffs on members who do not meet intermediate goals.

5.2 Institutional Structure and the Multilateral Fund for Developing Countries

Given the success of the Montreal Protocol as a cooperative environmental agreement, we propose an institutional structure based on its structure. The governing body of the Climate Club would be the Parties to the Agreement itself (the member countries), who would meet annually. The Parties to the Agreement would establish several advisory Technical and Economic Assessment Panels that include business representatives. The Parties would be assisted by a Secretariat operating in offices of the UNFCCC.

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[37] See Böhringer *et al*. (2012) and Tarr *et al*. (2023).

[38] The *cumulative* contributions to the Multilateral Fund of the Montreal Protocol from 1991 to November 2023 were US$ 4.7 billion. In the case of the Paris Climate Agreement, *in 2020 alone*, total climate finance provided and mobilized by developed countries for developing countries amounted to US$ 83.3 billion (OECD, 2022).

Since it is important to have carrots, not just sticks, to induce developing country membership, the Climate Club would establish a Multilateral Fund (MLF) for technical and financial assistance to developing countries. The fifth rule of our Climate Club is that access to these funds would be restricted to developing countries that: (i) are Parties to the Climate Club agreement; and (ii) whose per capita carbon emissions are less than an agreed minimum. Final decisions on which projects to fund would rest with an Executive Committee of the MLF, composed of an equal number of representatives from developing and developed countries. The Executive Committee of the MLF would be assisted by a Secretariat. The Fund's activities would be implemented by the World Bank and multiple agencies of the United Nations.[39] The Paris Climate Agreement commits developed countries to generate US$100 billion in aid (grants and preferred finance) to developed countries for climate activities. Contributions to the Multilateral Fund of the Climate Club would contribute to that pledge, not be in addition to that pledge and, to avoid discouraging developed country membership, would be voluntary. Given the conditionality linked to access to the MLF, developed country contributions to this MLF are likely to have a greater impact on the reduction of carbon emissions than the unconditional contributions linked to the Paris Climate Agreement.

5.3 Meeting the Challenge of Defining Comparable Commitments

There are both economic incentive issues and WTO-legal questions regarding our Climate Club requirement that members must take measures to achieve net-zero CO_2 emissions by 2050 by percentage reductions from initial emissions. This requirement is built on two pillars: (i) the scientific evidence on the limited remaining carbon budget and the need for net-zero emissions near 2050; and (ii) the political commitment in the Glasgow Climate Pact of 2021 of all countries in the world to achieve net-zero emissions around 2050. Consequently, we take as a hard constraint on our Climate Club that all significant emitters of CO_2 achieve net-zero emissions by 2050.

5.3.1 The Legal Challenge. We have explained in section 4.2.4 that any membership rule based on regulatory policies designed to achieve CO_2 reduction (such as carbon pricing) may be subject to a finding of discrimination by the WTO and introduces uncertainty in the relation between the regulatory policies and the objective of net-zero emissions. That is why our membership rule is based on the declared objective of all participating nations in COP26 to reach net-zero emissions by 2050, not the means to achieve that objective. Thus, our membership rule is a based on quantities of aggregate CO_2 emissions, not carbon prices or other regulatory policies.

Given a quantity-based membership rule, a remaining legal question is why choose percentage reductions as opposed to comparable absolute quantity reductions. Since our membership rule requires

[39] These could be the UNFCCC, United Nations Environment Program, United Nations Development Program and United Nations Industrial Development Organization.

greater reductions from those countries that have larger initial emissions of CO_2, would the WTO sustain our rule? We acknowledge that it is an unsettled question of WTO law whether a Climate Club can require percentage, as opposed to absolute reductions, in emissions. We respond, however, that *a percentage-based membership rule is the only type of CO_2 quantity-based membership rule that is feasible for the net-zero objective of all countries by 2050*. A rule for CO_2 reductions based on comparable absolute reductions cannot achieve net-zero emissions in 2050 due to the large disparity in initial emissions. If China annually reduces its emissions by the total emissions of Chad, it would take China about 7,000 years to reach net-zero emissions.[40] To reach net-zero near the mid-century, we clearly need greater absolute reductions from the larger emitters. This inevitably introduces some kind of percentage change rule for all countries where the sum of the percentage cuts from initial emissions equals 100 (not necessarily our suggested linear rule). That is, we believe the WTO would uphold our percentage-based decision rule since it contributes to the environmental objective of net-zero emissions by 2050.

In the case of 141 nations, net-zero by 2050 requires codifying and implementing measures to achieve what these countries have already independently pledged.[41] Significant emitters that have not taken the net-zero emissions by 2050 pledge (China, Russia and Indonesia, 2060; and India, 2070) will face the strategic decision of either improving their ambition and implementation for CO_2 emission reduction or face trade penalties.

Since the largest emitters of CO_2 are mostly the industrialized nations, larger reductions from the larger emitters partly addresses the equity complaint of some developing nations, i.e., the industrialized countries should take the largest reductions since they are primarily responsible for the *cumulative* CO_2 emissions in the atmosphere.[42] The contributions of the rich countries to the Multilateral Fund to assist developing country member countries that are low per capita emitters is also important for the equity issue. Similarly, we suggest below that the burden of subsidizing technology to lower the cost of clean energy for all falls on the developed countries.

5.3.2 The Economic Incentive Challenge. With respect to the economic incentives, some authors maintain (e.g., Nordhaus (2015) and Cramton *et al*., 2017) that it is necessary to impose a minimum carbon-pricing membership rule because an international agreement based on quantities or diverse regulations is too complicated to be possible. One argument for why an agreement cannot include quantities or diverse regulations is that it would be based on defining equivalents of regulations at the industry level. We agree it is excessively complicated to compare the regulations on industries across countries. In any industry, it is very difficult to compare a carbon tax on emissions in country A, with

[40] In 2020, Chad emitted 1,568 kilotons of CO_2, while China emitted 10,944,686 kilotons. See https://data.worldbank.org/indicator/EN.ATM.CO2E.KT

[41] Sweden, the UK, France, Denmark, New Zealand, and Hungary have made the legislative commitments to achieve net-zero emissions, and several other countries plan to. See: https://net0.com/blog/net-zero-countries

[42] Cumulative carbon dioxide emissions from 1751 to 2017 by country are (in billions of metric tons, and percent of global emissions): United States (399, 25%); EU 28 (353, 22%); China (200, 12.7%); Russia (101, 6%); Japan (62, 4%); India (48; 3%); South Africa (19.8, 1.3%); Australia (17.1, 1%); Iran (17, 1%); So. Korea (16, 1%); Brazil (14.2, 0.9%); Saudi Arabia (14, 0.9%); Indonesia (12, 0.8%); Kazakhstan (12, 0.8%). Source: Ritchie (2019).

different command-and-control regulations of the production methods in countries B and C and the carbon capture and sequestration methods in country D. These assessments of comparable or equivalent regulations would have to be done across many industries. And how do we compare regulations of emissions of households? The equivalents would have to be negotiated by Climate Club members, where one would expect contentious negotiations as some countries would lobby in favor of their own regulations. The task of obtaining a successful agreement along these lines is very daunting.

Although a micro-determination of comparability of regulations on carbon emissions appears extremely difficult at best, we bypass that problem by focusing on the macro goal of global net-zero emissions. The progress of a country toward net-zero emissions can and must be monitored. We think of carbon regulations as the inputs of a stochastic production function that has the reduction of carbon emissions as the output. It appears counterproductive to focus on the inputs, when we are concerned with the output and where we have great difficulty in defining the relationship between the inputs and output, but we can measure the output directly.

A second line of criticism comes from Cramton *et al.* (2017). They argue that since there is no international government, a *global* cap-and-trade regime, suffers from the problem of needing to agree on national shares (or quantities for each country) of the global cap. An acceptable agreement on the allocation of shares proved insurmountable in the Kyoto negotiations. A contributing problem is that the uncertainty of growth patterns introduces risk of having to buy permits on the international market. The criticism of global cap and trade is valid. However, global cap and trade is not our proposal and buying permits on the international market is not required (although it is permitted).[43] The Glasgow Climate Pact shows that, in principle, the countries of the world have agreed to their CO_2 quantity reductions.

5.4 Treatment of developing countries

The UNFCCC has adopted the principle of "common but differentiated responsibility" for the climate-change-abatement efforts of developing countries. The UNFCCC, the Kyoto Protocol and the Paris Agreement partly reflect that differentiated responsibility in their call for climate-related finance of US$ 100 billion annually provided or mobilized by developed countries for developing countries.[44] As explained above, the first accommodation of the Climate Club for developing country members is that developed countries would both contribute to the Multilateral Fund of the Climate Club and help arrange for preferred finance, where access to the Multilateral Fund of the Climate Club would be conditional on good performance on per capita CO_2 emissions.

Tarr *et al*. (2023) reviews several proposals[45] that go beyond climate fine'ance to accommodate the "common but differentiated responsibility" for developing countries. Based on the data of section 2,

[43] One could argue that there is a mathematical equivalence between global cap and trade with national shares of the cap and our proposed percentage cuts in initial emissions for all countries. Our response is that the world is much more concerned now about climate change than during the Kyoto negotiations. Net-zero by about 2050 is now a widely accepted goal that implicitly defines national CO_2 cuts or global shares of total emissions.
[44] See: https://unfccc.int/topics/introduction-to-climate-finance.
[45] Nordhaus (2015) proposes no penalty tariffs on the poorest countries. Parry *et al*. (2021) propose scaling the minimum carbon price of the Nordhaus-style Climate Club depending on development status. Several authors

an essential consideration of any proposal to accommodate developing countries is that that the trade penalties must apply to the large emitters of GHGs among developing countries to encourage them to participate in GHG emission reduction. Second, there is a need to preserve a common commitment between the developed countries and the large emitters of GHG among developing countries or there is a risk on non-participation by some developed countries, as occurred with the Kyoto Protocol. We find that it is best to tailor accommodation policies to the poorest countries that are low emitters of GHG. Based on this principle, as a start to the negotiation process, as an accommodation for developing countries, we suggest scaling the penalty tariff based on both development status and the significance of the emissions of the country, i.e., the lower the development status and the emissions, the lower the penalty tariff. Also, the poorest countries of the world who are not significant carbon emitters may become members of the Climate Club with a slightly extended deadline for net-zero emissions.

In section six we elaborate our proposal that rich countries devote 0.2 percent of their GDP to subsidies for game-changing technologies to make green technology cost competitive with processes and products that emit GHGs. A final accommodation for developing countries is that the subsidy burden falls on rich countries.

5.5 Why Carbon Pricing Can't be Required of Climate Club Members.

For individual countries, we support the widely held view among economists that carbon pricing, either by cap-and-trade or a carbon tax or a combination, should be *a core element* of a regulatory approach for reducing carbon emissions.[46] Carbon pricing is endorsed by many governments, corporations and organizations including the World Bank (2022), the Asian Development Bank (2021), the OECD (2021) and the staff of the International Monetary Fund (Parry *et al*. 2021).[47]

Carbon pricing, however, cannot be a requirement of a WTO-compliant Climate Club since it is a specific regulatory regime. Further, there are carbon reduction challenges that will require other regulatory measures either independent or complementary with carbon pricing. For example, in the crucial effort to decarbonize electricity generation, there are problems of network externalities and regulatory barriers to licensing new electricity sources to the network.[48] Other carbon emissions reduction approaches that a country could employ include: subsidies to innovative research and development for carbon-saving technology; command and control technical and performance regulations; removal of fossil fuel subsidies; support for carbon-saving infrastructure such as in transportation and buildings; subsidies for production and consumption of green energy; carbon capture and storage of

(including Cramton and Stoft, 2012; and Gollier and Tirole, 2017) have proposed a "Global Carbon Incentive Fund" that involves transfers into or withdrawals from the fund based on the emissions of a country compared to average per-capita world emissions.

[46] More than 3,600 economists endorse carbon pricing and have signed the "Economists' Statement." See https://www.econstatement.org/all-signatories.

[47] Sixteen countries plus the 27 countries of the European Union practice *some form* of nationwide carbon pricing.

[48] See Stiglitz *et al*., (2023, pp.8-9) for examples of the needed diverse regulatory policies for carbon reduction in the electricity and home and business heating sectors.

industrial gas; carbon sequestration through natural (e.g., forestation) and technological means; carbon dioxide recovery and storage from the atmosphere;[49] border carbon adjustment measures (known as the CBAM in the European Union)[50]; support for the voluntary and cooperative agenda of the G7 Climate Club; international sector agreements (Stiglitz *et al*., 2023); and local experimentation with international technology cooperation (Sabel and Victor, 2022).

A Carbon Club that *requires* carbon pricing, without taking into consideration other regulatory measures or conditions in another WTO member country that may have equivalent effect on GHG emissions has been defined as "discriminatory" by the WTO Dispute Settlement Body and therefore inconsistent with GATT Article XX(g).[51] In addition to the delays involved in the WTO amendment process and the likely ineffectiveness of negotiated op-outs for developing countries as discussed in section 4.1, we see it is highly unlikely that an amendment can be obtained that requires carbon pricing when the WTO regards a specific regulatory requirement as discrimination among WTO members.

5.6 Other Greenhouse Gases.

The most important other greenhouse gases are methane, nitrous oxide and hydrofluorocarbons. The Glasgow Climate Pact (para. 17) indicates these need a longer time frame to phase out. The Kigali Amendment of 2016 to the Montreal Protocol commits countries to cut production and consumption of hydrofluorocarbons by eighty percent by 2050.[52] Given universal membership of countries to the Montreal Protocol and its great environmental success, it is clearly best to leave responsibility for hydrofluorocarbons to the Parties to the Montreal Protocol.

How would the Climate Club expand to include methane and nitrous oxide. We propose an organizational structure for each of these two GHGs that is parallel to the institutional structure of our Climate Club above. It could be a total of three Climate Clubs or three sections within an aggregate Climate Club. Countries could be Parties to the agreement on one or two of the GHGs without being a Party to all three of the GHGs. Each section would have its own Secretariat operating with the UNFCCC offices. It would have Technical and Economic Assessment panels, Multilateral Fund and Executive Committee and Secretariat of the Fund. Given the difficult technical, economic, or scientific issues involved in eliminating methane and nitrous oxide, the Technical and Economic Assessment panels

[49] Some governments provide subsidies for carbon dioxide removal. For example, the U.S. provides a tax credit of $180 per ton for each ton of carbon dioxide a company can verify it has recovered and permanently stored.
[50] A well-designed and implemented CBAM should be successful at neutralizing the competitive advantage of imports from countries with weak carbon regulations and thereby contribute, importantly, to the political acceptance of carbon pricing. Model estimates presented in Tarr *et al*. (2023), Bohringer *et al*. (2012) and Bekkers and Cariola (2022, p.33) all show that a carbon border adjustment mechanism will have only a small impact on global carbon emissions.
[51] Further, it does make sense for a Climate Club to impose penalty tariffs on the exports of a country such as Bhutan or Suriname, which has been certified with net-zero emissions but may not employ carbon pricing.
[52] See: https://www.epa.gov/ozone-layer-protection/recent-international-developments-under-montreal-protocol

would have a very important role, as they did in the phasing out of ozone depleting substances under the Montreal Protocol.

We propose a Climate Club (or a section of an enlarged Climate Club) for methane (nitrous oxide) in which members:

(i) commit (with administrative plans and legislation) to phase out methane (nitrous oxide) emissions according to the plans of their Climate Club, with intermediate goals. These plans would include, where possible, total production and consumption quotas with phaseouts as in the Montreal Protocol;
(ii) On trade with non-members, impose high and progressive import tariffs and export taxes in the goods that are intensive in methane (nitrous oxide);
(iii) impose a progressive tariffs on members products that contain methane (nitrous oxide) who fail to meet intermediate goals.
(iv) Rich countries will contribute to a Multilateral Fund to assist developing country members of the Climate Club in their transformation to net-zero emissions. To access these funds, developing country members must have per capita emissions of methane (nitrous oxide) below an agreed threshold.

5.7 The Social Cost of Carbon

The social cost of carbon is the estimate of the monetary value of the additional damage to society of emitting one additional ton of GHG into the atmosphere. It is the marginal social cost of an additional metric ton of carbon emissions or, inversely, it is also the marginal social benefit of having one metric ton less of carbon emissions in the atmosphere. The marginal social benefit is an important estimate since we consider policies that require abatement costs to reduce carbon emissions. At a carbon price below (above) the social cost of carbon, the abatement costs are less (more) than the benefits of removing the carbon. Then the globally efficient carbon price is the social cost of carbon since, at that carbon price, the level of abatement costs of limiting carbon emissions would equal the marginal social benefit.

A report in 2017 by the National Academy of Sciences, Engineering and Medicine (2017) concluded that the estimates of the social cost of carbon available at that time no longer reflected the latest research in climate, demographic and economic science. A study by 24 authors (Rennert *et al.*, 2022) responded with updated estimates that incorporate the latest data and methodology.[53] Based on updated research on discount rates of future consumption and damages (Newell *et al*. 2022), their preferred near-term discount rate is two percent. In 2020 U.S. dollars, this yields a preferred estimated distribution of the social cost of carbon with a mean of US$185 per metric ton and a 90 percent

[53] Rennert *et al*. (2022) employ improved probabilistic projections of population and per capita income growth; recent climate system and sea-level models; and updated damage functions. The damage functions provide estimates of the US dollar impacts of climate change on agriculture, mortality, sea-level rise and energy consumption. The estimates use an empirically calibrated stochastic discounting framework of future values that is consistent with observed interest rates, stochastic economic growth and the theoretical contribution on stochastic discounting of Newell *et al*. (2022).

confidence interval of US$44 to US$413 per metric ton. The estimated mean of US$185 is substantially larger than any carbon price imposed anywhere in the world.[54]

5.8 Nuances and caveats

In their survey of Integrated Assessment Models, Gillingham *et al*. (2018) acknowledge considerable uncertainty regarding parameter values in their models. This uncertainty implies that the specific estimates are subject to a significant margin of error.

We limit the uniform tariff surcharge of the Climate Club to ten percent since we believe that higher uniform tariffs will likely impose costs on the members of the Climate Club. The argument for imposing a uniform tariffs is based on "terms-of-trade" effects; that is, if a country imposes a small uniform tariff starting from zero tariffs, it obtains benefits from "optimal tariff" considerations. Recent research by Caliendo and Feenstra (2024) and Balistreri and Tarr (2022), however, has shown that optimal tariffs are much smaller in models that incorporate the evidence of the heterogeneity among firms. Further, virtually all countries in the world have a regime with positive tariffs and many include some sectors with high tariffs (tariff peaks). Imposing a uniform tariff surcharge on top of a tariff line which is a tariff peak will likely induce losses, reducing the estimated gains from participation in the Climate Club.

6. Subsidies for game-changing basic research

6.1 The Importance Technological Progress to Complement the Climate Club

We noted that most models estimate that, with moderate green technological progress, U.S. carbon prices will have to exceed US$ 400 per metric ton in 2050 to achieve net-zero by 2050. Membership in a Climate Club falls as the carbon price (or costs of carbon regulations) increases. Then at these high estimated carbon prices, there is reason to question (e.g., Barret, 2018), that there are enough carrots and sticks in a Climate Club alone to induce adequate membership to achieve net-zero emissions. But with optimistic assumptions about green technological progress, the estimated necessary U.S. carbon prices to achieve net-zero emissions by 2050 fall by between 15 and 65 percent, which could be achieved with an effective Climate Club.

Regarding global objectives, Nordhaus (2021) investigates conditions under which his style Climate Club can achieve global net-zero CO_2 emissions by 2050. He concludes that neither the Climate Club nor rapid technological improvement for decarbonization alone will achieve net-zero global carbon

[54]These estimates are also three to four times larger than earlier estimates of the social cost of carbon based on the widely used DICE model. Rennet *et al*. (2022) explain the reasons for the higher estimates. First, Rennet *et al*. (2022) run the DICE-2016R model in default mode, which uses a 3 percent discount rate; this yields a mean estimate of the social cost of carbon of $44. Updating the demographic and economic projections but retaining other DICE default assumptions increases the mean estimate of the social cost of carbon to $59. Replacing the DICE damage functions with the updated damage functions increases the mean estimate of the social cost of carbon to $80. Finally, lowering the discount rate to two percent increases the mean estimate in the DICE model to $185, the same as estimated with the model used by Rennert *et al*. (2022). This decomposition shows that use of the lower discount rate is the most important reason for the larger estimates of Rennert *et al*. (2022).

emissions. But a strong Climate Club together with rapid technological change will be effective. His results are in table 4.

Table 4: The Need for both a Climate Club and Technological Advance

Policy scenario	**Global Emissions in 2050 Gigatons of CO_2 per year**
No Climate Club, base technologies	59.4
No Climate Club, rapid technology advance	32.6
Strong Climate Club, base technologies	26.5
Strong Climate Club, rapid technology advance	-2.5
Source: Nordhaus (2021, table 2)	

Technological change lowers the costs of the abatement of carbon emissions, so the Climate Club can achieve greater reduction of emissions at lower minimum carbon prices (or less costly carbon regulations), thereby attracting wider membership. Conversely, carbon prices provide incentives to technological development for decarbonization. An important nuance to the results of Nordhaus (2021) is that technological advance is exogenous in his model. Below we present evidence that emissions pricing induces faster technological advance to reduce emissions. The synergistic relationship between carbon pricing and technological advance would imply greater likelihood of rapid technological advance, and more likely attainment of net-zero emissions faster and at lower carbon prices.

6.2 The subsidy proposal

We call for the rich countries of the world to devote 0.2 percent of their GDP to basic research on game-changing technologies that produce cost competitive green energy and alternatives to greenhouse gas producing products and processes. The estimates in table 4 highlight the need for technological innovation to lower the cost of green energy production so that it will be adopted as a least cost method of producing energy, or at least at a cost that is significantly lower. Making green energy the least-cost choice is especially important in inducing green energy adoption in developing countries. Diverse analysts of Climate Change share this view,[55] including the Breakthrough Energy group of private investors founded by Bill Gates:

> Many existing energy options have a built-in advantage of being less expensive than newer green ones. That's because their price does not factor in the environmental damage they cause around the world. Our goal is to reduce the [advantage] through programs, investments, and policies that help bring down the costs of clean technologies, so consumers and industries will use them.[56]

[55] For example, Bjorn Lomborg proposes substantial funding for transformative energy research that would make clean energy cheaper than fossil fuels. See: https://www.theglobeandmail.com/opinion/article-at-cop26-lets-not-repeat-our-failed-climate-strategies/.

[56]https://www.breakthroughenergy.org/

We see an important role for governments of rich countries to subsidize basic research in game-changing technologies that would make the adoption of clean technologies the least-cost option and for technologies that provide cost competitive alternatives to products that produce other greenhouse gases. This includes nuclear, solar, and wind with cheap mass storage, fusion, biofuels, carbon capture and others. Further, there may be cases where carbon pricing is inefficient at controlling emissions and technological solutions work better. Investment today in game-changing carbon reduction technologies will, if successful, generate important externalities for the world. But before investments reach the stage of possible commercialization, it is typically difficult to find private financing. Further, it is understood that research and development generate spillovers, including environmental externalities that are not always captured by firms that invest in the technology. For example, after the expiration of a patent, the innovating firm will only partly capture the gains from the invention. [57]

Partly reflecting this view, worldwide, governments have allocated US$ 1.34 trillion to investments in clean energy between 2020 and June 2023, a portion of which is for basic research.[58] In the United States, the Inflation Reduction Act of 2022 has made hundreds of billions of dollars available for the production and use of clean energy and for subsidies for innovative technology for clean energy. The United States Congressional Budget Office (2022) estimates the fiscal costs of the Inflation Reduction Act at US$392 billion, composed of tax credits of US$271 billion and direct expenditures of US$121 billion. But, since the tax credits are open commitments, the Electric Power Research Institute estimates that the fiscal cost may be underestimated due to greater use of subsidized technologies. Their central estimate of the fiscal cost of the tax credits is US$780 billion over the ten-year life of the law, i.e., 2.9 times the estimate of the Congressional Budget Office (see Bistline *et al*., 2023).

In 2021, the GDP of high-income countries was US$59 trillion. [59] If high income countries were to devote 0.2 percent of their GDP to basic research on game-changing technologies, US$ 118 billion per year would be available for basic climate-change research. In contrast, the International Monetary Fund (IMF) estimates that fossil fuel subsidies are about fifty times this number at US$ 5.9 trillion annually, of which US$ 500 billion are explicit subsidies and US$ 5.4 trillion are implicit subsidies (where the IMF attempts to estimate all social costs).[60]

6.3 Complementarity between carbon reduction regulation and subsidies for carbon saving technology

We see the proposal to fund basic research on game-changing climate technologies and the proposal for a Climate Club as complementary. By implementing government policies to achieve net-zero carbon emissions, the Climate Club would incentivize investment in technologies that reduce carbon

[57] See Gillingham (2019) for a similar view on the justification for government support for green technology.
[58] See the data of the International Energy Agency "Government Energy Spending Tracker" at: https://www.iea.org/news/governments-are-continuing-to-push-investment-into-clean-energy-amid-the-global-energy-crisis
[59] The world GDP in 2021 was US$ 96 trillion of which high income countries GDP was US$ 59 trillion and the United States GDP was US$ 23 trillion. See: https://data.worldbank.org/indicator/NY.GDP.MKTP.CD
[60] See: https://www.imf.org/en/Topics/climate-change/energy-subsidies#Energy%20Subsidies

emissions.[61] Bellas and Lange (2011) and Frey (2013) find evidence that pricing the emissions of sulfur dioxide to control acid rain spurred the development of technologies to reduce the cost of the abatement of the emissions. Conversely, new technologies that lower the cost of reducing carbon in the atmosphere would encourage more countries to join the Climate Club, since the Climate Club could operate effectively with lower minimum prices of carbon, implying costs to their economies of pricing carbon would decline.

7. Conclusions

To hold temperatures to less than 2° Celsius above temperatures of the second half of the 19th century, climate scientists estimate that the world risks exhausting its remaining *cumulative* carbon budget by 2050 and that the world must achieve net-zero emissions. This has led to nearly 200 countries signing the Glasgow Climate Pact of 2021 declaring the need to achieve net-zero CO_2 emissions by about 2050. In 2019, middle income countries were responsible for 63 percent of global GHG emissions, up from 47 percent in 1990. This implies, that in addition to the United States and other developed nations, carbon reduction to achieve net-zero emissions must include the middle-income countries.

Given independent nations, a fundamental challenge to meet goals of limiting carbon emissions is to obtain a cooperative global agreement to reduce carbon emissions from all nations that are significant emitters of GHGs. We propose a Climate Club as an international cooperative agreement among the Parties. Our Climate Club has five rules mentioned in the introduction. The first rule of our Climate Club is that all countries achieve net-zero carbon dioxide emissions by 2050. This Climate Club meets the reciprocity and penalty requirements that the literature has shown are necessary for a successful international cooperative agreement on climate change. To impact the strategic decision of countries to join the Climate Club, it contains substantial sticks against non-participants and the carrot of the Multilateral Fund for developing countries with low per capita CO_2 emissions.

Crucially, we have designed our Climate Club such that it is permitted by the WTO under GATT Article XX(g), the WTO "Escape clause" for the "conservation of an exhaustible natural resource," and may be implemented immediately.

To achieve net-zero emissions by 2050, model estimates indicate the world needs both an effective Climate Club and rapid technological advance to lower the costs of clean energy. We also propose that all high-income countries of the world would devote 0.20 percent of their GDP to subsidizing basic research to attain game-changing technologies would produce cost competitive green energy and alternatives to greenhouse gas producing products and processes. We see the proposals for a Climate Club and subsidies to transformative research as synergistic. Further, as an obligation of rich

[61] Sabel and Victor (2022) advocate an "experimental" approach to technological innovation for climate change that encourages innovation at the local or industry level with diffusion of the best technologies through shared results globally.

countries, this contributes to the greater responsibility the United Nations has placed on developed countries regarding climate change solutions.

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Appendix: The U.S. Shrimp-Turtle Dispute Settlement Case at the WTO

Traditional shrimp fishing often used shrimp trawl nets to ensnare shrimp. The process often also ensnared sea turtles, causing many turtles to drown. Sea turtles are an endangered species under the Endangered Species Act of the U.S. The U.S. required all U.S. shrimp fishing boats to use a particular turtle excluder technology that proved to be effective at allowing turtles to escape the nets and avoid drowning. In 1996, the U.S. banned the import of shrimp and shrimp products harvested in the wild by citizens or vessels of nations which were not certified as using techniques that were safe for sea turtles."[62] India, Malaysia, Thailand and Pakistan complained to the WTO and a dispute settlement case was initiated. In 1998, the Dispute Settlement Body of the WTO adopted the Appellate Body report which

[62] See: http://www.sice.oas.org/dispute/wto/58r00/shrus31e.asp#:~:text=7.6%20In%20October%201996%2C%20the,to%20Section%20609%20when%20allowing%2C

ruled against the U.S. since it determined that the measure of the U.S. was arbitrary and unjustifiable discrimination for two reasons.

First, the Dispute Settlement Body ruled that the U.S. inflexibly required the use of its turtle excluder technology. The certification guidelines of the U.S. compelled other WTO member countries to adopt the regulatory approach of the U.S. when alternate comparably effective conservation methods were available; and the U.S. guidelines inadequately took into consideration different conditions in other WTO member countries.[63]

Second, the Dispute Settlement Body decision of 1998 ruled that the U.S. discriminated against several Asian and Indian Ocean countries since it negotiated a shrimp import agreement with about fifteen Latin American nations but did not make a serious effort to negotiate with Asian nations.[64]

To comply with the WTO ruling, the U.S. made two changes. First, the U.S. conducted negotiations that led to the Indian Ocean-South-East Asian memorandum of understanding (MOU)[65] and its associated conservation and management plan that comprehensively protects six sea turtles; this includes using fishing techniques that are safe for turtles.[66] Second, the U.S. modified its certification requirement for imported shrimp and shrimp products. The new guidelines for certification allowed imports that use technologies or processes that are "comparable in effectiveness" to the turtle exclusion technology used in the U.S. and requires the U.S. to take into account differing conditions.

Malaysia complained to the WTO about U.S. compliance arguing that while the U.S. met its obligation to *negotiate* in good faith with Malaysia, Malaysia alleged that the U.S. has an obligation to *conclude* an agreement with Malysia prior to implementation of the trade measure and the U.S. had not met the latter alleged obligation. Further, Malaysia alleged that the new U.S. guidelines for certification were not flexible enough to accommodate Malaysian conditions.

On October 22, 2001, the WTO Appellate Body ruled that the U.S. was in compliance with rulings of the Dispute Settlement Body in 1998. It found that under Article XX, the U.S. is only required to *negotiate* with all WTO members in comparably good faith, not to *conclude* an agreement.[67] The

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[63] See section 4.2.4 for the relevant text of the Appellate Body report.

[64] Referring to their decision in 1998, the Appellate Body report of 2001 stated (WTO, 2001, para 128): "we saw a clear contrast between the efforts made by the United States to conclude the Inter-American Convention and the absence of serious efforts on the part of the United States to negotiate other similar agreements with other WTO Members. We concluded there that such a disparity in efforts to negotiate an international agreement amounted to "unjustifiable discrimination".

[65] The MOU came into effect in September 2001, originally with nine signatories expanding by 2015 to 35 countries, including numerous African and Middle Eastern countries. See https://www.fisheries.noaa.gov/national/endangered-species-conservation/indian-ocean-south-east-asian-marine-turtle-memorandum

[66] https://www.cms.int/iosea-turtles/en/page/mou-text-cmp

[67] The Appellate Body report states (WTO, 2001, para. 134):

Appellate Body found that the revised guidelines of the U.S. for certification provide for adequate flexibility. Article XX does not require that a member explicitly provide for the specific conditions that prevail in all member countries. (World Trade Organization, 2001, para. 148,149).[68] Further, the Appellate Body ruled that negotiations in different international fora only need to be comparable, not identical.

Additional WTO Rulings in U.S. Shrimp Relevant to Climate Club Trade Measures.

Extraterritoriality. Is it permissible for a WTO member to impose a trade restriction for actions that occur outside of its jurisdiction? In the U.S. Shrimp case, the Dispute Settlement Body ruled that a member government has the right to impose trade restrictions for actions that occur outside of its jurisdiction under Article XX(g) if there is "sufficient nexus" between the exhaustible natural resource and the member government, World Trade Organization (1998, para. 133). GHGs emitted anywhere impact all countries which should establish a "sufficient nexus" between the GHG actions of all countries in global warming.

Product versus Process debate. In the U.S. Shrimp case, multiple appellees complained that the trade measure applied by the U.S. was not based on the characteristics of the imported product itself but rather was imposed based on the process and production method? The Dispute Settlement Body, however, accepted trade measures based on process or production methods when it ruled that the trade restriction of the U.S. "is a measure 'relating to' the conservation of an exhaustible natural resource within the meaning of Article XX(g) of the GATT 1994." See World Trade Organization (1998, para. 142) and Fayette (2002, pp. 690-691) for a similar view.

> In sum, Malaysia is incorrect in its contention that avoiding "arbitrary and unjustifiable discrimination" under the chapeau of Article XX requires the *conclusion* of an international agreement on the protection and conservation of sea turtles. Therefore, we uphold the Panel's finding that, in view of the serious, good faith efforts made by the United States to negotiate an international agreement, "Section 609 is now applied in a manner that no longer constitutes a means of unjustifiable or arbitrary discrimination… "

[68] The Revised Guidelines, on their face, permit a degree of flexibility that, in our view, will enable the United States to consider the particular conditions prevailing in Malaysia if, and when, Malaysia applies for certification…. Yet this is not the same as saying that there must be specific provisions in the measure aimed at addressing specifically the particular conditions prevailing in *every individual* exporting Member. Article XX of the GATT 1994 does not require a member to anticipate and provide explicitly for the specific conditions prevailing and evolving in every individual member.