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THE ROLE OF TRADE IN ADDRESSING CLIMATE CHANGE:

Recommendations for Policies and Practices

A REPORT FROM THE CENTER FOR COMMERCE AND DIPLOMACY TASK FORCE ON CLIMATE AND TRADE

OUT OF MANY, ONE PEOPLE

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TABLE OF CONTENTS

I — ABOUT THE CLIMATE AND TRADE TASK FORCE

The Climate and Trade Task Force is an independent and non-partisan group co-chaired by **Caroline Freund**, Dean of the UC San Diego School of Global Policy and Strategy, and The Most Honourable **Andrew Michael Holness**, Prime Minister of Jamaica and Co-Chair of the United Nations Climate Change Financing Initiative (with President of France Emmanuel Macron). It is composed of experts on climate and trade from academia, business, and government.

The purpose of the Task Force is to provide timely and practical direction to policymakers for climate and trade policies and practices. Trade is an essential component of economic cooperation, and simultaneously implicated in strategies to address climate change, via policies, practices and international institutions. This report focuses on the most salient points of intersection: Finance for Climate Adaptation, Border Carbon Adjustment measures, Clean Technologies and Supply Chains, Agriculture Trade, and the World Trade Organization and Fishery Subsidy Reform. The latter, although not specifically a climate issue, is an important test case for the world's largest trade agreement to facilitate progress on environmental matters. Our recommendations reflect extant political economy constraints.

A — ORGANIZING INSTITUTIONS

The Task Force was organized by the **Center for Commerce and Diplomacy** (CCD) at the UC San Diego School of Global Policy and Strategy (GPS). The mission of CCD is to advance global economic cooperation by building bridges between the academic, policy, and business communities. The organizing institutions are well-positioned to evaluate policy issues that lie at the intersection of climate and trade. CCD specializes in international trade and global economic cooperation and its leadership and affiliates are dedicated to the principle that foreign commerce promotes prosperity and peace. The center is situated within GPS, which stands among the world's top graduate schools of public policy, with an integrated faculty from the well-recognized UC San Diego fields of international relations, political science, economics, engineering, China studies, and climate science. GPS faculty are all internationally acclaimed in their respective disciplines.

GPS and CCD are interdisciplinary by design. This is because policy is not determined in a vacuum where technical expertise is all that matters. These organizations embrace the reality that political-economy forces interact with scientific knowledge to shape policy. We collaborate across disciplines within academia—and with policy experts and private-sector actors outside the academy—to provide practical solutions to the world's most pressing problems.

GPS and CCD have access to a wealth of talent in the wider UC system and throughout our networks. Our initial challenge was to cull from the many possible lines of climate change research a subset of experts that (1) explicitly connect trade and climate in their research, and (2) provide new insights and politically-viable policy recommendations.

B — PROCESS

We focus on five sectors where environmental cooperation requires trade coordination: finance, energy and manufacturing, agriculture, renewables, and fishing. We assigned a top scholar to summarize state-of-the-art research in each sector and to derive new, politically feasible policy insights. Our five topics (and experts) are:

- **Financing Climate Adaptation** (Haishi "Harry" Li, Postdoctoral Fellow at the Center for Commerce and Diplomacy and Assistant Professor in Economics, University of Hong Kong)
- **Energy, Manufacturing, and Border Carbon Adjustments** (James Rauch, Professor of Economics, UC San Diego)
- **Agriculture, Climate, and Trade** (Jennifer Burney, Marshall Saunders Chancellor's Endowed Chair in Global Climate Policy and Research, School of Global Policy and Strategy, UC San Diego)
- **Clean Technologies and Supply Chains** (Michael Davidson, Assistant Professor, School of Global Policy and Strategy and the Mechanical and Aerospace Engineering Department, UC San Diego)
- **Fisheries Subsidy Reform at the World Trade Organization** (Christopher Costello, Professor of Environmental and Resource Economics, UC Santa Barbara)

All members of the Task Force met remotely in July 2021 and in September 2021 to provide feedback on the authors' contributions. Each meeting included presentations by the academic experts followed by open discussion among all members. Throughout, the Task Force kept its focus on the climate-trade nexus and the trade-offs between environmental, economic, political, and national security objectives.

C — TASK FORCE MEMBERS

Four categories of people contributed to this report: The "Co-Chairs" provided high-level guidance and leadership; they also prepared a brief statement regarding the report. "Project Leaders" prepared the Executive Summary and "Table 1: Trade Coordination in Response to Current Policy Discussions," which draw from the substantive chapters, but the views here are solely those of the Project Leaders. "Authors" prepared the five substantive chapters of the report; the views they express are their own. "Advisors" provided critical feedback throughout the preparation of this report, but this should not be interpreted as endorsement of the report.

CO-CHAIRS

- **Caroline Freund,** Dean of the UC San Diego School of Global Policy and Strategy
- **The Most Honourable Andrew Michael Holness,** Prime Minister of Jamaica and Co-Chair of the United Nations Climate Change Financing Initiative (with President of France Emmanuel Macron)

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- **Rafael Pastor,** Chair of the International Advisory Board of UC San Diego's School of Global Policy and Strategy
- **David Victor,** Center for Global Transformation Endowed Chair in Innovation and Public Policy at the School of Global Policy, UC San Diego

II — ACKNOWLEDGEMENTS

The work of the Task Force would have been impossible without the contributions of many dedicated individuals, including Fabienne Perlov, the program director of the Center for Commerce and Diplomacy. Several people from UC San Diego's School of Global Policy and Strategy provided invaluable creative support, involving communication, editing, design, and production of the final report. We thank Rosemarie Pi'ilani Fernandez, Jade Griffin, and Amy Robinson for their efforts.

We thank Merle Donaldson, Chief of Staff at the Office of the Prime Minister in Jamaica for providing the crucial facilitation of communication between the Jamaican government and the academic members of the Task Force. Without this important link, the report and recommendations would not embody the developing country perspective of trade, and climate finance for adaptation, in particular, that is such an important component of this report.

We also acknowledge the contributions of external experts, collaborators, and research assistants, including Alan Xiaochen Feng (IMF), Ananthakrishnan Prasad (IMF), Juan Carlos Villasenor-Derbez (UC Santa Barbara), and Katherine Millage (UC Santa Barbara).

III — ACRONYMS

AD/CVD	Antidumping and Countervailing Duty
AE	Advanced Economies
BCA	Border Carbon Adjustments
CBAM	Carbon Border Adjustment Mechanism
CEPP	Clean Electricity Payment Program
CGIAR	Consultative Group on International Agricultural Research
EMDE	Emerging Market and Developing Economies
ESG	Environmental, Social, and Governance
ETS	EU Emissions Trading System
EU	European Union
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FSE	Fisheries Support Estimate
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GHG	Greenhouse Gas
IPCC	Intergovernmental Panel on Climate Change
IUU	Illegal, Unreported, or Unregulated
LUC	Land-Use Change
MNEs	Multinational Enterprises
NDC	National Data Center
OECD	Organisation for Economic Co-operation Development
RFS	Renewable Fuel Standard
R&D	Research & Development
USMCA	United States-Mexico-Canada Agreement
VATs	Value-Added Taxes
WTO	World Trade Organization

IV — FROM THE CO-CHAIRS

Action on climate change faces three critical challenges in the absence of cooperation on international trade and investment flows. The first is that the disparate climate measures taken under the Paris Accord's Nationally Determined Contributions (NDCs) could be undermined if high carbon intensity goods are produced in unregulated markets and traded freely. The second is that while border adjustment measures can address excessive production and trade in these goods, they could devolve into protectionism if not carefully calibrated to compensate solely for national measures. The third is that the historical contributions to climate change have not been proportional to its deleterious effects, implying that compensation is needed to ensure all countries have the necessary resources to mitigate carbon emissions and adapt to climate change.

This report offers direction to policymakers on how to address these fundamental tensions. The authors of the report are guided by the principle that trade is part of the solution, not the problem. When carbon emissions are appropriately priced and regulated, producing a greater share of energy-intensive goods in locations with abundant renewable energy sources becomes a key source of comparative advantage. From a global perspective, shifts in production of these energy intensive goods to renewable energy abundant countries leads to lower global emissions for any given level of production.

Until a global carbon tax becomes feasible, cooperation on climate policy will have to rely on trade coordination. Countries will need to agree on how to use border adjustment mechanisms to level the playing field. Without border adjustment measures, climate action will be watered down through trade; with their overuse, protectionism will depress global growth without necessarily reducing emissions.

Similarly, climate action will fail without the participation of developing countries. Here again, trade is part of the solution: a key finding of this report is that trade and supply chains transmit extreme weather events throughout the global financial system, creating vulnerabilities for rich and poor nations. Thus, globalization means that climate finance is in every nation's direct interest.

We are excited about the possibility that real progress on climate adaptation and mitigation can be accomplished by harnessing market forces, and not undermining them. This cannot be accomplished without coordination between advanced and developing countries, with industry, and on trade. We are pleased to present this report to begin these discussions.

Most Honorable Andrew Michael Holness, *Prime Minister of Jamaica*

Caroline Freund, *Dean of the UC San Diego School of Global Policy and Strategy*

1 — EXECUTIVE SUMMARY

This report provides a framework for policymakers to understand some of the interactions between climate change and trade in order to make policies that are emissions-efficient, economically efficient, and politically sustainable. The main findings of this report can be summarized as **climate cooperation is impossible without trade coordination**. Approaches to climate change have varied widely across and within nations and this heterogeneity has, unsurprisingly, resulted in tensions between nations. Each action addressing climate change introduces a price effect that changes economic behavior and leads to trade and competitive distortions. These inefficiencies ultimately undermine efforts to address climate change when they result in carbon leakage or restrict efficient production of climate-friendly products.

A solution to the climate crisis cannot exist without dialogue between policymakers and businesses to **make market mechanisms work for climate cooperation and not against it**. These market mechanisms include: taxes or fees on emissions, border adjustment measures, clean energy subsidies, financing, and international agreements. To reduce wrangling over the legality (WTO or otherwise) of each measure, countries must not only coordinate climate strategies, but also trade strategies, with the input of economic actors.

Coordination on climate will fail without including developing countries. The moral imperative to address developing country needs is evident—they suffer the most, but do the least harm. Furthermore, many advanced economy mitigation techniques will be regressive, as in the case of agriculture LUC recommendations. Beyond this moral imperative, our report shows that climate-induced supply chain shocks in developing countries have negative effects on financial markets in advanced economies. Climate adaptation and mitigation in developing countries is, thus, also an economic imperative for advanced economies and we recommend using border measures to finance it.

The recommendations in this report put political economy considerations front and center. For too long scientists and experts have advocated effective solutions to the crisis, but have met with resistance from business and policymakers alike. **Any solution to the climate crisis must take seriously the necessary domestic actors that will support it.** A quintessential example raised in the report is the proposed U.S. methane fee.[1] It has the potential to be a useful climate policy tool, but will find little support with industry. But combining methane mitigation with a border adjustment to restore domestic competitiveness reduces opposition from industry.

The suggestion of coordination begs the question: "Among whom?" Coordination must be self-enforcing and requires that market mechanisms are at work. With this caveat, the best effort to address climate change will have the biggest tent possible. Using existing institutional infrastructure to accomplish climate and trade coordination presents the path of least resistance, as evidenced by the discussion of fishery subsidies.

The recommendations for trade coordination follow three broad themes: 1) Domestic taxes on emissions must be coupled with a border adjustment to restore industry competitiveness. 2) Proceeds from border

1 S.645-Methane Emissions Reduction Act of 2021. Available at https://www.congress.gov/bill/117th-congress/senate-bill/645/.

adjustment measures should be used for climate finance in developing countries. 3) International coordination on climate and trade requires a multilateral approach using existing institutions. The implications for current policy discussions are summarized in Table 1. Further recommendations are included in each section of the report.

TABLE 1 — Trade Coordination in Response to Current Policy Discussions

Sector	Environmental Policy Objective	Trade Coordination	Developing Country Support	Implementing Institutions	Beneficiaries and Potential Backers
Energy & Manufacturing	Coordinated methane mitigation	Coordinated methane border adjustment	Proceeds of border adjustment go to EMDEs to supplement the Paris Climate Pledge.	UNFCCC in coordination with the WTO and USMCA	EMDEs, energy & manuf. industry, developing countries receiving finance
Agriculture	Robust grain and oilseed production with minimal land-use change	End U.S.-China trade restrictions on agricultural products, especially soybeans	Finance agricultural adaptation and conservation in developing countries through border adjustment proceeds.	U.S./China to coordinate removal of agricultural trade barriers.	U.S. farmers and recipients of climate adaptation finance
Fishing	Disincentivize overfishing by converting fishery production subsidies to transfers	Ratify a WTO agreement on fisheries; transfers reduce the need for special and differential treatment	Assist low-income countries with fishery management reforms using transfers and in-kind technical assistance; Finance through border adjustment proceeds	WTO forum for negotiation; WTO to enforce allowable fishing subsidies	Fisherwomen and men receiving transfers Consumers, fishers, and the public all benefit from reduced overfishing.
Clean Tech	Take advantage of global supply chains in clean tech products	Reduce barriers to clean tech deployment through removal of import tariffs	Support clean energy deployment in developing countries	U.S./China to coordinate removal of clean tech trade restrictions	U.S. renewable energy consumers and installation labor force
Finance	Mitigate supply chain risks from EMDE climate shocks	Mobilize public/private finance for EMDE adaptation	Finance climate adaptation through multilateral banks	Multilateral development banks and private sector	Multinationals with global supply chains and consumers

EMDE=Emerging Markets and Developing Economies, UNFCCC=United Nations Framework Convention on Climate Change

2 — INTRODUCTION

BY PROFESSOR LAWRENCE BROZ

The year 2021 may be remembered as a turning point in efforts to address climate change. Extreme weather events across the globe coincided with the release of the report of the United Nations Intergovernmental Panel on Climate Change (IPCC) to make climate change a "code red for humanity."[2] At the same time, the links between climate change and international trade have come to a head, as policymakers in the United States and Europe advance legislation that leverages trade policy to promote climate goals, and strengthen global supply chains in environmental goods and clean technology. With a backdrop of rising geopolitical tensions with China, and China's announcement to halt construction of coal plants abroad, the climate-trade nexus is at the top of the global policy agenda.[3]

Despite the urgency of the call to action, the interplay between trade and climate policies is complex and contested. One concern is that the pressure for decarbonization could go off the rails and deliver protectionism. Another challenge is that ambitious climate policies without commensurate ambition on climate finance could widen the development gap between rich and poor countries. Thus, there is a need for timely, research-based policy recommendations that can help leaders advance their national interests in ways that are climate friendly and still deliver on trade and development objectives. The Climate and Trade Task Force was organized for this purpose and has moved quickly to finalize its policy recommendations.

In this section we summarize what we see as the key contributions of each academic chapter in the report. We highlight the main policy recommendations and motivating evidence. The summary is followed by the deeper academic analysis of each topic by our five academic experts with elaborations and evidence to support policy recommendations. The final section concludes.

2.1 — FINANCING CLIMATE ADAPTATION

While Advanced Economies (AE) have pledged $100 billion to finance climate adaptation efforts in vulnerable Emerging Market and Developing Economies (EMDE), follow-through on existing pledges has been limited and there is little support for moving beyond $100 billion.[4] AEs have a moral obligation to act, because the nations that are most vulnerable to climate change are the least responsible for the problem. However, moral imperatives alone may be insufficient to compel rich nations to finance climate adaptation on the scale necessary to address the problem. Professor Haishi "Harry" Li points out that AEs have a vested interest in climate adaptation in developing countries, because the risks posed by climate change in these countries affect markets in AEs through trade and global supply chains.

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2 United Nations Secretary-General António Guterres, Aug. 9, 2021. Available at https://www.un.org/sg/en/content/secretary-generals-statement-the-ipcc-working-group-1-report-the-physical-science-basis-of-the-sixth-assessment.

3 *"China Says It Won't Build New Coal Plants Abroad. What Does That Mean?"* New York Times, Sept. 22, 2021. Available at https://www.nytimes.com/2021/09/22/world/asia/china-coal.html.

4 On Sept. 21, 2021, the Biden administration announced that the US will double its pledge to help developing countries deal with the present-day effects of climate change. Available at https://www.nytimes.com/2021/09/21/climate/climate-biden-un-general-assembly.html.

Professor Li addresses the problem of "moving beyond $100 billion." His work with Alan Xiaochen Feng (IMF) shows that financial markets in advanced economies are negatively affected by climate disasters and sea-level rise in *other nations* through the channel of international trade.[5] An average climate disaster decreases aggregate stock market valuation in the affected country's main export partner by 0.4% (or $6.1 billion) and by 0.5% (or $6.6 billion USD in 2020) in the main import partner. Upstream and downstream supply-chain linkages mean that foreign climate events, such as floods, landslides, and wildfires, reverberate through the worlds' leading stock markets, with negative effects on globalized firms. Rich countries thus have a direct financial interest in financing climate adaptation and mitigation in other nations.

Global firms with extensive supply-chain operations, such as those in the automobile industry, are a natural constituency for climate finance *within* advanced economics. These firms suffer share-price declines when foreign climate events disrupt their global supply chains, which gives them a stake in seeing climate finance progress at the international level. Consequently, financing climate adaptation in emerging markets and developing nations should no longer be considered a "foreign aid" issue. International climate events negatively affect financial markets in advanced economies through supply chain linkages, thus advanced economies have every incentive to mitigate these risks through providing climate adaptation finance.

2.2 — BORDER CARBON ADJUSTMENTS

Trade economist Professor James Rauch assesses recent legislative proposals in the United States for a "Carbon Polluter Import Fee," and a "Methane Polluter Fee."[6] While Professor Rauch finds that the carbon import fee proposal does not satisfy the principles that justify a BCA (because it does not require new cuts in carbon emissions), the methane polluter fee does. The methane polluter fee is a unilateral measure to reduce methane emissions from natural gas and oil facilities in the U.S. A methane fee in the U.S. combined with a methane BCA is a concrete step towards global emissions reduction.

Recent U.S. Government proposals do not include a methane BCA and, from a political-economy perspective, this is a mistake. Professor Rauch's key insight is that **"proposing a BCA in concert with any measure that raises the costs to industry of GHG emissions makes it politically easier to adopt that measure by weakening industry opposition."**

The addition of a methane BCA would mean that the U.S. natural gas and oil industry will not suffer losses due to foreign competition. Similarly, other U.S. industries that are heavily dependent on natural gas or oil energy as an input, such as steel and bulk chemicals, would see a BCA as a way to level the playing field with foreign competitors—especially in China—that are not subject to a methane fee.

Consider the problem of a Texas refiner that has just been told by its oil suppliers that they will have to charge more because of a fee or regulations. The refiner can let this eat its profits, or it can import oil from Mexico. A BCA eliminates the incentive to switch to imported oil from Mexico. This is economically

5 See Feng and Li 2021.

6 These proposals are part of the FY2022 Budget Resolution Agreement Framework. Available at https://www.democrats.senate.gov/imo/media/doc/MEMORANDUM%20for%20Democratic%20Senators%20-%20FY2022%20Budget%20Resolution.pdf.

efficient, emissions efficient and undercuts industry lobbying and lawsuits against the fee or regulations. At the international level, a BCA would be less likely to run afoul of WTO rules or conflict with Europe's climate agenda than the U.S. Carbon Polluter Import Fee proposal, which has protectionist undertones. This suggests a double benefit of conjoining a BCA to the Methane Polluter Fee proposal: it would reduce both domestic *and* international opposition to a U.S. methane fee. If implemented, a methane fee would be a win for the environment.

2.3 — AGRICULTURE, CLIMATE, AND TRADE

Land-based agricultural production is a major source of GHG emissions and a variety of mitigation strategies have been proposed. Yet relatively little attention has been given to how *international trade* relates to agriculture and climate change. Environmental scientist Professor Jennifer Burney highlights that trade in agricultural products itself accounts for a minor share of GHG emissions, but the larger concern is via "direct emissions" and "land-use change" (LUC).

The answer to agricultural emissions is not to make trade more difficult—that would likely have drastic humanitarian consequences. Trade in agriculture is essential to food security on the margins because it channels food to regions exposed to climate-related disruptions in domestic food production. Moreover, the energy used in agricultural production—including fuel for transportation to foreign markets—is a much smaller contributor compared to direct emissions and LUC.

Direct and LUC emissions can be addressed via changes in trade policy. Direct emissions come mainly from livestock production and soils and account for about half of all agricultural emissions; the other half is from land-use change, which occurs when native habitats, such as rainforests and grasslands, are cleared in order to expand cropland. Since LUC is more amenable to trade policy interventions than direct emissions, Professor Burney argues that governments should seek first and foremost to reduce LUC emissions.

One immediate way to reduce LUC emissions is for China to remove barriers to U.S. agriculture trade. These trade barriers have resulted in soybean production shifting to Brazil from the U.S., increasing LUC emissions. U.S. soybean and grain farmers are relatively environmentally-efficient (they generate direct emissions but almost no land-use change). The U.S.-China trade war has resulted in diversion of Chinese imports from the U.S. to Brazil, a less environmentally efficient country in terms of soybean production. This has increased LUC emissions and made grain in China more expensive. Removing China's agriculture trade barriers are environmentally and economically efficient.

In the longer run, Professor Burney encourages joint leadership between the United States and China on mitigating agricultural GHG emissions. This is because agricultural production in both nations does not involve much domestic land-use change but increasingly incentivizes forest destruction elsewhere for imported food products.

There are other long-range opportunities to advance climate-conscious agricultural trade policies. In particular, improving technical assistance can encourage innovations that mitigate direct emissions.

2.4 — CLEAN TECHNOLOGIES AND SUPPLY CHAINS

Expanding clean energy production is the linchpin in the fight against climate change. The expansion of global supply chains is an important reason why solar and wind power production has exploded over the past decade. Low cost solar modules and wind turbines, produced mainly in China, have reduced the price of clean technologies globally, thereby encouraging their use (in conjunction with tax incentives). However, geopolitical tensions between the U.S. and China could disrupt clean tech global supply chains and threaten to reduce these environmental gains. Over the past decade, the U.S. has erected trade barriers on imported clean tech products from China and policymakers are considering whether to ramp up these efforts in order to shift clean tech production and employment from China to the U.S.

Professor Michael Davidson surveys the available evidence on whether the measures were effective in on-shoring production of clean tech products and increasing U.S. employment in the sector, and concludes that the tariffs were a failure in both respects. The tariffs had little effect on clean tech imports into the U.S. due to trade diversion: in response to the tariffs, production shifted from China to Vietnam and other Asian economies. Since many of the firms in Asia that now assemble solar modules are Chinese-owned, and/or use components produced in China, the tariffs also had little impact on China's relative economic position in clean tech.

While U.S. tariffs likely had a neutral effect on imports of renewable energy-related products to the United States, they did lead China to retaliate. An escalating trade war in clean tech helps no one, and is harmful to the environment because it raises the costs of clean tech products. Professor Davidson recommends that the United States discontinue its clean tech tariffs: **"tariffs on solar modules and wind towers have outlived their usefulness."**

On the goal of promoting clean tech jobs in the U.S., Professor Davidson encourages policymakers to pay attention to the sector as a whole, which includes installation of clean technologies as well as production. Clean tech installation is far more labor intensive than production (e.g., installing solar panels requires 10 times more labor than manufacturing them). Thus, policymakers should give clean tech jobs more consideration. Since clean tech installation is a service that must be performed locally, these jobs will not only increase in number, they will also be immune to offshoring, which suggests additional political-economy benefits relative to manufacturing jobs.

> ***"Clean tech installation is far more labor intensive than production (e.g., installing solar panels requires 10 times more labor than manufacturing them)."***

In terms of U.S. manufacturing, the focus should be on supporting emerging areas of clean tech where the U.S. has a comparative advantage, as opposed to established areas where global supply chains have already yielded significant cost savings. Government support for new technologies such as lithium batteries, electric vehicles, and hydrogen-based processes should be in the form of domestic subsidies (e.g., financing and deployment requirements), rather than by restricting imports. Import restrictions are a substantially less economically efficient mechanism to support the clean tech industry.

2.5 — FISHERIES SUBSIDY REFORM AT THE WTO

Like climate change, overfishing is a global environmental problem that requires a cooperative global solution. Governments' subsidies to their fishing industries, to the amount of $35 billion per year, are a main source of the problem. The largest subsidizers are China (11%), the European Union (5.7%) and the United States (5.2%) (Sumaila et. al. 2019), who, along with many other countries, would ultimately reap the benefits of fish stock recovery.

Members of the WTO have been trying to negotiate limits on fishing subsidies for decades, but the prospect of reaching agreement improved recently due to a confluence of factors, including WTO Director General Ngozi Okonjo-Iweala's strong commitment to the cause. As Professor Christopher Costello emphasizes, one type of subsidy is at the root of the problem: ***capacity enhancing subsidies*** **that encourage overfishing, exacerbate the tragedy of the commons, and are ultimately harmful to the very people they are meant to help.** These subsidies incentivize overfishing, which reduces the fish stock's ability to produce food and support livelihoods into the future. Other types of subsidies, and subsidies that come in conjunction with robust fishery management programs, do not increase pressure on fish stocks.

Any successful WTO reform must recognize the importance of these distinctions. Negotiations are currently framed by the goal of reducing or eliminating fishing subsidies, rather than changing the *type* of subsidies that are allowed. Requiring governments to cut fishing subsidies is more difficult than requiring them to shift to more environmentally-efficient subsidies while keeping the level constant, making these solutions more politically feasible. Fully 100% of the $22 billion in capacity enhancing subsidies can be repurposed to maintain livelihoods and/or improve fishery management without incentivizing overfishing.

> ***"...when a fishery is truly well-managed, subsidies have little to no effect on fishing pressure."***

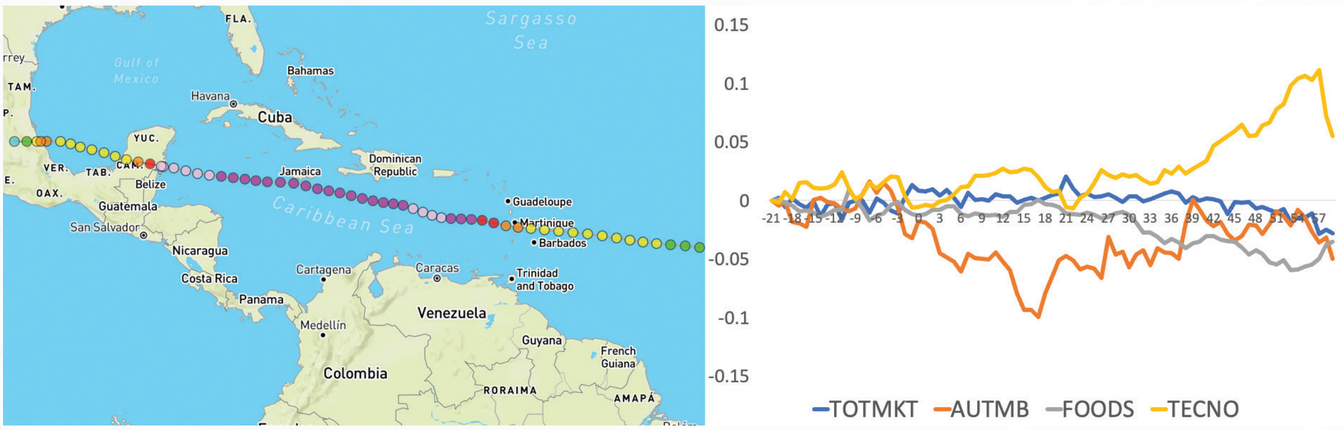
We also recommend allowing exceptions for nations with well-managed fisheries programs. Professor Costello notes that "when a fishery is truly well-managed, subsidies have little to no effect on fishing pressure." Acknowledging this in an agreement rewards countries that currently manage their fisheries and provides an incentive for other countries to follow suit.

3 — FINANCING CLIMATE ADAPTATION

BY PROFESSOR HAISHI "HARRY" LI

On August 13, 2007, Hurricane Dean hit the Caribbean. In Jamaica, it affected more than 33,000 people and caused more than $300 million in damages.[7] Most of the damage was concentrated in the agricultural sector.[8] More than 80% of the banana crop and 75% of the coffee trees under three years old were destroyed. It took Jamaica over a year to recover the lost banana production capacity. Hurricane Dean also caused substantial harm to other Caribbean countries. While Hurricane Dean's path did not significantly overlap with the United States (see the left panel of Figure 1), the hurricane did affect the U.S. stock market. The right panel of Figure 1 shows that the U.S. food production sector lost about 4% around the time of the hurricane. The automobile sector also lost about 4%. In aggregate, the U.S. stock market lost about 2% in returns. By contrast, the U.S. technology sector, which would not have been affected by the hurricane, continued its upward trajectory during this period with no obvious signs of slowing.

FIGURE 1 — The path of 2007 Hurricane Dean and the U.S. stock market cumulative abnormal return around the time of the hurricane



Notes: The left panel shows the path of 2007 Hurricane Dean. The datasource is Weather Underground.9 The right panel shows the cumulative abnormal return in U.S. aggregate and sector level stock market indices around 2007 Hurricane Dean, from 21 trading days before the disaster to 60 trading days after the disaster. The vertical dash line denotes the break-out date of the hurricane. The cumulative abnormal return is computed relative to a benchmark predicted by the CAPM model (See Feng and Li 2021). The data source is EM-DAT and Refinitiv Datastream.

3.1 —CLIMATE RISKS AND FINANCIAL STABILITY

Climate change poses significant risks for the financial stability of many countries. An important component of these rising risks is physical climate risks, which refer to the increase in frequency and

7 USAID spent almost $1M in disaster relief for Hurricane Dean in Latin America and the Caribbean.

8 Available at https://reliefweb.int/report/belize/latin-america-and-caribbean-hurricane-season-2007-fact-sheet-3-fiscal-year-fy-2007.

9 Available at https://www.wunderground.com/hurricane/archive/AL/2007/Hurricane-Dean/2007225N12331.

severity of climate disasters.[10] As a disaster breaks out, it damages human and physical capital and undermines productivity—a negative supply shock—and destroys household wealth and income—a negative demand shock. These shocks can harm business performance and lead to declining financial market returns.[11] Financial market participants will price in anticipation of future climate physical risks, which leads to lower financial market valuation. These adverse consequences challenge financial stability. Climate disasters have even worse consequences on Emerging Market and Developing Economies (EMDEs) because these countries are both more exposed and more vulnerable to climate physical risks.

The implications of climate physical risks extend beyond national borders. A country's climate disasters and long-term climate change risks can also lead to lower financial market valuation in the country's main international trade partners (Feng and Li 2021). Being a negative supply shock for downstream countries, and a negative demand shock for upstream countries, such risks propagate along the global value chain and undermine the returns in the tradable sectors of foreign countries. Upstream and downstream banking sector assets are indirectly affected, and the impact depends on the degree of trade protection in these countries and whether their banking sector is healthy enough to sustain the loss in the tradable sectors.

Such cross-border spillover effects of climate risks through trade should present Advanced Economies (AEs) with an economic rationale to help EMDEs adapt and mitigate. AEs have a moral obligation to act due to their historical emissions. However, moral imperatives alone may be insufficient to compel rich nations to finance climate adaptation on the scale necessary to address the problem. The analysis indicates that AEs have a vested interest in climate risk adaptation and mitigation in developing countries. Because EMDEs play a critical role in global trade, the climate disasters that hit vulnerable EMDEs can also lead to financial and economic losses in their main AE trade partners. Contributing to the adaptations and mitigations of EMDEs can reduce these losses for AEs.

3.2 —GEOGRAPHIC EXPOSURE TO PHYSICAL CLIMATE RISKS

Climate disasters create both supply and demand shocks. Studying the implications of historical climate disasters can help policymakers understand the potential consequences of future climate change under different projected scenarios. Figure 2 plots the geography of global climate disasters over the past half a century (1970-2020, EMDAT, Rosvold and Buhaug 2021).[12] A total of 8,972 disasters occurred with flooding being the most frequent, and a large fraction hitting coastal regions.

Disasters differ with respect to their damage. For example, in the distribution of storm disaster damage relative to national GDP, the 10th percentile equals 4% whereas the 90th percentile is as high as 32%. The financial institutions that lend to or invest in the affected firms will be indirectly impacted if the firms default on loans or deliver lower returns on equity. As a result, financial stability is undermined

10 The other component of climate risks is the transition risks, which include the business risks associated with policy, technology, and market uncertainties when countries take actions to respond to climate change. Other chapters of this report analyze the climate transition risks associated with trade policies.

11 If their debt or equity is publicly traded.

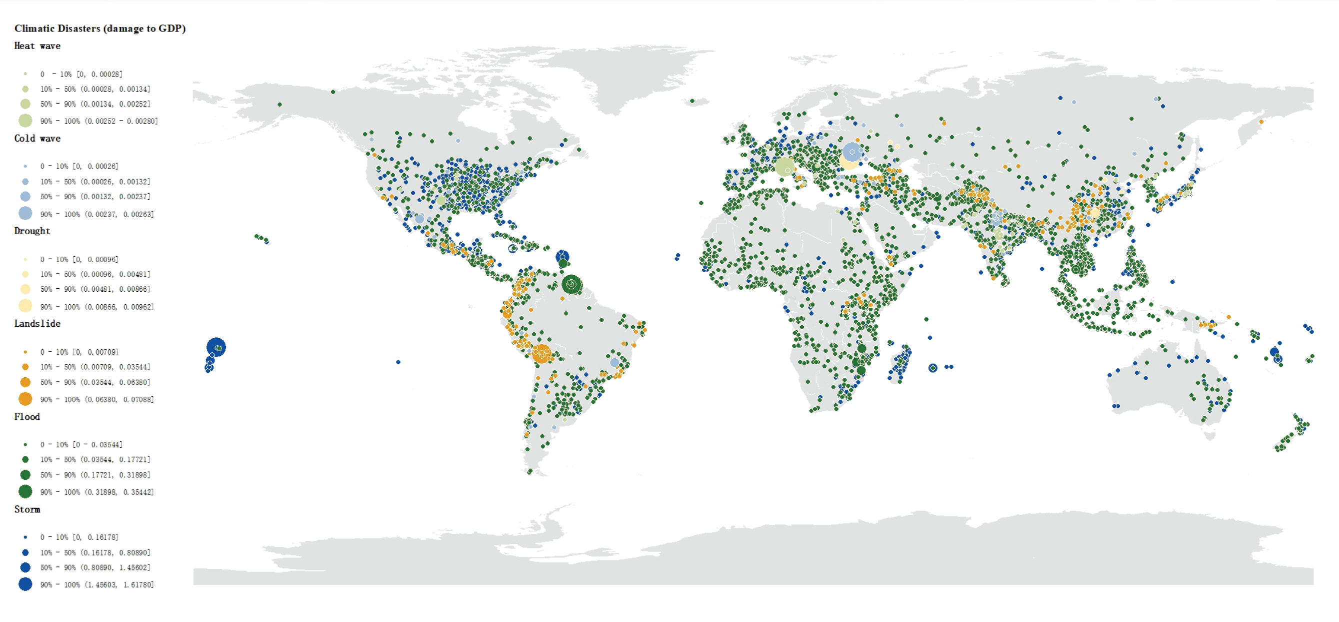
12 The climate disasters include heat and cold waves, droughts, landslides, floods and storms.

and may lead to systemic or "sub-systemic" financial risks.[13] Such risks concern a rising number of governments around the world (Bartholomew and Diggle 2021, ECB 2021).

"...73% of all climate disasters hit EMDEs."

EMDEs bear the greater losses from climate disasters. Figure 3 shows that 73% of all climate disasters hit EMDEs. Compared to AEs, EMDEs are also more severely harmed. For the average climate disaster, the affected persons to population ratio, the monetary damage to GDP ratio, and the death to population ratio are 9.5, 7.9, and 4.2 times higher in EMDEs.[14] This suggests that EMDEs are both more exposed and more vulnerable to climate disasters. Higher insurance protection and better sovereign rating in AEs may help explain the distance, as it is found that countries that have higher insurance protection and better sovereign rating are more resilient to climate disasters (IMF 2020).

FIGURE 2 — Spatial distribution of global climate disasters and their damage relative to national GDP (1970-2020)

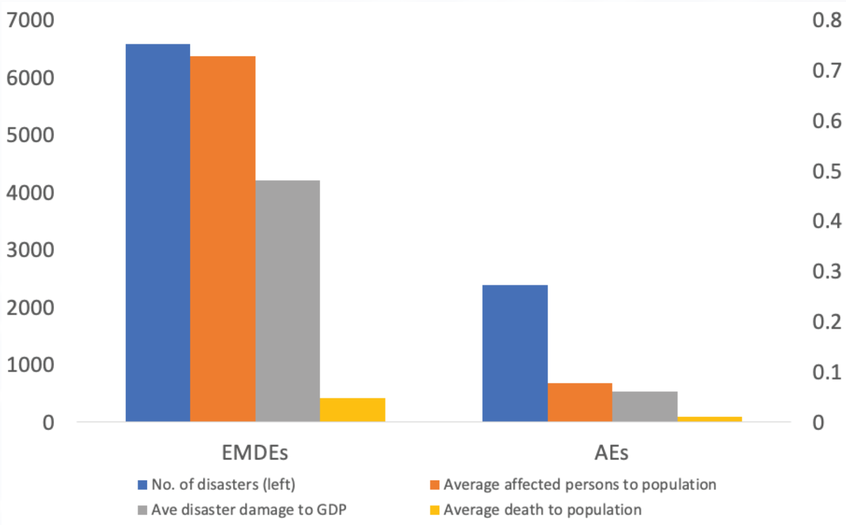


Notes: Climate disasters include heat waves, cold waves, drought, landslides, floods, and storms. The color of a circle denotes the form of a climate disaster. The size of a circle denotes the magnitude of a climate disaster, measured with monetary damage relative to national GDP (EM-DAT, Rosvold and Buhaug 2021).

13 The April 2020 Global Financial Stability Report (International Monetary Fund 2020) finds that climate disasters negatively impact financial market valuation and thus financial stability. An average disaster lowers aggregate stock market valuation by 1% from 21 trading days prior to the disaster to 40 trading days after the disaster.

14 It is generally believed that AEs keep better records of past climate disasters than EMDEs. Therefore, EMDEs may have experienced even greater losses from climate disasters than AEs than what is documented in the database.

FIGURE 3 — Number of disasters and the loss from an average disaster in EMDEs and AEs



Notes: The left axis plots the number of disasters. The right axis plots, for an average disaster, the affected persons to national population ratio, death to national GDP ratio, and disaster monetary damage to national GDP ratio.

3.3 —CROSS-BORDER SPILLOVERS OF PHYSICAL CLIMATE RISKS THROUGH TRADE

Climate disasters undermine the financial stability of not only the country that is directly hit by the disaster, but also the country's main international trade partners. In the complex and interconnected modern global value chain, production is divided into stages and each country can specialize in one or few stages. Along the chain, the midstream country acquires intermediate input from its upstream (importing partner), manufactures its output and sells it to its downstream (exporting partner), which uses the midstream output as input to the next stage of production or final consumption. As a climate disaster disrupts the midstream country's production, it reduces midstream purchasing power for upstream products as well as its input supplies to the downstream. Profitability and thus financial valuation of both upstream and downstream countries are negatively impacted.

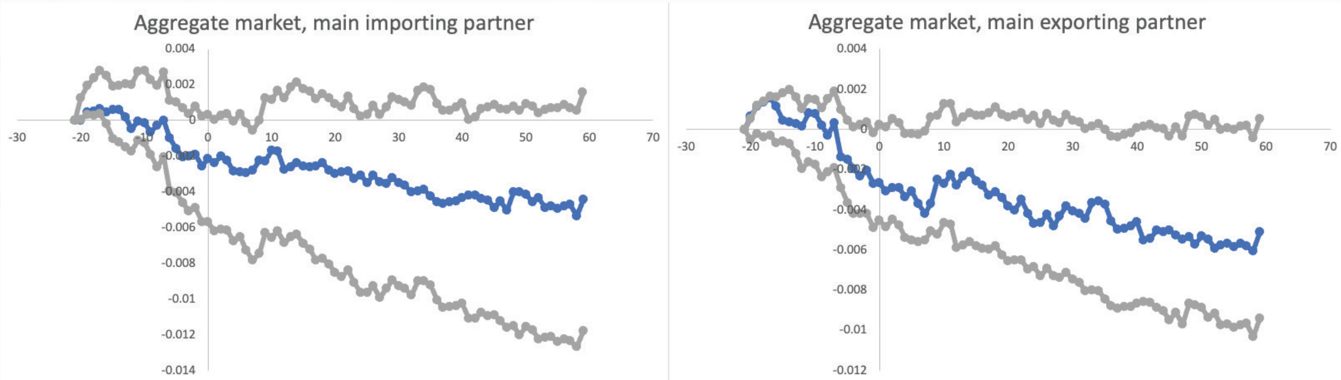
> ***"...average climate disaster decreases aggregate stock market valuation by 0.5% in the main importing partner and by 0.4% in the main exporting partner..."***

Feng and Li (2021) show that an average climate disaster decreases aggregate stock market valuation by 0.5% in the main importing partner and by 0.4% in the main exporting partner of the country that is directly hit by the disaster (Figure 3).[15] This amounts to a monetary loss of, for the average country, $6.1 billion from the average upstream disaster and $6.6 billion from the average downstream disaster.[16] This magnitude is comparable to the valuation loss from domestic climate disasters presented in Section 6b.

15 Measured with the cumulative losses from 21 trading days prior to the disaster to 40 trading days after the disaster.

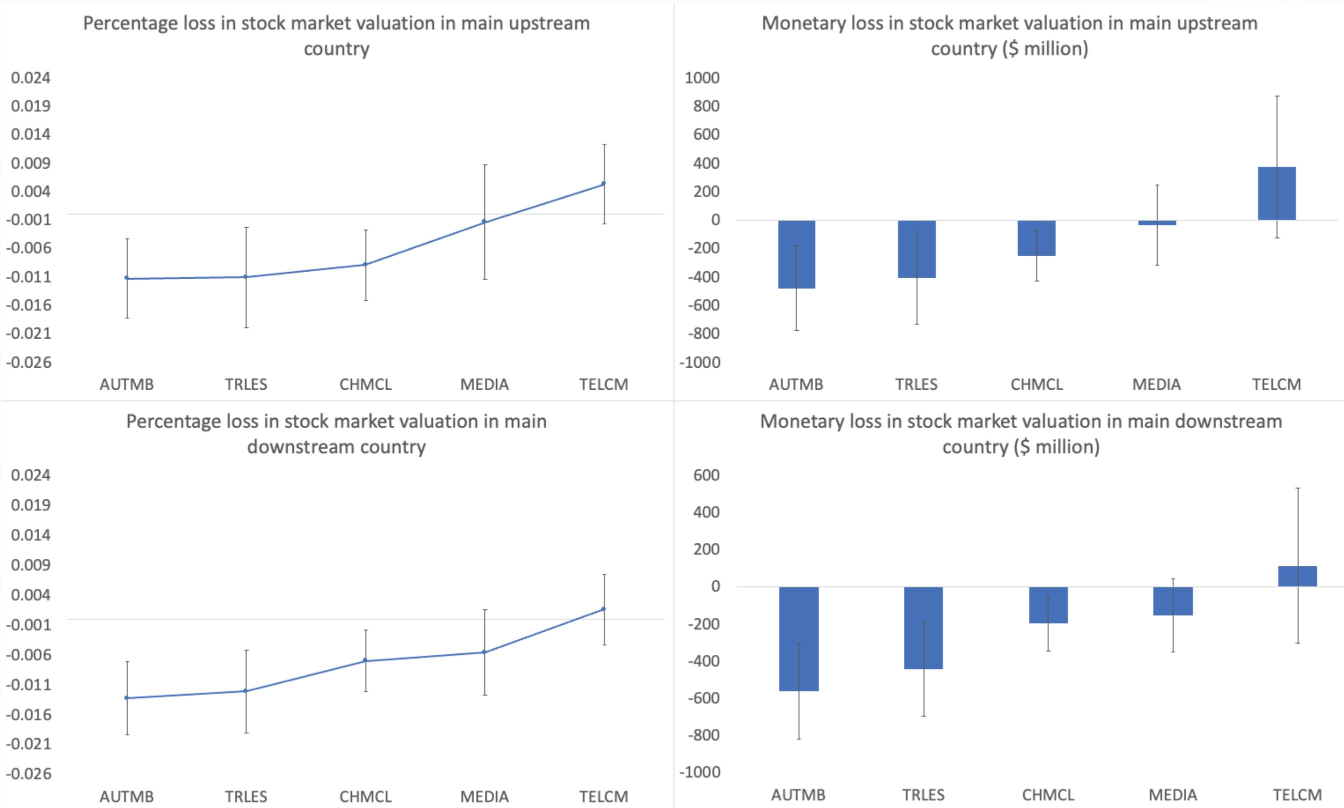
16 In 2020 dollars.

FIGURE 4 — A country's climate disasters can cause aggregate stock market valuation declines in the country's main exporting and importing partners



Notes: The left panel displays stock market dynamics in the main exporting partner of the disaster country. The right panel displays stock market dynamics in the main importing partner of the disaster country. The blue line represents the mean cumulative (total) aggregate stock market valuation loss from an average foreign climate disaster. The grey lines represent the 95% confidence intervals. The cumulative loss on 21 trading days (one month) before the disaster breaks out is normalized to 0.

FIGURE 5 — Sector level stock market valuations in upstream/downstream countries



Notes: The left two panels denote the percentage loss in stock market valuation of representative sectors from the average foreign climate disaster. The blue dot denotes the estimated mean return and the error bar denotes the 95% confidence interval. The right two panels denote the monetary loss in stock market valuation of representative sectors from the average foreign climate disaster. The unit is 2020 USD in millions. The height of the bar denotes the estimated mean loss and the error bar denotes the 95% confidence interval. The percentage loss is converted to monetary loss with the corresponding market capitalization.

Figure 5 shows that the negative effects are heterogeneous across sectors. For example, the automobile sector loses 1.3% from the average upstream disaster and 1.2% from the average downstream disaster.

In monetary terms, for the average country, the automobile sector loses $564 million from the average upstream disaster and $480 million from an average downstream disaster. A 0.1 percentage point increase in the exposure to upstream and downstream foreign climate disasters is associated with a 19.5% ($8.3 billion for an average country) and a 13.3% ($5.6 billion for an average country) decline in automobile sector valuation.[17] Notably, autos represent a tradeable manufacturing sector with significant supply chain linkages.

Figure 5 also shows that the travel and leisure sector suffers significant loss from an average foreign climate disaster. As a typical tradable service with supply chain linkages, the travel and leisure sector contributes significantly to the economic development in EMDEs (for example, coastlines in the Caribbean attract global tourists and create local business opportunities and jobs) and improves global household welfare (Faber and Cecile 2019). Climate disasters in EMDEs that disrupt tourism in these countries can undermine profitability in multinational hotels, travel agencies, and entertainment providers in AEs. As the global pent up demand for traveling can be predicted after COVID, global governments should pay increasing attention to these climate disasters in order for the sector to have a strong and resilient recovery.

In contrast to the previously mentioned sectors, the media and telecommunication sector does not significantly respond to foreign climate disasters. These sectors are less reliant on complex supply chains that are affected by climate risks.

The spillover effect of foreign climate disasters on the domestic financial system depends on the extent to which (1) the disruptions to foreign customers and suppliers can cause losses in domestic firms, and (2) the declining profitability in the domestic corporate sector can transmit to bank losses. Feng and Li (2021) show that more abundant international trade insurance/credit can alleviate the impact of the first channel, and a healthier domestic banking sector can alleviate the impact of the second channel. These findings suggest that efforts by the international community to improve trade financing availability and banking sector strength can contain the potential harms of climate change on financial stability.

Feng and Li (2021) also show that exposures to foreign long term climate change risks are also negatively associated with the stock market valuations in the home country.[18] [19] EMDEs, especially the low-income developing countries, are playing an increasingly important role in global trade. Therefore, the climate risks associated with them may weigh even more on the financial stability in AEs. By helping these countries better manage climate risks, AEs can not only reduce their foreign climate risks exposures but also broaden the gains from international trade.

3.4 —POLICY RECOMMENDATIONS

In this chapter, we recommend international collaboration in combating climate change. To support such collaboration, we have the following policy recommendations: (1) AEs should provide EMDEs a variety

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17 The exposure measure refers to the foreign disaster damage spilled over to the home country (measured with trade shares and foreign disaster damage,) relative to the home country's national GDP.

18 Measured with the Verisk Maplecroft Climate Change Index and international trade shares.

19 Measured with the stock market P/E ratio.

> ***"AEs should provide EMDEs a variety of financing sources (including the proceeds from border adjustment measures) that assist them in climate change adaptation and mitigation."***

of public and private financing sources that assist them in climate change adaptation and mitigation. (2) Global fiscal and monetary authorities should closely monitor and actively respond to foreign climate disasters and foreign climate risks. (3) More data-driven research should be done on the cross-border spillover effects of climate transition ESG risks, and on other mechanisms of international spillovers of such risks. (4) Countries, especially EMDEs, should further develop ESG financing instruments.

- **AEs should provide EMDEs a variety of financing sources (including the proceeds from border adjustment measures) that assist them in climate change adaptation and mitigation.**

Climate change adaptation requires resilient infrastructure and government/social institutions. Climate change mitigation requires clean technology development and application. Therefore, EMDEs'capacity to adapt to or to mitigate the rising climate risks is constrained by their limited fiscal room, fragile financial condition, and lack of funding for clean technology. The capacity is further dampened by the COVID-19 crisis and the global surge in trade protectionism. This makes EMDEs even more vulnerable to the damage from climate disasters if climate change is to continue at the current pace.

However, what has largely been ignored is that due to international trade, AEs have a direct financial interest in financing climate adaptation and mitigation in other countries. All possible financing sources should be considered, joining public and private sector forces. Public financing options include foreign aid/loans from states and international organizations (for example, the IMF and the World Bank) and fund provision under the United Nations Framework Convention on Climate Change (UNFCCC). Proceeds from border adjustments by AEs (discussed in Section 4 of the report) can also be used as a funding source. This can benefit global environmental justice and reduce the household income gap between AEs and EMDEs. Private financing options include foreign direct investment (FDI) by multinational enterprises (MNEs) and trade finance, as global firms with extensive supply-chain operations have a stake in financing climate adaptation and mitigation in EMDEs.[20]

- **Global fiscal and monetary authorities should closely monitor international climate disasters and international climate change risks and prepare policy tools that respond to these risks.**

Fiscal and monetary authorities have been paying growing interest to the impact of domestic climate risks on financial stability. Shocks to economic fundamentals that affect foreign trade have also been continually monitored due to their central role in a country's external sector stability. What has largely been missed is that foreign climate disasters can affect domestic stock market valuation by a similar magnitude to domestic climate disasters, and international trade acts as an important

20 Financing green investment in EMDEs can also reduce their demand for foreign investment in the pollution heavy industries, and also encourage countries whose investment abroad are predominantly "brown" (e.g., China and Russia) to reallocate their foreign investment to more green sectors. This constitutes another channel through which financing EMDE climate change adaptation/mitigation can benefit all countries. While we largely abstract from this channel in this report, we would like to bring the reader's attention to Liu and Urpelainen (2021) which analyzes this channel.

propagation mechanism. Therefore, overlooking foreign climate disasters and foreign climate risks may underestimate the financial stability risks that a country is facing and impede swift policy responses to such risks.

- **More data driven research should be conducted on the cross-border spillover effects of climate transition risks, and on other mechanisms of international spillovers besides international trade.**

As awareness grows, an increasing number of governments, firms, and households actively respond to climate change. This will likely significantly raise the risks that face sectors and regions due to a more uncertain business environment. It remains an open question how rising transition risks in one country affect other countries through international trade. For example, how do border adjustment measures that have been introduced or are under consideration in AEs affect economic competitiveness and wellbeing in EMDEs?[21] This in turn further undermines the ability of EMDEs to respond to climate events. It is an open question which channels most propagate climate risks. Multinational production, international capital allocation, tourism, among others, increasingly link economic activities across national borders, and greater understanding of which may transmit most risk can help policymakers and the private sector in AEs with their assessments.

- **Global economies, especially EMDEs, should further develop ESG financing instruments.**

The global sustainable investment fund sector has grown rapidly in recent years, more than doubling from its 2016 level to reach $3.6 trillion in 2020 (IMF 2021). On the one hand, private investors increasingly recognize the climate transition risks that the "brown sectors" face, as they may suffer substantial loss when environmental regulations are tightened. On the other hand, climate-aware financial lenders/shareholders, societies, and activists increasingly pressure the fund managers to devote a greater share of their portfolio to the assets whose growth can benefit the environment. The increase in global demand for green assets presents unique opportunities for EMDEs. The investment projects in EMDEs that are both profitable and environmentally friendly can now attract more cross-border investment from AEs. Furthermore, if we expect that environmental regulations in EMDEs may finally catch up with those in AEs and the transition may happen in the near to mid-term, the green firms in EMDEs can have greater growth potential than their AE counterparts. To fully take advantage of these opportunities, EMDEs should increase their supply of ESG financing instruments, for example, green bonds, to both home and foreign investors. To achieve this goal, EMDEs should improve their climate-related information disclosure standards and fulfill the compliance requirements by international rating and auditing agencies.

"Global economies, especially EMDEs, should further develop ESG financing instruments."

21 A few works have studied the impact of carbon or pollution leakages caused by more stringent regulations in AEs, for example, Copeland et al. (2021).

4 — BORDER CARBON ADJUSTMENTS

BY PROFESSOR JAMES RAUCH

> *"Fears that diverging climate change policies among countries could spark a trade war (Hufbauer 2021) perfectly illustrate the theme of this report: climate cooperation is impossible without trade coordination."*

Economists have long advocated taxes on greenhouse gas (GHG) emissions as the most efficient way to combat climate change. At the same time it has been recognized that imposing such a tax reduces the industrial competitiveness of the country that implements it, necessitating compensating trade policies. These hypothetical considerations have become very real with the announcement by the EU of its intention to include a Carbon Border Adjustment Mechanism with its European Green Deal. Fears that diverging climate change policies among countries could spark a trade war (Hufbauer 2021) perfectly illustrate the theme of this report: climate cooperation is impossible without trade coordination.

4.1 — ECONOMIC EFFICIENCY OF BCAS

A carbon tax is a price per ton of GHG emissions charged to emitters. The price should reflect the harm done by climate change caused by GHG emissions, sometimes called the "social cost of carbon." A carbon tax that reflects the social cost of carbon gives emitters the correct incentives to reduce their GHG emissions in the most efficient way possible.

Because GHG is a global pollutant, from an economic welfare perspective, a carbon tax should be imposed in all countries. In the absence of a global carbon tax—which is where we are today—each nation's climate efforts can be undermined by trade and investment flows. Thus, if a carbon tax is imposed unilaterally, economic efficiency requires border carbon adjustments (BCAs) to raise the cost of imports from (and lower the cost of exports to) countries that have not imposed carbon taxes (Kortum and Weisbach 2017).

To illustrate, consider a carbon tax paid by U.S. producers of steel. This will raise the cost of producing steel in the United States, and raise the cost of producing goods that use U.S. steel, such as U.S. automobiles. A BCA would raise the cost of imported steel to the level that would prevail if the foreign country had imposed the same carbon tax as in the United States. A BCA would also reduce the cost of steel for U.S. auto exports to countries without carbon taxes to the level that would prevail if the U.S. had not imposed a carbon tax.

The economic efficiency of BCAs can be seen in two ways. First, goods and services should be purchased from the supplier with the lowest resource cost, where resource cost includes cost to the environment. Without a BCA, in response to a U.S. carbon tax a U.S. consumer may switch from a U.S. to an imported product, or a foreign consumer may switch from a U.S. to a domestic product, even though the U.S. resource cost is lower. Note that this switching behavior partially undermines the emissions-reducing impacts of the U.S. carbon tax, a phenomenon known as "leakage." Thus, a second way to see the economic efficiency of BCAs is that they prevent leakage of consumption to countries with more GHG-intensive production.

In the illustration above, a BCA implies a tariff on steel imported to the United States and a subsidy to autos exported from the United States. Flannery et al. (2020) note that, "Rules of the World Trade Organization (WTO) allow nations to rebate value-added taxes (VATs) on exported products and impose them on imports." By analogy, it is widely expected that BCAs calibrated to carbon taxes will be considered legal by the WTO. Not only would WTO-legality facilitate enforcement of BCAs, it would make retaliation by affected countries such as China less likely.

The analogy to border tax adjustments in response to a VAT is also helpful in thinking about how a BCA in response to a carbon tax would be computed and administered. However, unlike a VAT, a carbon tax is not a percentage rate applied to a price. The resulting difficulties in computation and administration of BCAs put regulatory transparency at a premium. Any affected industry has an incentive to exaggerate the impact of a carbon tax on its costs so as to obtain a higher import tariff or export subsidy. Foreign firms exporting to the United States have an incentive to understate their direct or embedded GHG emissions so as to lower the tariffs on their products.

The United States tends to import more than export GHG-intensive products. A typical BCA will therefore generate net revenue for the U.S. Treasury. These funds could be used for climate finance, i.e., they could help pay for U.S. commitments to developing countries under the Paris Accord.

4.2 — BORDER CARBON ADJUSTMENTS IN RESPONSE TO REGULATORY MANDATES

A regulatory mandate achieves reductions in GHG emissions by requiring emitters to adopt certain techniques of production. The amount by which GHG emissions are reduced is more certain than what is achieved by a carbon tax. However, a regulatory mandate does not allow producers to choose the lowest cost method of reducing emissions.

A unilateral regulatory mandate raises the same issues as a unilateral carbon tax, because it increases the costs of domestic production relative to foreign production. Unlike a carbon tax, a mandate does not provide a straightforward method to calculate increases in costs, which considerably increases the difficulty of computing a BCA.

In theory, a carbon tax can be found that is equivalent to any given regulatory mandate. Consider, for example, a clean electricity standard that mandates a complete phase out of coal-generated electricity by 2030. Because burning coal is the most carbon-intensive method of generating electricity, a sufficiently high carbon tax would bring about the same result. Economists at *Resources for the Future* estimated that a $50 per ton price for CO2 emissions would virtually eliminate coal-generated electricity in the United States by 2030 (Palmer et al. 2018). It follows that $50 per ton is the carbon tax that is equivalent to this hypothetical clean electricity standard.[22]

In practice, we will usually not know the carbon tax that is equivalent to a given regulatory mandate. We could use the industry's own estimate of its increase in costs resulting from the mandate to compute BCAs, but of course the industry has an incentive to exaggerate that increase. Information generated by the EU Emissions Trading System (ETS) may be helpful. The ETS amounts to a carbon tax for many industries. By observing the quantities by which industries reduce GHG emissions in response to the ETS, one can compute the carbon taxes that are equivalents to mandated reductions in GHG emissions.

It is less straightforward to establish WTO-legality of BCAs that adjust for regulatory mandates than it is to establish WTO-legality of BCAs that adjust for explicit carbon taxes. One argument, based on Bagwell and Staiger (2001), is that by raising costs for U.S. producers new regulatory mandates will unilaterally increase foreign access to the U.S. market, justifying BCAs to restore access to its former level. It may be possible to use environmental exceptions to the GATT (Article XX, paragraphs (b) and (g)) to buttress or substitute for this argument.

4.3 — POLICY RECOMMENDATIONS

Any BCA should be imposed only in response to specific new measures to reduce GHG emissions. Matching BCAs to specific new legislation will keep administrative costs under control. We provide recommendations for policies embodied in proposed legislation that have potential implications for BCAs using these principles.

- **A methane polluter fee should be accompanied by a BCA.**

The U.S. and EU have promoted a Global Methane Pledge to reduce global methane emissions by at least 30% from 2020 levels by 2030. The proposed Methane Emissions Reduction Act of 2021 (S. 645) in the U.S. would impose a fee of $1,800 per ton on methane emissions from natural gas and oil facilities, starting in calendar year 2023.[23] The fee would increase by two percent plus overall inflation each year thereafter. The reason the fee is so high relative to that typically discussed for CO2 emissions is that CH4 (methane) emissions are a far more potent heat-trapping gas.

The intention of S. 645 was to force industry into best practice emission reduction and to stimulate innovation in emission reduction. In the short run, however, the cost impact will be substantial. In fact, the methane polluter fee is a type of unilateral carbon tax. Following the logic of subsection 4.1, the methane polluter fee merits a methane BCA applied to trade with countries that have not imposed a comparable fee. If a BCA is proposed in concert with the methane polluter fee, adoption of the latter will become more likely, because it will not cause the U.S. natural gas and oil industry (or industries that make heavy use of U.S. natural gas or oil) to lose business to foreign competition and will therefore weaken their opposition.

22 Note that each regulatory mandate will, in general, yield a different equivalent carbon tax. As a result, different industries will face different effective prices per ton of GHG emissions, even though every ton of CO2 emissions (say) is alike. This is another source of economic inefficiency of a regulatory approach to reducing GHG emissions relative to a carbon tax approach.

23 Available at https://www.congress.gov/bill/117th-congress/senate-bill/645/text?r=8&s=1.

Policymakers may also address methane emissions from natural gas and oil facilities through new EPA regulations. It is therefore important to note that the methane polluter fee is complementary to regulations. If regulations reduce emissions, the fees paid are reduced accordingly. If firms find ways around the regulations, the fees paid are high, which incentivizes the firms to cut emissions in ways that are less costly than the ways specified by the regulations that they evaded.

- **The Carbon Polluter Import Fee should be replaced with a methane BCA.**

The Carbon Polluter Import Fee was included in S. 2378, the FAIR Transition and Competition Act. The stated intention of S. 2378 is to impose an import fee that reflects the "domestic environmental cost" of legislation "designed to limit or reduce greenhouse gas emissions." However, the first piece of legislation listed to which the Carbon Polluter Import Fee should apply is the Clean Air Act, containing regulations dating back to 1963! Imports from countries with comparable environmental regulations *and* no BCAs applicable to the United States would be exempt from the Carbon Polluter Import Fee.

Although S. 2378 was written as if it were following the principles we described in subsections 4.1 and 4.2, its main practical effect is likely to be protection of industries that are heavy air polluters from imports from countries with less stringent air pollution regulations. It is important to remember that BCAs are tools to facilitate new reductions in GHG emissions. In this sense the Carbon Polluter Import Fee is not a BCA, despite being described as such by S. 2378.

In the worst case scenario, the Carbon Polluter Import Fee might discourage the EU from adopting its own BCA, the Carbon Border Adjustment Mechanism (CBAM). As noted above, proposing a BCA in concert with any measure that raises the costs to industry of GHG emissions makes it politically easier to adopt that measure by weakening industry opposition. If the Carbon Polluter Import Fee discourages the CBAM, it might undermine the entire EU climate initiative.

> ***"...proposing a BCA in concert with any measure that raises the costs to industry of GHG emissions makes it politically easier to adopt that measure by weakening industry opposition."***

- **Propose a BCA for U.S. industries that make heavy use of natural gas (steel) and oil (bulk chemicals).**

A BCA is merited for industries that make heavy use of U.S. natural gas or oil because the methane polluter fee will raise their costs substantially. In particular, natural gas and oil are key feedstocks for bulk chemical production. Natural gas (but not oil) is heavily used in steel production that uses direct reduced iron as an input. Industries other than bulk chemicals and steel may lobby for a BCA in response to the methane polluter fee. Since the administrative costs of a BCA are substantial, only industries with a major cost impact should be considered.

- **Use methane emissions and industry cost structures to calculate the BCA on industrial products.**

For bulk chemicals and steel, calculation of the BCA requires knowledge of the cost structure of foreign producers in addition to foreign methane emissions from natural gas and oil facilities. If the cost structure of foreign producers is unknown, the cost structure of U.S. producers can be used. Foreign firms can then be allowed to collect data and make a case that their embedded emissions are lower, a procedure recommended by Kortum and Weisbach (2017).

- **Use actual methane emissions from natural gas and oil facilities in Canada and other trading partners to calculate BCAs on imported gas and oil.**

Roughly 98% of all U.S. imports of (dry) natural gas come from Canada. Canada is also the single largest source of U.S. oil imports (about 56%), followed by Mexico (about 9%). It follows that the most important legal framework applicable to the BCA for natural gas and oil is the United States-Mexico-Canada Agreement (USMCA) rather than the WTO. We are optimistic that approval of the BCA for natural gas and oil will be at least as easy under the USMCA as under the WTO.

- **Use satellite technology to measure foreign methane emissions.**

S. 645 proposes to measure methane emissions associated with each U.S. geologic basin from which natural gas and oil are extracted. Using satellite technology, measurement of emissions associated with foreign basins should be feasible. The BCA for natural gas and oil can therefore be determined using actual foreign emissions rather than an assumed level of emissions.

> ***"Using satellite technology, measurement of emissions associated with foreign basins should be feasible."***

- **Incentive programs should not be combined with a BCA**

The goal of incentive programs, such as the proposed Clean Electricity Performance Program (CEPP), is to increase the share of US electricity generated without GHG emissions to 80% by 2030. The CEPP has been approved by the Energy and Commerce Committee of the House of Representatives, but even if it clears the House it faces an uncertain future in the Senate.

The CEPP would make payments to utilities that increase the amount of carbon-free electricity they sell and penalize those that do not. If it worked, the CEPP would achieve what a clean electricity standard would but without increasing rates for utility customers. In effect, the federal government would bear the costs of a clean electricity standard instead of consumers.

Since in theory the CEPP would not increase costs even for industries that are heavy users of electricity, there is no need to accompany it with a BCA. The same would not be true for a conventional clean electricity standard.

5 — AGRICULTURE, CLIMATE, AND TRADE

BY PROFESSOR JENNIFER BURNEY

Global food trade is likely to become even more important in the future given projected increases in "coordinated shocks" from rising temperatures, and more circulating moisture leading to precipitation extremes (droughts and floods).[24] While trade in agriculture and food products does generate climate-warming emissions from transportation, those are swamped by the other emissions from agricultural production itself. Agriculture is a major source of greenhouse gas emissions (IPCC AR5 WG3 CH11) and is thus an important driver of anthropogenic climate change. The answer to agricultural emissions is not to make trade more difficult, as that would be likely to have drastic humanitarian consequences. Instead, trade policy must simultaneously ensure food security without driving "leakage" in the climate system, whereby demand in one part of the world induces emissions-intensive production in another region.

5.1 — AGRICULTURAL EMISSIONS

Emissions from agriculture fall into three main categories: First, *direct agricultural emissions* are emissions from soils, irrigated fields, animal digestion, and manure management. These emissions constitute at present about half of the total agricultural climate burden, and are very difficult to abate. Doing so will require new technologies and practices that will need to be shared globally and tailored locally (e.g., Lamb et al 2016).

> ***"LUC emissions have ebbed and flowed over time, but are at present about half of agricultural emissions."***

The second major category of agricultural emissions is from *land-use change (LUC)*, or the clearing of native habitat, like forest, savannah, or grassland for use as cropland. As land is cleared, most of the biomass carbon is released into the atmosphere through burning, either immediately, or after some time as intermediate products (a fraction of soil carbon is also typically lost). LUC emissions have ebbed and flowed over time, but are at present about half of agricultural emissions (Hong et al 2021). A key component of global climate mitigation is minimizing land-use change to keep existing biomass carbon stores intact. This means keeping global agricultural area constant, and not expanding into native habitat, grasslands, or especially forests. The corollary to this principle increased food production to expand to meet rising demand should come from intensification (higher yields) (Burney et al 2010, Foley et al 2011).

Third, in addition to direct agricultural emissions and LUC emissions, the world food economy also

24 d'Amour et al 2016, IPCC AR6 CH3.

generates *indirect emissions* from related energy use (manufacture and use of machinery, industrial inputs production, and on-farm electricity and fuel consumption) and transportation, including for international trade. These emissions are non-negligible, but are much smaller than the other two components (e.g., Weber and Matthews, 2008). Emissions associated with on-farm fuel, energy, and input use can be reduced through penetration of renewables, heavy-duty vehicle electrification, and innovation. For example a renewables-based, fossil-free Haber-Bosch process for nitrogenous fertilizers; better strategies for efficient use and recycling of phosphorus and potassium are technologies that can be developed to reduce indirect emissions.

5.2 — CLIMATE, FOOD SECURITY, AND TRADE

Climate and food security are tightly coupled: changing climatic and environmental conditions are negatively impacting our collective ability to grow enough food (IPCC Special Report, Wiebe et al 2015). Moreover, against this backdrop, food demand pressure continues to mount: global population projections now have no "peak" in sight before the end of the century (UN Population Projections); incomes are rising and bringing new food preferences along with them; and more than 800 million people still do not have enough to eat on a daily basis (SOFI 2021). One of the most fundamental questions for humanity is thus whether it is possible to feed the world and stabilize climate at the same time.[25]

Trade is an important mediator in the food-climate system. Broadly, most food is consumed domestically (see Figure 6 panel A), but imports are critical from a food security perspective. Climate shocks around the world are largely buffered by the stocks of exporting countries (conversely, the major food price spike of 2007-2008 was created by a drought and cascading export bans). In recent years, however, total stocks have declined slightly (Figure 6 panel B) and stock-to-use ratios even more so (Figure 6 panel C), especially for major exporters (Figure 6 panel D). This means that the capacity to arbitrage shocks via trade has lessened.

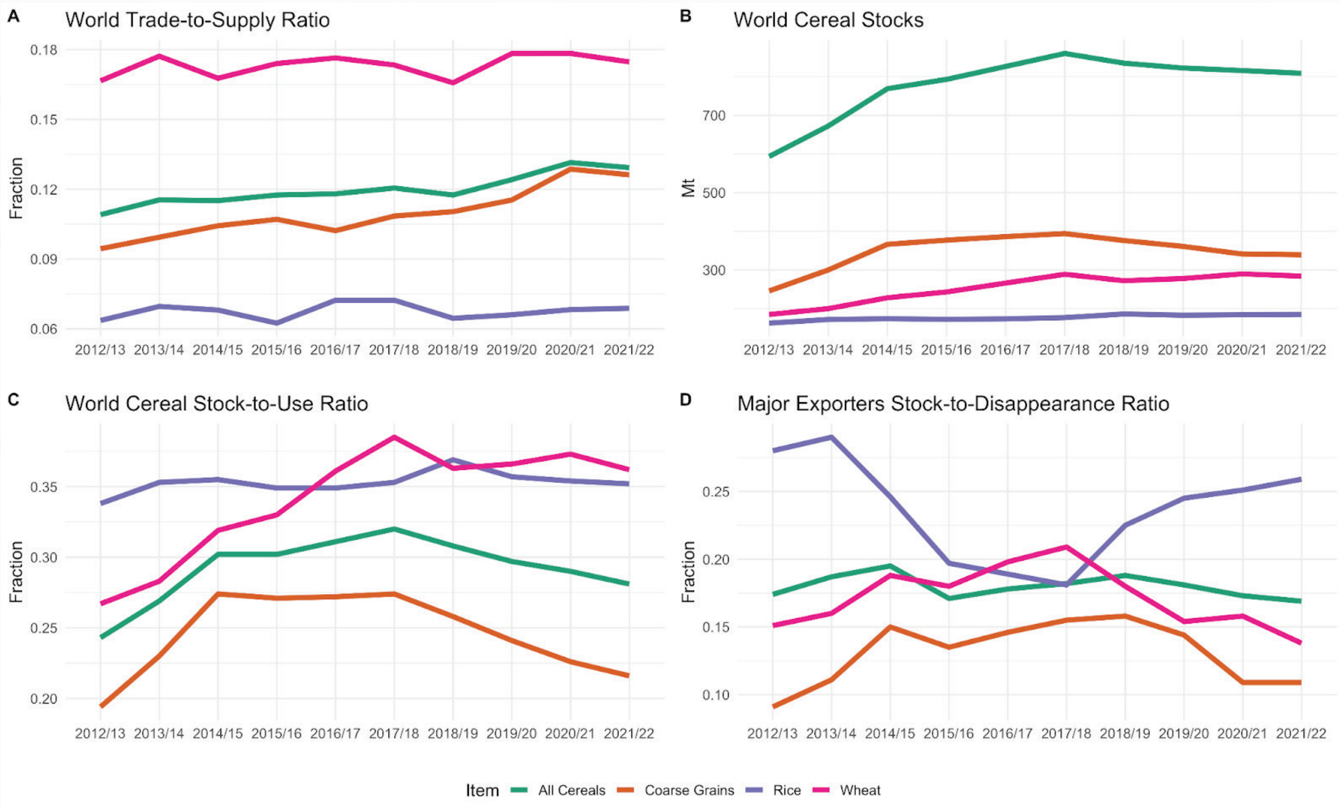
5.3 — TRADE POLICY AND AGRICULTURAL EMISSIONS

Evidence is mounting that while trade has contributed tremendously to food security and has facilitated economically efficient production, it has also facilitated emissions-inefficient production. A quarter of direct agricultural and land-use change emissions is associated with cultivation of products that are traded. Most recent emissions have been driven by oilseed production (soybeans and palm oil) in Brazil and southeast Asia (see Figure 7), where land dedicated to these crops has expanded through clearing of native forests and grasslands for new farms and plantations.

> ***"Evidence is mounting that while trade has contributed tremendously to food security and has facilitated economically efficient production, it has also facilitated emissions-inefficient production."***

25 This section focuses on land-based agriculture, as ~90% of calories consumed globally are from crops and land-based animal sources. However, ocean-based foods—fish and seafood—play a critical role in overall food security, and are a particularly important source of protein and fats in coastal communities. Fishing/oceanic policy related to trade has a quite different set of concerns than land-based food, and is covered in a separate section of this report.

FIGURE 6 — World Cereals Reports (UN FAO, FAOSTAT)



This dynamic has been directly exacerbated in recent years by trade policy. The deteriorating trade relationship between the United States and China over the past five years had a detrimental effect on agricultural and land-use emissions by shifting Chinese soybean imports from the United States to Brazil (Figure 8). On average, soybean production in the United States is more emissions-efficient than in Brazil, where soybean production has driven far more land-clearing (Figure 7 panel B). Between 2014 and 2017, Brazilian soybean production was approximately 4.6 times as emissions intensive as U.S. soybean production, and so the displacement of ~30Mt of soybean exports is associated with around 120Mt CO2e emissions per year.

FIGURE 7 — (A) Emissions from production of oilseeds (mostly soybeans and oil palm), (B) Area under oilseed production

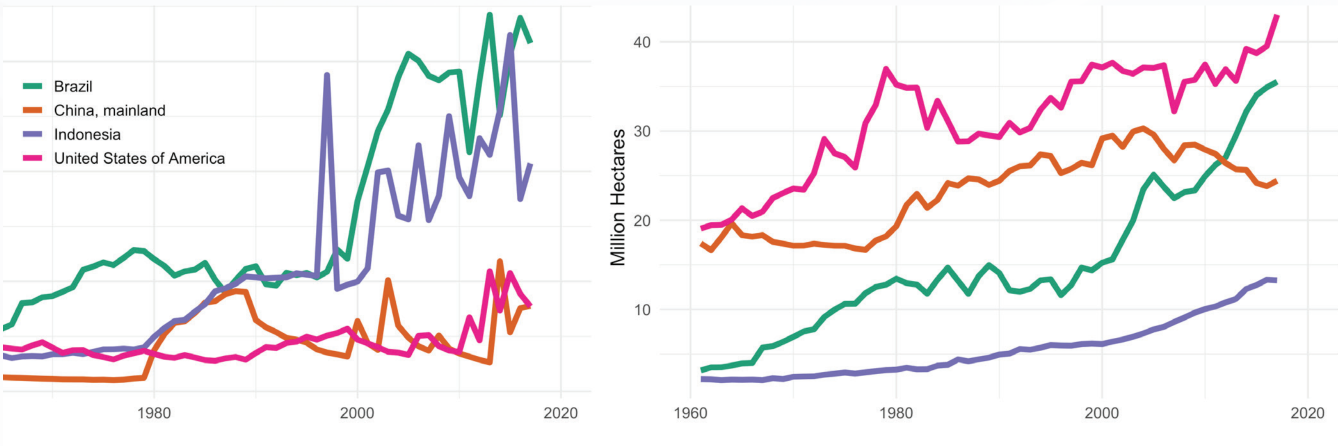
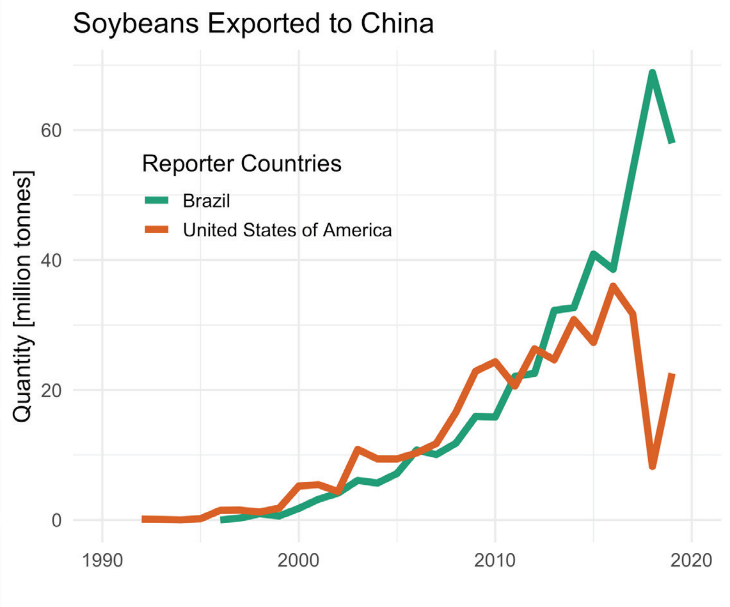
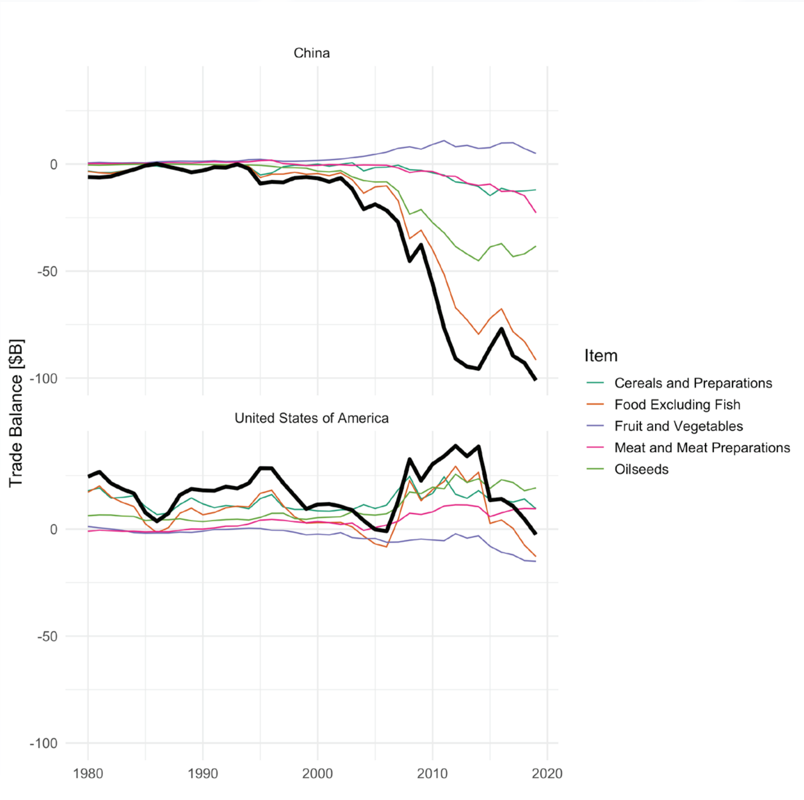


FIGURE 8 — Recent exports of soybeans to China from the United States and Brazil (FAOSTAT)



China and the U.S. are the world's largest importers of agriculture (See Figure 9) and both are net importers of land-use change emissions. In addition, both countries' agricultural production is relatively emissions-efficient, because it is primarily through direct emissions and not land-use change. This presents an opportunity for leadership for the two countries to work together to reduce land use emissions globally.

FIGURE 9 — Agricultural trade balances for China and the United States (total in black)



Notes: China is now the world's largest importer of food; the United States's trade balance in agriculture is currently the lowest in recent years.

"The deteriorating trade relationship between the United States and China over the past five years had a detrimental effect on agricultural and land-use emissions by shifting Chinese soybean imports from the United States to Brazil."

China and the U.S. can coordinate on addressing emerging hotspots in this area: sub-Saharan Africa is a region of concern, both in terms of food security trends (it is the only region that has not kept up agriculturally with population growth) and in terms of threatened resources (many areas are facing land constraints—declining per capita land area, still vast swaths of population dependent on agriculture) that are putting pressures on forests and native habitats. This region highlights the need for joint consideration of trade, food security, and conservation. Southeast Asia and Amazon are hot-spots for cropland expansion into forests driven by oilseed production, which is a key component of protein/fats for humans, livestock, and aquaculture. There will thus be strong overlaps between these regional land-use pressures and fisheries/aquaculture policy, suggesting that WTO leadership on fisheries subsidies can be translated into leadership on agriculture land-use policy.

Beyond addressing land-use emissions, trade policy surrounding R&D and innovation will be important for a near-zero (or net-zero) emissions world food economy. This is particularly the case for direct agricultural emissions. At present, no region globally has on average produced food with an emissions footprint lower than 0.5t CO2e per person per year (Hong et. al. 2021). It is not clear where the biophysical "floor" is, in terms of direct emissions, but significant research is needed to find it, and drive it as low as possible.

Research and innovation needs include direct agricultural emissions abatement advances to reduce soil emissions (both technological, like precision agriculture or rice water management, as well as biophysical, like new breeds), better feeds and improved management systems to reduce ruminant emissions, and innovative manure management for all animal systems. Trade openness and coordination will be critical for these efforts, and pro-active partnerships to spread and locally-tailor these technologies will also be needed. The Consultative Group on International Agricultural Research (CGIAR) has long helped connect countries in agricultural partnership, and would be well-suited to lead the international coordination effort to reduce direct agricultural emissions.

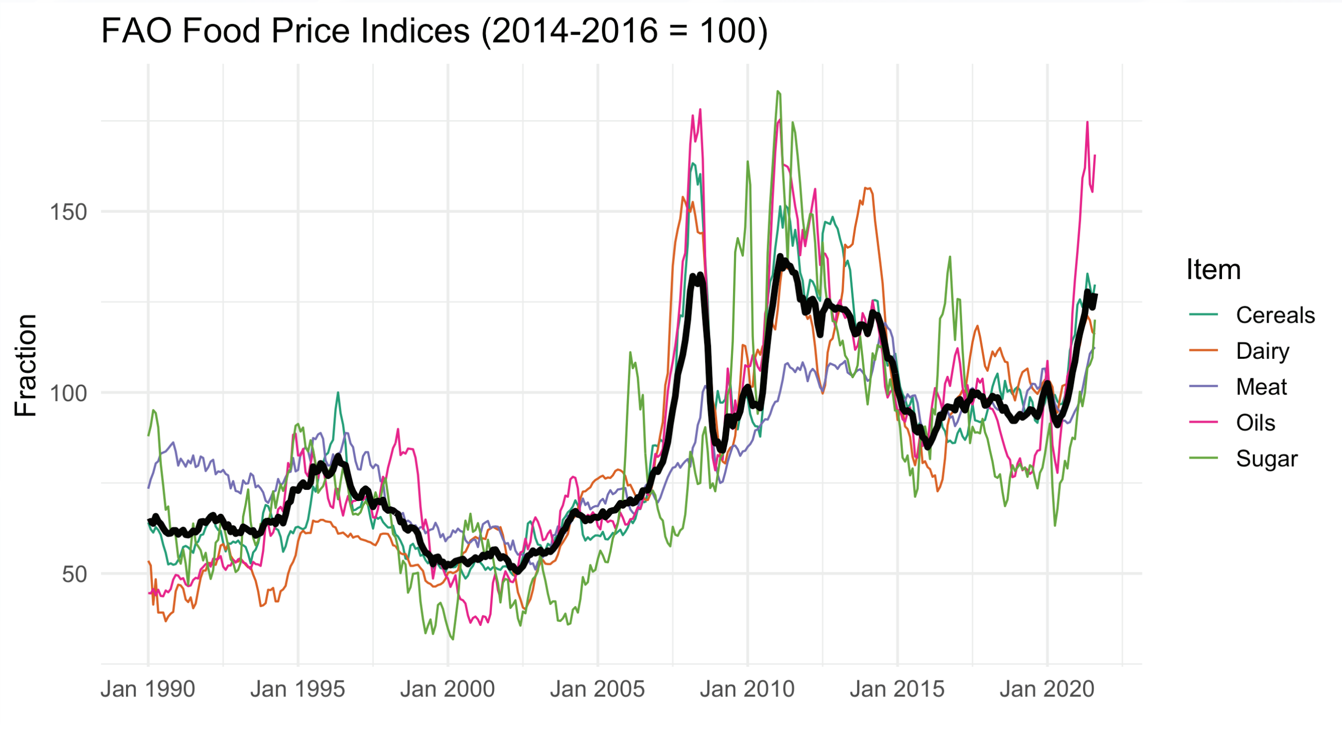
Finally, while greenhouse gas emissions are reported in CO2-equivalent terms, much of direct agricultural emissions are actually nitrogen. There are many scientific uncertainties about what the current rate of nitrogenous emissions (and overall perturbation of earth's nitrogen cycle) will mean in the longer term, beyond impacts on warming. Joint and open knowledge and technology sharing around this issue will be critical.

5.4 — POLICY RECOMMENDATIONS

Climate-conscious trade policy would generate environmental gains as well as economic gains. This can be achieved through:

- **Reducing Chinese barriers to U.S. trade in agriculture and soybeans in particular to reduce land-use change (LUC) emissions.**
- **Supporting direct zero-deforestation agreements.**
- **Supporting technology transfer, agricultural innovation, and rapid dissemination of best emissions-reducing practices among farmers.**
- **Nimble trade policy can be leveraged to additionally support emissions-efficient agriculture through buffering the pressures created by high prices and price volatility.**
- **Coordinated research is needed to understand the reach and impacts of this price environment from a climate perspective. (Figure 10)**

FIGURE 10 — After declining and steadier prices through the early 2000s, food prices are both higher and more volatile at present



6 — CLEAN TECHNOLOGIES AND SUPPLY CHAINS

BY PROFESSOR MICHAEL DAVIDSON

Since 2010, the costs of clean energy technologies ("clean tech") have fallen dramatically: prices of solar panels and lithium batteries have dropped by nearly 90%, and wind turbines by 70%.[26] These developments are due to economies of scale, learning effects, and global supply chains, all spurred by policy efforts to create demand pull and supply push. The increasing affordability of alternatives to fossil fuels makes ambitious climate change goals feasible, such as delivering 100% clean electricity in the U.S. nationwide by 2035.[27] Globally, meeting climate targets will require continued cost reductions in existing technologies as well as rapid commercialization of new technologies.

Yet, as the clean tech sector expands to meet climate objectives, serious concerns are being raised about current global supply chains, which are heavily integrated with foreign producers, particularly China.[28] In the absence of intervention, products with large economies of scale and high transportation costs should see a concentration of production near demand centers, a phenomenon known as the "home market effect".[29] However, the U.S. and other countries, in order to advance supply chain security and preserve and grow domestic manufacturing jobs, are exploring whether and how to accelerate "onshoring" elements of production. Policy interventions to date have primarily imposed trade restrictions on imported clean tech, which have mixed results in reshoring manufacturing and have provoked retaliatory trade measures. Continued reliance on efforts that restrict global trade could arrest further cost decline, generating negative impacts on consumers and downstream employment. Instead, a proactive industry-shaping effort that fosters emerging centers of manufacturing excellence connecting new innovations with the necessary finance to scale-up could generate significantly more positive impacts for the manufacturing sector as a whole while meeting climate goals. Robust, long-term policy signals for demand pull can simultaneously enhance the attractiveness of localizing production while ensuring that the largest source of clean tech employment—installation—continues to grow.

> ***"...following the first set of solar tariffs, China imposed retaliatory tariffs on U.S. exports of polysilicon, a key component in the production of solar cells, after which China began to scale up and eventually dominate global polysilicon production."***

26 Azevedo et al., "The Paths to Net Zero."

27 The White House, "President Biden Sets 2030 Greenhouse Gas Pollution Reduction Target Aimed at Creating Good-Paying Union Jobs and Securing U.S. Leadership on Clean Energy Technologies."

28 Ladislaw et al., "Industrial Policy, Trade, and Clean Energy Supply Chains"; The White House, "Building Resilient Supply Chains, Revitalizing American Manufacturing, and Fostering Broad-Based Growth."

29 Krugman, "Scale Economies, Product Differentiation, and the Pattern of Trade."

6.1 — CURRENT U.S. TRADE MEASURES AND RESPONSE

Over the last decade, the U.S. has put in place a range of trade-related measures related to imports of solar cells and modules, and wind towers. Indirectly, measures on related materials—steel and aluminum—have also impacted manufacturing and clean tech deployment (see Table 2). These measures have taken the form of tariffs on specific suppliers or uniform tariffs applied to all imports from certain countries, and in some cases include quota exemptions.

TABLE 2 — U.S. trade measures on clean tech (2012-2020)

Trade Action	Authority	Impact and Response
Solar cells and modules		China imposed retaliatory tariffs on U.S. polysilicon
Tariffs on specific China and Taiwan suppliers (2012, 2014)	AD/CVD	
Safeguard tariffs on most imports with quota exemption (2018)	Section 201	
Wind towers		
Tariffs on specific China and Vietnam suppliers (2013, 2018)	AD/CVD	
Tariffs on larger group of suppliers (2020)	AD/CVD	
Related materials		
Steel and aluminum tariffs from most countries (2018, 2020)	Section 232	Indirectly affecting manufacturing and clean tech deployment
Semiconductor tariffs on China imports (2020)	Section 301	Indirectly affecting solar inverter and module manufacturing

These policies have generated retaliatory responses from targeted countries, in particular China. Immediately following the first set of solar tariffs, China imposed retaliatory tariffs on U.S. exports of polysilicon, a key component in the production of solar cells, after which China began to scale up and eventually dominate global polysilicon production.[30] China also challenged Section 201 solar tariffs at the WTO, which recently ruled in favor of the U.S.[31]

6.2 — EVIDENCE OF EFFECTS ON ONSHORING, EMPLOYMENT, AND CONSUMERS

U.S. solar trade measures have had limited impacts on increasing domestic manufacturing capacity in the solar supply chain. The dominant technology, crystalline-silicon (c-Si), has remained almost entirely

> ***"...U.S. solar trade measures have had limited impacts on increasing domestic manufacturing capacity in the solar supply chain."***

30 BNEF, "Solar PV Trade and Manufacturing: A Deep Dive."

31 WTO, "United States: Safeguard Measure on Imports of Crystalline Silicon Photovoltaic Products."

foreign-based, and the alternative technology, thin film, has one major U.S. supplier that has witnessed improvement in production in recent years. Imports remained high throughout the tariff period, but sourcing indicates substantial trade diversion from China to other countries. From the first quarter of 2015 to the third quarter of 2020, the share of U.S. solar module imports from Vietnam and Malaysia grew from 12% to 64%, while over the same period imports from China fell from 32% to just 1%.[32] Importers have not faced the full cost of tariffs either, due to diversion and exemptions which can be the result of an opaque decision process—notably, bifacial modules were initially exempt from the tariffs, but as of November 2020 face import tariffs. Furthermore, when final module production takes place in third countries, many of these firms are Chinese-owned and much of the upstream components are made in China, thereby rendering them ineffective as a tool to address contentious U.S.-China technology and trade tensions. Domestic manufacturers and installers further face tariffs on aluminum, an important material for solar module frames and racking. Modules in the U.S. now sell at a 55% premium over global average sales prices.[33]

Wind turbines consist of components typically sourced from multiple suppliers and less commonly as completely assembled equipment. The U.S. has production capacity across all major components, while importing $2.6 billion worth of equipment in 2019.[34] After the U.S. imposed tariffs on wind towers from China, total imports dropped and were diverted to a variety of other suppliers. However, when steel tariffs were put in place, this increased costs for domestic tower producers, and imports doubled in 2019 over the previous year.[35] Concrete is the largest material by weight used in onshore wind turbine installations and turbines are getting larger and heavier to ship, trends which tend to localize parts of the supply chain absent other factors.

The cumulative impact of these measures on clean tech local value, employment, and consumers are so far relatively modest. In total, 54% of the value of a wind turbine installed in the U.S. (and 70% of the total value including project development and balance of plant costs) accrues locally.[36] In terms of employment, solar installation is roughly 10 times as labor intensive as the full manufacturing supply chain, indicating that over 90% of jobs can never be outsourced.[37] Despite the U.S. solar module price premium, changes in annual deployment do not appear to follow tariff policies, with 2020 posting a 61% year-on-year growth.[38] This could indicate that demand pull policies such as tax credits and renewable energy targets are the main drivers for deployment currently.

"...solar installation is roughly 10 times as labor intensive as the full manufacturing supply chain, indicating that over 90% of jobs can never be outsourced."

32 BNEF, "Solar PV Trade and Manufacturing: A Deep Dive."

33 Feldman and Margolis, "H2 2020: Solar Industry Update."

34 BNEF, "Wind Trade And Manufacturing: A Deep Dive."

35 BNEF.

36 BNEF.

37 Feldman and Margolis, "H2 2020: Solar Industry Update."

38 Feldman and Margolis.

6.3 — POLICY RECOMMENDATIONS

- **Avoid trade measures related to end-use products in well-established global supply chains.**

Steep import restrictions such as tariffs and quotas have been, in general, unsuccessful in forcing the reshoring of substantial parts of clean tech global supply chains. Targeted restrictions result in trade diversion by globally-competitive firms to low-cost production locations, while general restrictions appear similarly ineffective due to exemption rules and the high costs of establishing new supplier relationships. Trade measures such as tariffs on solar modules and wind towers have outlived their usefulness.

- **Consider indirect effects and retaliatory responses on the entire sector when evaluating trade measures.**

Key suppliers such as China will most likely retaliate to specific trade measures, which has implications for suppliers well beyond the complainants. The U.S. polysilicon industry used to supply China before the solar tariffs, which when put in place led to the concentration of polysilicon production in China. Domestic manufacturers facing higher import input costs without cost-effective substitutes can become less competitive globally.

- **Conduct sector-wide labor analysis on employment quality and growth potential.**

To generate millions of good-paying jobs in clean tech, the Administration needs a baseline for the number, location, and quality of jobs (inclusive of manufacturing and installation) across major technologies. While not every state can host a major clean tech manufacturer, every state will deploy clean energy, whose jobs cannot be outsourced internationally or even out of state. Even states without robust incentives for rooftop solar, such as Texas and Florida, are witnessing record growth due to consumer demand.[39] Employment-inducing policies should target the entirety of the clean tech labor force along with its expected growth trajectory.

- **Use direct incentives, not trade policy, to stimulate new areas of manufacturing excellence**.

Providing support to manufacturers in emerging industries has shown to be successful in creating strong localized supply chains elsewhere, such as in China.[40] The U.S. should target emerging clean tech areas (including, but not limited to, batteries, electric vehicles, and the hydrogen sector) with resources such as financing that can connect innovators with skilled manufacturers. Creating global champions in new technological areas mitigates the need for protracted trade remedies down the road to support late-comers.

- **Long-term policy certainty is most important for supply chain sourcing decisions.**

Establishing robust long-term policy directions in demand pull and industry support will generate the strongest incentive for low-cost domestic supply and high-value concentration. Shocks such as short-lived trade disputes do not necessarily lead to predictable or desirable supply chain reorganizations, but a large and expanding market as well as a welcome environment for innovative manufacturing can.

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39 Available at https://www.eia.gov/todayinenergy/detail.php?id=46996.

40 Nahm and Steinfeld, "Scale-up Nation."

7 — FISHERIES SUBSIDY REFORM AND THE WTO

BY PROFESSOR CHRISTOPHER COSTELLO

> ***"Fishing is the dominant human impact on the world's oceans, delivering significant food (~85 MMT/yr.) and economic benefits (~$100 Billion/yr. in revenue), but also contributing to climate change and ecosystem deterioration."***

Fishing is the dominant human impact on the world's oceans, delivering significant food (~85 MMT/yr.) and economic benefits (~$100 Billion/yr. in revenue), but also contributing to climate change and ecosystem deterioration. About one third of the world's fisheries are overfished or collapsed, which not only has ecosystem implications, but compromises the ability of the fishery to sustain harvest into the future.

Because fish populations often span multiple countries' waters, and because fish are one of the most globally traded goods, the world's fisheries are highly interconnected. Policies or incentives in one country can have significant consequences for economic opportunities, and ecosystem integrity, in other countries.

One dominant set of incentives is the $35 billion in subsidies bestowed on the world's fisheries each year. These subsidies come in many forms including positive subsidies that support marine protection and fishery management and the $22 billion in "capacity enhancing" subsidies that may encourage overfishing. This latter category artificially lowers the price of fuel, vessel construction, or other fishing capacity. In so doing, they distort fishing incentives, causing fishers to spend more time fishing and doing so in locations that would otherwise be unprofitable to fish. For example, on the high seas (62% of the ocean), subsidies have propelled fishing activity to the point where fishing cost actually exceeds revenue.

It is easy to see how such capacity enhancing subsidies could drive fish stocks to much lower levels than would arise without them. This reduces long-term fishery profits and exacerbates many of the problems they were intended to overcome. Counterintuitively, fishery subsidies may, in the long-run, compromise the livelihoods of the very people they were intended to serve. They cost taxpayers money, may ultimately not support the livelihoods of the fishers they target, and reduce ecosystem health and fish stocks accessible to other countries.

In addition to crippling domestic fisheries in the long-run, capacity enhancing subsidies exacerbate the tragedy of the commons across countries. Even if subsidies are individually rational, they are collectively disastrous, motivating the need for coordination across countries.

The WTO recognizes these likely deleterious effects of fishery subsidies, and has been debating possible reforms for decades with no significant agreement. Recent negotiations have been promising, however, and the WTO is now actively negotiating policies that would reduce or eliminate specific kinds of fishery subsidies. After years of debate and analysis, the four main principles being discussed at the WTO are:

- Whether to prohibit subsidies that drive illegal, unreported, or unregulated (IUU) fishing or human rights abuses. There is generally agreement on this, though observing IUU fishing remains a challenge.
- Whether to prohibit subsidies for fishing on overfished stocks. A sticking point is how to define "overfished" when most global fisheries lack assessments.
- Whether to prohibit subsidies that drive overfishing or overcapacity. There is a lack of agreement on how to define these harmful subsidies, and many countries argue that well-managed fish stocks should be exempt from subsidy reforms.
- Whether to grant exceptions to subsidy reforms for under-resourced countries. Because they are often the most marginalized, small scale fishers are of particular concern.

7.1 — EVIDENCE

While notable progress has been made in the past few decades to curb overfishing, robust fishery management covers less than half of the world's fish catch. Recent evidence suggests that $50-$80 billion per year in profit is lost due to ineffective management and overfishing. One important driving factor is fishery subsidies.

> ***"...$50-$80 billion per year in profit is lost due to ineffective management and overfishing."***

What evidence exists linking fishery subsidies to overfishing? Early research into the effects of fishery subsidies predominantly focused on their potential to distort trade, but links to resource sustainability began to be considered in the late 1990's and early 2000's by international fisheries organizations (e.g., FAO 2000). Sumaila (2003) describes the theory behind how subsidies that reduce the operational costs of fishing or raise the price of harvested fish can lead to overexploitation of the resource in an open access fishery. Many papers since have reiterated similar conceptual arguments supporting the link between fishery subsidies and overfishing (Sumaila et al. 2019), with many providing convincing anecdotes (e.g., Sala et al. 2018). Many such studies have focused on particular types of fishery subsidy programs like fuel subsidies (Sumaila et al. 2008) or vessel buyback schemes (Clark, Munro, & Sumaila 2005).

Nonetheless, most of these studies lack theoretical or empirical evidence of the link between fishery subsidies and overfishing. Sakai (2017) is the first to derive a causal link between fishery subsidies and fishing pressure in a reduced form causal inference framework. He finds that whether subsidies drive excessive fishing pressure depends on the form of management. If property rights approaches like ITQs are used, which contain all of the elements of robust fishery management, then subsidies have little to no effect on fishing pressure. But if input controls are used, then subsidies lead to an increase in fishing pressure. Martini and Innes (2018) take a different approach, deriving a structural model and parameterizing it with data from the OECD-FAO Agricultural Outlook report and the OECD Fisheries Support Estimate (FSE) database. They find that all types of subsidies drive overfishing, but they vary in magnitude and distribution across fleets. Finally, Costello et al. (2021) use satellite data on the world's fishing fleet to show that subsidized fishing is geographically extensive (it occurs nearly everywhere that fishing occurs) and that larger subsidies tend to occur in fisheries that are poorly managed. This latter finding suggests that exempting well-managed fisheries from reforms would have little impact on fishery outcomes.

7.2 — POLICY RECOMMENDATIONS

Based on the state of negotiations at the WTO, the scholarly research linking fishery subsidies to fishing pressure, and additional analysis generated to support the WTO negotiations, we conclude with the following recommendations for the WTO:

- **Provide tools for countries to repurpose subsidies.**

In most cases, the support to fishers currently given in the form of capacity enhancing subsidies could instead be repurposed in ways that still support fishers' livelihoods, but without the marginal incentive to overfish. The WTO could advise and encourage countries to pursue these options. This will not only smooth the transition for fishers, but will make the reforms proposed below more politically and socially palatable. This avenue has been largely absent from the WTO debate (which, even today, focuses on "to subsidize or not") and could significantly change the political calculus from countries currently opposed to subsidy reforms.

- **Be ambitious and resist carve-outs.**

Capacity enhancing subsidies drive overfishing and fuel the tragedy of the commons. This affects all countries, not just those who subsidize their fishing fleets. The concomitant reduction in fish stocks can disproportionately affect developing countries, both because they tend to rely more on fisheries for livelihoods and food, and because they tend to have weaker fishery management institutions. Many countries argue for "special and differential treatment" because they have special circumstances that merit an exemption to subsidy reform. Of course, these loopholes essentially allow countries to evade reforms (Harper et al. 2012), which ultimately weakens the agreement, to the detriment of all countries. Any such exemptions should be judicious and systematic (e.g. for fishery management), not idiosyncratic. Pursuing Recommendation #1 (repurposing subsidies away from capacity enhancing) will help ease the transition for low-income countries, and will reduce the need to engage in special and differential treatment.

- **Allow an exemption for demonstrably well-managed fisheries.**

The evidence seems clear that when a fishery is truly well-managed, subsidies have little to no effect on fishing pressure. Acknowledging this, and thus allowing a subsidy reform exemption for well-managed fisheries, rewards countries that currently manage their fisheries and provides an incentive for other countries to follow suit. We propose that a very high bar be set to determine which fisheries are "well-managed". For example, rigorous catch quotas and the UN-FAO standard of F ≤ FMSY and B ≥ BMSY could be used, which would imply that a formal stock assessment is a necessary (though not sufficient) condition for this exemption. One way to repurpose subsidies (Recommendation 1), would redirect funds to improve fishery management. It is well-known that this can improve livelihoods, food security, and ecosystem outcomes. Recent studies suggest that improved fishery management and institutional reforms could increase fishery profits by $50-$80 billion/yr, increase food provision by 12 million tons/yr, and increase fish stocks by up to 50%, and (Costello et al. 2016, World Bank 2017, Costello et al 2020).

> ***"...improved fishery management and institutional reforms could increase fishery profits by $50-$80 billion/yr, increase food provision by 12 million tons/yr, and increase fish stocks by up to 50%..."***

- **Strictly prohibit subsidies to companies and operators who engage in IUU fishing or other illicit behavior.**

Most WTO negotiators agree that IUU fishing and companies engaging in human rights abuses at sea should not be subsidized. The challenge is that these illicit activities are (almost by definition) notoriously hard to observe, so it is difficult to discipline the subsidies that fuel them. By removing subsidies to companies, not just individual operators, who are found to engage in IUU fishing or human rights abuses, the reach of this discipline can be amplified. Modern technology, such as satellite surveillance and machine learning, can be used to help illuminate illicit activities at sea (Park et al. 2020; McDonald et al. 2021)

- **Keep it simple and reach an agreement.**

The WTO has debated this topic for decades with no agreement. At this point, some agreement is better than no agreement, and we believe that the recommendations listed above appropriately balance the bargaining positions of most of the interested parties. An agreement of this sort will be pathbreaking, and could be strengthened in the future as its effects become apparent.

> ***"...some agreement is better than no agreement..."***

8 — CONCLUSION

We highlighted five sectors where climate cooperation requires trade policy coordination to forestall protectionism and ensure that developing countries obtain the financing they need for adaptation and mitigation.

Our proposals are sensitive to political economy constraints and opportunities at both the domestic and the international levels. One of our main conclusions is that when rich countries impose coordinated border adjustment measures and dedicate the tariff proceeds to climate finance, the result is less domestic industry opposition and more support from developing countries. Financing climate adaptation from border adjustment measures would need to be coordinated among a set of like-minded nations, but this is feasible within current negotiating frameworks.

Similar progress could be made quickly in agriculture. Reducing Chinese barriers to U.S. trade in agriculture—especially soybeans—would have a substantial impact on reducing land-use change (LUC) emissions. American farmers would benefit, as well as the environment and China, creating a window for cooperation on agricultural emissions. If future cooperation includes border measures, the proceeds should then be earmarked for climate finance, to ease the transition to clean agriculture in developing countries.

The main message of this report is that globalization ties the economic fate of all nations together as we address climate change. We discuss new research that connects extreme weather events in distant lands to financial volatility and losses in the United States and other global financial centers. Weather disasters are transmitted via trade and supply chains, causing volatility and losses to sectors with extensive global business operations. The implications for global cooperation are clear: advanced economics have an economic interest in coordinating their own climate and trade policies, while financing climate adaptation and mitigation in developing countries. The moral obligation of the latter is well-understood, but less so the economic obligation.

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