Globalization and the Environment

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Globalization Important for the Environment

- **Important**
  - Trade, foreign investment drive environmental outcomes
    - Climate change, species extinction, air/water pollution, groundwater exploitation
  - International air/sea fastest growing broad sector for CO_2
  - Trade provides carrots and sticks

- **Policy debates**
  - Carbon border adjustments
  - Climate clubs
  - Climate finance
  - Trade policy for solar panels, electric vehicles, batteries, rare earth minerals
  - Inflation Reduction Act / friendshoring

- **Research**
  - Burgeoning combination of questions, policies, theory, methods, data

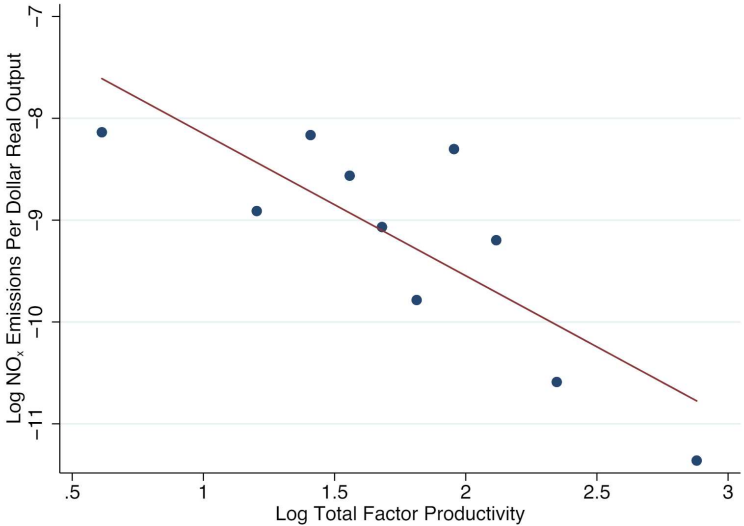
Globalization and the Environment: Research Questions

- **How do globalization and international economic policy affect the environment?**
  - How do tariffs affect greenhouse gas emissions?
  - Does globalization cause a “race to the bottom” in environmental policy?
- **How do environmental goods and policies affect globalization?**
  - When does environmental policy constitute protectionism?
  - How do carbon border adjustments, climate clubs affect the economy?
- **Intellectual arbitrage between international and environmental economics?**
  - Can trade data/models/methods help measure marginal cost of abating pollution?
  - How do environmental goods affect comparative advantage?

Agenda for Today

- **Stylized facts**
- Summarize the subfield
- Toy model
- Policy
- Conclusions

Stylized Fact #1: Productive Firms Have Lower Pollution Intensity



Source: Shapiro and Walker, 2018, "Why is Pollution from US Manufacturing Declining?" *American Economic Review*

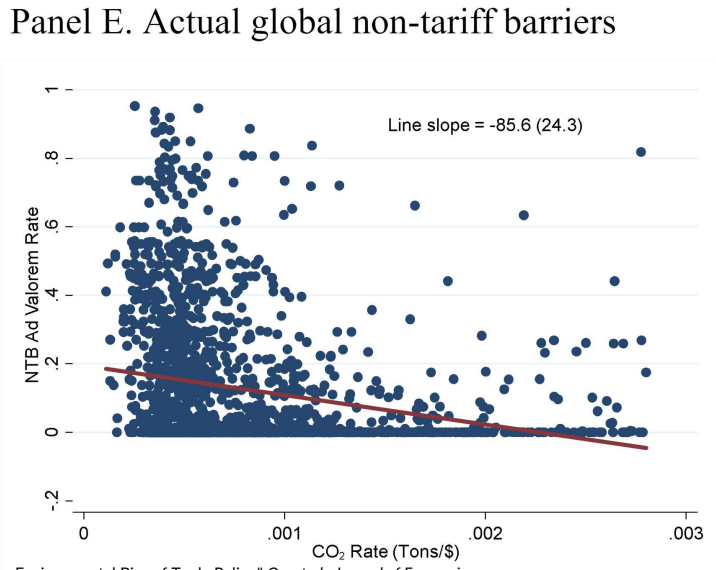
Stylized Fact #2: Dirty Industries are More Exposed to Trade

Table 1: Cleanest and Dirtiest Industries in Global Data

	Direct Emission Rate		Total Emission Rate		Total Output ($trillion)	Output Traded (%)	Upstream-ness
	CO_2	NO_x	CO_2	NO_x			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Panel A. Cleanest industries							
Real estate activities	8	0.0	84	0.3	$7.9	0.6%	1.5
Financial intermediation	11	0.0	101	0.3	$7.2	7.0%	2.3
Equipment & machine rentals	28	0.1	166	0.6	$10.0	8.6%	2.7
Wholesale trade	25	0.1	201	0.8	$5.9	7.9%	2.2
Retail fuel; vehicle repair, sales	34	0.1	186	0.6	$1.2	1.2%	1.9
Mean of cleanest 5 industries	*21*	*0.1*	*148*	*0.5*	*$6.4*	*5.1%*	*2.1*
Panel B. Dirtiest industries							
Coke, oil refining, nuclear fuel	359	0.5	984	2.4	$2.5	22.9%	2.7
Air transport	1,227	4.8	1,613	6.0	$0.6	31.0%	2.1
Water transport	1,147	12.7	1,681	16.0	$0.6	40.6%	2.9
Other non-metallic mineral	1,332	4.0	2,291	6.4	$1.3	11.2%	2.6
Electricity, gas, water supply	3,295	5.6	4,324	7.8	$3.4	2.1%	2.8
Mean of dirtiest 5 industries	*1,472*	*5.5*	*2,179*	*7.7*	*$1.7*	*21.5%*	*2.6*

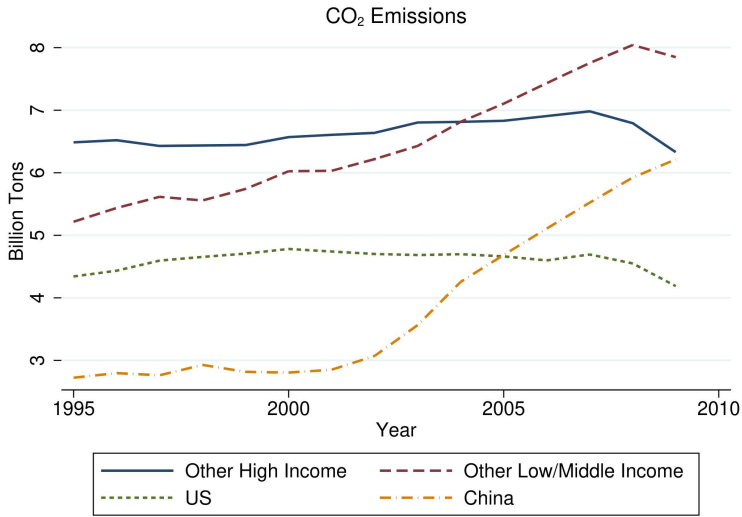
Source: Copeland, Shapiro, and Taylor, 2022, "Globalization and the Environment," *Handbook of International Economics*

Stylized Fact #3: Dirty Industries Face Lower Trade Protection



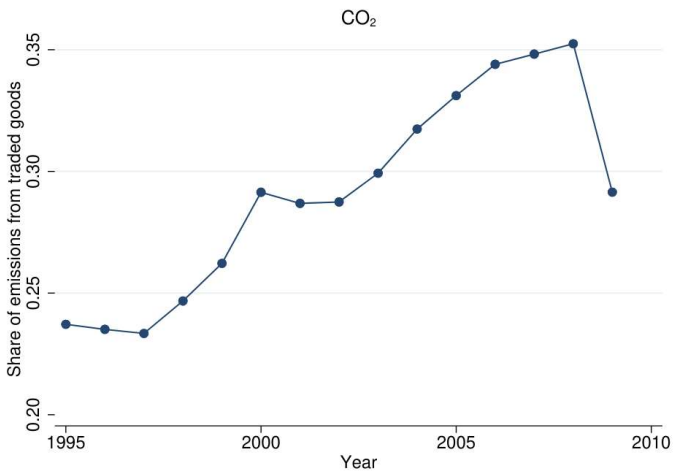
Source: Shapiro, 2021, "The Environmental Bias of Trade Policy," *Quarterly Journal of Economics*

Stylized Fact #4: Emissions Growth is from Non-Rich Countries



Source: Copeland, Shapiro, and Taylor, 2022, "Globalization and the Environment," *Handbook of International Economics*

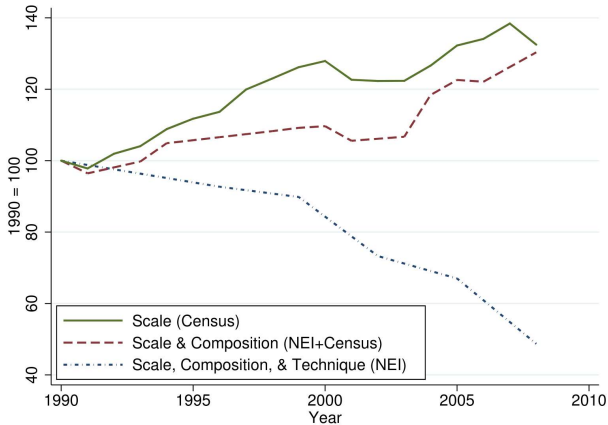
Stylized Fact #5: Int'l Trade Accounts for Over a Fourth of Emissions



Source: Copeland, Shapiro, and Taylor, 2022, "Globalization and the Environment," *Handbook of International Economics*

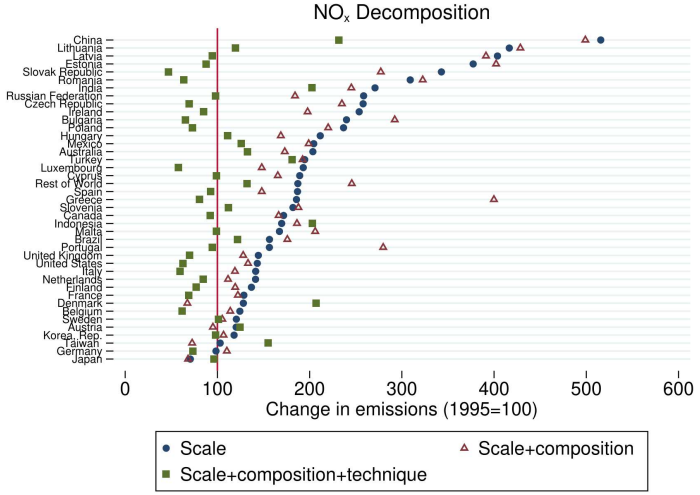
Stylized Fact #6: Technique Exceeds Composition in Time Series (1/2)

Figure 3: Nitrogen Oxides Emissions From United States Manufacturing



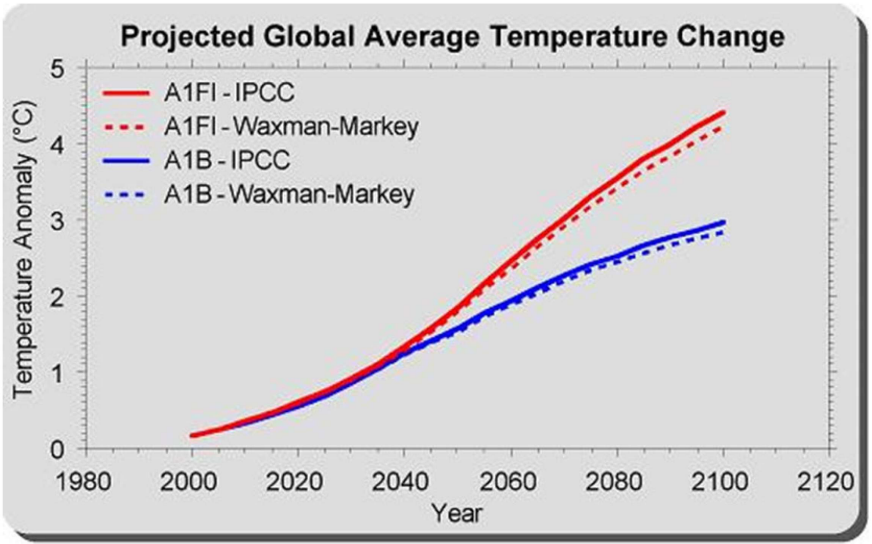
Source: Shapiro and Walker, 2018, "Why is Pollution from US Manufacturing Declining?" *American Economic Review*

Stylized Fact #6: Technique Exceeds Composition in Time Series (2/2)



Source: Copeland, Shapiro, and Taylor, 2022, "Globalization and the Environment," *Handbook of International Economics*

Stylized Fact #7: Global Problems Need Global Solutions



Source: Knappenberger, 2009, "Climate Impacts of Waxman-Markey"

Agenda for Today

- Stylized facts
- **Summarize the subfield**
- Toy Model
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Trade and Environment Research: Classic

- **1970s/80s: highly stylized—Pethig, Markusen**
- **1990s: NAFTA, Grossman and Krueger (QJE 1995)**
  - Environmental Kuznets Curve
  - Scale, composition, technique
- **1990s/2000s: Stylized Models, Reduced-form Regressions**
  - Copeland & Taylor (2005), *Trade and the Environment*
  - Frankel & Rose (*REStat* 2005), “Is trade good or bad for the environment”

Globalization and Environment Research: Current (1/3)

Organized by method, approach:

- **Quantitative trade models**
  - Nordhaus (AER 2015), “Climate Clubs”
  - Shapiro (AEJ:Policy 2016), “Trade Costs, CO2, and the Environment”
  - Farrokhi & Lashkaripour (2024), “Can Trade Policy Mitigate Climate Change?”
- **Political economy, trade policy**
  - Shapiro (2021), “The Environmental Bias of Trade Policy”
  - Hsiao (2024) “Coordination and Commitment in International Climate Action”
- **Dynamic quantitative spatial equilibrium models**
  - Balboni (2024), “In Harm’s Way?”
  - Rossi-Hansberg et al. (2015, 2021, 2024, ...)

Globalization and Environment Research: Current (2/3)

Organized by method, approach:

- **Multinational production**
  - Castro-Vincenzi (2024), “Climate Hazards and Resilience in the Global Car Industry”
  - Garcia-Lembergman et al. (2024), “The Carbon Footprint of Multinational Production”
- **Agriculture**
  - Costinot, Donaldson, and Smith (JPE 2016), “Evolving Comparative Advantage”
  - Carleton, Crews, Nath (2024), “Agriculture, Trade, and Spatial Efficiency...”
  - Farrokhi et al. (2024), “Deforestation: A Global and Dynamic Perspective”
  - Dominguez-Iino (2024), “Efficiency and Redistribution in Environmental Policy”
- **Industry studies**
  - Arkolakis & Walsh (2024), “Clean Growth”
  - Allcott, Shapiro, & Tintelnot (2024), “Buy American”

Globalization and Environment Research: Current (3/3)

Organized by question:

- **How can trade/investment policy support climate policy?**
  - Nordhaus (2015), Shapiro (2016, 2021), Garcia-Lembergman et al. (2024), Farrokhi & Lashkaripour (2024), Hsiao (2024)
- **What are spatial impacts of climate change, how should policy reflect them?**
  - Balboni (2024), Rossi-Hansberg et al. (2021, 2024, ...)
- **How does trade affect adaptation to climate change?**
  - Costinot, Donaldson, & Smith (2016),
- **How does trade, int'l policy affect other environmental goods?**
  - Carleton, Crews, Nath (2024), Dominguez-Iino (2024), Farrokhi et al. (2024)

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Toy Model (ACR)

Preferences:

$$U_j = \left[\sum_{i=1}^{n} q_{ij}^{(\sigma-1)/\sigma} \right]^{\sigma/(\sigma-1)}$$

Prices:

$$P_j = \left[\sum_{i=1}^{n} (w_i \tau_{ij})^{1-\sigma} \right]^{1/(1-\sigma)}$$

Trade:

$$X_{ij} = (w_i \tau_{ij} / P_j)^{1-\sigma} Y_j$$

Equilibrium:

$$Y_i = w_i L_i$$

Welfare:

$$\hat{W}_j = \hat{\lambda}_{jj}^{1/(1-\sigma)}$$

Toy Model: Environmental Extensions

- **Industries**
  - Dirty versus clean
  - Input-output: energy goods upstream
- **Factors**
  - Natural resources: energy, water, land
  - Complementarity: dirty industries capital-intensive
- **Policy**
  - Pollution taxes, standards
  - Tariffs, NTBs, investment subsidies
- **Other assumptions**
  - Trade imbalances: production v. consumption emissions
  - Market structure: polluting industries concentrated
  - Economic geography: spatially resolved environmental goods

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Carbon Border Adjustments: Estimates With All Countries

	Non-Cooperative Border Taxes			Cooperative Carbon Taxes		
Country	Δ CO_2	ΔV	ΔW	Δ CO_2	ΔV	ΔW
EU	0.7%	-1.2%	-1.3%	-9.2%	0.0%	2.0%
BRA	-6.0%	-1.3%	-1.3%	-70.7%	-1.3%	-0.8%
CHN	3.0%	-1.0%	-1.0%	-69.3%	-1.3%	-0.9%
IND	1.1%	-4.4%	-4.4%	-76.0%	-2.6%	-2.1%
JPN	3.4%	-0.9%	-0.9%	-23.1%	-0.2%	1.5%
MEX	-1.6%	-3.2%	-3.2%	-79.5%	-0.6%	-0.4%
USA	1.3%	-1.7%	-1.7%	-48.2%	-0.3%	0.3%
Global	-0.6%	-1.7%	-1.7%	-61.0%	-0.6%	0.4%

Source: Farrokhi & Lashkaripour, 2022, "Can Trade Policy Mitigate Climate Change," Mimeo

Carbon Border Adjustments: Estimates With OECD v. Brazilian Steel

Table 2: Emission and Welfare Effects from Environmental Trade Policies

	First Best	BCA	Voluntary Certification $f = 0$	Voluntary Certification $f = f^*$
Welfare				
Gains in M USD	1212	714	692	866
% of First Best Gains	100	58.9	58.4	71.5
Emissions				
Reduction in Mt	24.4	5.6	6.3	11.1

Note: All gains are calculated relative to a unilateral domestic carbon tax in the OECD without border adjustments. First best is a global carbon emissions tax. f is a tax on certification, with f^* denoting the optimum certification tax.

Source: Cicala, Hemous, Olsen, 2023, "Adverse Selection as a Policy Instrument," Mimeo

Climate Clubs

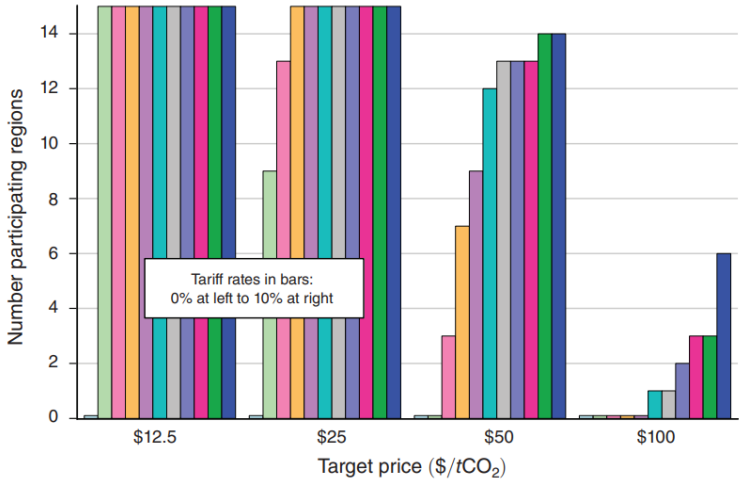
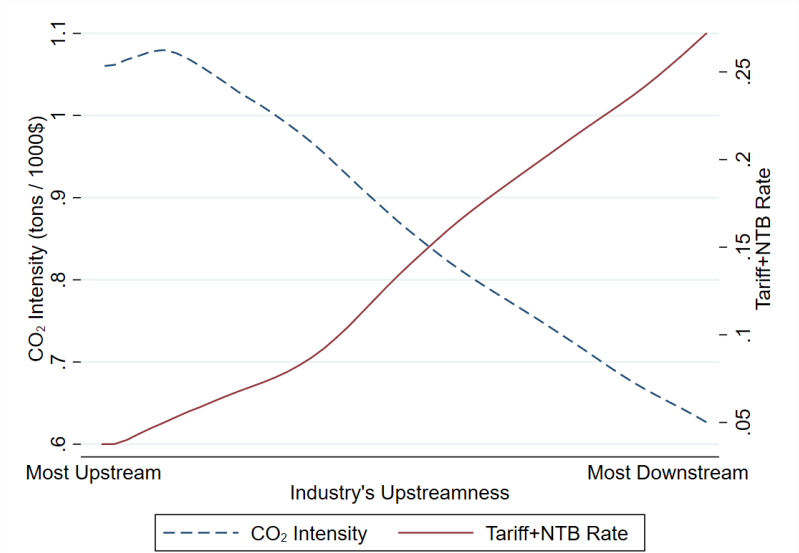


FIGURE 3. NUMBER OF PARTICIPATING REGIONS BY INTERNATIONAL TARGET CARBON PRICE AND TARIFF RATE

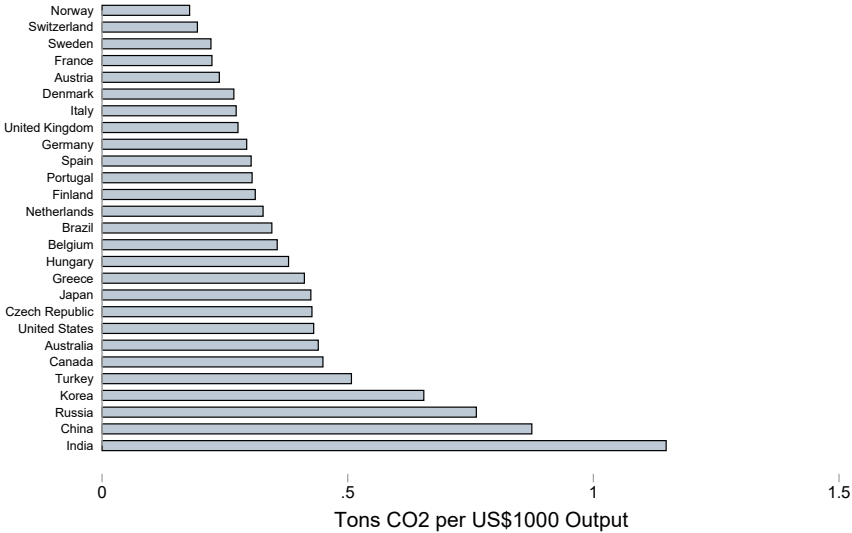
Source: Nordhaus, 2015, "Climate Clubs," *American Economic Review*

Environmental Bias of Trade Policy



Source: Shapiro, 2021, "The Environmental Bias of Trade Policy," *Quarterly Journal of Economics*

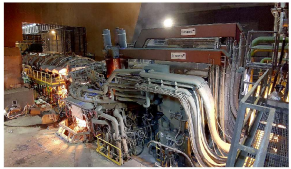
Multinational Production (MP)



Source: Garcia-Lembergman, Ramondo, Rodriguez-Clare, Shapiro, 2023, "The Carbon Footprint of Multinational Production, " Mimeo

Multinational Production (MP)

Tenova (Italy): mini mill (electric arc furnace)



MP Italy->Vietnam

Kunming Iron & Steel (China): integrated mill (blast furnace)

MP China->Vietnam

Vietnam steel corporation (Vietnam)

Source: Garcia-Lembergman, Ramondo, Rodriguez-Clare, Shapiro, 2023, "The Carbon Footprint of Multinational Production, " Mimeo

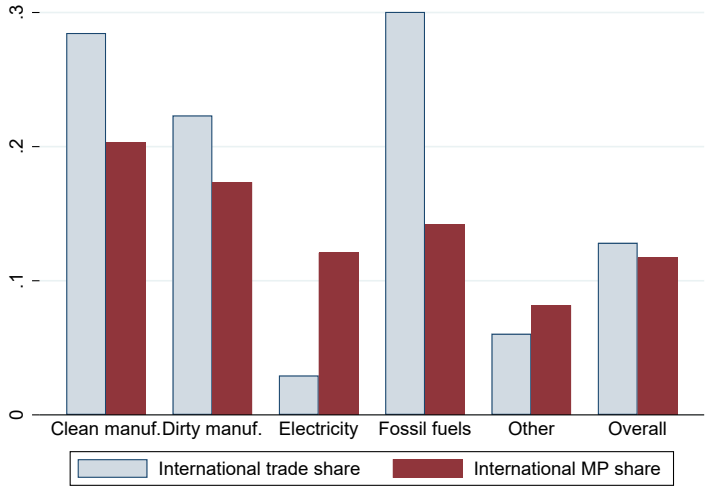
MP: Cleaner Home Countries Have Cleaner Affiliates

Firm f, home country i, host country l, industry s. $\mathcal{E}$ Emissions. Y Revenue

$$\log\left(\frac{\mathcal{E}_{fi,l,s}}{Y_{fi,l,s}}\right)^{CDP,Orbis} = \beta_1 \log\left(\frac{\mathcal{E}_i}{Y_i}\right)^{WIOD} + X'_{f,l}\gamma + \delta_{l,s} + \epsilon_{fi,l,s}$$

Dependent variable:	Log firm CO_2 rate					
Home log CO_2 rate	0.96***	1.07***	0.56*	0.63**	0.63**	0.60**
	(0.24)	(0.22)	(0.30)	(0.25)	(0.23)	(0.29)
Host log CO_2 rate	0.89***	0.86***				
	(0.09)	(0.09)				
Firm log revenues						-0.48***
						(0.08)
Observations	4,833	4,833	4,833	4,833	4,833	4,833
R-squared	0.05	0.24	0.28	0.48	0.63	0.70
# host countries	42	42	42	42	42	42
# home countries	32	32	32	32	32	32
Industry FE	no	yes	no	yes	-	-
Host country FE	no	no	yes	yes	-	-
Industry x host country FE	no	no	no	no	yes	yes

Multinational Production and Trade Important for Dirty Industries



Source: Garcia-Lembergman, Ramondo, Rodriguez-Clare, Shapiro, 2023, "The Carbon Footprint of Multinational Production, " Mimeo

MP: Carbon Accounting with Multinational Production

Steel

Rubber

Glass

Glencore (h) in Australia (j)

GM (i) in South Korea (l)

(n)

$$\mathcal{E}_{hi,jln,ks} = \frac{e_{l,k}}{p_{l,k}} \chi_{hi,jl,ks} X^{C}_{i,ln,s}$$

Source: Garcia-Lembergman, Ramondo, Rodriguez-Clare, Shapiro, 2023, "The Carbon Footprint of Multinational Production, " Mimeo

MP: Carbon Accounting: Allocating Emissions

$$\mathcal{E}_{l}^{P} = \sum_{hi,jn,ks} \mathcal{E}_{hi,jln,ks} \quad \text{Production}$$

$$\mathcal{E}_{n}^{C} = \sum_{hi,jl,ks} \mathcal{E}_{hi,jln,ks} \quad \text{Consumption}$$

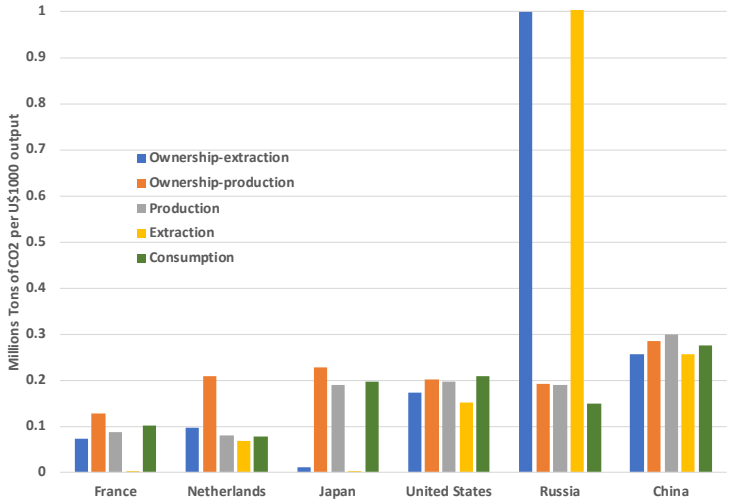
$$\mathcal{E}_{j}^{M} = \sum_{hi,ln,ks} \mathcal{E}_{hi,jln,ks} \quad \text{Mining}$$

$$\mathcal{E}_{i}^{O,P} = \sum_{h,jln,ks} \mathcal{E}_{hi,jln,ks} \quad \text{Ownership-Production}$$

$$\mathcal{E}_{h}^{O,M} = \sum_{i,jln,ks} \mathcal{E}_{hi,jln,ks} \quad \text{Ownership-Mining}$$

h, i = Country of ownership for inputs, outputs; j, l = Country of production for inputs, outputs
n = Country of consumption; k, s = Industry for inputs, outputs

MP: Carbon Accounting, Selected Countries



Source: Garcia-Lembergman, Ramondo, Rodriguez-Clare, Shapiro, 2023, "The Carbon Footprint of Multinational Production, " Mimeo

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Conclusions

- **Stylized facts, research frontier, adaptable models, policy impact**

- **Takeaways**
  - Globalization important to environment
  - Enviroment important to globalization
  - Research important to policy