The Global Effects of Carbon Border Adjustment Mechanisms

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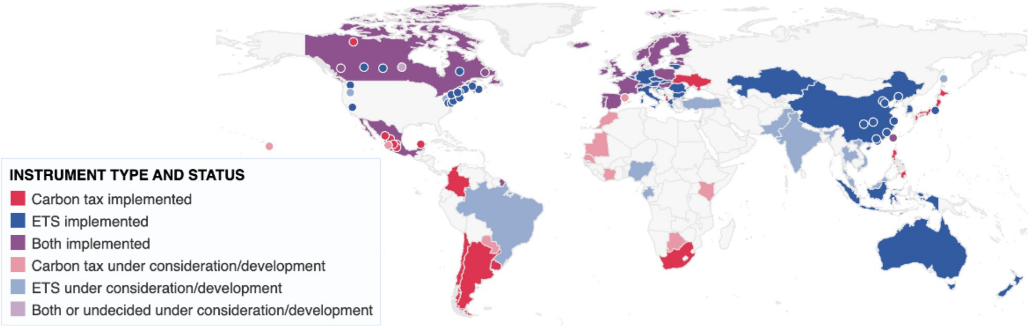
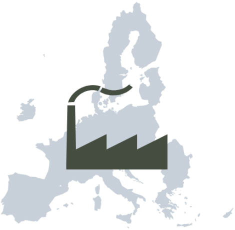
Carbon pricing around the world (2024)



Carbon border adjustment mechanism (CBAM)

Cement, iron and steel, aluminium, fertilisers, electricity and hydrogen



EU Production

EU production is subject to the **EU-ETS***

(Assuming an ETS allowance price of 90€ per tonne of CO2)

Non- EU Production

Non-EU production is subject to a lower **ETS** and **CBAM certificates**

Three motivations and one concern

- Boost domestic competitiveness
- Reduce foreign emissions leakage
- Encourage foreign regulation

- But may disadvantage lower-income trading partners

Potentially regressive for lower-income countries

- Guardian (2024): "India seeks UK carbon tax exemption in free trade deal talks"
- Bloomberg (2024): "EU CBAM Damaging ASEAN Businesses?"

- Center for Global Development (2022): "Mozambique, a large aluminum exporter, could experience a fall of 1.6 percent of its GDP as a result of a shift in demand following the introduction of the CBAM"

This paper

1. Detailed global data on aluminum and steel
   - Key sectors targeted in first phase of EU/UK CBAM
   - Most emissions-intensive and heavily traded
2. Descriptive analysis of emissions
   - Lower-income countries not more emissions-intensive
3. Quantitative equilibrium model of regulation and trade
   - Welfare impacts of carbon taxation and CBAM

Carbon taxation with a CBAM

- **Increased competitiveness:** profit losses for regulated producers 15% $\downarrow$
- **Reduced leakage:** emissions increases for unregulated producers 30% $\downarrow$
- **Incentives for regulation:** free revenue for unregulated markets

- Similar incidence across lower- and higher-income countries

Background

Policy timeline

- EU CBAM proposed in 2021
  - Phase-in starting October 1, 2023 with reporting only
  - Full implementation from January 1, 2026 for target sectors
- UK CBAM announced in 2023, targeting implementation by 2027
- In discussion in Canada, Australia, and Taiwan
- Expansion of Chinese ETS to cover target sectors

EU CBAM target sectors

(%)	Trade Intensity	Global Emissions
Steel	23	11
Aluminum	41	3
Electricity	2	33
Fertilizers	60	1
Cement	2	6
Hydrogen	0.1	2

Aluminum and steel

- Globally traded commodities
  - London Metal Exchange reports global prices and facilitates trade

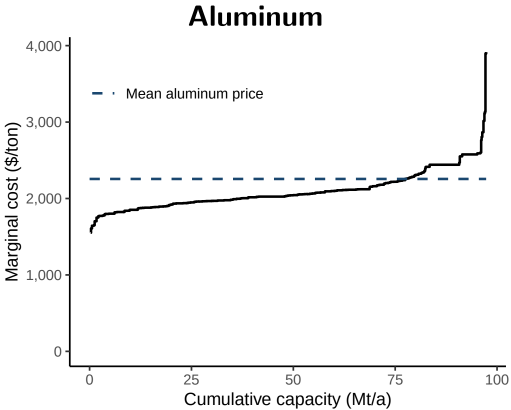
- Aluminum
  - Primary: smelted from alumina with CO_2 from chemistry and electricity
  - Secondary: recycled from scrap with 5-10% emissions

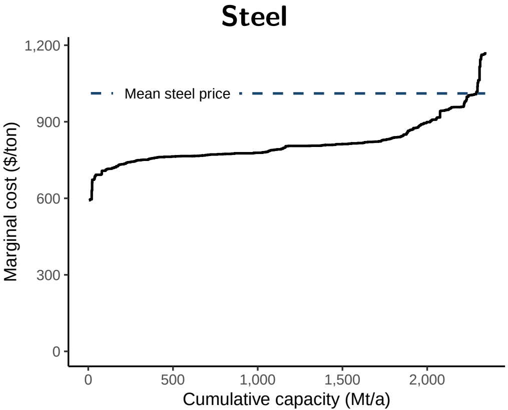
- Steel
  - Primary: blast furnace/basic oxygen furnace (BF-BOF) from iron ore
  - Secondary: electric arc furnace (EAF) from scrap with 35-40% emissions

Global data by plant for 2023

- Aluminum smelters from WoodMac
  - 153 worldwide with some Chinese smelters aggregated
  - Public data + site visits
  - LIC producers: 7% of global production, 9% of global emissions
- Steel mills from Climate TRACE
  - Every steel mill with capacity above 500k tons
  - Satellite and mill-level sensor data
  - LIC producers: 7% of global production, 6% of global emissions
- Production, capacity, costs, and emissions
  - Primary and secondary plants, Scope 1 and 2 emissions

Production costs and capacity





Aluminum quantities

Producers

Country	Mt	%
China	48.9	57.9
India	4.7	5.6
EU + UK	4.6	5.5
USA	4.1	4.9
Russia	4.0	4.7
Rest of world	18.1	21.5

Consumers

Country	Mt	%
China	50.8	60.2
EU + UK	9.1	10.8
USA	8.6	10.2
India	3.0	3.6
Japan	2.9	3.4
Rest of world	10.0	11.8

Steel quantities

Producers

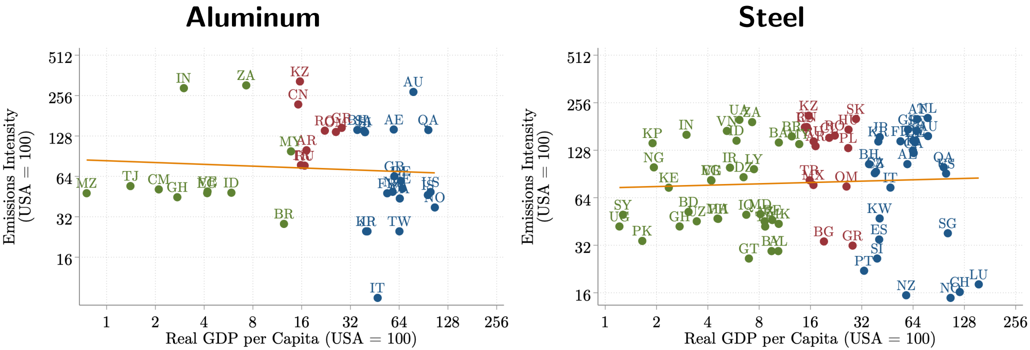
Country	Mt	%
China	860	51
EU + UK	153	9
Japan	88	5
USA	86	5
India	76	5
Rest of world	409	25

Consumers

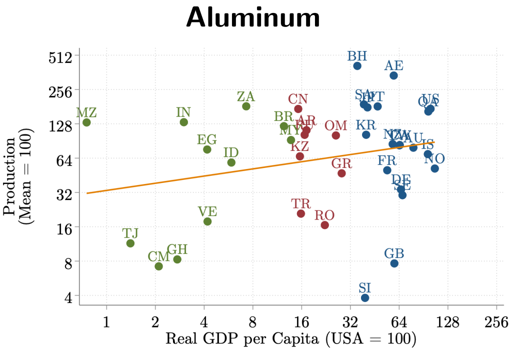
Country	Mt	%
China	827	49
EU + UK	169	10
USA	101	6
India	77	5
Japan	68	4
Rest of world	431	26

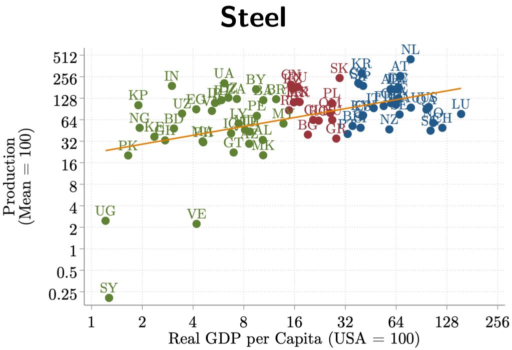
Descriptives

Emissions intensity by income

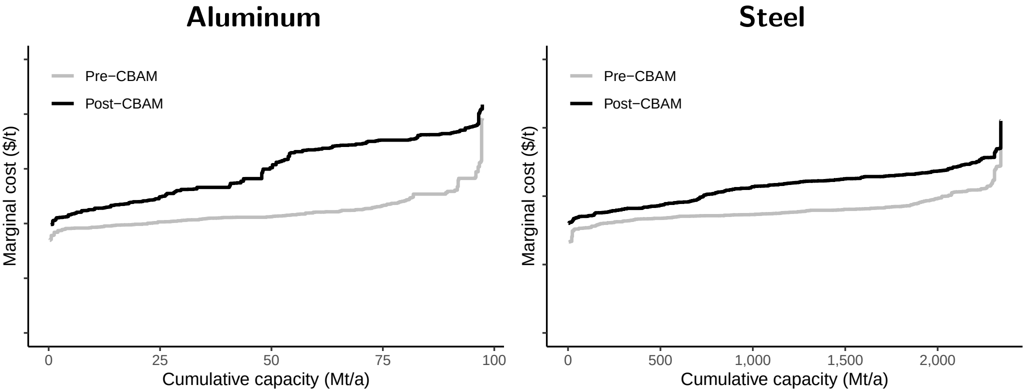


Production scale by income

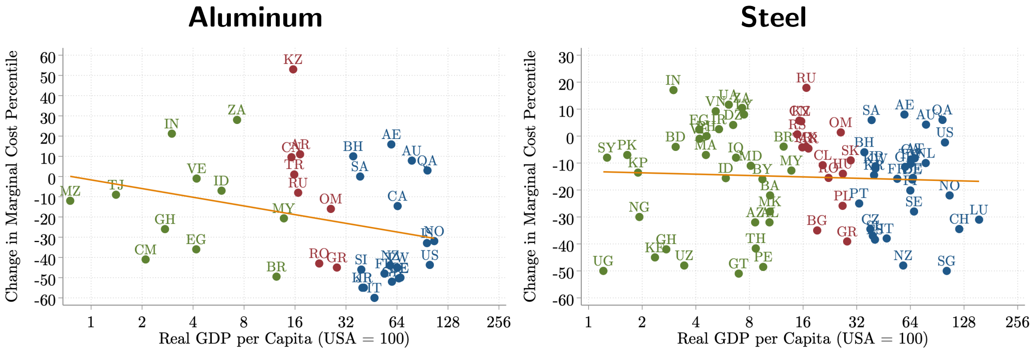




CBAMs add to costs



CBAM impacts by income



Model

Global aluminum market

- Demand by market, supply by smelter
  - Markets with high (H) and low (L) carbon regulation
- Regulator in H considers a CBAM
  - Smelters can shift sales across markets
  - Will quantify distributional effects

Demand by market m

$$\log D^m = \delta^m + \varepsilon^m \log P^m$$

- Log-linear with calibrated $\varepsilon^m = -0.25$

Supply by smelter i

$$S_i = s_i o_i^m$$

$$o_i^m = \mathbb{1}(p_i^m > c_i)$$

- Observed capacity s_i
- Choice to operate o_i^m, given price p_i^m and observed cost c_i

Carbon regulation and CBAM

$$
\begin{aligned}
p_i^m &= \max\{p_i^{mH}, p_i^{mL}\} & \qquad p_i^{HH} &= P^H - \tau^H e_i & \qquad p_i^{LH} &= P^H - \tau^H e_i \\
h_i^m &= \mathbb{1}(p_i^{mH} > p_i^{mL}) & \qquad p_i^{HL} &= P^L - \tau^H e_i & \qquad p_i^{LL} &= P^L - \tau^L e_i
\end{aligned}
$$

- Choice of destination market, given prices (P^H, P^L)
- Regulation (τ^H, τ^L) at home
- CBAM $\alpha^H = \tau^H - \tau^L$ in H

Markets clear

$$D^H(P^{H*}) = S^H(P^{H*}, P^{L*}; \alpha^H)$$
$$D^L(P^{L*}) = S^L(P^{H*}, P^{L*}; \alpha^H)$$

- CBAM α^H induces reallocation
  - Price P^L falls as dirty supply pushed to L
  - Price P^H rises and pulls clean supply to H
- Can compute welfare: CS, PS, G, E

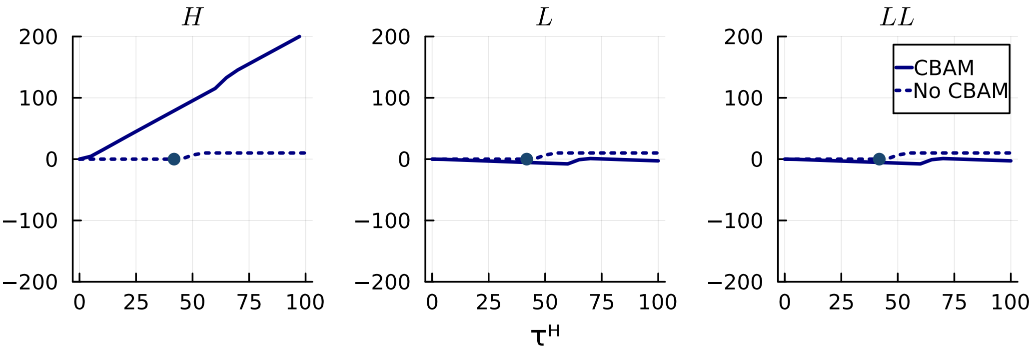
Counterfactuals

Policy simulations

- Carbon regulation in market H
  - Relative to business as usual
  - With and without a CBAM
- Impacts on H, L, LL
  - H: EU + UK [+ China]
  - L: all other countries
  - LL: low and lower-middle income countries
- Calculate price and welfare impacts
  - Regulation and reallocation effects

H = EU + UK (6.5% of global consumption)

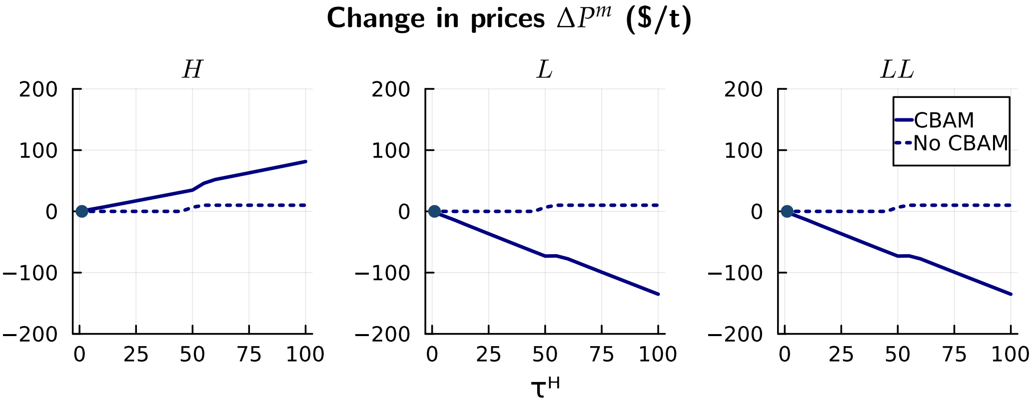
Change in prices ΔP^m (\$/t)



Regulation effect: no CBAM

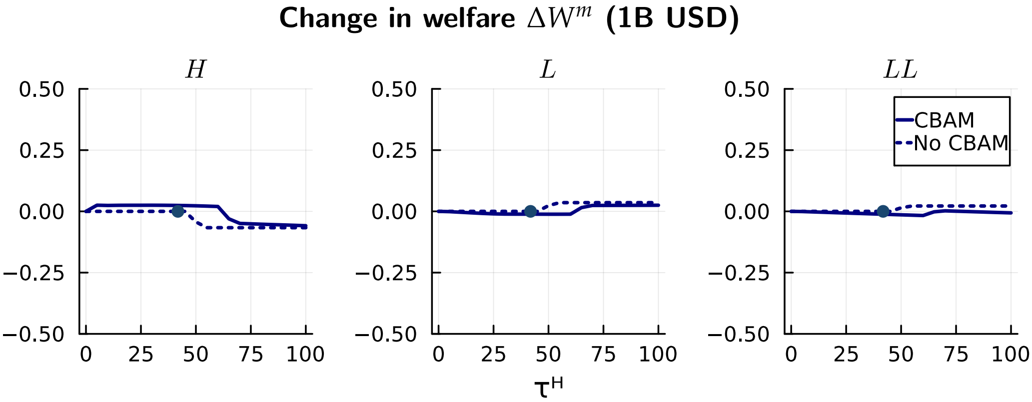
Reallocation effect: CBAM - no CBAM

H = EU + UK + China (68.4% of global consumption)



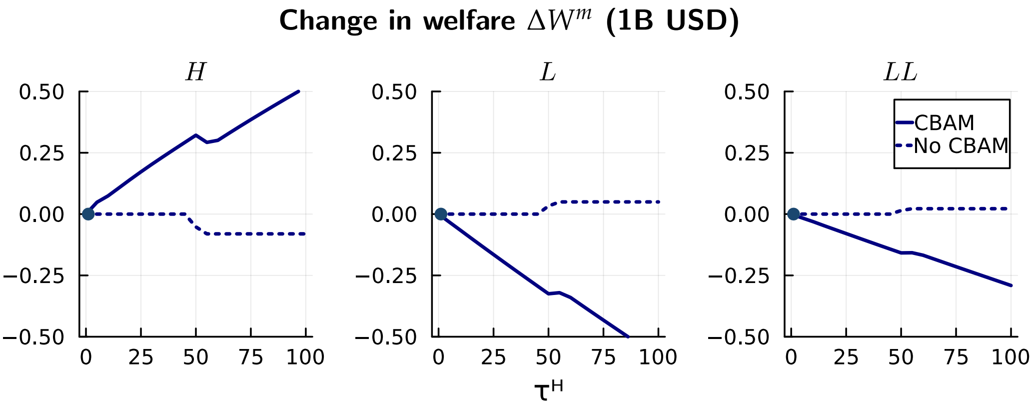
Less reallocation effect for H, more for L

H = EU + UK (6.5% of global consumption)



Relatively small welfare consequences, especially with CBAM

H = EU + UK + China (68.4% of global consumption)



Meaningful welfare gains for H: CS ↓, PS ↓, G ↑↑

But at welfare cost to L and LL

Conclusion

Summary

- Aluminum emissions not necessarily higher in lower-income countries
- CBAM rewards clean producers in lower-income countries

- Simulations with steel, electricity, and other sectors
- Policy spillovers through government revenue