The Economics of Carbon Border Adjustment Mechanisms for Lower-Income Countries

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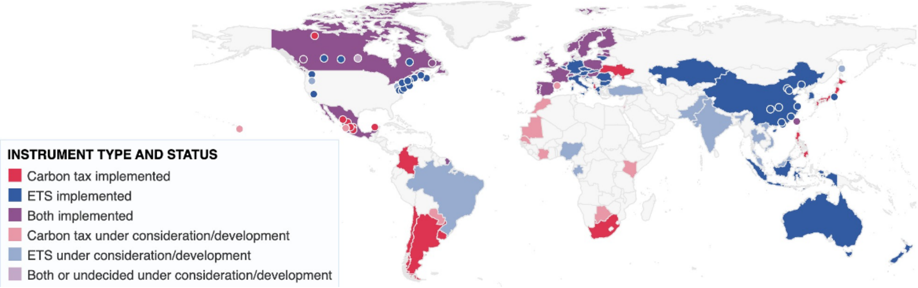
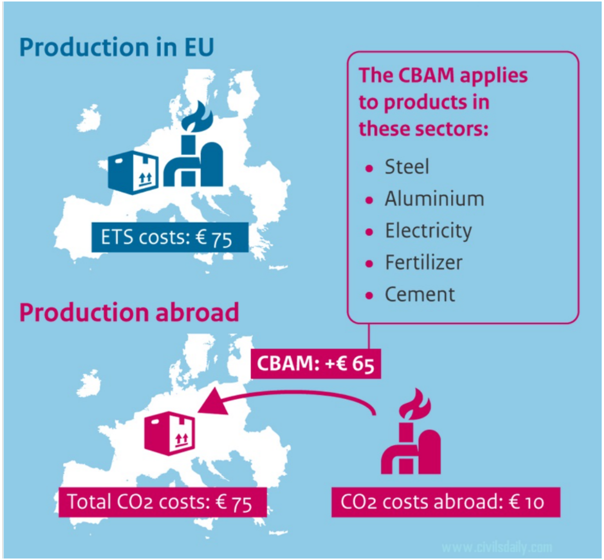
Carbon pricing around the world

Compliance carbon pricing instruments around the world, 2024

Map shows jurisdictions with carbon taxes or emissions trading systems implemented, under development or under consideration, subject to any filters applied in the table below the map. The year can be adjusted using the slider below the map.



EU Carbon Border Adjustment Mechanism



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 sector
   - Other EU target sectors in progress
2. Descriptive analysis of emissions
   - Production emissions not strictly higher in lower-income countries
3. Simple equilibrium trade model
   - Captures reallocation in response to regulation
   - CBAM raises equilibrium prices and profits for cleaner producers

Aluminum

Globally traded commodity

- London Metal Exchange reports a global price
  - Regional premia mainly reflect tariffs
- 2% of global emissions
  - 80% of Al emissions are Scope 2 (electricity)

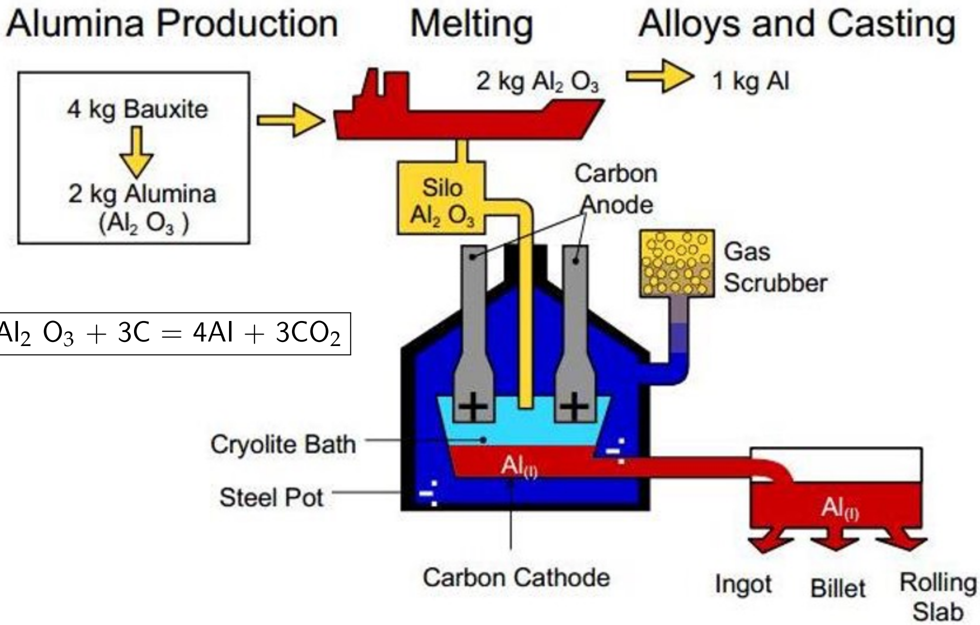
Global quantities (2023)

Consumers

Country	Mt
China	42.7
EU + UK	4.5
United States	3.6
India	2.6
Russia	2.3
United Arab Emirates	1.9
Bahrain	1.4
Norway	1.3
Turkey	1.2
Canada	1.1
Rest of world	6.4

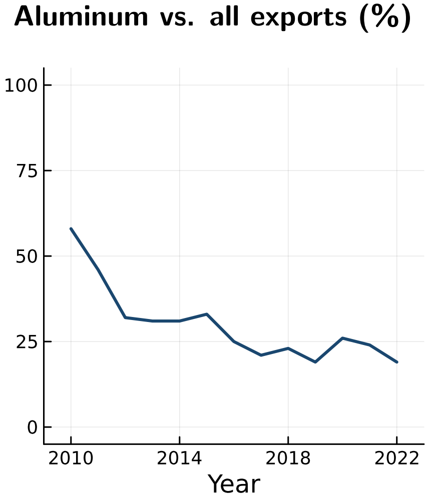
Producers

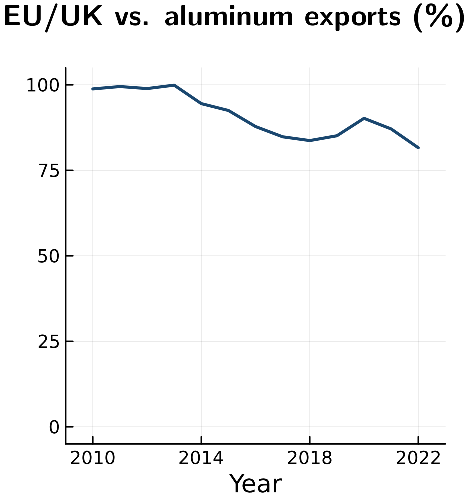
Country	Mt
China	41.3
India	4.1
Russia	4.0
Canada	3.3
United Arab Emirates	2.7
Bahrain	1.6
Australia	1.6
Norway	1.3
Brazil	1.0
EU + UK	1.0
Rest of world	7.2



$$2Al_2O_3 + 3C = 4Al + 3CO_2$$

Mozambique


Aluminum vs. all exports (%)
100
75
50
25
0
2010
2014
2018
2022
Year


EU/UK vs. aluminum exports (%)
100
75
50
25
0
2010
2014
2018
2022
Year

Mozal

- Largest industrial employer in Mozambique
  - 1,200 employees vs. private-sector average of 14
- Majority owned by Australian conglomerate South32

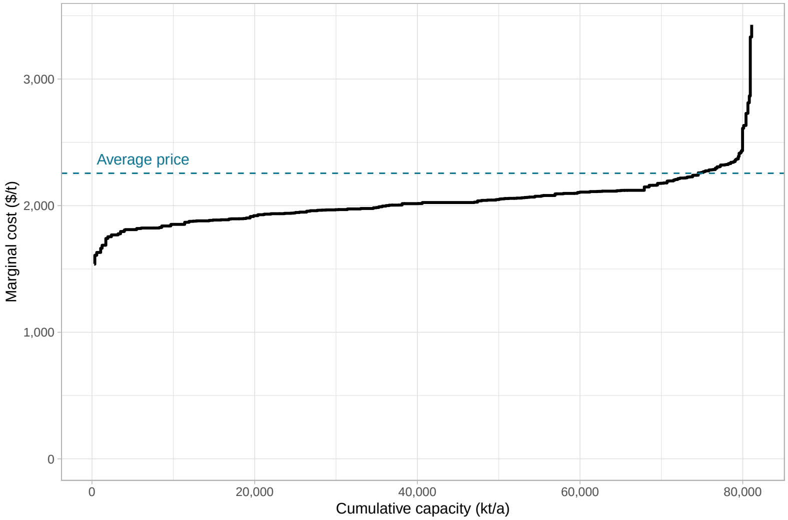
Smelter-level data

- Near universe of smelters from WoodMac
    - 153 worldwide with some Chinese smelters aggregated
- Production, capacity, costs, emissions
    - Costs: electricity, alumina, other materials, labor, maintenance, freight
- Publicly available data + plant tours

Carbon pricing data

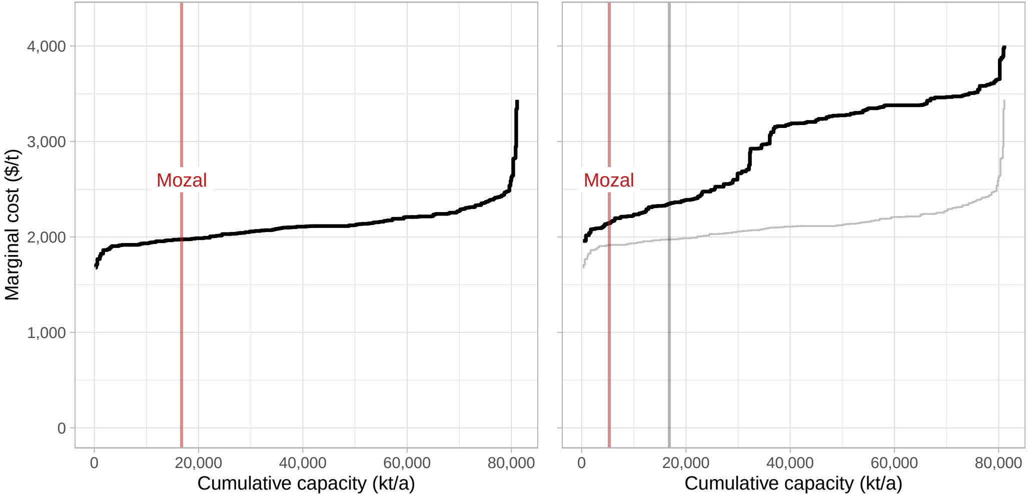
	Prices ($/t)	
Country (Region)	Unadjusted	Adjusted
Argentina	2.35	2.35
Canada (British Columbia)	48.15	48.15
Canada (Quebec)	33.35	4.09
China (Hubei)	6.50	6.50
China (Sichuan)	9.62	9.62
France	91.79	37.99
Germany	91.79	51.03
Greece	91.79	38.27
Iceland	91.79	31.97
New Zealand	48.35	10.30
Norway	91.79	29.65
Romania	91.79	66.51
South Africa	8.62	1.29
Sweden	91.79	50.61
United Kingdom	66.59	28.06

Capacity vs. costs

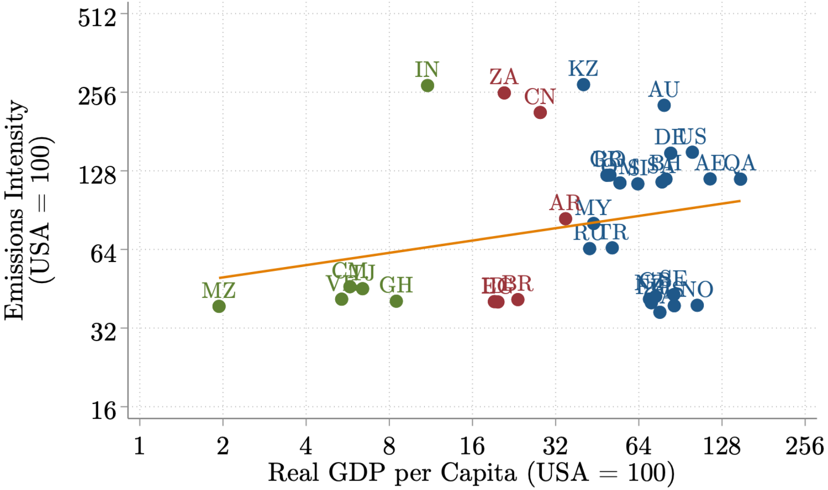


Emissions

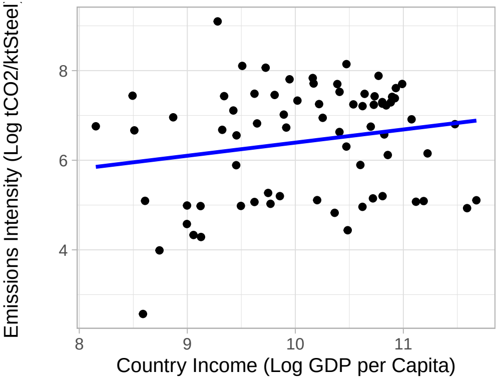
Emissions become costly under a CBAM



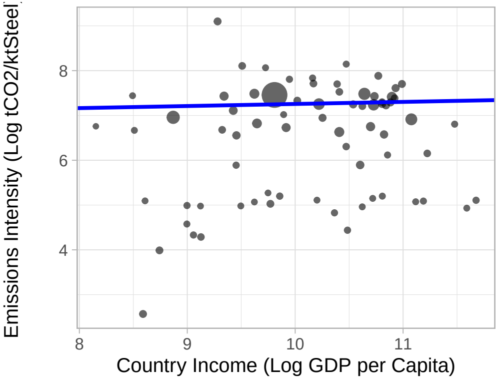
High-emissions not just from lower-income countries



Also true for steel



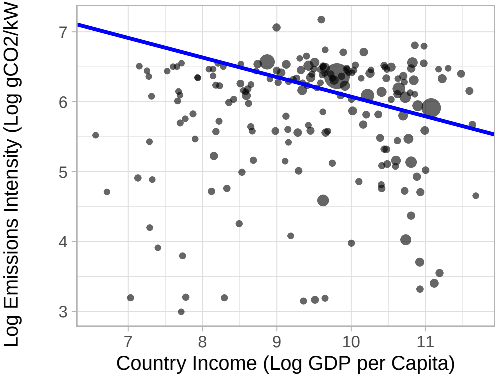
Coeff: 0.293 | SE: 0.18



Coeff: 0.046 | SE: 0.116

And perhaps also electricity

Coeff: 0.04 | SE: 0.057



Coeff: −0.28 | SE: 0.061

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

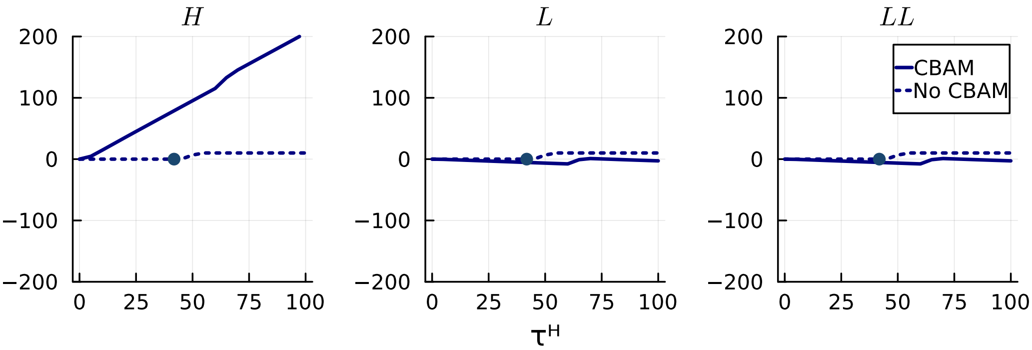
Counterfactuals

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)

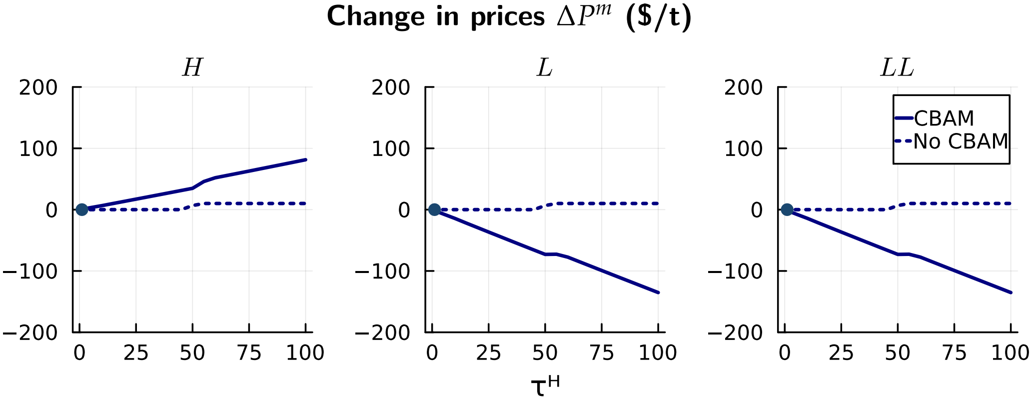
Change in prices ΔP^m ($/t)



Regulation effect: no CBAM

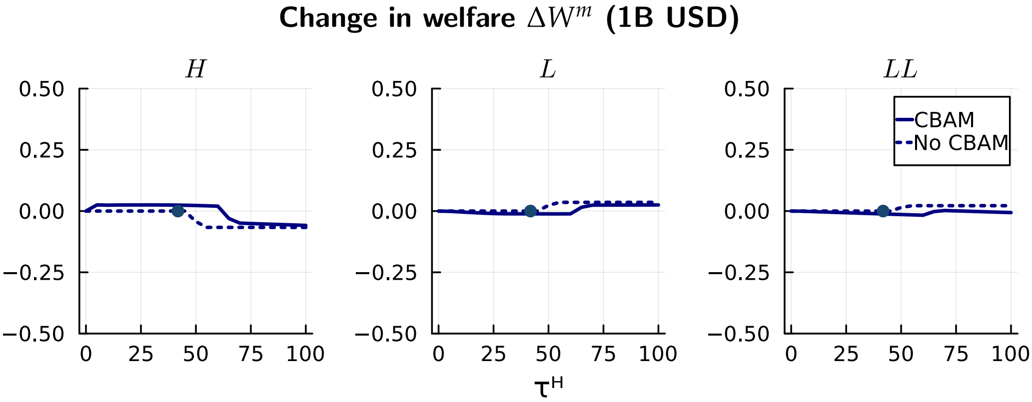
Reallocation effect: CBAM - no CBAM

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



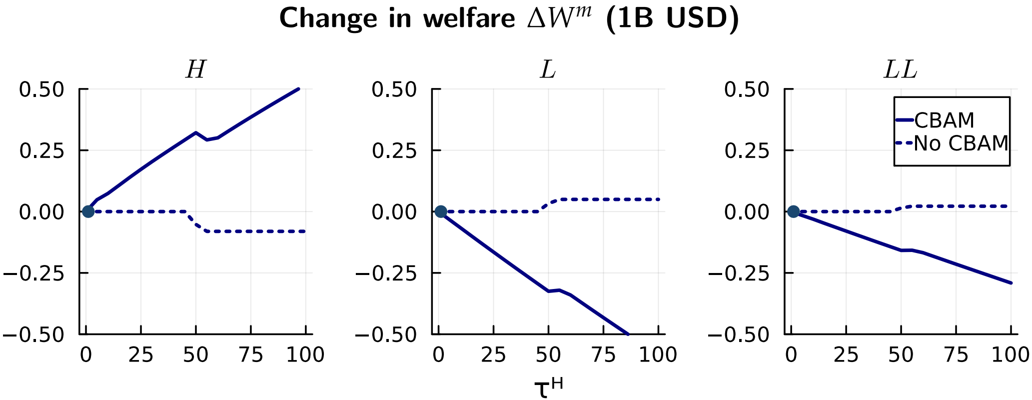
Less reallocation effect for H, more for L

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