Greening Ricardo: Environmental Comparative Advantage and the Environmental Gains from Trade

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The paper in a nutshell

- **Main result:** Climate policy can unlock large environmental gains from trade by inducing countries to specialize according to their environmental comparative advantage.

- **Main idea:** Global emissions fall when countries specialize in industries where they have relatively low emissions, just like global real incomes rise when countries specialize in industries where they have relatively high productivity.

- **Contribution:** While our notion of environmental comparative advantage therefore builds directly on the classic idea of economic comparative advantage, it has so far been largely absent from the trade and climate change debate.

Changing the narrative

- **Trade is part of the solution:** Our results provide a strong counterpoint to the widespread view that international trade is an obstacle in the fight against climate change, as evidenced by the ubiquitous "buy local" initiatives.

- **Transport vs production emissions:** While it is true that international trade causes transport emissions, our analysis shows that it can also be a powerful tool to reduce production emissions.

- **Sustainable development:** It also offers a more inclusive perspective on sustainable development by highlighting that countries do not need to sacrifice the economic gains from trade in the name of climate stewardship.

Simulating sustainable globalization

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- **A quantitative model:** We explore the effects of a carbon tax in a multi-country, multi-industry quantitative trade model with input-output linkages, calibrated to 64 regions and 45 industries spanning the world economy.

- **Various carbon pricing schemes:** Our benchmark scenario is a uniform carbon tax of $100/tCO2eq on all goods in all countries, but our main result holds for a wide range of carbon tax rates and coverages.

- **No integrated assessment:** We do not model how greenhouse gas emissions cause climate change, or how climate change affects economic activity. This is not essential for measuring the environmental gains from trade.

Our findings in more detail

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- **Main result:** The environmental gains from trade account for more than one-third of the emissions reductions brought about by the carbon tax.

- **Robustness:** This result holds for a wide range of carbon pricing regimes thus suggesting that trade is a strong force multiplier for climate policy.

- **Resilience:** Moreover, we find that increases in carbon tax rates leave the volume of world trade relative to world gross production largely unchanged.

Isolating the environmental gains

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- **Decomposition:** To isolate the environmental gains from trade, we decompose the greenhouse gas emissions reductions brought about by the carbon tax into three effects.

- **Three effects:** A reduction in the scale of global production (scale effect), a shift in economic activity towards greener sectors (composition effect), and a shift in economic activity towards greener countries (green sourcing effect).

- **Role of trade:** While the scale and composition effects also operate in a closed economy, the green sourcing effect exploits a margin that is only available with trade and thus captures the environmental gains from trade.

Contribution to the literature

Model: Setup

- Many-country, many-industry Armington model with input-output linkages. The model is static so that we abstract from changes in production technologies.

- The carbon tax is imposed on all goods and services. It is levied in the country of final or intermediate consumption and redistributed lump-sum to households.

- We use a carbon tax of \$100/tCO_2-eq as our benchmark. For our calculations, we convert it into an ad valorem tax or tariff using emissions intensities.

Details

Data: Overview

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- We have data on 64 countries (including ROW) and 45 sectors (including NES) spanning the **entire world economy** in 2018.

- Data on trade flows of final and intermediate goods comes from the OECD "Inter-Country Input-Output Tables".

- Data on GHG emissions in CO_2 equivalents are constructed by combining three different datasets covering **CO_2, CH_4, and N_2O** (covering 93% of world total):
  - OECD: "Carbon Dioxide Emissions Embodied in International Trade".
  - FAOSTAT: "Emissions Totals".
  - European Commission: "Emissions Database for Global Atmospheric Research".

Data: Two limitations

- First, we can only calculate emissions intensities based on trade values, even though a more realistic approach would involve trade volumes.

- Consequently, in our counterfactual scenarios, changes in emissions reflect not only shifts in trade volumes but also fluctuations in prices.

- Second, we cannot differentiate emissions intensities by destination. A ton of Austrian steel has the same emissions intensity in Austria as it has in the US.

- While this is consistent with our iceberg formulation of transport emissions, it does not capture the differential emissions intensity of transportation services.

Results: Aggregate effects

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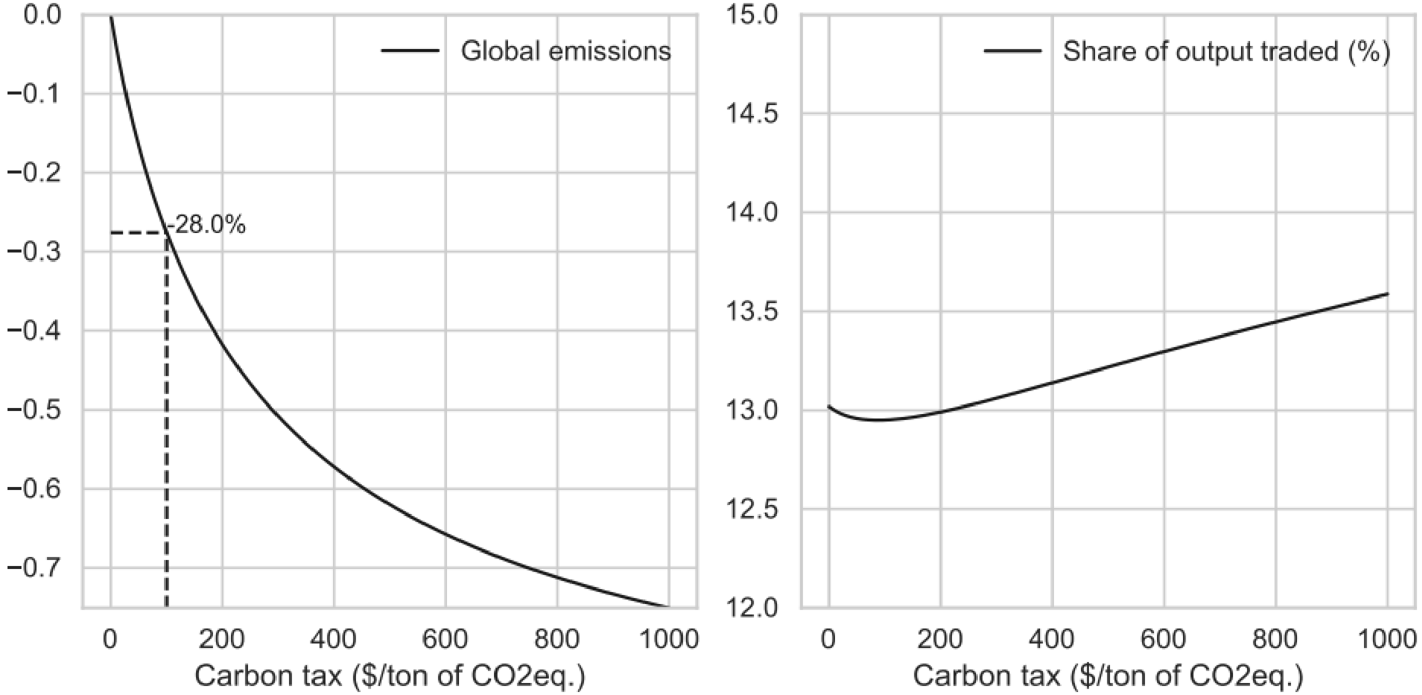
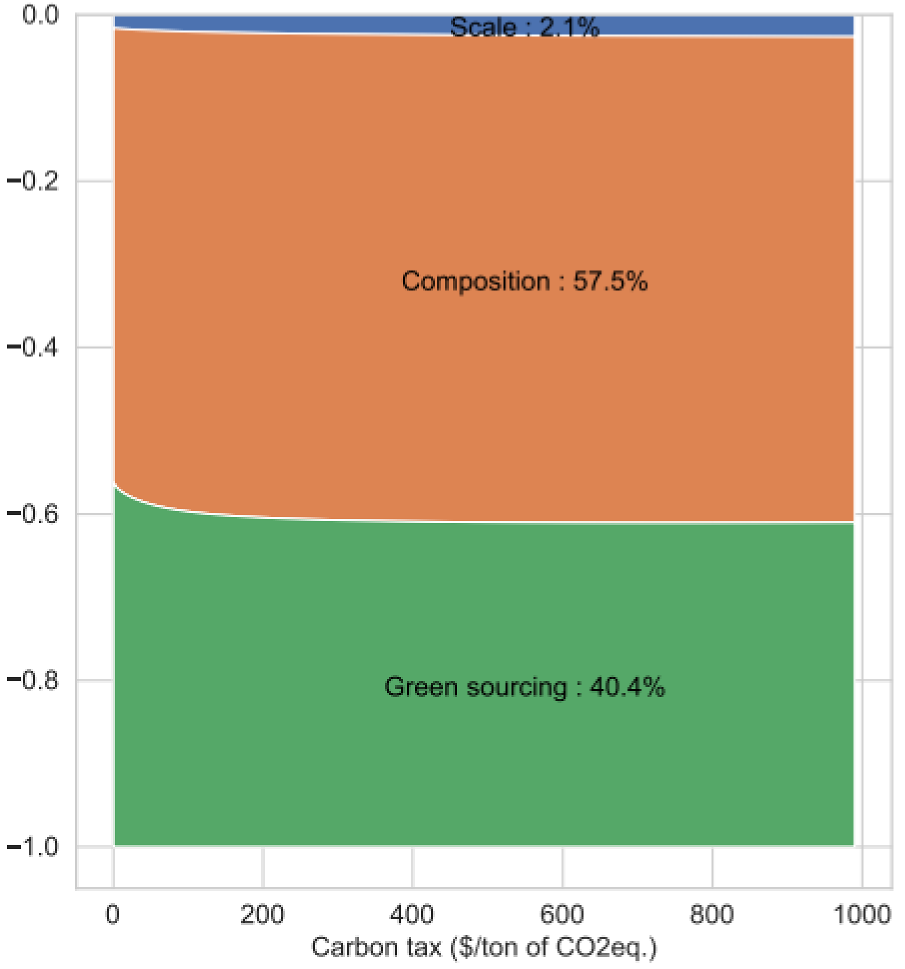


Note: The left panel shows the proportional reduction in global greenhouse gas emissions for varying levels of carbon taxes. The right panel shows world trade as a share of gross production.

- As one would expect, GHG emissions are **strongly decreasing** in the carbon tax.
- Strikingly, the share of output traded is **remarkably inelastic** with respect to the tax.

Distributional effects

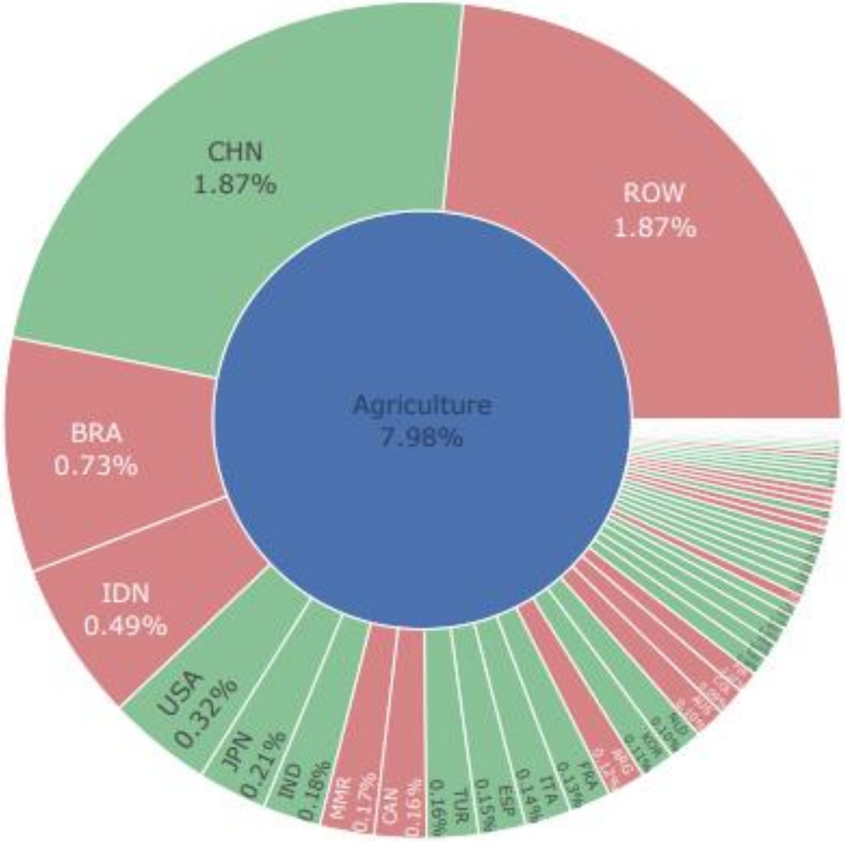
Results: Decomposition



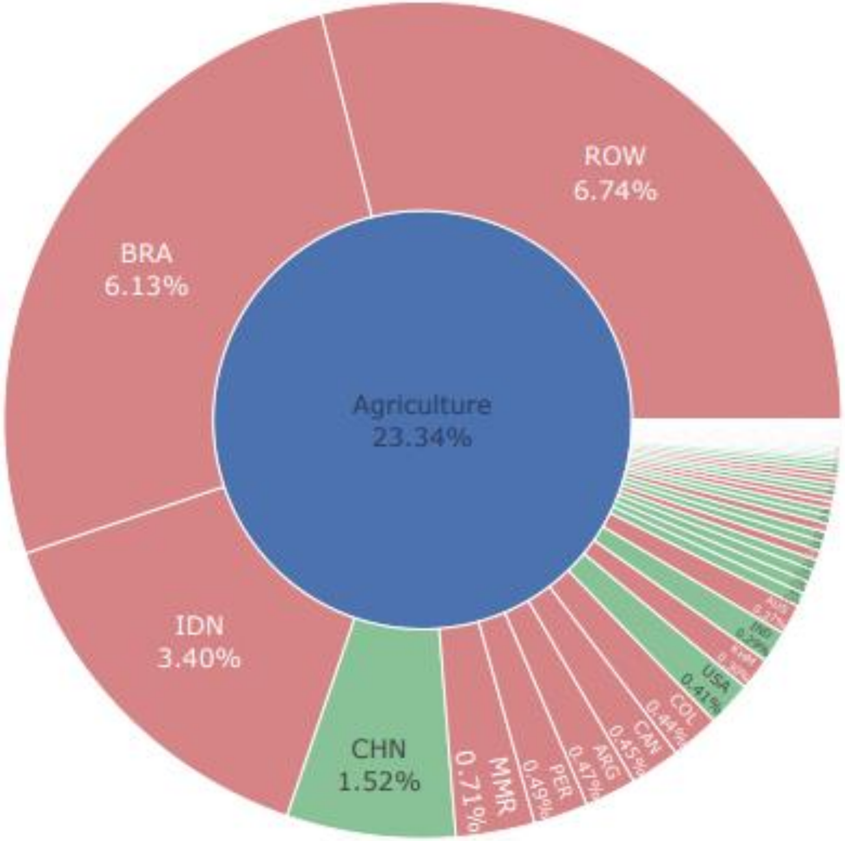
- **More that 1/3 of the emissions reduction is driven by environmental comparative advantage**
- This share is remarkably inelastic with respect to the carbon tax
- International trade is a crucial part of the solution in the fight against climate change

Results: Environmental comparative advantage

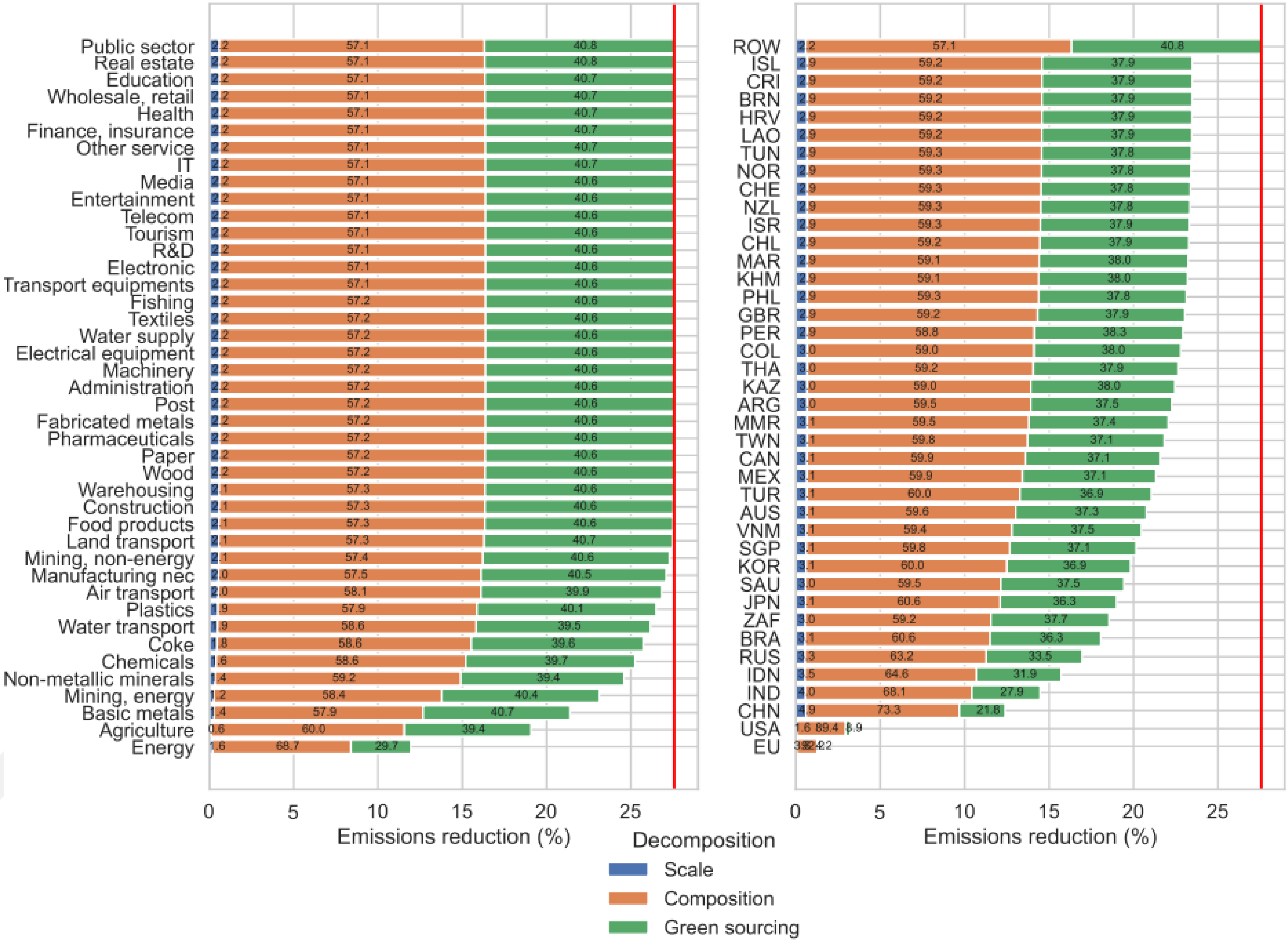
Output reallocation



Emissions reallocation



Results: Incomplete tax coverage



Taking stock

- We demonstrate that climate policy can unlock substantial environmental gains from trade by encouraging countries to specialize according to their environmental comparative advantage.

- Our main finding is that the environmental gains from trade account for over one-third of the total reduction in greenhouse gas emissions brought about by the carbon tax.

- An important policy implication is that international trade, and the multilateral trading system specifically, must not become the collateral damage of trade-related environmental policies.

Border carbon adjustments can create trade tensions

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- Momentum is building for explicit carbon pricing policies, with the use of such policies on the rise since 2010 according to OECD and World Bank research.

- Currently, there are 75 carbon taxes and ETSs in operation worldwide, covering approximately 24 percent of global emissions.

- These carbon pricing schemes are increasingly combined with border carbon adjustments to help avoid carbon leakage.

- It is important to preempt trade tensions arising from such schemes. The WTO Secretariat has offered a carbon pricing framework and convened a task force.

The WTO provides a clear framework for industrial policy

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- The IMF defines industrial policy as “any government intervention aimed at developing specific firms, industries, or economic activities …”

- If one adopts this broad definition, most industrial policy instruments are covered by WTO agreements.

- Examples: Subsidies, tariffs, quotas, TRIMs, TBT, SPS, government procurement, intellectual property rights.

- Our rules on industrial subsidies covered in the WTO Agreement on Subsidies and Countervailing Measures are particularly relevant.

Ceterum censeo: The WTO continues to deliver but requires reform

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- The WTO continues to deliver through its negotiation, implementation, and (even) dispute settlement functions. More than 75 percent of world trade continue to be conducted directly under WTO most-favored nation tariffs.

- WTO members are working towards revitalizing the negotiations function, strengthening the implementation function, reforming the dispute settlement system, and embracing the deliberative function.

- We also need to update trade rules for the digital economy, integrate environmental and climate concerns, address industrial subsidies, and adapt to geopolitical shifts.

Thank you!

Appendix

Our contribution

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- **Our pitch:** To the best of our knowledge, we provide the first estimate of the environmental gains from trade driven by environmental comparative advantage.

- **Standard methods:** We leverage well-known methods at the intersection of international and environmental economics. Our model builds on Caliendo and Parro (2015), our decomposition extends Grossman and Krueger (1991).

- **New perspective:** The novelty of our paper does not lie in the tools we develop but in the perspective we provide on the relationship between international trade and climate change.

Points of contact with the literature

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- **Shapiro (2016):** Our paper follows in the footsteps of this pioneering work, which spearheaded the use of modern quantitative trade models in environmental economics. We do not compare trade to autarky but look at first-best.

- **Farrokhi and Lashkaripour (2021):** Our paper also has points of contact with this ambitious work, which explores to what extent climate clubs work. We do not study optimal carbon taxes but simply example the implications of a range of exogenous carbon tax regimes.

- **Carbon leakage:** A closely related theme that has received much attention in the literature is carbon leakage. The green sourcing effect identified in this paper essentially reverses this type of carbon leakage. However, all countries are part of the solution in general equilibrium.

Back

Model: Households

- Consumers have Cobb-Douglas-CES preferences over varieties differentiated by country of origin:

$$U_j = \prod_{s'} \left(U_{s'j}\right)^{\beta_{s'j}}$$

$$U_{s'j} = \left[\sum_i \left(a_{is'}\right)^{1/\sigma_{s'}} \left(q_{is'j}\right)^{(\sigma_{s'}-1)/\sigma_{s'}}\right]^{\sigma_{s'}/(\sigma_{s'}-1)}$$

- The carbon tax makes browner varieties more expensive thus inducing greener consumption choices:

$$q_{is'j} = a_{is'} \frac{\left[p_{is'j}\left(1 + t^e_{is'j}\right)\right]^{-\sigma_{s'}}}{\left(P^c_{s'j}\right)^{1-\sigma_{s'}}} \beta_{s'j} I_j$$

$$I_j = w_j L_j + \sum_{i,s'} p_{is'j} q_{is'j} t^e_{is'j} + \sum_{i,s',s} p_{is'j} m_{is'js} t^e_{is'j} + D_j$$

Model: Firms

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- Firms produce these varieties from labor and intermediates using Cobb-Douglas-CES technologies:

$$q_{js} = A_{js}\left(\frac{L_{js}}{\gamma_{j,L_s}}\right)^{\gamma_{j,L_s}} \prod_{s'} \left(\frac{m_{s'js}}{\gamma_{s'js}}\right)^{\gamma_{s'js}}$$

$$m_{s'js} = \left[\sum_i \left(b_{is'}\right)^{1/\sigma_{s'}} \left(m_{is'js}\right)^{(\sigma_{s'}-1)/\sigma_{s'}}\right]^{\sigma_{s'}/(\sigma_{s'}-1)}$$

- The carbon tax makes browner varieties more expensive thus inducing greener production choices:

$$m_{is'js} = b_{is's} \frac{\left[p_{is'j}\left(1+t^e_{is'j}\right)\right]^{-\sigma_{s'}}}{\left(P^P_{s'j}\right)^{1-\sigma_{s'}}} \gamma_{s'js} E_{js}$$

Model: Decomposition

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$$d \ln GHG = \underbrace{d \ln x}_{\text{scale effect}} + \underbrace{\sum_s \epsilon_s d \ln \alpha_s}_{\text{composition effect}} + \underbrace{\sum_i \sum_s \epsilon_{is} d \ln \alpha_{is}}_{\text{green sourcing effect}}$$

- In the above equation, x is world expenditure, the α’s are expenditure shares, and the ε’s are emissions shares.
- There is no technique effect since we hold emissions intensities constant, given our focus on industry-level, static environmental gains from trade.
- Note that a uniform carbon tax affects absolute and comparative advantage thus leading to adjustments in relative wages and the pattern of specialization.

Calibration: Hat algebra

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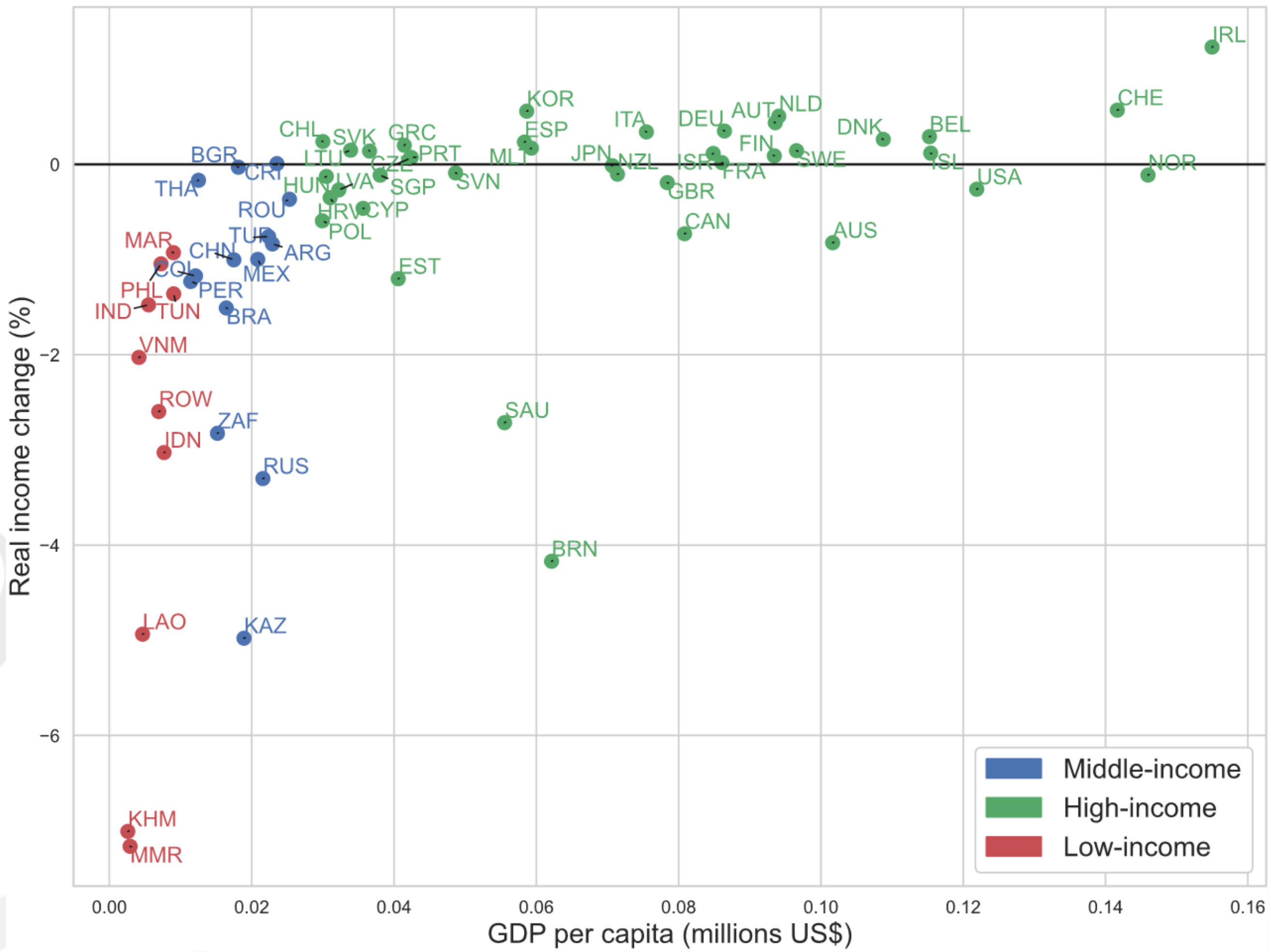
- As is now standard in quantitative trade models, we calculate our counterfactual using '**exact hat algebra**'.
- This **eliminates the need** to estimate the preference shifters, productivity shifters, and iceberg trade costs.
- It also ensures that our model **perfectly matches** the global pattern of production and trade in the baseline.
- We **estimate σ_s**, following Caliendo and Parro (2015), finding an average σ_s, of 3.6 (min = 1.8, max = 5.9)

Back

Distributional effects



- **Climate action disproportionately affects poor countries.**
- This is because they face a higher effective tax burden given that they specialize in browner sectors and produce with browner technologies.

Back