Watershed

Errors due to domestic import assumption in corporate carbon accounts

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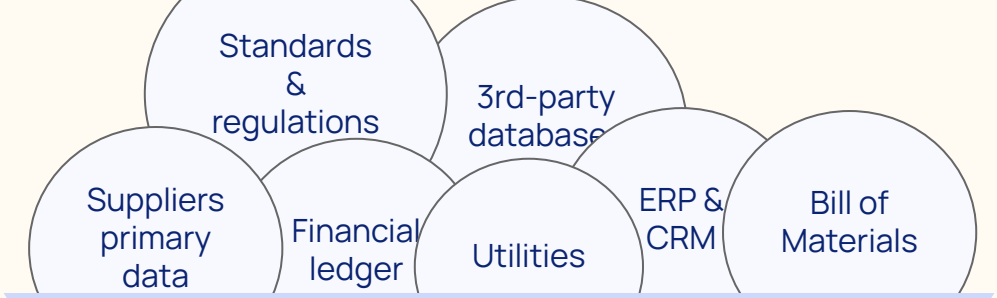


Intelligent Data Ingestion (IDI)

In-house databases and methods

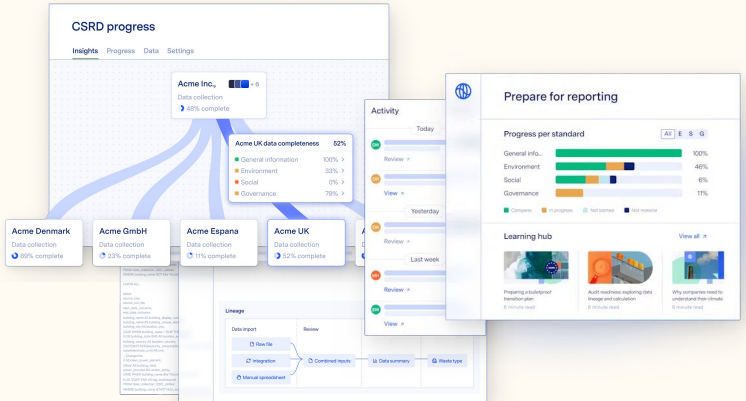
Visualization and reporting

Audit-grade outputs

Watershed

- Measure
- Report
- Reduce

@ unprecedented speed & scale



~2 $GtCO_2e$

currently under management, more than Australia's annual emissions

Background

Corporate Carbon Accounting

- Quantification and reporting of a company's greenhouse gas emissions across scopes 1, 2, and 3

Environmentally Extended Input-Output

- Because the main data source for upstream emissions estimation (Scope 3, category 1)
- USEEIO & DEFRA

EPA | Department for Environment Food & Rural Affairs

Dominance of SRIO

- ~70% of reported upstream corporate GHG emissions were estimated using SRIO (CDP)

CDP

Watershed

Scope 3 is hard to measure

- Time consuming measurement process, and can't even stand behind data
- Nearly impossible to collect data directly from thousands of suppliers

Averages won't cut it

- Outdated and misrepresentative averages, where the only way to reduce emissions, is to spend less.

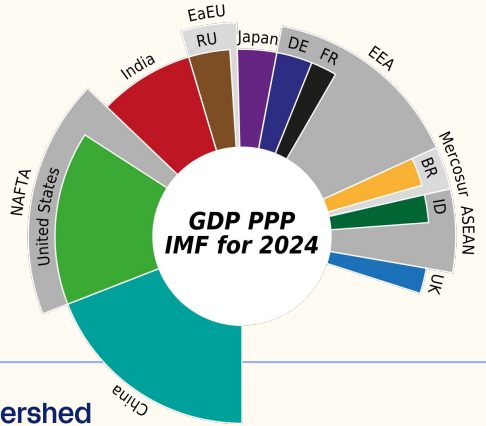
Need to focus on decarbonization

- Focus on where to decarbonize the supply chain, and spend less time measuring it.

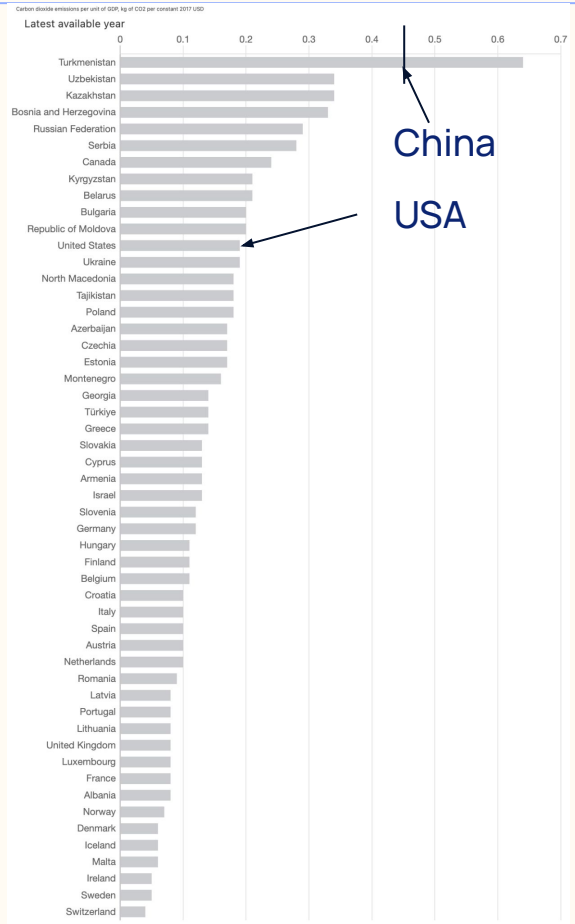
Domestic technology assumption

- Assumes that imports are produced using the same technologies as domestic ones
  - $x = (I - A_{dom} - A_{imp})\, y$
- Extended to emissions intensities

The global corporate GHG emissions are views from the lenses of the US and the UK



Global GDP share by country (IMF, 2024)



CO2 intensity of GDP (UNECE: https://w3.unece.org/SDG/en/Indicator?id=28)

Question

How much corporates are over or underestimating their upstream emissions due to the use of domestic import assumption?

Method

SRIO

- $B(I - A_{US,\,dom} - A_{US,\,imp})^{-1}\,\sigma r_{CDP}$
  - σ: summation matrix with identity matrices repeated horizontally by n times the number of countries
  - r_{CDP} : revenue of 5,450 companies reported revenue to CDP

MRIO

- $B(I - A_{GLO})^{-1} r_{CDP}$

Revenue

- The sector categories of the 5,450 companies that report revenues to CDP.

Data: CEDA

	CEDA	USEEIO	EXIOBASE	EORA
Geographical relevance	148 countries + 1 RoW region	1 country	44 countries + 5 RoW regions	189 countries
Technological relevance	400 industries	411 industries	164 industries	26- 200, depending on country
Data recency	2018 base year (2024 September v7 update)	2012 base year	1995-2011 base years	1990-2015 base years
Maintenance and Support	Produced for corporate use, highly maintained with most advanced methodologies. Access to timely support.	Produced by government institution, not frequently updated. No structure for support.	Produced for academic purposes. Currently underfunded for continuity of development. No structure for support.	Produced for academic purposes. Limited structure for support (researchers engaged in other full time jobs).

Results

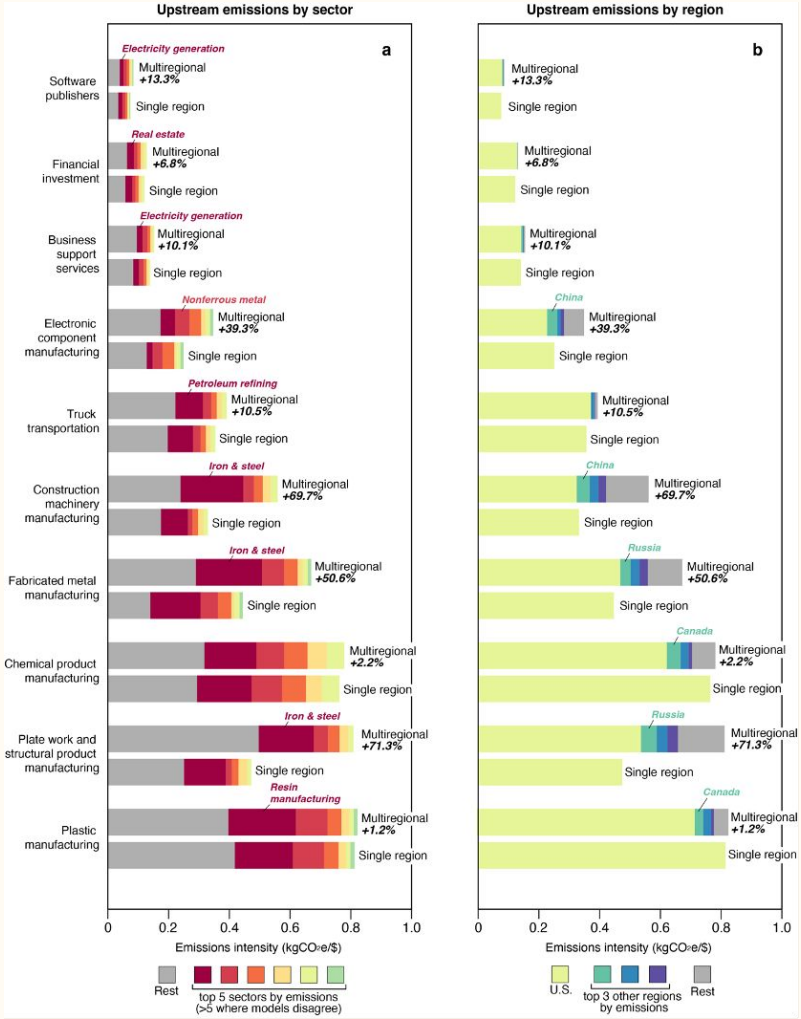
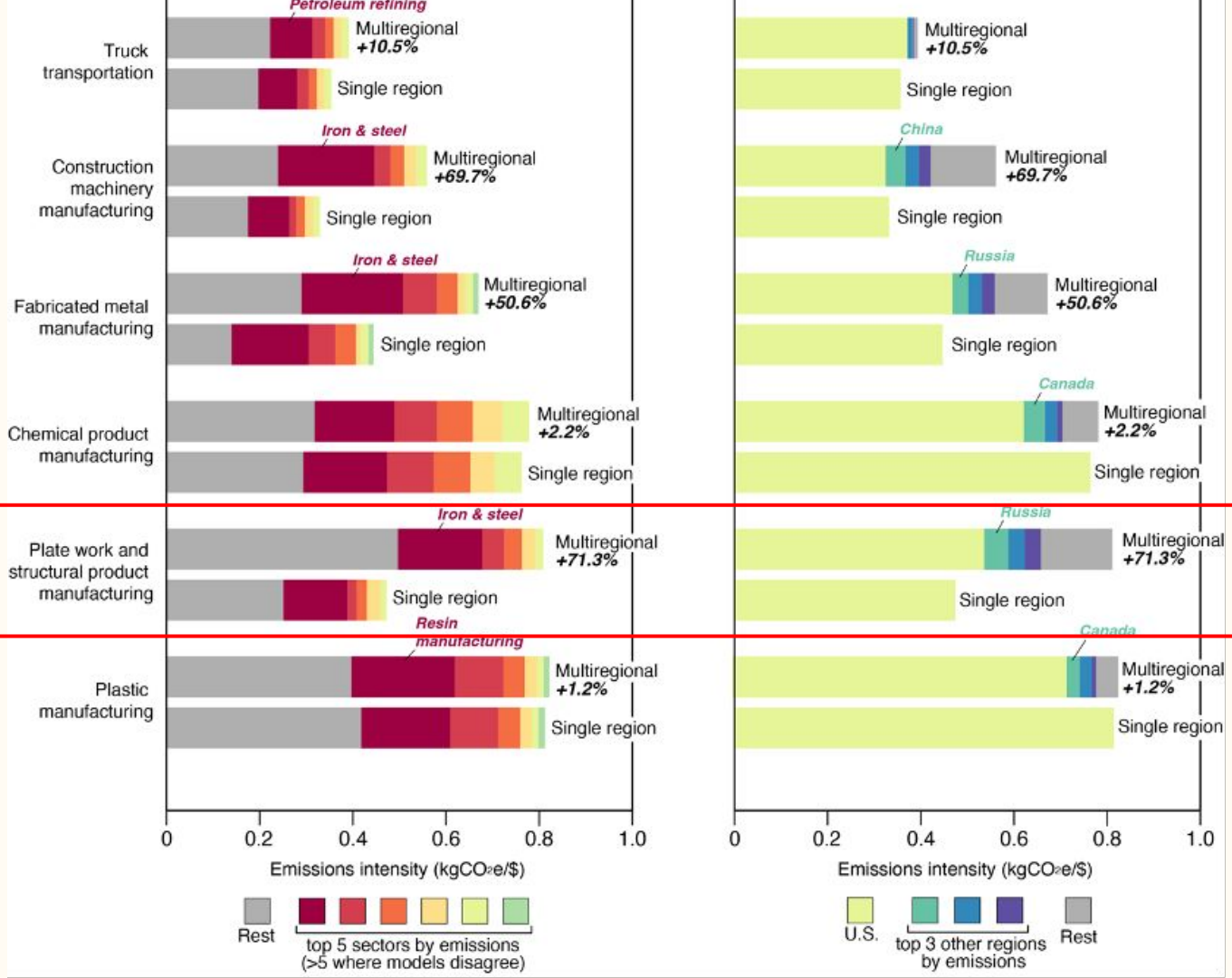


Figure 1 | Sector-specific differences in upstream emissions due to multiregional resolution. Paired bars show differences in the industry average upstream emissions related to purchased goods (i.e. scope 3.1) per dollar of products or services produced among the top 10 industry sectors of companies reporting their emissions to CDP 2021-2023 calculated by single-region (U.S.-specific) and multiregional input-output models. The differences are further decomposed as they relate to specific sectors (**a**) and regions (**b**). In all these cases, the single-region model underestimates upstream emissions.


Upstream emissions by sector
Upstream emissions by region
a
b
Software publishers
Financial investment
Business support services
Electronic component manufacturing
Truck transportation
Construction machinery manufacturing
Fabricated metal manufacturing
Electricity generation
Real estate
Nonferrous metal
Petroleum refining
Iron & steel
Multiregional
+13.3%
+6.8%
+10.1%
+39.3%
+10.5%
+69.7%
+50.6%
Single region
China
Russia


Business support services
Multiregional +10.1%
Single region
Multiregional +10.1%
Single region
Electronic component manufacturing
Nonferrous metal
Multiregional +39.3%
Single region
China
Multiregional +39.3%
Single region
Truck transportation
Petroleum refining
Multiregional +10.5%
Single region
Multiregional +10.5%
Single region
Construction machinery manufacturing
Iron & steel
Multiregional +69.7%
Single region
China
Multiregional +69.7%
Single region
Fabricated metal manufacturing
Iron & steel
Multiregional +50.6%
Single region
Russia
Multiregional +50.6%
Single region
Chemical product manufacturing
Multiregional +2.2%
Single region
Canada
Multiregional +2.2%
Single region
Plate work and structural product manufacturing
Iron & steel
Multiregional +71.3%
Single region
Russia
Multiregional +71.3%
Single region
Plastic manufacturing
Resin manufacturing
Multiregional +1.2%
Canada
Multiregional +1.2%


Truck transportation
Petroleum refining
Multiregional +10.5%
Single region
Construction machinery manufacturing
Iron & steel
Multiregional +69.7%
Single region
Fabricated metal manufacturing
Iron & steel
Multiregional +50.6%
Single region
Chemical product manufacturing
Multiregional +2.2%
Single region
Plate work and structural product manufacturing
Iron & steel
Multiregional +71.3%
Single region
Plastic manufacturing
Resin manufacturing
Multiregional +1.2%
Single region
0 0.2 0.4 0.6 0.8 1.0
Emissions intensity (kgCO2e/$)
Rest
top 5 sectors by emissions (>5 where models disagree)
China
Russia
Canada
U.S.
top 3 other regions by emissions
Rest

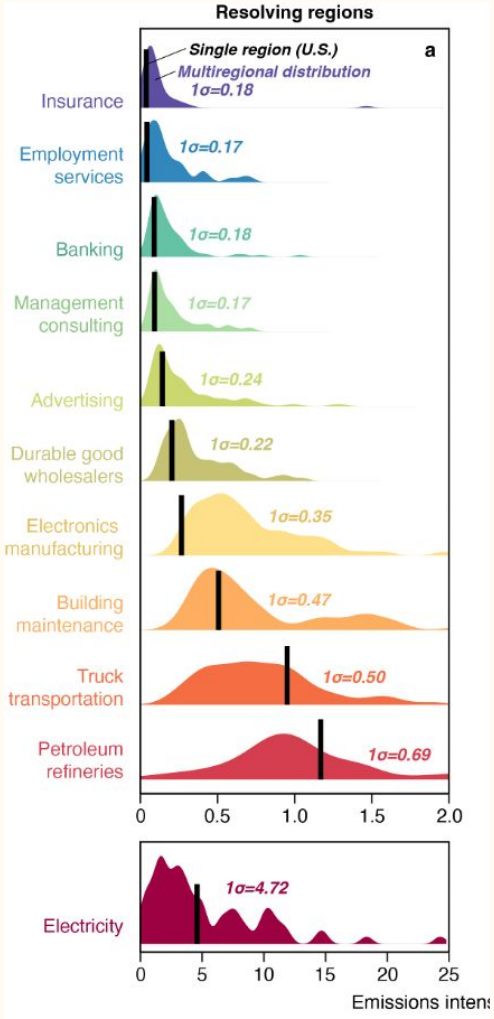
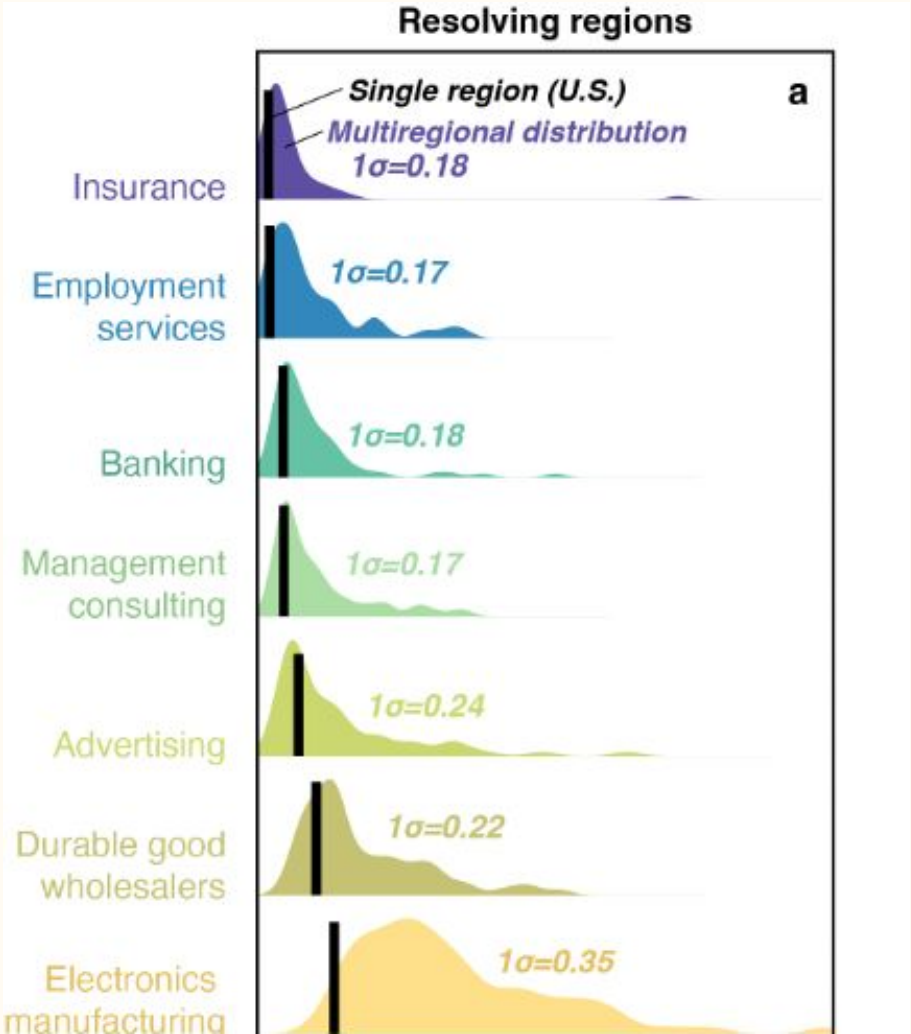
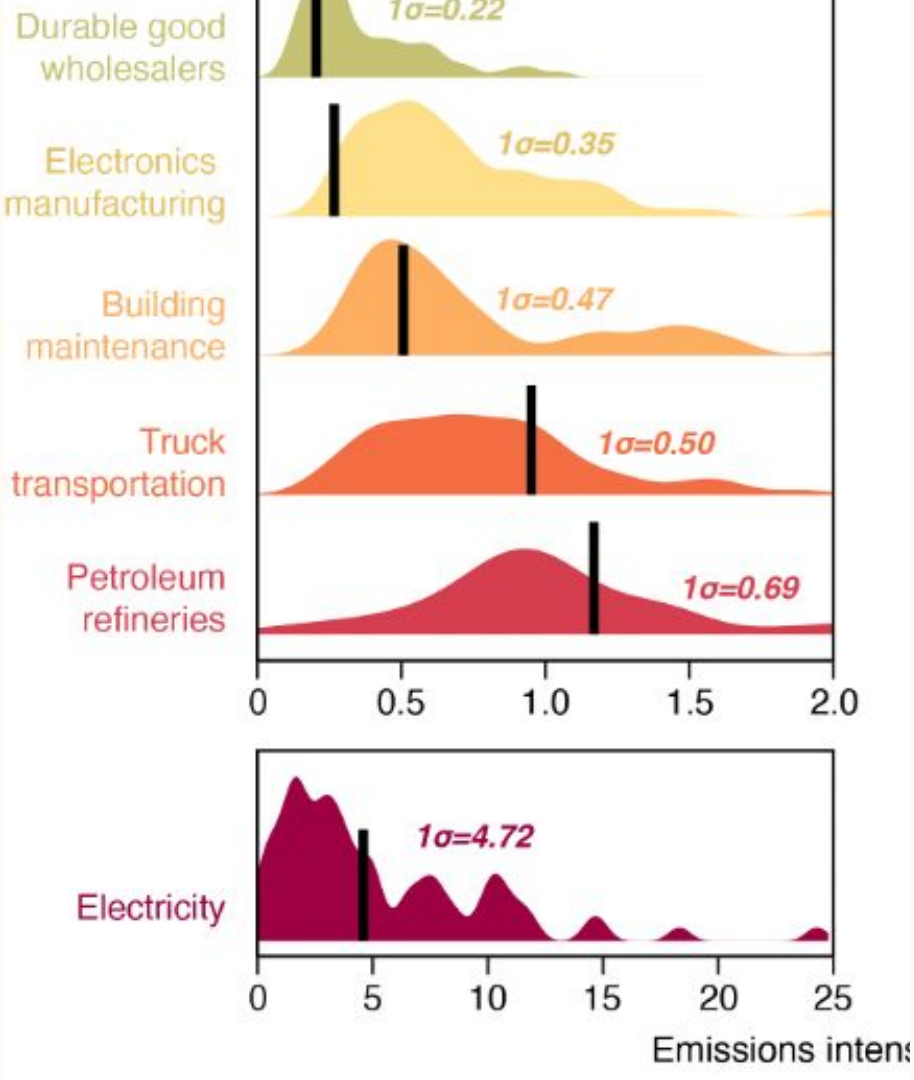


Figure 2 | Distributions of emissions intensity in key supplier sectors. Across regions, there is wide variation in the average emissions intensity (emissions per dollar of products or services produced) of key supplier sectors (colored probability density plots in **a**), such that the emissions intensity from a single-region (U.S.-based) model (black lines in **a**) may substantially over- or underestimate the reality. Similarly large variation in the average emissions intensity of specific sectors within broader industry categories (gray density plots in **b**), such that even multiregional models with fewer (more aggregate) industry sectors may also over- or underestimate the emission intensity of a specific sector (colored lines in **b**) by a similar margin.


Resolving regions
Single region (U.S.)
Multiregional distribution
a
Insurance
1σ=0.18
Employment services
1σ=0.17
Banking
1σ=0.18
Management consulting
1σ=0.17
Advertising
1σ=0.24
Durable good wholesalers
1σ=0.22
Electronics manufacturing
1σ=0.35


Durable good wholesalers
1σ=0.22
Electronics manufacturing
1σ=0.35
Building maintenance
1σ=0.47
Truck transportation
1σ=0.50
Petroleum refineries
1σ=0.69
0
0.5
1.0
1.5
2.0
Electricity
1σ=4.72
0
5
10
15
20
25
Emissions intens

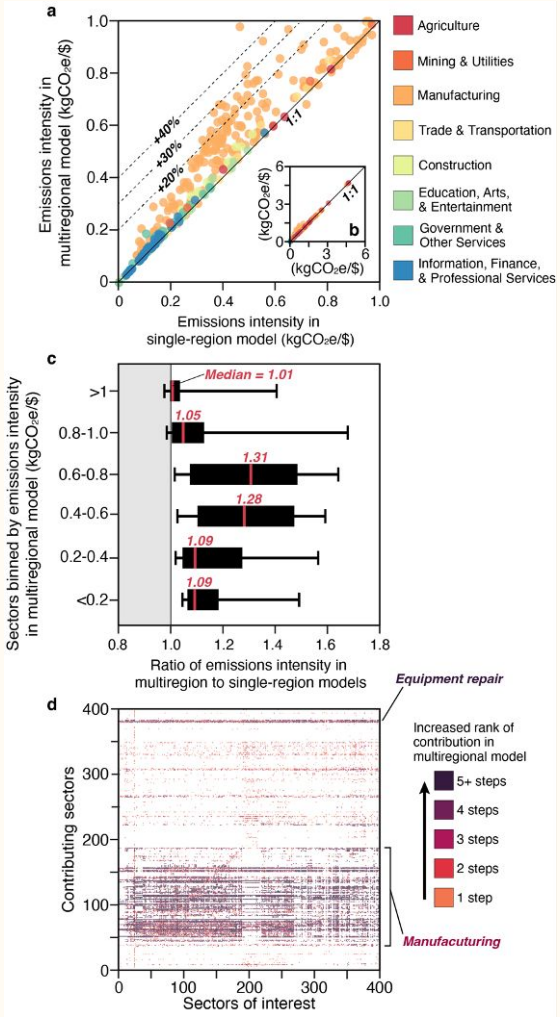
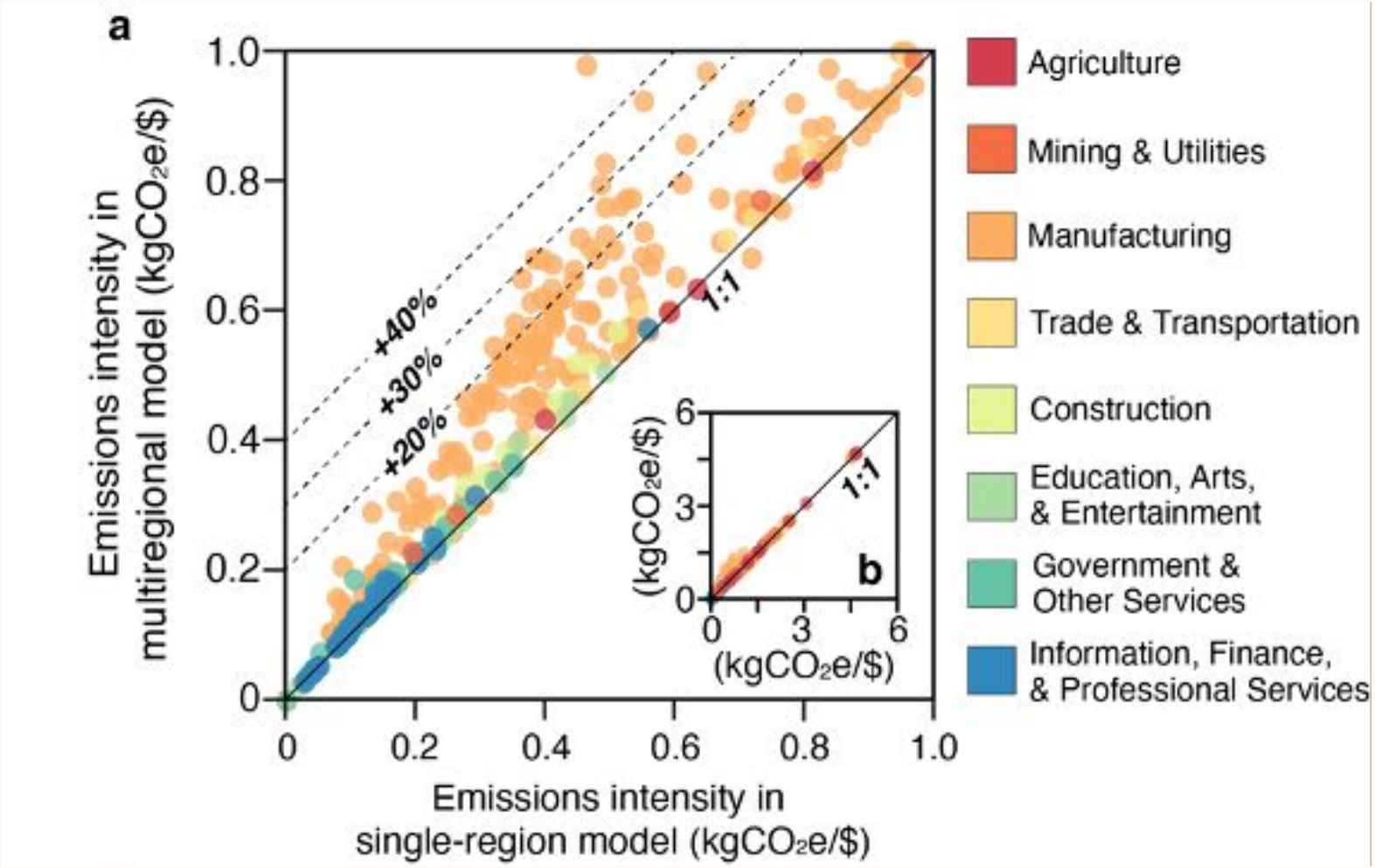
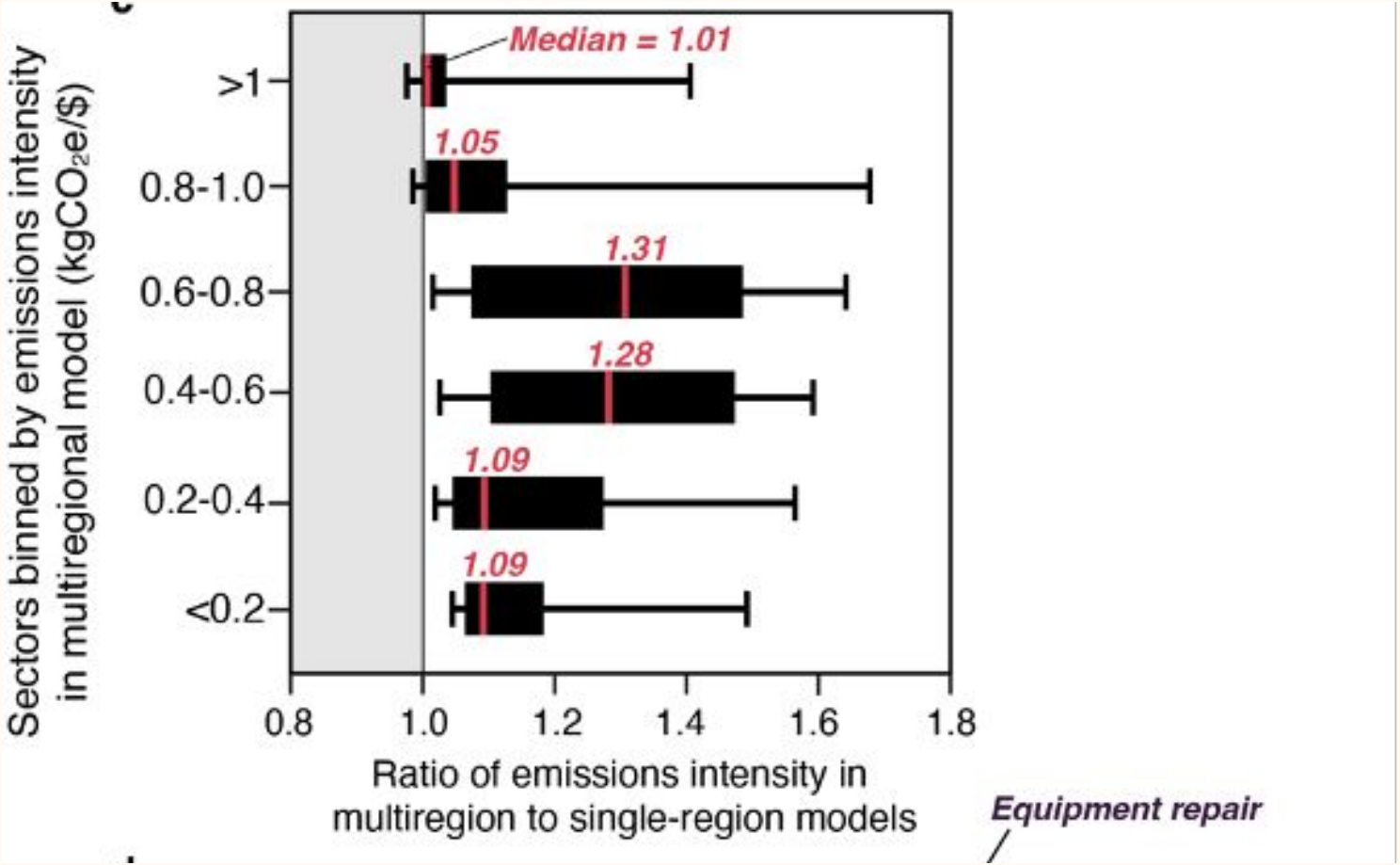
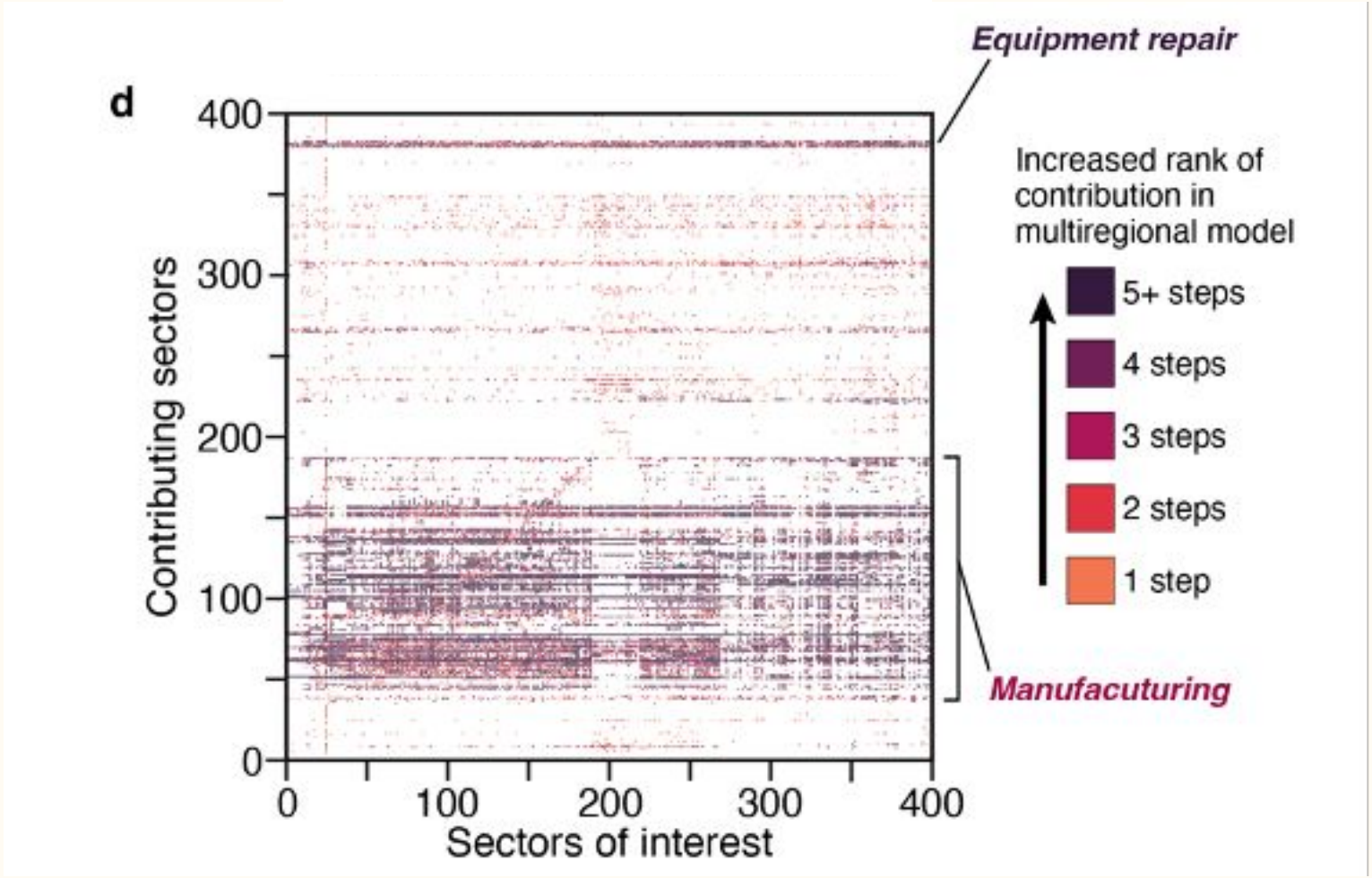


Figure 3 | Comprehensive comparison of sector-level differences between single-region (U.S.-based) and multiregional models. Across all 400 industry sectors, the emission intensities (emissions per dollar of products or services produced) estimated by the multiregional model are generally greater than those estimated by the single-region model (points above 1:1 line in **a**), particularly among manufacturing sectors (orange points). Grouping sectors according to their emissions intensity as estimated by the multiregional model shows that the emission intensities from the multiregional are most different (roughly 30% greater) in sectors with emissions intensity of 0.4-0.8 $kgCO_2e/\$$, and the rare cases in which the single-region model estimates greater emissions intensity than the multiregional model are mostly in sectors which very high emissions intensities (>0.8 $kgCO_2e/\$$; **c**). Colors plotted in **d** indicate the magnitude of increases in the rank order of contributing (upstream) sectors (y-axis) as sources of emissions to different sectors of interest (x-axis) when using the multiregional rather than single-region model.


a
1.0
0.8
0.6
0.4
0.2
0
0
0.2
0.4
0.6
0.8
1.0
Emissions intensity in multiregional model (kgCO2e/$)
Emissions intensity in single-region model (kgCO2e/$)
+40%
+30%
+20%
1:1
6
3
0
0
3
6
(kgCO2e/$)
(kgCO2e/$)
1:1
b
Agriculture
Mining & Utilities
Manufacturing
Trade & Transportation
Construction
Education, Arts, & Entertainment
Government & Other Services
Information, Finance, & Professional Services


Median = 1.01
1.05
1.31
1.28
1.09
1.09
>1
0.8-1.0
0.6-0.8
0.4-0.6
0.2-0.4
<0.2
Sectors binned by emissions intensity in multiregional model (kgCO2e/$)
0.8
1.0
1.2
1.4
1.6
1.8
Ratio of emissions intensity in multiregion to single-region models
Equipment repair


d
Equipment repair
Increased rank of contribution in multiregional model
5+ steps
4 steps
3 steps
2 steps
1 step
Manufacuturing
Contributing sectors
0
100
200
300
400
Sectors of interest

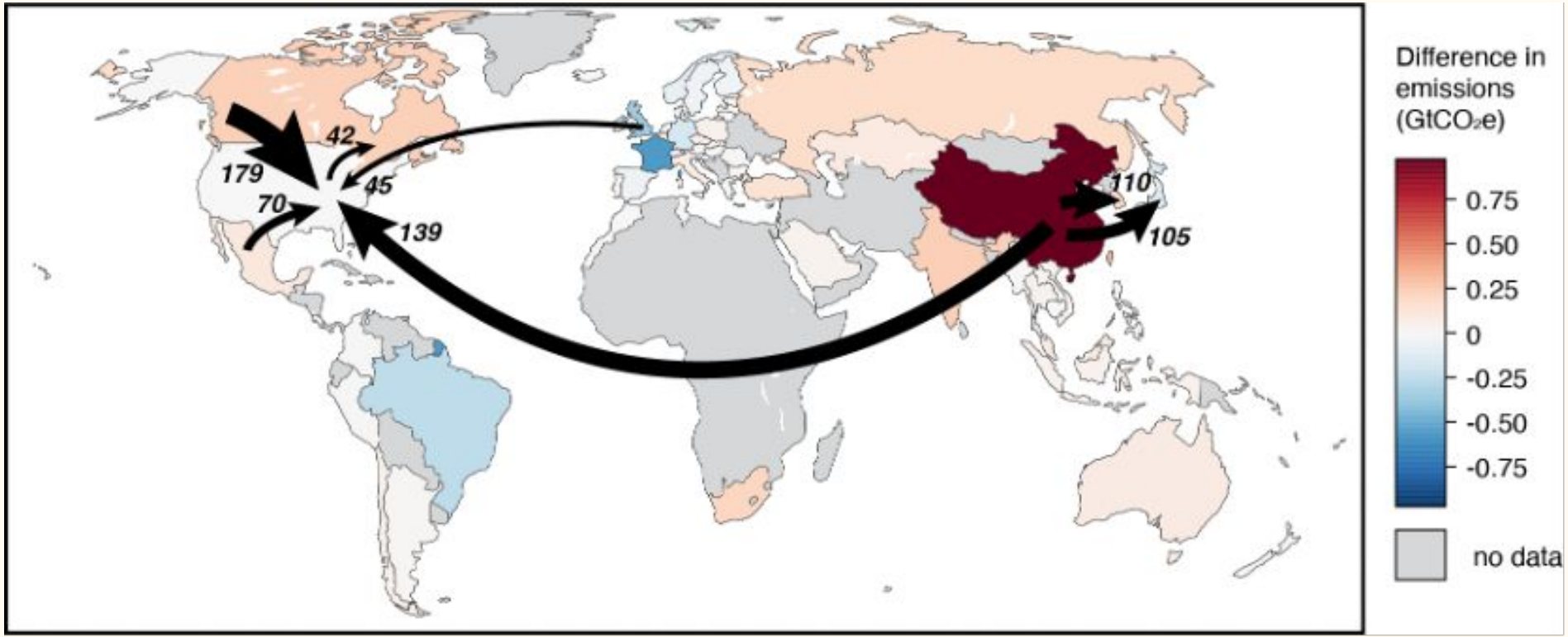


Figure 4 | Map of differences between single-region (U.S.-based) and multiregional EEIO models. Shaded colors indicate country-level differences in emissions when estimating upstream emissions of CDP-reporting companies using the multiregional model instead of a single-region (U.S.) model. In total, the multiregional model estimates 2.0 $GtCO_2e$ more emissions worldwide than the single-region model, but international supply chains and higher emissions-intensities of production in China lead to much greater emissions in China (+973 $MtCO_2e$), and somewhat lower emissions in areas which rely more heavily on low-carbon sources of energy (e.g., France, Brazil, and the U.K.). Arrows highlight the largest international transfers of emissions embodied in these companies' upstream supply chains that are missed by a single-region model.

Conclusions and Discussion

- The estimate of upstream GHG emissions by 5,450 companies was 2.0 GtCO2e (~10%) lower under domestic import assumption.
- Substantial differences were found in manufacturing sectors of moderate emissions intensity (0.4-0.8 kgCO2e/$) band.
- The use of multiregional model can improve the overall quality of upstream scope 3 emissions estimates in corporate carbon accounting.


Watershed
CEDA