# Article presentation :

## Chancel L., Rehm Y., The Carbon Footprint of Capital: Evidence from France, Germany and the US based on Distributional Environmental Accounts

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# Outline

# Introduction

# Carbon Footprint



**Carbon Footprint:** The measure of the exclusive total amount of emissions of carbon dioxide that is directly and indirectly caused by an activity or is accumulated over the life-cycle stages of a product.

**Individual Carbon Footprint:** The carbon footprint associated with an individual's activities, lifestyle or choices.

**Challenge:** What to include in the carbon footprint?

The Consumption-based Approach

# Carbon Footprint of Capital : Chancel and Rehm (2024)

"The Carbon Footprint of Capital: *Evidence from France, Germany and the US based on Distributional Environmental Accounts*"

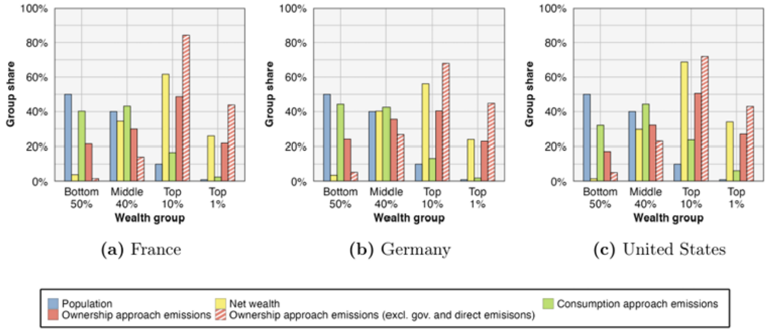
**Motivations:** *Individuals are not only responsible for their consumption, but also for the assets they own.*

1. Linking carbon emissions to asset ownership to construct a new framework for individual carbon footprint (3 Approaches: Consumption, Ownership and Mixed).
2. Applying this framework to France, Germany and the US.
3. Deriving new stylized facts about emissions inequality in the context of environmental and tax policy.

# Key findings

1. Carbon inequalities are notable in every approach.
2. In the ownership approach, the majority of emissions for the wealthiest 10% originates from the assets they own.
3. Emissions from capital ownership appear to be even more concentrated than capital itself.

**Figure 1.** Distribution of emissions and wealth by wealth group




(a) France (b) Germany (c) United States

# Related Literature

2. Related Literature

2.1 Measuring the Carbon Footprint

2.2 Consumption-based Approaches

2.3 Production-centered Approaches and Methods of Shared Attribution

2.4 From the Carbon Footprint of individual investment portfolios to the DINA

# Measuring the Carbon Footprint

*What makes a good Carbon Footprint estimate?*

The 2 fundamentals of carbon accounting:

1. **Comprehensiveness:** measuring both direct and indirect emissions associated with the economic activity.
2. **Exclusivity:** no double-counting.

Together, these conditions guarantee the **macro-consistency** of the measures.
So far, the two common ways to measure the carbon footprint have been to focus on **countries and firms** or **individuals** (as final consumers).

# Consumption-based Approaches

**Individuals' consumption guides the resource allocation in the economy.**

- Underlying assumption: *"Individuals express their preferences through consumption, which sens a signal to producers about what to manufacture and in what quantity."*
- The **"consumer-pays"** principle

**Advantage:** Particularly relevant at the country level (accounts for outsourced emissions).
**Drawback:** Puts the entire responsibility for all emissions on final consumers (despite market failures: lack of information, agency or alternatives).

# Production-centered Approaches and Methods of Shared Attribution

Contrasting consumption footprints with the production footprints of firms.

**Production-centered approaches**: Focusing on the firm level
Critique: Firms operate through human intervention and individuals are behind their behaviors. $\rightarrow$ **Ownership-based approach**

**Methods of shared attribution**: Split emissions between consumers and firm owners
Critique: Hard to implement at the individual level. $\rightarrow$ **Mixed-based approach**

**Income-based carbon accounting**: An alternative at the individual level?

# From the Carbon Footprint of individual investment portfolios to the DINA

*There already were some attempts at measuring the carbon emissions of individual portfolios (GHG, PCAF). But there exists no consensus regarding these methods and their estimates were not always consistent with aggregate estimates.*

Their answer: **the Distributional National and Environmental Accounts (DINA)**

- Goal of the DINA framework: *Reconciling macroeconomic studies (e.g., production, income, wealth) with microeconomic distributional analysis by integrating the study of inequality into the system of national accounts.*

# Data Sources and Methodology

## Data Sources and Methodology

## Conceptual Framework

**Three Approaches to Carbon Footprints:**

- **Ownership Approach:** Attributes all direct emissions of firms to their owners.
- **Mixed Approach:** Attributes emissions linked to investment to owners and all others to consumers.
- **Consumption Approach:** Allocates all direct and indirect emissions to consumers.

**Key Principles:**

- **Consistency:** Aligns with national accounts.
- **Exclusivity:** Ensures no double counting of emissions.

# Data Sources

**Main Data Sources:**

- **Wealth Data:** HFCS for France and Germany, DINA micro-files for the U.S.
- **Capital Stock:** National accounts data from Eurostat and OECD.
- **Emissions:** Air emission accounts (Eurostat, OECD).
- **Input-Output Tables:** EU-FIGARO dataset for indirect emissions.
- **Cross-Border Investment:** EU-Finflows database and EU-EDGAR.

**Challenges:**

- Surveys underrepresent ultra-wealthy households.
- Need for alignment between financial and environmental datasets.

# Methodology Overview

**Two Key Steps:**

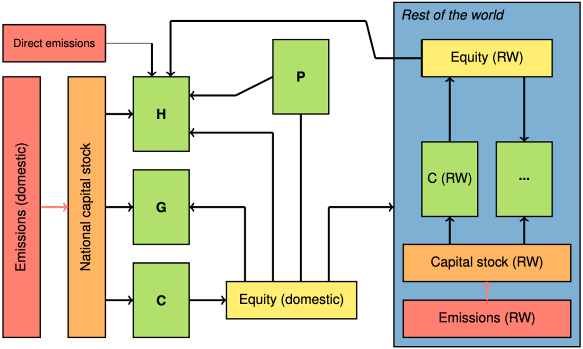
1. **Extended Aggregate Environmental Accounts:** Relates emissions to industries, asset classes, and institutional sectors.
2. **Distributional Environmental Accounts:** Allocates emissions from institutional sectors to individuals.

**Key Metrics:**

- Emissions per industry.
- Emissions per asset class.
- Emissions per wealth group.

# Methodology Overview

**Figure 2.** Attribution of emissions to economic sectors in the ownership-based approach




*Note:* Schematic illustration of emission attribution to the capital stock and to institutional sectors in the economy in the ownership-based approach. Black arrows depict the flow of emissions in each step of the attribution process. Red arrows represent the emissions linked to the national and foreign capital stock. The figure demonstrates how all national emissions are ultimately attributed to either the household sector (H), the government (G), or to foreign investors (RW). (P) refers to the equity owned by pension funds and life insurance.

# Extended Aggregate Environmental Accounts

**Purpose:**

- Calculate total emissions by industry and institutional sector.
- Link emissions to the value of the capital stock.

# Distributional Environmental Accounts

**Purpose:**

- Distribute total emissions from sectors to individuals.
- Attribute emissions based on asset ownership and consumption patterns.

**Methodology:**

- **Ownership Approach:** Allocates emissions directly linked to owned assets.
- **Mixed Approach:** Allocates investment-related emissions to owners, all others to consumers.
- **Consumption Approach:** Allocates all emissions to consumers.

**Challenges:**

- Accurate attribution of emissions for cross-border investments.
- Limited data granularity for certain asset classes.

# Conclusion of Section 3

**Key Takeaways:**

- Emission allocation methods depend on robust data and models.
- Ownership and mixed approaches provide nuanced insights into emissions inequality.
- Data quality and granularity remain critical for future research.

# Carbon Footprint of the Capital

# Capital emissions by industry and institutional sector

Industries :

- Agriculture and mining
- Energy, water and waste
- Manufacturing
- Transport
- Real estate and construction
- Health and education
- Public administration
- Services

Results :

- Manufacturing as the largest emitting sector in FR and DE
- Agriculture and mining as the largest emitting sector in the US
- Agriculture and mining as the most carbon-intensive sector
- Similar carbon intensity for the manufacturing sector
- Difference in definition for the Real Estate and Construction sector

Following : Table 1, Emission intensities by industry groups

# Capital emissions by industry and institutional sector

| Industry | Mixed: tCO2e/ m euros capital | Mixed: tCO2e/ m euros value-added | Mixed: million tCO2e | Ownership: tCO2e/ m euros capital | Ownership: tCO2e/ m euros value-added | Ownership: million tCO2e |
|---|---|---|---|---|---|---|
| **Panel A. France (2017)** | | | | | | |
| Agriculture and mining | 65.5 | 291.9 | 10.9 | 528.4 | 2,354.9 | 87.8 |
| Energy, water and waste | 85.8 | 562.0 | 27.1 | 150.6 | 987.0 | 47.6 |
| Manufacturing | 120.0 | 212.9 | 49.6 | 230.2 | 408.4 | 95.1 |
| Transport | 38.3 | 103.1 | 9.8 | 163.5 | 440.5 | 41.7 |
| Real estate and construction | 0.8 | 20.4 | 7.7 | 1.0 | 24.7 | 9.3 |
| Health and education | 0.3 | 0.6 | 0.2 | 19.0 | 34.5 | 10.3 |
| Public administration | 0.1 | 1.1 | 0.2 | 3.2 | 30.6 | 4.9 |
| Services | 6.7 | 9.7 | 7.7 | 30.2 | 44.0 | 35.0 |
| **Panel B. Germany (2017)** | | | | | | |
| Agriculture and mining | 84.0 | 568.3 | 18.2 | 335.3 | 2,269.7 | 72.8 |
| Energy, water and waste | 113.5 | 912.2 | 81.0 | 289.4 | 2,326.2 | 206.6 |
| Manufacturing | 96.6 | 131.9 | 87.9 | 232.6 | 317.8 | 211.7 |
| Transport | 24.0 | 116.0 | 14.9 | 161.9 | 783.5 | 100.5 |
| Real estate and construction | 0.8 | 15.5 | 7.0 | 1.2 | 23.2 | 10.5 |
| Health and education | 0.3 | 0.9 | 0.3 | 8.7 | 28.7 | 10.2 |
| Public administration | 0.3 | 1.8 | 0.3 | 4.9 | 30.7 | 5.5 |
| Services | 4.0 | 6.6 | 6.9 | 22.2 | 36.5 | 38.1 |
| **Panel C. United States (2019)** | | | | | | |
| Agriculture and mining | 97.3 | 641.7 | 297.9 | 534.9 | 3,526.6 | 1,637.3 |
| Energy, water and waste | 146.7 | 1,262.1 | 455.3 | 431.4 | 3,710.8 | 1,338.6 |
| Manufacturing | 117.7 | 214.7 | 508.1 | 205.7 | 375.2 | 887.7 |
| Transport | 105.7 | 254.8 | 179.1 | 359.1 | 865.8 | 608.6 |
| Construction | 158.4 | 69.7 | 62.9 | 212.5 | 93.6 | 84.4 |
| Services and other industries | 0.9 | 4.1 | 65.5 | 6.6 | 30.2 | 477.5 |

# Capital emissions by asset class

Assets :

- Housing assets
- Business assets
- Equities
- Pension assets
- Fixed income assets

Results :

- Equity is the most polluting asset class.
- Pension assets are the second most polluting asset class.
- Business assets are the third most polluting asset class.
- Housing has an important market valuation, but emits little.
- Important intensity of pension assets for Germany.

In clear, there exist important differences between types of assets.

# Capital emissions by asset class

**Table 2.** Asset classes and emission intensity per million $/EUR owned (ownership-based approach)

| Asset class | France (2017) b euros owned | France (2017) million tCO2e | France (2017) tCO2e/ m euros owned | Germany (2017) b euros owned | Germany (2017) million tCO2e | Germany (2017) tCO2e/ m euros owned | USA (2019) b dollars owned | USA (2019) million tCO2e | USA (2019) tCO2e/ m dollars owned |
|---|---|---|---|---|---|---|---|---|---|
| Housing assets | 6,808.5 | 0.3 | 0.1 | 6,901.2 | 0.5 | 0.1 | 36,475.5 | 260.8 | 7.2 |
| Business assets | 727.9 | 38.3 | 52.6 | 1,036.7 | 90.4 | 87.2 | 6,748.4 | 966.5 | 143.2 |
| Equities | 1,528.7 | 123.2 | 80.6 | 1,332.7 | 203.7 | 152.9 | 17,553.6 | 1,314.4 | 74.9 |
| *Domestic* | *1,183.9* | *83.1* | *70.2* | *808.2* | *117.5* | *145.4* | *13,965.3* | *1,118.4* | *80.1* |
| *Abroad* | *344.8* | *40.1* | *116.4* | *524.6* | *86.2* | *164.4* | *3,588.3* | *196.0* | *54.6* |
| Pension assets | 2,026.9 | 75.4 | 37.2 | 1,351.5 | 197.6 | 146.2 | 31,564.2 | 1,015.9 | 32.2 |
| Fixed-income assets | 1,552.8 | 0.0 | 0.0 | 2,579.9 | 0.0 | 0.0 | 17,363.7 | 0.0 | 0.0 |

*Note:* Emissions correspond to the average emissions of an individual who owns the asset for one year. The table presents household sector ownership-based emissions and does not include government-owned assets. Emissions attributed to assets based on the approach explained in the paper (ownership-based approach). The value of total assets owned is sourced from Eurostat national balance sheets (France and Germany) and from distributional national accounts released by Piketty et al. (2018) for the Unites States. Pension assets include life insurance assets.

# The role of foreign capital in national emissions

- In France and in the US, equity held abroad represents about 20-25% of owned equities.
- In Germany, equity held abroad represents about 40% of owned equities.
- Foreign equity held by French and German citizens are more carbon intensive than those owned by the US citizens.

# The Distribution of Carbon Footprints

# The Distribution of Carbon Footprints

# Emissions rise with income and wealth

Generally :

- Emissions are positively correlated with wealth.
- Consumption approach : carbon inequalities are less concentrated than income.
- Mixed-based approach : carbon inequalities are as concentrated as income.
- Ownership approach : carbon inequalities are more concentrated than wealth.

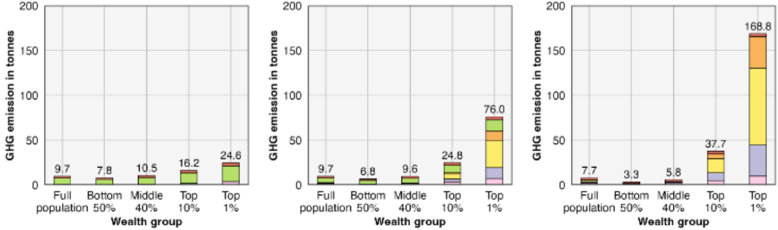
International comparison :

- The US are more carbon inequal than Germany, which is more carbon inequal than France.
- The majority of the US emit as much as the top of the distribution of France and Germany in the two first approaches.
- The top French group emits less despite owning more of the national equity than their German counterpart.

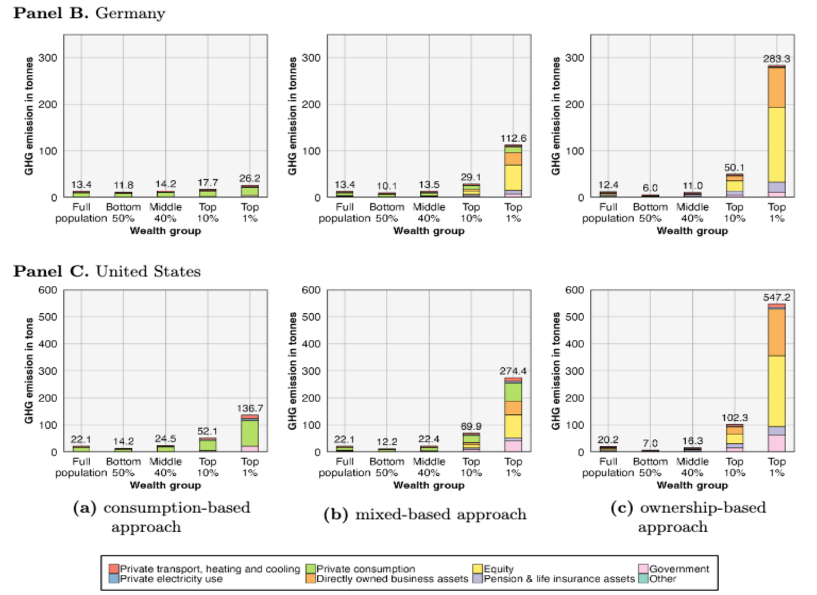
# Emissions rise with income and wealth

**Figure 5.** Per capita emissions by wealth group

**Panel A.** France



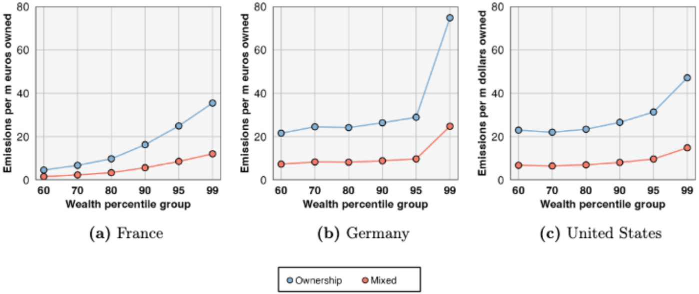
# Emissions rise with income and wealth



# Emissions intensity rises with wealth

Average emission intensity tends to increase alongside with wealth at the very top of the distribution. This explains the greater concentration of carbon emissions compared to wealth.

**Figure 6.** Average annual emissions in tonnes per million dollars or euros owned




(a) France (b) Germany (c) United States

## The weight of capital emissions among top groups

- Importance of the emissions of top groups.
- Emissions of the top 1% (p.36) :

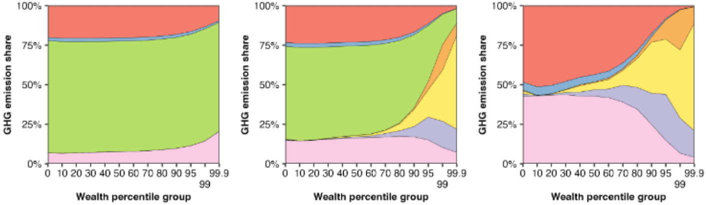
| Countries | Consumption | Ownership | Multiplication in tCO2e |
|---|---|---|---|
| France | 2.5% | 21.5% | 6 |
| Germany | 2% | 22.3% | 11 |
| US | 6.2% | 26.9% | 16 |

- Key role of Capital ownership in the determinant of the top of the distribution.
- Structure of the emissions alongside the wealth distribution.

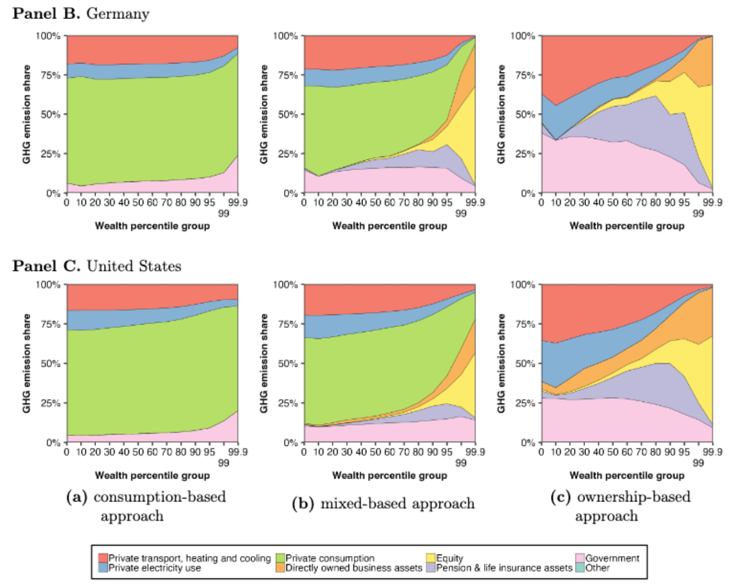
# The weight of capital emissions among top groups

**Figure 7.** Breakdown of emissions according to the three approaches

**Panel A.** France



# The weight of capital emissions among top groups



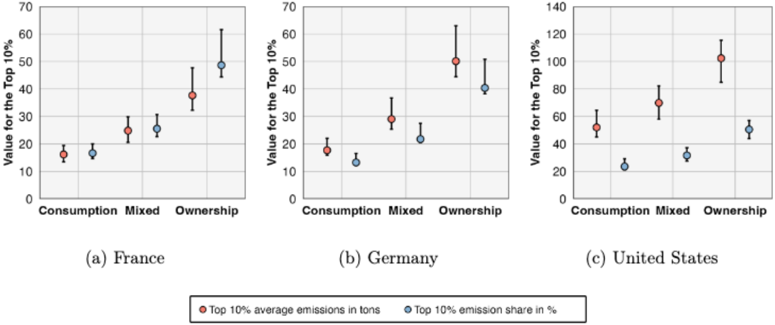
# Discussion

# Discussion

# Robustness of the results

**Robustness checks** *Even under extreme combinations of assumptions, the general patterns observed hold, in particular that accounting for ownership-based emission footprints increases emission inequality considerably.*

**Figure 8.** Upper and lower bound of Top 10% average emissions and emission shares




*Note:* The graph presents the range of the share of emissions and average emissions attributed to the top 10% net wealth holders under different assumptions. The dot represents the benchmark strategy explained in the paper. The bands correspond to the lowest and highest value obtained when calculating all potential combinations of alternative scenarios (216 scenarios per country). Alternative assumptions concern the attribution of government emissions, non-ownership-based emissions or housing-related emissions. Tables with average emissions and emission

# Scopes and limitations - Limitations due to the data

Incomplete Data for High-Wealth Individuals

**Issue :**

- Surveys like HFCS and DINA underrepresent the top 1% of wealth holders.
- This underestimates emissions linked to equity and business assets.

**Discussion :**

- Integrate alternative data sources (e.g., tax records, billionaire lists).
- Refine attribution of emissions to high-net-worth individuals.

**Impact:**

- Potential bias in emissions share attributed to the wealthiest.

# Scopes and limitations - Limitations due to the data

Sensitivity to Assumptions

**Issue :**

- Allocation of government emissions varies (proportional to income vs. lump-sum distribution).
- Cross-border investments use average intensities, ignoring sector-specific differences.

**Discussion :**

- Tested alternative assumptions for government emissions:
    - Proportional to income: increases share of emissions for wealthy groups.
    - Lump sum: reduces their share.
- Importance of robust sensitivity analysis.

## Scopes and limitations - Limitations due to the data

Lack of Granularity in Asset Data

**Issue :**

- No differentiation between carbon-intensive and low-carbon investments.
- Masks the role of sustainable finance in reducing emissions.

**Discussion :**

- Propose linking firm-level environmental data to financial datasets.
- Enables better identification of green vs. carbon-intensive portfolios.

**Impact:**

- Improved insights into the role of individual investment behavior.

# Scopes and limitations - Limitations due to the data

Challenges with Cross-Border Investments

**Issue :**

- Relies on average carbon intensities by country.
- Ignores sector-specific variations in foreign economies.

**Discussion :**

- Highlighted uncertainty in emissions from foreign equity.
- Proposed improvements:
  - Granular international investment data.
  - Sector-specific emissions intensities for cross-border assets.

# Scopes and limitations - Limitations due to the data

Dependence on Static Models

**Issue :**

- Relies on static multi-regional input-output models (MRIOs).
- Assumes linear relationships between inputs and emissions.

**Discussion :**

- Recommends dynamic or hybrid models.
- These models require richer datasets, currently unavailable.

**Impact:**

- Limits ability to capture feedback effects and technological change.

# Scopes and limitations - Interpretative Limitations and Individual Responsibility

**Carbon footprint and individual responsibility:**

No broadly defined individual footprinting approach can fully capture the actual responsibility individual bears for emissions.

The three conditions for individual responsibility:

- Agency
- Intentionality
- Alternatives

In reality, these conditions are rarely met.

A potential way to account for individual responsibility:

- $\alpha$: rate of control over indirect emissions embedded in individual consumption
- $\beta$: rate of agency and control over direct emissions embedded in direct consumption

The role of the government in decarbonization.

# Stylized facts on inequality and emissions

1. **Challenging the Kuznets curve**: a pronounced economic gradient linked to emissions.
   *Emissions do not decline after a certain income level.*

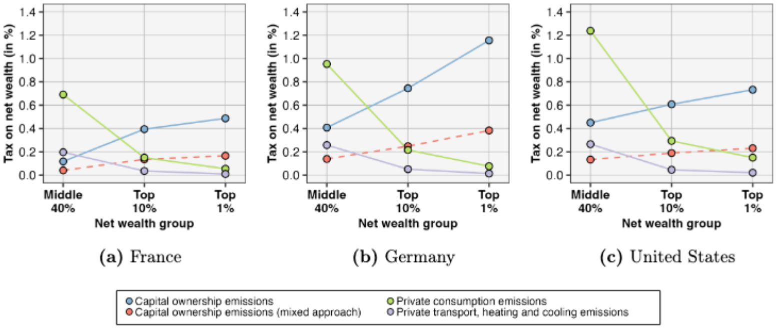
2. **Consumption-based emissions are less concentrated than income and wealth.**
   *Because wealthier individuals consume a smaller fraction (and wealth) than less well-off individuals.*

3. **Wealth emissions are even more concentrated than wealth itself.**
   *Because the type of assets owned by the bottom 90% (mostly housing and deposits) have low or zero carbon intensity.*

# Distributional properties and revenue estimates for a carbon wealth tax

So far, climate tax policy mirrors the approaches taken in the climate inequality literature, which have not considered the role of the individual. **A 150 euro/dollars "pet-tonne" tax on the carbon content of assets**

**Figure 9.** Progressivity of a 150 euros/dollars per-tonne tax on different types of emissions




*Note:* The graphs present the static distributional impact of a tax levied annually per tonne of emissions on different types of emissions. For tax simulations, emissions are distributed to adult individuals instead of the

# Conclusion

# Conclusion

- Complementarity of the three approaches, way to analyse emissions inequality.
- Calling for a broader theory on optimal taxation based on capital carbon emissions.