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Ph.D. Summer School on the Economics of the Green and Digital Transitions: Innovation Policies for a Global Europe

Income inequality and the twin transition

Facts and policy insights in the European context

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Welcome!

Outline

Income inequality between countries

Income inequality within countries

Income inequality and the digital transition

Income inequality and the green transition

Outline

Income inequality between countries

Income inequality within countries

Income inequality and the digital transition

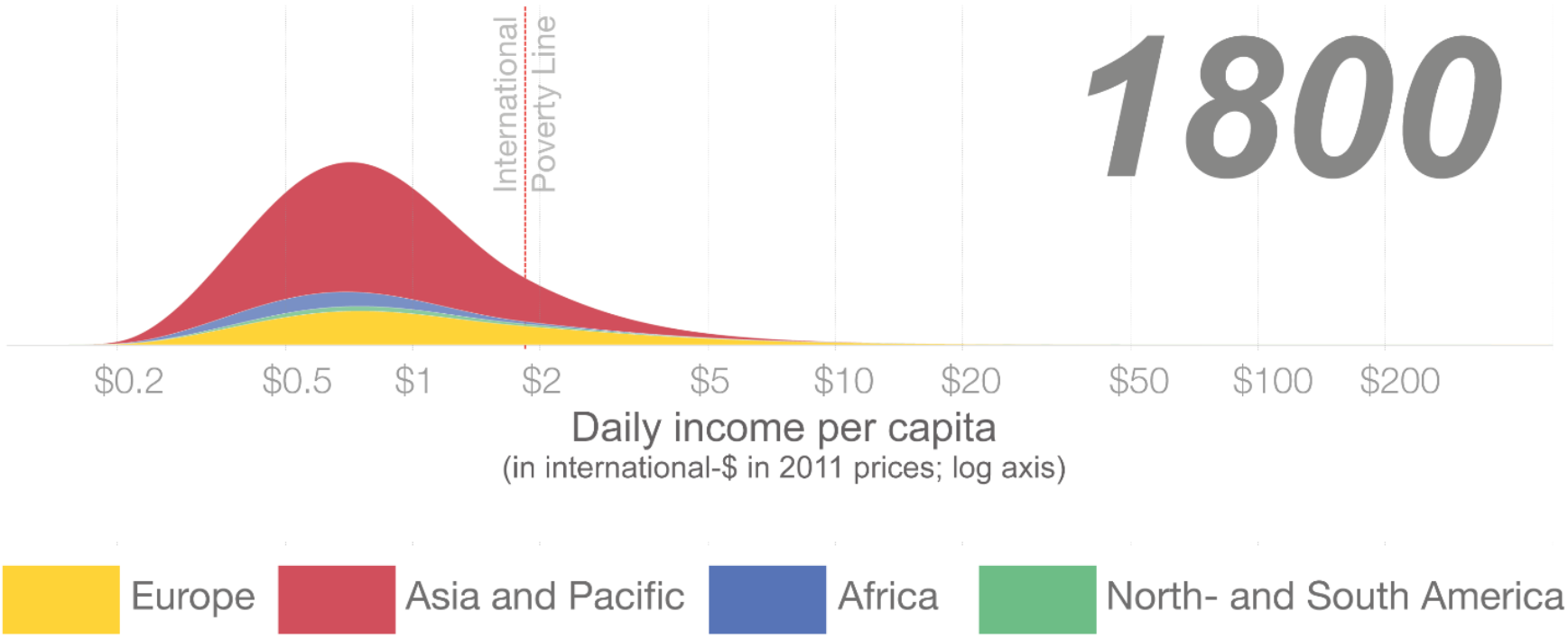
Income inequality and the green transition

Inequality between countries

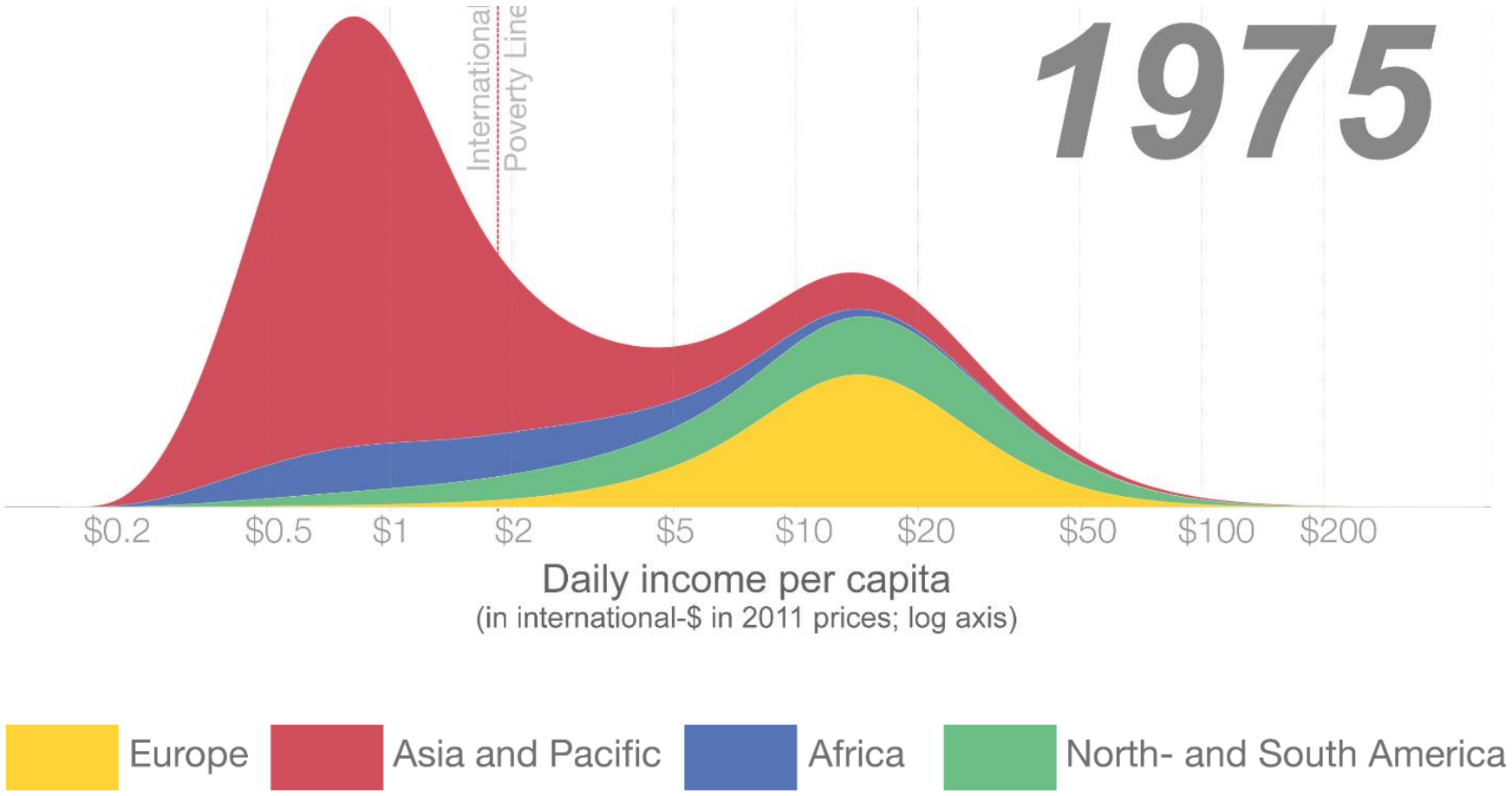
Global income distribution in 1800, 1975, and 2010

Our World in Data

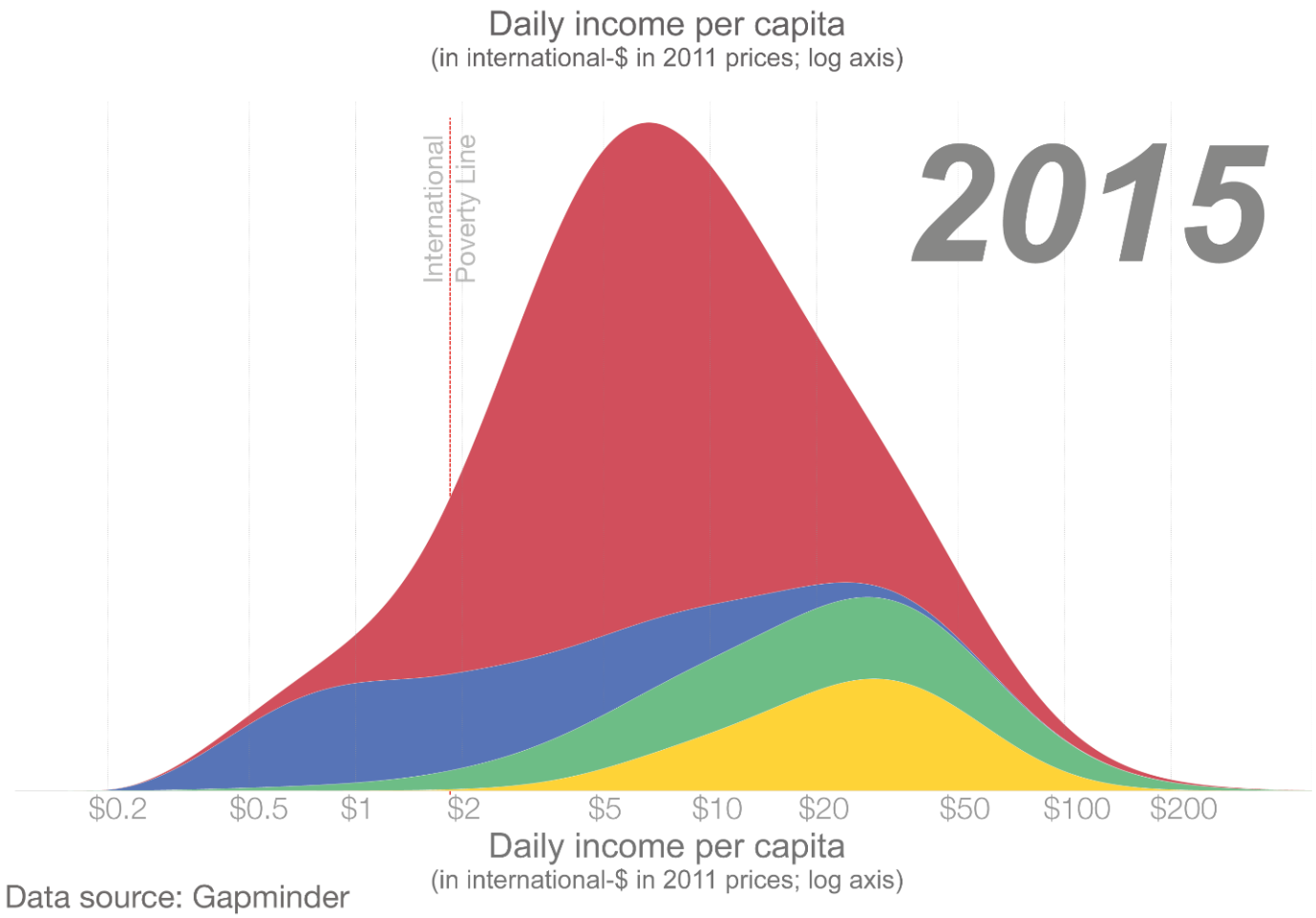
Income is measured by adjusting for price changes over time and for price differences between countries (purchasing power parity (PPP) adjustment).
These estimates are based on reconstructed National Accounts and within-country inequality measures.
Non-market income (e.g. through home production such as subsistence farming) is taken into account.



Inequality between countries



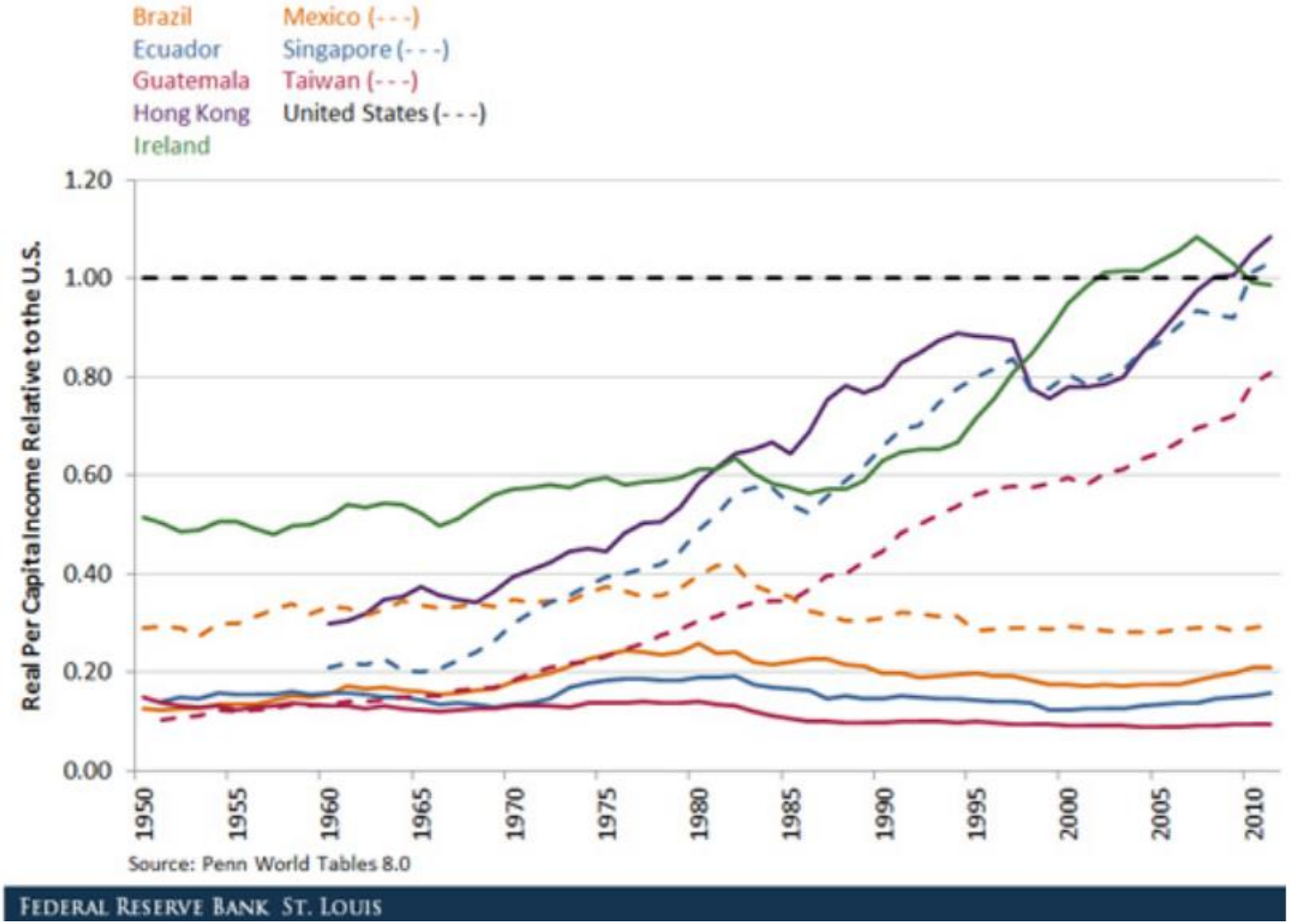
Inequality between countries



Data source: Gapminder

Europe
Asia and Pacific
Africa
North- and South America

Explaining divergence
(relative to the US)

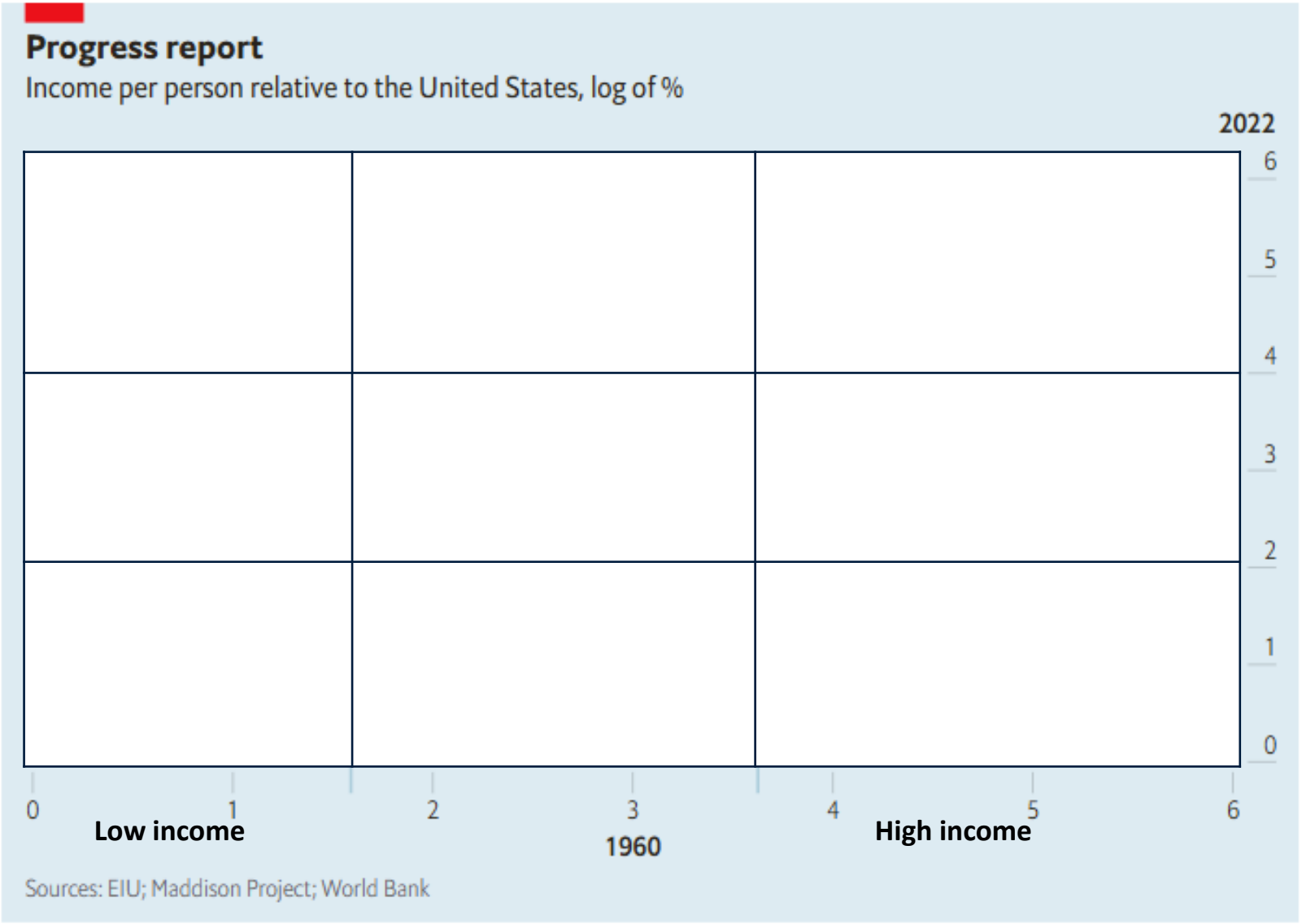


Hong Kong
Singapore
Ireland

Taiwan

Mexico
Brazil
Ecuador
Guatemala

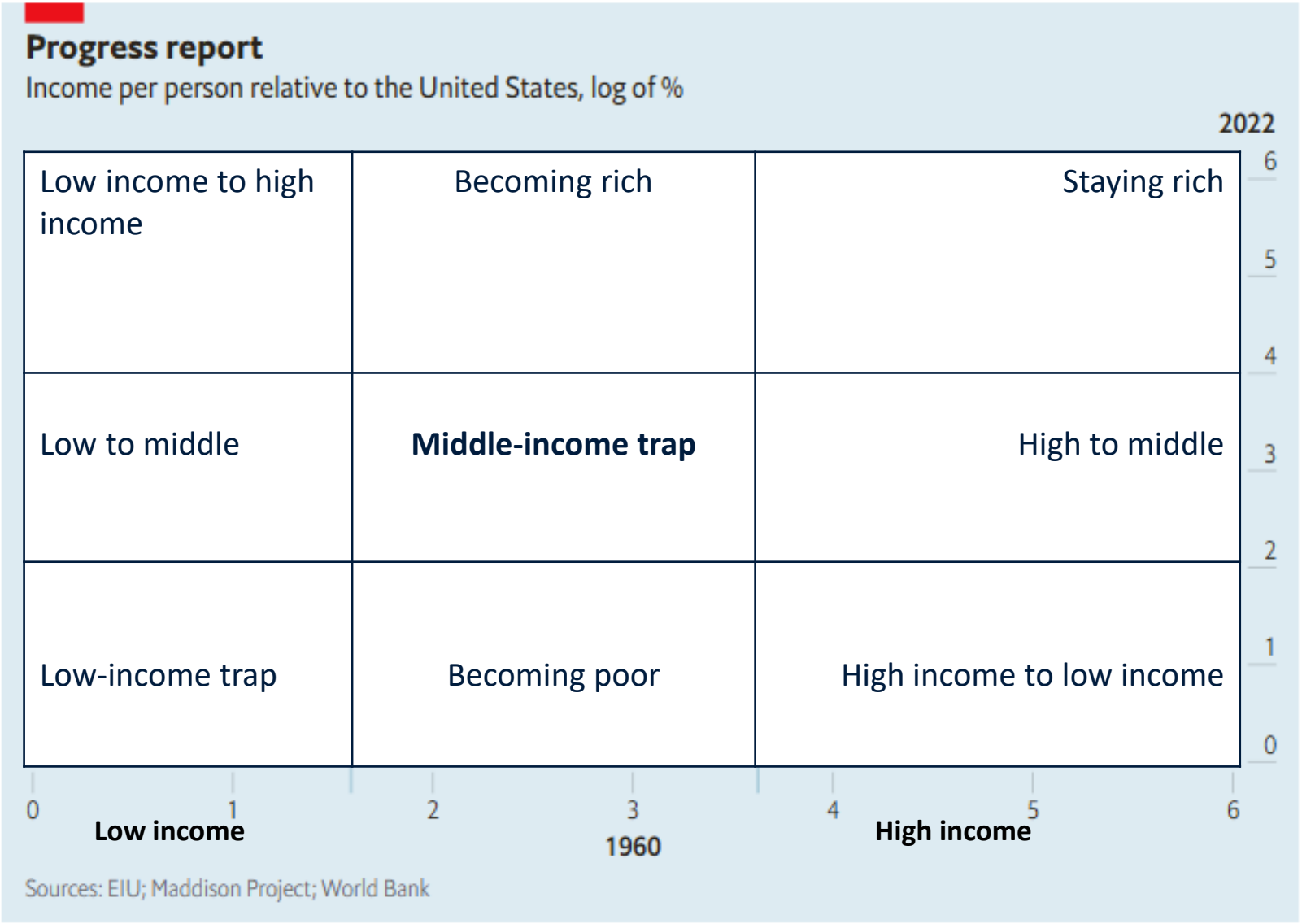
The middle-income trap



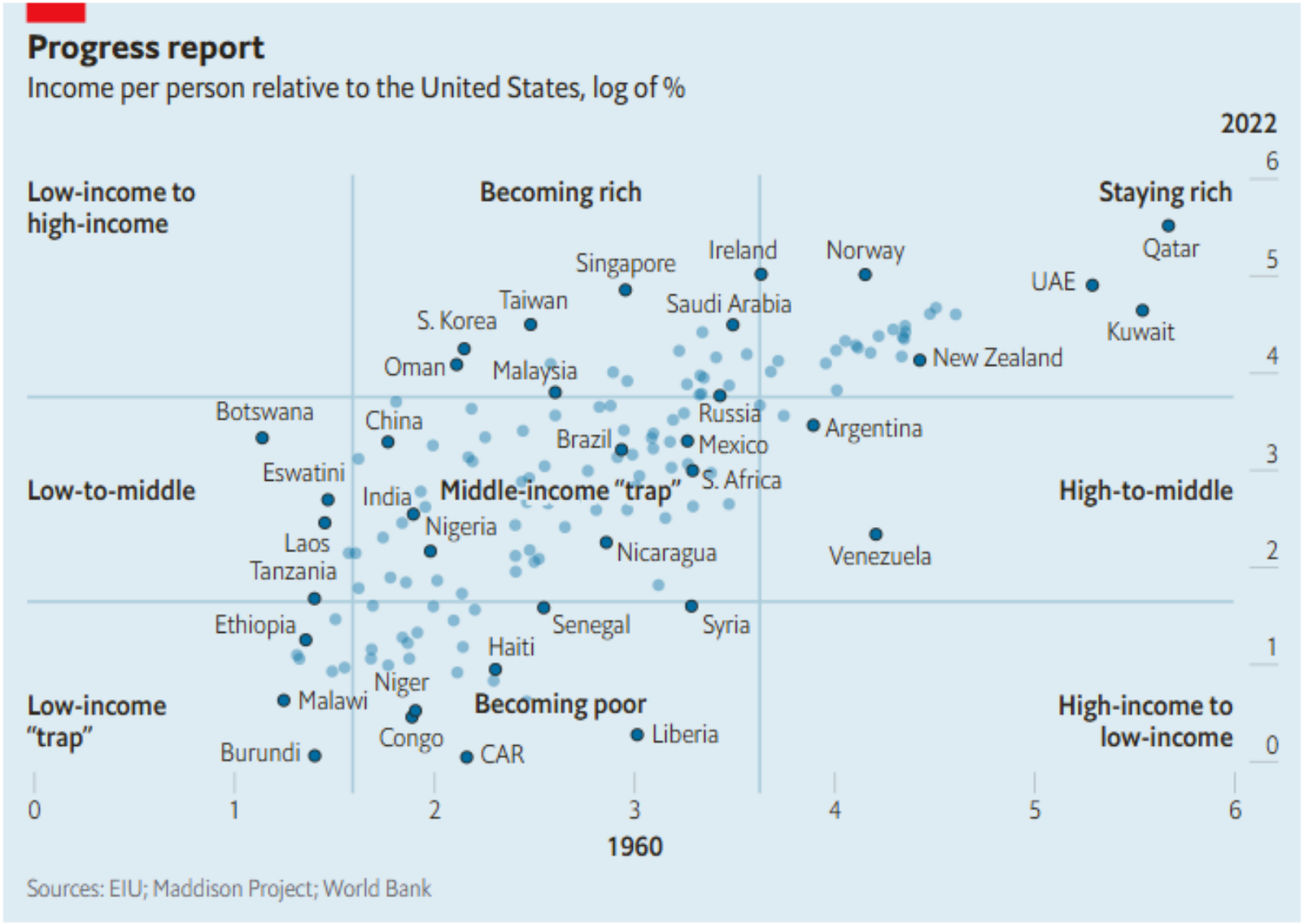
High income

Low income

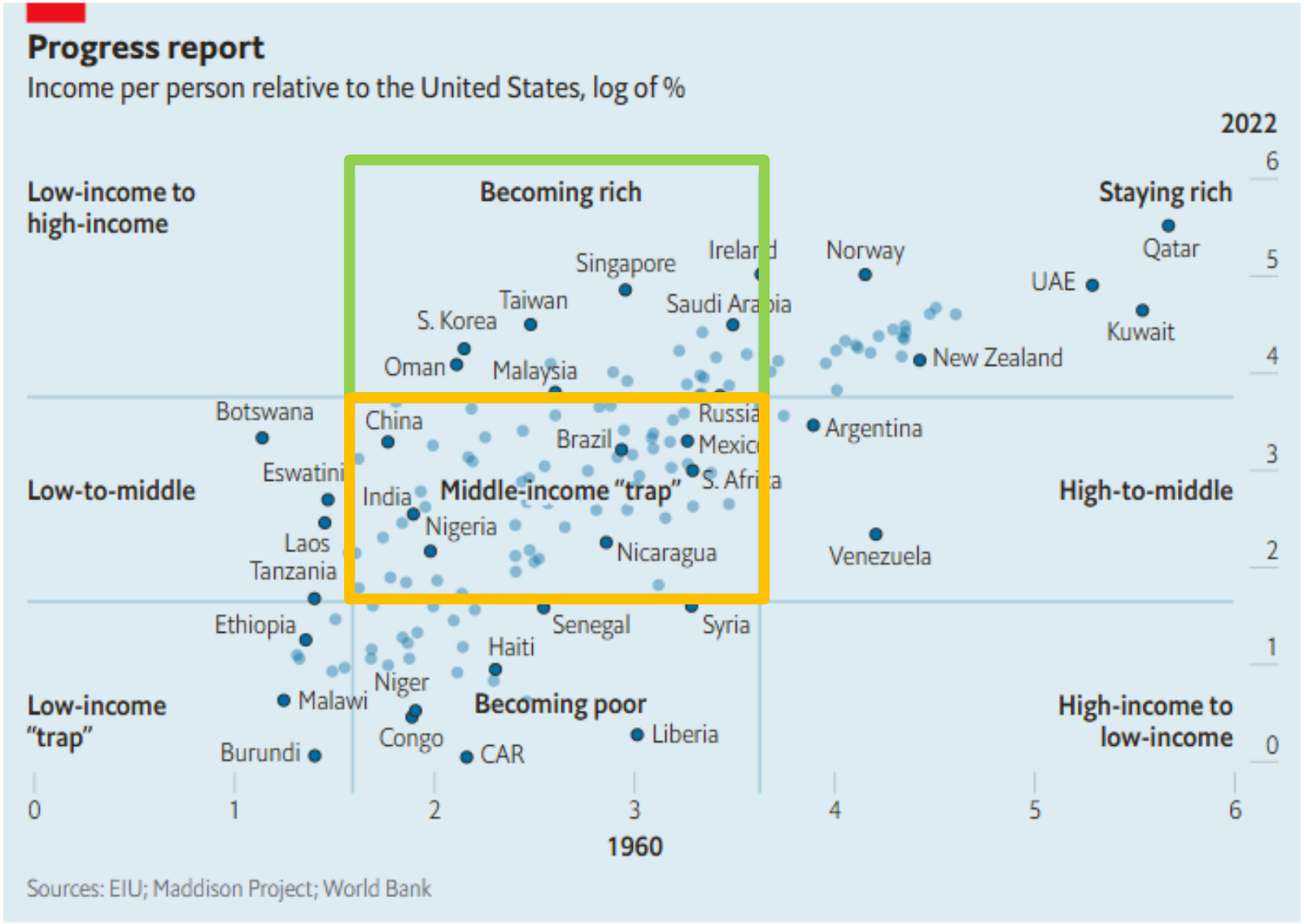
The middle-income trap



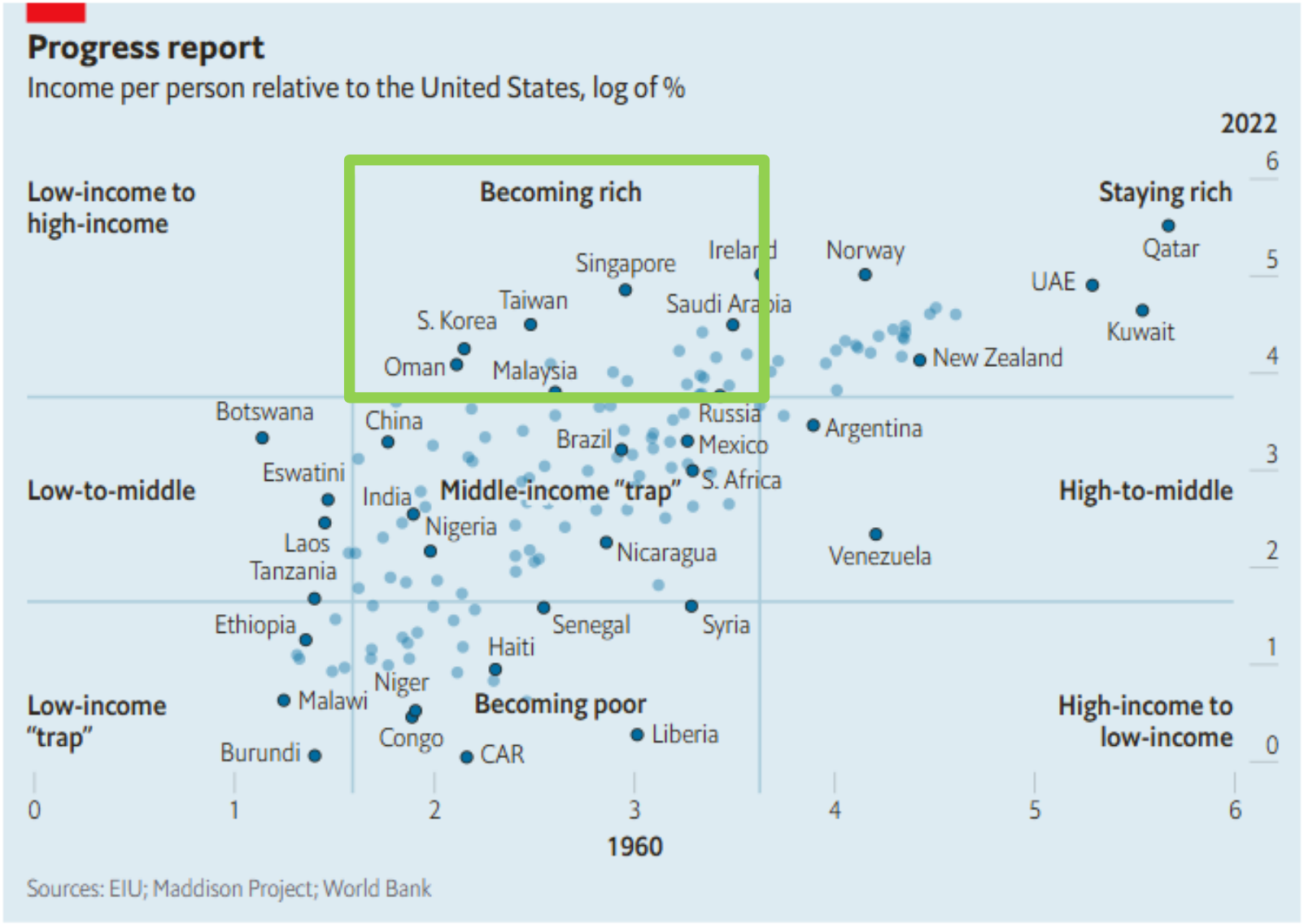
Escaping the middle-income trap?



Escaping the middle-income trap?



Success stories?

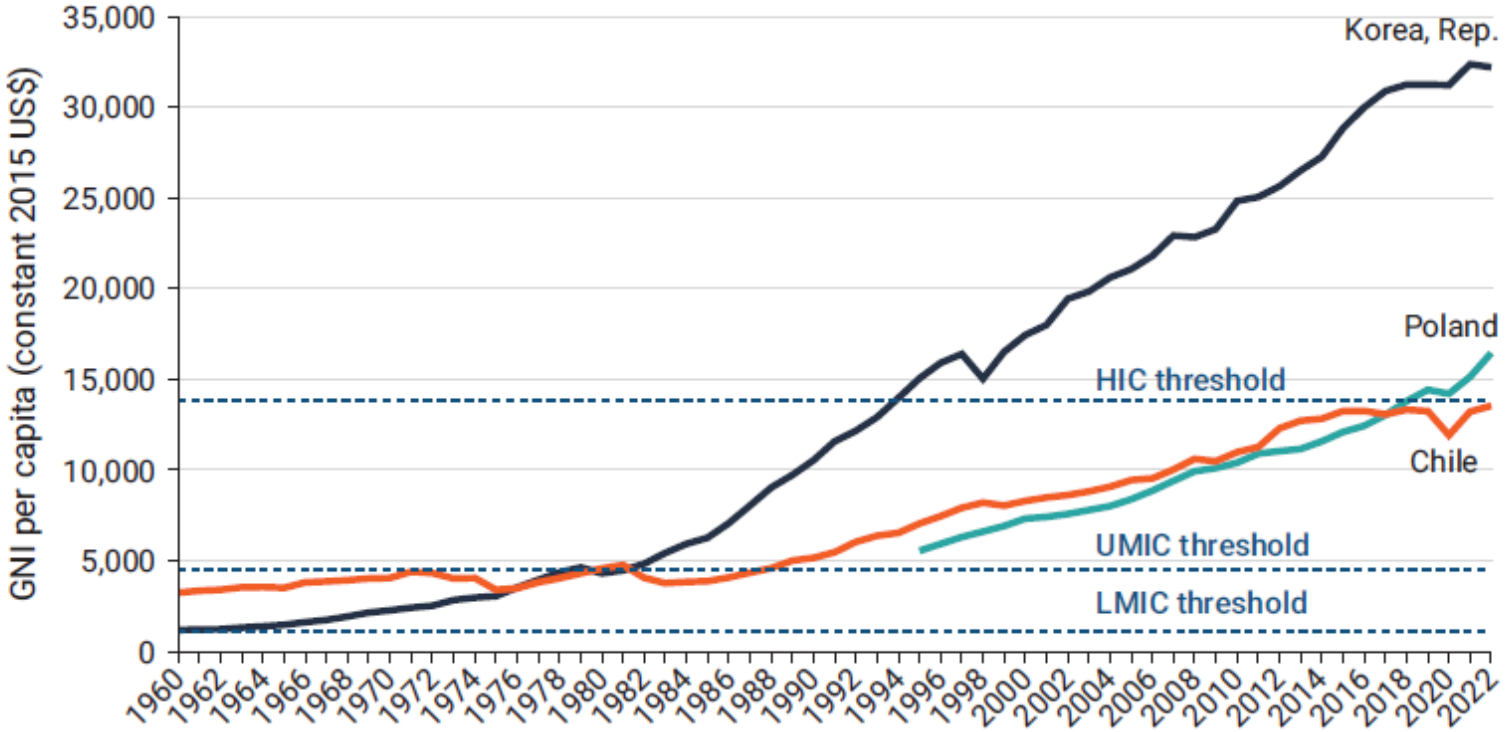


Success stories?

World Development Report 2024

The Middle-Income Trap

Figure O.5 In the Republic of Korea, Poland, and Chile, the rapid growth from middle- to high-income status has been interspersed with economic crises



Source: WDR 2024 team using WDI (World Development Indicators) (Data Catalog), World Bank, Washington, DC, https://datacatalog.worldbank.org/search/dataset/0037712.

Note: GNI = gross national income; HIC = high-income country; LMIC = lower-middle-income country; UMIC = upper-middle-income country.

Success stories?

World Development Report 2024

Figure O.6 From infusion to innovation in the Republic of Korea

a. An agreement between companies to collaborate on technology

Figure A.1: Example of Adoption Contract

TECHNICAL COLLABORATION AGREEMENT

BY AND BETWEEN

NIPPON ELECTROIC CO., LTD.

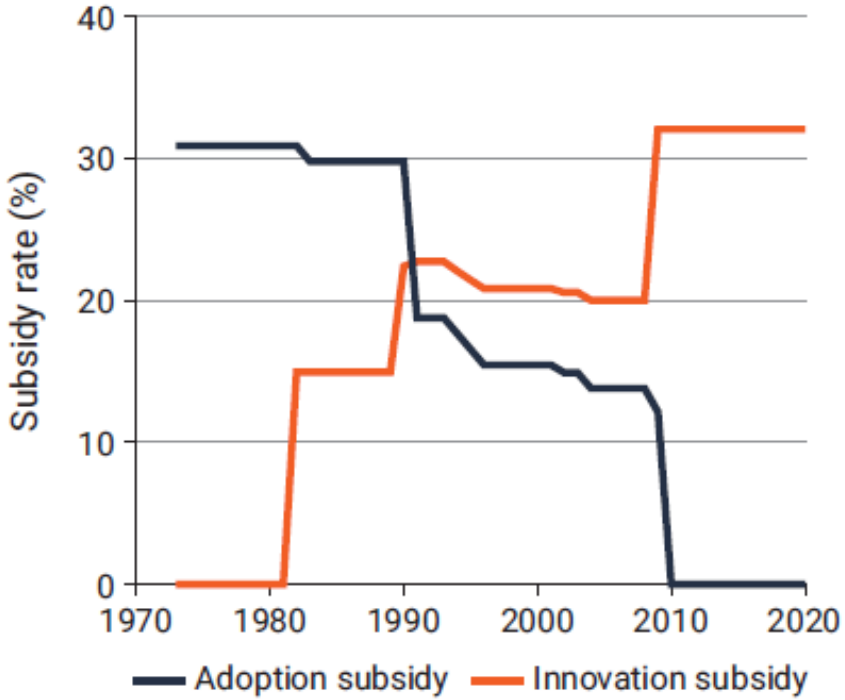
AND

SAMSUNG ELECTRON DEVICES CO., LTD.

Section 4 Supply of written Technical Information

(a) During the term of this Agreement NEC will upon reasonable request furnish SED with one transparent copy of each drawing, specification and other technical document as well as programs and related documentation within the scope specified in Section 1 (d) hereof. The time, manner and other details of furnishing such written NEC Technical Information shall be separately determined by the parties upon mutual consultation.

b. Government incentives (subsidies)



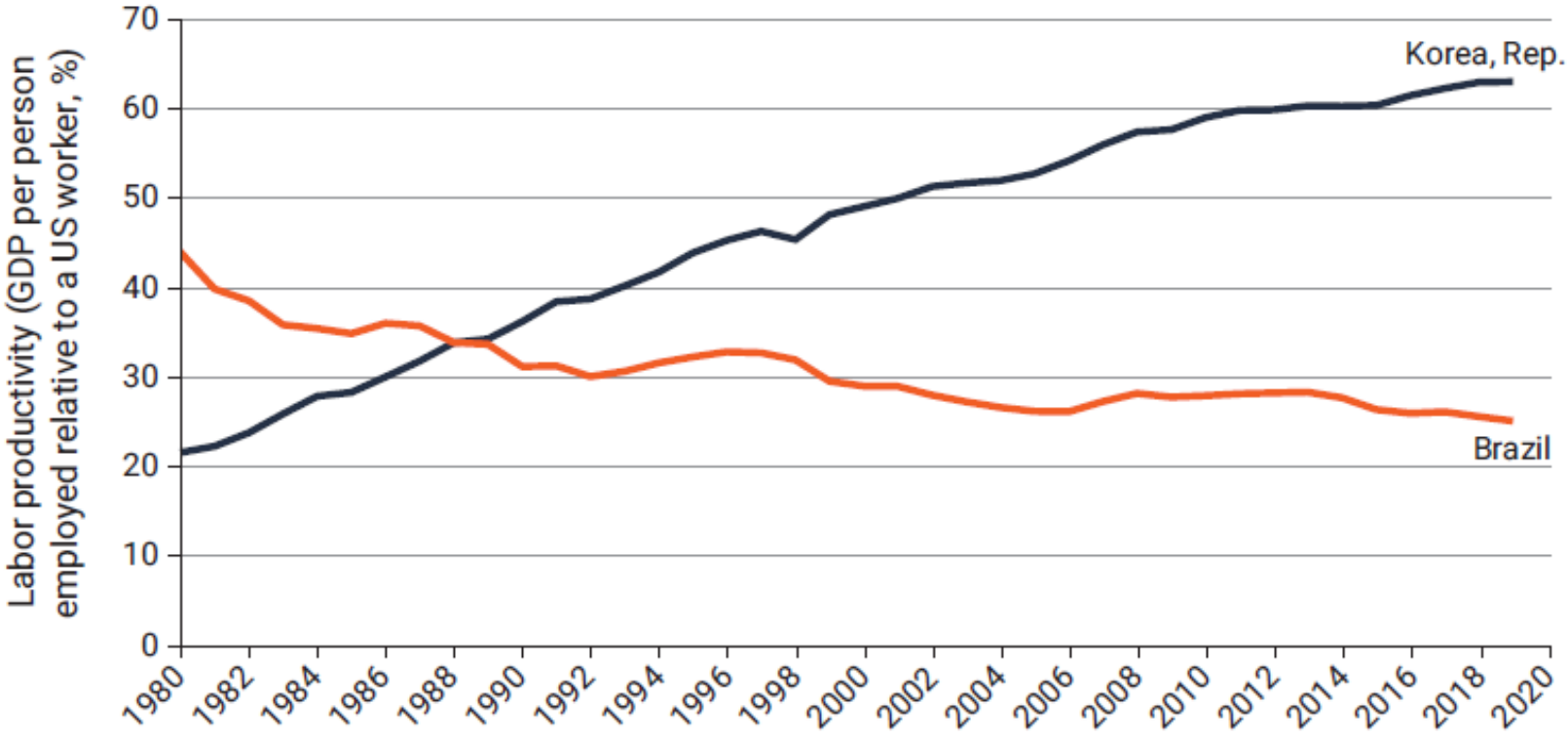
Sources: Panel a: National Archives of Korea, https://www.archives.go.kr/english/index.jsp. Panel b: Choi and Shim 2024.

Note: Panel b shows the adoption subsidy rate alongside the innovation (R&D) subsidy rate, calculated using the tax credit rate and the corporate tax rate. For example, a 30 percent subsidy rate indicates that firms can receive a reimbursement equivalent to 30 percent of their expenditures on adoption fees or R&D. R&D = research and development.

Counter-examples

World Development Report 2024

Figure O.7 Over the last four decades, as the Republic of Korea's labor productivity relative to that of the United States continued to climb, Brazil's peaked—and then sagged



Source: WDR 2024 team using data from PWT (Penn World Table) (database version 10.1), Groningen Growth and Development Centre, Faculty of Economics and Business, University of Groningen, Groningen, the Netherlands, https://www.rug.nl/ggdc/productivity/pwt/.

Note: GDP = gross domestic product.

Escaping the middle-income trap

World Development Report 2024

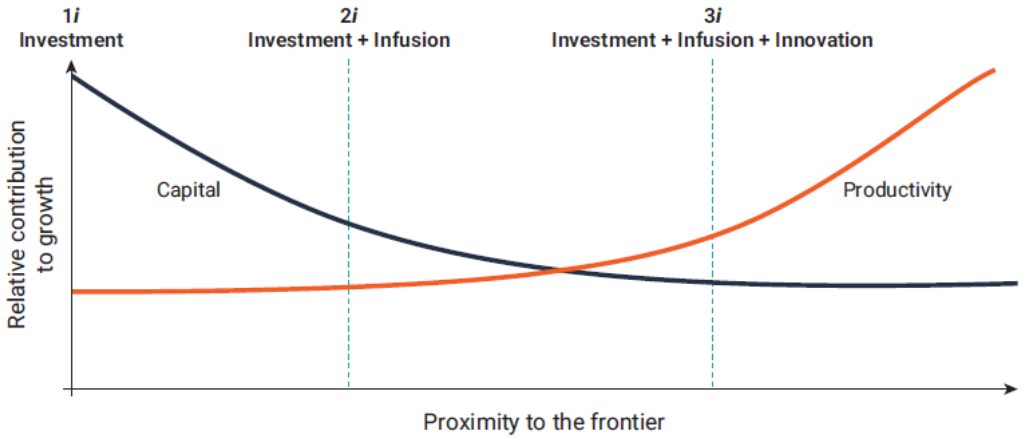
Sources of growth:

From capital-based to productivity-based

Policy priorities:

Supporting technology adoption and innovation

Figure O.4 Middle-income countries must engineer two successive transitions to move to high-income status



Source: WDR 2024 team.

Note: The curves illustrate the relative contributions of capital and productivity to economic growth (y-axis), according to countries' proximity to the frontier (represented by the leading economies). Countries farther out on the x-axis are closer to the frontier.

Table O.2 To achieve high-income status, countries will need to recalibrate their mix of investment, infusion, and innovation

INCOME CLASSIFICATION	INVESTMENT	INFUSION	INNOVATION
Low-income	Higher priority	Lower priority	Lower priority
Lower-middle-income	Higher priority	Higher priority	Lower priority
Upper-middle-income	Higher priority	Higher priority	Higher priority

Source: WDR 2024 team.

Note: The orange dials indicate a strategy that is a priority for that particular income group. The blue dials indicate a strategy that is less of a priority for that particular income group until the priority strategy is successfully achieved.

Outline

Income inequality between and within countries

Income inequality within countries

Income inequality and the digital transition

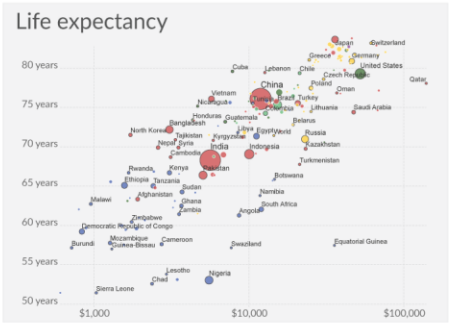
Income inequality and the green transition

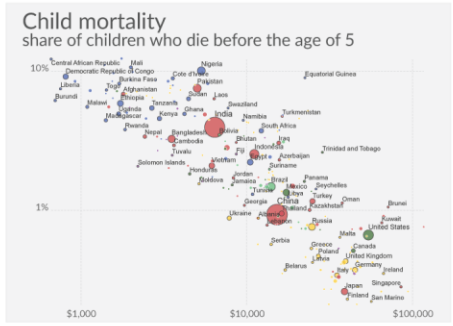
Why do we care about income per capita?

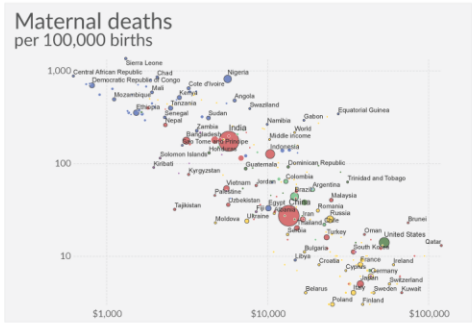
How is life at different levels of income?

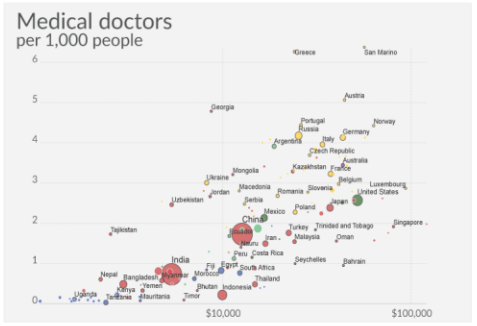
The horizontal axis of each of the 12 charts shows GDP per capita adjusted for price differences between countries to allow for comparisons between countries.
The size of the circles corresponds to the population of the country. Their color represents the world region.

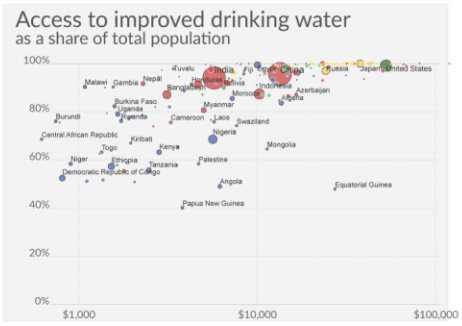
Our World in Data

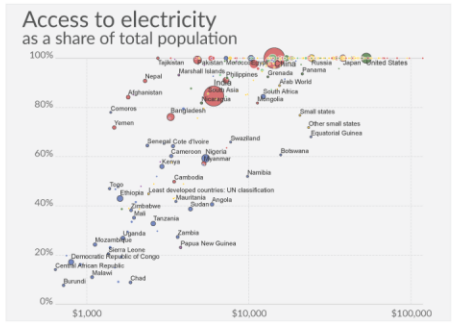


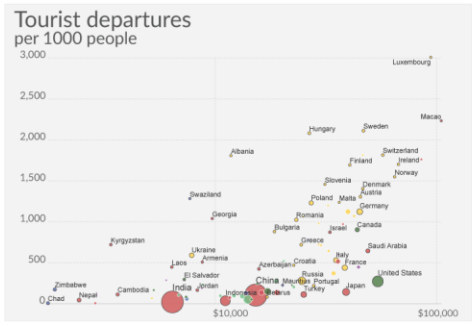


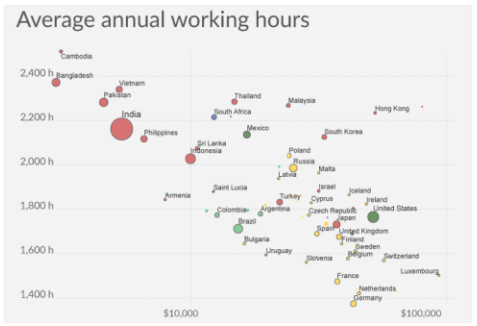


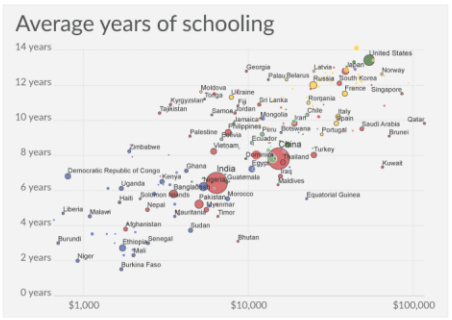


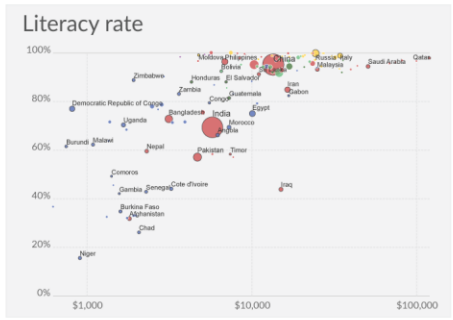


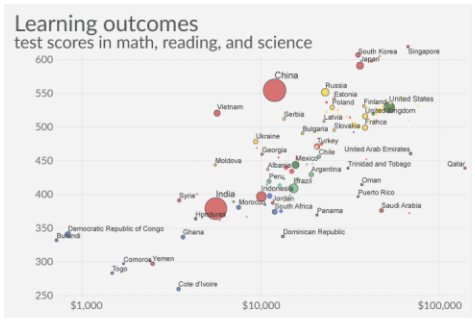


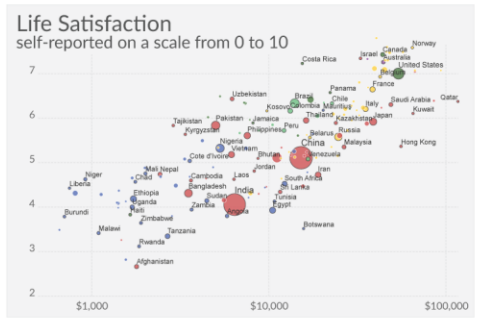








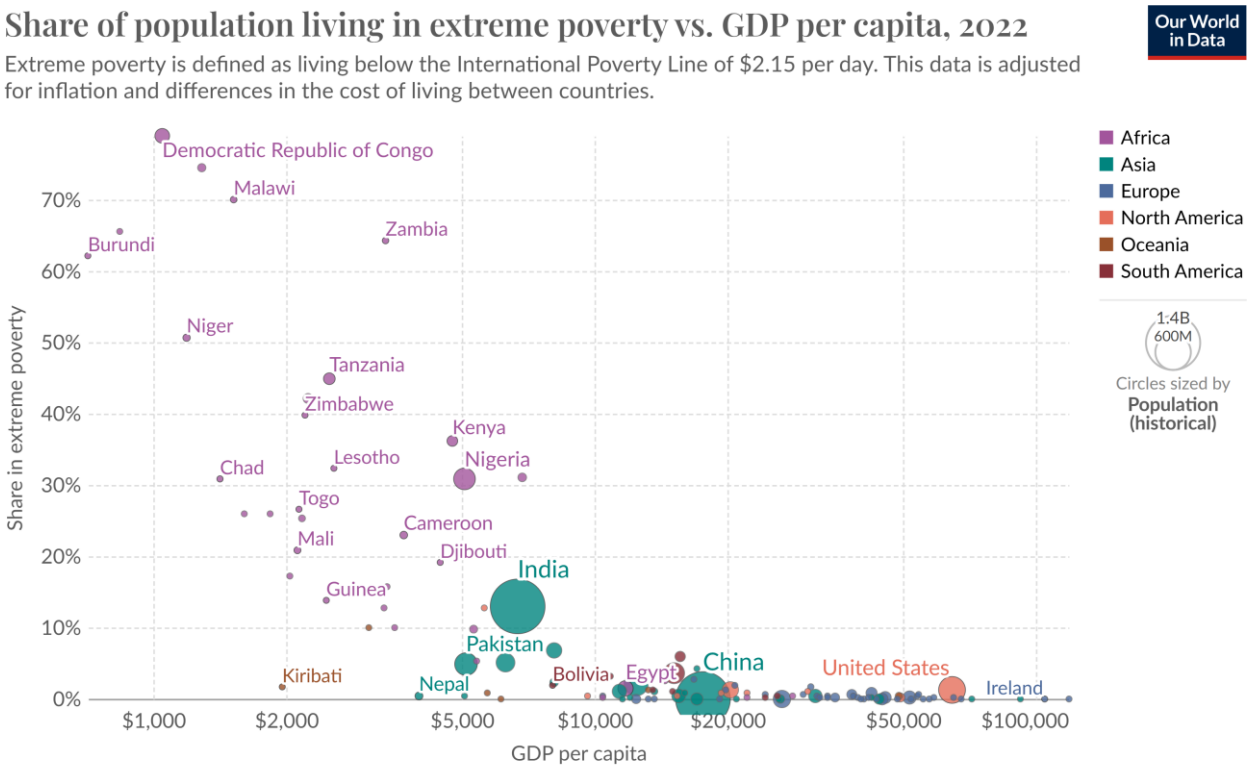




All data refers to 2015-17. The World Development Indicators are the source for all metrics except life satisfaction (Gallup World Poll) and learning outcomes (Altinok, Angrist and Patrinos – 2018)
This is a visualization from OurWorldinData.org, where you find data and research on how the world is changing.

Why do we care about income per capita?

Income per capita and poverty



Data source: World Bank Poverty and Inequality Platform (2024); World Bank (2023) OurWorldinData.org/poverty | CC BY

Note: This data is expressed in international-$[1] at 2017 prices. Depending on the country and year, poverty data relates to income measured after taxes and benefits or consumption per capita[2].

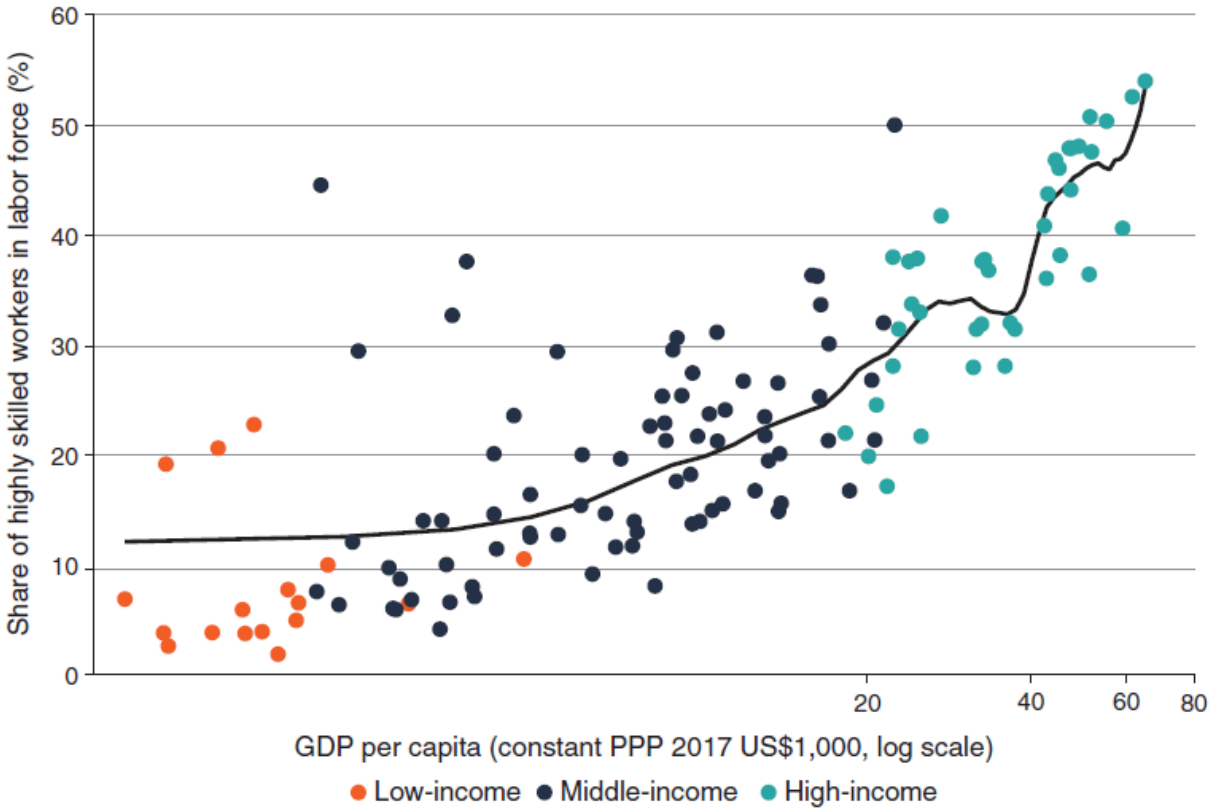
1. International dollars: International dollars are a hypothetical currency that is used to make meaningful comparisons of monetary indicators of living standards. Figures expressed in international dollars are adjusted for inflation within countries over time, and for differences in the cost of living between countries. The goal of such adjustments is to provide a unit whose purchasing power is held fixed over time and across countries, such that one international dollar can buy the same quantity and quality of goods and services no matter where or when it is spent. Read more in our article: What are Purchasing Power Parity adjustments and why do we need them?

2. Per capita: 'Per capita' here means that each person (including children) is attributed an equal share of the total income received by all members of their household.

Why do we care about income per capita?

Income per capita and employment opportunities

Figure 2.3 The demand for highly skilled workers increases in middle-income countries



Source: WDR 2024 team using DataBank: Jobs, World Bank, Washington, DC, https://databank.worldbank.org/source/jobs; WDI (World Development Indicators) (Data Catalog), World Bank, Washington, DC, https://datacatalog.worldbank.org/search/dataset/0037712.

Note: Skilled workers consist of the top three International Standard Classification of Occupations (ISCO) codes ("Legislators, sr. officials, managers"; "Professionals"; "Technicians and associate professionals"). See ISCO (International Standard Classification of Occupations), International Labour Organization, Geneva, https://ilostat.ilo.org/methods/concepts-and-definitions/classification-occupation/. GDP = gross domestic product; PPP = purchasing power parity.

Inequality within countries

Measuring inequality:

Comparing measures

Measure	How It's Measured	Data Needed	Pros	Cons
Gini Coefficient	Index between 0 (perfect equality) and 1 (maximum inequality); based on Lorenz curve.	Full income distribution of entire population.	• Captures entire income distribution • Standardized and widely used.	• Hard to interpret intuitively. • Insensitive to changes at the extremes.
Top 1% Income Share  World Inequality Lab **Top 10% Income Share**	Share of total income earned by the top 1% of earners. Share of total income earned by the top 10% of earners.	Detailed high-end income data (often tax data). Income data, ideally detailed tax records.	• Highlights concentration of income at the top. • Simple to communicate. • Shows broader elite group than top 1%. • Easy to compare over time or across countries.	• Ignores rest of distribution. • Sensitive to top coding and tax evasion. • Still ignores bottom 90%. • Less sensitive to extreme wealth concentration.

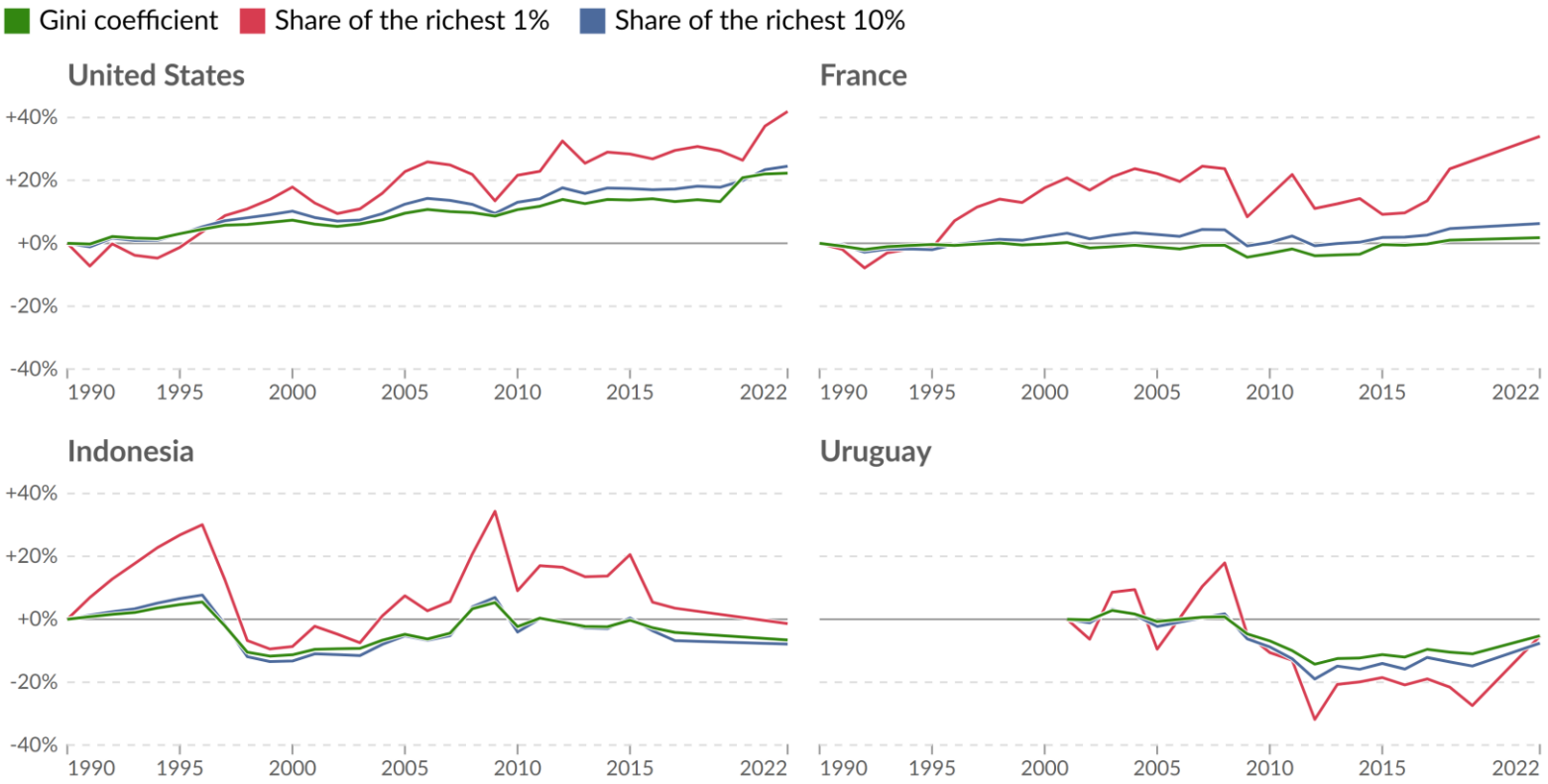
Measuring inequality:

Comparing measures

Proportional change in three inequality metrics

Our World in Data

The percentage change relative to initial levels (in 1990, or 2001 for Uruguay). For example, a change in Gini from 0.4 to 0.5 would be shown as +25%. The measures relate to inequality of incomes before taxes and benefits.



Data source: World Inequality Database (WID.world) (2024)

OurWorldinData.org/economic-inequality | CC BY

Note: Income is measured before payment of taxes and non-pension benefits, but after the payment of public and private pensions.

Income inequality in Europe

The DINA database

Blanchet et al. (2022)
Why is Europe More Equal than the United States?

- ***Survey data*** *on pre and post-tax incomes per household*
- *Data checks using machine learning tools*
- ***Tax data*** *to calibrate the survey data*
- *Linking to* ***consumption and capital surveys*** *to complement incomes*

Methodological Step	Detailed Steps	Sources and Coverage
Step 1: Direct Measurement of Income Concepts in Survey Microdata.	Construction of pretax and posttax income variables.	EU-SILC (2004–2017); LIS (1980–2017); ECHP (1994–2001)
	Imputation of social contributions.	Employee contributions (OECD, 2004–2017); Employer contributions (OECD, 2004–2005, EU-SILC, 2006–2017)
Step 2: Harmonization of Survey Tabulations.	Collection and interpolation of survey tabulations, and harmonization using a machine learning algorithm.	World Income Inequality Database, PovcalNet, other survey data sources (1980–2017).
Step 3: Combination of Surveys and Tax Data.	Calibration of survey microdata using top income shares series estimated from tax data.	World Inequality Database, various research articles, authors (1980-2017).
	Application of the correction to all survey distributions.	
Step 4: Distribution of Unreported National Income Components.	Estimation and calibration of consumption, imputed rents, and stock ownership.	HFCS/WAS surveys for stock ownership; HBS for consumption; EU-SILC for imputed rents.
	Missing incomes matched statistically to calibrated survey distributions.	

Income inequality in Europe

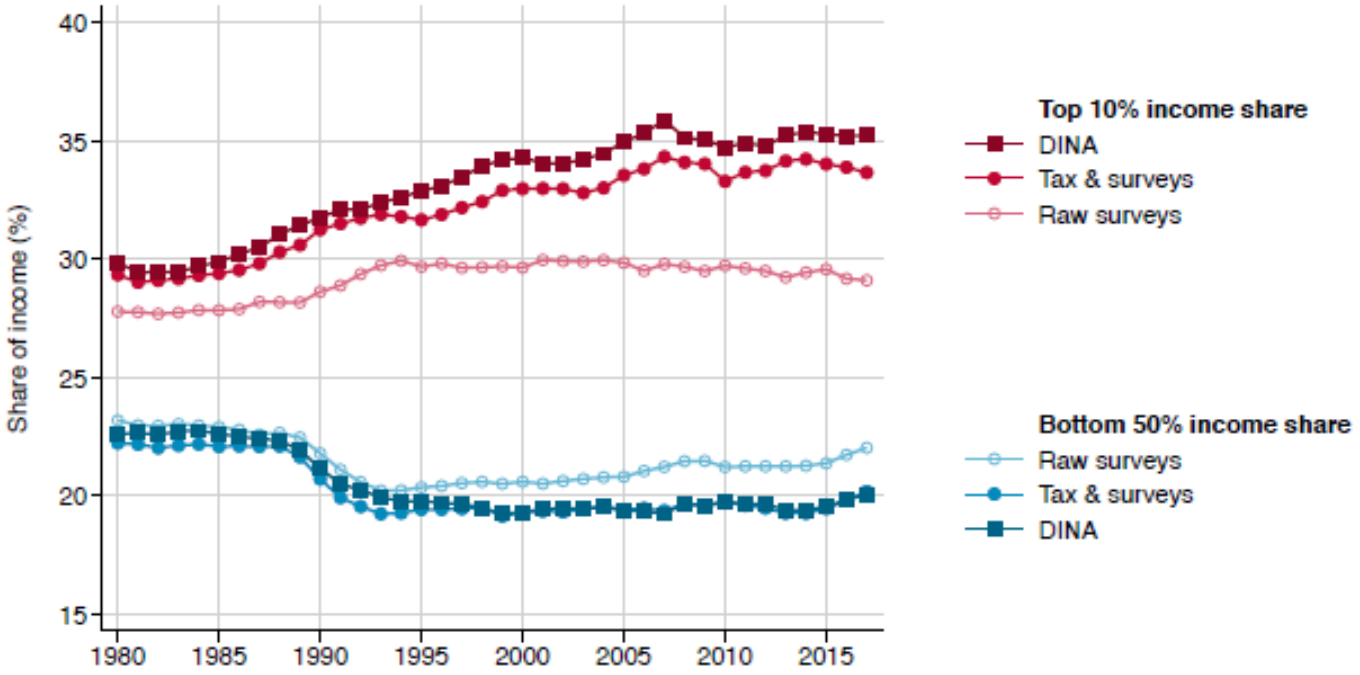
The DINA database

Blanchet et al. (2022)

Figure I

Measuring Inequality: From Surveys to Distributional National Accounts

(a) Pretax Income Inequality in All 26 European Countries, 1980–2017



Source: Authors' computations combining surveys, tax data and national accounts. *Note*: Incomes measured at purchasing power parity. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses, except for the "raw survey income" series in panel (b), for which income is split equally among all adult household members. Posttax DINA series distribute taxes on products proportionally to income for consistency with Bozio et al. (2018), see appendix 3 for other approaches that follow the latest DINA guidelines.

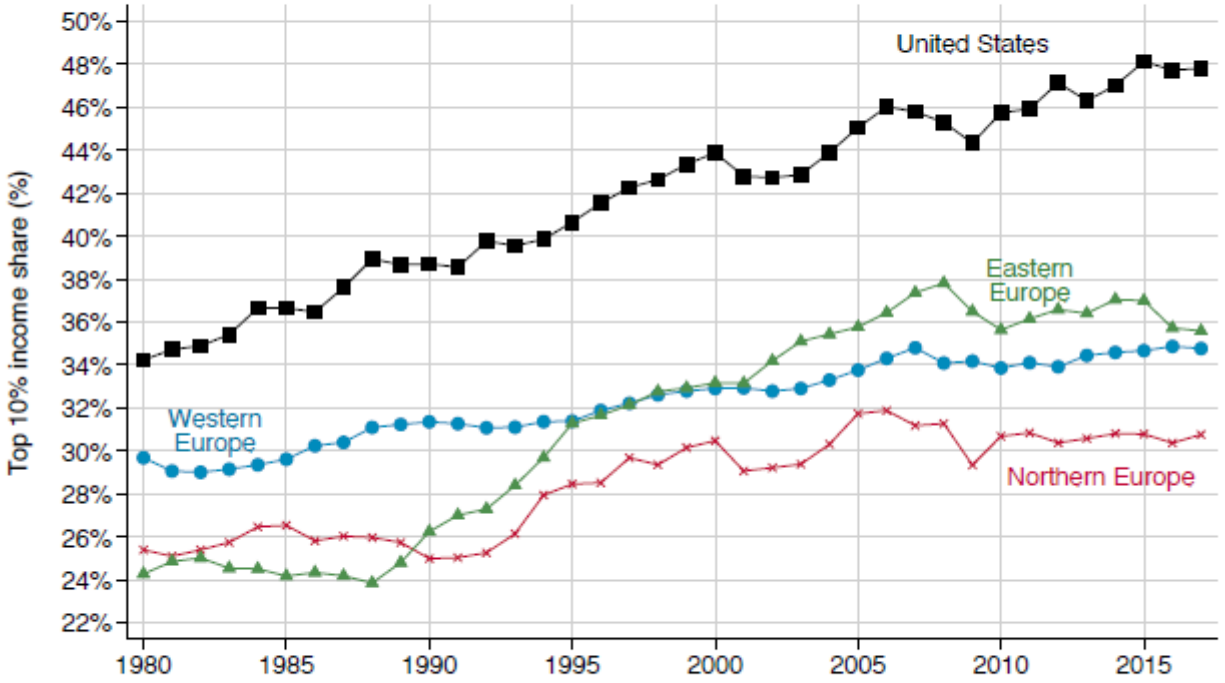
Income inequality in Europe

vs the US

Blanchet et al. (2022)

Figure II
The Rise of Top Incomes in Europe and the United States, 1980-2017

(a) Top 10% Pretax Income Share, 1980-2017



Source: Authors' computations combining surveys, tax data and national accounts. *Notes:* Panel (a) represents the evolution of the share of pretax income received by the top 10% in Western Europe, Northern Europe, Eastern Europe, and the United States. Panel (b) plots the percentage point change in the top 10% pretax income share by country between 1980 and 2017. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

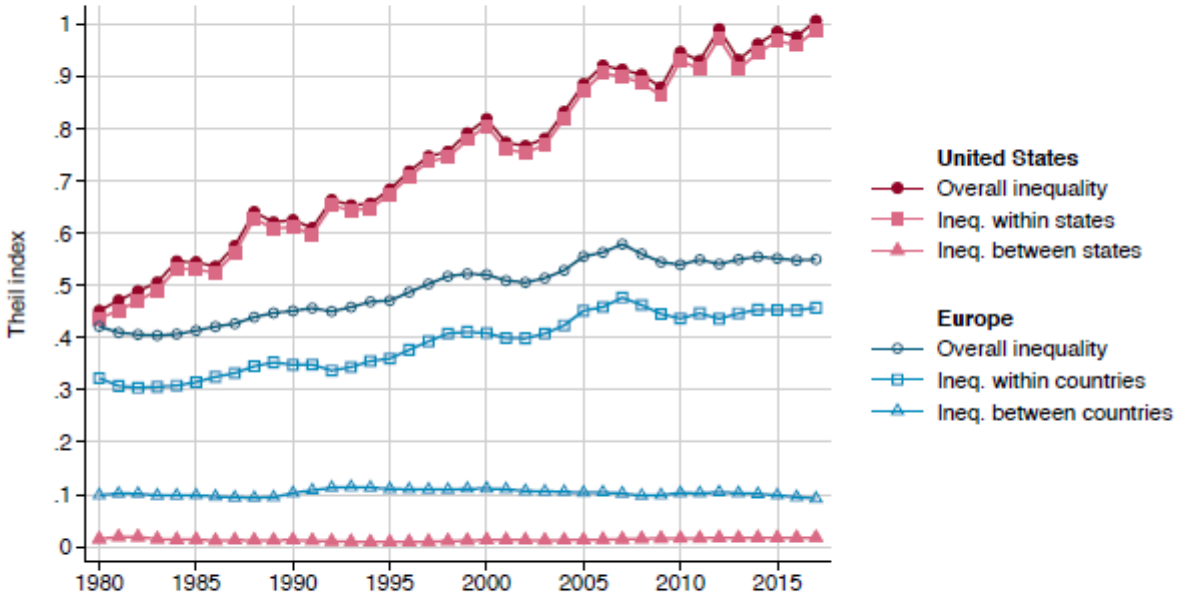
Income inequality in Europe

vs the US

Blanchet et al. (2022)

Figure IV

Pretax Income Inequality in Europe and the United States, 1980-2017: Theil Decomposition



Source: Authors' computations combining surveys, tax data and national accounts for European countries. Figures for the US come from Piketty, Saez, and Zucman (2018) for the overall Theil index, and from state GDP estimates of the Bureau of Economic Analysis for the US between-group component. *Notes:* Figures for Europe correspond to Europe at large, that is, after accounting for differences in average national incomes between European countries, measured at market exchange rates. The income concept is pretax income. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses.

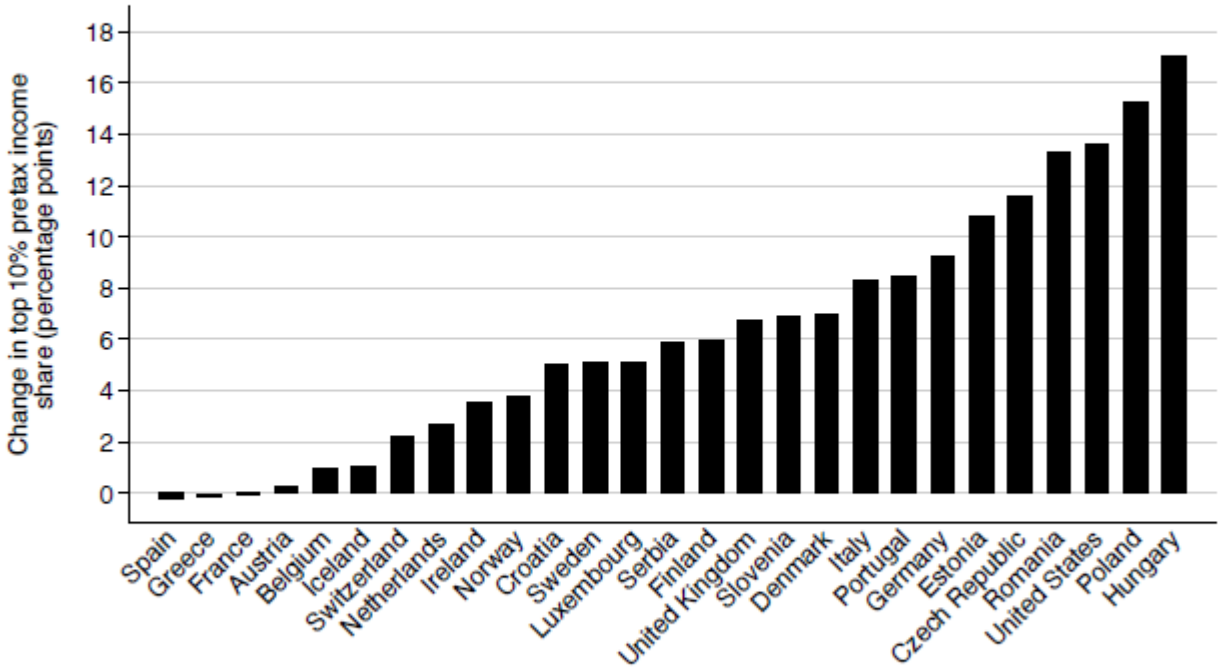
Income inequality in Europe

Across countries

Blanchet et al. (2022)

Figure II
The Rise of Top Incomes in Europe and the United States, 1980-2017

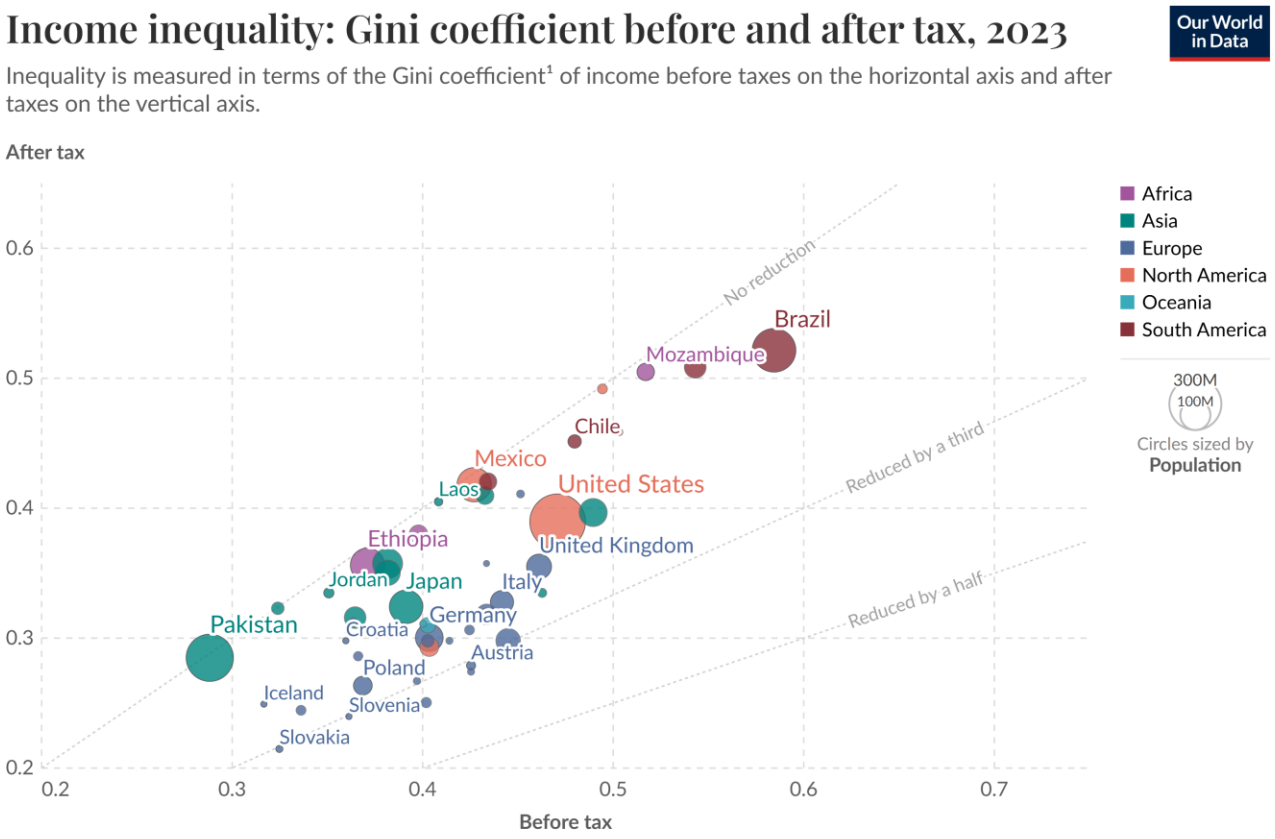
(b) Percentage Point Change in Top 10% Pretax Income Share by Country, 1980-2017



Source: Authors' computations combining surveys, tax data and national accounts. *Notes:* Panel (a) represents the evolution of the share of pretax income received by the top 10% in Western Europe, Northern Europe, Eastern Europe, and the United States. Panel (b) plots the percentage point change in the top 10% pretax income share by country between 1980 and 2017. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

The role of policy:

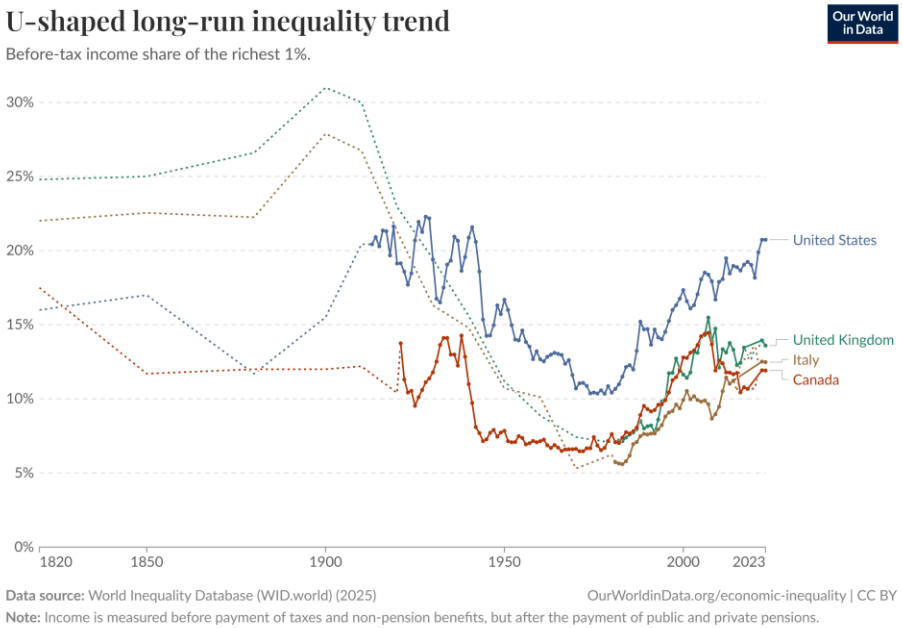
pre vs post tax inequality

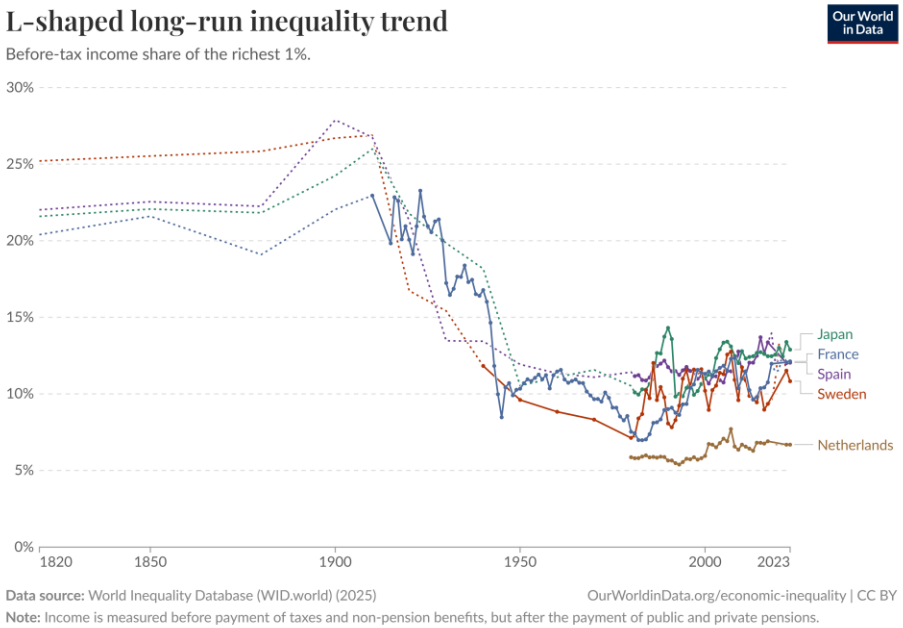


1. Gini coefficient The Gini coefficient is the most commonly used measure of inequality.
It is typically used as a measure of income inequality, but it can be used to measure the inequality of any distribution – such as the distribution of wealth, or even life expectancy.
It measures inequality on a scale from 0 to 1, where higher values indicate higher inequality. This can sometimes be shown as a percentage from 0 to 100%, this is then called the 'Gini Index'.
A value of 0 indicates perfect equality – where everyone has the same income. A value of 1 indicates perfect inequality – where one person receives all the income, and everyone else receives nothing.
Read more in our article: Measuring inequality: What is the Gini coefficient?

The role of policy:

U-shaped vs L-shaped trends





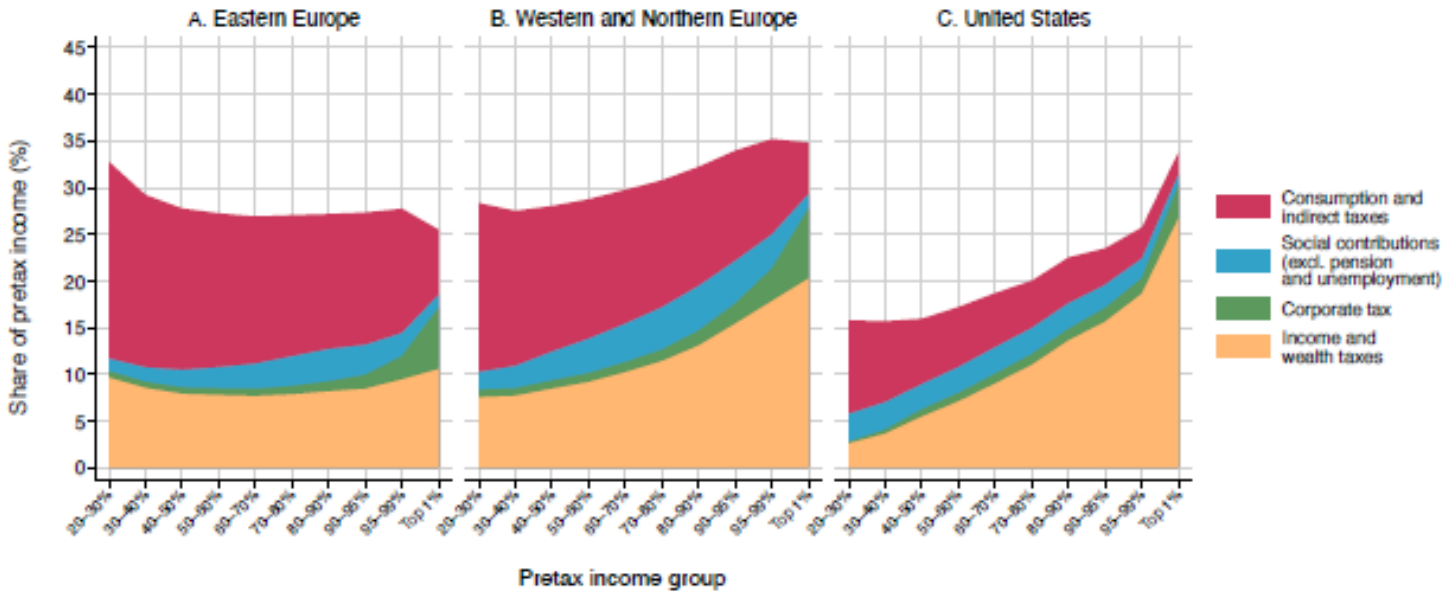
The role of policy

Europe vs the US

Blanchet et al. (2022)

Figure V
The Distribution of Taxes in Europe and the United States

(a) Non-contributory Taxes Paid as a Share of Pretax Income



Source: Authors' computations combining surveys, tax data and national accounts for European countries; Piketty, Saez, and Zucman (2018) for the United States. *Notes:* Figures correspond to averages over the 2007–2017 period for European countries (population-weighted average of country-specific estimates in the case of European regions), and to 2017–2018 for the US. In panel (b), the composition of bars corresponds to the composition of taxes paid by the top 10%. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

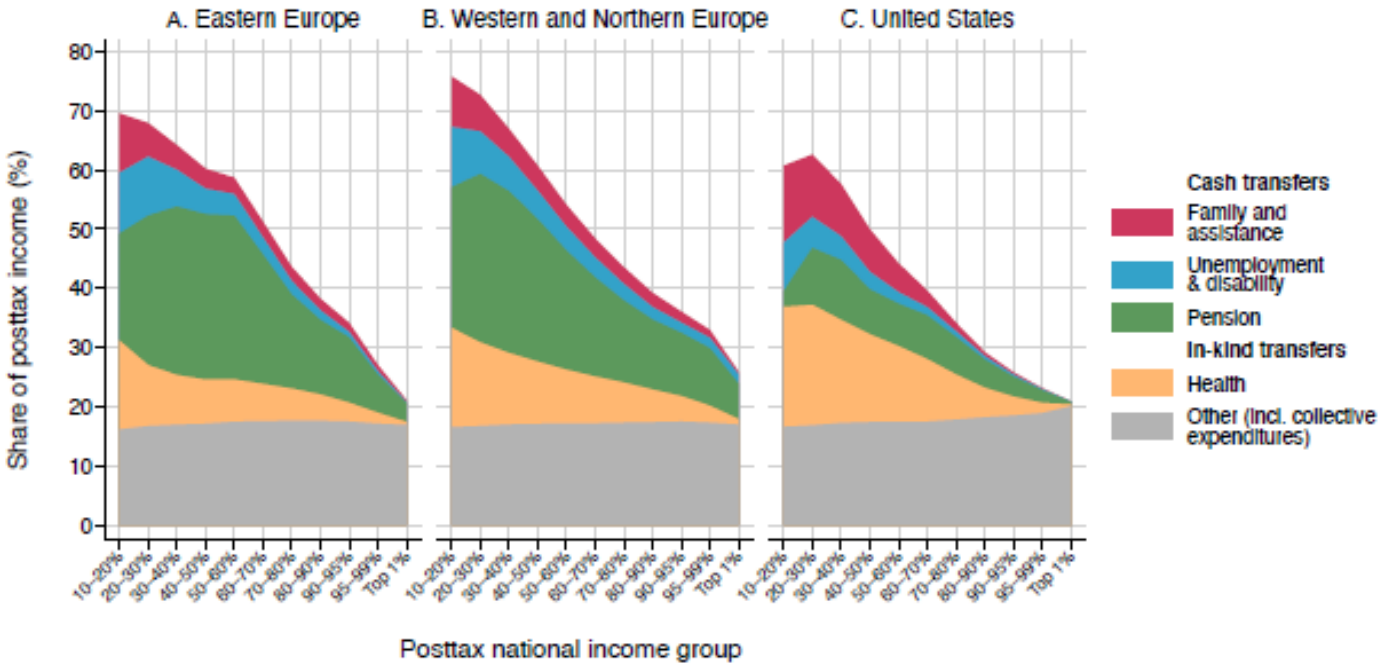
The role of policy

Europe vs the US

Blanchet et al. (2022)

Figure VI
The Distribution of Transfers in Europe and the United States

(a) Total Transfers Received by Posttax Income Group (% of posttax income)



Source: Authors' computations combining surveys, tax data and national accounts for European countries; Saez and Zucman (2019) for the US. *Notes:* Figures correspond to averages over the period 2007–2017 for European countries (population-weighted average of country-specific estimates in the case of European regions), and to 2017–2018 for the US. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

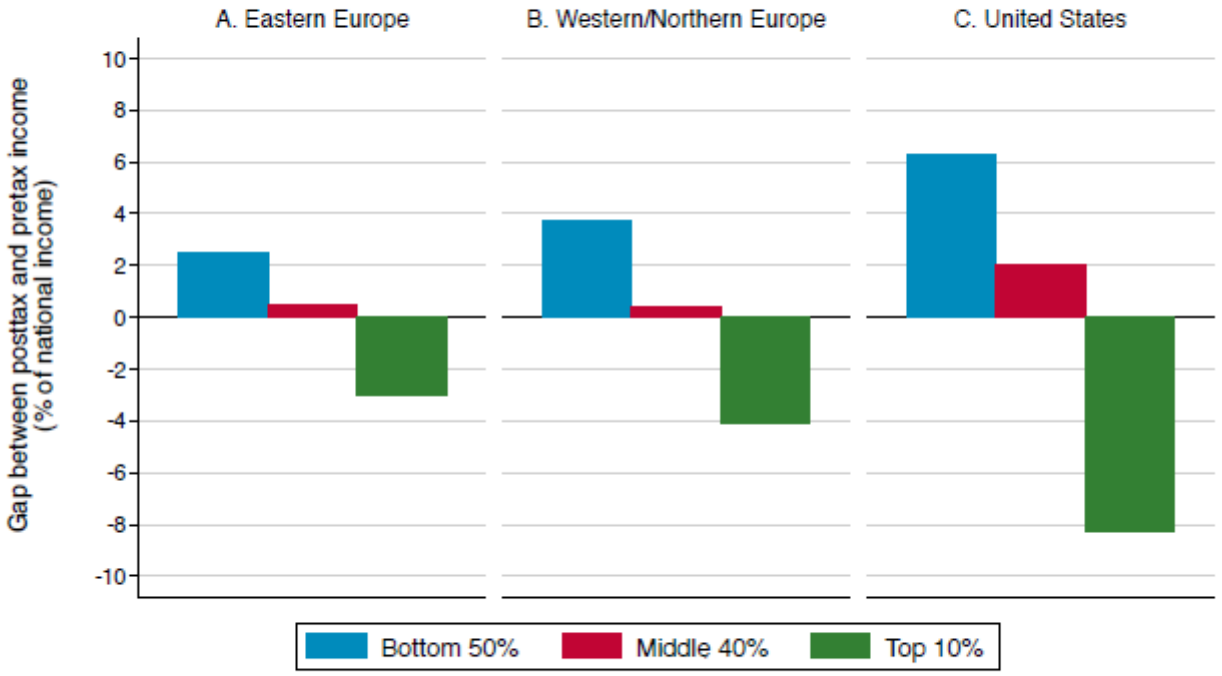
The role of policy

Europe vs the US

Blanchet et al. (2022)

Figure VII
Net Redistribution in Europe and the United States

(a) Net Transfers Operated by the Tax-and-Transfer System Between Pretax Income Groups (% of National Income)



Source: Authors' computations combining surveys, tax data and national accounts for European countries; Piketty, Saez, and Zucman, 2018 for the US. *Notes:* Panel (a) represents the net transfer received or paid by pretax income group in Eastern Europe, Western and Northern Europe, and the United States in 2017. Panel (b) represents the net transfer received by the bottom 50% by country, expressed as a share of national income, in 2017. The unit of observation is the adult individual aged 20. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

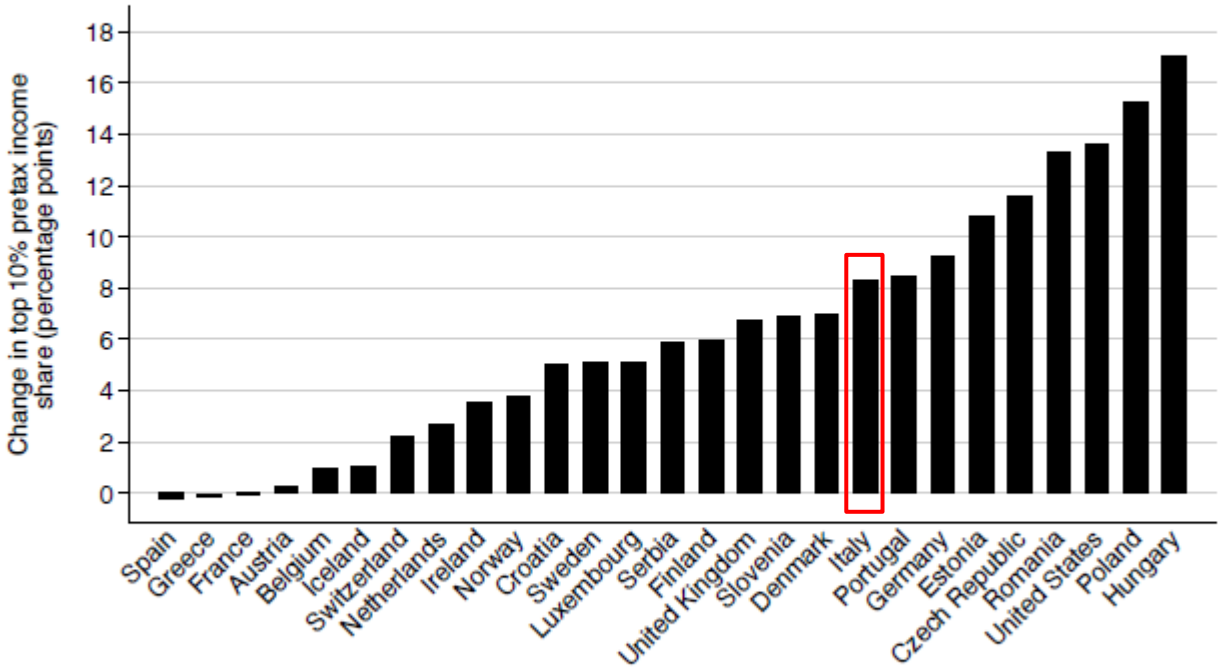
Income inequality in Europe

Italy

Blanchet et al. (2022)

Figure II
The Rise of Top Incomes in Europe and the United States, 1980-2017

(b) Percentage Point Change in Top 10% Pretax Income Share by Country, 1980-2017



Source: Authors' computations combining surveys, tax data and national accounts. *Notes:* Panel (a) represents the evolution of the share of pretax income received by the top 10% in Western Europe, Northern Europe, Eastern Europe, and the United States. Panel (b) plots the percentage point change in the top 10% pretax income share by country between 1980 and 2017. The unit of observation is the adult individual aged 20 or above. Income is split equally among spouses. See online appendix table A.2.7.1 for the composition of European regions.

Income inequality in Europe

Italy

Guzzardi et al. (2024)

Reconstructing Income Inequality in Italy

Sources of income

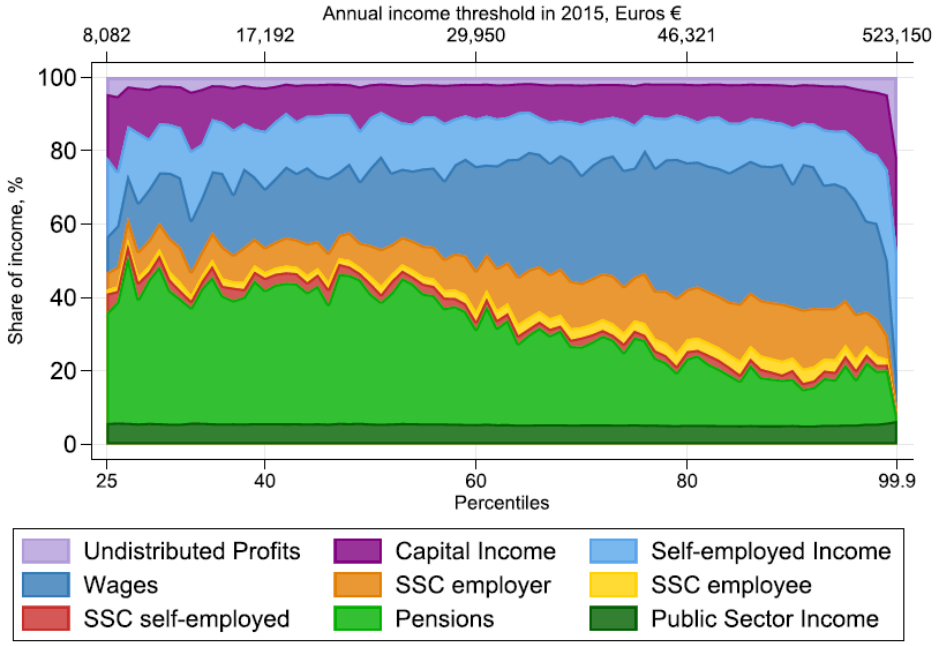


FIGURE 9. Pre-tax National Income composition including Social Security Contributions, 2015. Capital income is composed of the sum of actual and imputed rents and financial income.

Tax profiles

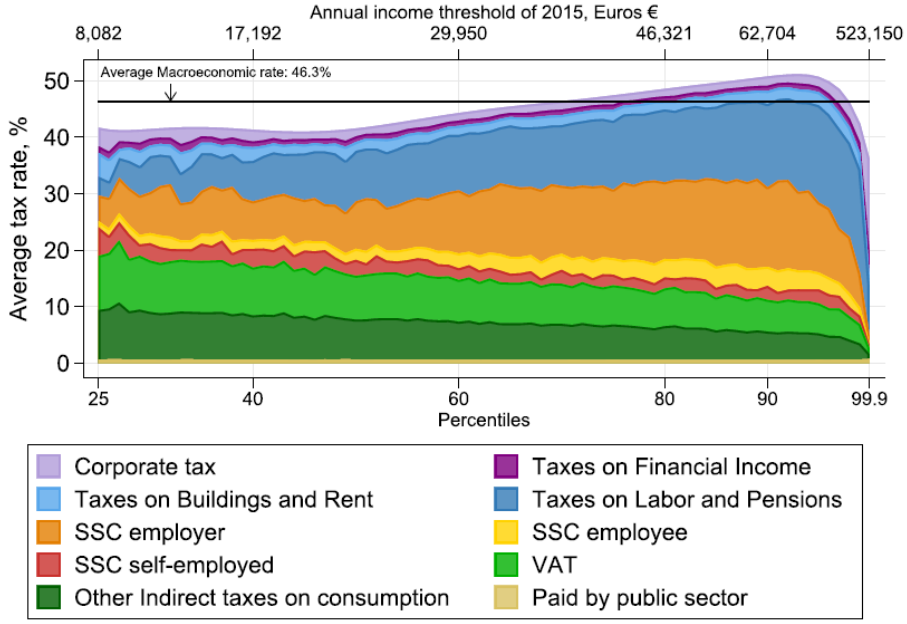


FIGURE 11. Tax rate by income percentiles, 2015. In this figure, income is defined as the sum of pre-tax national income and social security contributions. The reported macro-economic tax rate is equal to about 46.3% of the SSCs-adjusted national income, where SSCs are included in both numerator and denominator. This tax-rate is lower then the usual rate reported from official international institutions (see e.g. OECD, World Bank, and Eurostat), where the denominator is the GDP, rather then the national income, and social security contributions are included only in the numerator as a source of taxation. Please note also that "Taxes on Labor and Pensions" do not include the capital component of the Personal Income Tax.

What are the sources of wage inequality?

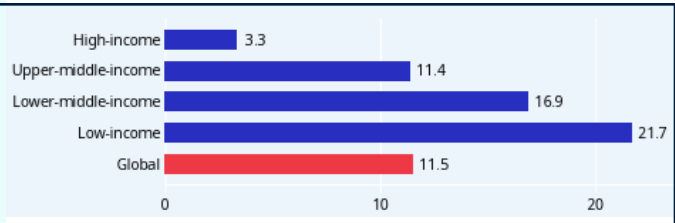
Wage inequality

Measurement

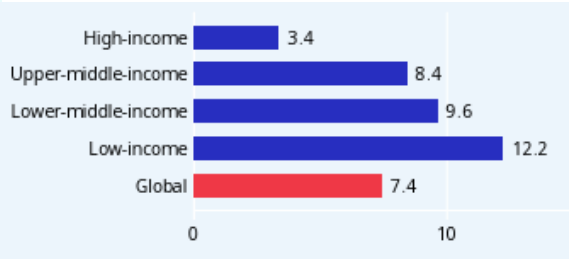
ILO (2024) *Global Wages report*

Box 5.1. Measures of inequality

Low-paid wage workers are defined as those whose hourly wage falls below 50 per cent of the median hourly wage in a given country. In most national surveys, hours are declared on a weekly basis – except for a few countries that provide monthly hours worked. Therefore, for this report, the number of monthly hours worked is approximated by multiplying the total number of hours worked per week, as declared by the employee in the survey, by 52 weeks and then dividing by 12 months.



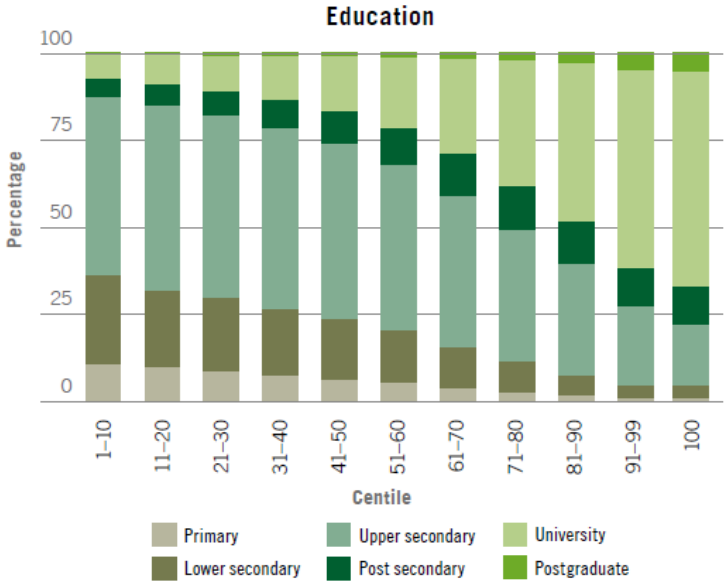
The D9/D1 D8/D2, D9/D5, D5/D1 inequality measures are calculated taking the ratios between the threshold values that mark the upper end of the corresponding deciles (a decile corresponds to 10 per cent of the distribution). For example, to determine the D9/D1 ratio, workers' wages are first ranked from lowest to highest using the hourly wage. The values of the hourly wage identified at the upper end of the **first decile** (**D1**, at the 10 per cent mark in the distribution) and the upper end of the **ninth decile** (**D9**, at the 90 per cent mark in the distribution) correspond to the values of D1 and D9, respectively. The D9/D1 ratio therefore measures how many times higher the hourly wage is at the top of the ninth decile relative to the top of the first decile. The D8/D2, D9/D5 and D5/D1 ratios are constructed and interpreted similarly, with D8, D2 and D5 representing the upper ends of the eighth, second and fifth deciles of the hourly wage distribution, respectively.

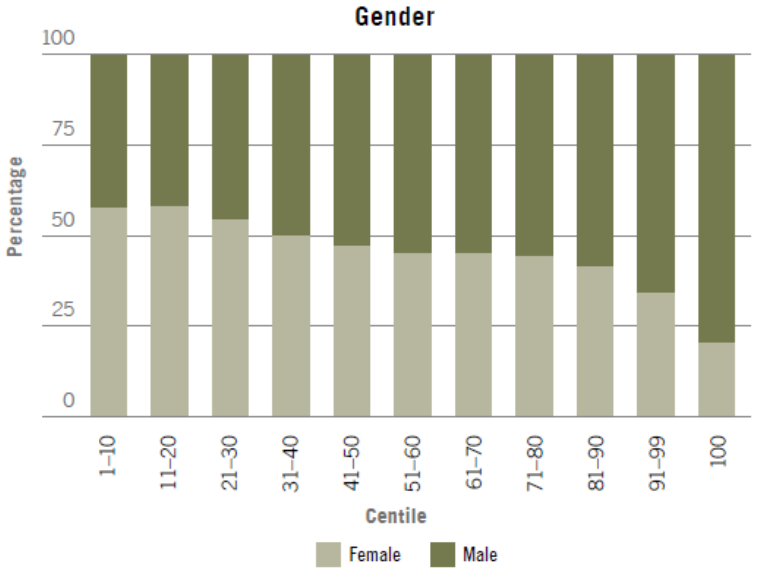


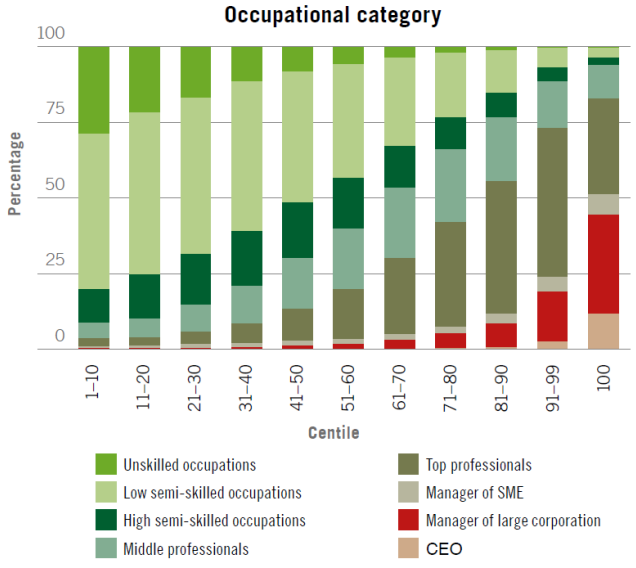
What are the sources of wage inequality?

Worker characteristics

ILO (2016)
Global Wages report







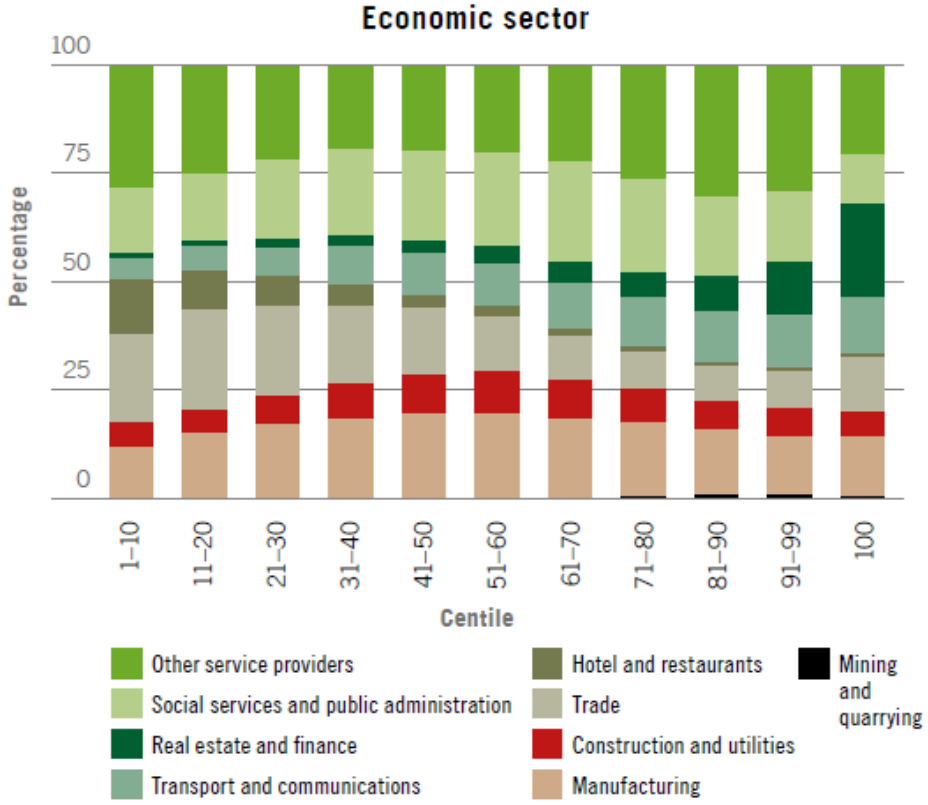
Maastricht University

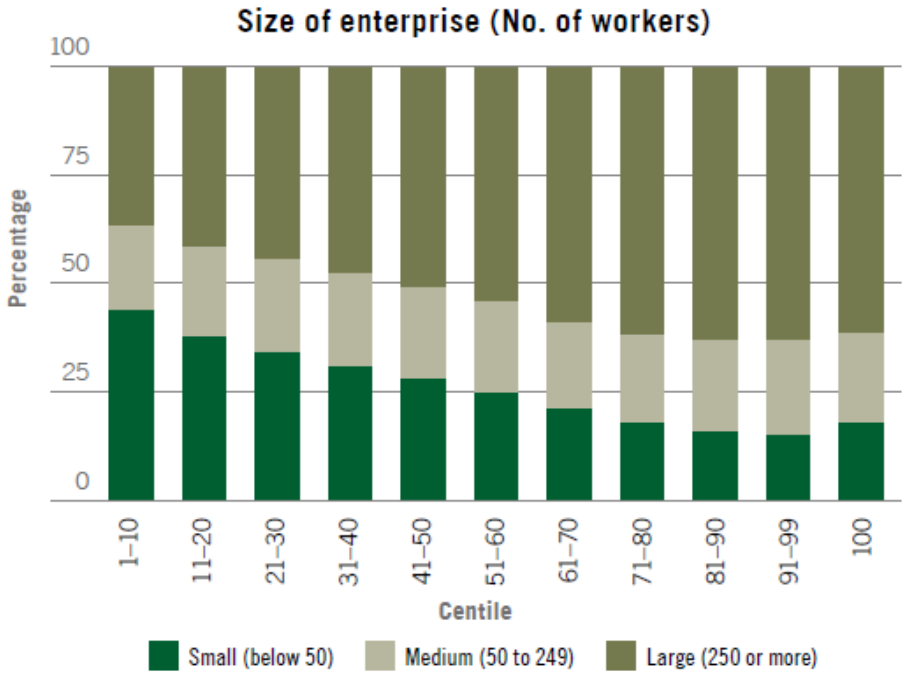
What are the sources of wage inequality?

Firm characteristics

ILO (2016)

Global Wages report

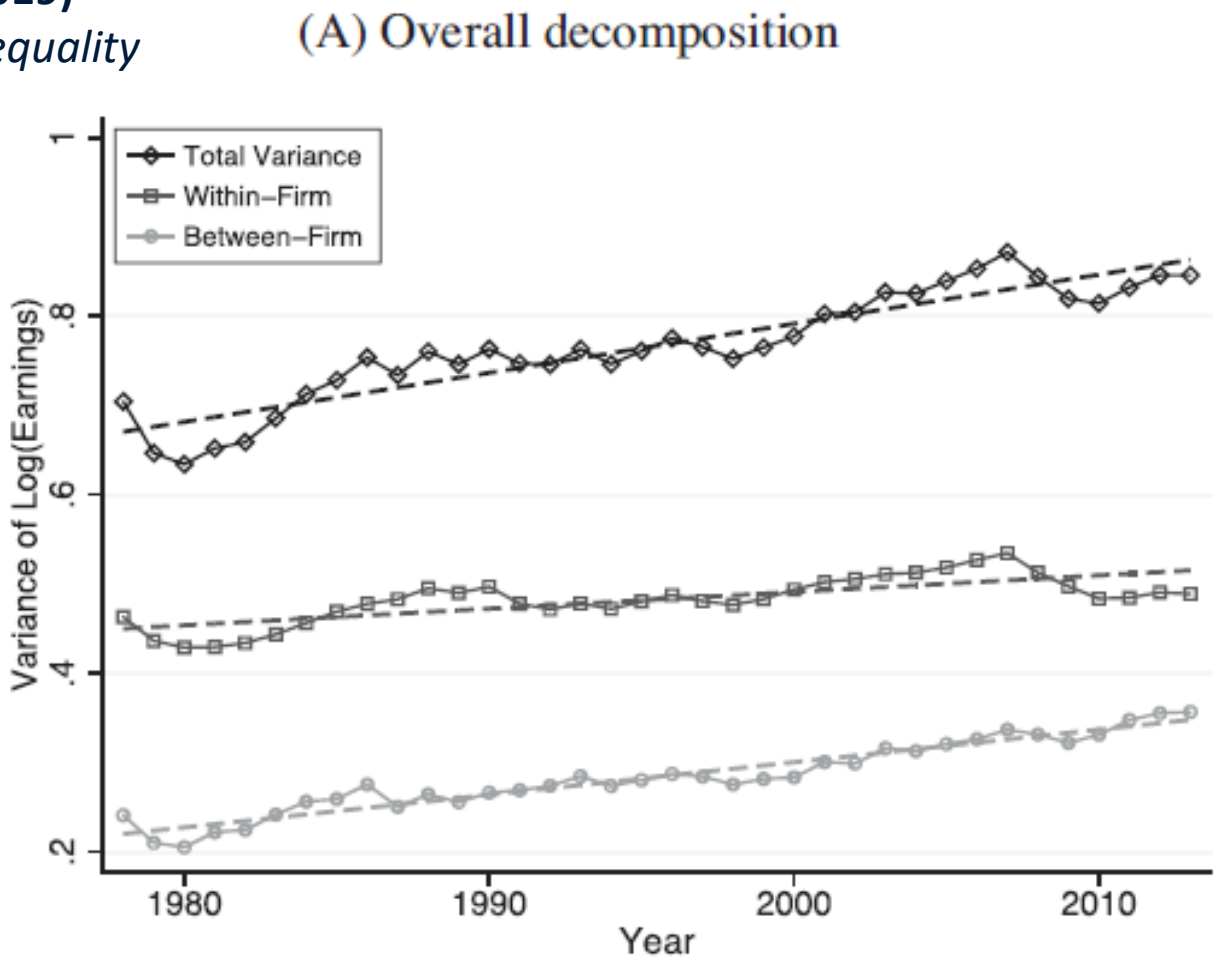




What are the sources of wage inequality?

Between vs within firms

Song et al. (2019)
Firming up inequality



Outline

Income inequality between countries

Income inequality within countries

Income inequality and the digital transition

Income inequality and the green transition

The role of technology

Automation and the future of work

How does innovation affect employment ?

- Technology is presented in the policy debate either as the main driver of societal change or as a major threat to employment
- Technological unemployment is an old debate (Marx, Keynes, Ricardo...)

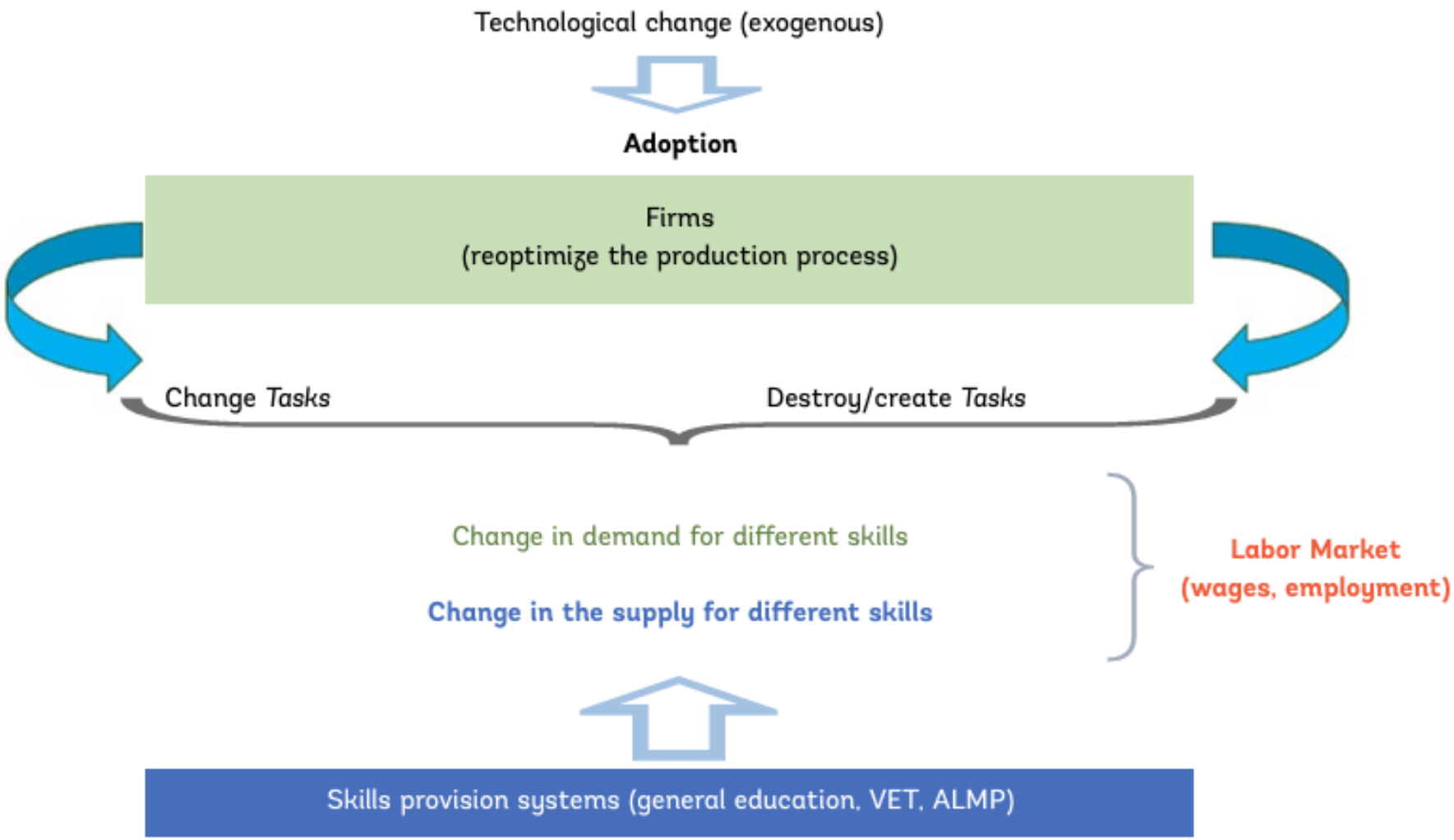
New challenges in the digital era:

- The type of jobs affected is much more diffused and difficult to identify (routine-intensive rather than manual; cf. Autor, 2015; Autor et al., 2003; Frey and Osborne, 2017; Furman and Seamans, 2018; Goos et al., 2014; Trajtenberg, 2018)
- The type of firms and sectors impacted is also much larger (general rethinking of production processes; cf. Caliendo and Rossi-Hansberg, 2012)

The role of technology

Dalvit et al. (2023) *The Future of Work – Implications for equity and growth in Europe*

FIGURE O.1. Conceptual linkages between technology, firms, and labor markets



Labour market effects of automation/AI
Conceptual framework

Acemoglu and Restrepo (2019) *Automation and new tasks: How technology displaces and reinstates labor*

- **Displacement effect (Automation replaces human tasks)**
  - labor share and overall wages decrease
  - change in relative labor demand >> some workers are more demanded and wage inequality increases

- **Productivity and scale effects (Automation makes labor and capital more productive)**
  - The firm grows and wages increase (rent sharing)
  - Heterogeneous productivity effects >> wage inequality increases
  - Automation requires the creation of new (human) tasks

Labour market effects of automation/AI
Empirical evidence

Effects on employment

- *Aggregate studies fail to find a consensus*

(Acemoglu et al., 2020; Acemoglu and Restrepo, 2017; Dauth et al., 2018; Graetz and Michaels, 2018; Klenert et al., 2020)

- *Firm-level studies* consistently show increase in employment of adopters of automation/robots

(Acemoglu et al., 2020; Aghion et al., 2020; Bessen et al., 2020; Bonfiglioli et al., 2020; Koch et al., 2019)

Effect on wage (inequality)

- *Employee level*: After an automation cost spike, incumbent workers experience wage income loss (Bessen et al., 2019, NL)

- *Firm level*: Robots increase wages for high-skilled/tech workers wrt production workers and thus within-firm inequality (Barth et al. 2020, NO.; Humlum 2020, DK)

Labour market effects of automation/AI

A study of French firms

Domini et al. (2022) *The firm-level effects of automation on wage and gender inequality*

What is the effect of automation/AI investments on employment and wage inequality within firms?

What are the mechanisms?

1. **Measuring automation/AI**
2. **Labor market effects of automation/AI**
3. **Automation and export performance**

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022) *The firm-level effects of automation on wage and gender inequality*

Datasets

- DADS *Postes*: employer-employee database (social security forms) covering all French firms *with employees*
  - worker-level information on gross yearly remuneration, hours worked, age, gender, occupation, etc.
  - we exclude primary sector (NACE 01-09), household employers, and public administration
- DGDDI: customs database
  - transaction-level information on value, product sector, etc.
- FICUS/FARE: balance-sheet and revenue-account data

Main variables:

- Within-firm measures of employment and (hourly) wage inequality: p90/p10 and SD (based on worker-level wage = yearly remuneration / hours)
- Firm-level events (spikes) of investment in automation and/or AI (based on imports of relevant technologies)

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

Identifying automation/AI adoption

We use imports of capital goods embedding automation/AI technologies

Why? Lack of systematic firm-level info on adoption of automation/AI technologies

- Done by several studies (Acemoglu et al., 2020; Aghion et al., 2020; Bonfiglioli et al., 2020; Dixon et al., 2019; Domini et al., 2021)
- Exceptions: survey data (Bessen et al., 2019; Dinlersoz et al., 2018)
- We are aware of the limitations, discuss them, and address them with robustness checks

How? Identified via product codes ▸ appendix

- We build on a taxonomy by Acemoglu and Restrepo (2018)

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

Characterising automation/AI adoption

Imports of such goods display the typical **spiky behavior** of investment (Asphjell et al., 2014; Grazzi et al., 2016):

- They are *rare across firms*
  In a given year, only around 14% of importing firms import automation/AI-related products
  Over 2002-2017, less than half of them do it

- They are *rare within firms*
  Among firms that do import such goods, close to 30% do it only once
  The frequency decreases smoothly with higher values

- A firm's largest event of import of such goods (in a year) accounts for a *very large share* (around 70%) of its total across years ▸ appendix

Automation/AI investment spike = a firm's largest adoption event

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

Regression approach:

event study within adopters of automation/AI (Bessen et al., 2020)

- Accounts for spiky behavior
- Accounts for selection into automation/AI: only firms importing at least once automation/AI with ≥ 10 emp)
  $\rightarrow$ exploits heterogeneity in timing of the event among relatively similar firms

$$y_{ijt} = \sum_{k \neq -1; k_{min}}^{k_{max}} \beta_k D_{kit} + \delta_i + \zeta_{jt} + \varepsilon_{it}$$

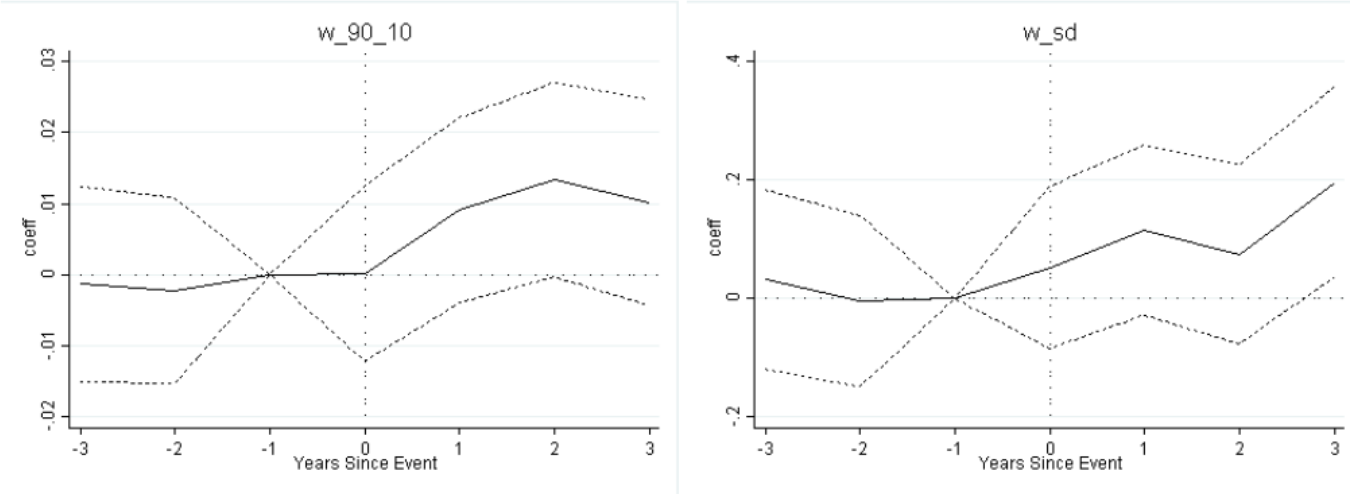
y_{ijt} is the dependent variable of interest for firm i at time t in sector j; D_{kit} is a dummy $= 1$ if index$=$ k for firm i in year t

Centered at $t-1$, so the coefficient on $t=0$ measures what happens in the year of the spike, with respect to the previous year

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

Results: Wage inequality (p90/p10 and SD)



Solid line: coefficients β_{-3} to β_3. Blue lines: conf. intervals at 5%

No effect on within firm wage inequality…

Labour market effects of automation/AI
A study of French firms

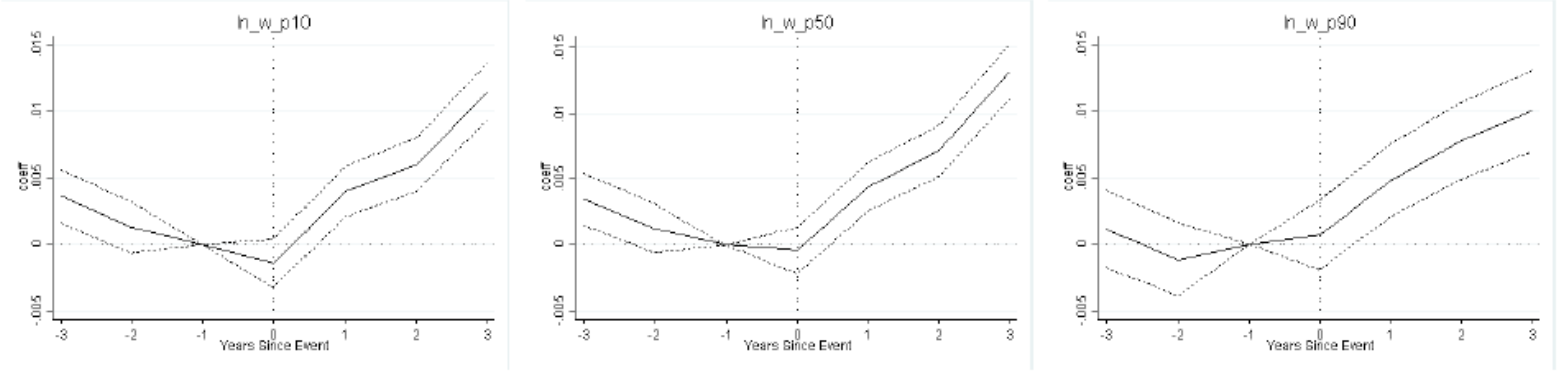
Domini et al. (2022)

- *Are automation/AI and wage disconnected?*
- *Is the wage change evenly distributed within adopting firms?*

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

- *Are automation/AI and wage disconnected?*
- *Is the wage change evenly distributed within adopting firms?*



Solid line: coefficients β_{-3} to β_3. Blue lines: conf. intervals at 5% ; Wage is in log so coefficients are read as percentage change

- 3 years after the spike, mean wage increases of around 1% at different points of the distribution

Labour market effects of automation/AI
A study of French firms

Domini et al. (2022)

Mechanism: employee matching channel (AKM)

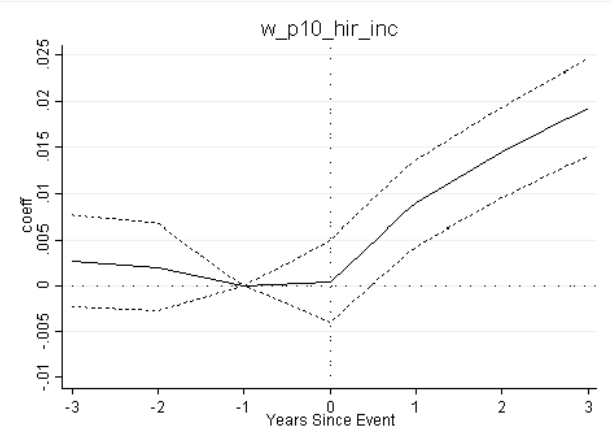
- *Is the profile of new hired workers changing in relation to the adoption of automation/AI?*

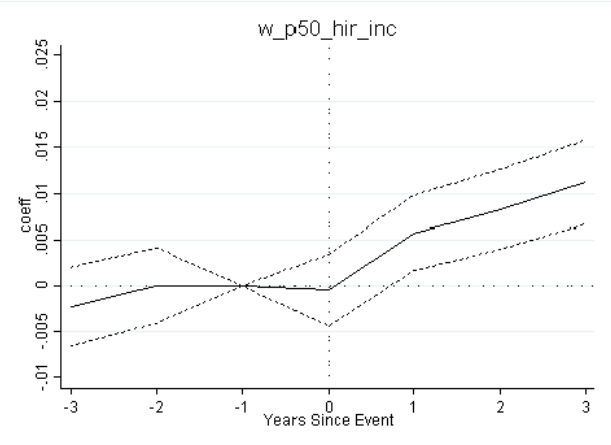
Labour market effects of automation/AI
A study of French firms

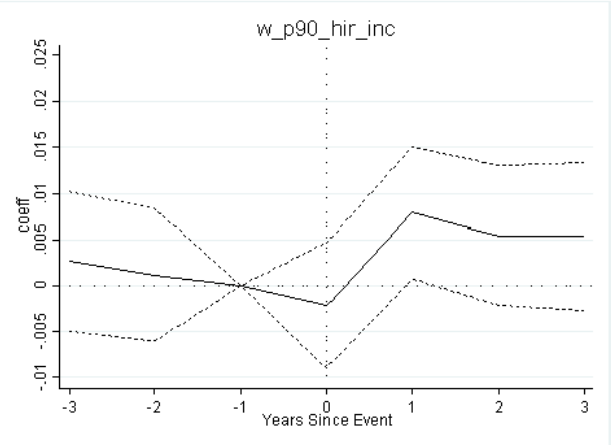
Domini et al. (2022)

Mechanism: employee matching channel (AKM)

- *Is the profile of new hired workers changing in relation to the adoption of automation/AI?*







- After 3 years, at the 10th percentile, firms tend to pay an hourly wage to new workers that is around one percentage point higher w.r.t. one year before the spike
- Similar trend at the 50th, no significant effect at the 90th percentile
- **Explanation?**: matching + wage rigidity among incumbents

Outline

Income inequality between and within countries

Income inequality within countries

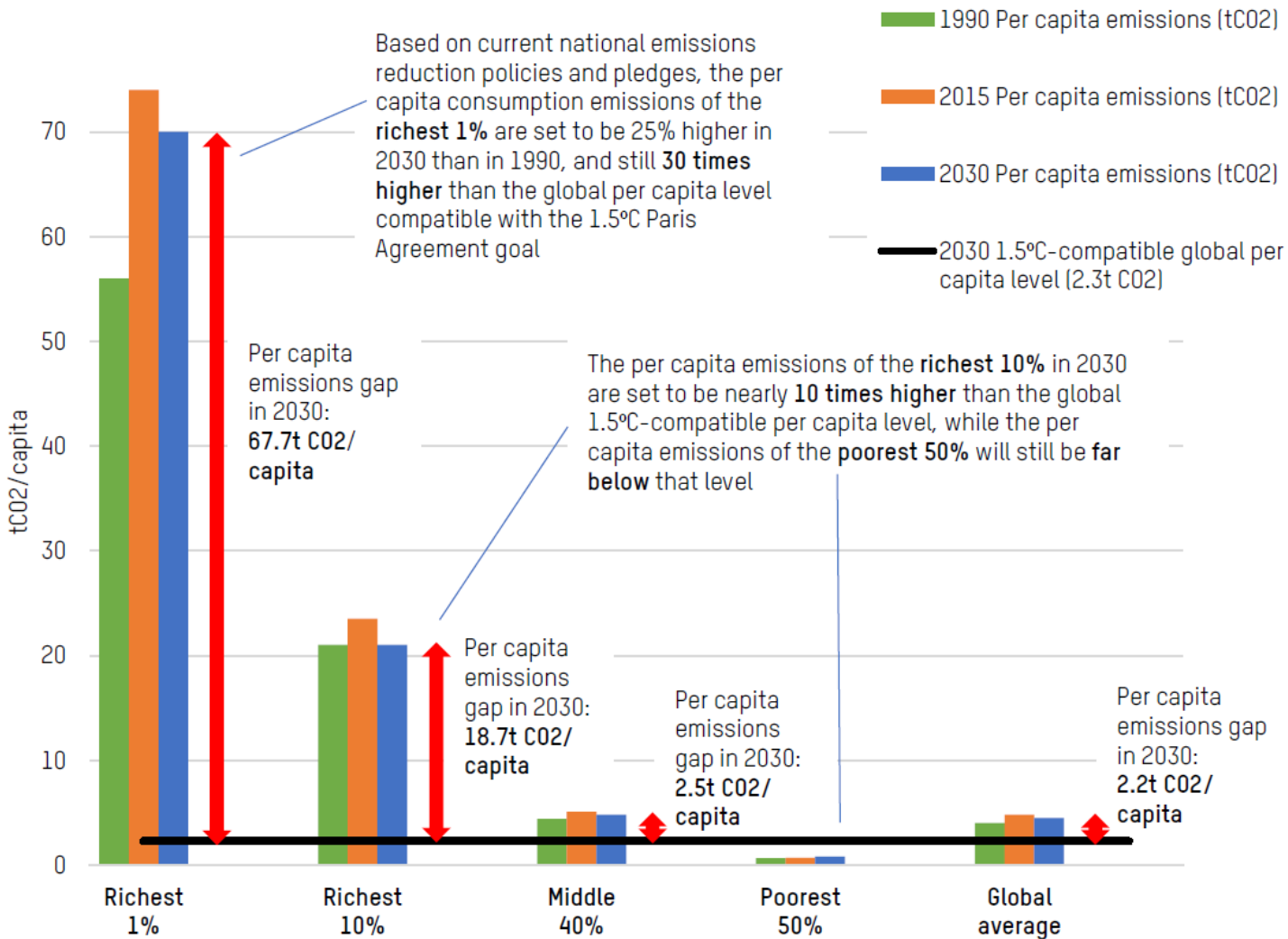
Income inequality and the digital transition

Income inequality and the green transition

CO2 emissions by income group

Gore (2021)
Carbon inequality in 2030

Figure 1: Per capita consumption emissions of global income groups 1990–2030 and the 2030 1.5°C-compatible global per capita goal



Maastricht Univer

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025) *Tackling emissions and inequality*

They employ an **integrated assessment agent-based model (ABM)** (Lamperti et al., 2018) calibrated on a high-income economy to study whether progressive and environmental fiscal policies can simultaneously reduce carbon emissions and personal economic inequality, while maintaining macroeconomic stability.

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)
Tackling emissions and inequality

- Representing income groups receiving wages and dividends
- Fiscal policies affecting incomes (taxes and benefits)
- Carbon emissions

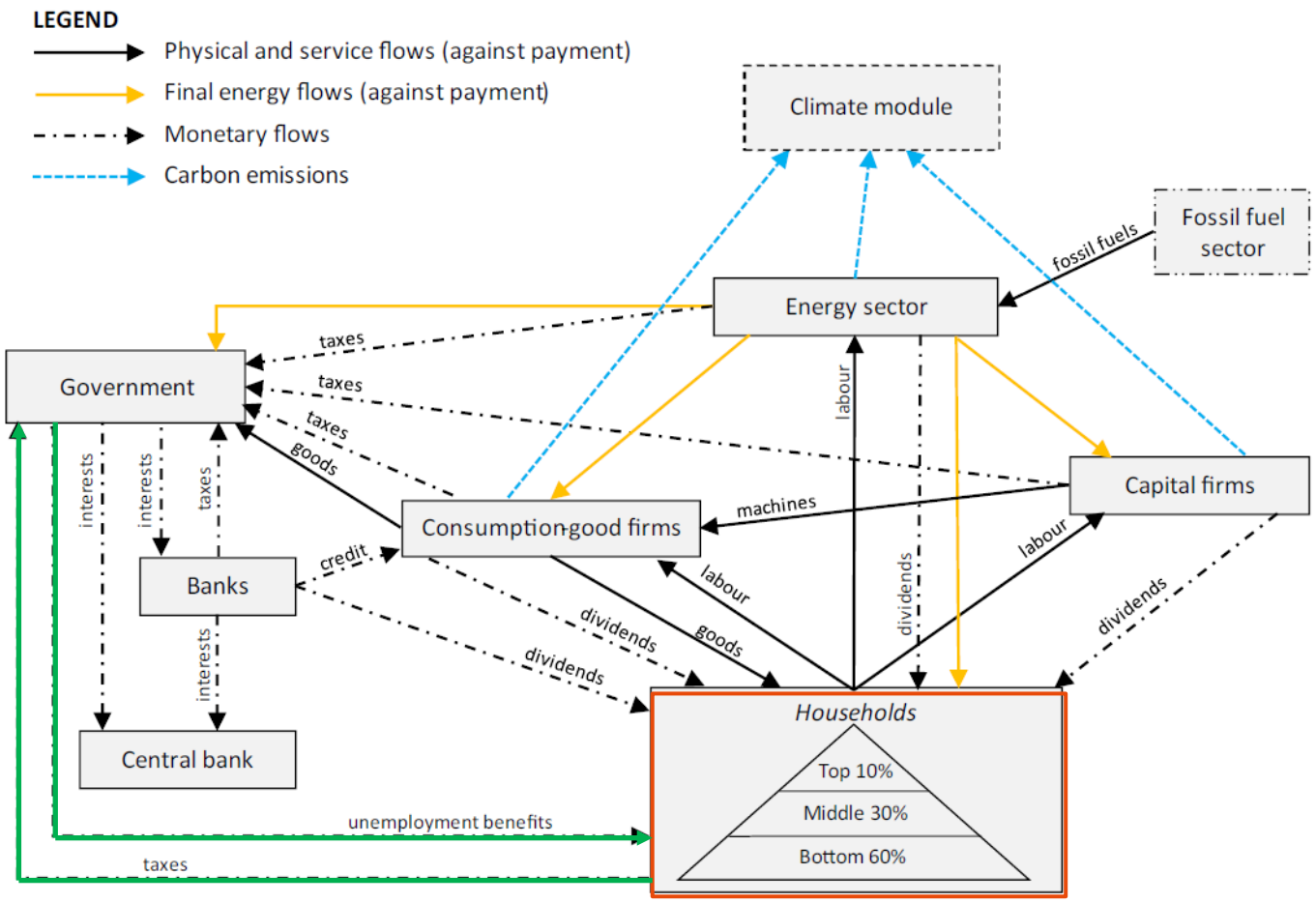


Figure 1: schematic representation of the model, with all agents and main flows. Flows are represented as arrows going from the providing to the receiving agent(s). Solid lines represent flows of goods or services, among which yellow ones represent flows of energy, to which correspond monetary flows in the opposite direction. Dot-dashed lines represent monetary flows. Blue dashed lines represent flows of carbon emissions. For a representation of all flows and stocks, refer to Table S.1 and Table S.2 in Appendix A.5.

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Income inequality

- disaggregating the household sector into three classes differing by income, wealth and propensity to consume
  - households in the Bottom 60% [don't receive dividends]
  - Middle 30% and
  - Top 10% of the income distribution

- Income sources:
  - wages (Wcl,t) [wage is uniform within classes]
  - dividends ($Divcl,t-1$) [proportional to their ownership share of the sector]
  - unemployment benefits ($UBcl,t$)
  - interest payments on Bank deposits ($iDcl,t$).
- Taxes
  - Taxes on wage ($Taxcl,tw$),
  - dividends ($Taxcl,tdiv$) and
  - deposits ($Taxcl,tdep$).

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Policy experiments

Progressive income tax	increase the progressivity of tax rates on wages while keeping the total amount of labour income taxes collected unchanged
Shift taxes to capital	Change in fraction of total Households' income taxes collected that is shifted from labour to capital income
Higher tax Top 10%	increase the tax rate on labour income of Top 10% Households
Lower tax Bottom 60%	reduce the tax rate on labour income of Bottom 60% Households
Green capital subsidies	the Government subsidises C-firms for purchasing capital vintages with low carbon intensity (The subsidy offered per machine decreases linearly with increasing carbon intensity and it is zero for vintages with higher carbon intensity than the market average)
Dirty capital taxation	the Government taxes C-firms for purchasing capital vintages with high carbon intensity (zero for vintages with lower carbon intensity than the market average)
Carbon tax	tax on carbon emissions from the Energy Sector, C- and K-firms

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Results:

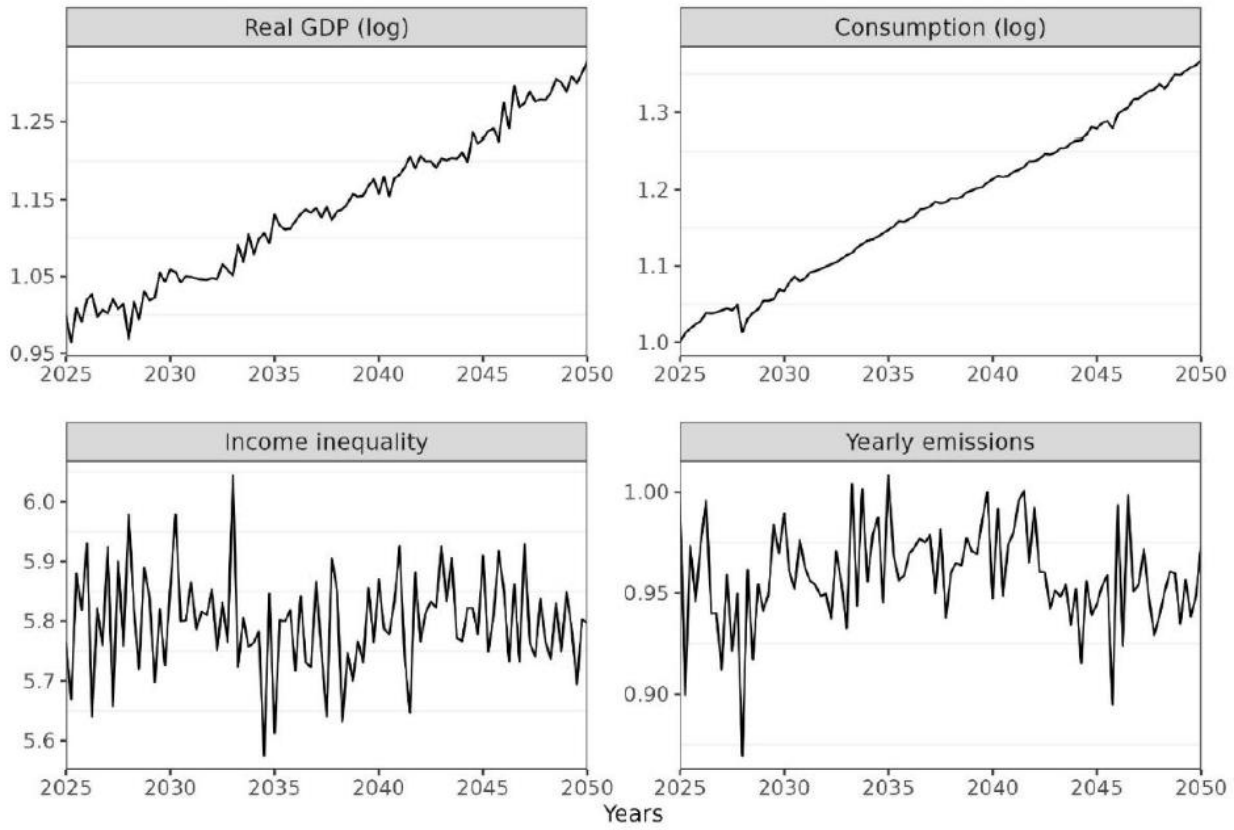


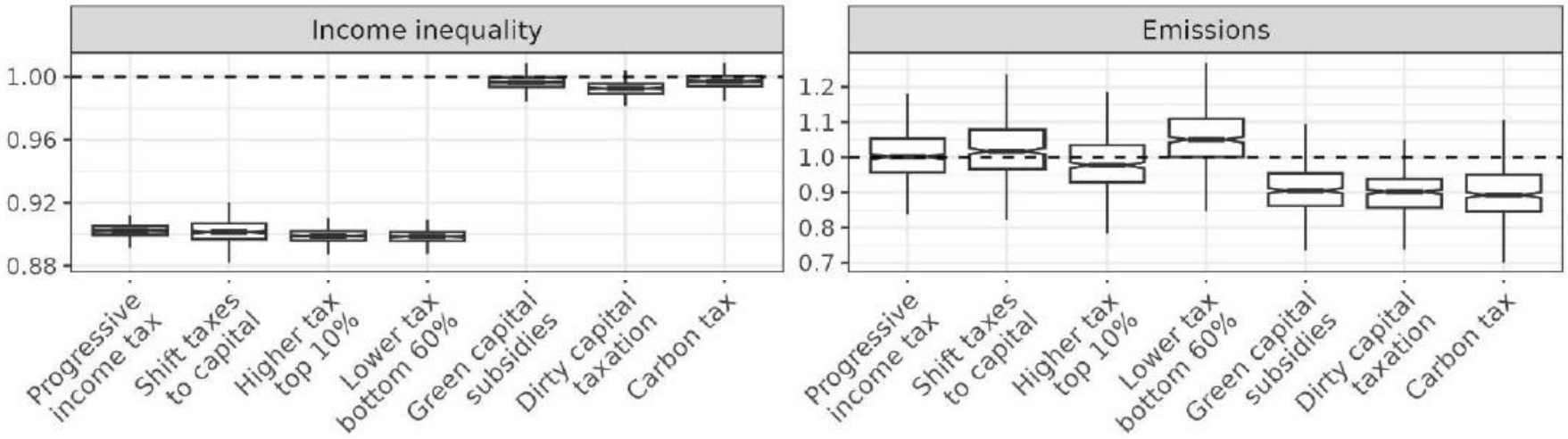
Figure 2: time series of selected variables for one run of the model, randomly selected. Real GDP and consumption are in logarithmic scales. Values for real GDP, consumption and yearly emissions are normalised to the value they have in the year 2025. Income inequality is measured as the net income ratio of a household in the Top 10% to one in the Bottom 60%.

Maastricht

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Results: single policies



Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Table 2: effects of individual policies on selected indicators as compared to their trends in the baseline. An upward arrow indicates an increase in the value of the indicator due to the introduction of the policy, a rightward arrow indicates a negligible effect, and a downward arrow indicates a decrease. The effects are based on a sensitivity analysis on each policy's parameter, and two arrows separated by a slash imply different effects with an increasing value of the policy parameter. The colour of the arrows indicates if the direction of change of the indicator is desirable (green) or not (red), while yellow is used for negligible effects. The caption of Figure 3 describes the indicators and policies.

	Emissions	Income inequality	Unempl-oyment	Economic instability	Public debt to GDP	GDP growth	Bottom 60% consumption
Progressive income tax	→/↑	↓	↓	→	↓	→/↑	↑
Shift taxes to capital	→/↑	↓	↓	→	↓	→/↑	↑
Higher tax Top 10%	↓	↓	↑	→	↓	→/↓	→
Lower tax Bottom 60%	↑	↓	↓	↓	→/↓	↑	↑
Green capital subsidies	↓	→	↓	→/↓	→/↑	↓	↓
Dirty capital taxation	↓	→	→/↓	↑	→/↓	↓	↓
Carbon tax	↓	→	↑	↑	↓	→/↓	↓

Policy: jointly tackling emissions and inequality?

Ravaioli et al. (2025)

Results: Policy mix

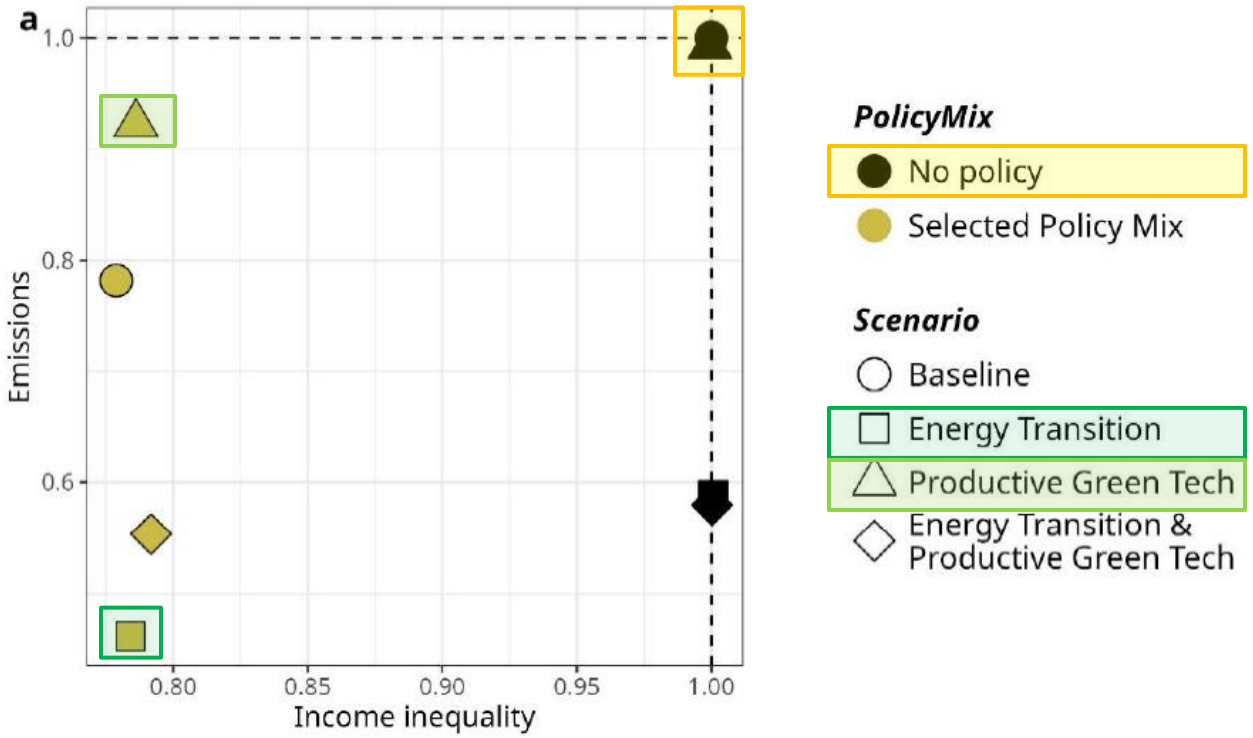


Figure 5: effect on selected indicators of introducing the Selected Policy Mix under different scenarios. Each dot represents the average value of the indicators on the y-axis and x-axis under no policy or the Selected Policy Mix (identified by the dot's colour) and a scenario (identified by the dot's shape), averaged over 300 Monte Carlo runs run for 100 quarterly timesteps. "Energy Transition" refers to the scenario in which share of energy supplied from green plants increases linearly to a value of 70% at the end of the simulation. "Productive Green Tech" refers to the scenario where we assume that green innovation leads to higher labour productivity. Indicators are normalised to the value they assume in the baseline scenario with no policy mix implemented, which are reported as black dashed lines. Figure a) and Figure c) show the effects respectively on emissions and inequality and on GDP growth and the real consumption of Bottom 60% Households, measured as described in the caption of Figure 4. Figure b) shows the effects on direct and indirect industrial emissions, measured as the yearly values at the end of the simulation.

Questions?

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Thank you!

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