SOCS0078 - Macro-Economic Perspectives on Climate Change

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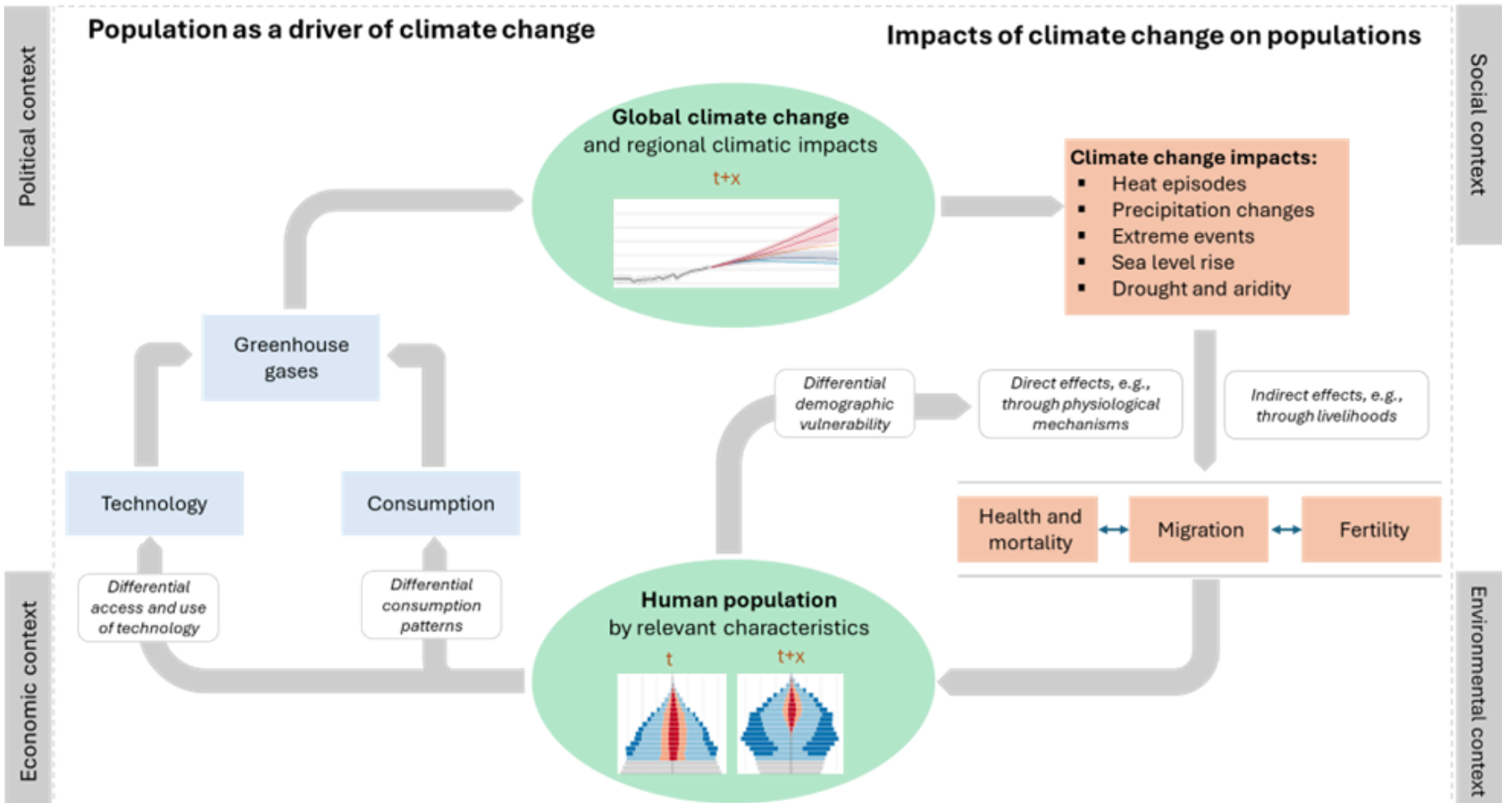
Last week

The Populsation Bomb and IPAT

- `Malthusian trap': Overpopulation & inevitable disaster
- Paul Ehrlich's The Population Bomb (1968)
- $$I = P \times A \times T$$

Climate & Population Dynamics

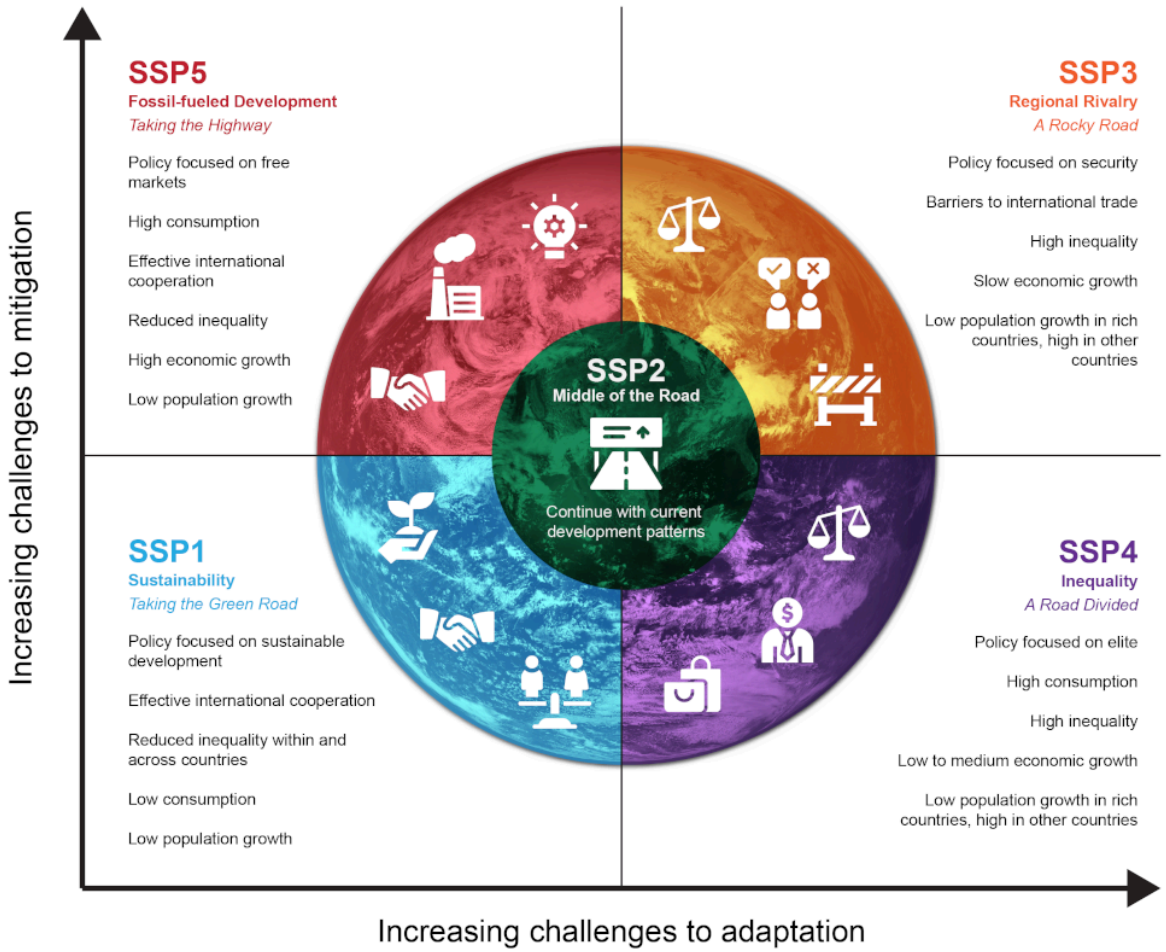


Climate mitigation
Actions to reduce or prevent greenhouse gas emissions from human activities. Demographic factors influence mitigation.

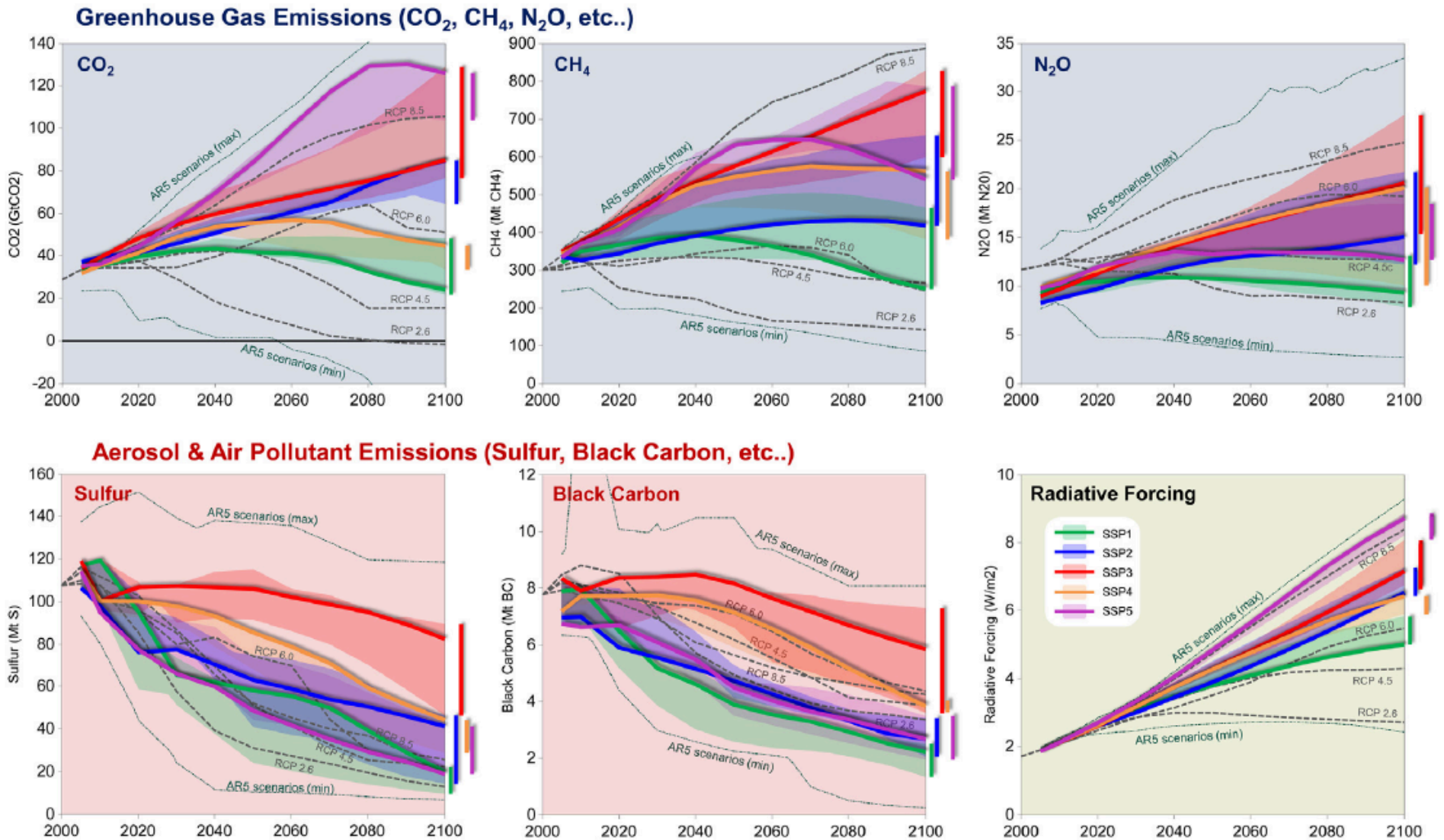
Climate justice
Countries and population groups therein have an unequal contribution to global emissions. Typically, those worst affected by climate impacts have contributed the least.

Climate adaptation
Actions to prepare for and adjust to the current and projected impacts of climate change. Adaptive capacities vary between population groups.

Socio-economic Pathways (SSP)

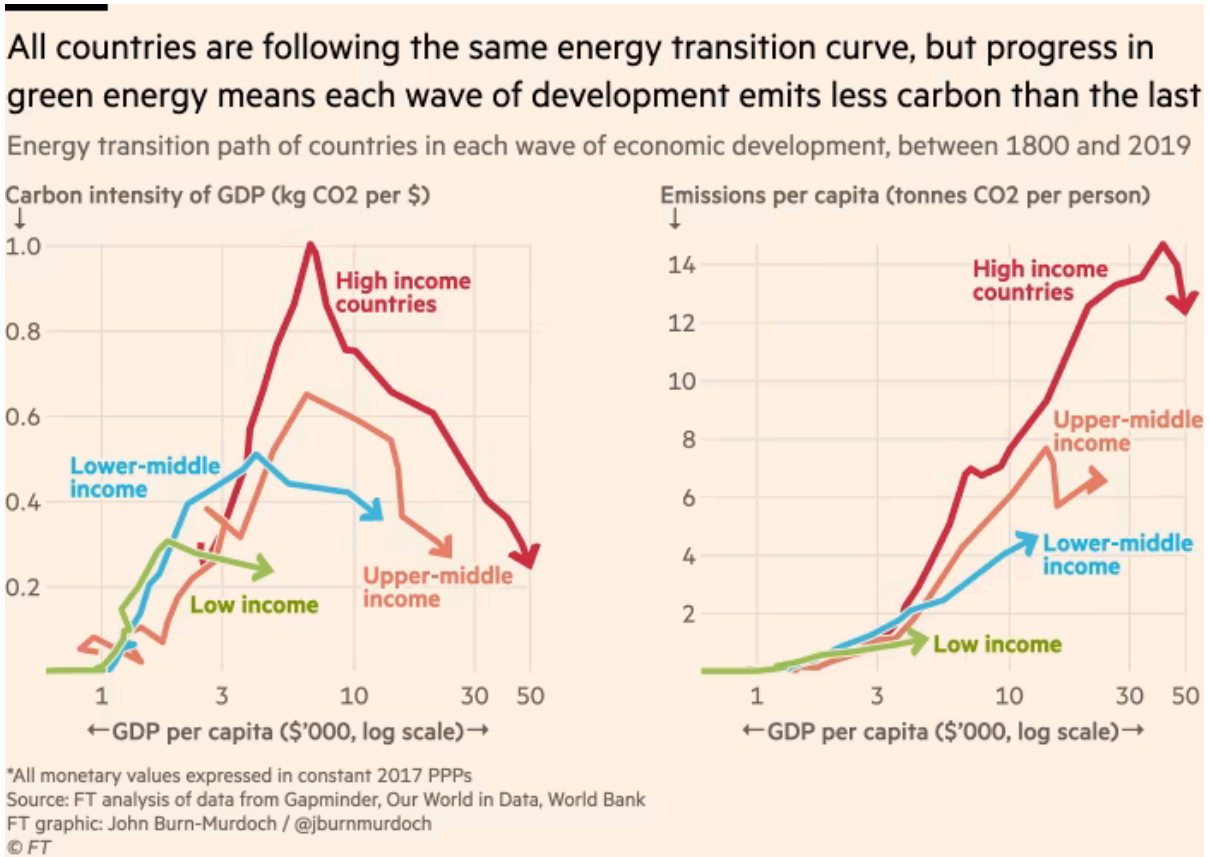


Socio-economic Pathways (SSP)



Macro-Economic Perspectives on Climate Change

“Green growth is already here”



In 2016, 70 countries — more than one in three worldwide — had a run of at least five years in which carbon emissions declined while GDP grew. Green growth is already here.

John Burn-Murdoch in the Financial Times (2022)

“Green growth is already here”

Macro-Economic Perspectives on Climate Change

- What are the driving forces that produce the environmental impacts and degradation?
- Focus on macro-explanations rather than individual behaviour.

Three broader perspectives:

Human Ecology (e.g. IPAT)	Ecological Modernization	Political Economy (e.g. Treadmill)

Macro-Economic Perspectives on Climate Change

- What are the driving forces that produce the environmental impacts and degradation?
- Focus on macro-explanations rather than individual behaviour.

Ecological Modernization

Environmental Kuznets Curve

Kuznets Curve

- Original Kuznets Curve (Kuznets 1955) on the relation between economic growth and income inequality.
- Increasing economic growth first increases, then decreases inequality
- Industrialisation profits mainly the capitalists
- Industrialisation pushes rural farmers into the city, reducing wages
- Turning point: Democratisation & rise of welfare state

Environmental Kuznets Curve

- Within a neoclassical tradition
- Reformulation by Grossman and Krueger (1995) applying the KC to environmental issues.
- The **Environmental Kuznets Curve (EKC)** explores the relationship between economic development and environmental quality.

What is the EKC?

Environmental Kuznets Curve

“The environmental Kuznets curve (EKC) is a hypothesized relationship between various indicators of environmental degradation and income per capita.

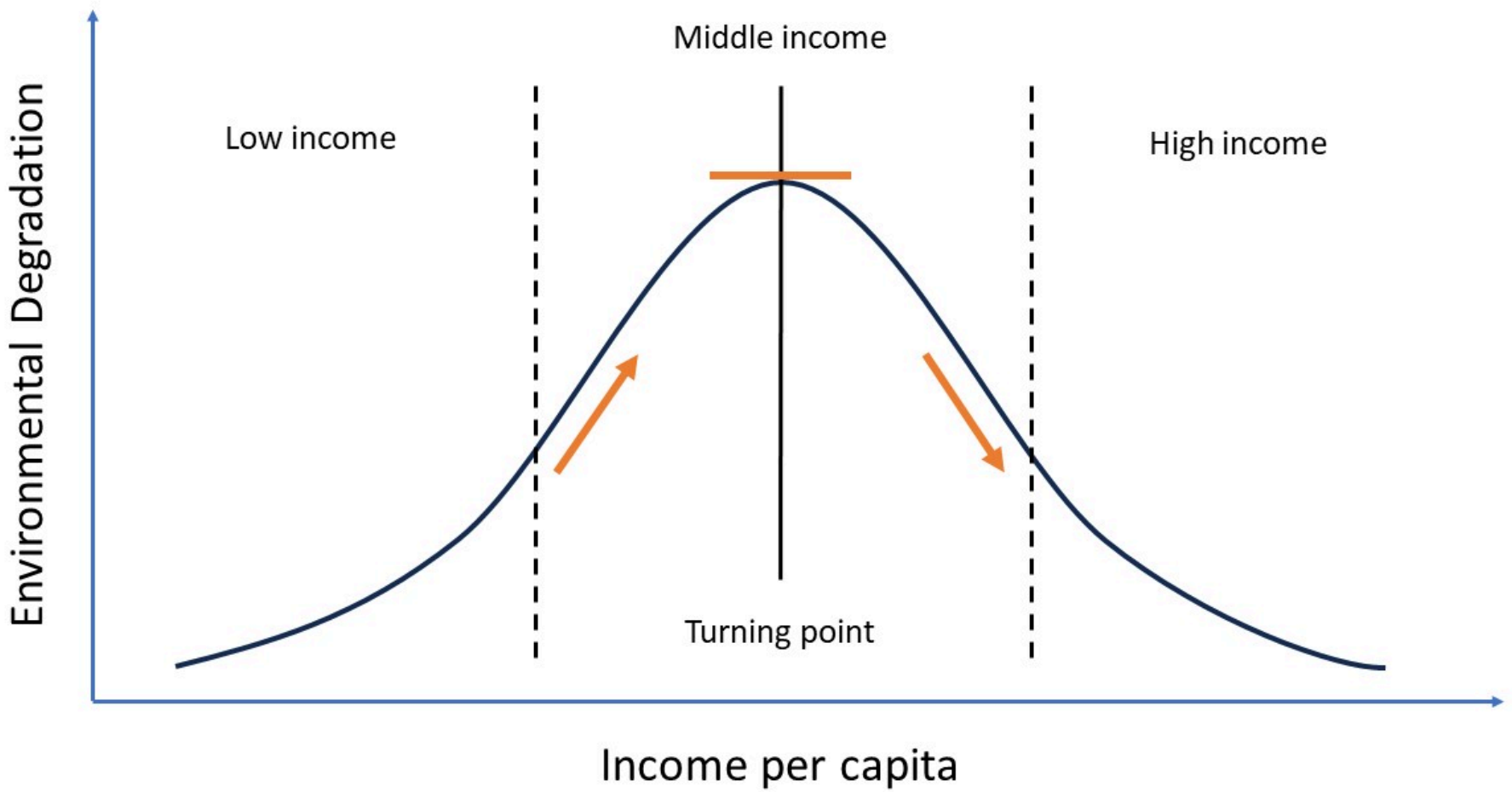
In the early stages of economic growth degradation and pollution increase, but beyond some level of income per capita, which will vary for different indicators, the trend reverses, so that at high income levels economic growth leads to environmental improvement.”

(David I. Stern 2004)

The Inverted U-Shape

- In the EKC, environmental impact is often depicted as an inverted U-shaped curve:
  - Initial stage: Environmental degradation increases as economies grow.
  - Turning point: At a certain income level, environmental degradation peaks.
  - Later stage: Beyond the turning point, further economic growth leads to environmental improvement.

The Inverted U-Shape



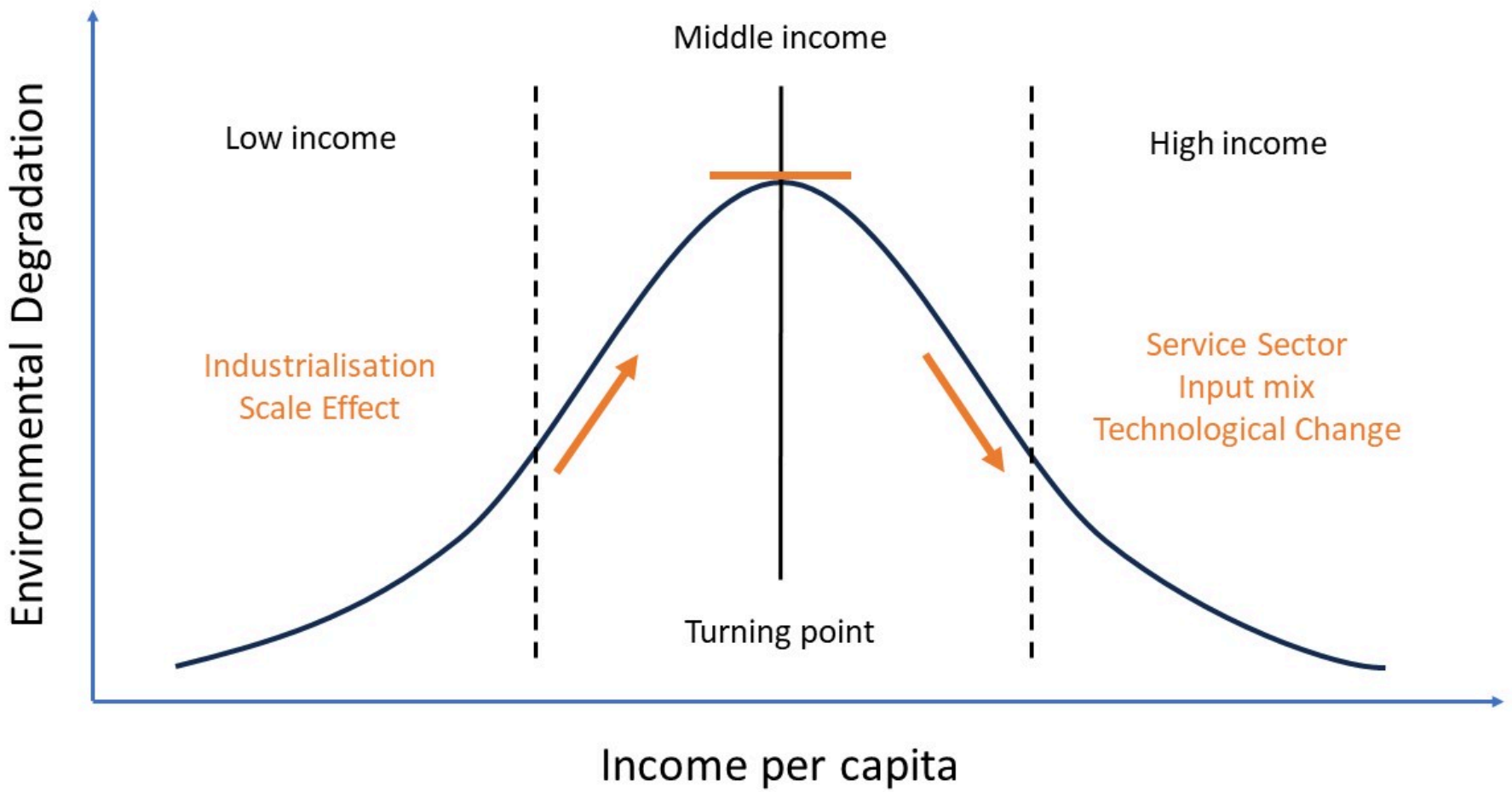
Factors Influencing the EKC

Several factors influence the shape of the EKC:

- **Scale Effect:** Economic growth leads to increased resource use and pollution.
- **Changes in Industry:** Shifts from heavy industry to services can impact emissions.
- **Changes in Input:** Shifts towards more sustainable resources for production.
- **Technological Change:** Advancements can lead to cleaner production processes.
  - Production efficiency: Using less input/resources.
  - Emission efficiency: Same input producing less emissions.
- Shift in values and norms

(David I. Stern 2004; David I. Stern 2017)

The Inverted U-Shape



What Do You Think?

https://www.menti.com/alpxnk7jdxfm

Your Answers

Early EKC Studies

- Grossman and Krueger (1995) estimated EKCs for SO2, dark matter, and heavy particles
  - They used a cubic function of GDP per capita and found turning points at around $4,000–5,000.
- Selden and Song (1994) estimate the effect on dioxide, oxides of nitrogen, and carbon monoxide
  - They confirm the inverted U-shaped relationship
  - But turning points are much higher, at around $10,000

There are many more (David I. Stern 2004; David I. Stern 2017).

Early EKC Studies

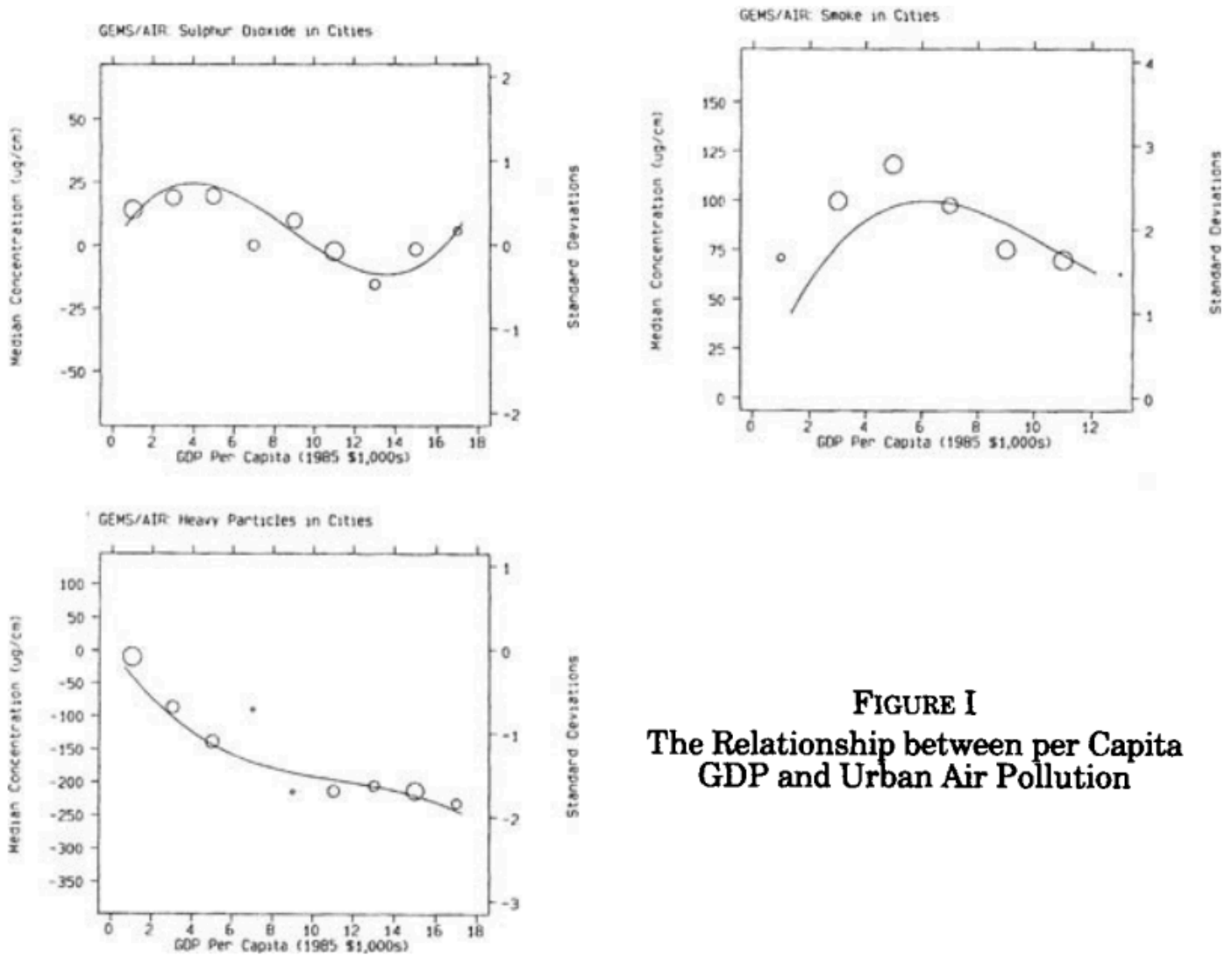


FIGURE I
The Relationship between per Capita GDP and Urban Air Pollution

Criticism

Theoretical Challenges

- Assumption that income is independent of environmental damage
  - Effect of extreme weather on economy?
- Differences between various pollutants
  - Shift from one problem to another?
- Externalisation and trade
  - Production vs. Consumption oriented measures of emission?
  - Decrease of production in Global North based on increase in Global South?
- Environmental regulations push pollution to the South?
- Skewed distribution of income and wealth: increase concentrated among a small group.

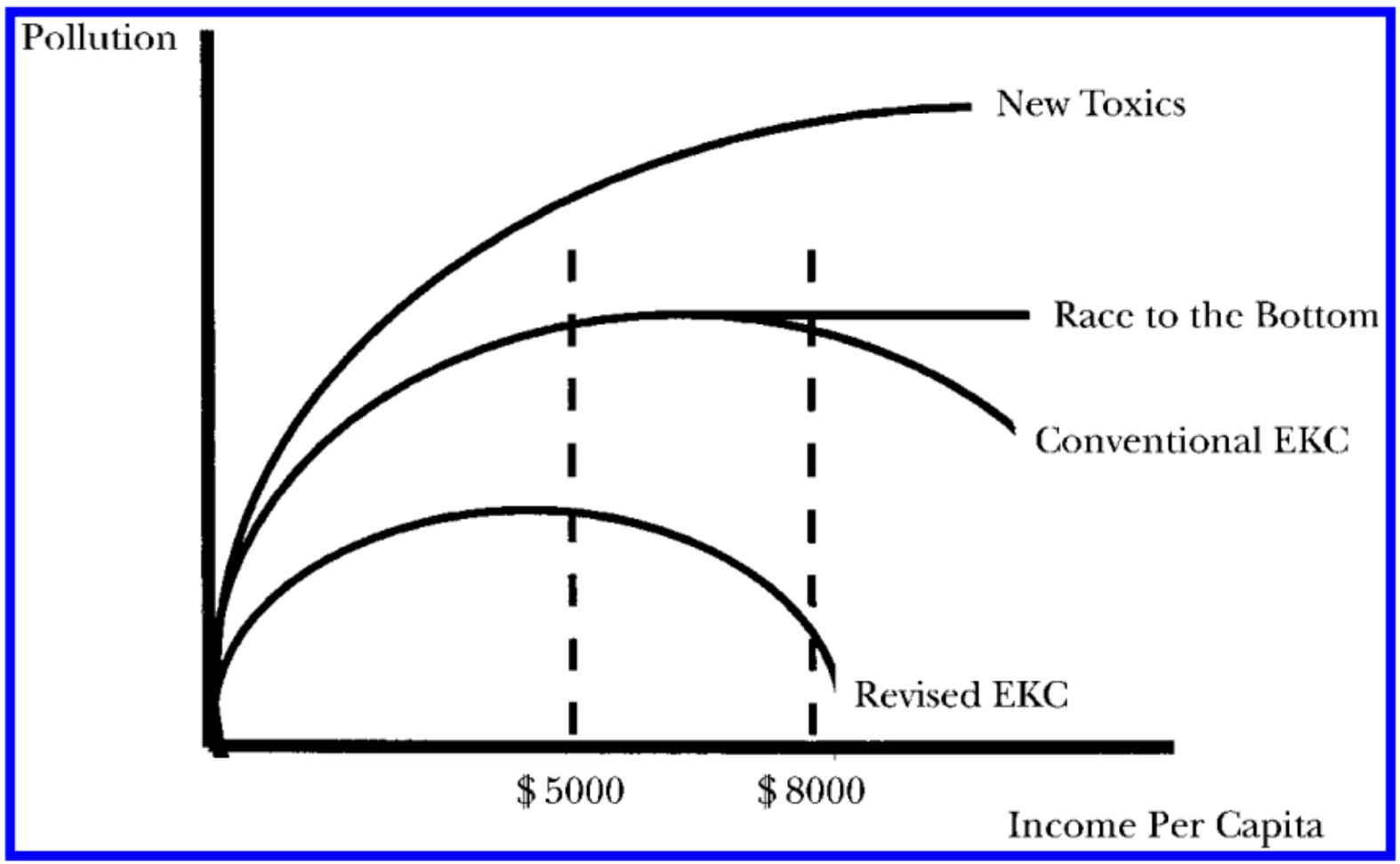
(Arrow et al. 1995; David I. Stern 2017)

Methodological Challenges

- Heteroskedasticity and modeling of non-linearity are common challenges.
- David I. Stern (2004) noted that using data mainly from developed countries led to lower turning points.
- Problem of cointegration in panel data (time-series wander together): how to separate (potentially independent) time-trends in the data?
- Omitted variables bias: industrial trade, geographic region, urbanisation, …? (York, Rosa, and Dietz 2003)

Alternatives and Reformulations

Environmental Kuznets Curve: Different Scenarios



Source: Dasgupta et al. (2002)

Let’s have a look at some data

World Development Indicators

The code below loads the WDI packages and searches for an indicator on CO2 per capita. It uses the statistics software R (more later).

```
# load package
library(WDI)

# Search GDP per capita (log-transformed)
WDIsearch("CO2.*capita")
```

```
          indicator
6032 EN.ATM.CO2E.PC
6048 EN.ATM.METH.PC
6059 EN.ATM.NOXE.PC
                                                                  name
6032                              CO2 emissions (metric tons per capita)
6048                  Methane emissions (kt of CO2 equivalent per capita)
6059 Nitrous oxide emissions (metric tons of CO2 equivalent per capita)
```

The code below uses the WDI API to retrieve the data and creates a dataframe of three indicators.

```
# Define countries, indicators form above, and time period
wd.df <- WDI(country = "all",
             indicator = c('population' = "SP.POP.TOTL",
                           'gdp_pc' = "NY.GDP.PCAP.KD",
                           'co2_pc' = "EN.ATM.CO2E.PC",
                           'nox_pc' = "EN.ATM.NOXE.PC",
                           'pm25_mean' = "EN.ATM.PM25.MC.M3",
                           'parliament_women_pt' = "SG.GEN.PARL.ZS",
                           'gini'  = "SI.POV.GINI",
```

```
                            'fossil_fuel_pt' = "EG.USE.COMM.FO.ZS",
                            'taxes_total' = "IC.TAX.TOTL.CP.ZS"),
             extra = TRUE,
             start = 2000, end = 2019)

# Drop all country aggregates
wd.df <- wd.df[which(wd.df$region != "Aggregates"), ]

# Save data
save(wd.df, file = "WDI_short.RData")
```

Empirical Test Using 2019 data

▶ show code

```
Call:
lm(formula = log(co2_pc) ~ log(gdp_pc) + I(log(gdp_pc)^2), data = wd.df[wd.df$year ==
    2019, ])

Residuals:
     Min       1Q   Median       3Q      Max
-1.21519 -0.40234 -0.09141  0.33265  1.75904

Coefficients:
                  Estimate Std. Error t value Pr(>|t|)
(Intercept)      -19.99727    1.54396 -12.952  < 2e-16 ***
log(gdp_pc)        3.96016    0.36116  10.965  < 2e-16 ***
I(log(gdp_pc)^2)  -0.17695    0.02076  -8.525 5.89e-15 ***
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.5776 on 181 degrees of freedom
  (31 observations deleted due to missingness)
Multiple R-squared:  0.8339,    Adjusted R-squared:  0.832
F-statistic: 454.3 on 2 and 181 DF,  p-value: < 2.2e-16
```

- Positive and highly significant linear term
- Negative and highly significant quadratic term

Really a “Curve”?

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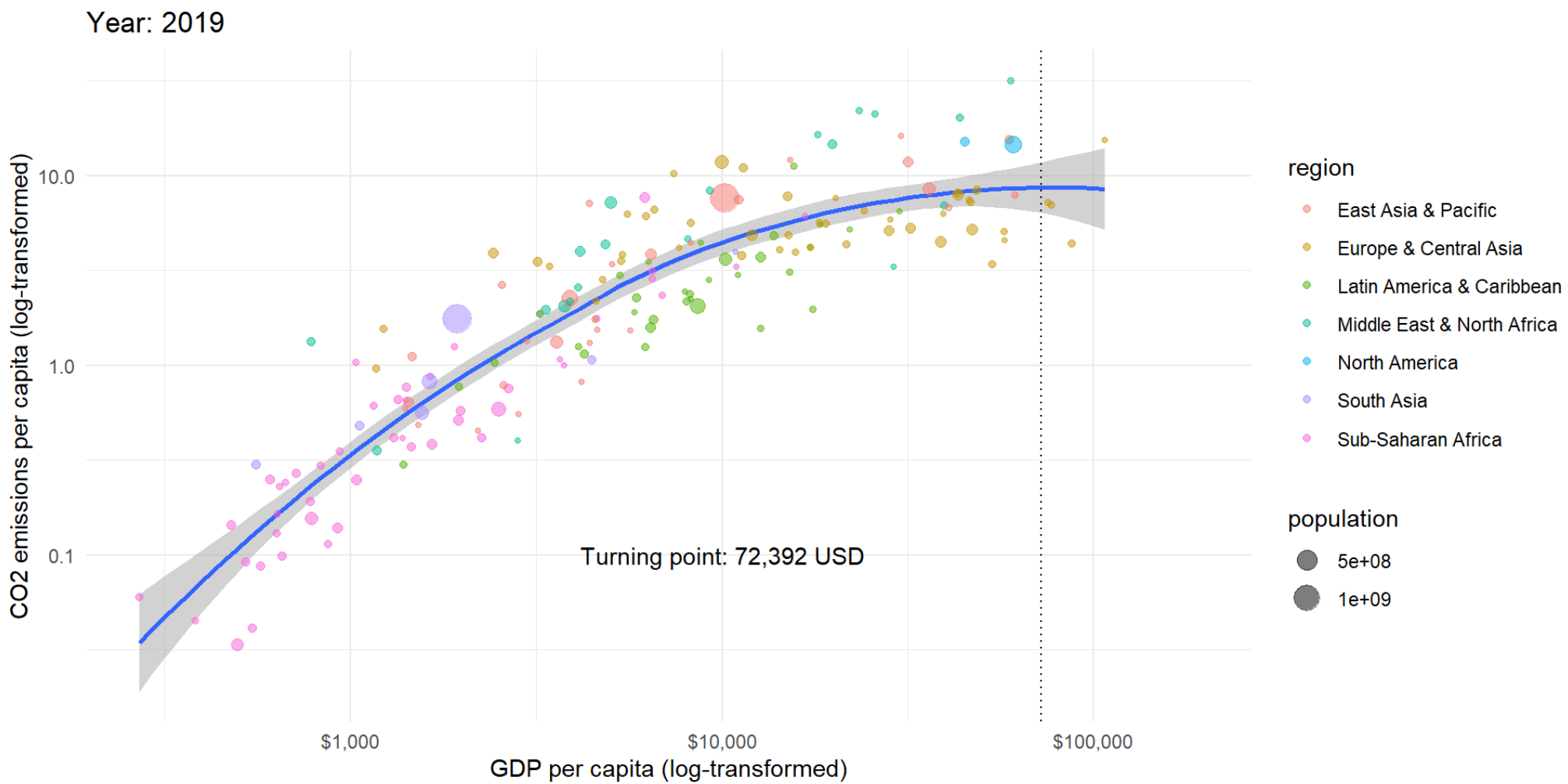


Maybe Over Time?

▶ show code

Key Takeaways

- The EKC explores the relationship between economic growth and the environment.
  - It suggests an inverted U-shaped curve, with a turning point of peak environmental degradation.
  - Multiple factors, including scale, technology, and policy, influence the EKC.
- Evidence varies, and the EKC is based on a fragile foundation.
  - Wrong conclusion: de-emphasize environmental policy and pursue growth instead.
  - EKC is overly simplistic.
- Some optimism: There are downwards trends in emissions in several European countries.

Questions?

- Do you have any questions about the Environmental Kuznets Curve?

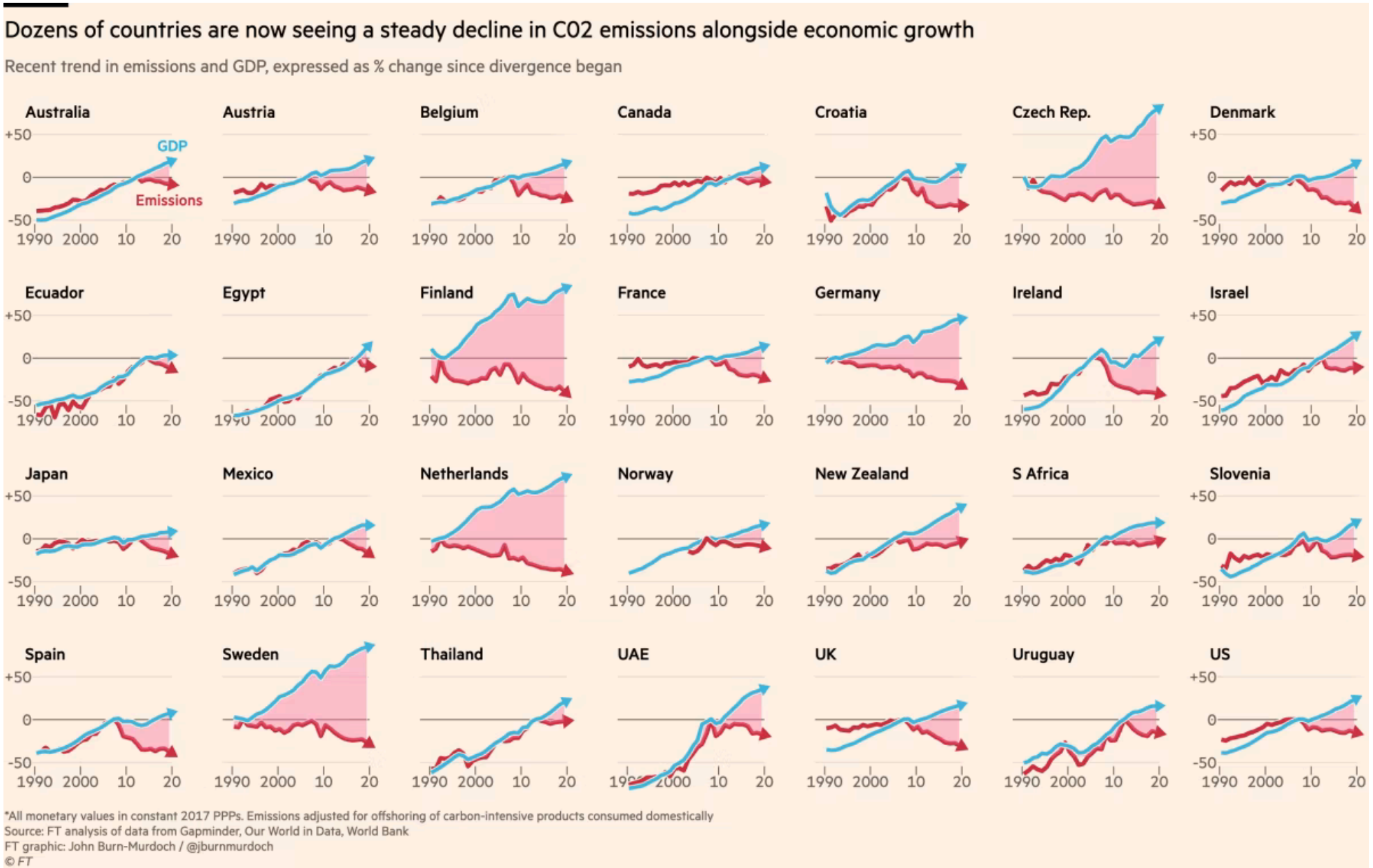
Is this debate about the Environmental Kuznets Curve an old hat?

Back to “Decoupling” and “Green Growth”

For the best part of the past 200 years, one rule held across the world: if a country’s economic activity expanded, so did its carbon emissions. But starting in the 1980s with the advent of nuclear power, it became increasingly common to see countries cutting emissions while growing GDP.

The pace of this decoupling has now accelerated as the shift from carbon-intensive manufacturing to services and from dirtier to relatively cleaner fossil fuels has been supercharged by proliferating cheap renewables.

John Burn-Murdoch in the Financial Times (2022)



Source: John Burn-Murdoch in the Financial Times (2022)

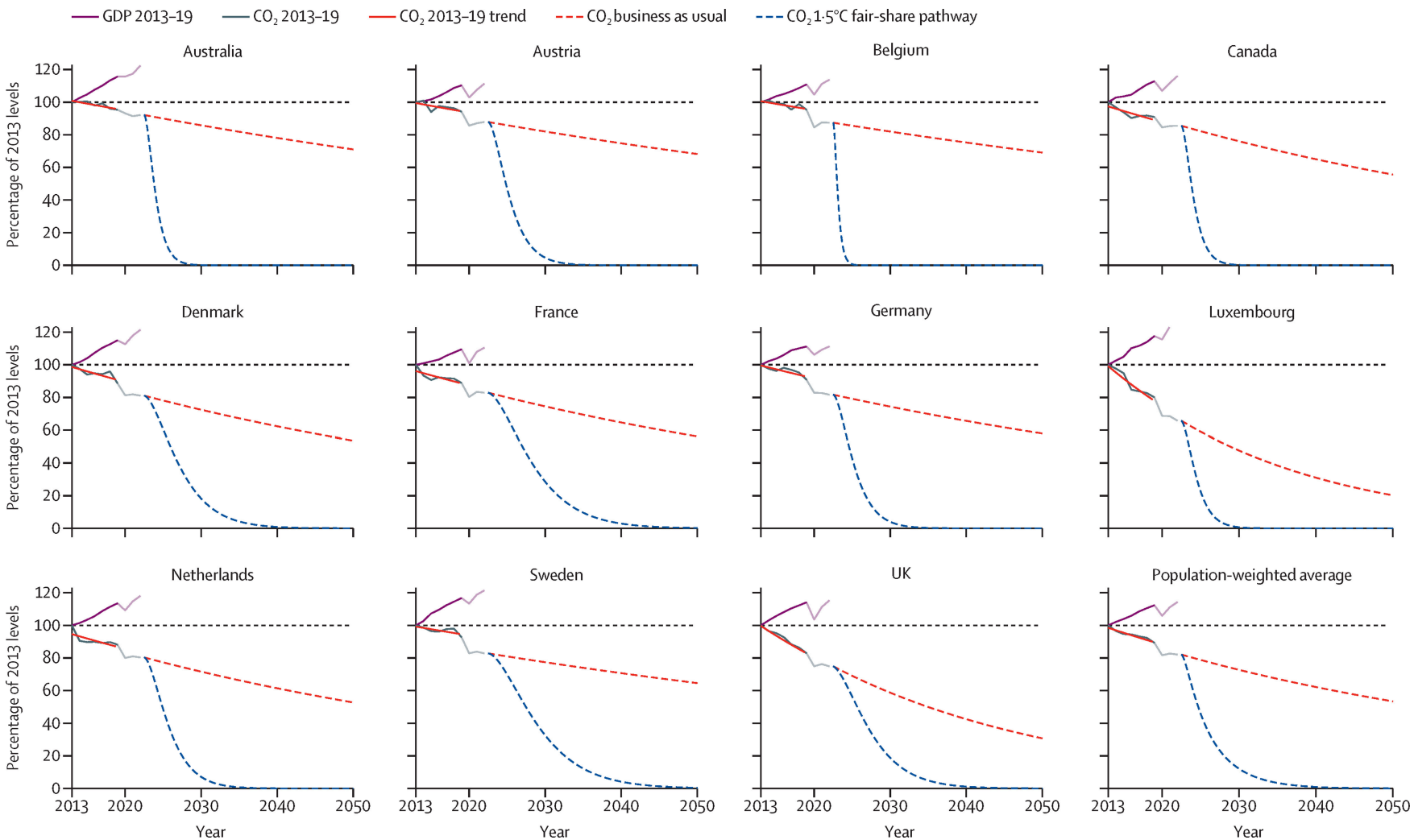
But Remember the Absolute Level

Over the past decade, some countries have reduced their CO2 emissions while increasing their gross domestic product (absolute decoupling). Politicians and media have hailed this as green growth.

The emission reductions that high-income countries achieved through absolute decoupling fall far short of Paris-compliant rates. At the achieved rates, these countries would on average take more than 220 years to reduce their emissions by 95%

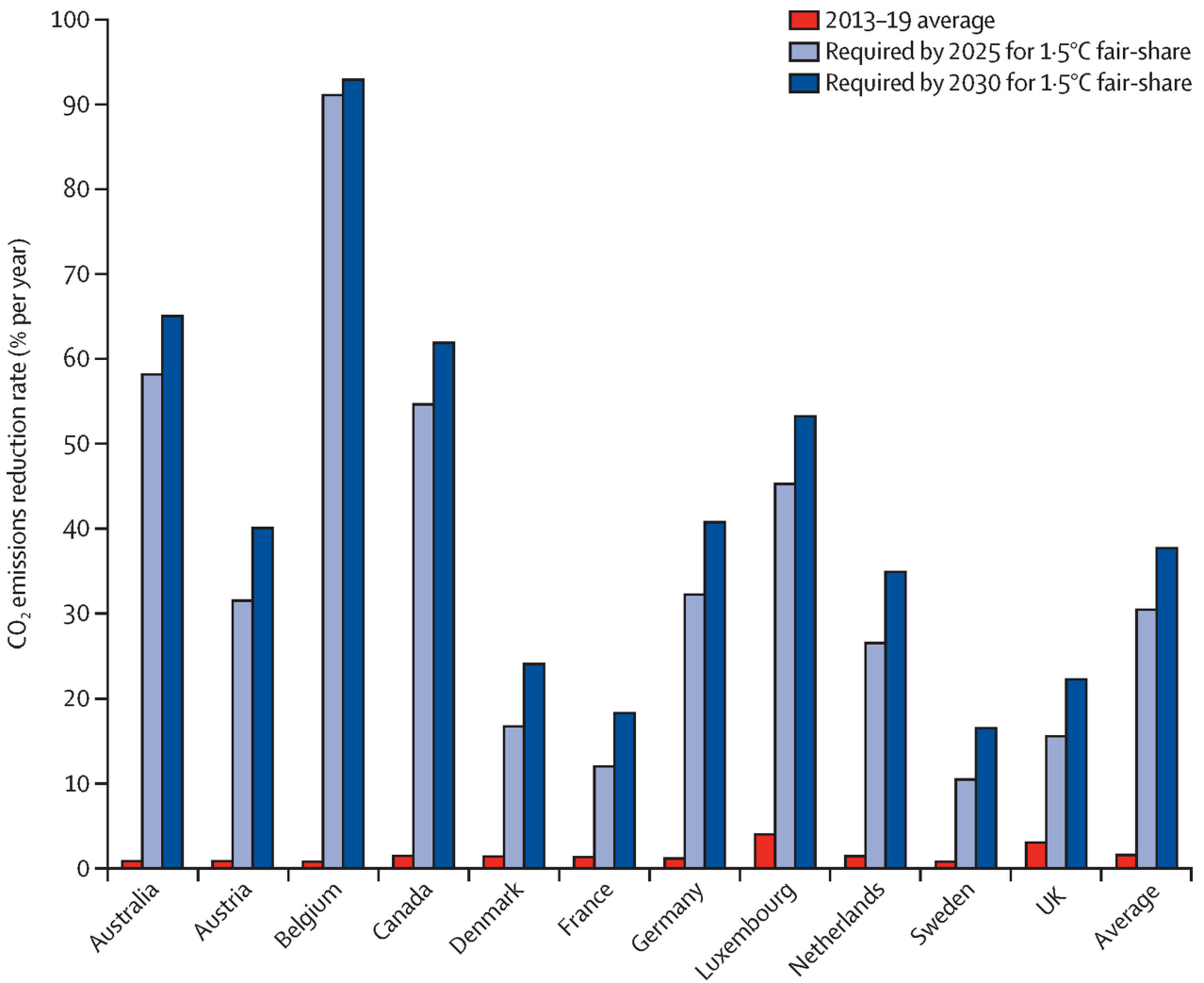
(Vogel and Hickel 2023)

But Remember the Absolute Level



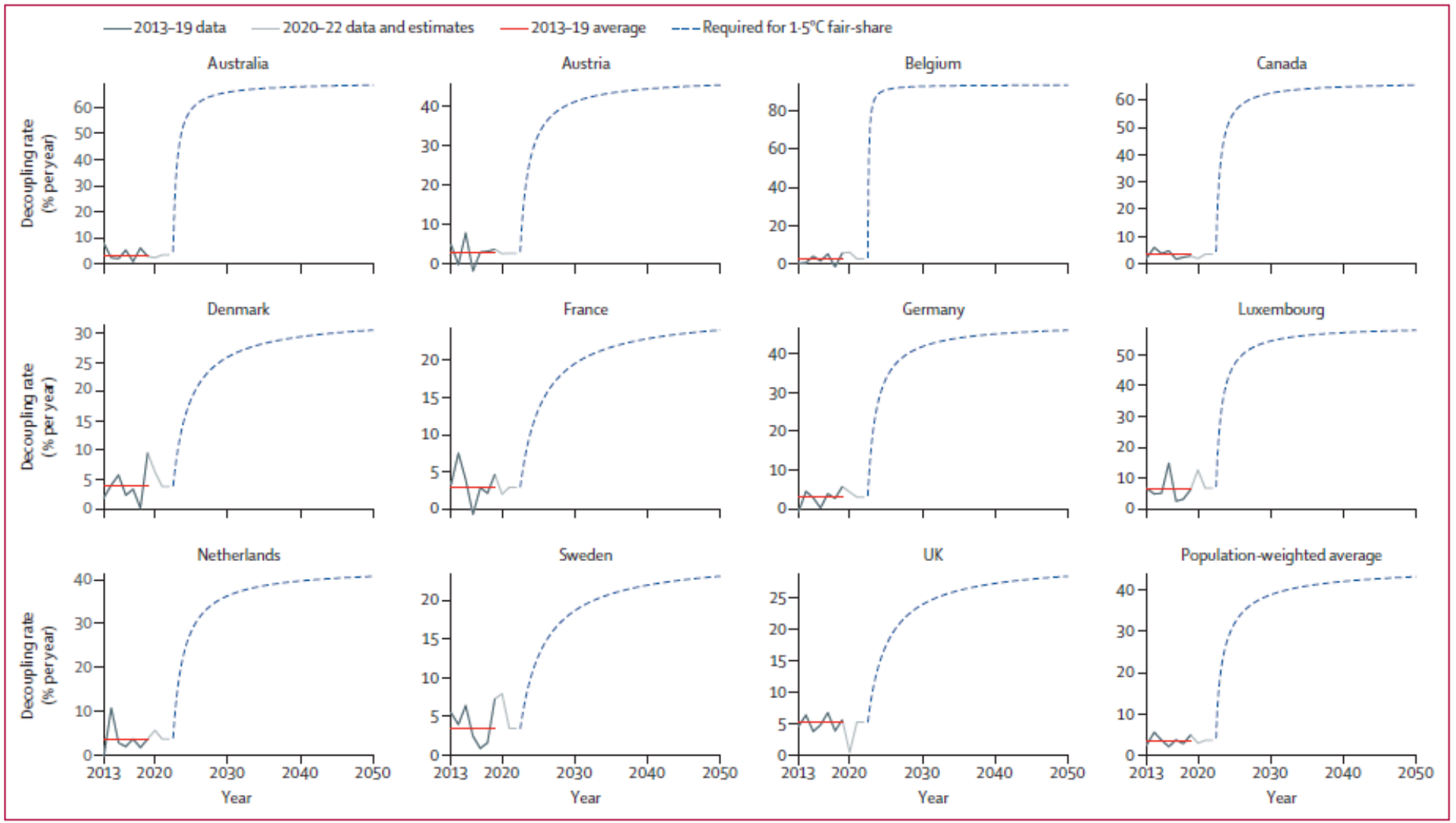
High-income countries that have recently achieved absolute decoupling. Source: Vogel and Hickel (2023)

Still a Long Way



High-income countries that have recently achieved absolute decoupling. Source: Vogel and Hickel (2023)

What we would need



Source: Vogel and Hickel (2023)

Key Takeaways

- “Green growth” (as EKC) alone is not going to solve the problem.
- Continued economic growth within 1.5°C fair-shares seems empirically out of reach, even for the best-performing countries.
- Vogel and Hickel (2023) suggest post-growth approaches:
  - reducing carbon-intensive and less-necessary production and consumption,
  - shifting to low-carbon alternatives,
  - abandoning the pursuit of aggregate economic growth.

How to achieve in high-income countries?

“Green growth is already here”

Treadmill of Production

Ecological Modernization

Treadmill of production

Treadmill of Production

- To maintain profits, producers must constantly seek to expand production.
- Efficient technologies are adopted to increase profit per unit of labour
  - decreasing emissions,
  - but displacing workers.
- To keep unemployment low and tax revenue high
  - Worker support increasing production
  - Governments support companies and expansions
- The treadmill increases environmental impacts through resource demands and waste.

[Schnaiberg, Pellow, and Weinberg (2002); Jorgenson.2012]

Treadmill of Production

- No internalisation of environmental costs.
- Capitalism is focused on profit and expansion.
- Efficiency-improving technology leads only to reinvestment in production.
- The solution, according to the treadmill perspective, is to restructure society to limit producer hegemony.

[York, Rosa, and Dietz (2003); Jorgenson.2012]

Your opnion

Birthday on EVEN day (e.g. 18th, 22nd)

Birthday on ODD day (e.g. 7th, 15th)

EVEN Answers

ODD Answers

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