

# **SOCs0078 - Macro- Economic Perspectives on Climate Change**

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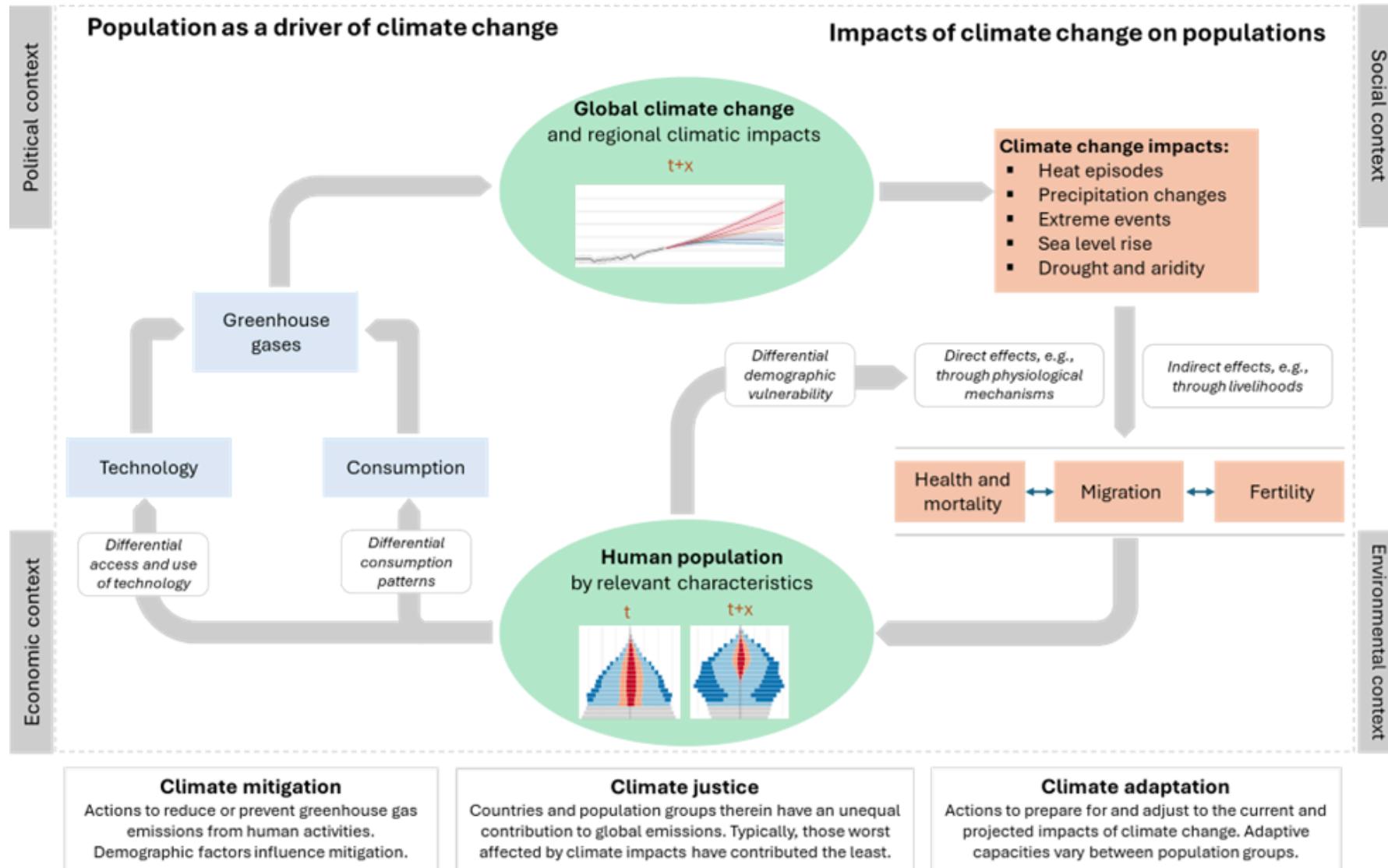


# Last week

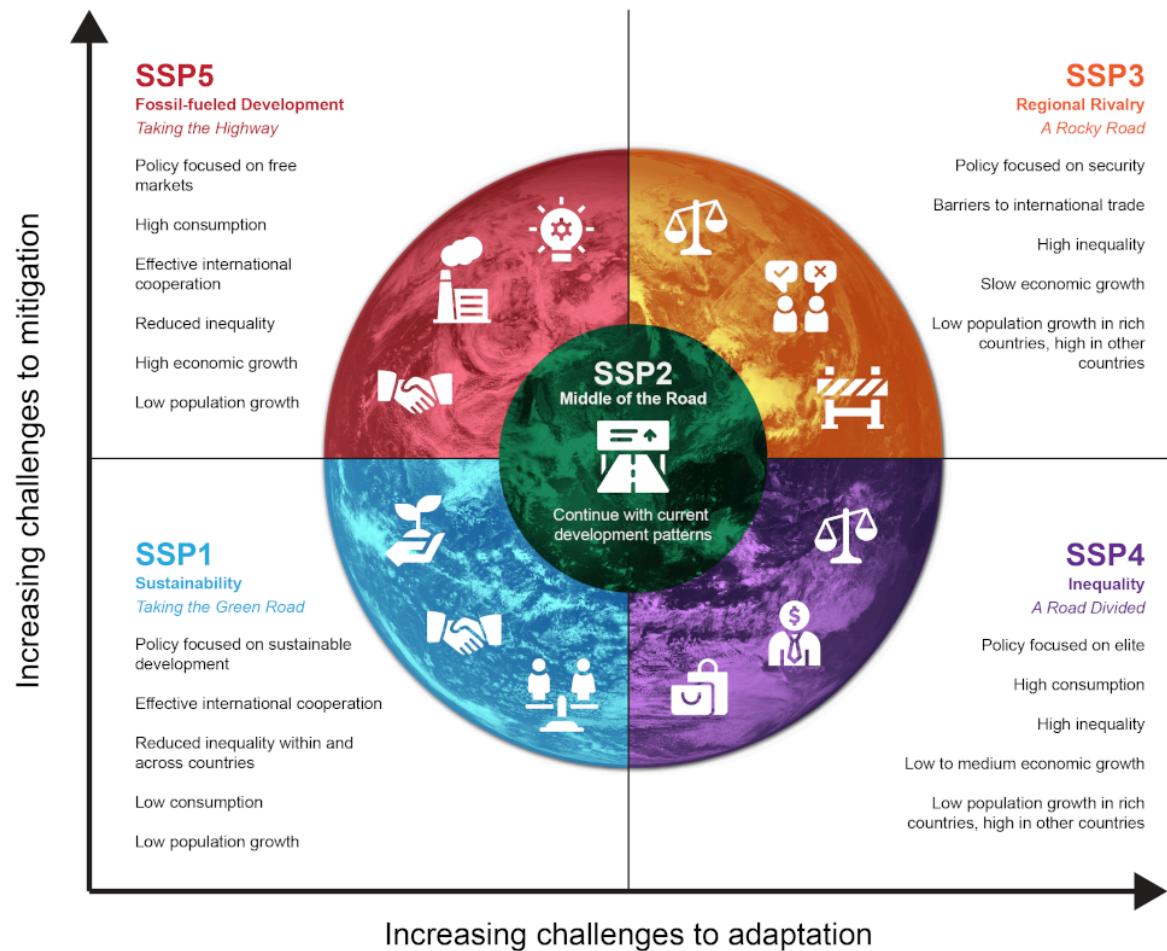
# The Populsation Bomb and IPAT

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

# Climate & Population Dynamics

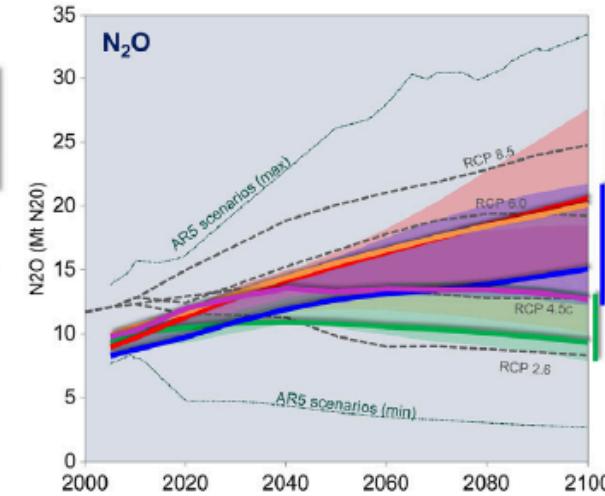
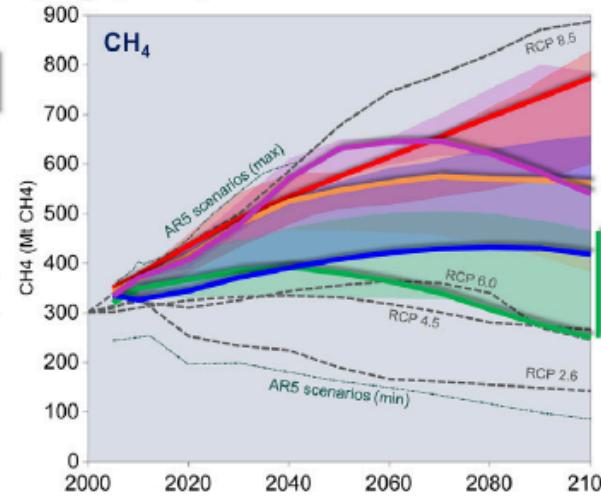
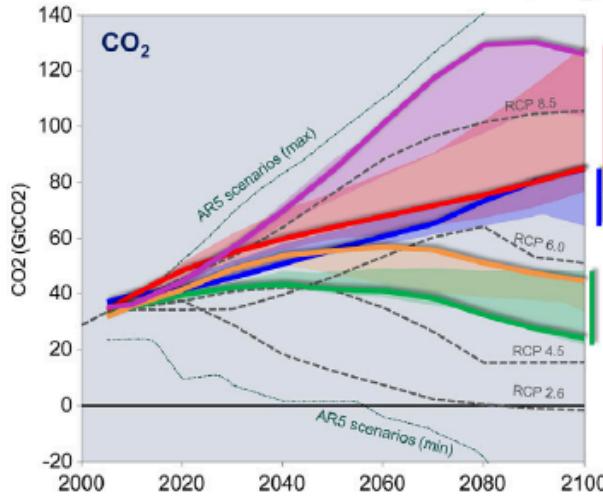


# Socio-economic Pathways (SSP)

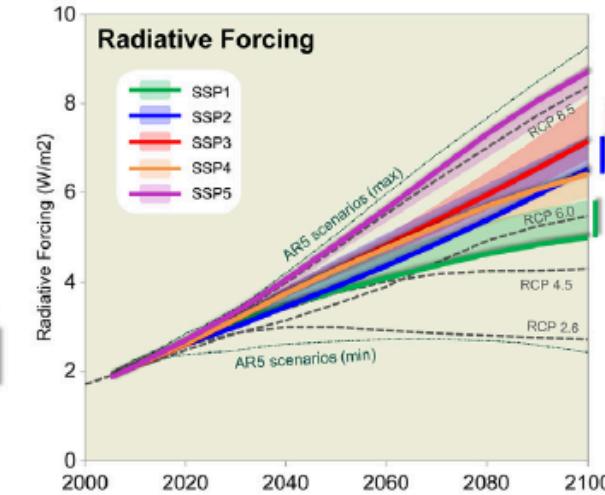
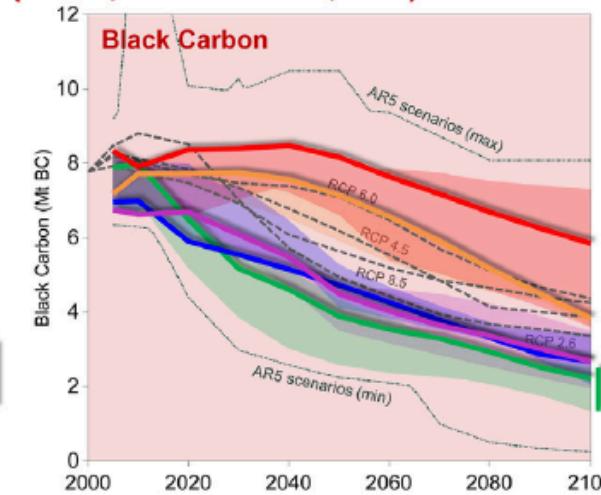
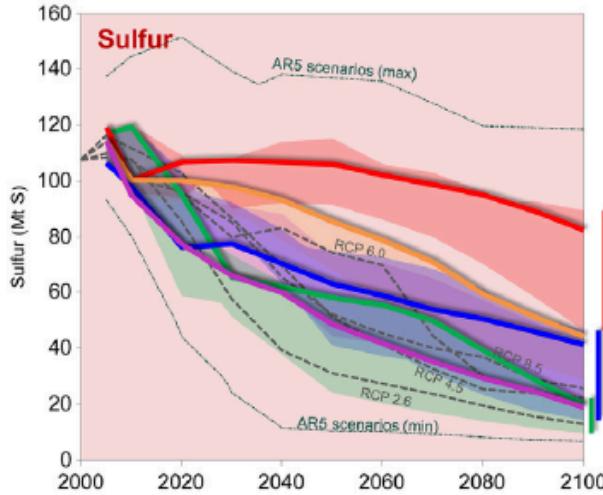


# Socio-economic Pathways (SSP)

Greenhouse Gas Emissions ( $\text{CO}_2$ ,  $\text{CH}_4$ ,  $\text{N}_2\text{O}$ , etc..)



Aerosol & Air Pollutant Emissions (Sulfur, Black Carbon, etc..)

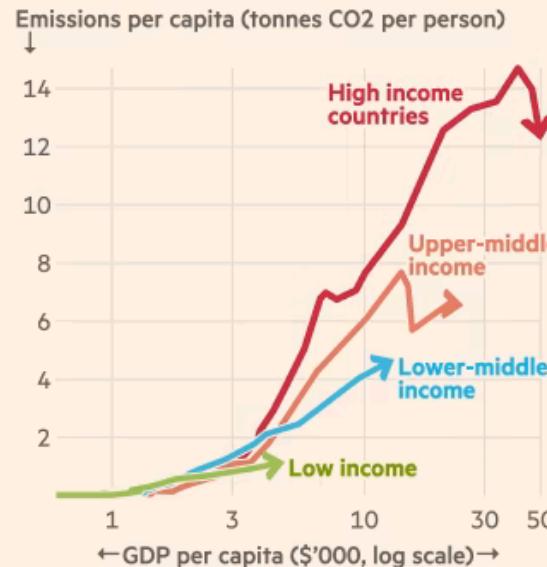
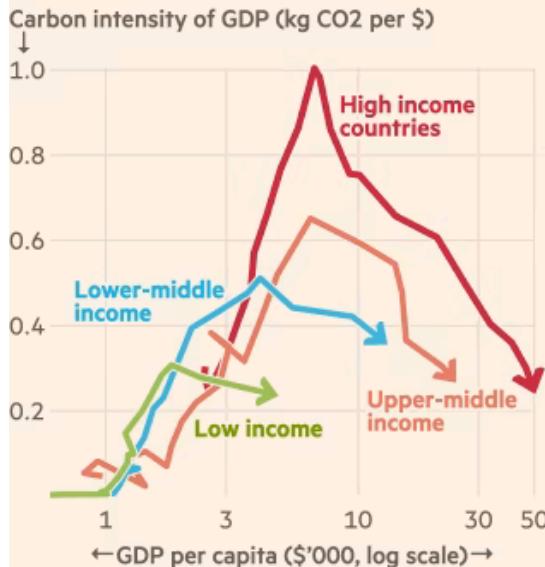


# Macro-Economic Perspectives on Climate Change

# “Green growth is already here”

All countries are following the same energy transition curve, but progress in green energy means each wave of development emits less carbon than the last

Energy transition path of countries in each wave of economic development, between 1800 and 2019



\*All monetary values expressed in constant 2017 PPPs

Source: FT analysis of data from Gapminder, Our World in Data, World Bank

FT graphic: John Burn-Murdoch / [@jburnmurdoch](#)

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*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.*

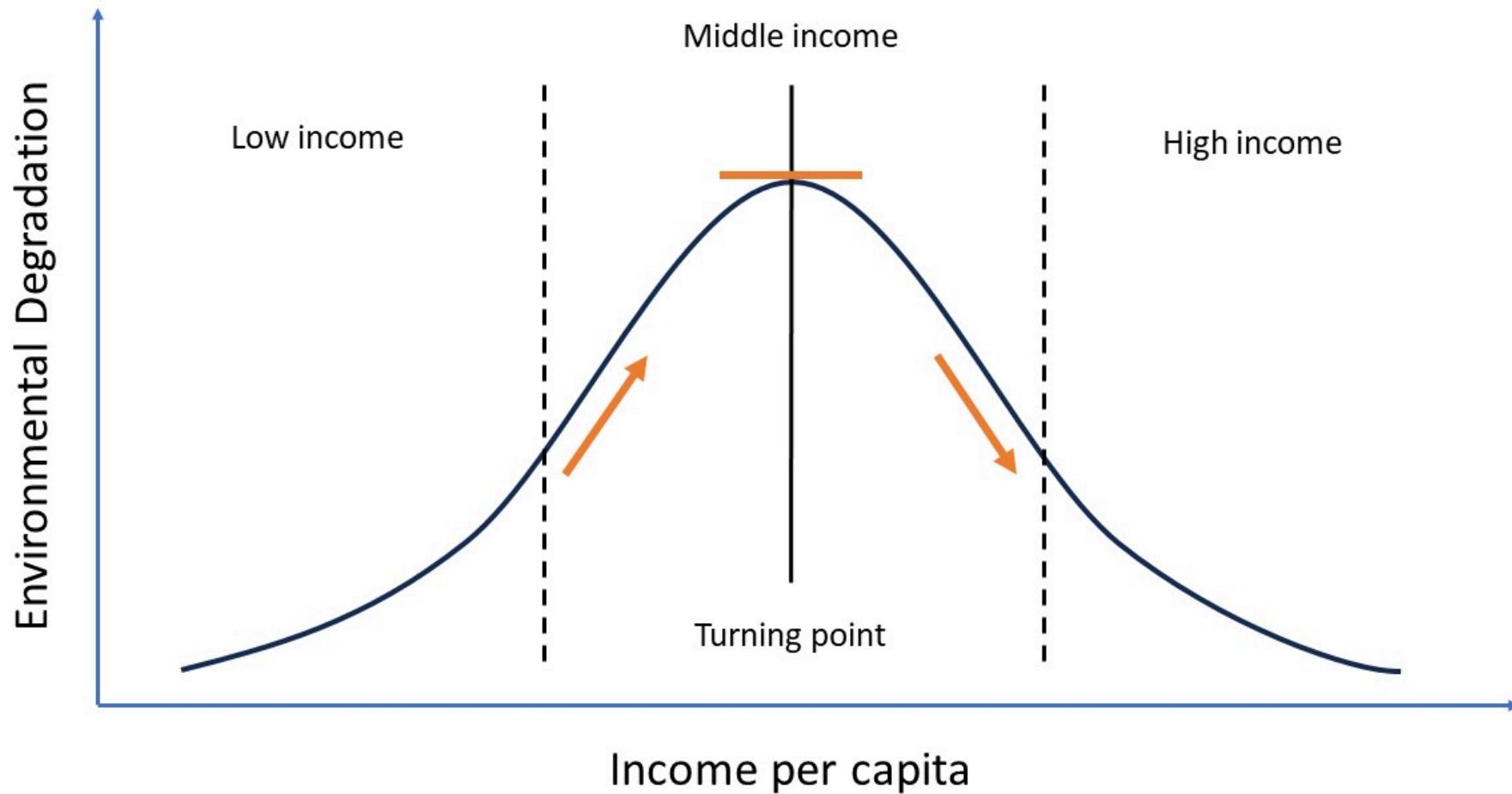
*In the early stages of economic growth degradation and pollution increase, but beyond some level of income per capita, which will vary for different indicators, the trend reverses, so that at high income levels economic growth leads to environmental improvement.”*

(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



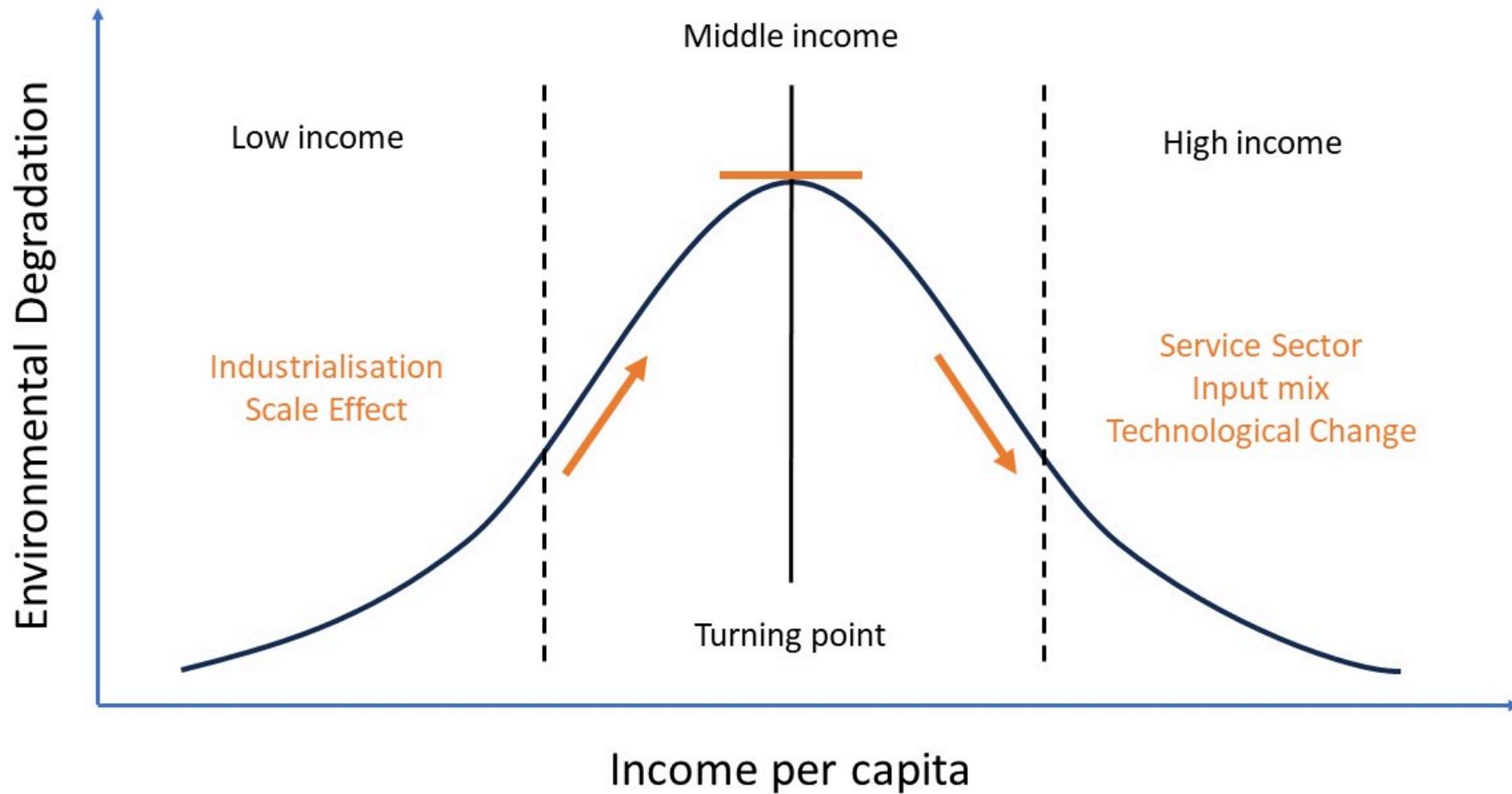
# Factors Influencing the EKC

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.

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

# The Inverted U-Shape



# What Do You Think?



<https://www.menti.com/alpxnk7jdxm>

# Your Answers

Join at <https://www.menti.com/alpxnk7jdxfm>

**What does the Environmental Kuznets Curve (EKC) hypothesis suggest about the relationship between income and environmental degradation?**

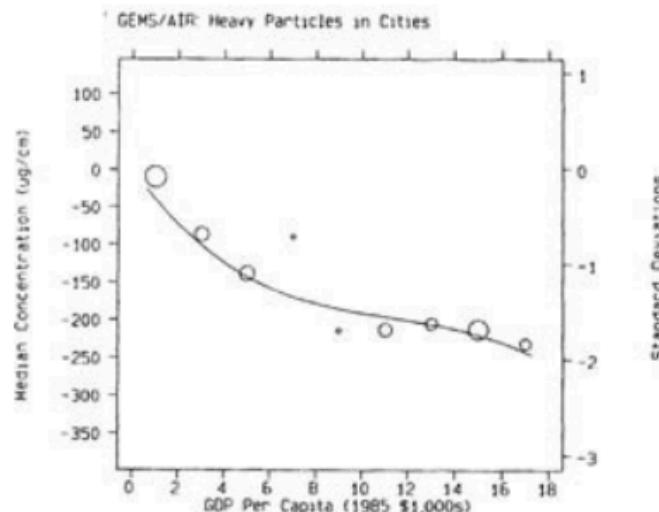
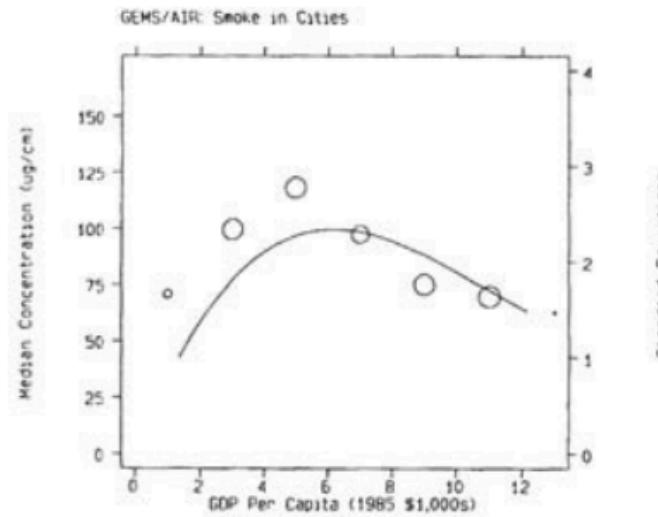
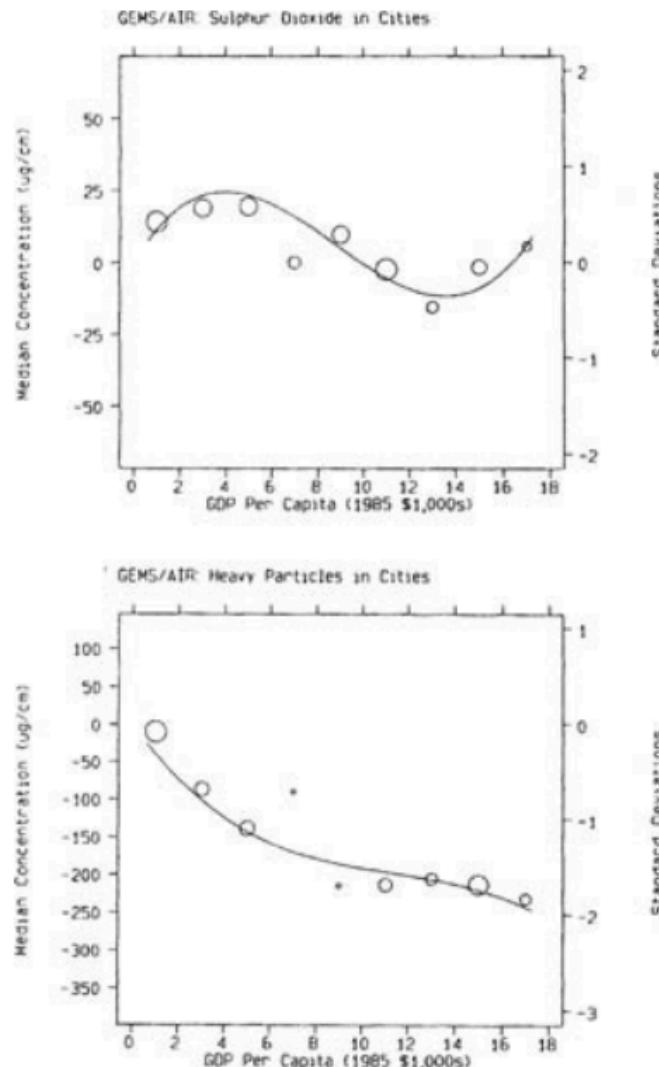


# Early EKC Studies

- Grossman and Krueger ([1995](#)) estimated EKCs for SO<sub>2</sub>, 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

# 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](#))

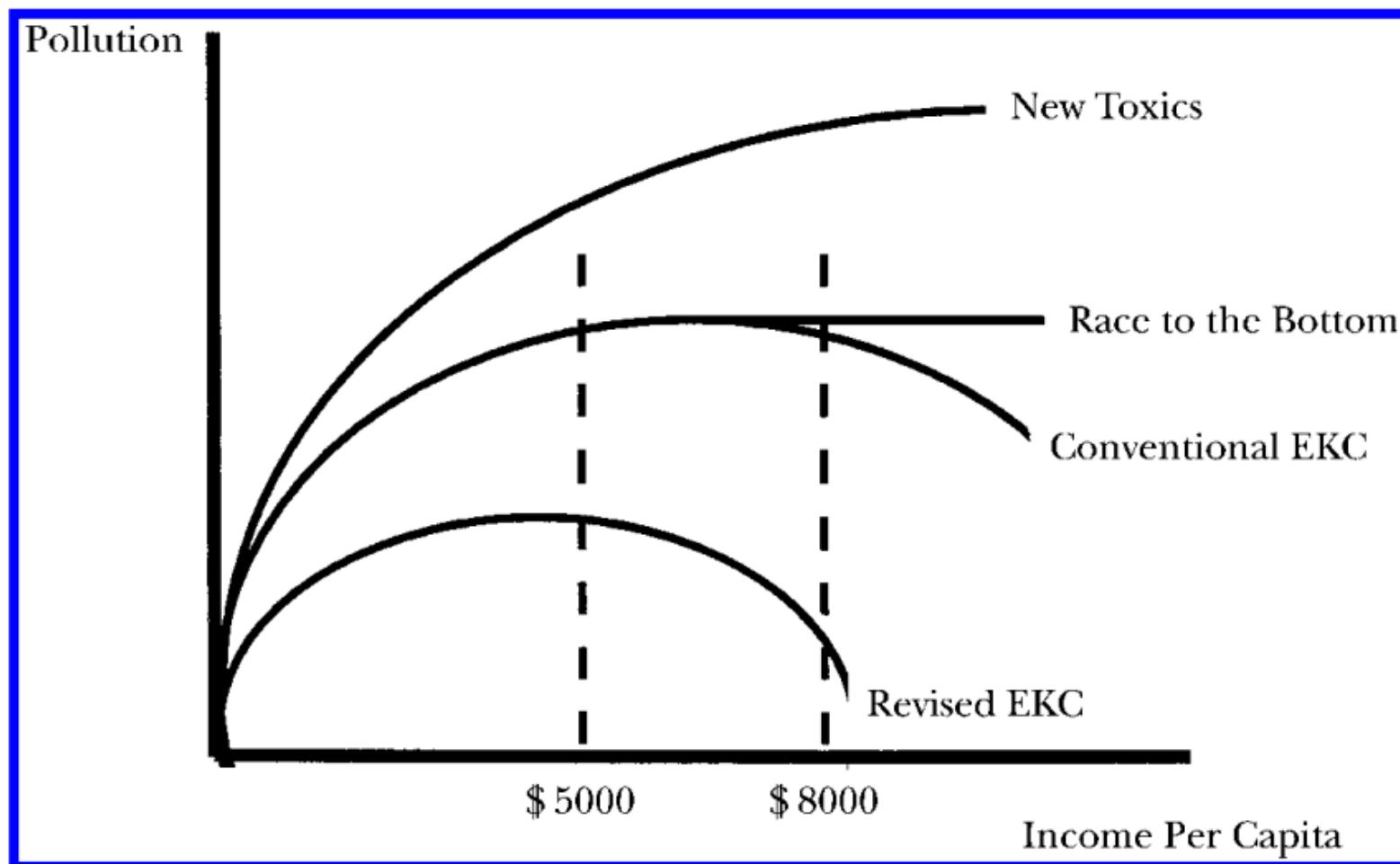
# Theoretical Challenges

- A fundamental assumption of the EKC model is that income is independent of environmental damage.
- There are likely differences between various pollutants.
- Externalisation and trade: Decrease of production in global north based on increase in global south.
- Environmental regulations in global north may negatively impact global south.
- Skewed distribution of income and wealth: increase concentrated among a small group.

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

# 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).

```

1 # load package
2 library(WDI)
3
4 # Search GDP per capita (log-transformed)
5 WDIsearch("CO2.*capita")

      indicator
032 EN.ATM.CO2E.PC
048 EN.ATM.METH.PC
059 EN.ATM.NOXE.PC

                                name
032                      CO2 emissions (metric tons per capita)
048                  Methane emissions (kt of CO2 equivalent per capita)
059 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.

```
10          'fossil_fuel_pt' = "EG.USE.COMM.FO.ZS",
11          'taxes_total' = "IC.TAX.TOTL.CP.ZS"),
12      extra = TRUE,
13      start = 2000, end = 2019)
14
15 # Drop all country aggregates
16 wd.df <- wd.df[which(wd.df$region != "Aggregates"), ]
17
18 # Save data
19 save(wd.df, file = "WDI_short.RData")
```

# Empirical Test Using 2019 data

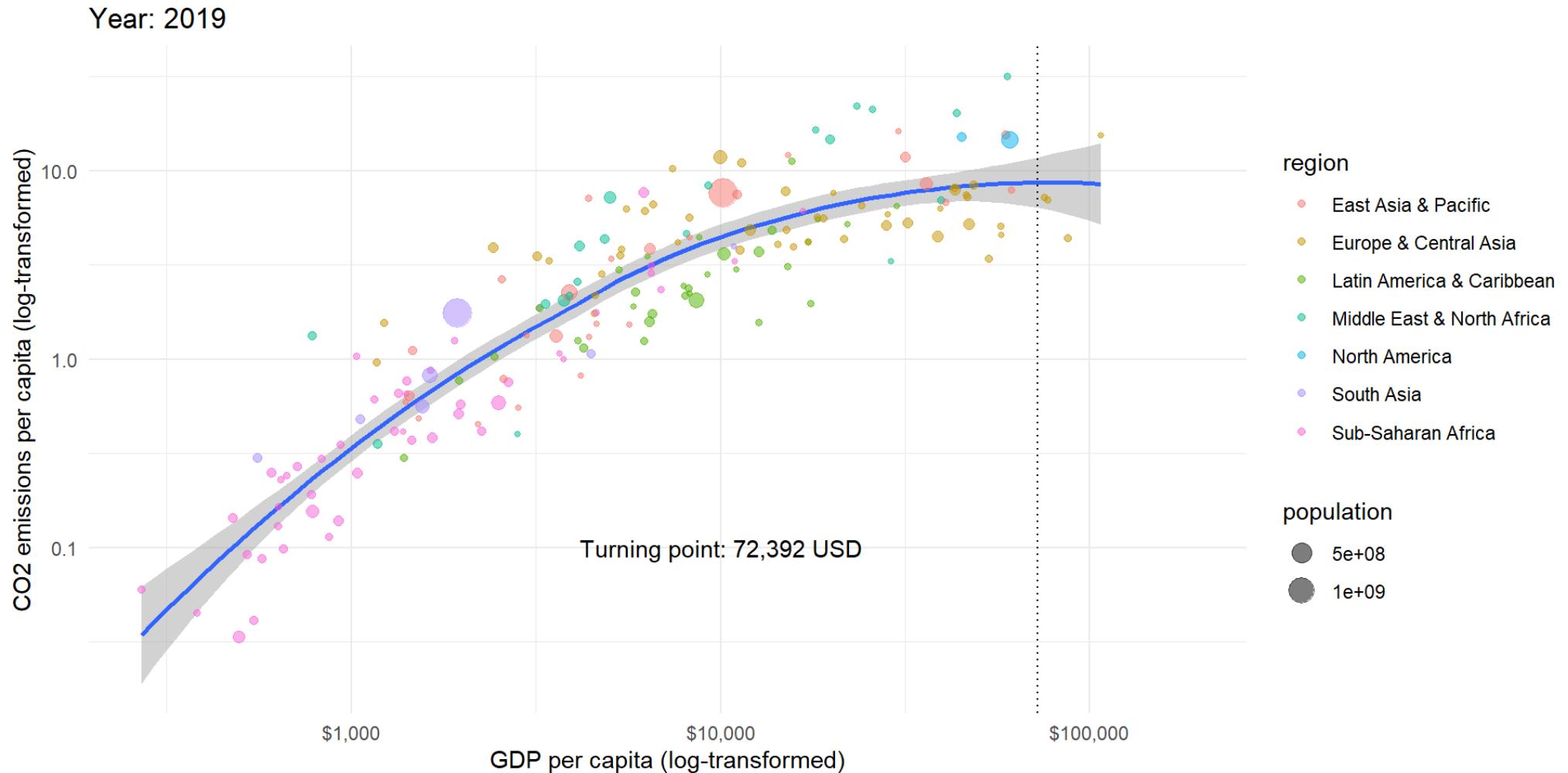
► show code

```
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

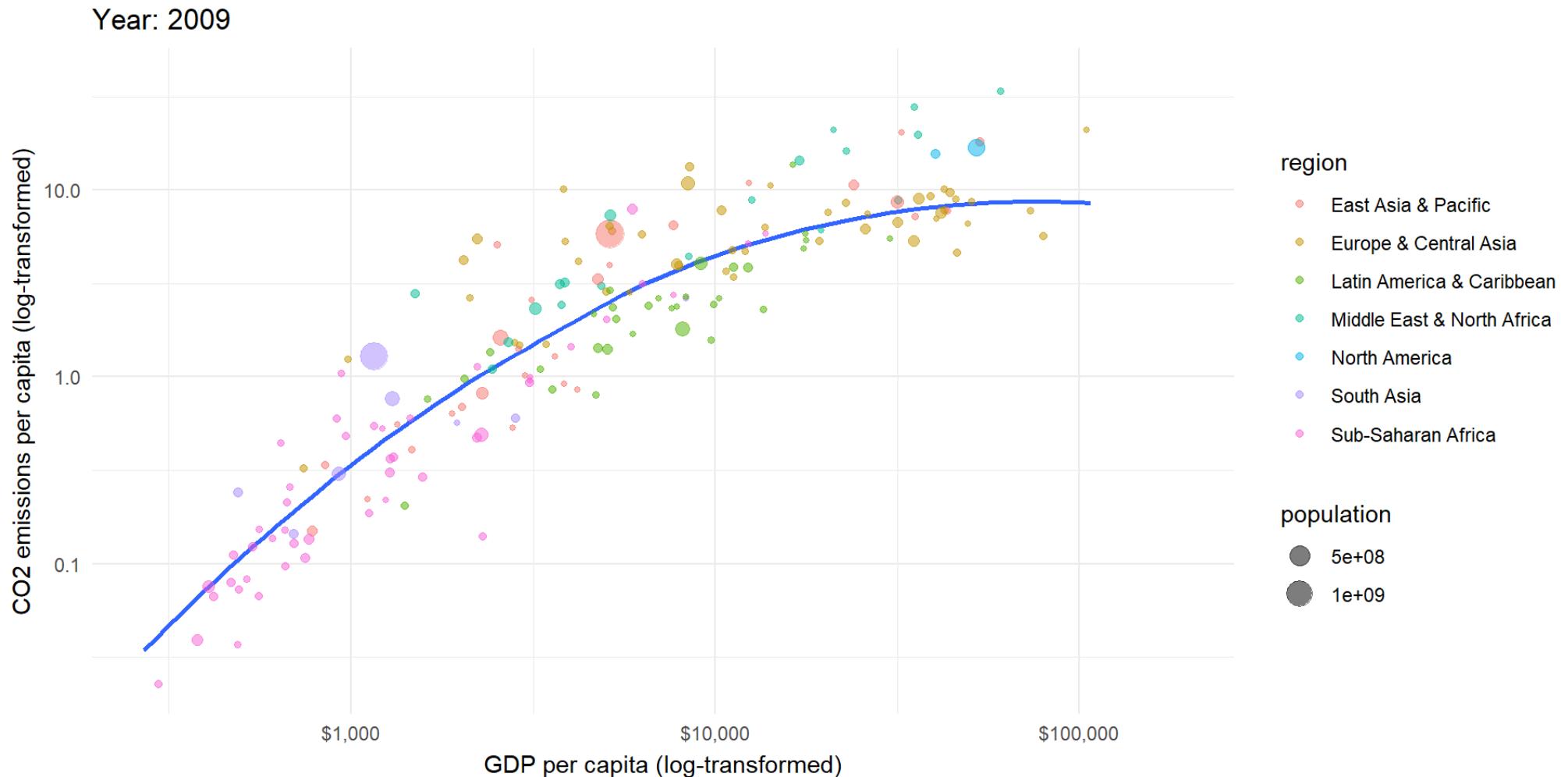
# Really a “Curve”?

► show code



# 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”

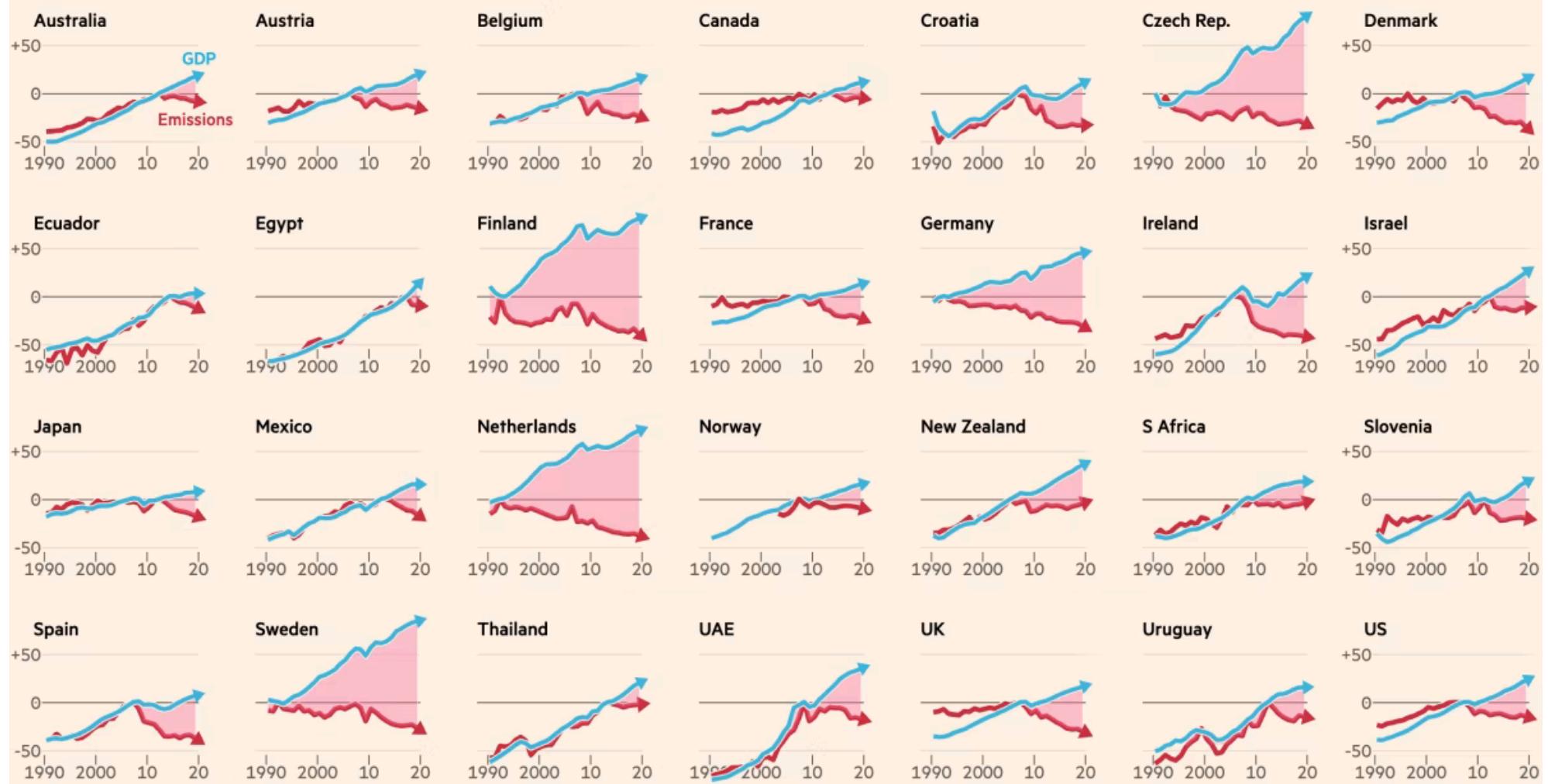
*For the best part of the past 200 years, one rule held across the world: if a country’s economic activity expanded, so did its carbon emissions. But starting in the 1980s with the advent of nuclear power, it became increasingly common to see countries cutting emissions while growing GDP.*

*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 \(2022\)](#)

## Dozens of countries are now seeing a steady decline in CO2 emissions alongside economic growth

Recent trend in emissions and GDP, expressed as % change since divergence began



\*All monetary values in constant 2017 PPPs. Emissions adjusted for offshoring of carbon-intensive products consumed domestically

Source: FT analysis of data from Gapminder, Our World in Data, World Bank

FT graphic: John Burn-Murdoch / @burnmurdoch

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

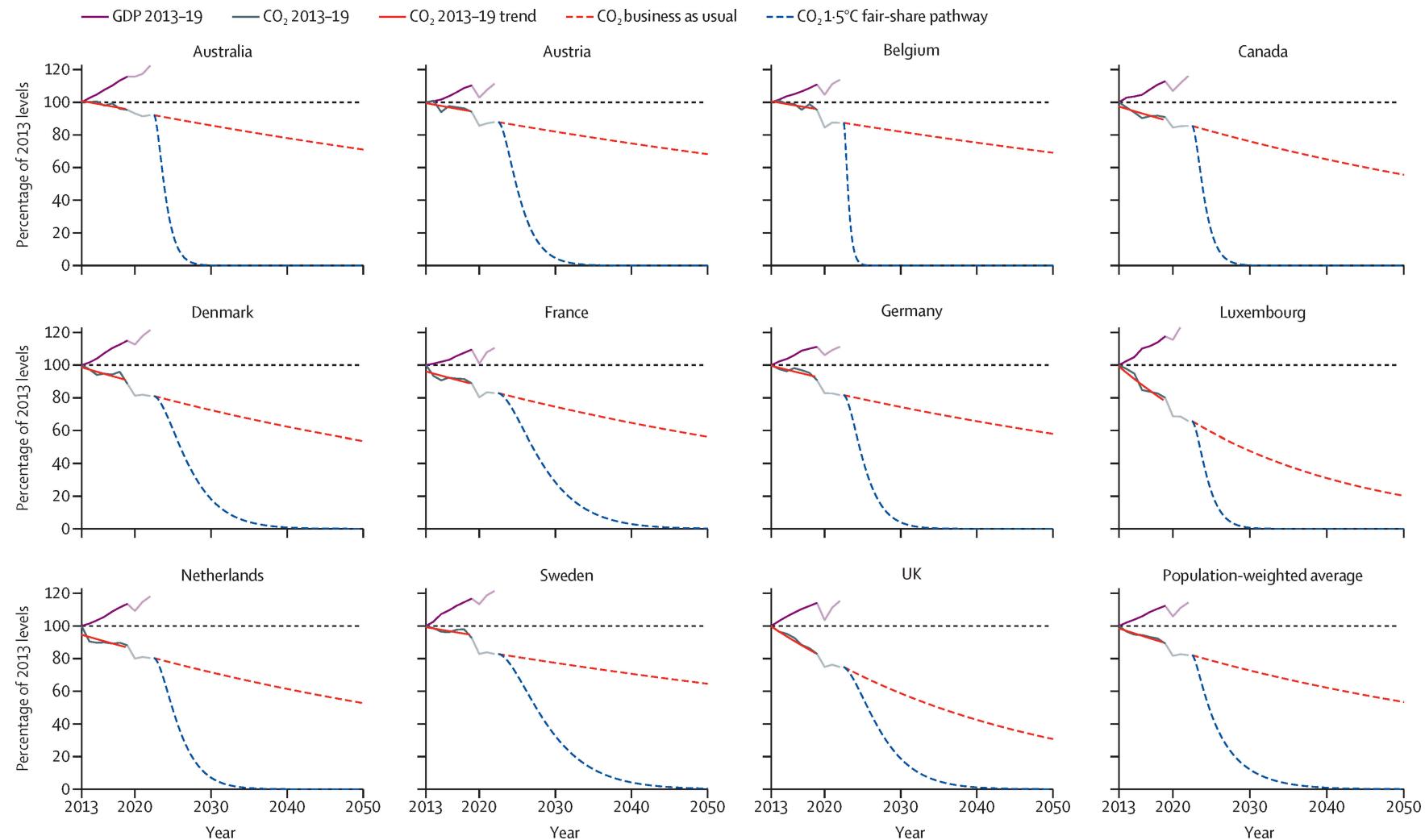
# But Remember the Absolute Level

*Over the past decade, some countries have reduced their CO<sub>2</sub> 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%*

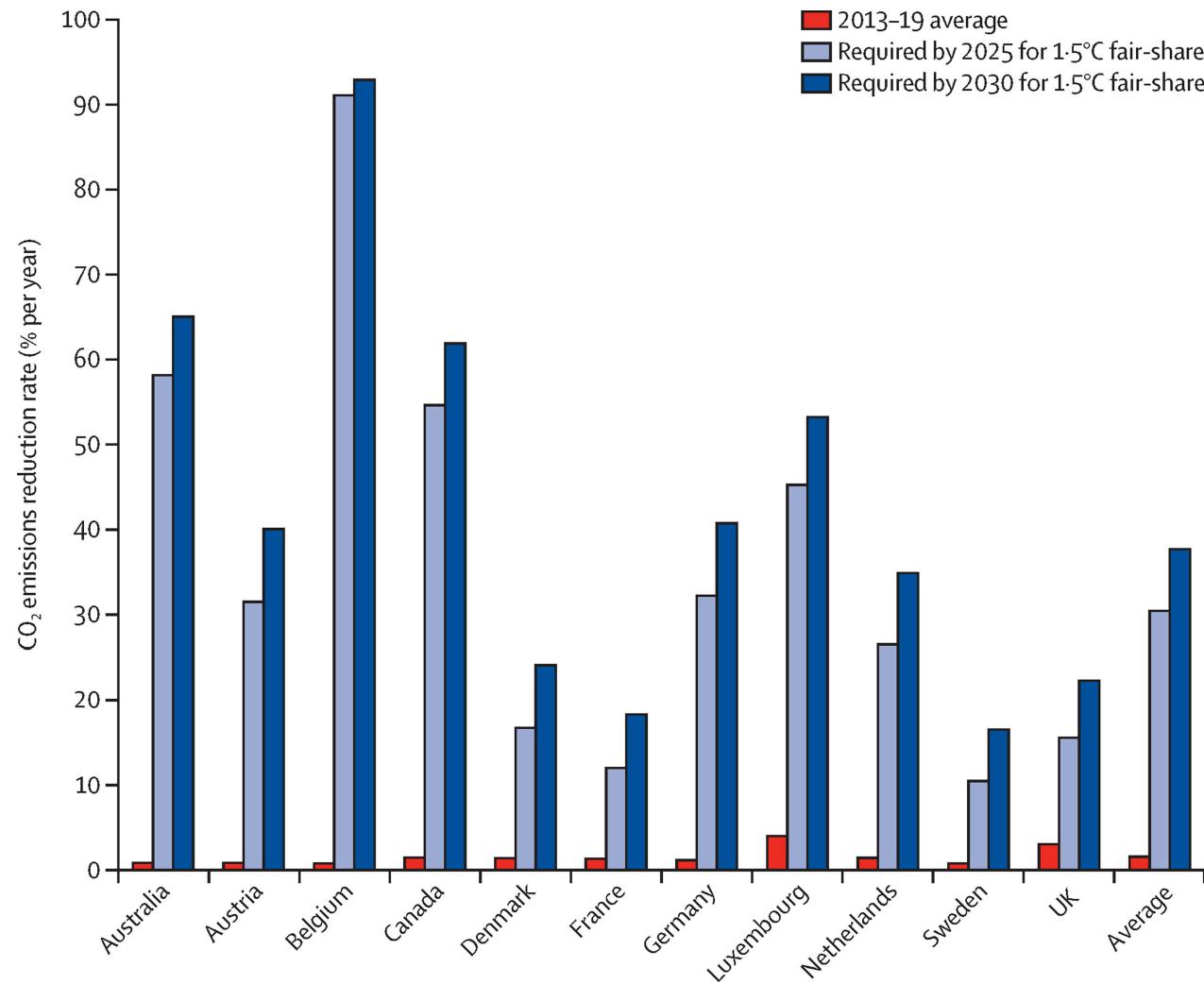
*(Vogel and Hickel 2023)*

# But Remember the Absolute Level



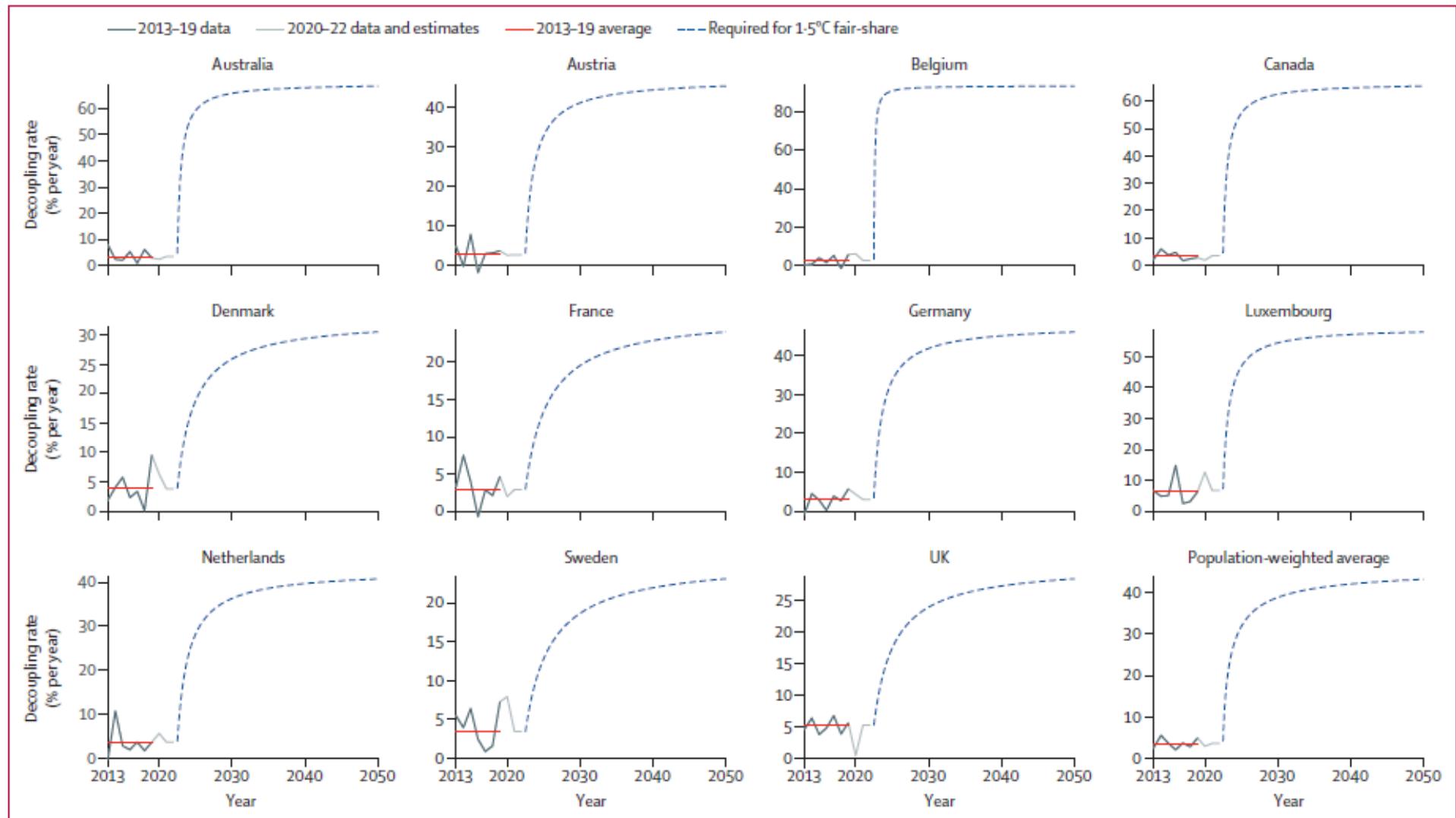
High-income countries that have recently achieved absolute decoupling. Source: Vogel and Hickel (2023)

# 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

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