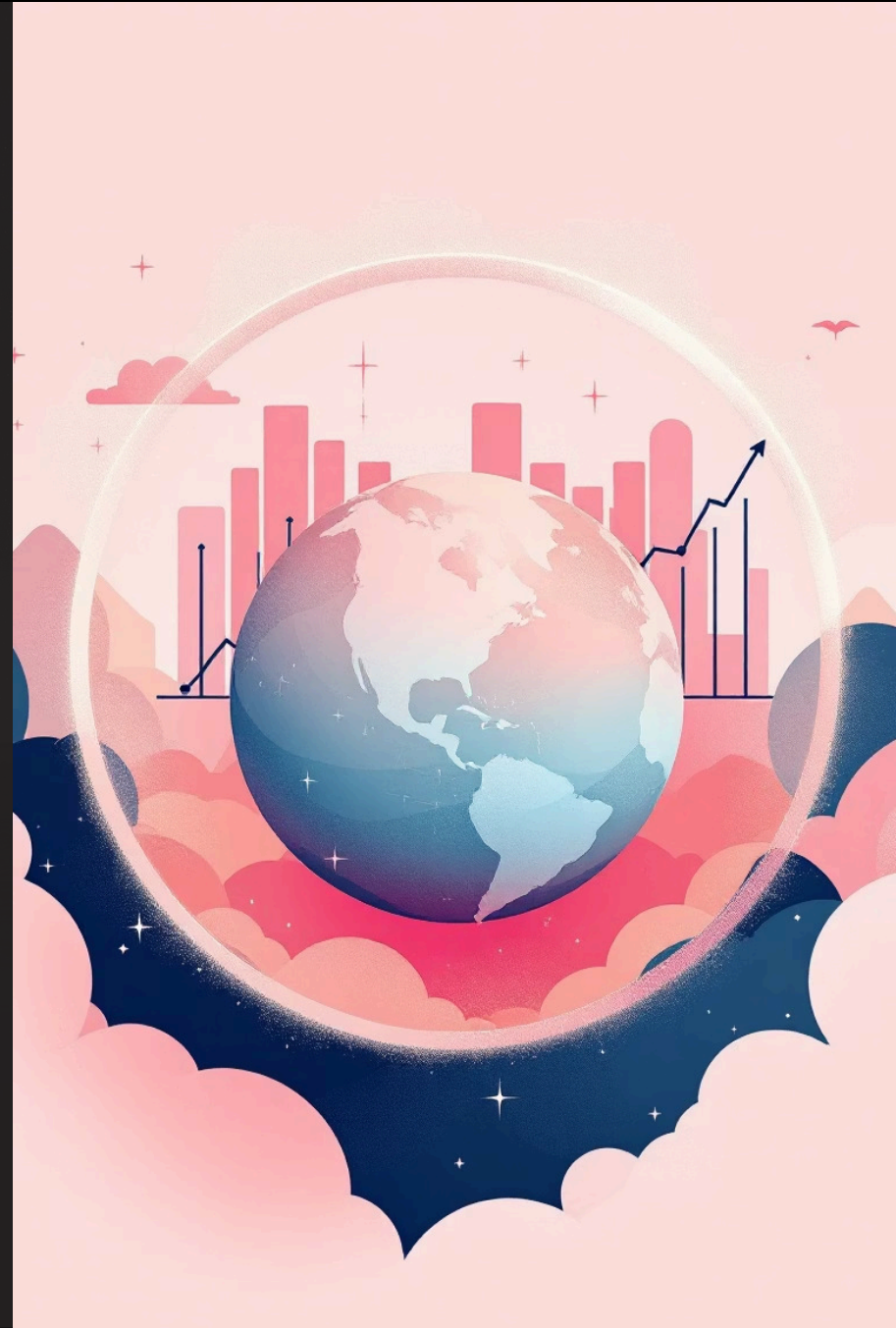
# Post-Paris Agreement Decoupling

A Data-Driven Assessment of GDP Growth & Greenhouse Gas Emissions



# Introduction: Environmental Economics

This report analyses the evolution of territorial $CO_2$, $CH_4$, and $N_2O$ emissions alongside GDP growth for major emitters between 1970–2015 and 2016–2024. We use IEA/EDGAR emissions data and World Bank GDP growth data.

1

### Emissions Evolution

How have $CO_2$, $CH_4$, and $N_2O$ emissions evolved for major economies over 1970–2015 versus 2016–2024, in respect to the Paris Agreement?

2

### GDP Co-movement

How strongly does GDP annual growth co-move with $CO_2$, $CH_4$, and $N_2O$ emissions growth over these two periods?

3

### Post-Paris Decoupling

Does the GDP per capita–emissions relationship appear weaker after the Paris Agreement, indicating partial decoupling?

# Data Significance & Relevance

Territorial $CO_2$, $CH_4$, and $N_2O$ emissions are primary drivers of anthropogenic climate change. Long-run emissions series combined with GDP growth provide an empirical basis to study whether economic development has become less carbon intensive.

## Climate Goals

Key indicators for tracking progress towards the Paris Agreement's 2°C temperature goals.

## Empirical Basis

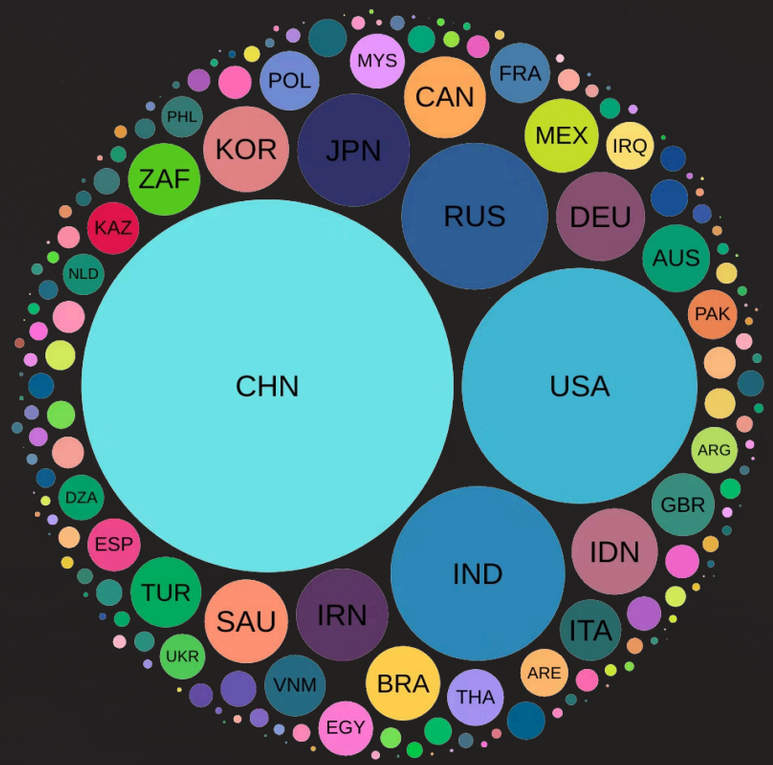
Studying if economic development has become less carbon-intensive, central to decoupling debates.

## Global Impact

Chosen countries are major contributors to emissions, global GDP, energy use, and population.

## Policy Insights

Assessing the Paris Agreement's effectiveness and informing policy on burden-sharing and transition speed.



# Technical Implementation: Data Sources

This statistical analysis was conducted using Stata/MP 19.0. We used the Emissions Database for Global Atmospheric Research (EDGAR) for annual country-level time series on $CO_2$, $CH_4$, and $N_2O$ emissions (1970–2024).

For economic data, we utilised the World Bank World Development Indicators (WDI), specifically GDP per capita (annual % growth) for the same countries and years. These sources were merged by country code and year to construct a balanced panel.

```
* 2) combine dataset (CO2 + CH4 + N2O + GDP)

use "C:\Users\Admin\Documents\Github\Group_2\Data\process\edgar_co2_1970_2024_panel.dta", clear

* merge CH4
merge 1:1 Country_code_A3 year using
"C:\Users\Admin\Documents\Github\Group_2\Data\process\edgar_ch4_1970_2024_panel.dta", keep(3) nogen

* merge N2O
merge 1:1 Country_code_A3 year using
"C:\Users\Admin\Documents\Github\Group_2\Data\process\edgar_n2o_1970_2024_panel.dta", keep(3) nogen

* merge with GDP annual growth
merge 1:1 Country_code_A3 year using
"C:\Users\Admin\Documents\Github\Group_2\Data\process\gdp_annual_growth_panel.dta", keep(3) nogen



* add post-paris agreement
capture confirm variable post_paris
if _rc {
    gen post_paris = year>=2016
}

keep Country_code_A3 Name year ///
     co2_gg co2_mt ch4_gg ch4_mt n2o_gg n2o_mt ///
     gdp_annual_growth post_paris

order Country_code_A3 Name year ///
      co2_gg co2_mt ch4_gg ch4_mt n2o_gg n2o_mt ///
      gdp_annual_growth post_paris

save "C:\Users\Admin\Documents\Github\Group_2\Data\process\multigas_gdp_countries.dta", replace
```

Our workflow was organised into Stata do-files for reproducibility: import & cleaning, merge, ranking, summarise, decoupling, and visualise. A master file allows re-running the entire workflow.

# Data Preparation & Management

Raw EDGAR Excel files for $CO_2$, $CH_4$, and $N_2O$ emissions (1970–2024) posed import challenges due to multiple header rows and explanatory notes. We identified exact data ranges and used Stata's `cellrange()` and `firstrow` options for accurate import.

### Variable Harmonisation

Renamed variables and standardised formats for consistent analysis.

### Unit Conversion

Converted emissions from gigagrams (Gg) to megatonnes (Mt) by dividing by 1,000 (1 Gg = 0.001 Mt).

### Dataset Merging

Combined cleaned datasets into a single harmonised panel linking emissions and economic variables at the country-year level.

### Post-Paris Indicator

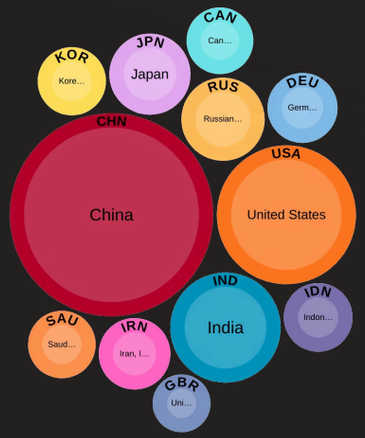
Generated an indicator for the post-Paris Agreement period (after 2016) to distinguish observations.

# Country Sample Selection

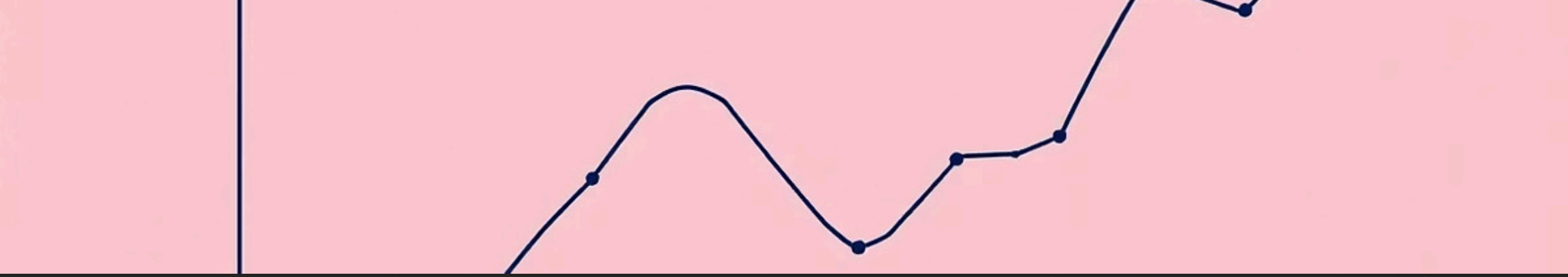
We selected a country sample transparently by computing average $CO_2$ emissions over a chosen reference period and ranking all countries. The 11 largest emitters were chosen as a core group, capturing a substantial share of global emissions and diverse economic structures.

The United Kingdom was manually added as a twelfth sample due to its relevance for this class. This list of 12 countries was saved and used as a filter for the analysis.

- China
- United States
- India
- Russian Federation
- Japan
- Iran, Islamic Republic of
- Germany
- Indonesia
- Korea, Republic of
- Saudi Arabia
- Canada




| rank | Countr~3 | Name | co2_mt_~n |
|---|---|---|---|
| 1 | CHN | China | 12032.707 |
| 2 | USA | United States | 4818.0167 |
| 3 | IND | India | 2643.5231 |
| 4 | RUS | Russian Federation | 1862.5112 |
| 5 | JPN | Japan | 1099.3531 |
| 6 | IRN | Iran, Islamic Republic of | 737.78162 |
| 7 | DEU | Germany | 683.0402 |
| 8 | IDN | Indonesia | 644.81318 |
| 9 | KOR | Korea, Republic of | 638.70157 |
| 10 | SAU | Saudi Arabia | 605.38802 |
| 11 | CAN | Canada | 579.85947 |
| 12 | BRA | Brazil | 480.25073 |
| 13 | MEX | Mexico | 473.92027 |
| 14 | ZAF | South Africa | 452.99223 |
| 15 | TUR | Turkey | 433.66389 |
| 16 | AUS | Australia | 394.80279 |
| 17 | GBR | United Kingdom | 342.80894 |
| 18 | ITA | Italy | 325.32124 |
| 19 | VNM | Viet Nam | 324.63681 |
| 20 | FRA | France | 310.55696 |
| 21 | POL | Poland | 308.24662 |
| 22 | THA | Thailand | 278.81515 |
| 23 | MYS | Malaysia | 262.34215 |
| 24 | EGY | Egypt | 259.92916 |
| 25 | ESP | Spain | 243.88359 |
| 26 | KAZ | Kazakhstan | 235.4378 |



# Decoupling Analysis: Methodology

We created absolute and relative decoupling indicators for $CO_2$ and $CH_4$ at the country-year level. These indicators help assess progress towards decoupling economic growth from greenhouse gas emissions.

### Absolute Decoupling

GDP grows while emissions fall. This represents a significant achievement in environmental policy.

### Relative Decoupling

Both GDP and emissions grow, but emissions grow more slowly than GDP. This indicates a positive trend but not a complete separation.

Focusing on the Paris period (2016-2024), we counted for each country how many years exhibited absolute or relative decoupling. We then computed the share of post-Paris years with any decoupling, and the proportion of those years that were absolute.

# Key Findings: Emissions & GDP Growth

Summary statistics reveal diverse $CO_2$ growth profiles among the selected countries. China and India show the highest average emissions with strong upward trends, particularly pre-Paris Agreement.

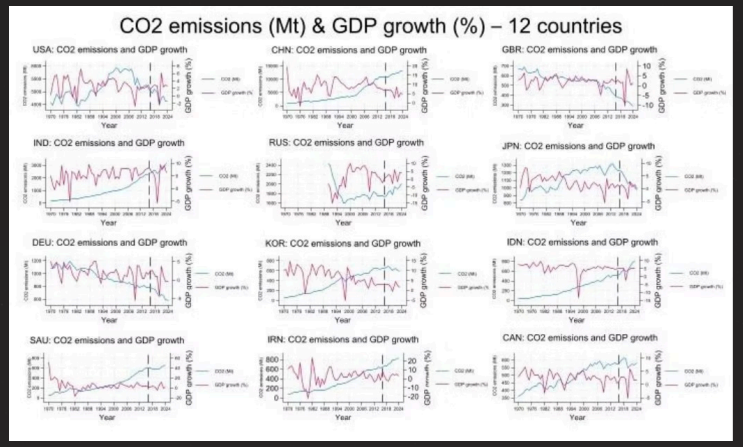
Indonesia, Iran, Korea, Russia, and Saudi Arabia also display high and volatile emissions growth.

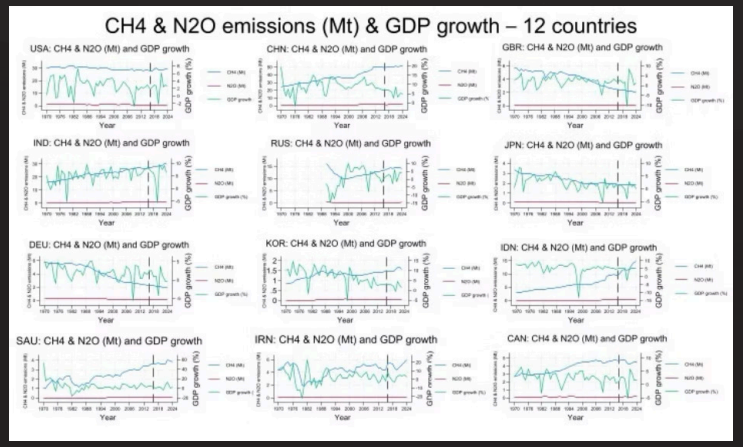
In contrast, Germany, the UK, Japan, Canada, and the US exhibit much lower average $CO_2$ growth, with several cases showing flat or declining emissions post-Paris, even as GDP continues to grow.

| | Countr~3 | sd_co2~h | sd_gdp~h | vol_ra~o |
|---|---|---|---|---|
| 1. | CAN | 3.346728 | 2.233038 | .6672303 |
| 2. | CHN | 4.235531 | 3.617203 | .854014 |
| 3. | DEU | 3.523253 | 2.098114 | .5955049 |
| 4. | GBR | 3.967454 | 2.80844 | .7078695 |
| 5. | IDN | 6.225656 | 3.205168 | .5148322 |
| 6. | IND | 3.200355 | 3.16187 | .987975 |
| 7. | IRN | 6.029222 | 7.681906 | 1.274112 |
| 8. | JPN | 3.713444 | 2.633761 | .7092501 |
| 9. | KOR | 5.759789 | 4.212189 | .7313095 |
| 10. | RUS | 4.136934 | 5.997166 | 1.449664 |
| 11. | SAU | 8.868847 | 9.443295 | 1.064771 |
| 12. | USA | 3.502833 | 2.031873 | .5800657 |

$CO_2$ growth is generally more volatile than GDP growth, especially in Indonesia and Korea. Only Iran, Russia, and Saudi Arabia show GDP growth as more volatile than $CO_2$ emissions, reflecting their resource-dependent economies.

# Visualising Decoupling Trends




Time-series graphs plot $CO_2$ emissions and annual GDP growth on dual y-axes for each country, with a vertical line in 2016 marking the Paris Agreement. These visuals highlight differing dynamics.

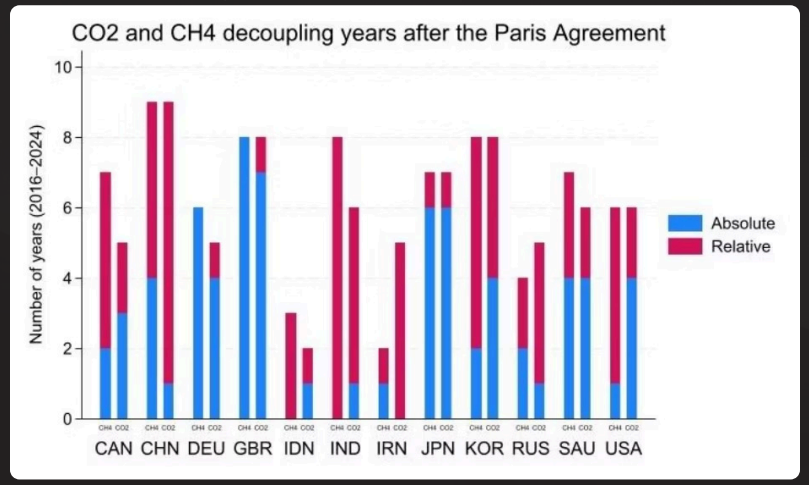
The UK and Germany show clear downward $CO_2$ trends post-2015 despite fluctuating GDP. Japan's emissions peaked in the early 2010s and then fell. India and Russia continue to show steep increases in $CO_2$.

Meanwhile, $CH_4$ and $N_2O$ emissions are broadly flat or slowly declining, while annual GDP growth fluctuates strongly. There is no systematic pattern of emissions falling when GDP rises, suggesting methane and nitrous oxide are only weakly linked to short-run macroeconomic cycles and are driven more by sectoral structures and long-term policies than by annual growth.

Overall, high-income economies achieve declining or stabilising emissions despite GDP volatility, while many middle- and lower-income countries still experience growing $CO_2$ emissions alongside economic expansion.

# Conclusions & Implications

Emissions continue to rise or plateau after 2016, but the growth rate slowed or decreased drastically compared to the pre-Paris Agreement period. GDP growth remained volatile, with spikes during the 2008 housing crisis and the 2020 Covid-19 pandemic.




1

### Absolute Decoupling

Concentrated in a small group of high-income countries post-Paris Agreement.

2

### Policy Reinforcement

Highlights the need for direct policies to shift energy mix, raise energy efficiency, and accelerate low-carbon structural change.

3

### Future Research

Incorporate energy intensity, sectoral output shares, renewable energy investment, and country-specific policies.

The continued coupling of GDP and emissions highlights challenges in aligning development objectives with strict climate targets.