

Personal Report

Who Bears the Responsibility? Insights into Global CO₂ Emissions and Responsibilities

Module: ECON 705 – Data Management and Visualization

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Abstract & Key Takeaways

- Global CO₂ emissions have doubled since 1972, from 16.2 to over 30 billion tons in 2022.
- China and India are leading contributors to total current emissions, with China accounting for 30.7% and India 7.6% of global emissions in 2022.
- Based on absolute and per capita emissions, the U.S. emitted over 15 billion tons per person in 2022.
- Cumulative emissions reveal that the U.S. remains the highest historical emitter, responsible for more than 20% of global emissions.
- High-income nations bear significant responsibility due to their historical and per capita emissions, while emerging economies like China and India require support to transition sustainably.
- GDP per capita and emissions are correlated: Wealthier countries typically have higher emissions, but some nations are decoupling economic growth from carbon output through clean energy initiatives.
- Effective action such as investments in renewable energy, improving energy efficiency, and supporting technology transfers, requires collaboration, balancing responsibilities across regions.

Introduction

This analysis investigates CO₂ emissions using data from Our World in Data, focusing on trends, and controversies surrounding the responsibility of reducing emissions. The study spans the 50-year period from 1972 to 2022, allowing for an examination of both historical and contemporary dynamics. This timeframe captures critical events such as the industrialization of emerging economies, key global crises, and the rise of clean energy technologies. 2022 is the most current data.

The study addresses the following key research questions:

1. How much CO₂ has been emitted over time?
2. Who should bear the highest responsibility for reducing emissions?
3. What is the relationship between per capita GDP and per capita emissions?

By addressing these questions, the analysis aims to contribute to the global debate on emissions responsibilities, particularly focusing on the roles of China and India.

Analysis

1. How much CO₂ has been emitted over time?

Figure 1. Annual global CO₂ emissions and percentage change, 1972 to 2022

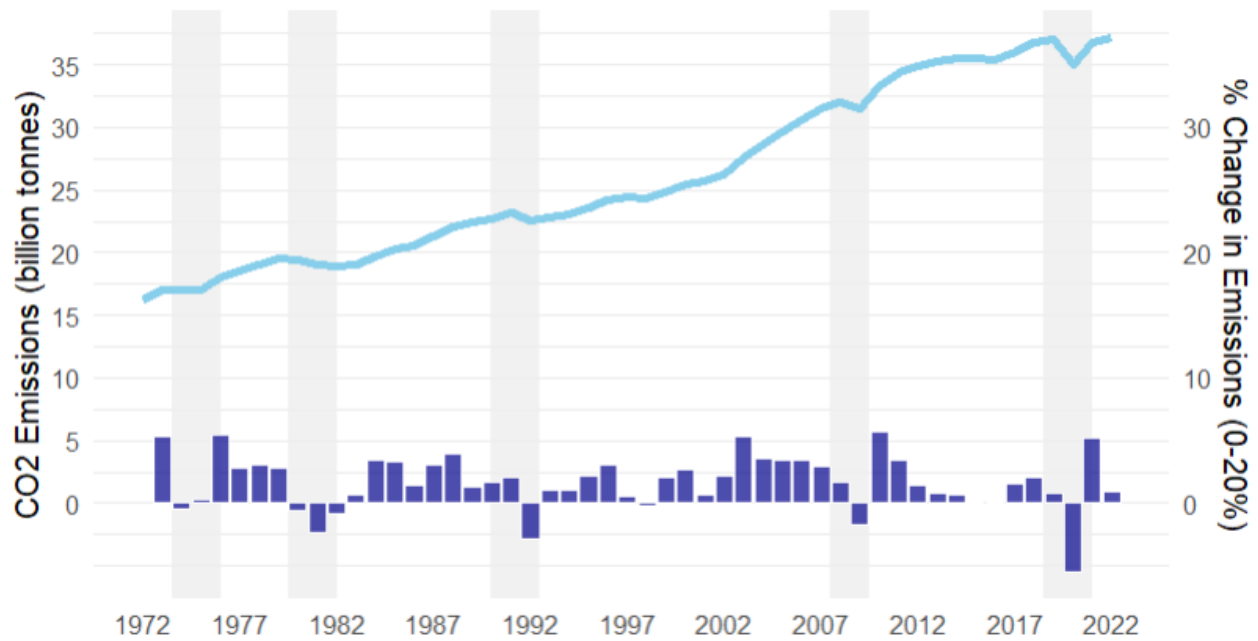


Figure 1 illustrates the overall **increase in CO₂ emissions, doubling from 16.2 to over 30 billion tons in 2022**. This trend is primarily driven by industrialization, economic growth, and rising energy demand worldwide (FAO, n.d.). Although emissions growth has slowed in recent years, they have yet to reach their peak (Our World in Data, n.d.).

Data also reveals that notable **plateaus and declines in emissions align with significant macroeconomic and geopolitical events**, such as the two energy shocks of 1970s, the Soviet Union's collapse in the early 1990s, the 2008 financial crisis and the COVID-19 pandemic in 2020 (Harvard China Project, n.d.). These events temporarily slowed emissions growth or led to sharp declines, followed by recovery periods.

In recent decades, particularly since 2010, the growth rate of emissions has slowed, probably due to solar, wind power, and other clean energy technologies. However, the challenge of rising emissions persists, underscoring the urgency of sustained action to reduce emissions globally.

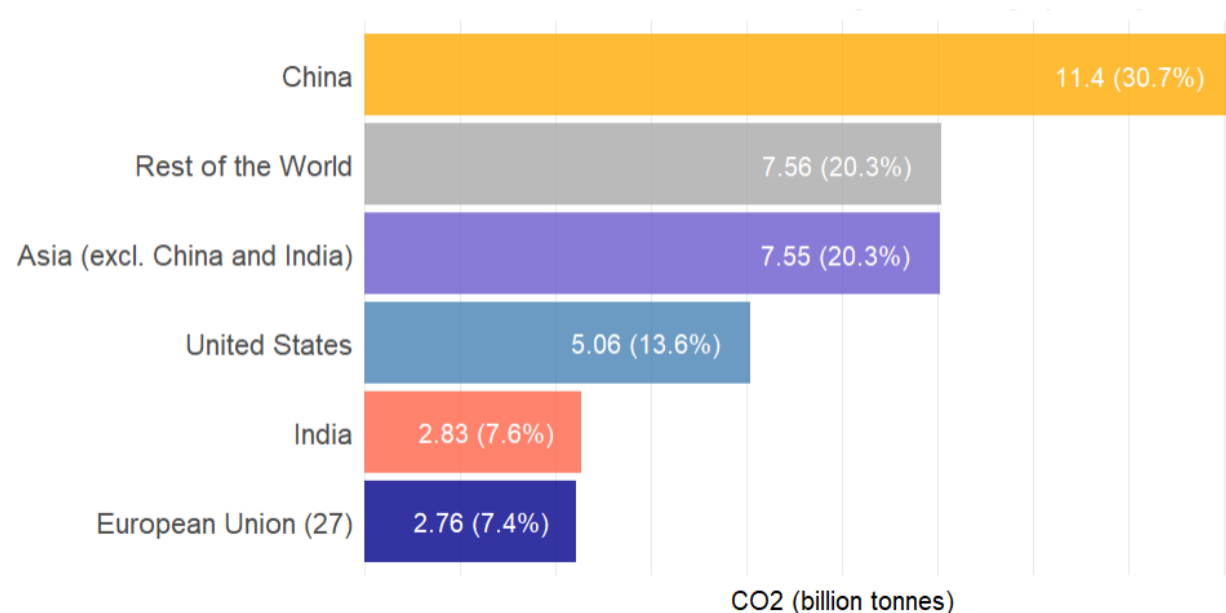
2. Who should bear the highest responsibility for reducing emissions?

The global debate on emissions responsibility often focuses on current contributors, with China and India among the top emitters (BBC, 2021) (Euronews, 2021).

Our analysis starts to discuss this debate by exploring the top five highest CO₂ emitters in 2022 (Figure 2). Data shows that **China ranked first with 30.7% of global emissions, while India contributed 7.6% in 2022**. Collectively, they represent over one-third of global emissions, driven by industrial growth and rising energy demands.

This reflects China's energy-intensive industrial base and continued reliance on coal and presents India as a rapidly growing emitter due to its expanding energy demands and population growth. However, these absolute figures do not tell the full story. Our analysis will examine the debates over per capita emissions and within historical contexts in the following parts.

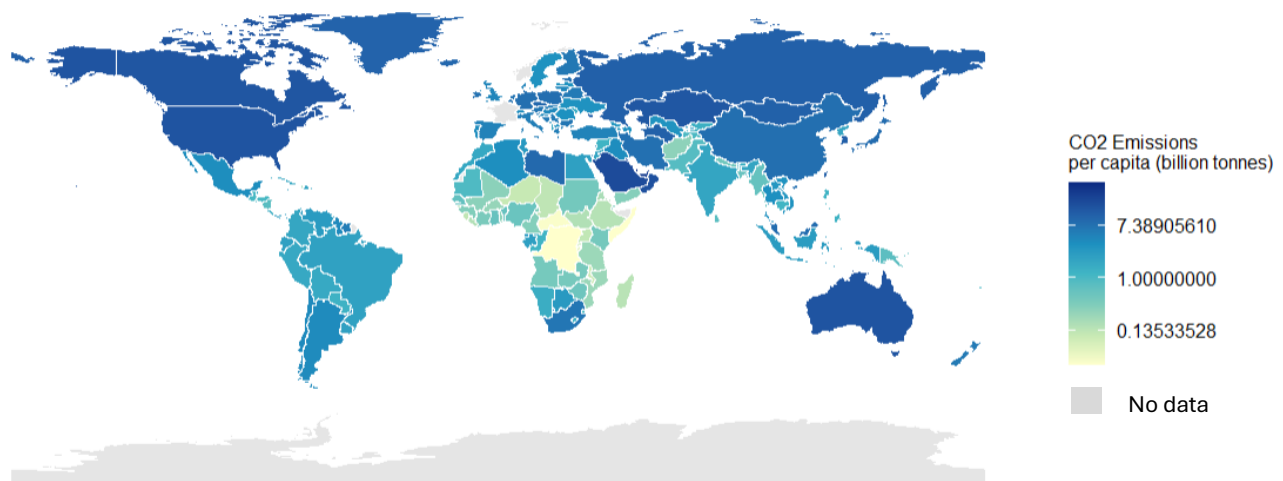
Figure 2. Regions* with the highest CO₂ emissions and the rest of the world in 2022 (in billion tons CO₂ and percentage of the global)



**Regions are based on Our World in Data (n.d.)*

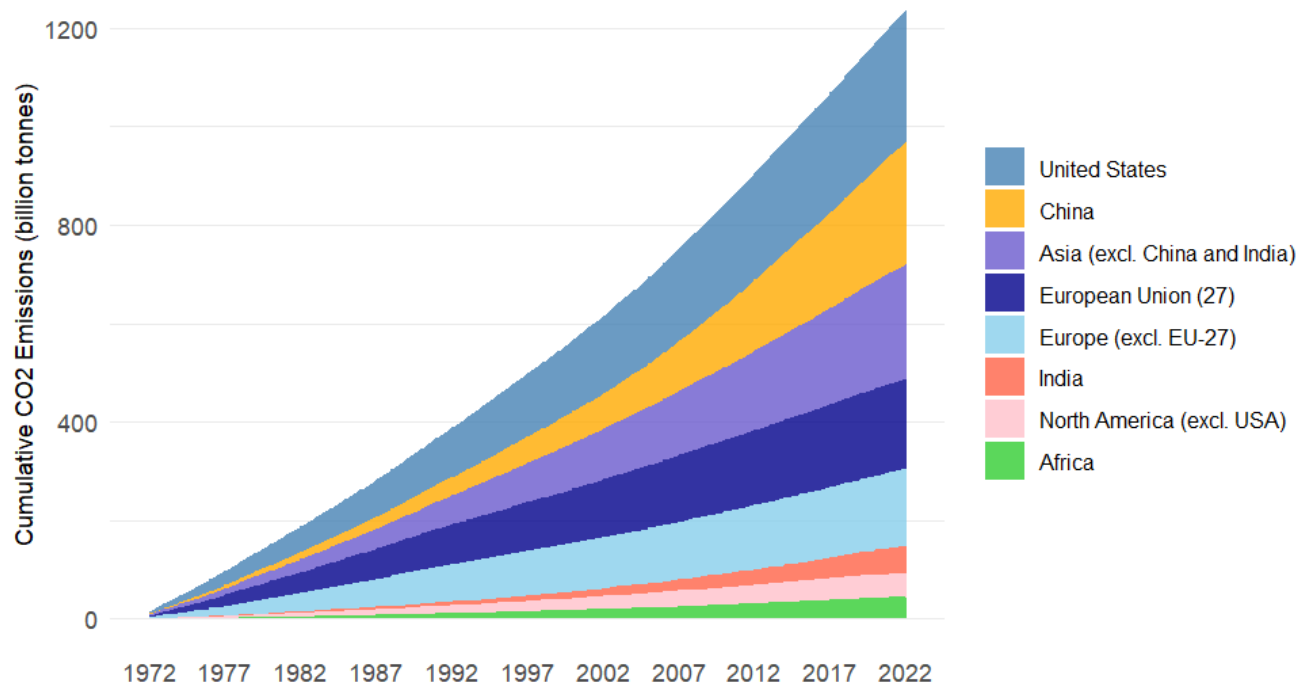
Next, when our report considers emissions per capita, the narrative shifts. High-income nations, particularly in North America and the Middle East, exhibit the highest per capita emissions. In contrast, many low to middle-income countries, especially in Sub-Saharan Africa and parts of Asia, maintain per capita emissions below 1 ton. According to Figure 3, **in 2022, the United States emitted over 15 tons of CO₂ per person, significantly higher than China (8.1 tons) and India (2.0 tons).**

Figure 3. World map of CO₂ emissions per capita in 2022



Finally, cumulative CO₂ emissions (in Figure 4) suggesting that placing the blame solely on China and India ignores the 50-year contributions of emissions from developed nations. Countries like the **United States and the European Union, peaked in emissions decades ago** and have since stabilized or declined due to energy transitions and policy measures. **United States alone has emitted approximately 268 billion tons of CO₂ since 1972**, the highest globally, accounting for over one-fifth of historical emissions. In contrast, China's emissions surged post-2000, reflecting rapid industrialization. India, while growing steadily, remains a relatively minor contributor historically.

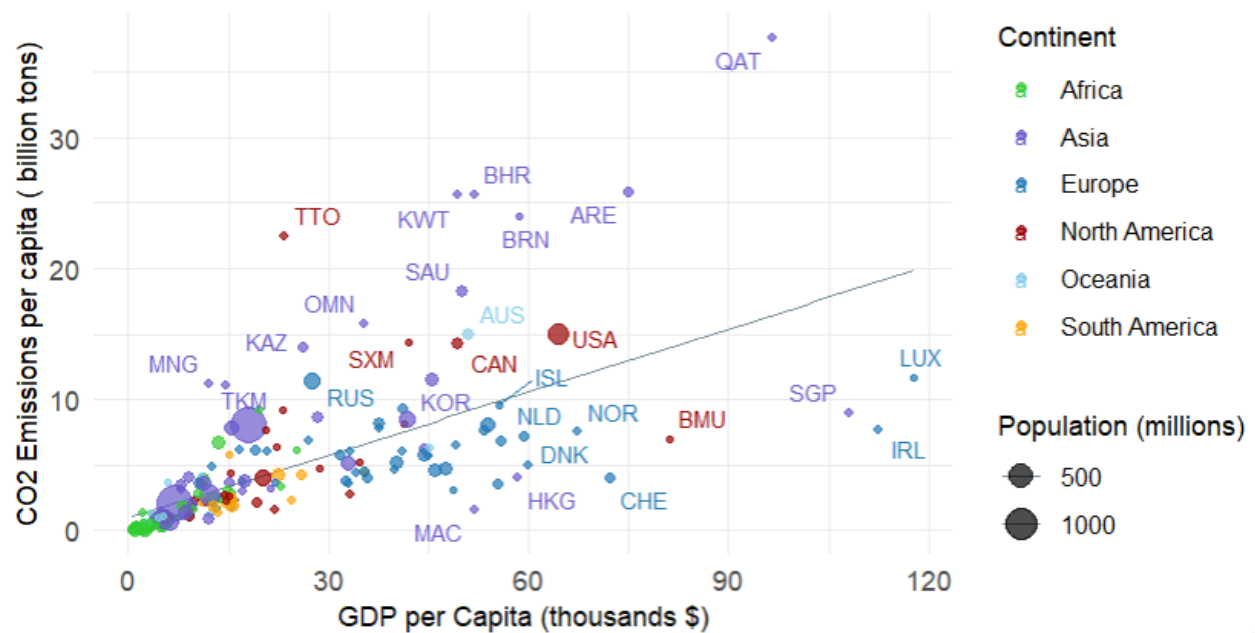
Figure 4. Cumulative CO₂ emissions by regions, 1972 to 2022



3. What is the relationship between per capita GDP and emissions?

Generally, it shows that **as GDP per capita increases, CO₂ emissions per capita also tend to rise**. This trend indicates that wealthier countries, which typically have higher GDP per capita, often have higher CO₂ emissions per capita due to greater industrial activity, energy consumption, and transportation needs. However, it's important to note that this relationship is not uniform across all countries. **Some nations have managed to decouple economic growth from CO₂ emissions**, meaning they have increased their GDP without a corresponding rise in emissions (Our World in Data, n.d.). The result of regression (Appendix B) explains a moderate proportion of the variance, suggesting that while GDP per capita is a crucial factor, other variables may also contribute to the outcome. This report does not include a more comprehensive regression modeling due to the time constraint.

Figure 5. CO₂ emissions per capita vs. GDP per capita, 2022



Conclusion

The report underscores the complexity of the global CO₂ emissions debate, emphasizing the significant contributions of China and India as current top emitters while highlighting the broader context of historical and per capita emissions. Although China leads global emissions today and India's share is rapidly increasing, the United States and other developed nations remain the highest contributors when considering cumulative emissions and per capita output.

This disparity in emissions responsibility calls for a balanced approach. While emerging economies like China and India must be responsible for reducing emissions, their economic development demands, and lower historical contributions necessitate equitable solutions. Advanced economies, with their greater financial and technological resources, should lead by example. This includes making investments in renewable energy, improving energy efficiency, and providing technology transfers to developing nations.

However, the analysis has its limitations as it does not fully account for regional disparities, consumption-based emissions, or other socio-economic factors

influencing emissions. Future research could explore alternative metrics, such as consumption-based CO₂, emissions per dollar of GDP, sector-specific emissions, to provide a more nuanced understanding of global emissions responsibilities.

Appendix

Appendix A. Top emitters contribution of CO₂ emissions, GDP, and population

Entity	CO ₂ emissions (billion tons)	% Global CO ₂ Emissions	% Global Cumulative Emissions
World	37,149.8	100.0%	100.0%
China	11.4	30.7%	18.7%
Asia (excl. China and India)	7.5	20.3%	17.5%
United States	5.1	13.6%	20.1%
India	2.8	7.6%	4.1%
European Union (27)	2.8	7.4%	13.6%

Appendix B. Regression output between per capita GDP and CO₂ emissions

Variable	Estimate	Std. Error	t-value	p-value	Significance
Intercept	0.9315	0.4340	2.146	0.0332	*
GDP per Capita	0.0001607	0.00001368	11.749	< 0.0001	***

Model Statistics	Value
Residual Standard Error	4.207 (on 184 degrees of freedom)
Multiple R-squared	0.4286
Adjusted R-squared	0.4255
F-statistic	138 (on 1 and 184 degrees of freedom)
p-value (overall model)	< 2.2e-16

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