# Econometrics for Climate Change

Session 4 — Causality in Climate Econometrics

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2026-04-28

# Objectives For Today’s Session

- Modern econometrics is more about finding causal relations
- What does it mean that there is a causal relationship?
  - Linear regression: More a tool than the final objective
- Example: Carbon pricing mitigation strategies

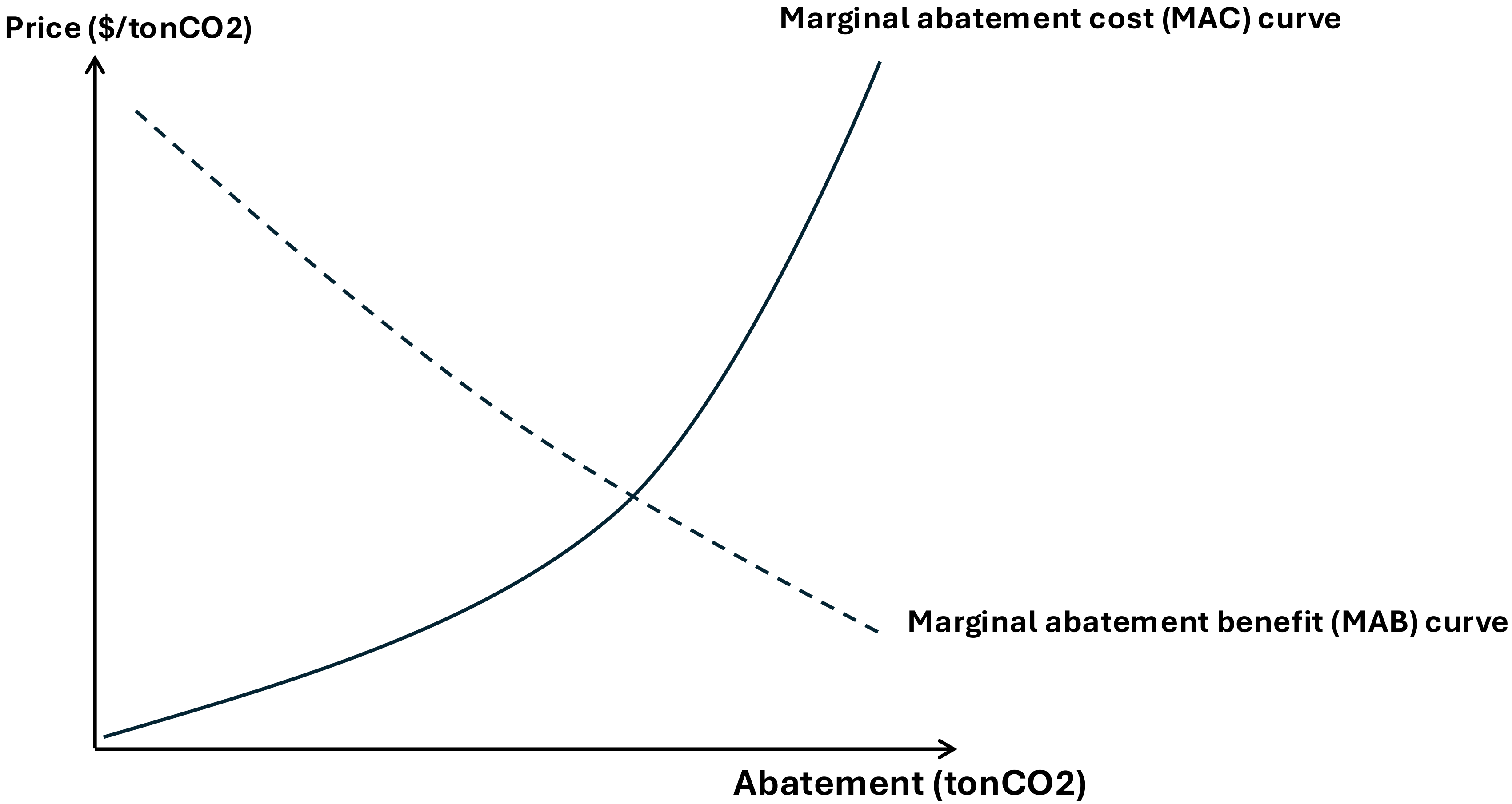
# Carbon pricing?

- What is carbon pricing?

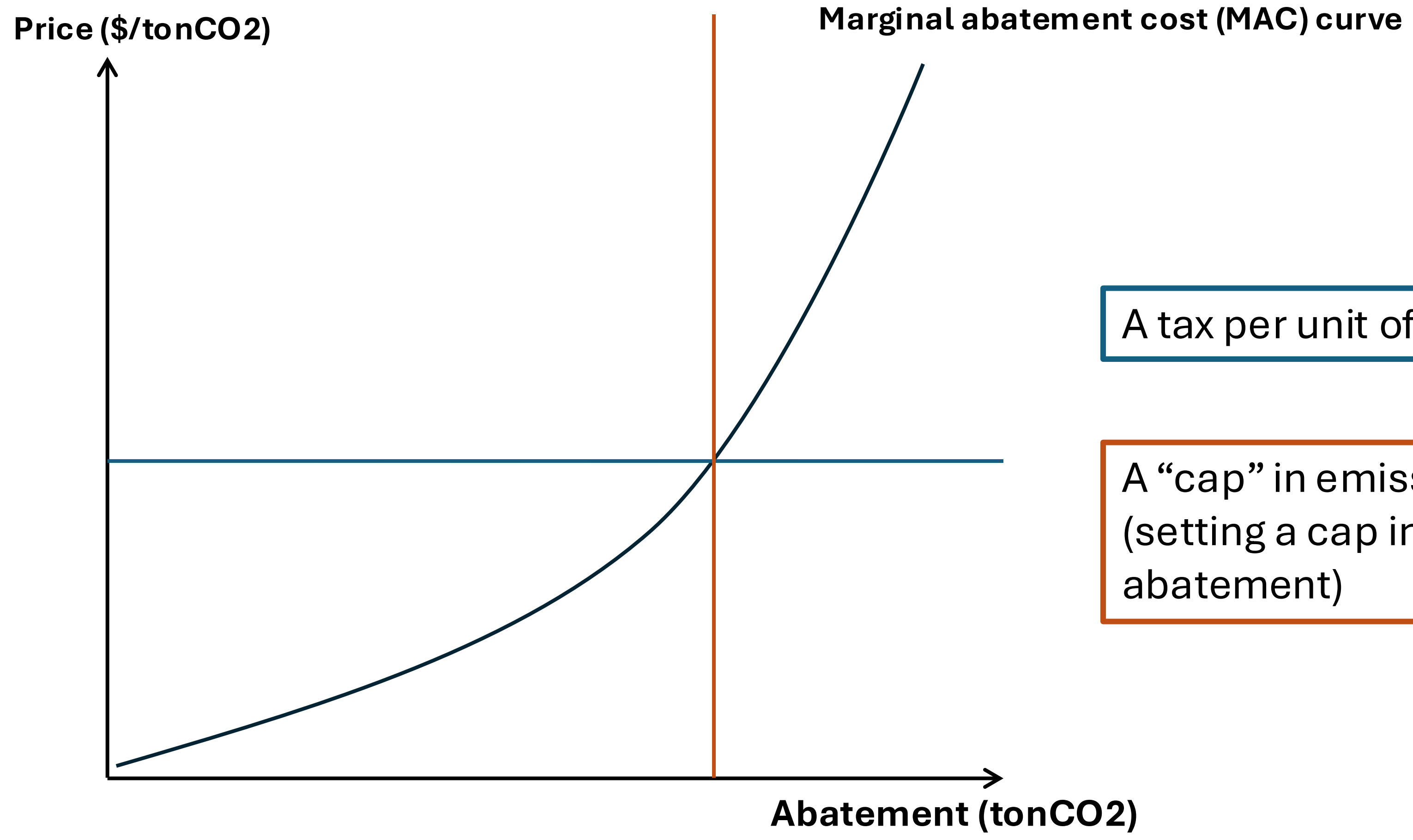
  **Carbon pricing** is a policy mechanism that puts a direct monetary cost on greenhouse gas emissions, making polluters pay for the climate damage their emissions cause.

- What are the two main pricing policies for addressing climate change?

# Taxes Vs Cap and trade



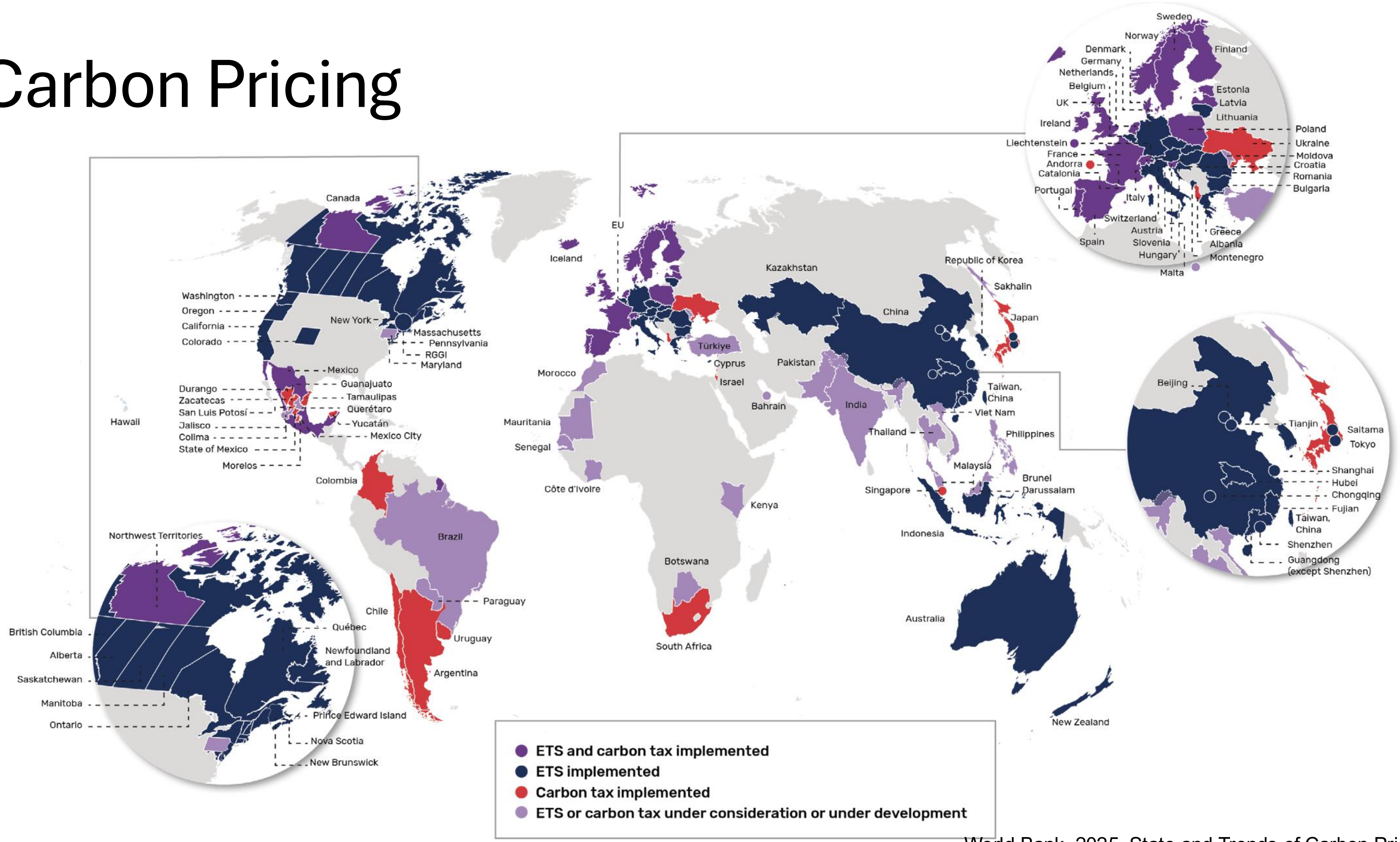
# Taxes Vs Cap and trade




A tax per unit of emission

A “cap” in emissions (setting a cap in the abatement)

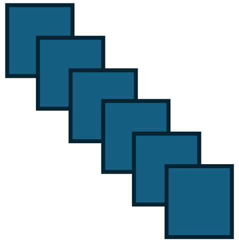
# Carbon Pricing



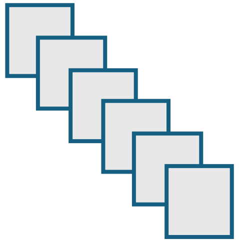

World Bank. 2025. State and Trends of Carbon Pricing 2025.

# Is carbon pricing working?

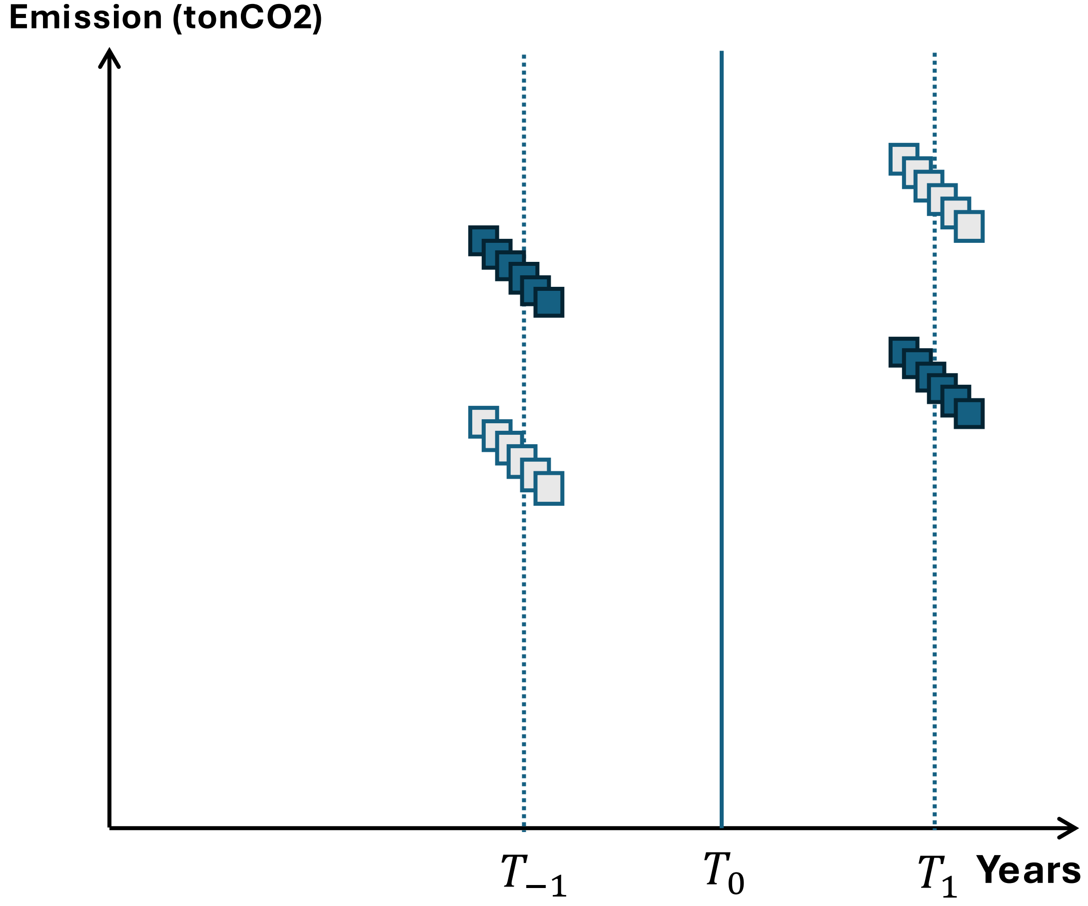
- Who can we answer that question?



Set of countries that have some form of Carbon Pricing



Other that don't



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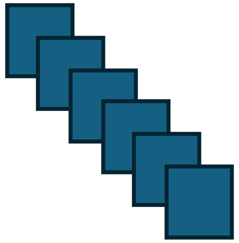

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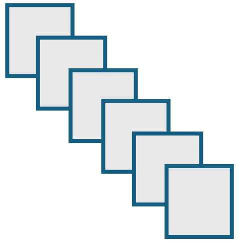
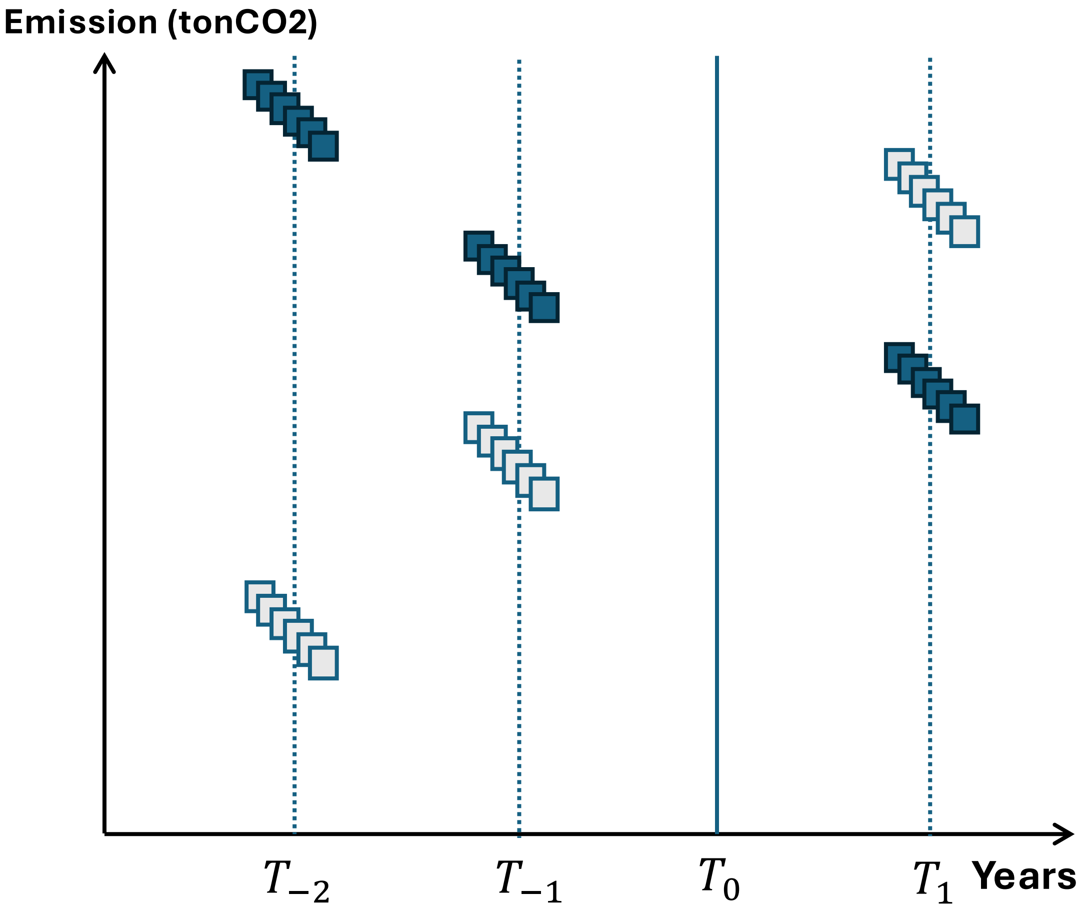


Other that don't

What if this was the case in $T_{-2}$?
Will this change your opinion?



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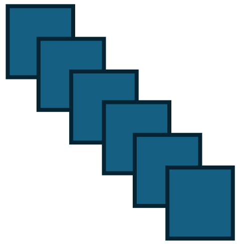

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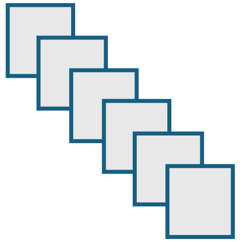
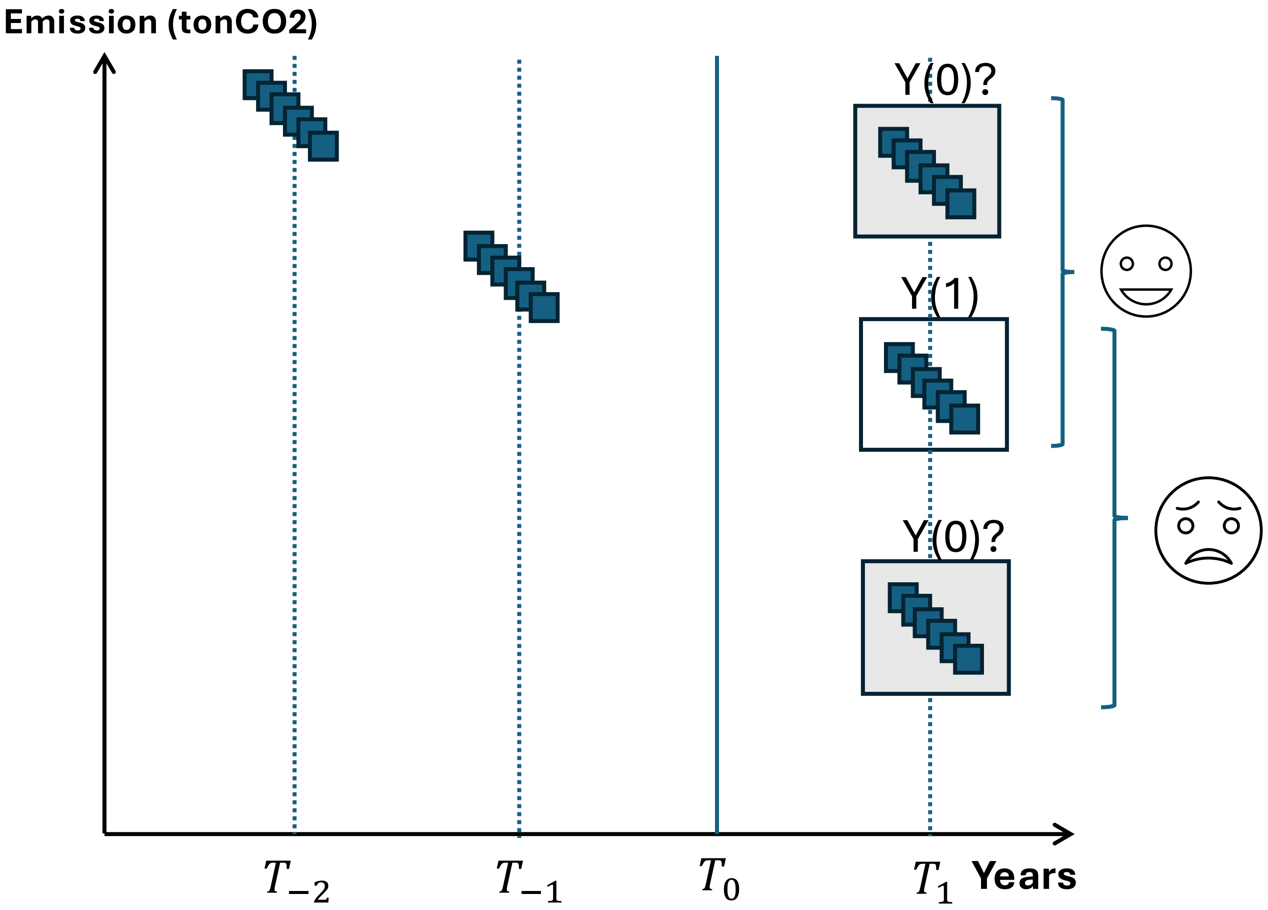


Other that don't

***The fundamental problem of causal inference!***

**Correlation is different to causation**



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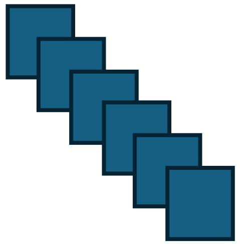

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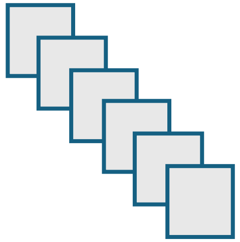

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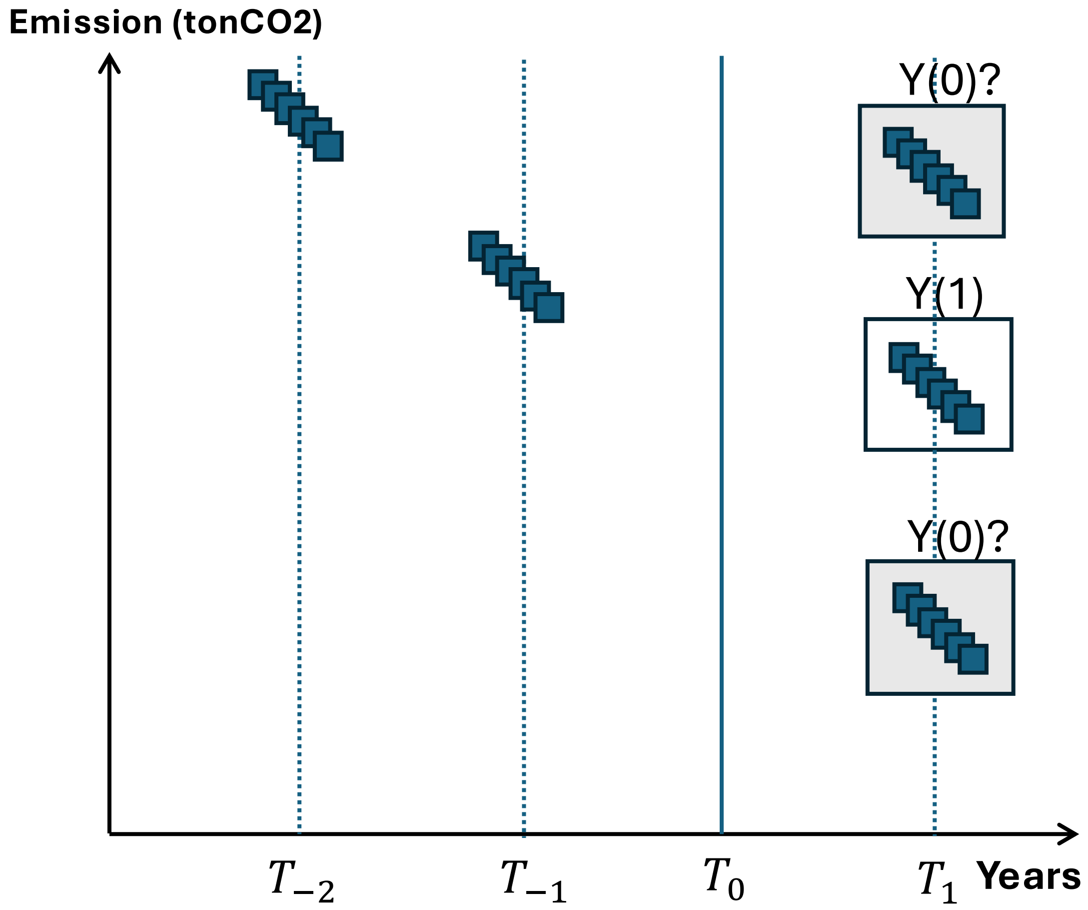



***The fundamental problem of causal inference!***

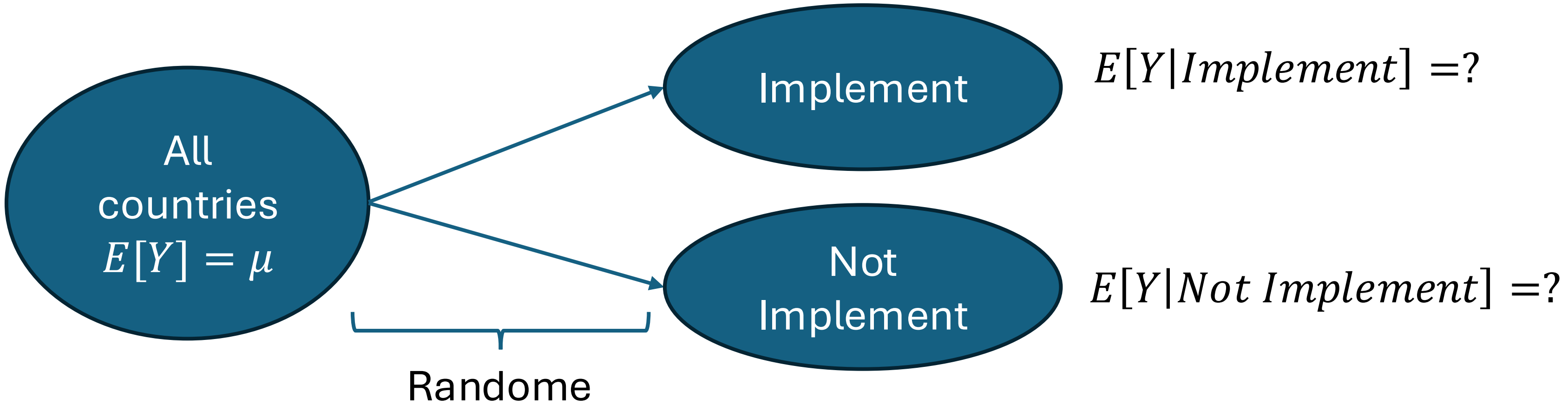
# Definitions

**Causal Inference:** The use of statistical tools for identifying**,** estimating and making inference about the existence and size of causal relations.

- The **fundamental problem of causal inference** is that it is impossible to observe the same unit in two different states of the world at the same time.
- We will define the **Individual Treatment Effect** as
$$\tau_i = Y_i(1) - Y_i(0)$$
- We will define the **Average Treatment Effect** as the expected value of the Individual Treatment Effects
$$E[\tau_i] = E[Y_i(1) - Y_i(0)]$$
- Other terms: **Outcome Variable**, **Treatment**, **Potential Outcome**, ***Rubin's causal model***

# What is the ideal setting to identify causality?

- The key difficulty comes from choosing the implement the policy
- Choose Vs Chance
- **Experiments is the ideal setting**: Random assignation




- In this case, we can easily derive the effect by comparing the average for those implementing carbon policy with those that don't

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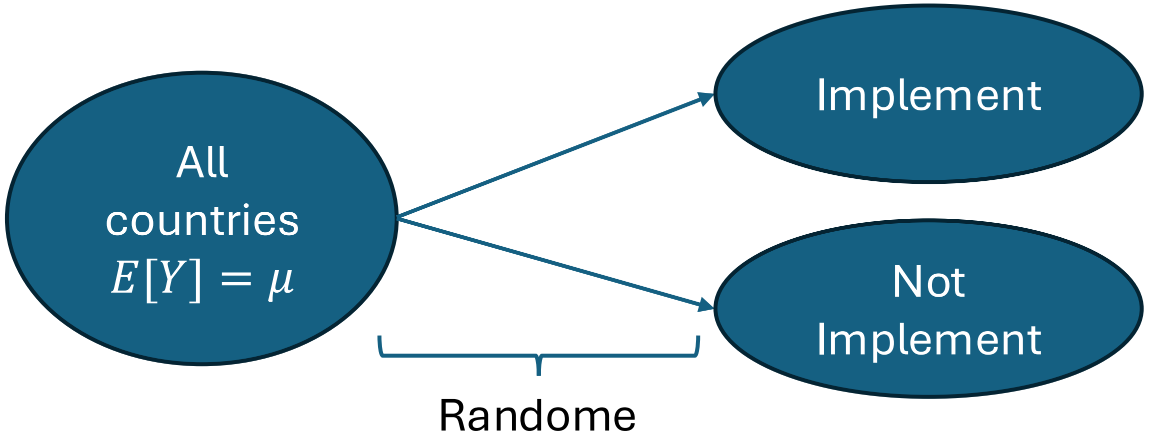


$$E[Y|Implement] = E[Y|Not\ Implement] = \mu$$

$$E[Y(0)|Implement] = E[Y(0)|Not\ Implement]$$
$$E[Y(1)|Implement] = E[Y(1)|Not\ Implement]$$

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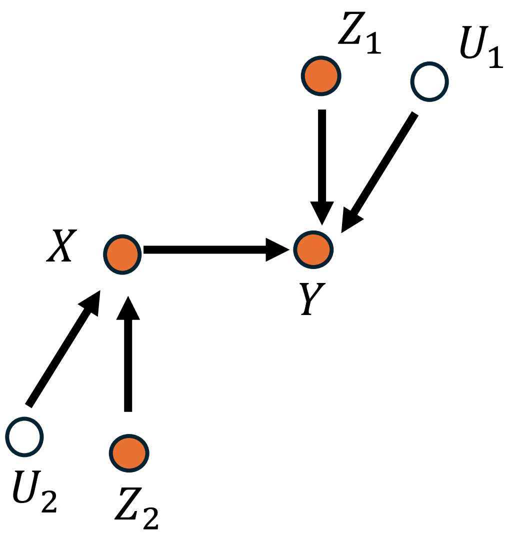
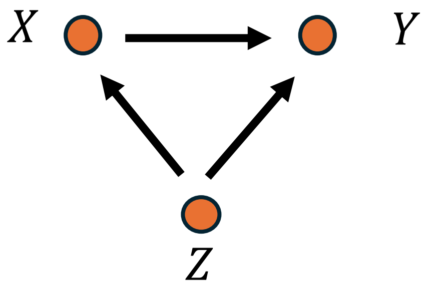
# Acyclical graphs

**Randomness**




**Quasi-randomness – Selection on observables**

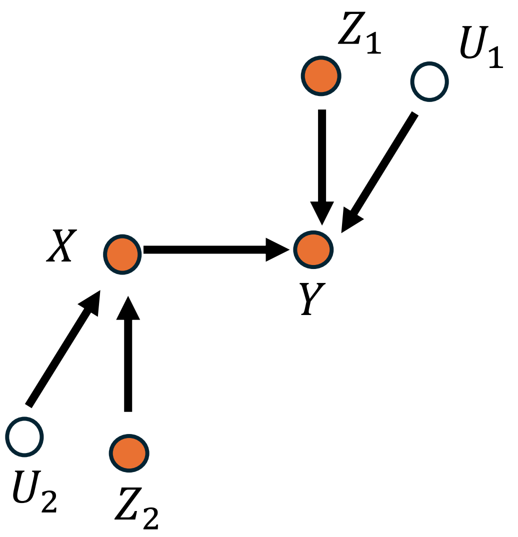



- Regression model will work well!
- The "intuition" behind the Climate Damage Functions
- Once I add $Z$ as controls, I could clame causality

# Acyclical graphs

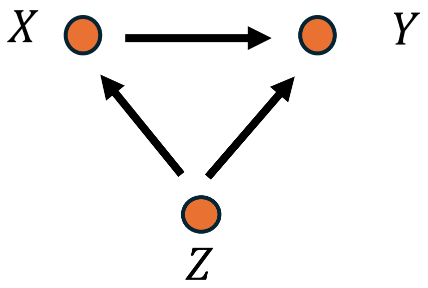
... in non experimental settings
we use **Observational data**

## Randomness




Experimental settings creates
**Experimental data**

## Quasi-randomness – Selection on observables

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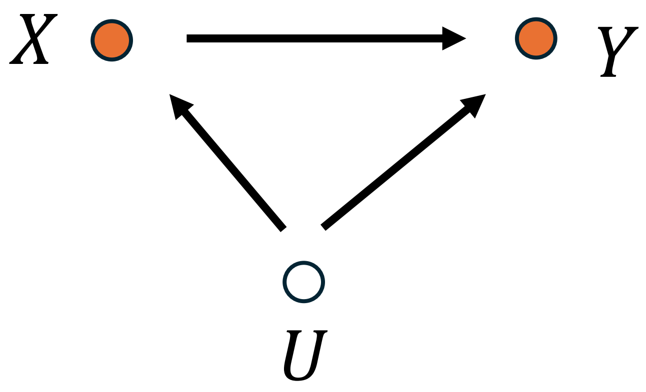
# Acyclical graphs

**Selection on unobservables**




Alternatives:

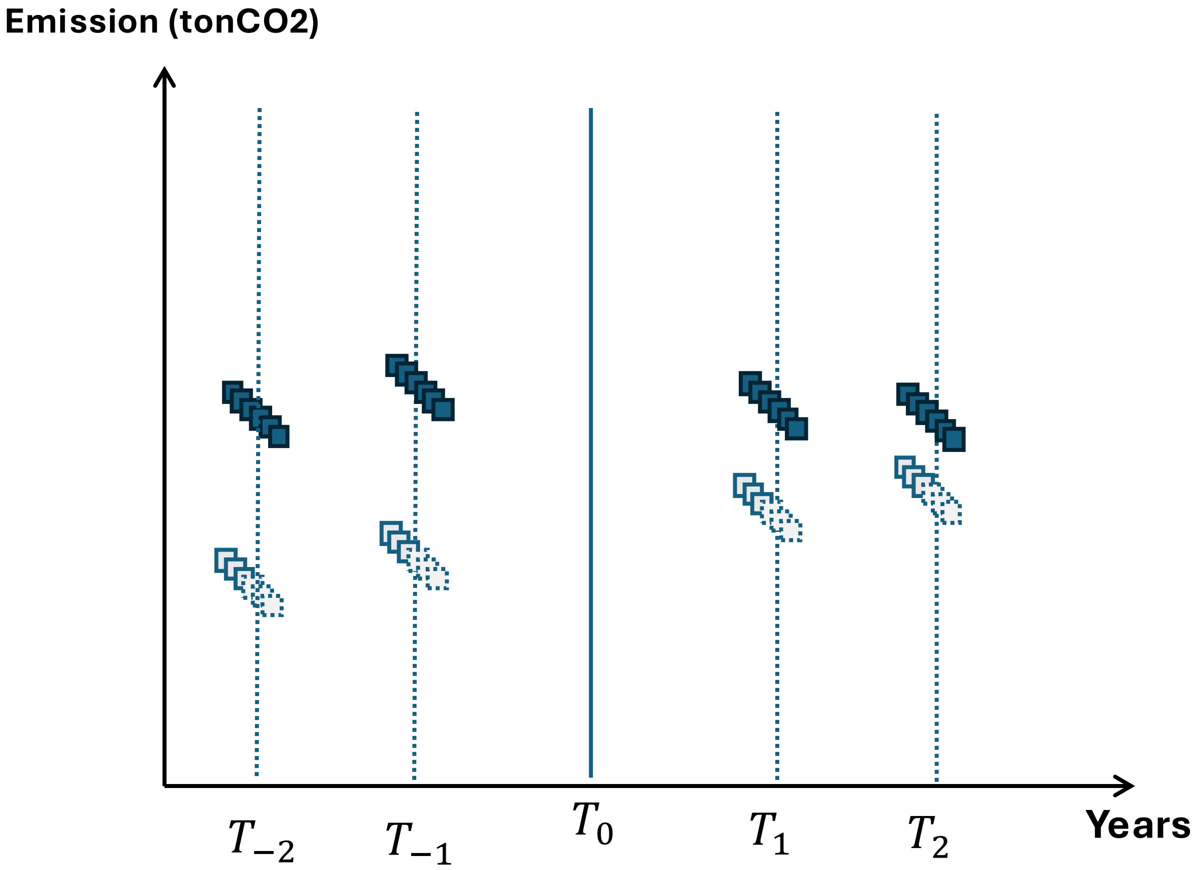
Exploit variation in time

Exploit variation in population

Exploit some randomness in the treatment

# Differences in Differences

**Differences-in-Differences** (DiD) is one of the most used alternatives when experiments will be impossible to implement or they are too costly



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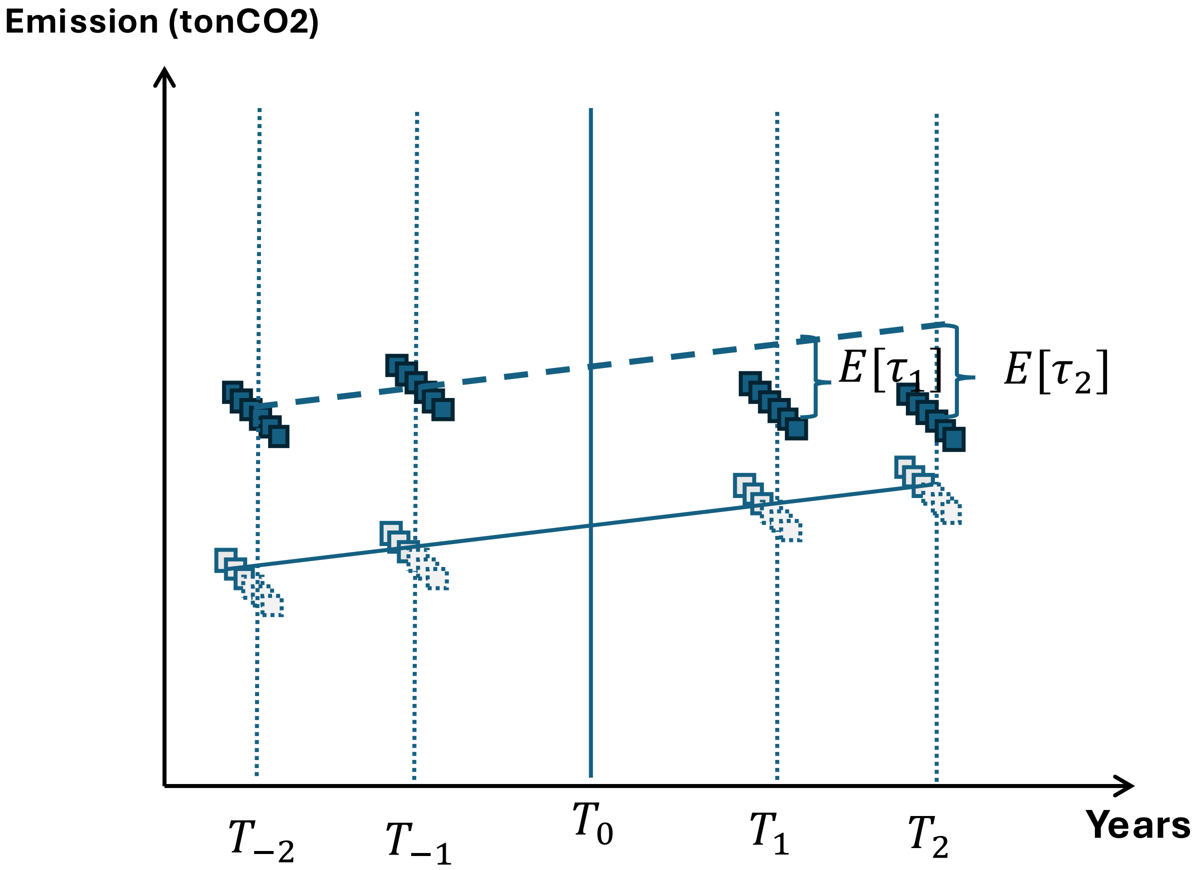


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Journal of Environmental Economics and Management
Volume 118, March 2023, 102758

## The joint impact of the European Union emissions trading system on carbon emissions and economic performance ☆

Antoine Dechezleprêtre [a], Daniel Nachtigall [a], Frank Venmans [b]

Show more

- Reduction in carbon emissions in the order of −10% between 2005 and 2012
- No significant impact on profits and employment

# How generalizable are these results?

nature communications

Article https://doi.org/10.1038/s41467-024-48512-w

**Systematic review and meta-analysis of ex-post evaluations on the effectiveness of carbon pricing**

Received: 9 May 2023

Accepted: 2 May 2024

Published online: 16 May 2024

Check for updates

Niklas Döbbeling-Hildebrandt[1,2], Klaas Miersch[1,3], Tarun M. Khanna
Marion Bachelet[1], Stephan B. Bruns[5,6,7], Max Callaghan[1],
Ottmar Edenhofer[1,3,8], Christian Flachsland[1,9], Piers M. Forster[2],
Matthias Kalkuhl[1,10], Nicolas Koch[1,11], William F. Lamb[1,2], Nils Ohlendc
Jan Christoph Steckel[1,12] & Jan C. Minx[1,2]

| | Effect sizes | Studies |
|---|---|---|
| Chinese pilot ETS | 179 | 46 |
| EU ETS | 77 | 13 |
| BC carbon tax | 39 | 7 |
| RGGI | 7 | 5 |
| UK carbon price support | 10 | 4 |
| Tokyo ETS | 14 | 4 |
| cross−country | 18 | 4 |
| Saitama ETS | 20 | 3 |
| Swedish carbon tax | 77 | 2 |
| Quebec ETS | 10 | 2 |
| Korea ETS | 2 | 2 |
| Finnish carbon tax | 8 | 2 |
| California CaT | 2 | 2 |
| Swiss ETS | 5 | 1 |
| Australian carbon tax | 2 | 1 |
| **Total** | 470 | 98 |