Unilateral climate policies can substantially reduce national carbon pollution

with Matto Mildenberger, *Climatic Change*, 166:31, 2021.

Paper: https://doi.org/10.1007/s10584-021-03111-2

Data: https://doi.org/10.5281/zenodo.4566804

Code: https://github.com/walice/synth

Research question

- Industrialized countries have implemented a wide array of policies to mitigate climate change. We need to know if they work to inform future climate action.
- The menu of policy options to reduce CO_2 emissions is varied: market-based solutions such as emissions trading schemes or carbon taxes, regulatory obligations, renewable portfolio standards, etc. How can we evaluate them?

What was the causal impact of the Climate Change Programme (CCP) of 2001 on British carbon dioxide emissions?

The problem

- Can we say that policy X caused a reduction in emissions of Y? Making a causal statement is difficult.
- Current CO_2 levels are overdetermined due to a multiplicity of latent socio-economic and technological drivers.
- Adoption of climate policies is not random.
- Estimates of total CO_2 abated are hard to generate because they rely on a counterfactual statement of what the state of the world would have been absent that policy.

It is hard to pinpoint the specific contribution of climate policies to reducing emissions.

Inferential framework

Chapter 1 conducts a policy impact evaluation of a climate mitigation policy in the United Kingdom.

Estimand

The treatment effect of the CCP on the UK's emissions of carbon dioxide

Estimator

Synthetic control method (Abadie et al., 2010)

Preview of estimates

In 2005, CO_2 emissions per capita were 9.8% lower relative to what they would have been if the CCP had not been passed.

The Climate Change Programme

- The Climate Change Programme (CCP) was launched in 2001.
- Three interlocking policy instruments, designed to be mutually reinforcing:
    1. Tax on energy
    2. Agreements with industry groups
    3. Domestic emissions trading scheme
- Several design features of the CCP prompted concerns about its efficacy:
    - Lax CO_2 targets
    - Generous concessions to industry
    - Baseline-and-credit rather than cap-and-trade

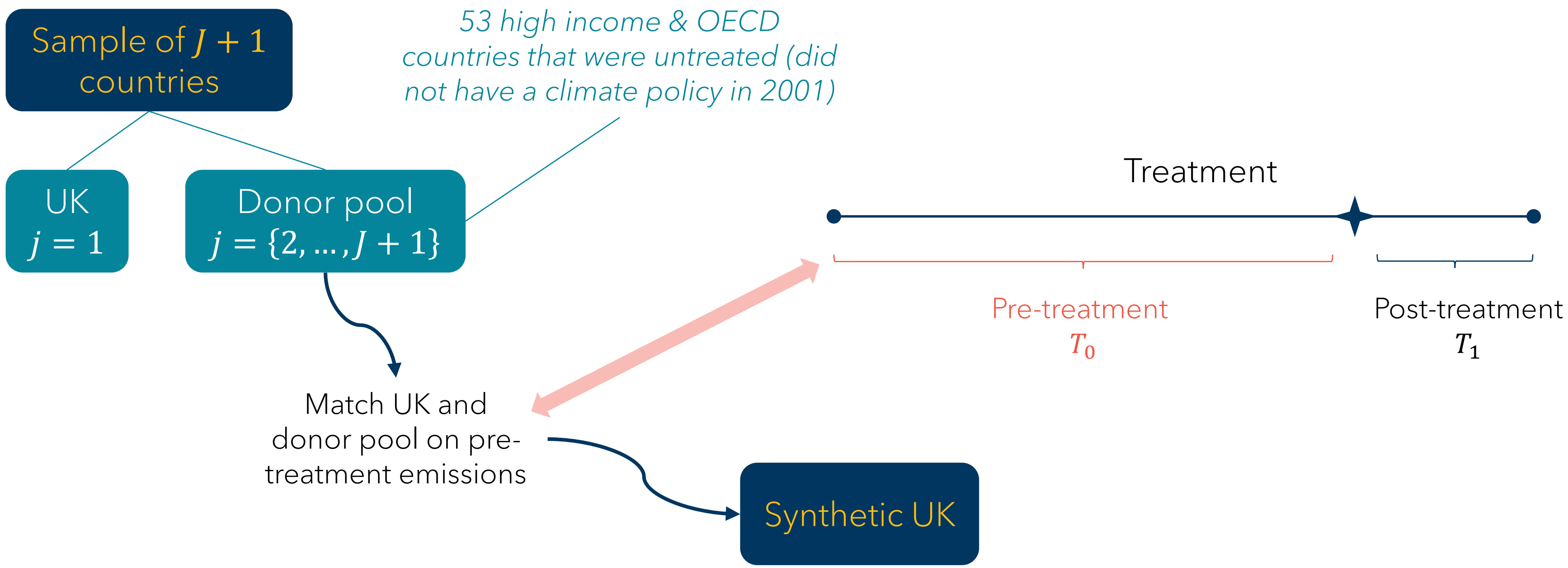
Synthetic Control Method

- Two potential outcomes: potential emissions in the UK under treatment (if the CCP had been passed) and under control (if the CCP had *not* been passed).
- The goal is to estimate the difference between the two, which gives the causal impact of the CCP.
- However, the potential outcome under control is unobserved: we do not know what would have happened in the UK if the CCP had *not* been passed.
- We construct a synthetic counterfactual by creating a weighted combination of countries that most closely resembled the UK before the CCP was implemented.

The synth algorithm

Outcome variable: CO_2 emissions per capita.

The algorithm (Abadie et al. 2010) finds weights that minimize the distance between the pre-treatment emissions trajectories of the UK and of the "synthetic UK".

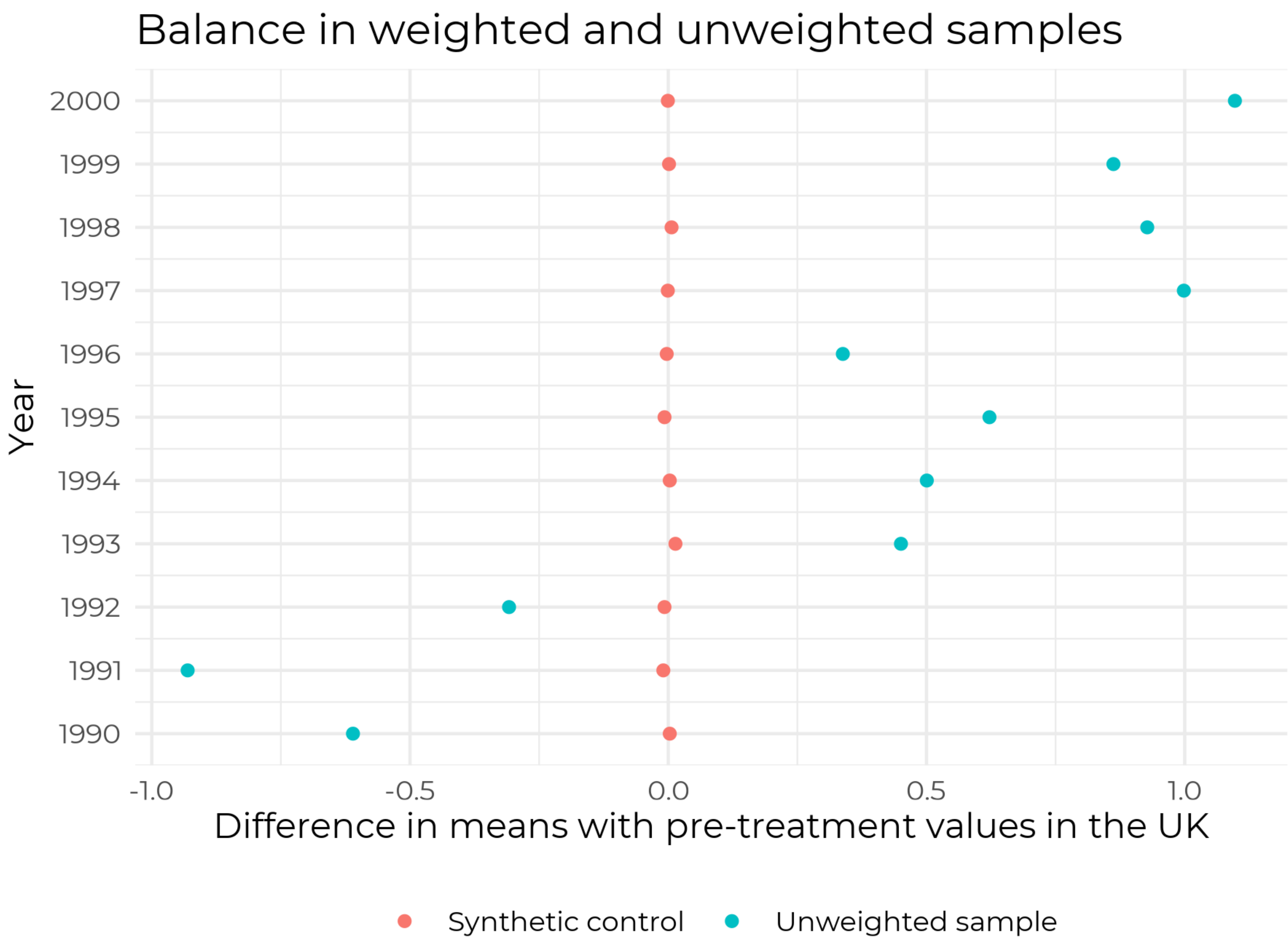


Donor pool

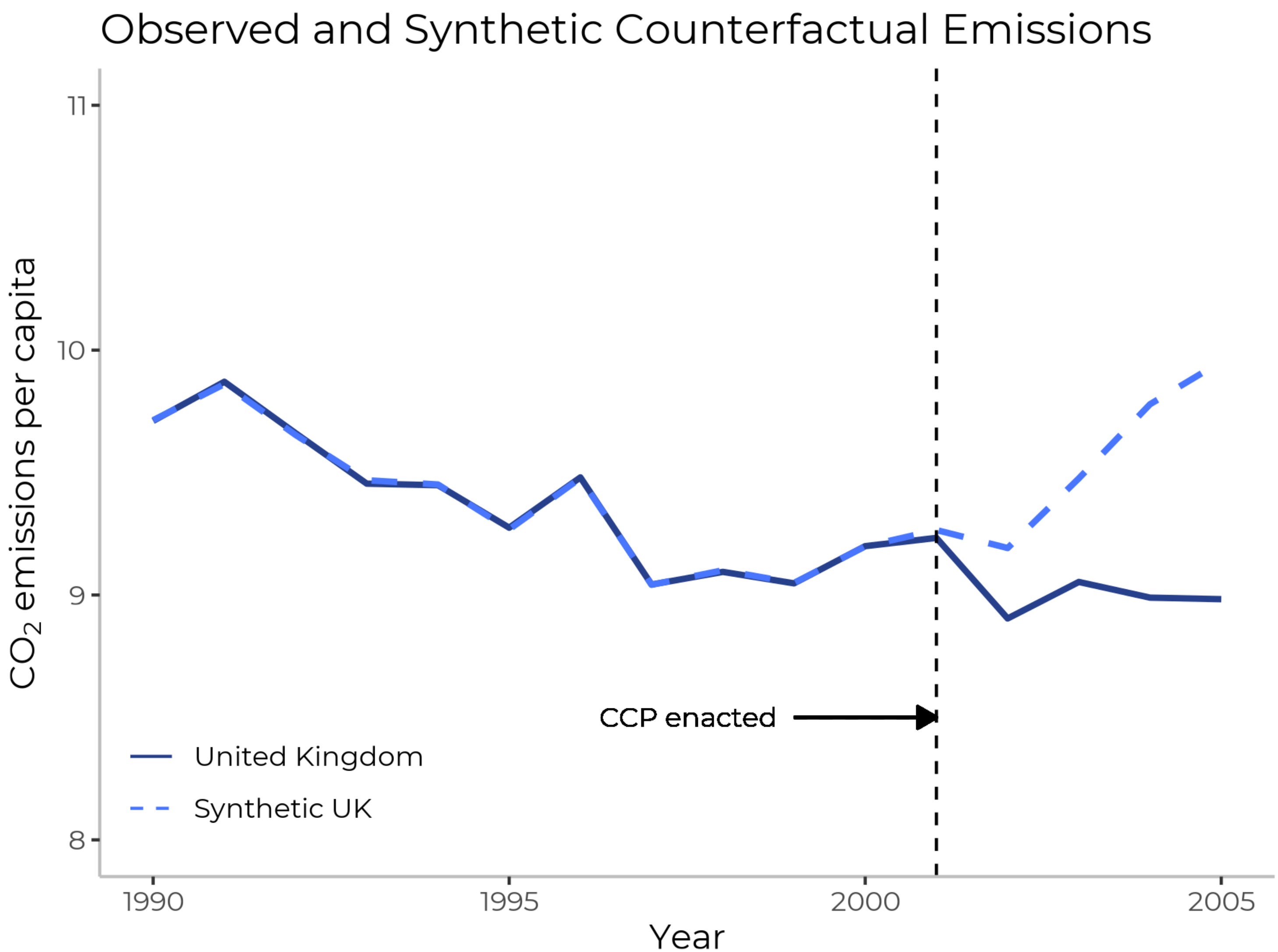
The top 8 countries in the donor pool account for 88% of the weights used to construct the synthetic UK.

Donor	Weight
Poland	19.2%
Libya	18.7%
Bahamas	18.1%
Belgium	16.4%
Trinidad & Tobago	5.8%
Uruguay	4.5%
Luxembourg	4.2%
Brunei	1.4%

Balance test



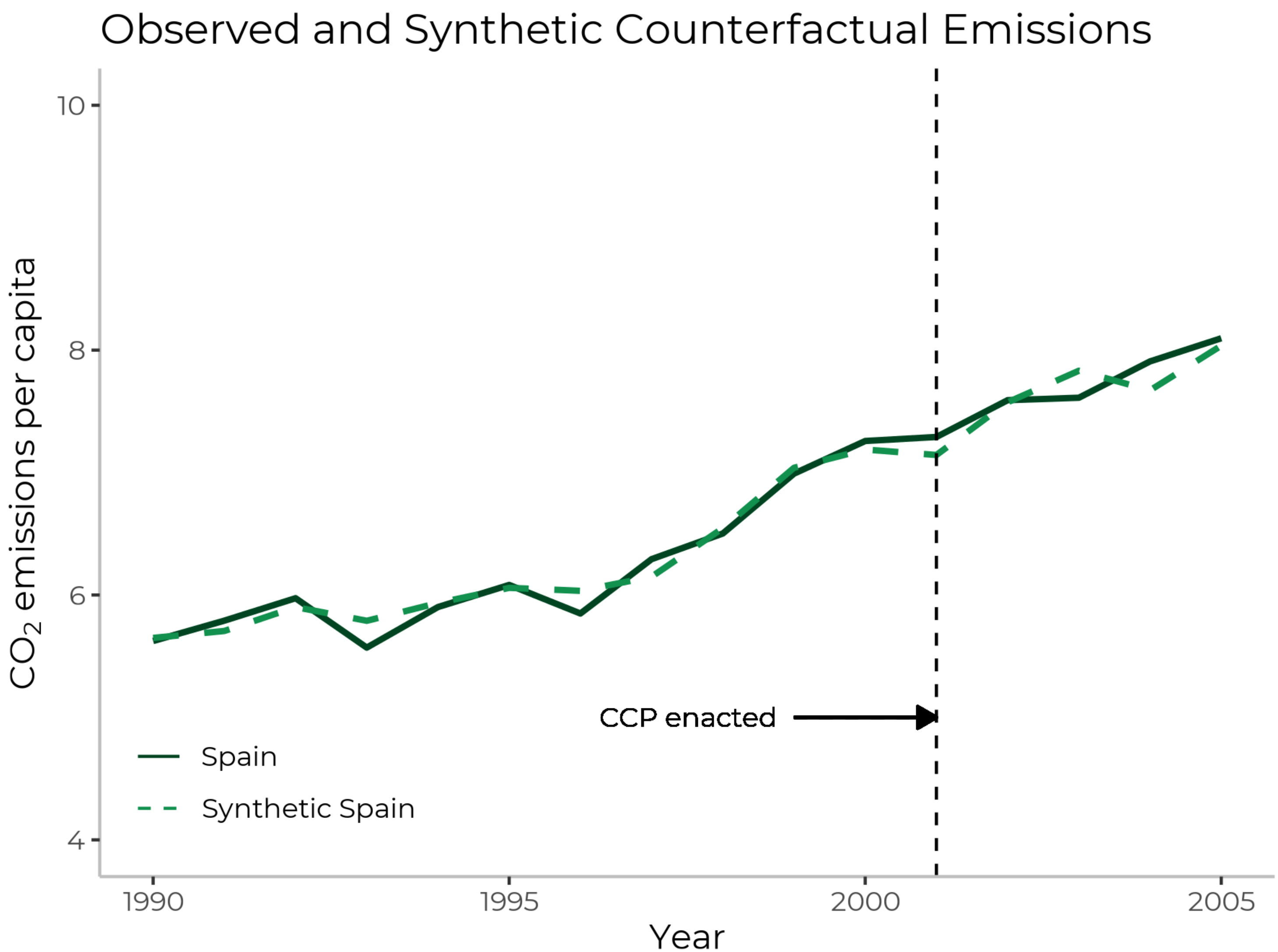
CCP caused -0.6t CO_2 / capita / year



Inference with placebo tests

- Synthetic control methods allow for randomization inference using falsification tests.
- We re-assign treatment to each country in the donor pool.
- Since we know they were untreated, we should expect to see no divergence in the emissions trajectories of the placebo unit and its synthetic control.

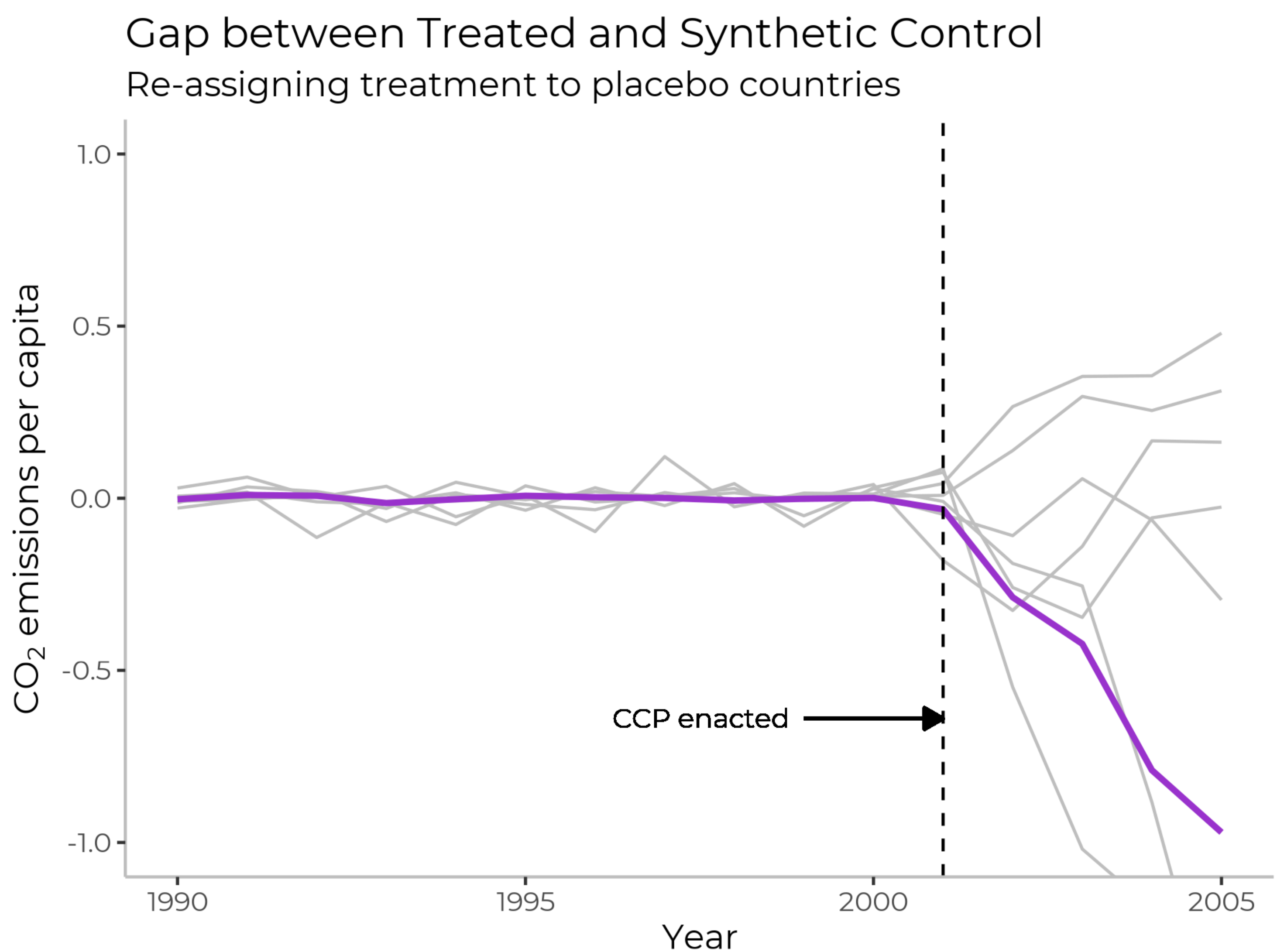
Emissions trajectories in placebo



Statistical significance

- When we iteratively re-assign treatment to countries in the donor pool, this creates a null distribution of what we should expect to see if the policy had no effect.
- We should expect to see little to no gaps between the emissions of the placebo countries and their synthetic controls.
- If the results in the UK were driven entirely by chance, the gap in emissions between the UK and the synthetic UK would lie within the distribution of placebo gaps.

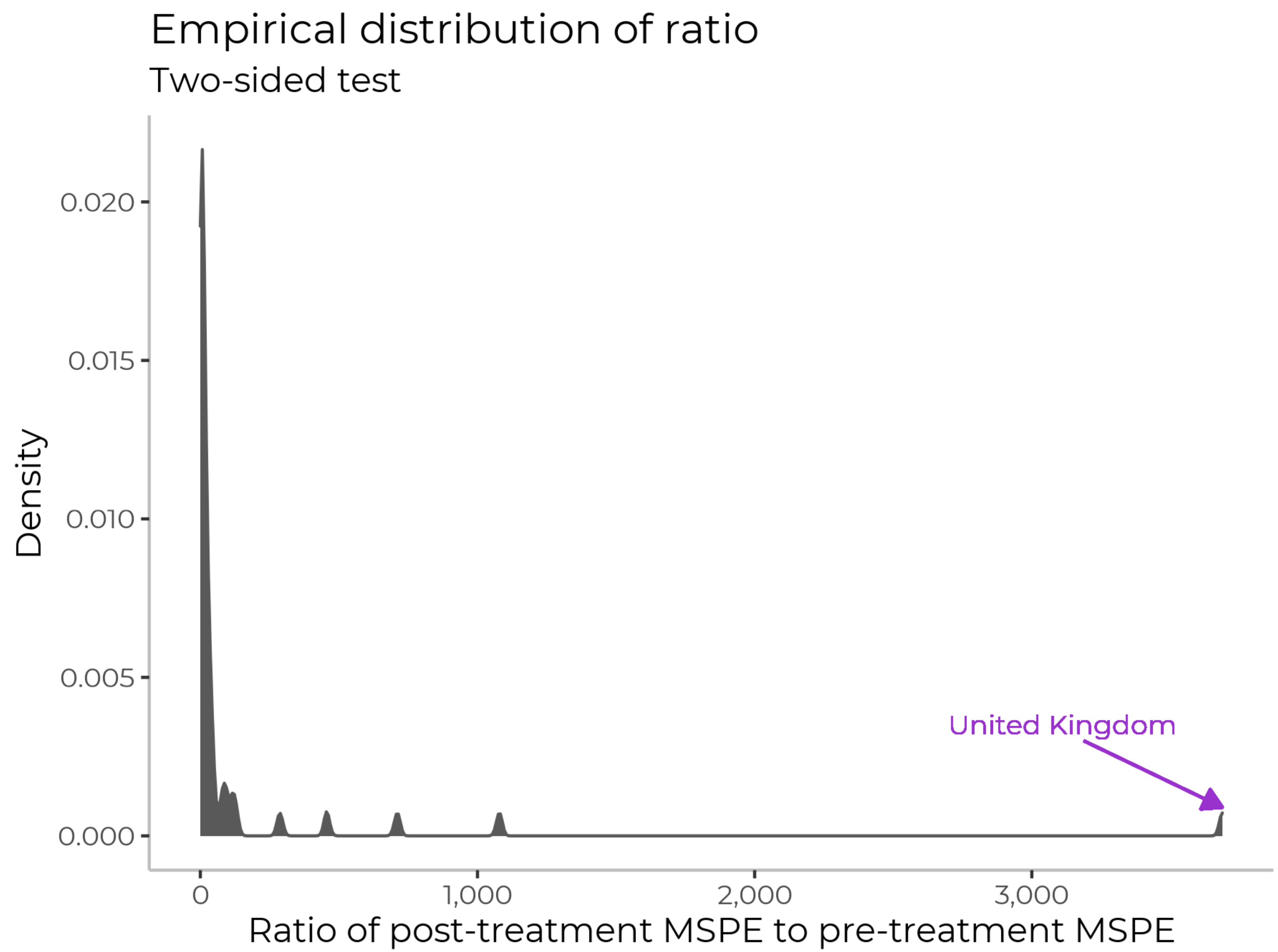
Gap in emissions



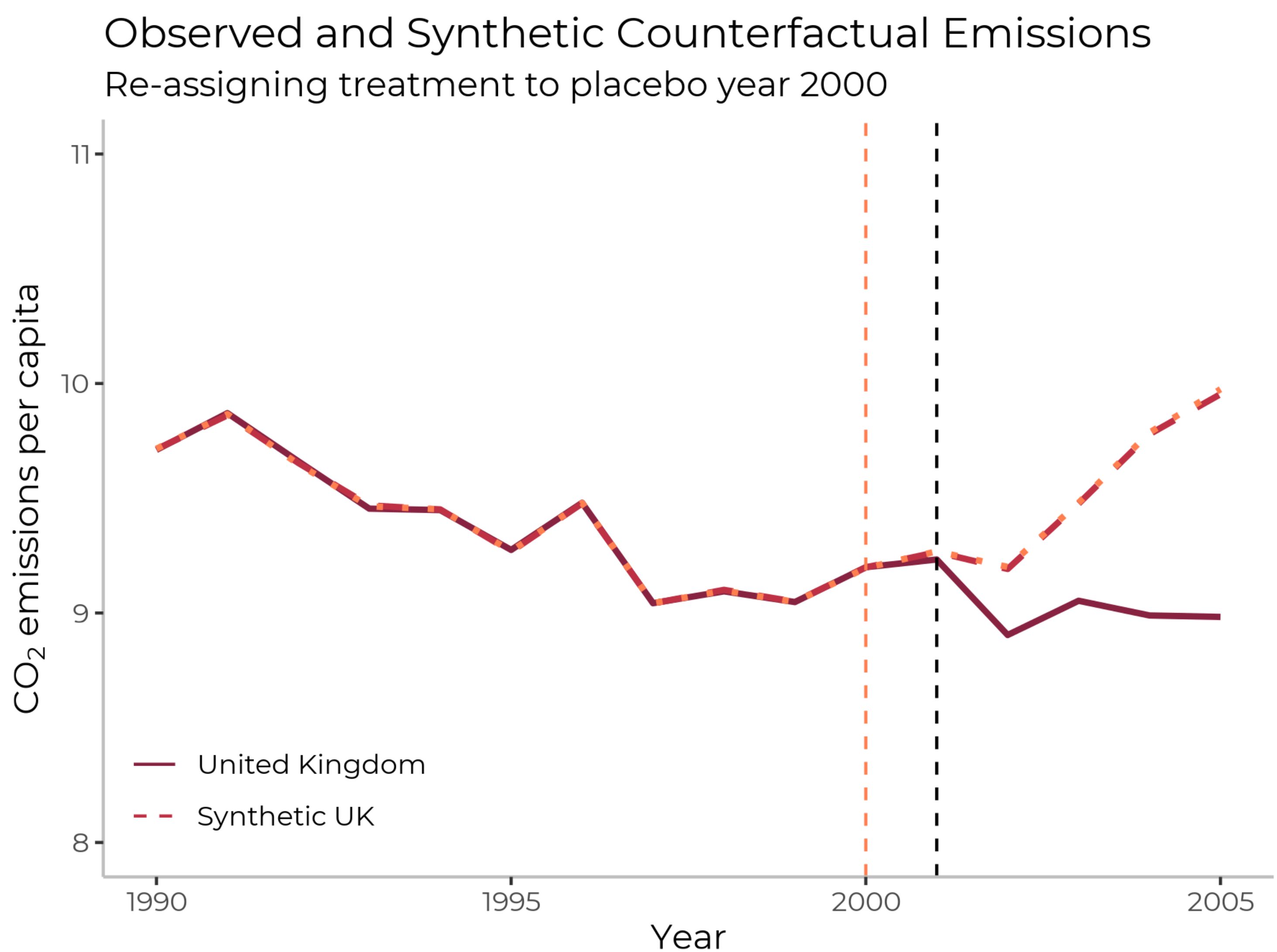
p-value (ish)

- We construct a statistic for the treatment effect that is the ratio of post-treatment Mean Square Prediction Error (MSPE) to pre-treatment MSPE.
- The ratio statistic penalizes uninformative placebo runs that result in a poor fit between the placebo and its synthetic control.
- The distribution of the ratio statistic is a non-parametric null distribution.
- The probability of seeing an effect as large as the UK's is $1/51 \approx 0.02$ (like a p-value), which is statistically significant.

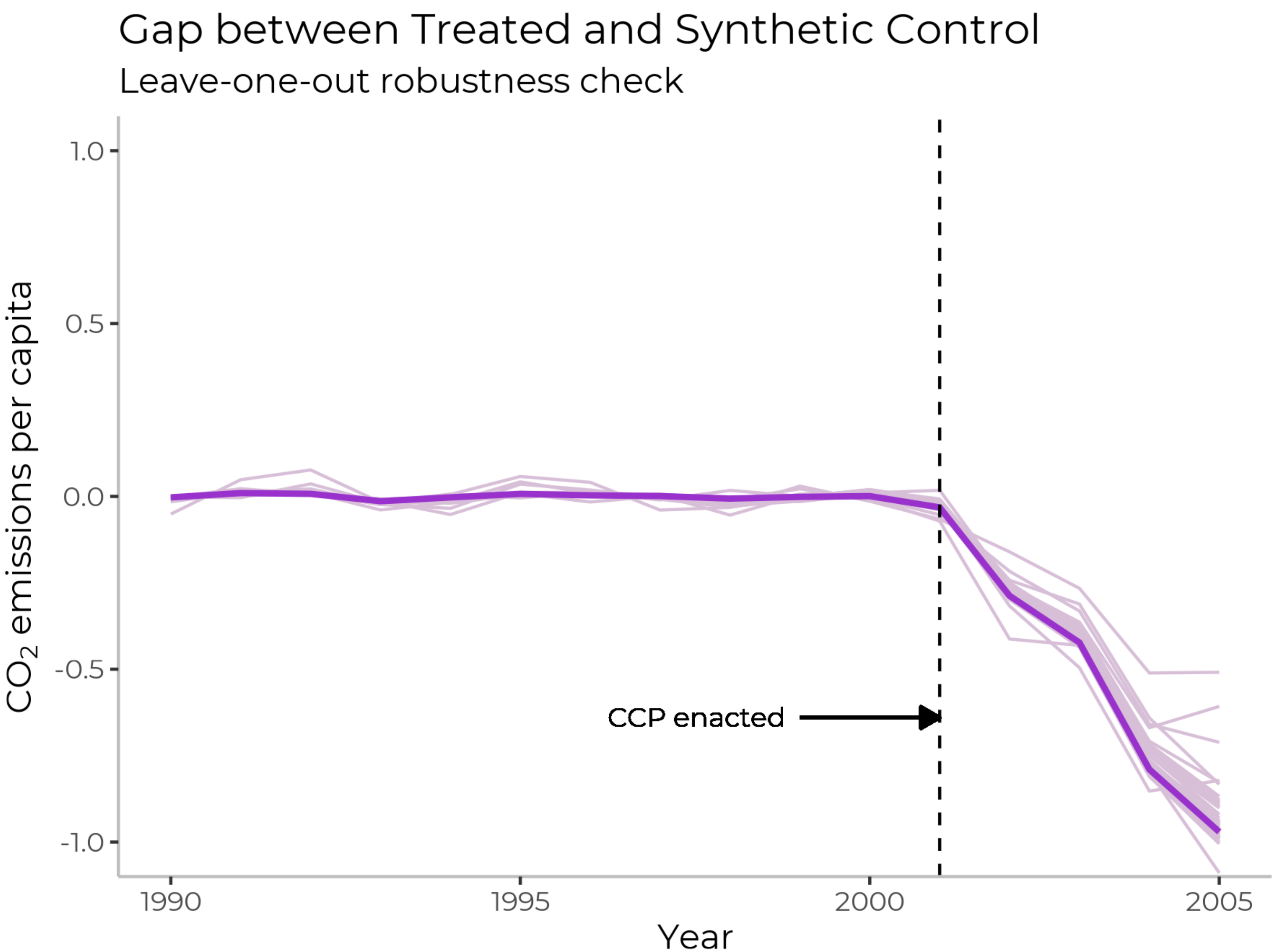
Distribution of treatment effect



Placebo treatment year



Leave-one-out robustness check



Conclusions & policy implications

- This paper shows how to conduct *ex post* national assessments of climate policies without relying on simplistic BAU assumptions.
- Synthetic control methods offer a data-driven, empirically calibrated way to pick comparison units.
- The UK met its 2008-2012 Kyoto target of reducing emissions by 8% compared to 1990 levels three to seven years of schedule.
- Successful unilateral climate mitigation policies can be implemented despite the absence of a global and legally binding climate treaty.
- Imperfect carbon pricing policy instruments can meaningfully reduce emissions.