Identifying effective climate policies in Austria: a reverse-causal analysis

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Introduction

My motivation

My quest to find effective climate action

- A love for nature
- **Australia:** a land of fires and floods
- **Activism:** Australian Youth Climate Coalition
- **Small scale action:** University Sustainability Office
- **Education:** Bachelors in Sustainability Science
- **Technology:** Working in Renewable Energy Innovation
- **Research:** Climate Plan for Austria

“Policy is the most effective tool we have to fight climate change.”

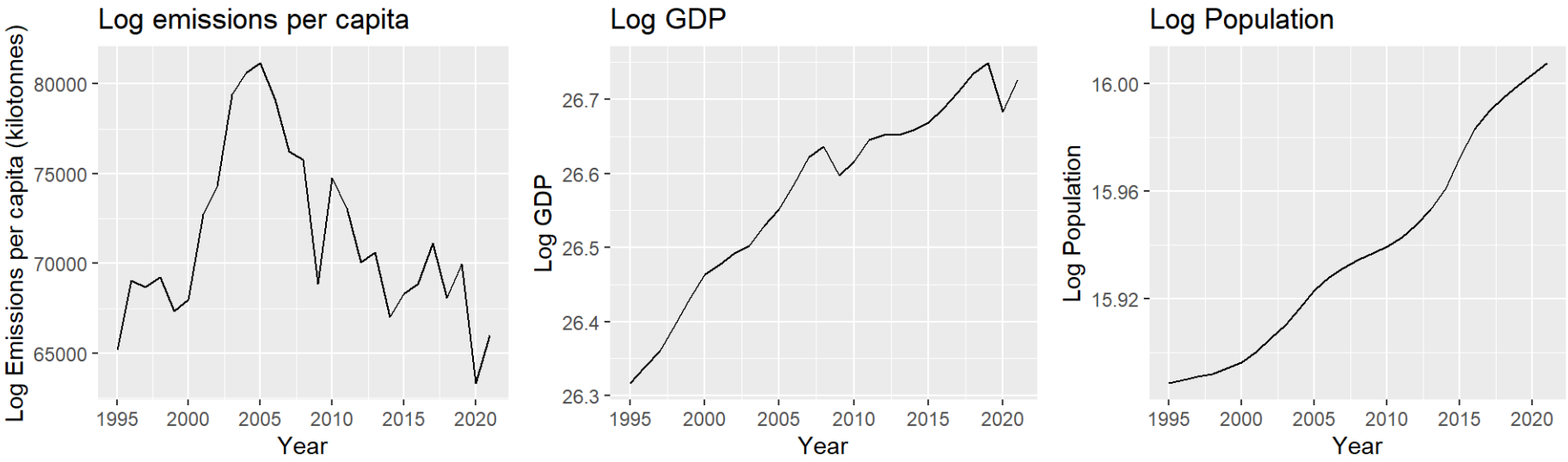
What makes good climate policy?

“Under the European climate law, EU countries must cut greenhouse gas emissions by at least 55% by 2030. Their goal is to make the EU climate neutral by 2050.”

- Need to identify effective climate policy (as economists, we love efficiency)
- Limited resources: time and money
- Dissonance between targets and policies
- Need to evaluate policy in a non-biased way

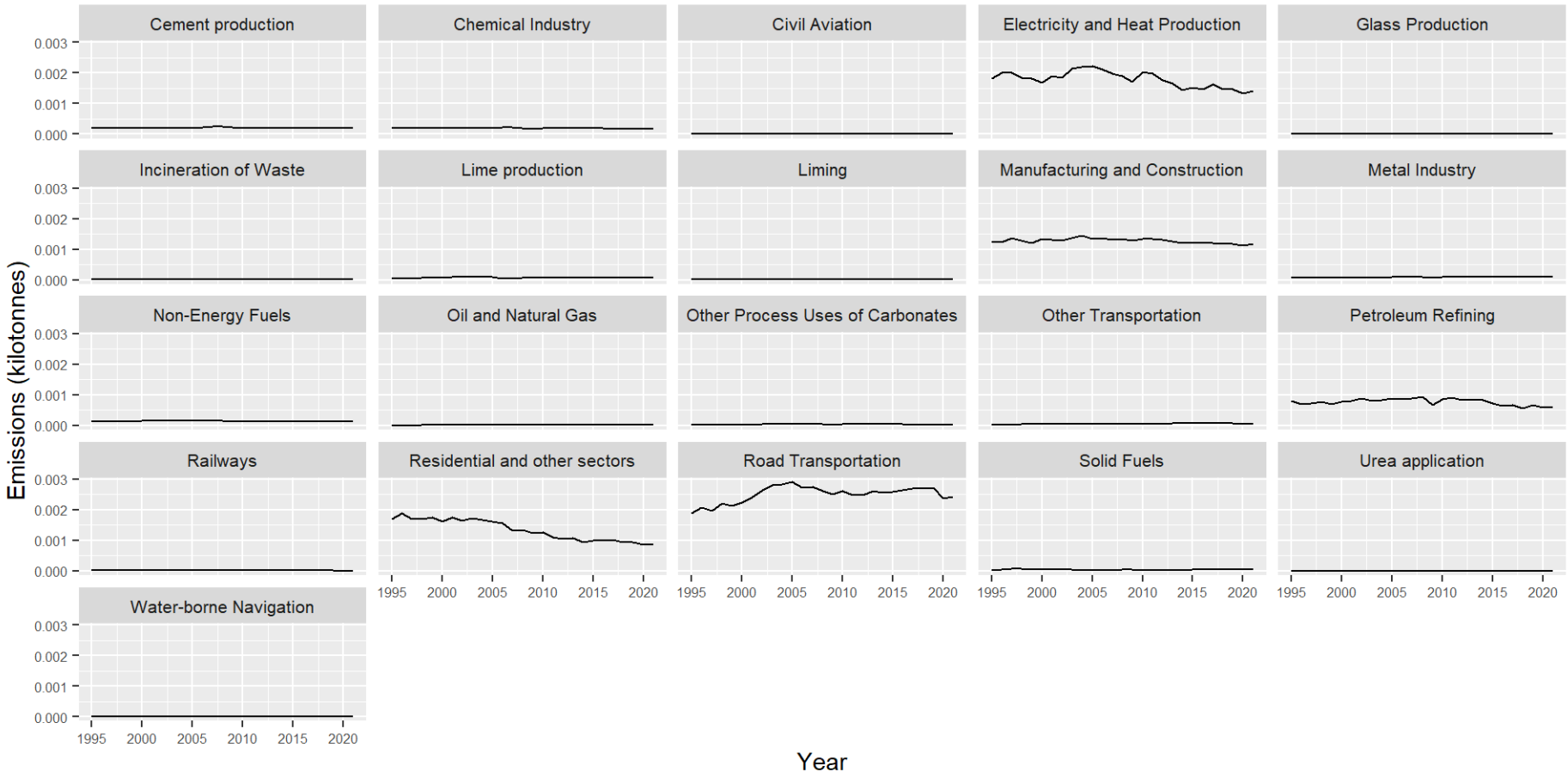
What does all of this mean for Austria?

GHG emissions in Austria



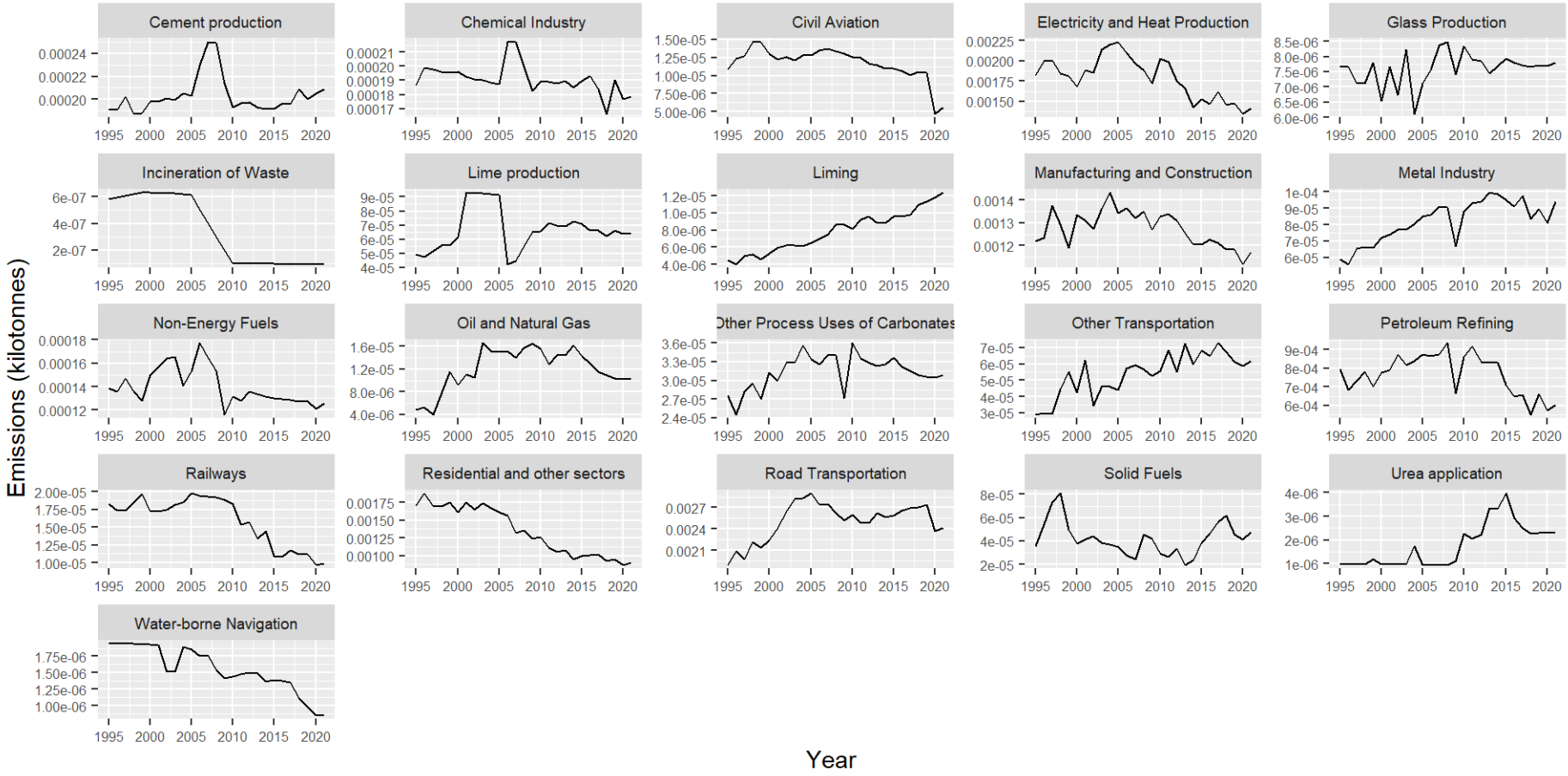
Emissions per capita, GDP and Population in Austria

GHG emissions in Austria



Emissions per capita by sector

GHG emissions in Austria



Emissions per capita by sector

Methodology

Identifying effective climate policy

Standard policy evaluation

- Identify effects-of-causes of single, known policies
- Difficult to isolate individual policies in a real-world setting
- Narrow analysis: potential to miss policies

Reverse-causal policy evaluation

- An agnostic approach to policy evaluation for policy mixes
- Identify a-priori unknown or underappreciated interventions

An application of Koch et al. (2022)

- "Attributing agnostically-detected large reductions in road CO_2 emissions to policy mixes"
- What do I do differently? Focus on Austria, on all sectors
- Identify structural breaks in emissions, not accounted for by GDP or population, using machine learning
- Attribute breaks to policies, using emissions policy databases

Data

Structural break identification

- CO_2 emissions: combination of EDGAR (Emissions Database for Global Atmospheric Research) and International Energy Agencies (IEA) databases
- **Population and GDP**: World Bank, World Development Indicators

Policy databases

- **The IEA's Policies and Measures Database**: past, existing, or planned climate and energy policies. Data is collected from governments, international organisations, and IEA analyses, and governments can review the provided information periodically.
- **IEA/IRENA Renewable Energy Policies and Measures Database**: a joint database of renewable energy policies and measures of the IEA and IRENA.
- **The National Communications to the UNFCCC secretariat**: obligatory for our sample countries to submit regularly.

Model

Structural break identification

- Two-way fixed effects (TWFE) panel estimators
- 26 time periods and 15 countries = 390 indicators (more than observations)
- 2 samples: EU15 (2004) and EU31 (2020 EU27 + Norway, Iceland, Switzerland, and the United Kingdom because they were part of the European Single Market and subject to harmonized regulations)
- Sparse treatment of countries using block search machine learning algorithm

General model

$$log(CO_2)_{i,t} = \alpha_i + \phi_t + \sum_{j=1}^{N}\sum_{s=2}^{T} \tau_{j,s} 1_{\{i=j, t \geq s\}} + x'_{i,t}\beta + \epsilon_{i,t} \quad (1)$$

Specific model

$$log(CO_2)_{i,t} = \alpha_i + \phi_t + \sum_{j=1}^{N}\sum_{s=2}^{T} \tau_{j,s} 1_{\{i=j, t \geq s\}} + x'_{i,t}\beta + \epsilon_{i,t} \quad (1)$$

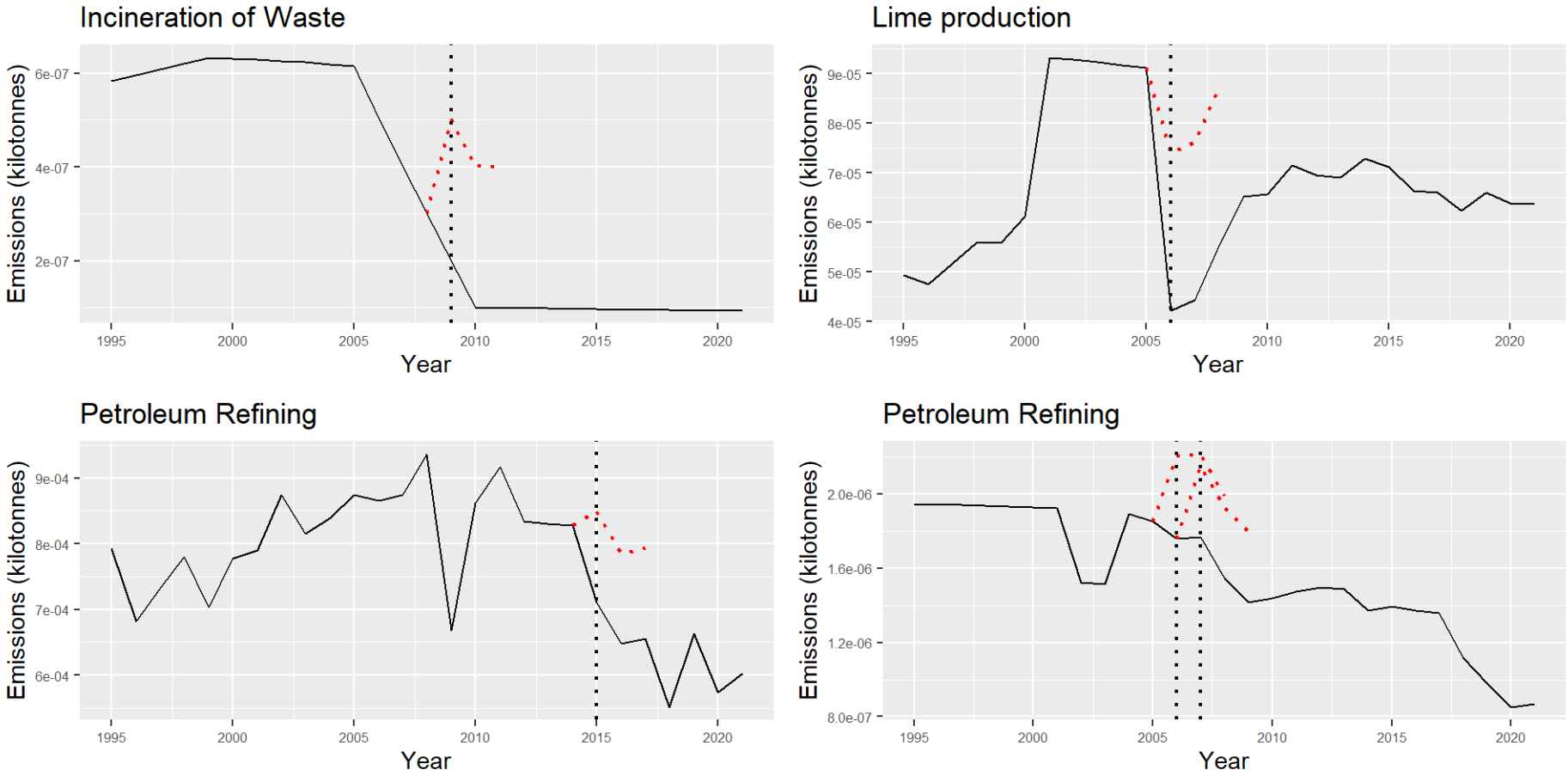
Results

Structural breaks

Table 1. Negative structural breaks in Austrian emissions

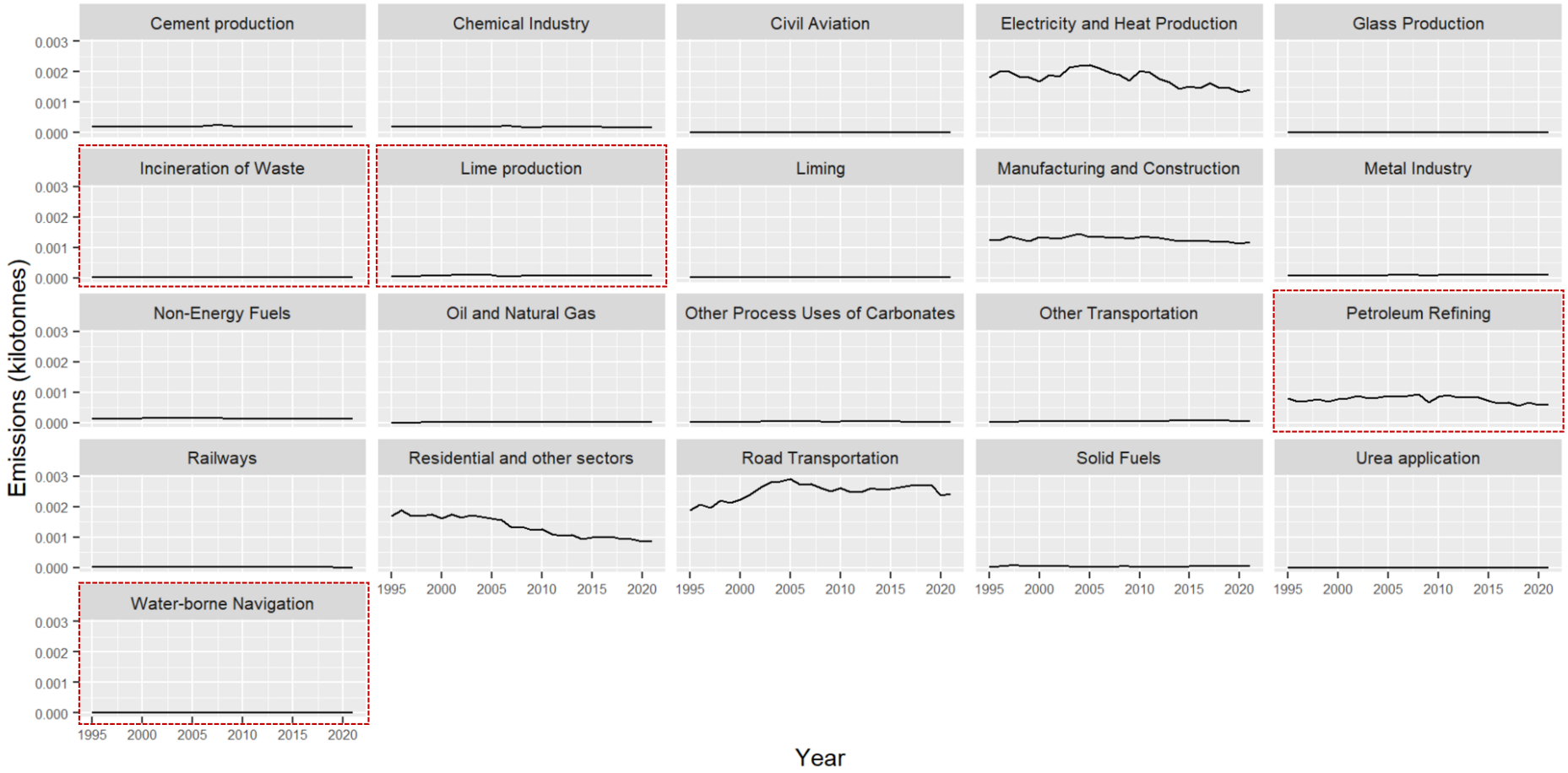
	Year	Coefficient	P-Value Test			Sample	
			0.05	0.01	0.001	EU15	EU31
IPCC Category (Level 1)							
Waste	2009	-1.508	•	•	•	•	•
IPCC Category (Level 2)							
Incineration of Waste	2009	-1.508	•	•	•	•	•
IPCC Category (Level 3)							
Incineration of Waste	2009	-1.508	•	•	•	•	•
Lime production	2006	-0.755	•	•	•	•	
Petroleum Refining	2015	-0.194	•			•	
Water-borne Navigation	2006	-0.255	•	•			•
Water-borne Navigation	2007	-0.217	•	•		•	

Structural breaks



Emissions per capita for sectors with structural breaks

Structural breaks



Emissions per capita by sector

Policy attribution

Table 2. Policy attribution to identified structural breaks

Sector	Year	Policy title	Policy year	Policy type	Description
Incineration of waste	2009	Ökostromverordnung	2009	Subsidy	Feed-in tariffs for green electricity, including landfill gas, biomass and biogas, diverting waste from landfill.
		Klimastrategie	2008	Strategy	Austria's climate strategy, including policy provisions for waste management.
Lime production	2006	Emission Trading System	2005	Tax	Emission Trading System implemented in 2005, which affected mineral industries.
		Expert System for an Intelligent Supply of Thermal Energy in Industry (EINSTEIN)	2007	Regulation	A methodology for the implementation of a holistic integral approach to thermal energy auditing in industry.
Petroleum refining	2015	Residential building, energy and environmental subsidies	2014	Subsidy	Subsidies aimed at reducing natural gas consumption by residential actors.
Water-borne navigation	2006-2007	Klima:aktiv programme Renewable Energy	2005	Strategy	Climate strategy including provisions for biogas and biomethane for transport use

Conclusion

Headline

There were very few highly effective climate policies identified using the reverse-causal approach for Austria.

Caveats

- Reverse-causal approach is not a substitute, but a complement
- This approach identifies relatively large effects
- Causal interpretation of policies relies on assumption of no other interventions being present at the time of the break

Appendix

Countries in each sample group

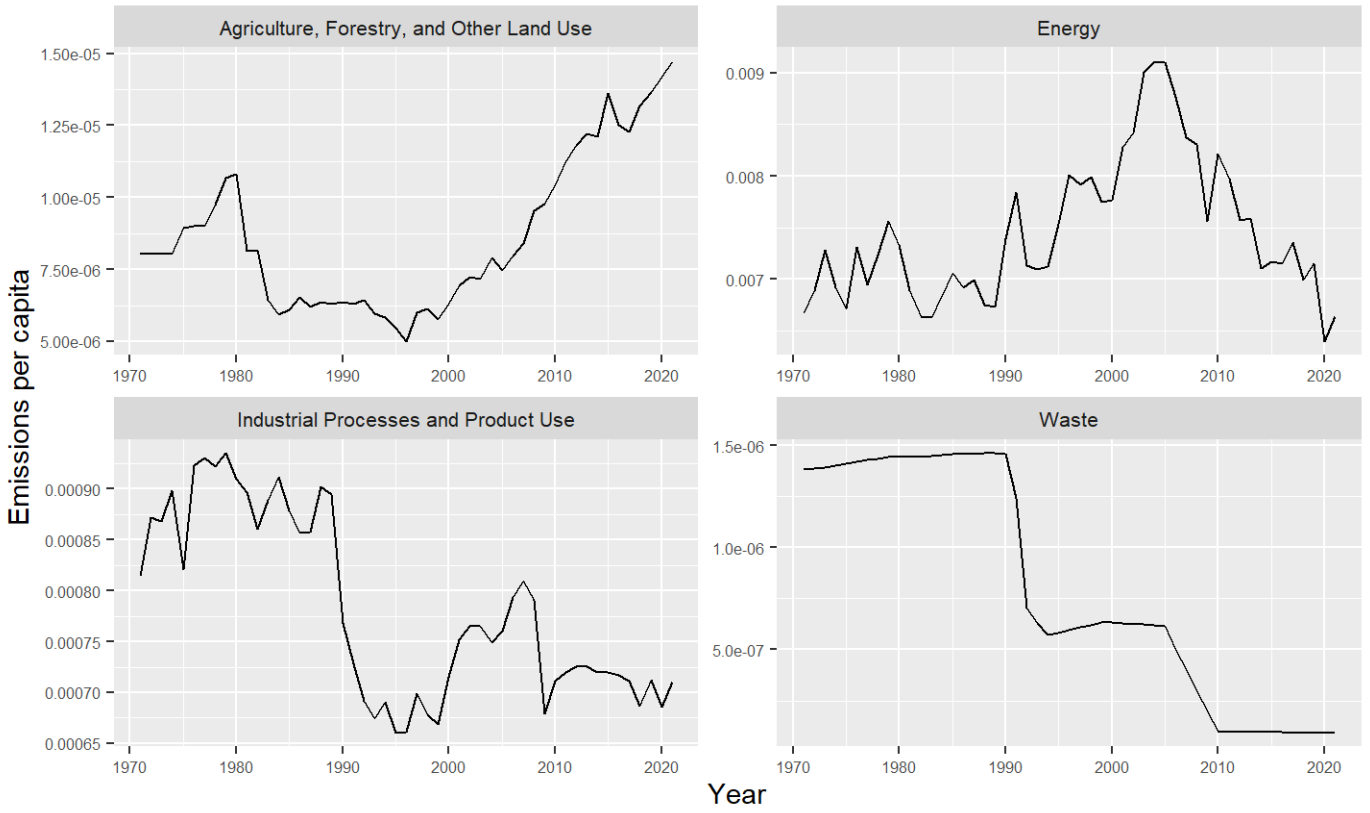
EU15:

Austria, Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, Luxembourg, Netherlands, Greece, Portugal, Sweden

EU31:

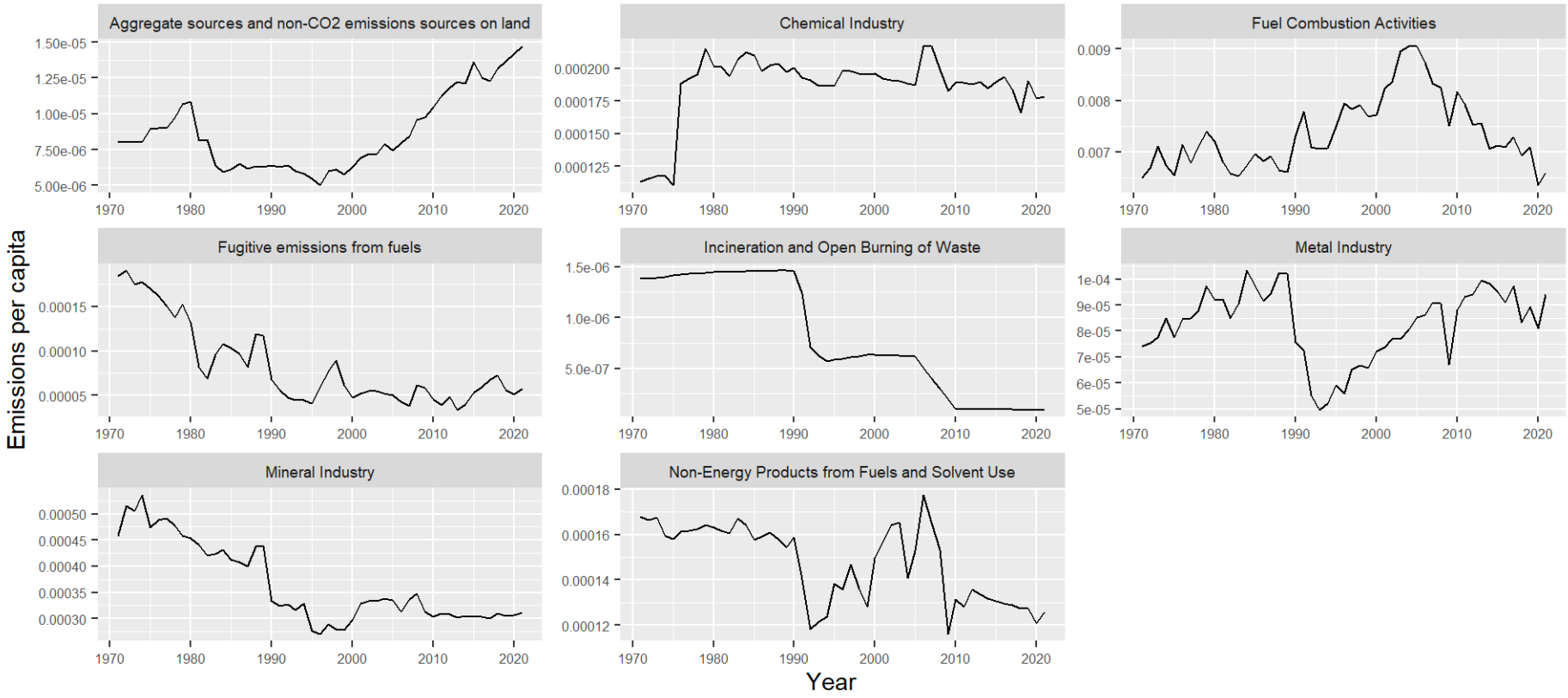
Austria, Belgium, Germany, Denmark, Spain, Finland, France, United Kingdom, Ireland, Italy, Luxembourg, Netherlands, Greece, Portugal, Sweden, Croatia, Bulgaria, Cyprus, Czechia, Estonia, Hungary, Lithuania, Latvia, Malta, Poland, Romania, Slovak Republic, Slovenia, Switzerland, Iceland, Norway

GHG emissions in Austria



Emissions per capita by sector (Level 1)

GHG emissions in Austria



Emissions per capita by sector (Level 2)

Structural Breaks (Negative)

Table 3. Negative structural breaks in Austrian emissions (Level 1)

IPCC emissions category	Sample	P-value	Year	Coefficient	Significance
Waste	EU15	0.050	2009	-1.430338	***
Waste	EU15	0.010	2009	-1.549998	***
Waste	EU15	0.001	2009	-1.646822	***
Waste	EU31	0.050	2009	-1.390561	***
Waste	EU31	0.010	2009	-1.494903	***
Waste	EU31	0.001	2009	-1.536252	***

Structural Breaks (Negative)

Table 4. Negative structural breaks in Austrian emissions (Level 2)

IPCC emissions category	Sample	P-value	Year	Coefficient	Significance
Incineration and Open Burning of Waste	EU15	0.050	2009	-1.430338	***
Incineration and Open Burning of Waste	EU15	0.010	2009	-1.549998	***
Incineration and Open Burning of Waste	EU15	0.001	2009	-1.646822	***
Incineration and Open Burning of Waste	EU31	0.050	2009	-1.390561	***
Incineration and Open Burning of Waste	EU31	0.010	2009	-1.494903	***
Incineration and Open Burning of Waste	EU31	0.001	2009	-1.536252	***

Structural Breaks (Negative)

Table 5. Negative structural breaks in Austrian emissions

IPCC emissions category	Sample	P-value	Year	Coefficient	Significance
Incineration and Open Burning of Waste	EU15	0.050	2009	-1.430338	***
Incineration and Open Burning of Waste	EU15	0.010	2009	-1.549998	***
Incineration and Open Burning of Waste	EU15	0.001	2009	-1.646822	***
Incineration and Open Burning of Waste	EU31	0.050	2009	-1.390561	***
Incineration and Open Burning of Waste	EU31	0.010	2009	-1.494903	***
Incineration and Open Burning of Waste	EU31	0.001	2009	-1.536252	***
Lime production	EU15	0.050	2006	-0.627740	***
Lime production	EU15	0.010	2006	-0.821937	***
Lime production	EU15	0.001	2006	-0.815060	***
Petroleum Refining - Manufacture of Solid Fuels and Other Energy Industries	EU15	0.050	2015	-0.194130	***
Water-borne Navigation	EU15	0.050	2007	-0.214128	***
Water-borne Navigation	EU15	0.010	2007	-0.220208	***
Water-borne Navigation	EU31	0.050	2006	-0.259891	***
Water-borne Navigation	EU31	0.010	2006	-0.249270	***