Where Have All the Green Patents Gone? The Patents Break Detection Project

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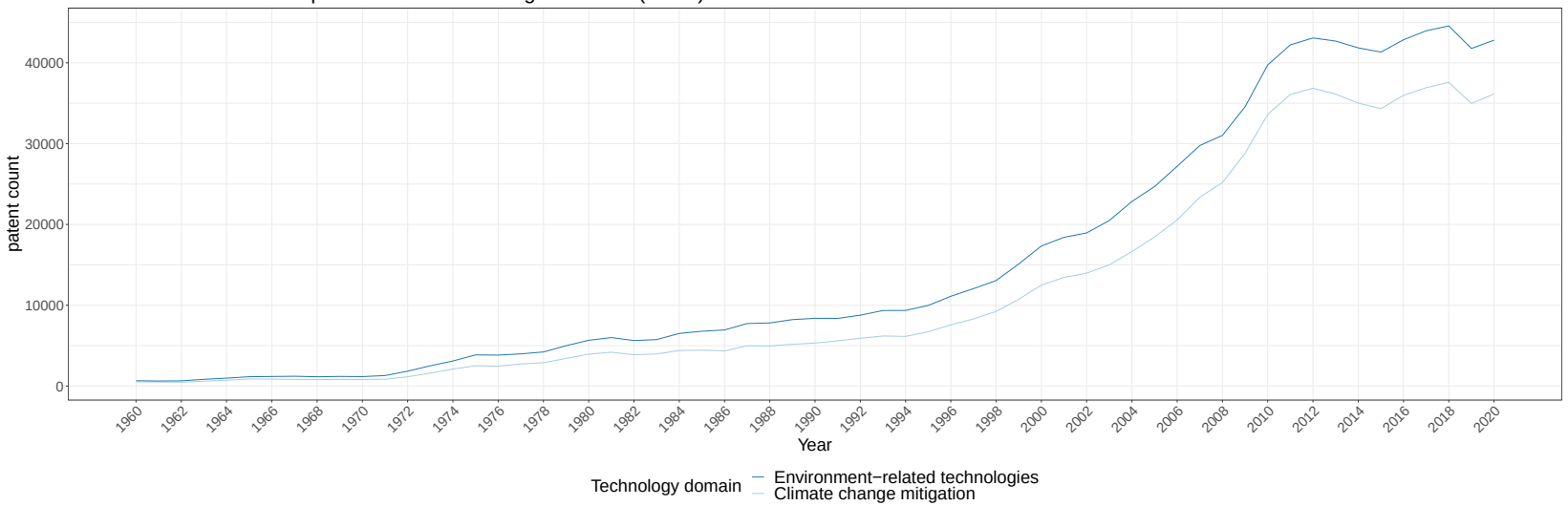
Puzzle and Research Question

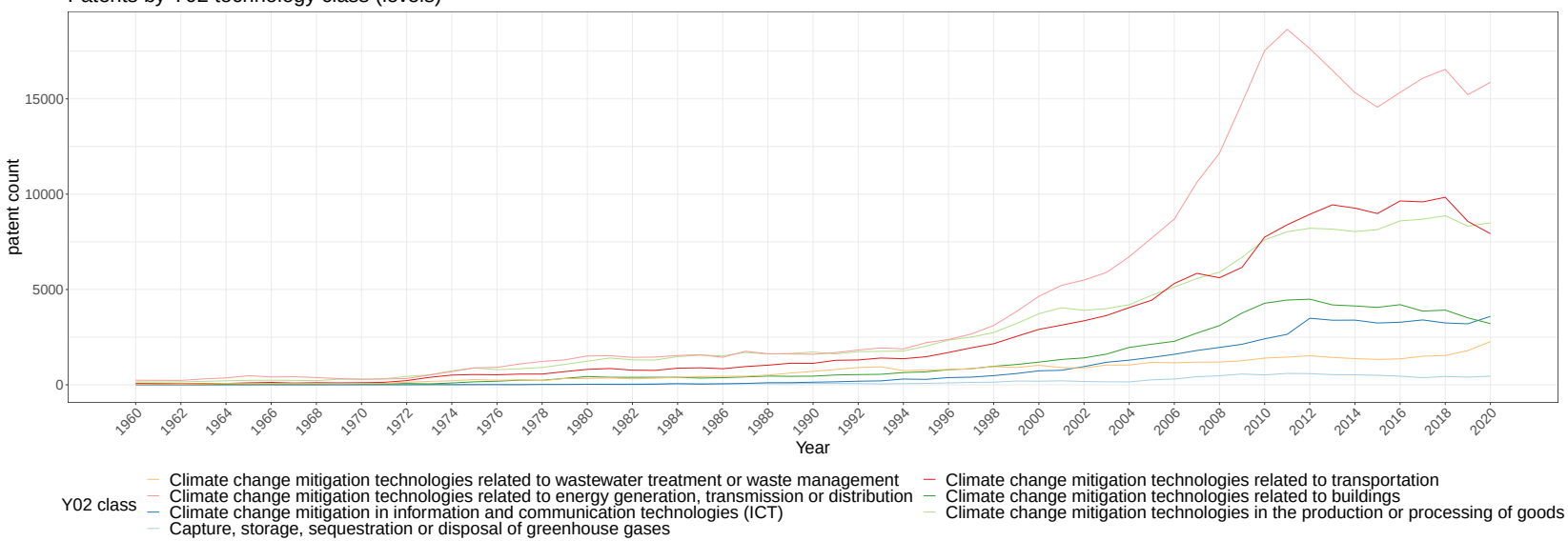
Acemoglu et al. 2019, Popp 2002, Popp et al., 2020

Green patents over time

All environmental−related patents vs climate−mitigation ones (levels)



Patents by Y02 technology class (levels)



Background

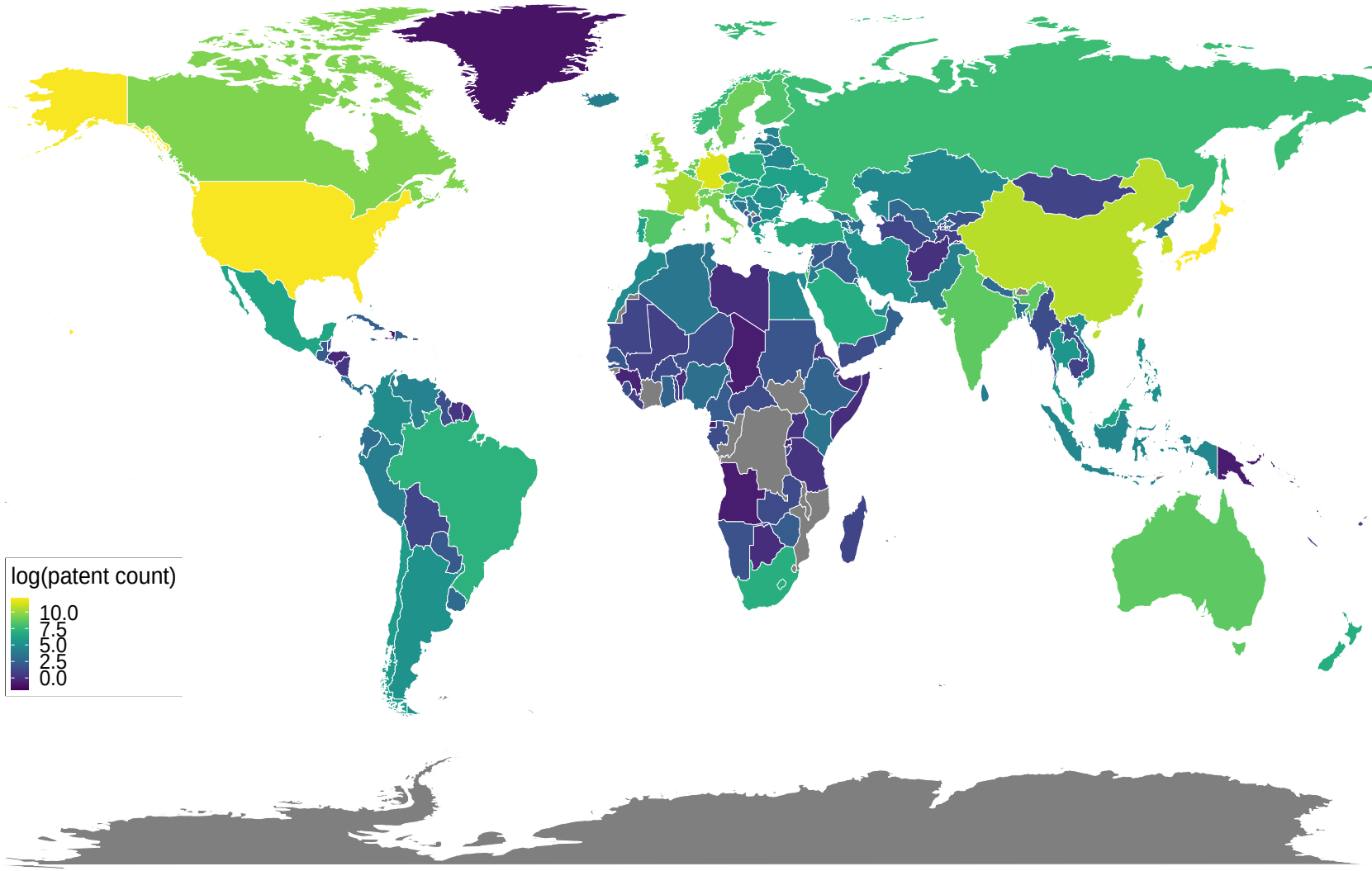
Popp 2019, Aghion et al. 2016, Noailly 2012, Johnstone et al. 2010

- Environmental innovation suffers from multiple market failures:
  - Environmental externality $\rightarrow$ can be addressed by environmental policy, a.k.a. **demand-pull policies**
  - Knowledge as a public good $\rightarrow$ can be addressed by science and technology policy a.k.a **technology-push policies**
  - More distinctions possible: *technology-neutral* policies (carbon-tax, RPS, cap-and-trade, ...) vs *technology-specific* policies (FiT, ren. auctions, investment subsidies, ...)
- What does the evidence tell us?
  - Higher energy prices encourage innovation (Aghion et al. 2016)
  - In some cases, prices alone are not enough (Noailly et al. 2012)
  - Effects of specific policies vary by technology (Johnstone et al. 2010)

Let's Look at Four Key Sectors

Let's Look at Regional Variation

Geographical distribution of climate−change mitigation technologies (CCMT)



What We Have (Done So Far)

- We have explored the OECD Patent dataset
- We have done a thorough literature review (included in Laura's master thesis)
- We have drawn on expert domain knowledge (Nils R. – many thanks!)
- We have run the break detection for the case of US states (Laura's master thesis)

  $\rightarrow$ Very similar problems occur on the global level!

The OECD Patent Database

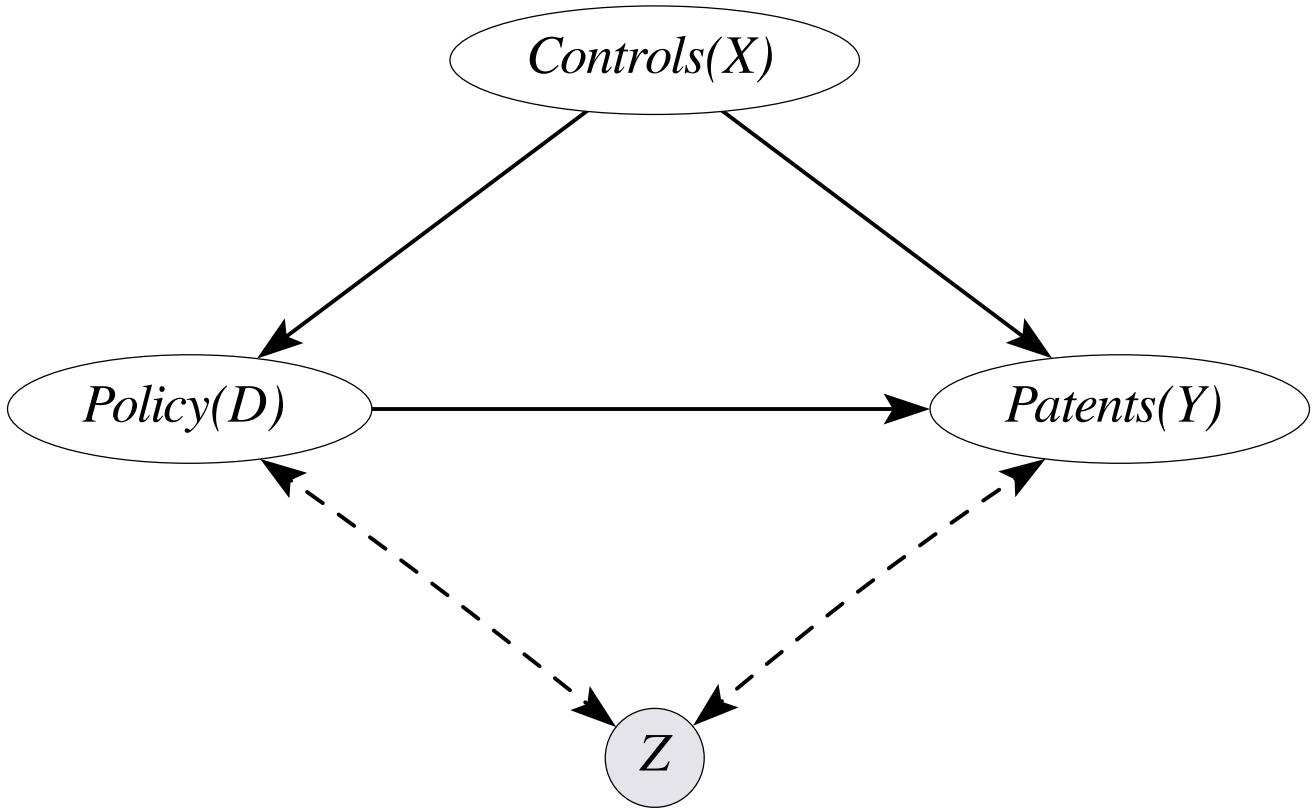
Haščič, 2015

- Already aggregated patent counts by country fractional value
- Family size ≥ 2 [1]
- Measure of technology development
- 200+ countries
- 1960-2020 (not for all countries)
- Can be filtered for climate change mitigation technologies
  - Possibility to scale down to specific technology class (e.g. Solar PV) according to IPC/CPC code classification

NB: Increased scaling down leads to greater data incompleteness, as the panel is not balanced across all countries for the whole time series. The extent of disaggregation chosen determines this outcome.

[1] A family size is the number of countries where the same invention has been filed.

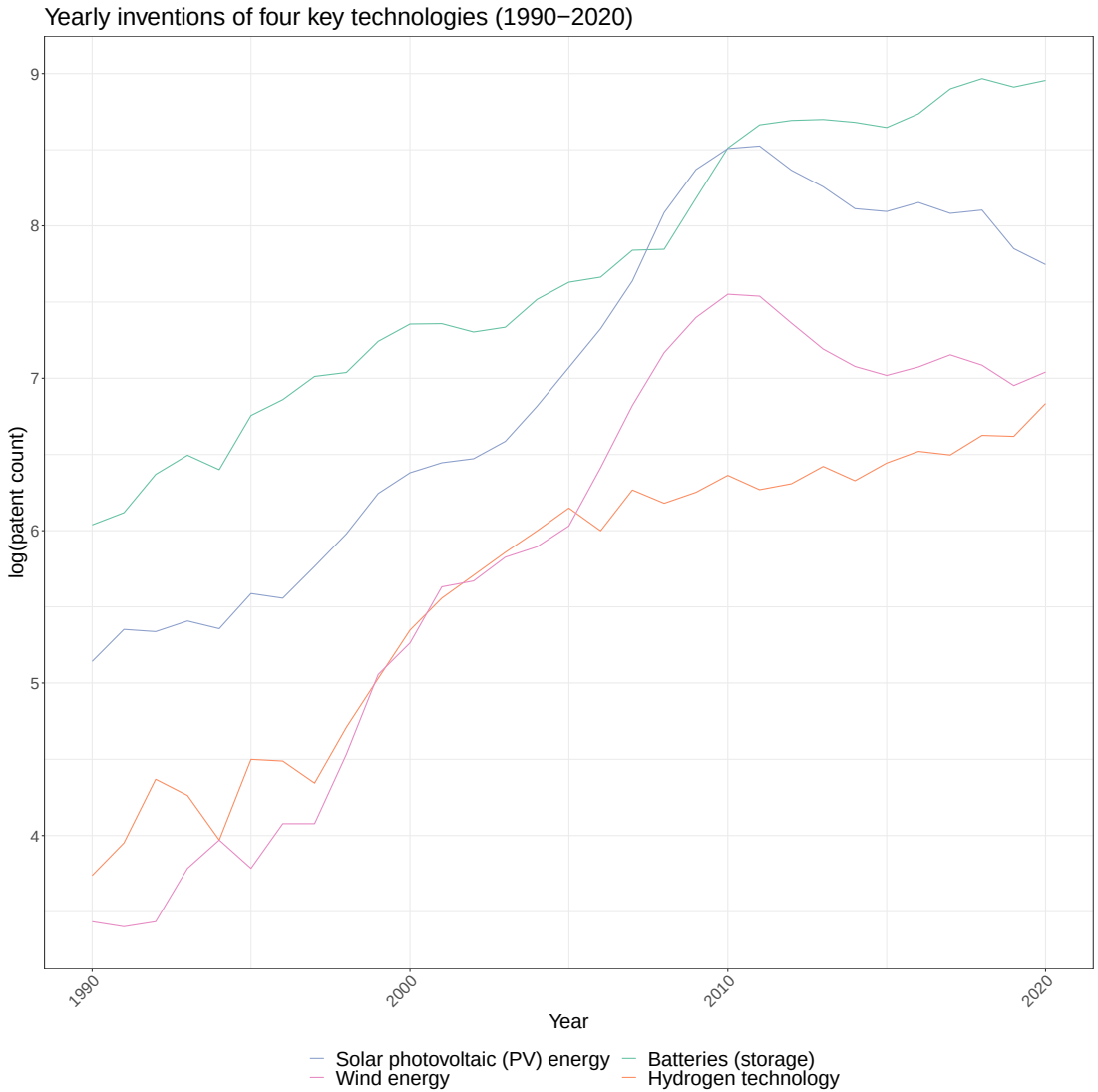
The Identification Strategy: BD Panel w/ Controls + FEs



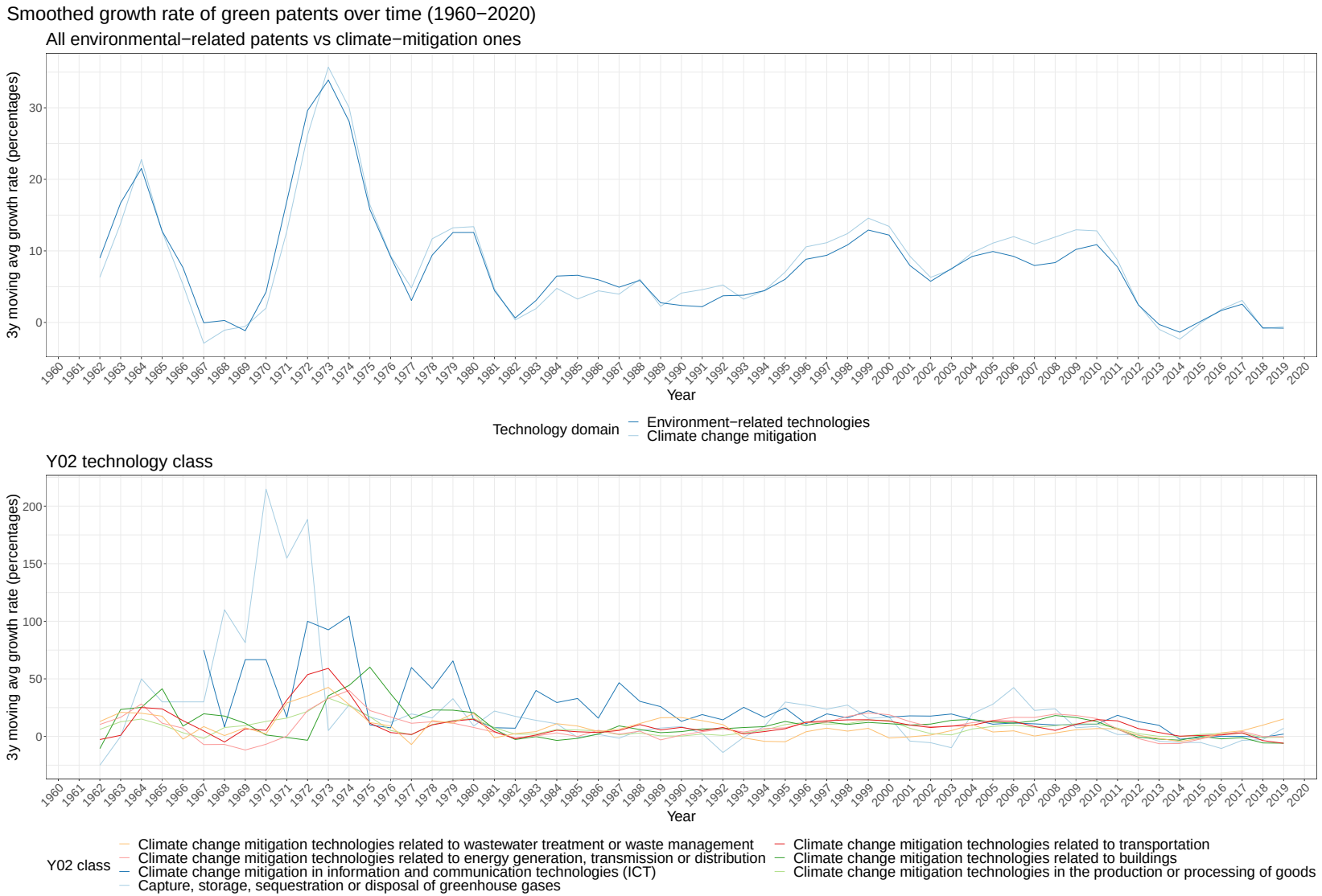
What We Need (To Do)

- Operationalize Y: Patent count growth rates?
  - Sectors: Y02 sub-sectors: energy, buildings, transport, CCS, ... (see figure above)
  - Technologies: Solar PV, Wind turbines, batteries, hydrogen, ... (see figure below)
- List of Controls: GDP, Population, ... what else?
  NB: R&D policy should not be part of the controls, but what about other policies? There we need domain knowledge.
- Decide on Patent Data Set: OECD Patent or PATSTAT or ...
- Decide on Policy Data Set
- Sample: Threshold to exclude ultra-low-patenting countries?
- Explore how "phasing-out" of policies can be operationalized within the context of the break detection method (talk to Felix/Moritz?)

Let's Look at Four Key Technologies



(Smoothed) Growth Rates as Dependent Variable



Open Questions and Problems

Pichler et al. (2020)

- Problem: Spillovers
  - Solution 0: Accounted for by family size already?
  - **Solution 1: Use growth rates**
  - Solution 2: Nils R.'s spatial regression idea
- Problem: Patents are very concentrated in very few countries – suitable control group?
  - Solution 1: Subset the sample
  - **Solution 2: Use (smoothed) growth rates of patent count instead of patent count?**
- Problem: Convincing economists (Anwesha): Higher frequency, more granularity, ...?
- Open Question: Exact research question (focus on policy!)
- Open Question: Level of granularity: sector, technology, ...

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Thank you!

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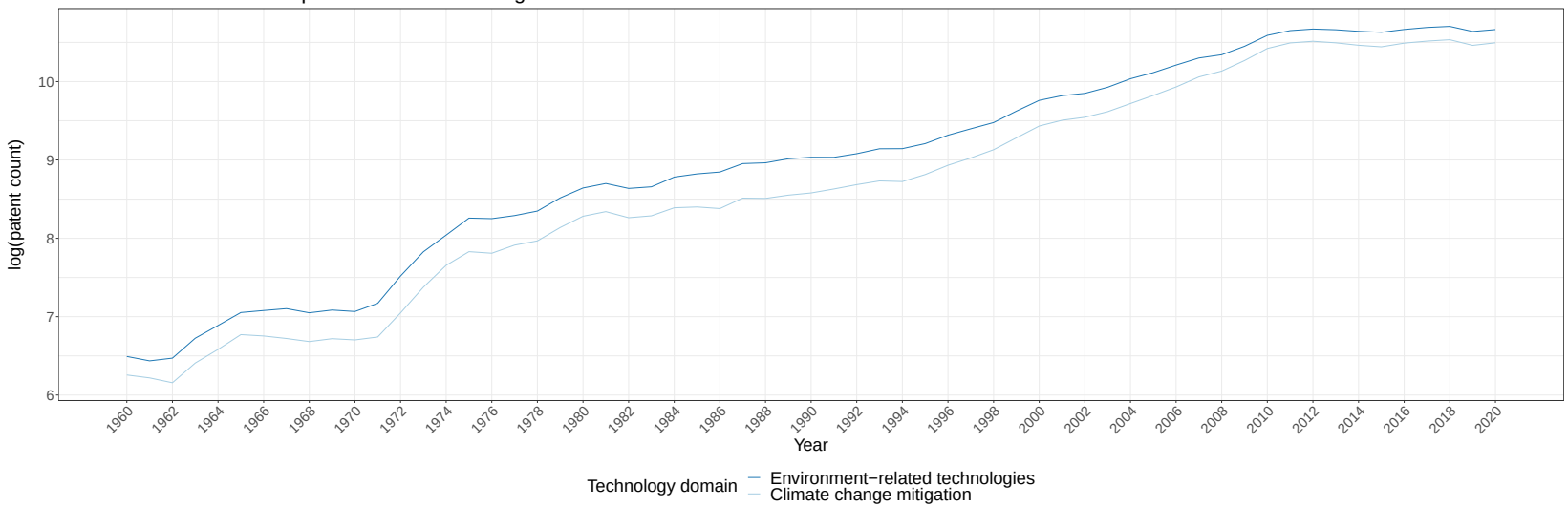
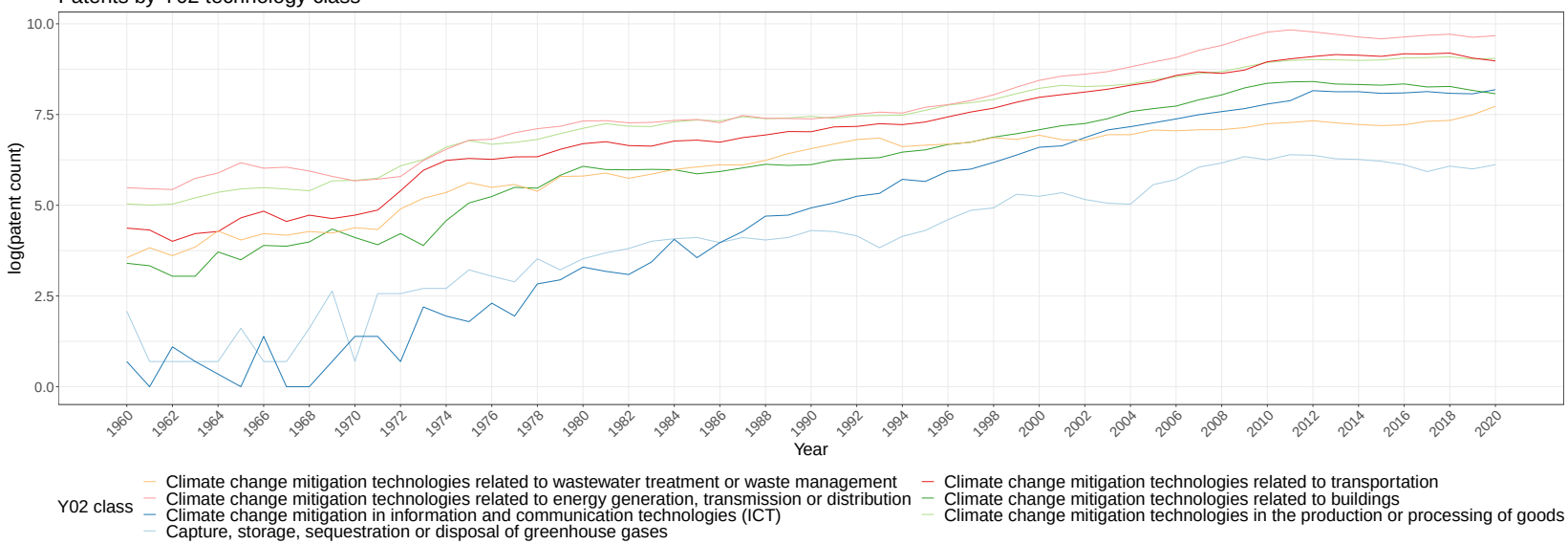
Main trends (log scales)

Green patents over time (1960−2020)

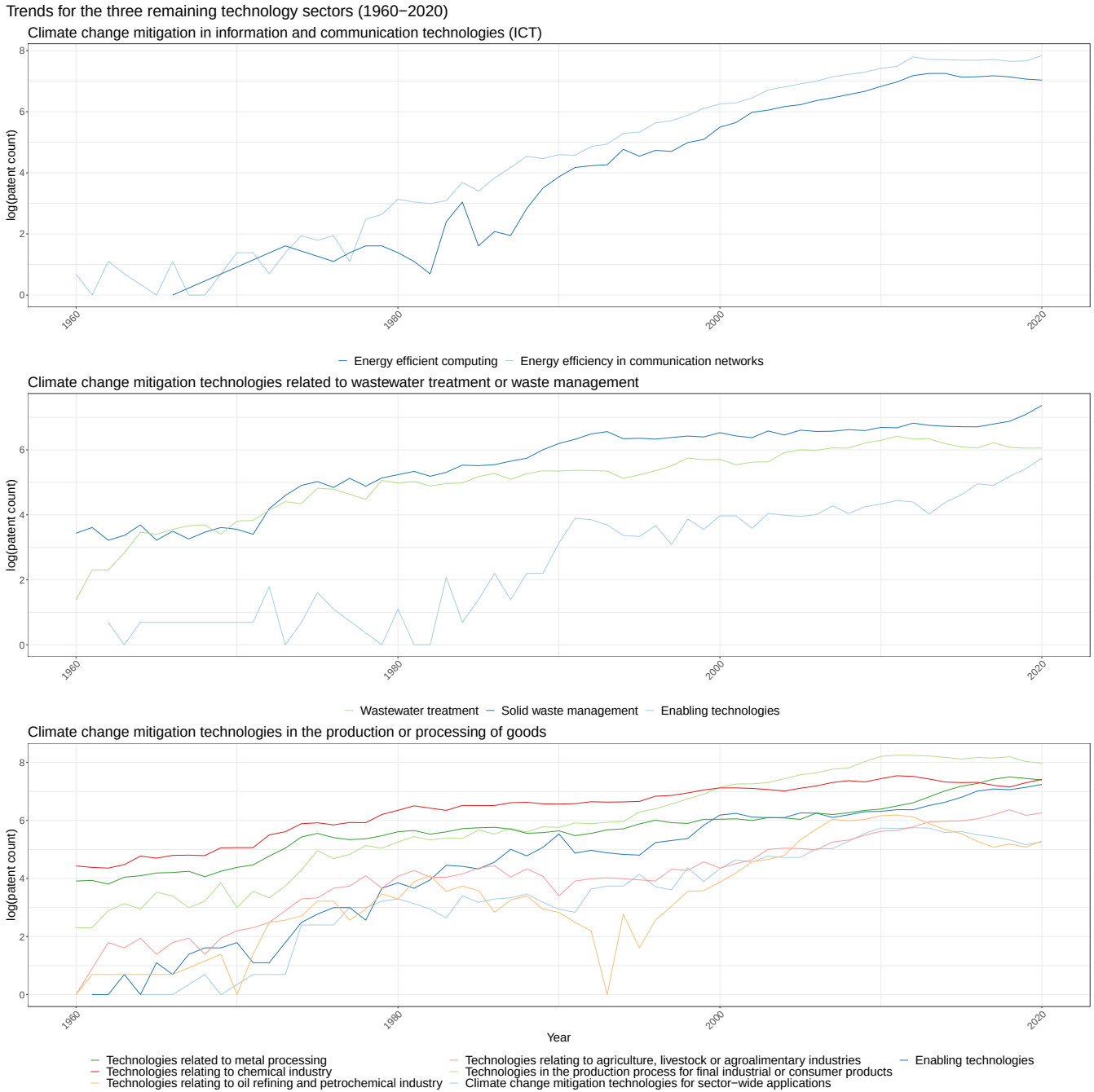
All environmental−related patents vs climate−mitigation ones



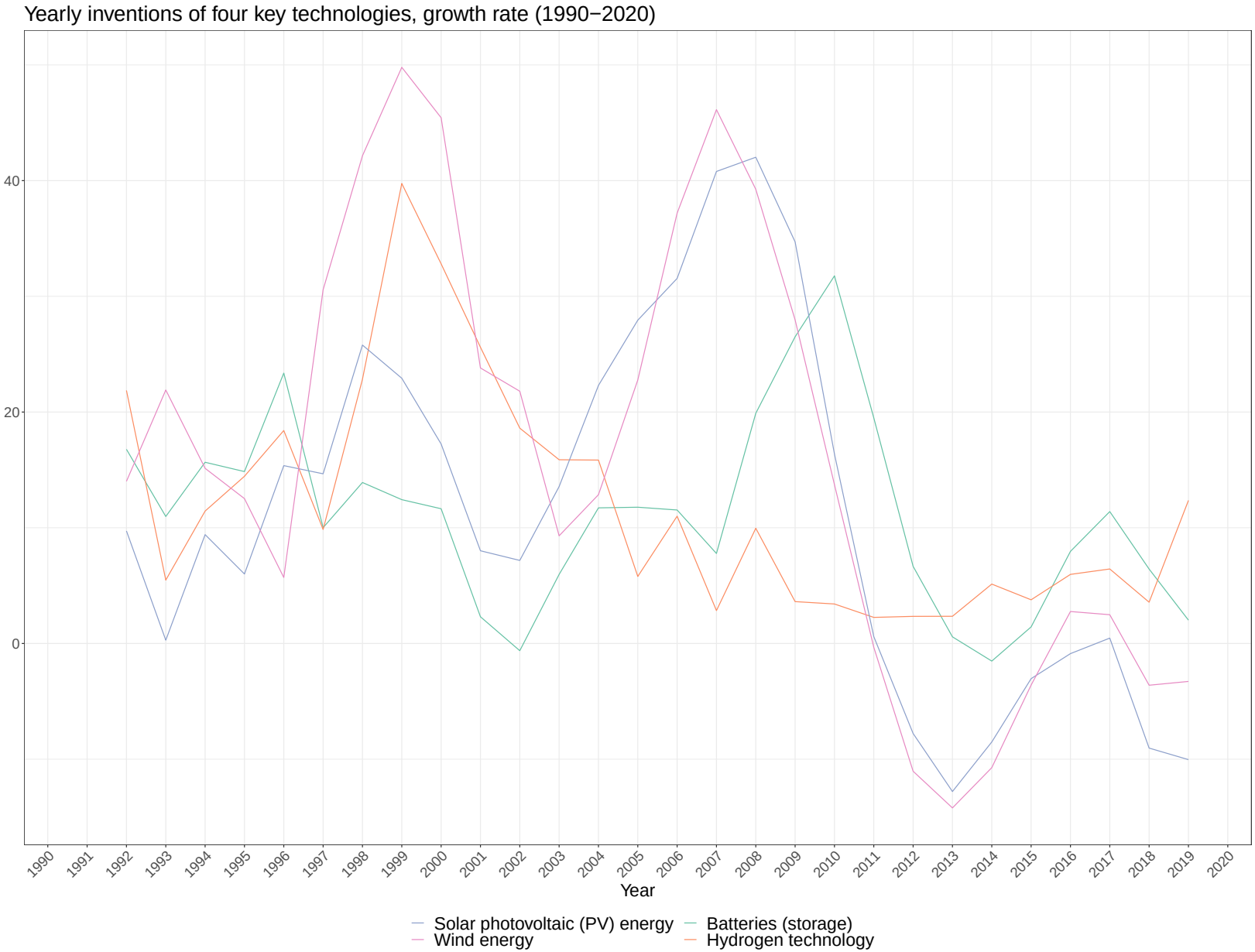
Patents by Y02 technology class



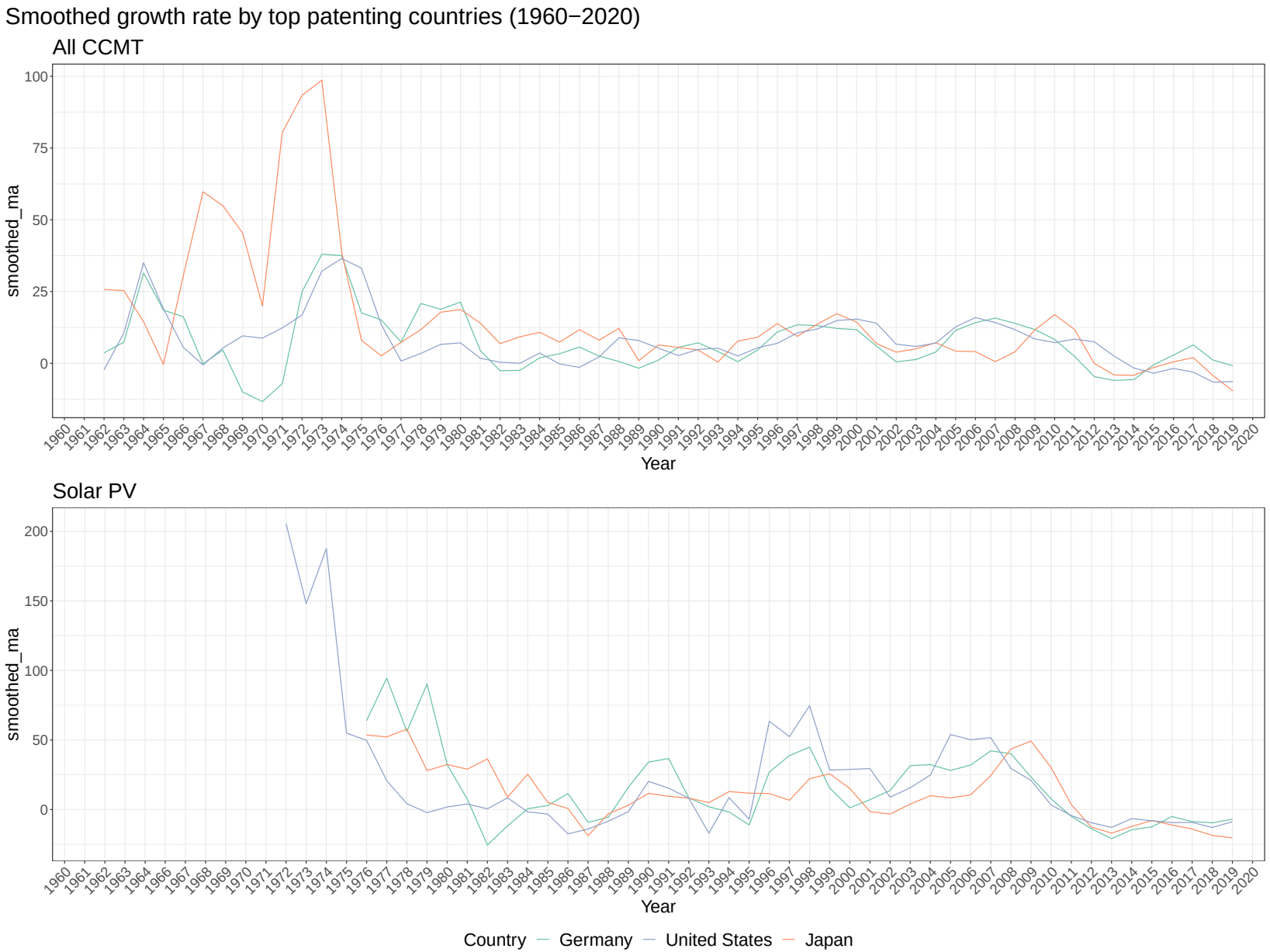
Trends for remaining Y02 sub-sectors (log scales)



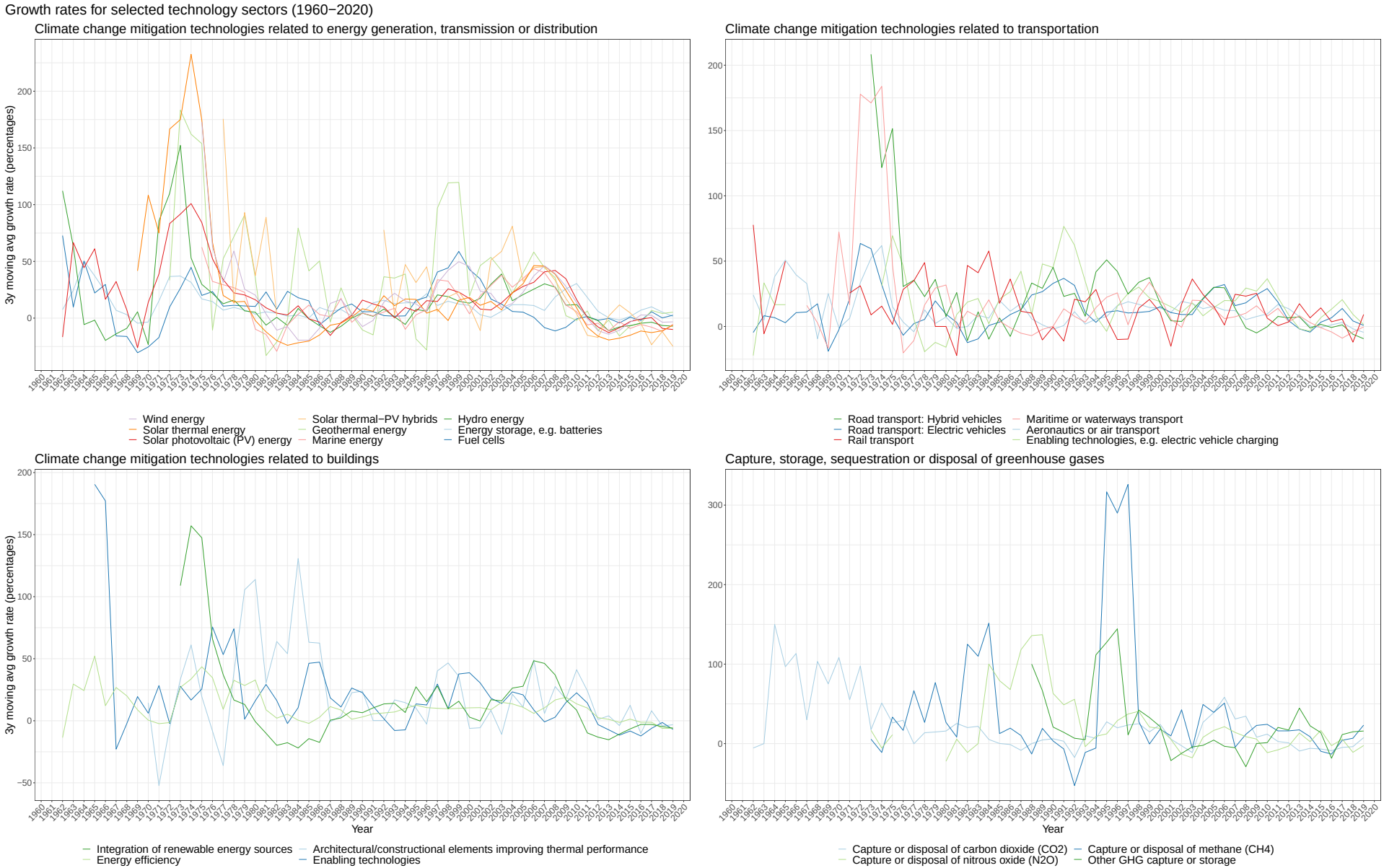
Smoothed growth rates: key technologies



Smoothed growth rates: top three patenting countries



Smoothed growth rates: four key sectors



OECD Patent Datasets comparison

Name	Type of patent indicator	Disaggregation level	Time interval	Reference country, N	Other info
Technology development (OECD Environment)	Patent family	Lowest-level Y02 class (i.e. specific technology)	1960-2020	Inventor country, 226	Possible to select gender share of invention as count
Patent by technology (OECD STI)	Patent applications and grants to EPO, PCT, USPTO, Triadic, IP5	Y02 sub-sectors	1976-2021	Inventor/Applicant, 110	Possible to select priority, application, grant year
REGPAT	Patent applications to EPO, PCT	Application ID	1977-2020	Inventor/Applicant, 36 (regional aggregation until NUTS3/TL3)	Possible to select priority, application year; linkable with citations, quality indicators data

Table: OECD datasets for environment-related technology patents