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Industrial innovation for competitive sustainability

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Do the two make a pair? Digital and green transition in European regions and their impact on greenhouse gas emissions

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Context

- Climate change perhaps the most challenging current environmental issue

- Mitigation of GHG emissions to limit global warming top priority
  - 2030 Agenda for Sustainable Development (UN, 2015)
  - the European Green Deal to make the EU climate neutral in 2050 (EC, 2019)
  - EU industrial strategy (EC, 2020) ➔ green and digital transitions – **'the twin transition'** – towards a globally competitive, climate-neutral and digitalised EU industry

Aims and boundaries of the study

- Are the digital and green transitions mutually compatible? Or is one transition likely to offset the other? What's the environmental impact of the green and digital transitions' interactions?
- Focus on:
  - the **technological dimension** of the twin transition
  - **GHG emissions from industrial activities**
- (First) empirical assessment of the role of digital and green technological development on GHG emissions from industrial production

Testable hypotheses

- Theoretical and empirical studies indicate positive contribution of innovation and technologies at reducing human activities' environmental impact

H1: *the (local) development of environmental technologies contribute reducing (local) GHG emissions from production activities.*

- Digital technologies highly intensive in energy and materials

H2: *the (local) development of digital technologies directly contributes increasing (local) GHG emissions in production activities through increased use of energy and disposal of waste materials.*

- Digital technologies may spill over in further technological breakthroughs – including environmental ones – and may lead to more efficient use of resources

H3: *the reduction (increase) of GHG emissions from production activities in places with stronger development of environmental (digital) technologies is augmented (smoothed) by a coexisting strong development of digital (environmental) technologies.*

GHG emissions

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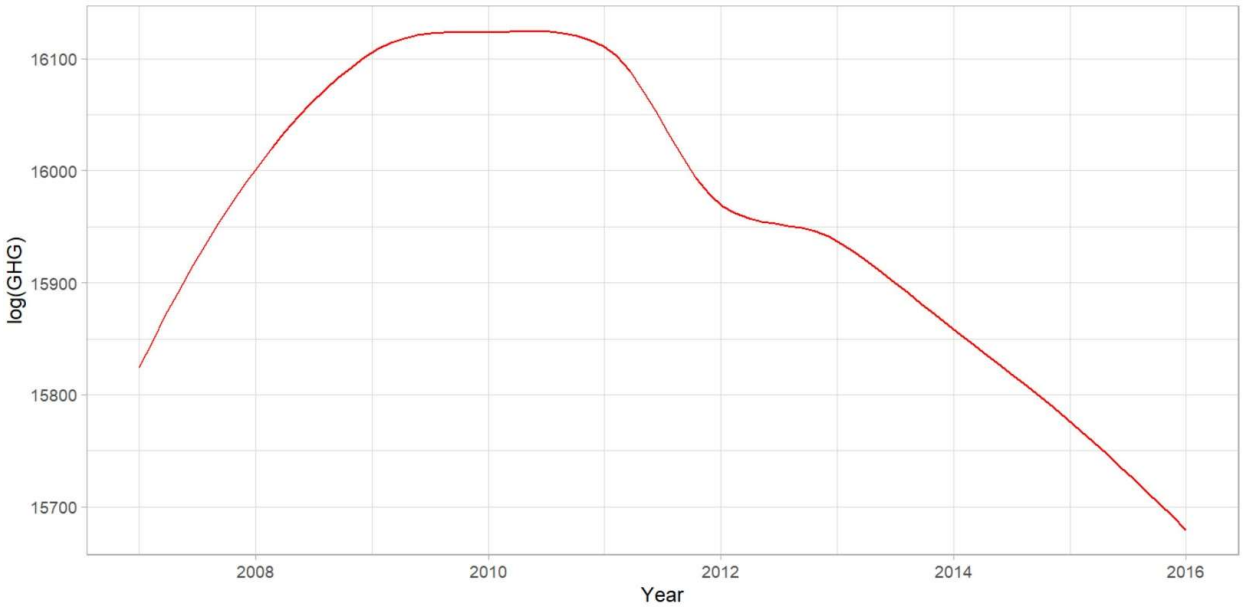

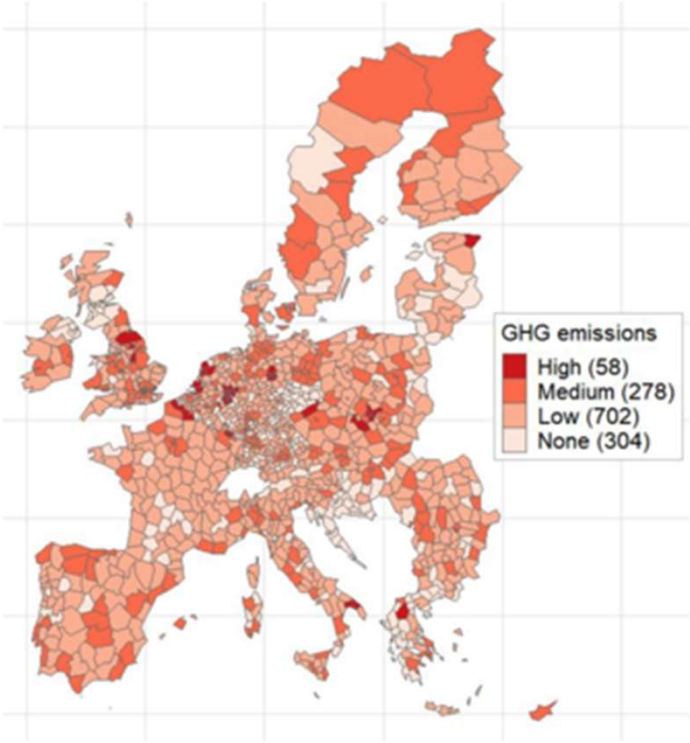

GHG emissions from **E-PRTR data** that emissions from most polluting plants (48% of total GHG emissions)

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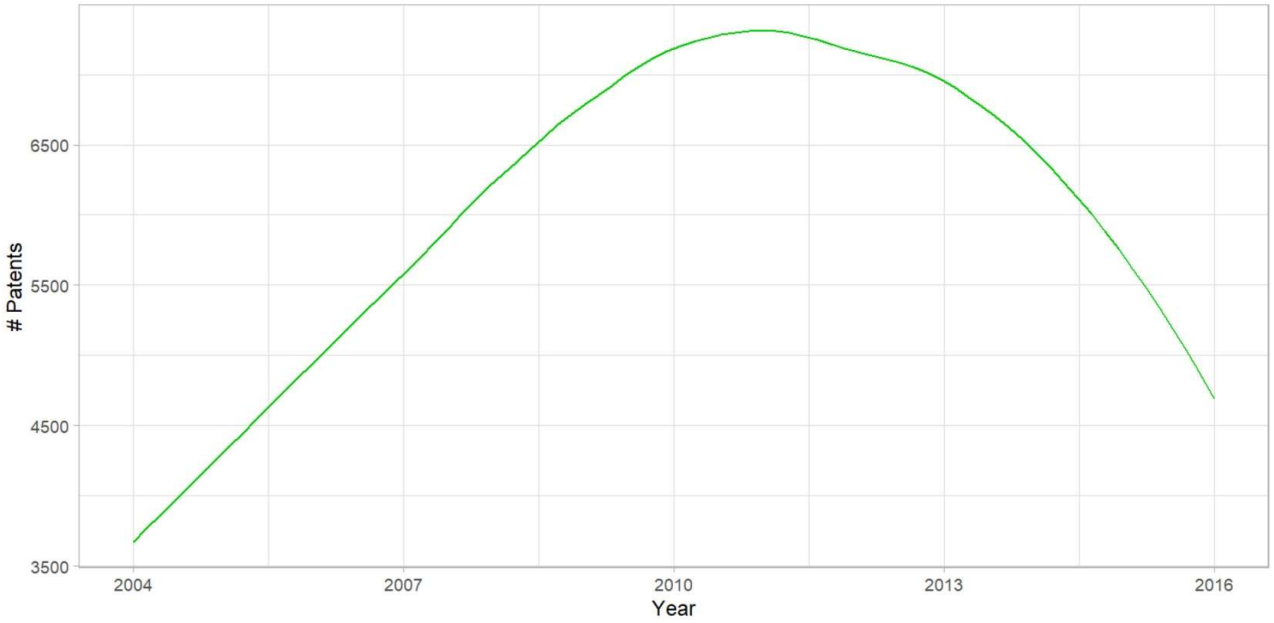
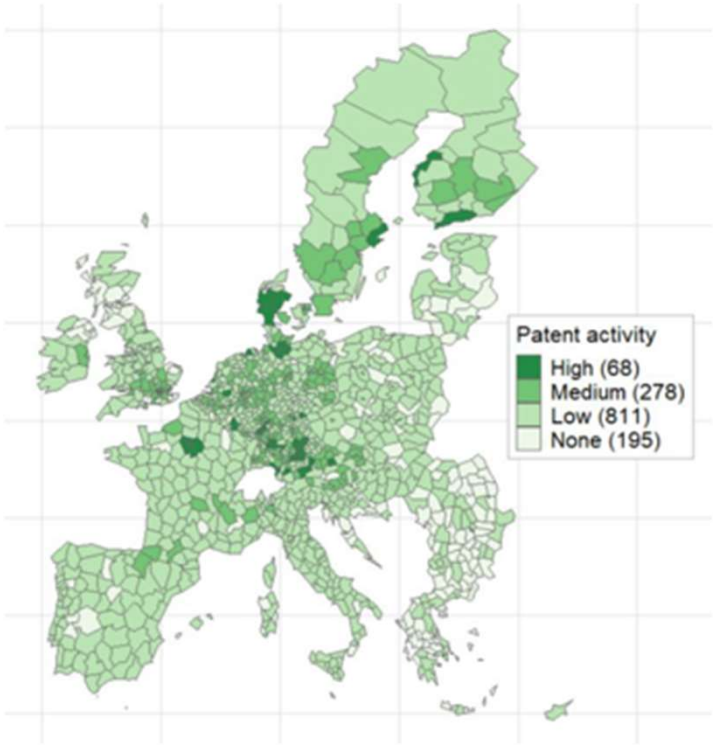
Green technologies





EPO patent applications in green technologies from OECD Envtech classification

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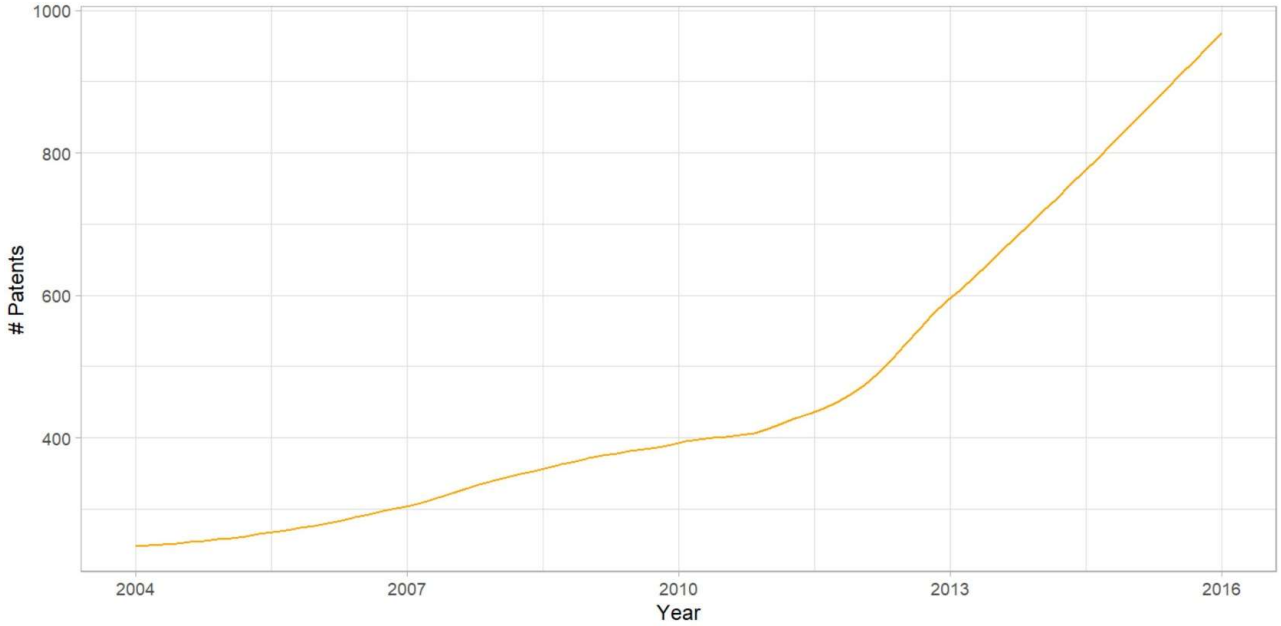
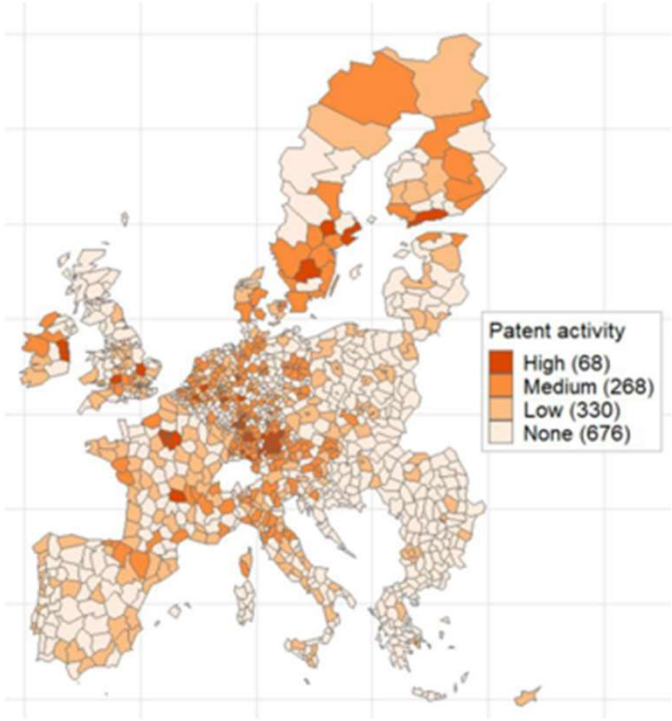
Digital technologies





EPO patent applications in digital technologies retrieved from **Patstat** using **keywords search** in patents' title and abstract

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Methods

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- Tobit model to account for the censored nature of the dependent variable:

$$GHG_{i,t} = \beta_1 Green\ Tech_{i,t} + \beta_2 Digital\ Tech_{i,t} + \beta_3 Green\ Tech_{i,t} * Digital\ Tech_{i,t} + \gamma\ CONTROLS_{i,t} + \delta\ Pre\ sample\ Mean\ GHG_i + \zeta\ Time_t$$

where:

- ❖ *i* indexes the 1,342 metropolitan regions in the EU27 and the UK
- ❖ *t* indexes years from 2007 to 2016
- ❖ unbalanced sample of 10,510 observations
- ❖ Yearly volatility of $Green\ Tech$ and $Digital\ Tech$ is smoothed through a 3-years moving average
- ❖ CONTROLS include the regional population, urbanisation degree and share of value added in manufacturing
- ❖ Cross-sectional estimators ae preferred to panel ones as most (76%) variance of GHG occurs between regions
- ❖ $Pre\ sample\ Mean\ GHG_i$ allows to control for persistent unobserved regional differences in GHG emissions
- ❖ Continuous variables (GHG, $Green\ Tech$, $Digital\ Tech$, population and and share of value added in manufacturing,) taken in logs

- Instrumental variables (2SLS) to account for bi-directional link between GHG and $Green\ Tech$:
  - ❖ Right-Left orientation of the party who won the regional election
  - ❖ Institutional Quality

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	(1)	(2)	(3)
Green Tech (log)	-0.451***	-0.570***	-0.534***
	(0.073)	(0.093)	(0.094)
Digital Tech (log)		0.554**	1.527***
		(0.253)	(0.533)
Green × Digital Tech (log)			-0.250**
			(0.112)
Population (log)	4.517***	4.504***	4.518***
	(0.119)	(0.119)	(0.119)
Value Added Manuf (log)	1.788***	1.785***	1.776***
	(0.214)	(0.214)	(0.214)
Intermediate	1.075***	1.077***	1.074***
	(0.221)	(0.221)	(0.221)
Rural	0.741***	0.725***	0.749***
	(0.252)	(0.252)	(0.252)
Pre-sample Mean GHG (log)	0.479***	0.481***	0.480***
	(0.011)	(0.011)	(0.011)
Log(scale)	2.157***	2.157***	2.157***
	(0.010)	(0.010)	(0.010)
Year Dummies	✓	✓	✓
# Observations	10,510	10,510	10,510
Log Likelihood	-30,970.37	-30,968.04	-30,965.99

Notes: Robust standard errors in parentheses, clustered at metroregion-level: ***, **, *, indicate significance at the 1%, 5% and 10% level, respectively.

Results

- Confirmation of our hypotheses:
  - Local development of green tech reduces local GHG emissions
  - Local development of digital tech reduces local GHG emissions
  - Interaction term of green and digital techs nehatively affects GHG emissions
- Controls statistically significand with expected signs
- Main results confirmed when:
  - using IV
  - looking at specific digital tech (Big data, IoT, Robotics, Computing infrastructures), but effects lose statistical significance in IV models

Discussion and conclusions

- Digital technologies have a mixed impact on GHG emissions of industrial activities:
  - ❖On the one hand, digital technologies directly increase emissions, possibly through their high-energy requirements and disposal of digital equipment
  - ❖On the other hand, the interaction of environmental and digital technologies contributes positively to emission reductions
  - ➔the overall impact of digital technologies is only beneficial for regions with strong green technological capabilities

- Key policy implication:
  - ❖The effectiveness of the twin transition policy approach on environmental performance may substantially vary depending on regional technological strength and specialisation

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Thanks for your attention!

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Thank you!