UNIVERSITÄT BIELEFELD

Leibniz ScienceCampus SOEP RegioHub at Bielefeld University

Exploring the Impact of Artificial Intelligence on Skill Demand:

A (Spatial) Analysis of German Job Vacancies

Katrin Rickmeier & Mariya Afonina

Introduction

- Introduction of ChatGPT to the general public in November 2022 generated renewed and heightened interest in AI
  - Increased accessibility of AI

- Public debate about the potential impact of AI on work and education
  - Promise to yield productivity gains through enhanced efficiency and reduced costs

Concerns about its impact on the labour market and society, i.e. displacements

Introduction

- Generative AI, like ChatGPT, reached a level of versatility and transformative capacity at which it can be perceived as a **general purpose technology** (Eloundou et al. 2023; OECD 2019)
  - Such technologies have the potential to be the start of a technological revolution and to disrupt the economy (Bresnahan & Tratjenberg 1995)

- Concerns about job displacement and wage erosion

- **40.5%** of the German workforce **anticipates significant impact** of technologies like ChatGPT on their professional lives (IU Internationale Hochschule 2023)
- Around **80%** of the US workforce could have at least **10%** of their work tasks affected by the introduction of LLMs, **19%** of workers may see at least **50%** of their tasks impacted (Eloundou et al. 2023)

Introduction

- We link advancement in AI to the demand for different abilities
- This paper examines how the presence and availability of ChatGPT affects the skill requirements in the German labour market
- There is no study researching the effect of the introduction of ChatGPT on actual **skill demand** in the (German) labour market

Literature

Previous research on the impact of AI on labour

- In contrast to previous waves of automation, AI also impacts **non-routine cognitive** occupations
- Occupations in requiring physical labour are least exposed (Oschinski 2023; Webb 2019)

- Overall, **moderate impact** of AI on skills and competencies, **7%** of the ESCO skills are at high or very high risk of negative impact, 55% at low or very low risk (Oschinski 2023)
- Skills for working with **computers** and information processing like **programming** and **writing** skills are susceptible to influence by LLMs (Eloundou et al. 2023; Oschinski 2023)
- **Social** skills like recognizing natural human emotions in real-time and responding intelligently to them remain challenging for algorithms (Frey & Osborne 2017; Lane & Saint-Martin 2021)
- **Creative** skills and **critical thinking** seem to be less affected by current LLMs (Eloundou et al. 2023; Lane and Saint-Martin 2021)

- Occupations with high potential for automation may not necessarily disappear, but undergo **adjustments** (Brynjolfsson et al. 2018; Frank et al. 2018; Kropp & Dengler 2019)

Literature

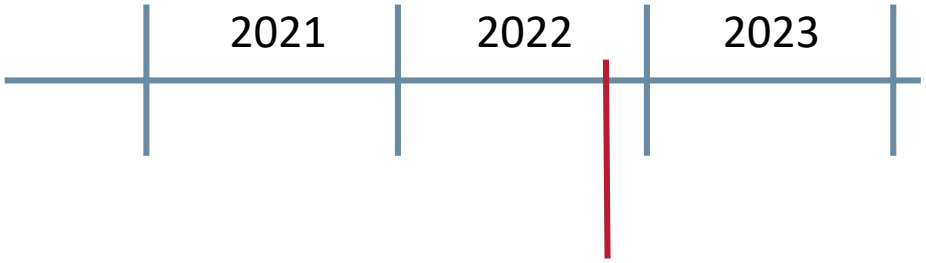
Previous research on the impact of AI on labour

- Regional differences in previous waves of automation
- Lack of analysis which considers the subnational geographical implications of automation risk posed to employment (Crowley and Doran 2022)
- Pronounced urban-rural differences in the susceptibility of workers to automation in the US (Frank et al. 2018)
- The share of highly substitutable occupations ranges from 14 to 51% across German districts (Kropp and Dengler 2019)

Data

Job vacancy data

- Sourced from online platforms
- Provided by the Bertelsmann foundation
- Data on jobs posted at daily frequency from 01/2014 until 12/2023
- Information on the vacancy itself and metainformation on the job posting



Release of ChatGPT on November 30, 2022

Data

Job vacancy data

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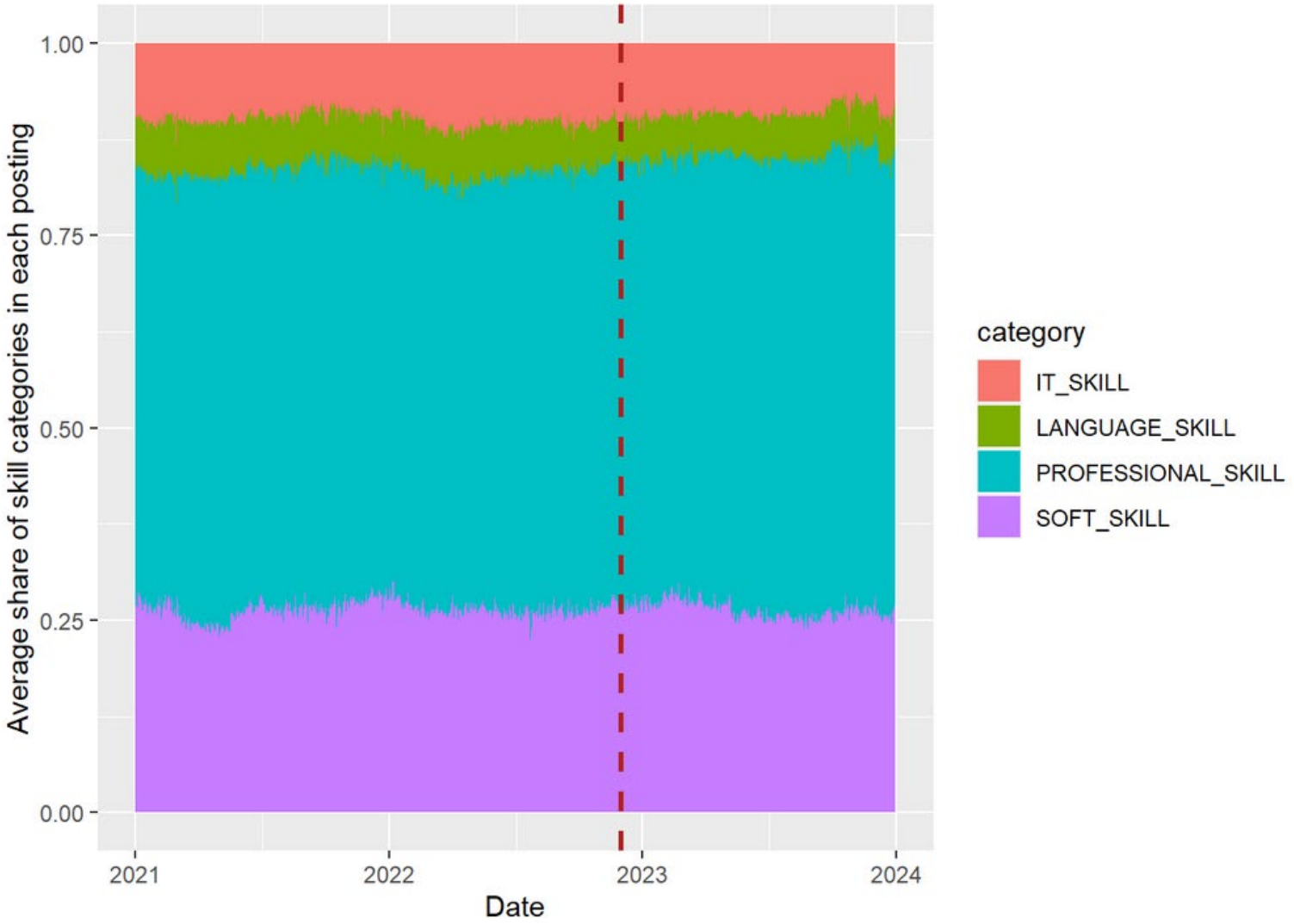
Sample

- 01.01.2021 – 31.12.2023
- German and English postings only
- Full-time employment only
- Exclusion of internships, franchise, voluntary work, freelance, apprenticeships, temporary work
- Availability of skill data and geolocation coordinates
- 173,138,206 unique postings of 130,027,922 unique jobs

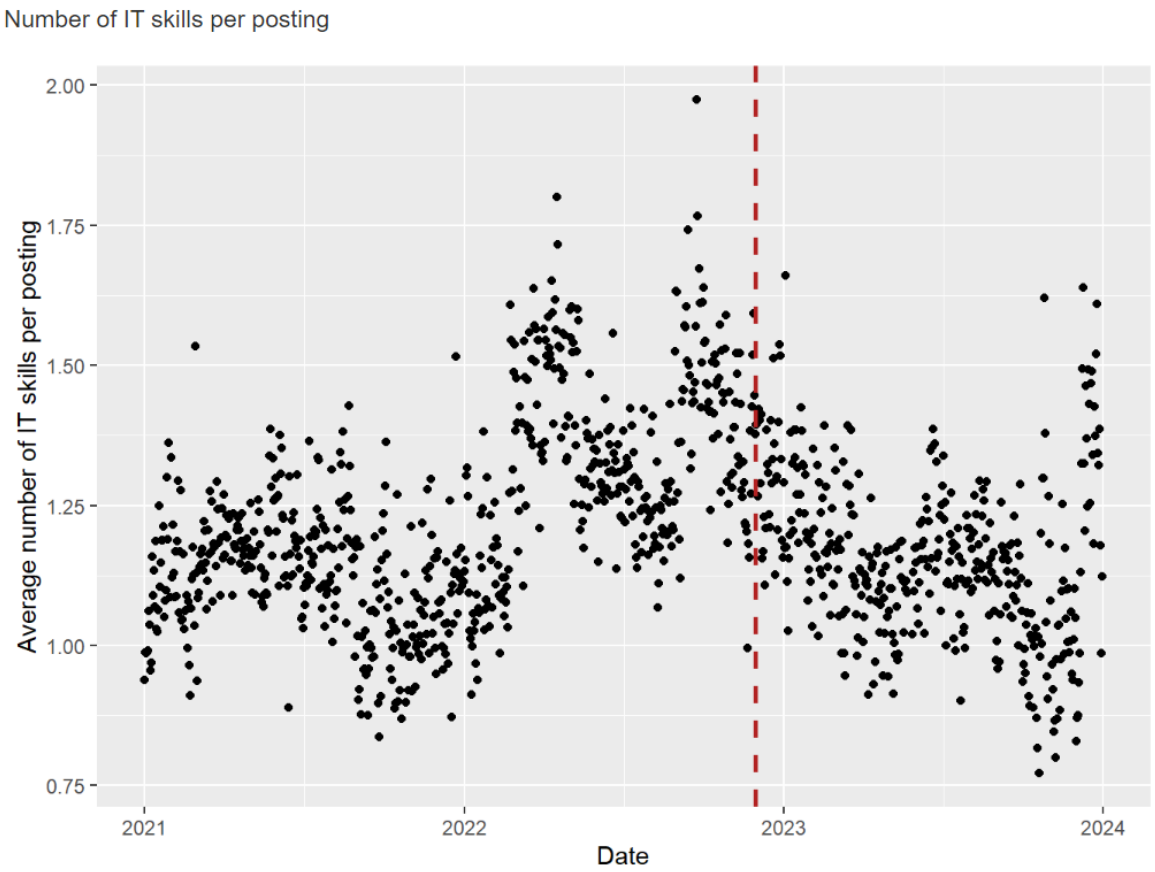
Descriptives



- The skills are divided into four categories
- Here: their average composition over time
- Red dotted line marks the release of ChatGPT in November 2022
- Slight growth of professional skills on the expense of IT skills

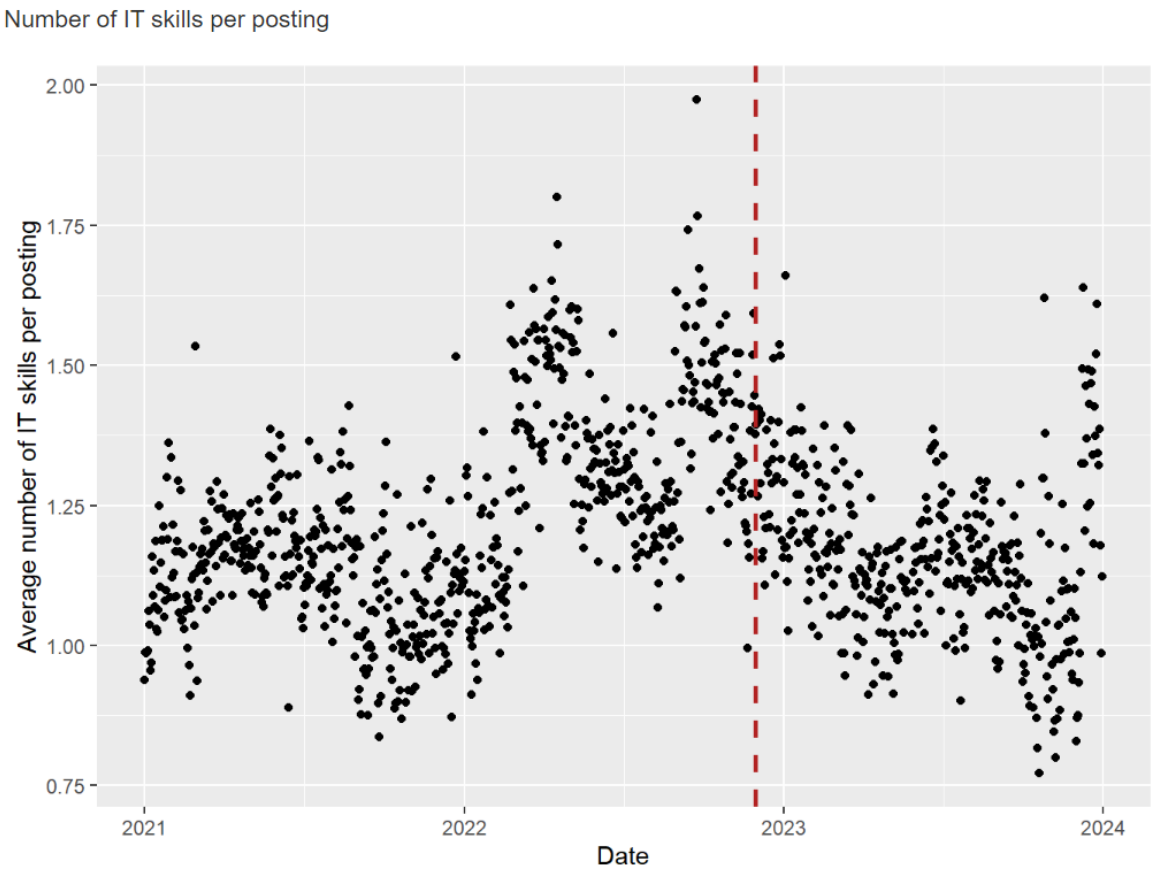
Descriptives

IT skills



Descriptives

IT skills



What are „IT skills“?

- There are 4570 different IT skills
- A random sample of those:
  - Apache Cordova
  - Cara
  - Zeichenprogramm
  - It-Beratung
  - Mailbox (Computer)
  - Data Analysis
  - Apache Flink
  - Qgis
  - Datenpräsentation
  - Ipsec

→ We need more meaningful categories!

Research Question

Sub-categorisation of IT skills

Research Question

Sub-categorisation of IT skills

General software
Professional software
Professional creative software
AI development

Programming languages
Hardware
Professional qualification
Miscellaneous

Research Question

Sub-categorisation of IT skills

General software
- H: lower demand after introduction of ChatGPT

Professional software
- H: lower demand after introduction of ChatGPT

Professional creative software
- H: lower demand after introduction of ChatGPT

AI development
- H: increased demand after introduction of ChatGPT

Programming languages

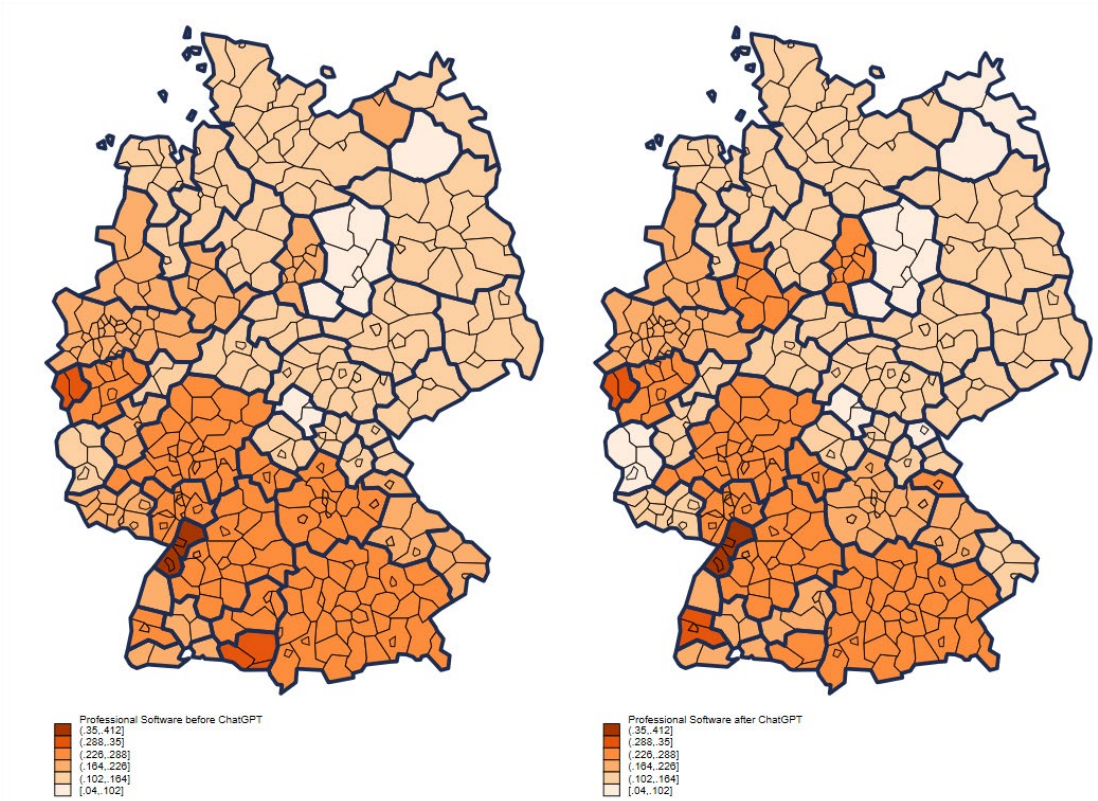
Hardware

Professional qualification

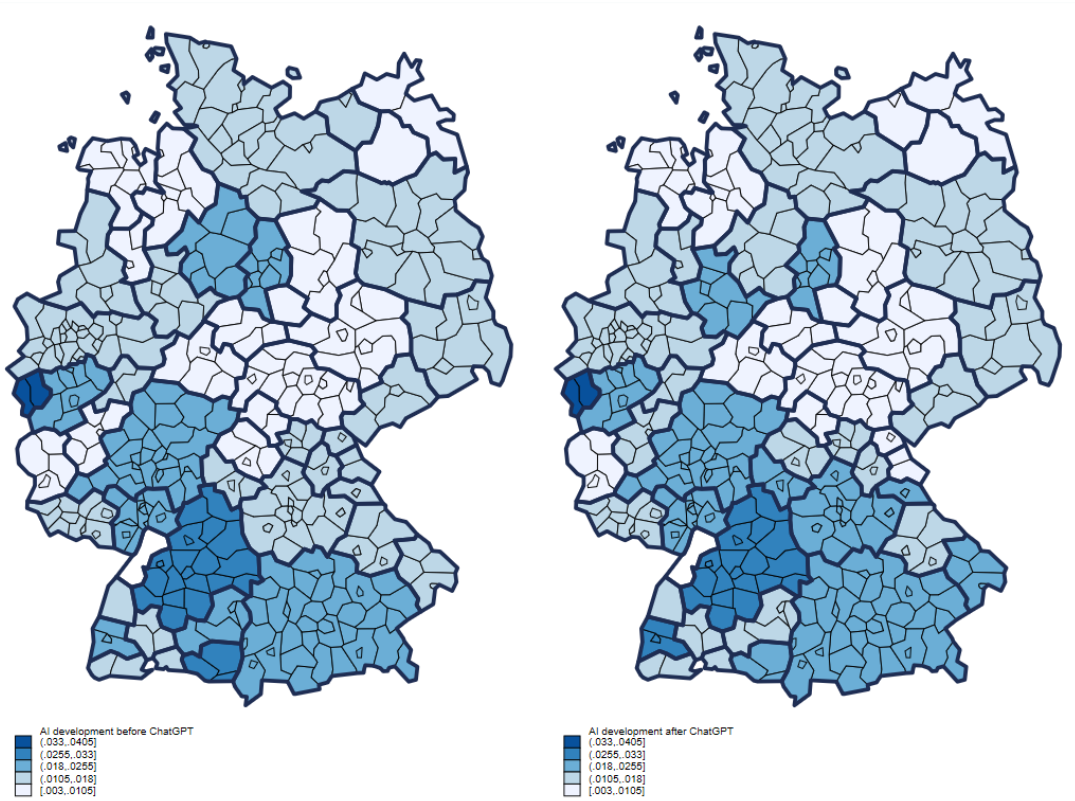
Miscellaneous

Regional Disparities

Professional software



AI development



Method

Segmented Regression of interrupted time series

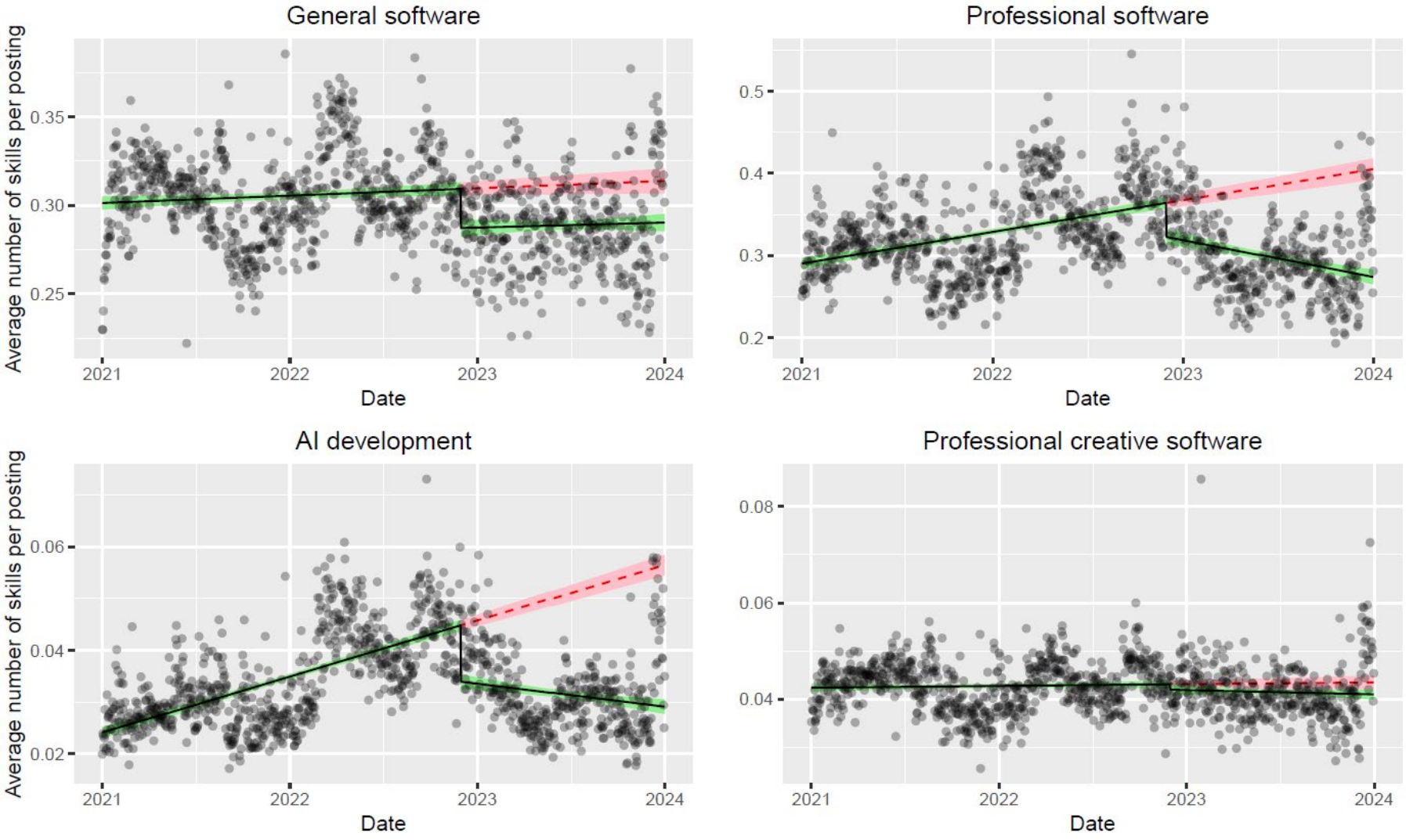
$$Y_t = \beta_0 + \beta_1 T_t + \beta_2 I + \beta_3 T_{after} + \epsilon_t$$

Counterfactual

$$Y_t = \beta_0 + \beta_1 T_t + \epsilon_t$$

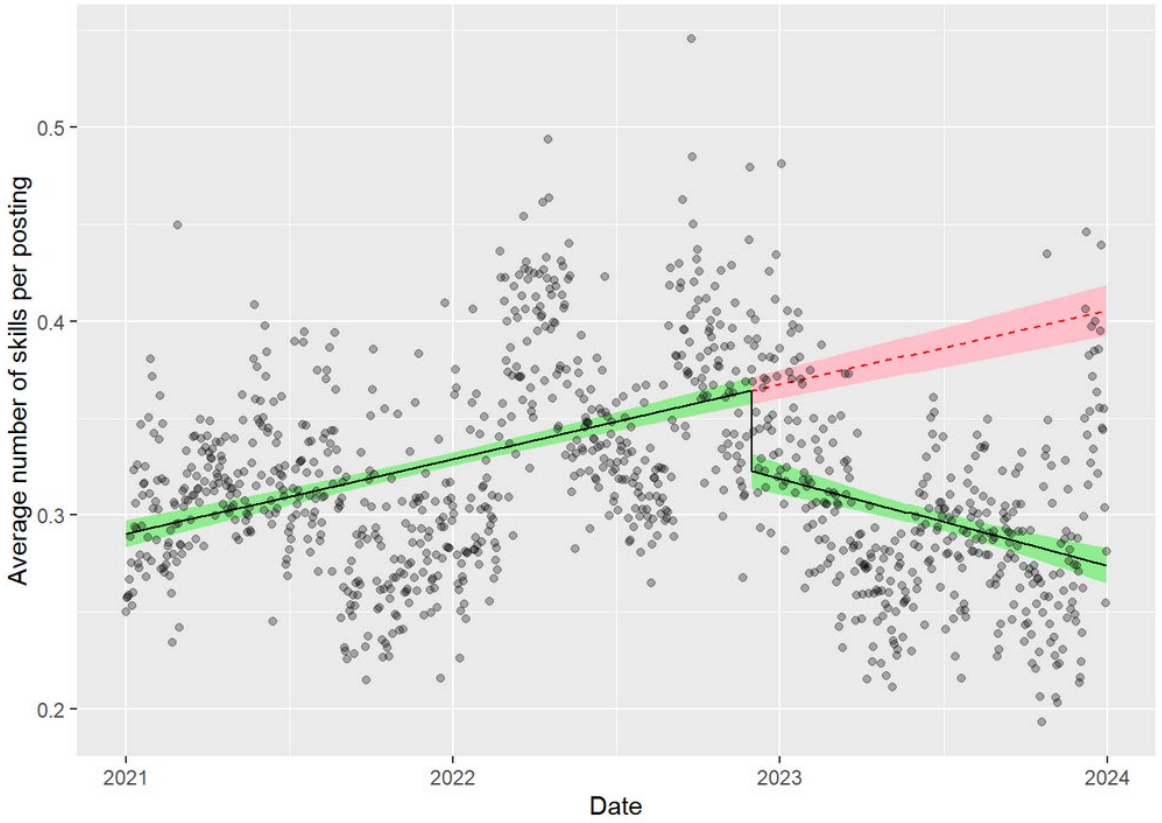
Variable	Definition
Y_t	Outcome at time t
T_t	Time variable, which is 1 at the beginning of the observation window and increases with time
I	Dummy variable indicating whether the observation was measured after the intervention
T_{after}	Time variable, which counts the number of periods since the intervention

Preliminary Results

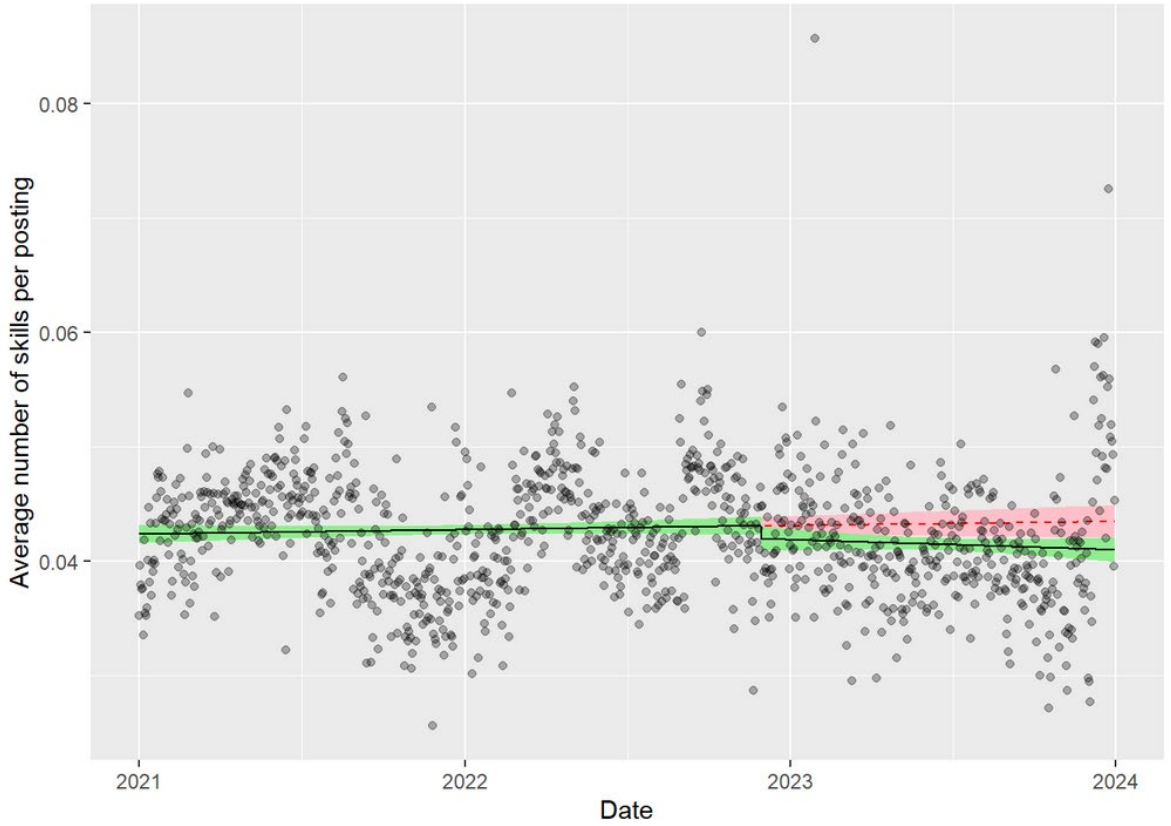


Preliminary Results

Professional software

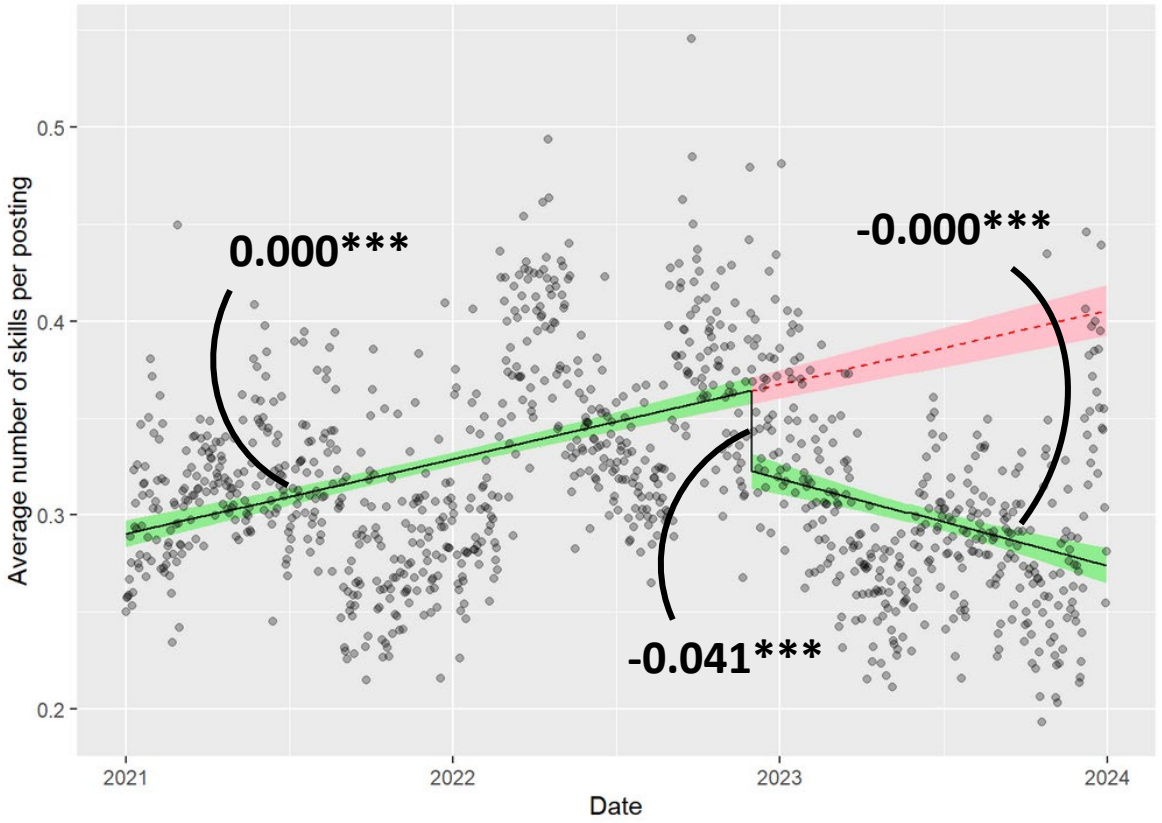


Professional creative software

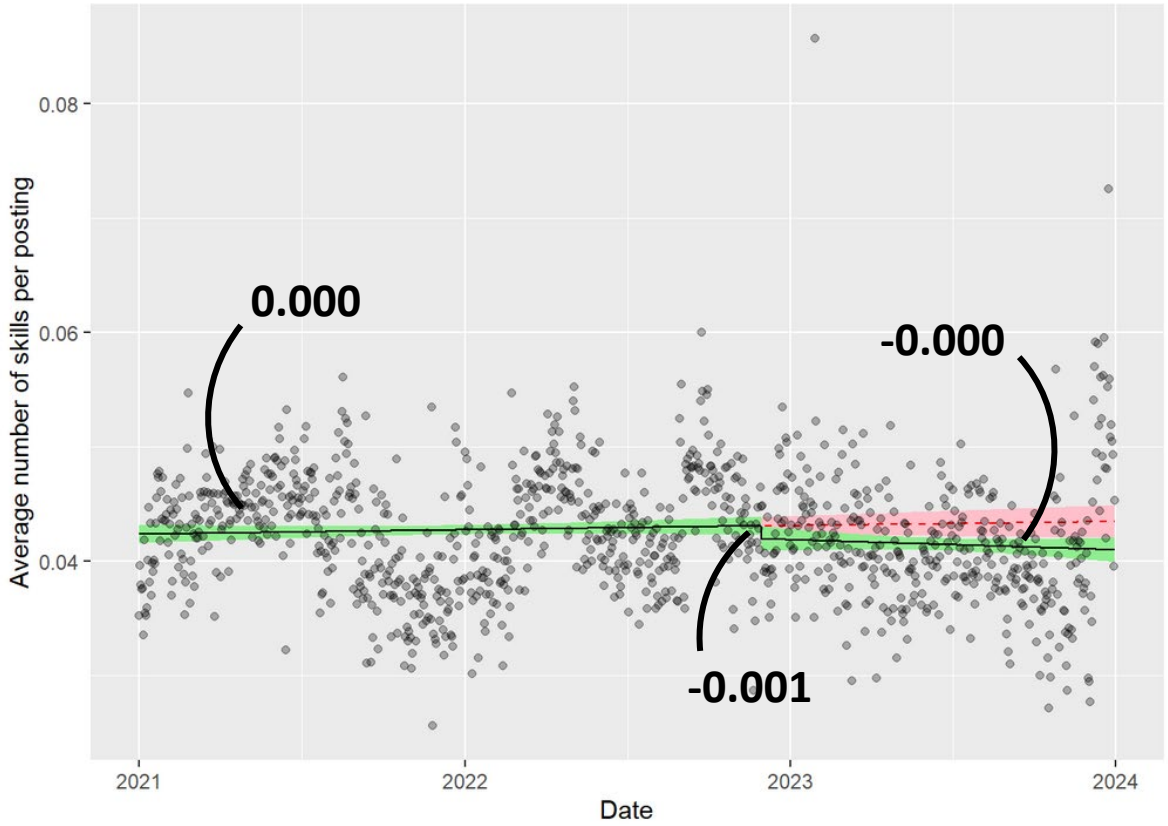


Preliminary Results

Professional software



Professional creative software



Conclusions

- Significant decreases in demand for AI development and software skills, but no effect on professional creative software skills
- We observe more demand for IT skills in the south-west compared to north-east in Germany

Results point towards **immediate effects** of the release of ChatGPT on the demand of IT skills on the German labour market

- General challenge: development and deployment of AI is not happening in a vacuum
- Regional indicators will be published later this year

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Thank you for your attention!

Literature

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Appendix

Segmented ITS results

General software

	Value	Std. Error	t-value	p-value
Intercept	0.301	0.002	159.540	0.000
Time	0.000	0.000	2.441	0.015
Intervention	-0.022	0.003	-7.034	0.000
Post intervention time	-0.000	0.000	-0.297	0.766

Professional software

	Value	Std. Error	t-value	p-value
Intercept	0.290	0.003	83.079	0.000
Time	0.000	0.000	12.240	0.000
Intervention	-0.041	0.006	-7.115	0.000
Post intervention time	-0.000	0.000	-10.369	0.000

AI development

	Value	Std. Error	t-value	p-value
Intercept	0.024	0.001	44.278	0.000
Time	0.000	0.000	21.999	0.000
Intervention	-0.011	0.000	-12.001	0.000
Post intervention time	-0.000	0.000	-12.133	0.000

Programming language

	Value	Std. Error	t-value	p-value
Intercept	0.107	0.001	73.013	0.000
Time	0.000	0.000	14.088	0.000
Intervention	-0.002	0.002	-0.993	0.321
Post intervention time	-0.000	0.000	-20.401	0.000

Appendix

Segmented ITS results

Hardware

	Value	Std. Error	t-value	p-value
Intercept	0.007	0.000	37.207	0.000
Time	0.000	0.000	25.047	0.000
Intervention	0.001	0.000	3.367	0.000
Post intervention time	-0.000	0.000	-19.872	0.000

Professional qualification

	Value	Std. Error	t-value	p-value
Intercept	0.001	0.000	34.258	0.000
Time	0.000	0.000	17.947	0.000
Intervention	-0.000	0.000	-12.173	0.000
Post intervention time	-0.000	0.000	-13.811	0.000

Professional creative software

	Value	Std. Error	t-value	p-value
Intercept	0.042	0.000	103.614	0.000
Time	0.000	0.000	1.034	0.302
Intervention	-0.001	0.001	-1.673	0.095
Post intervention time	-0.000	0.000	-1.349	0.178

Miscellaneous

	Value	Std. Error	t-value	p-value
Intercept	0.287	0.004	65.759	0.000
Time	0.000	0.000	24.700	0.000
Intervention	-0.092	0.007	-12.685	0.000
Post intervention time	-0.000	0.000	-11.787	0.000

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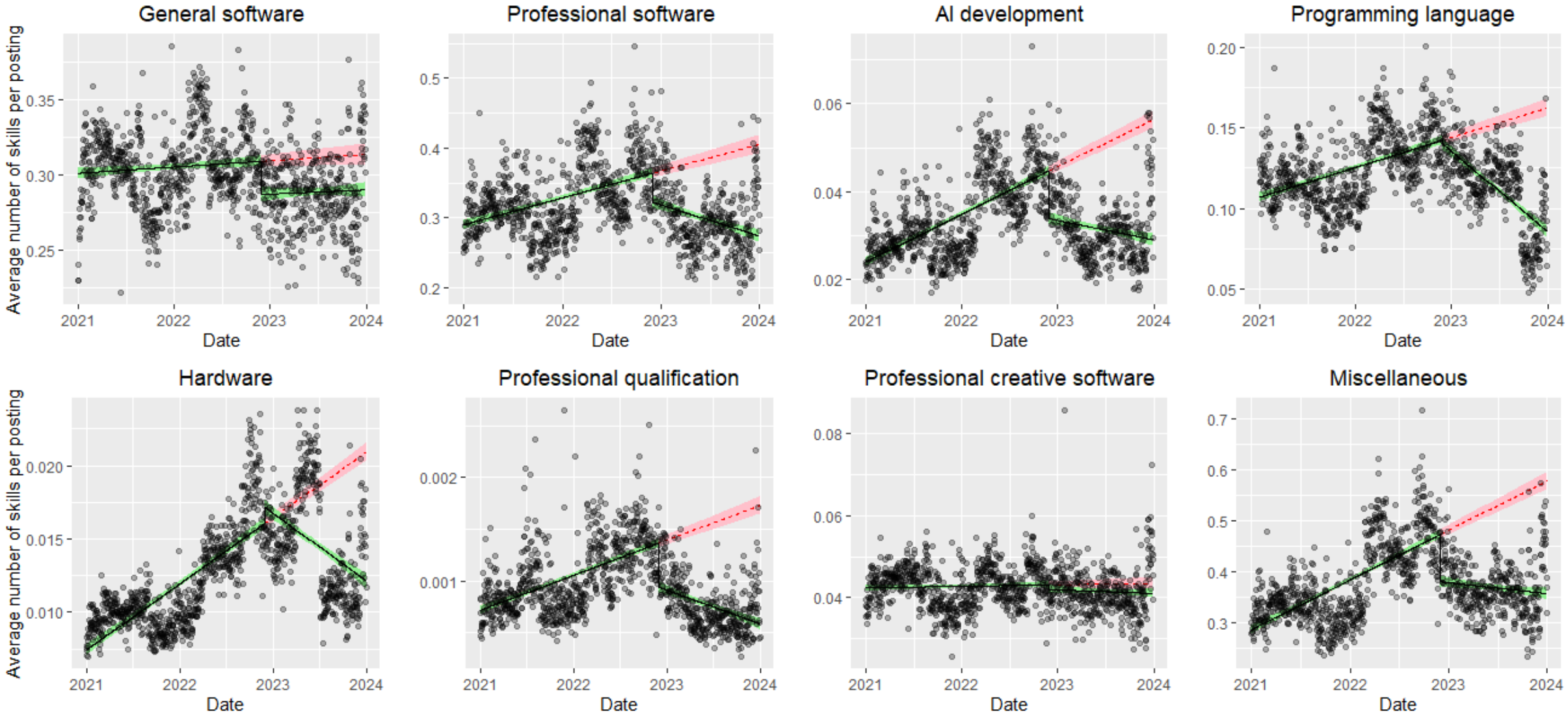
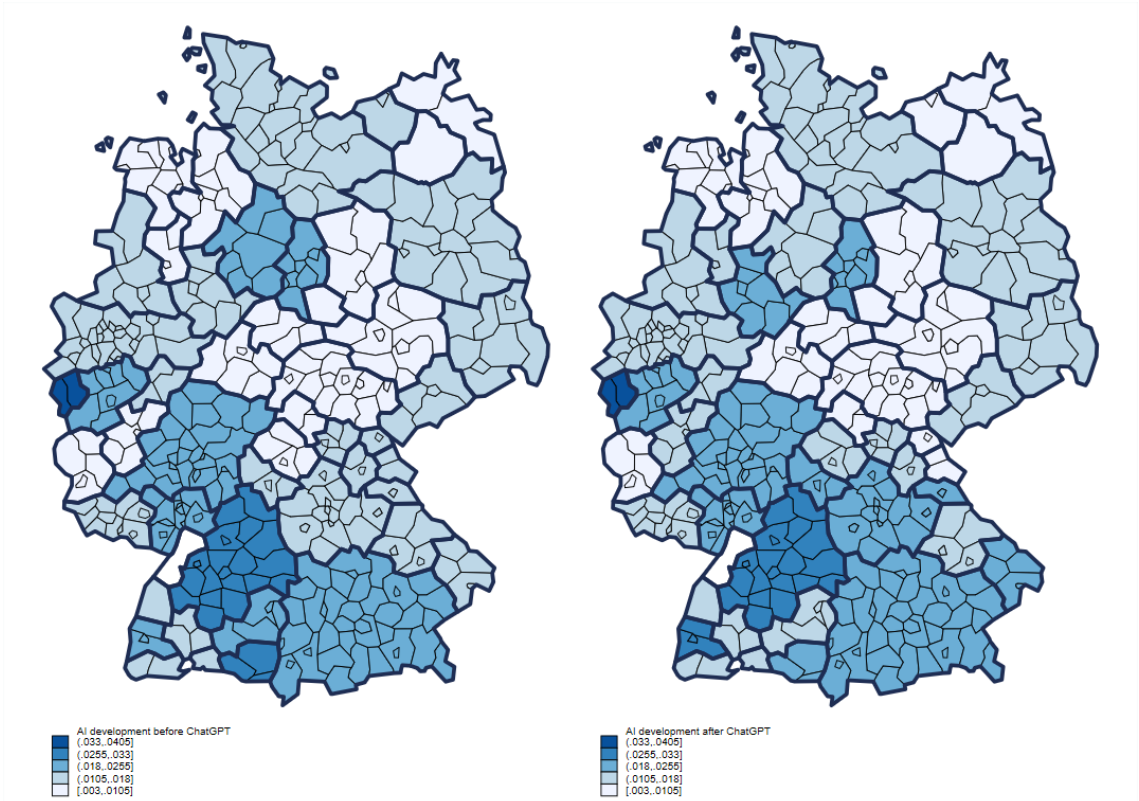


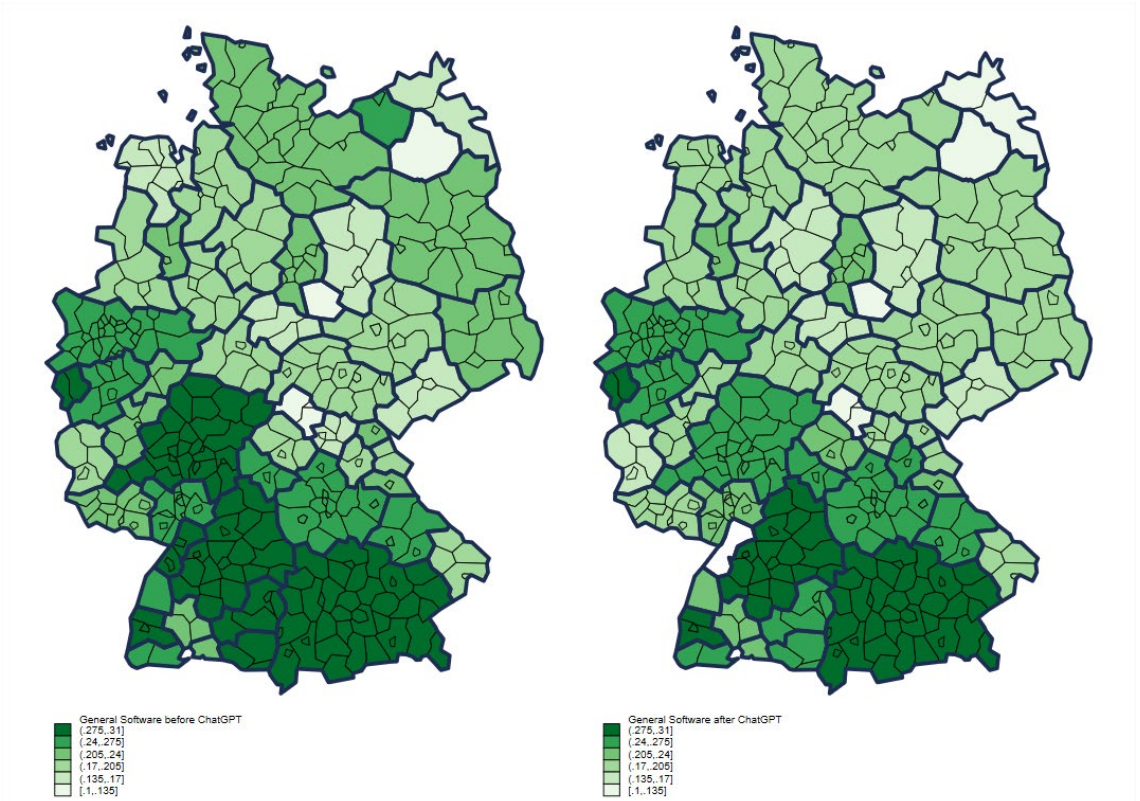
Appendix

Regional disparities

AI development



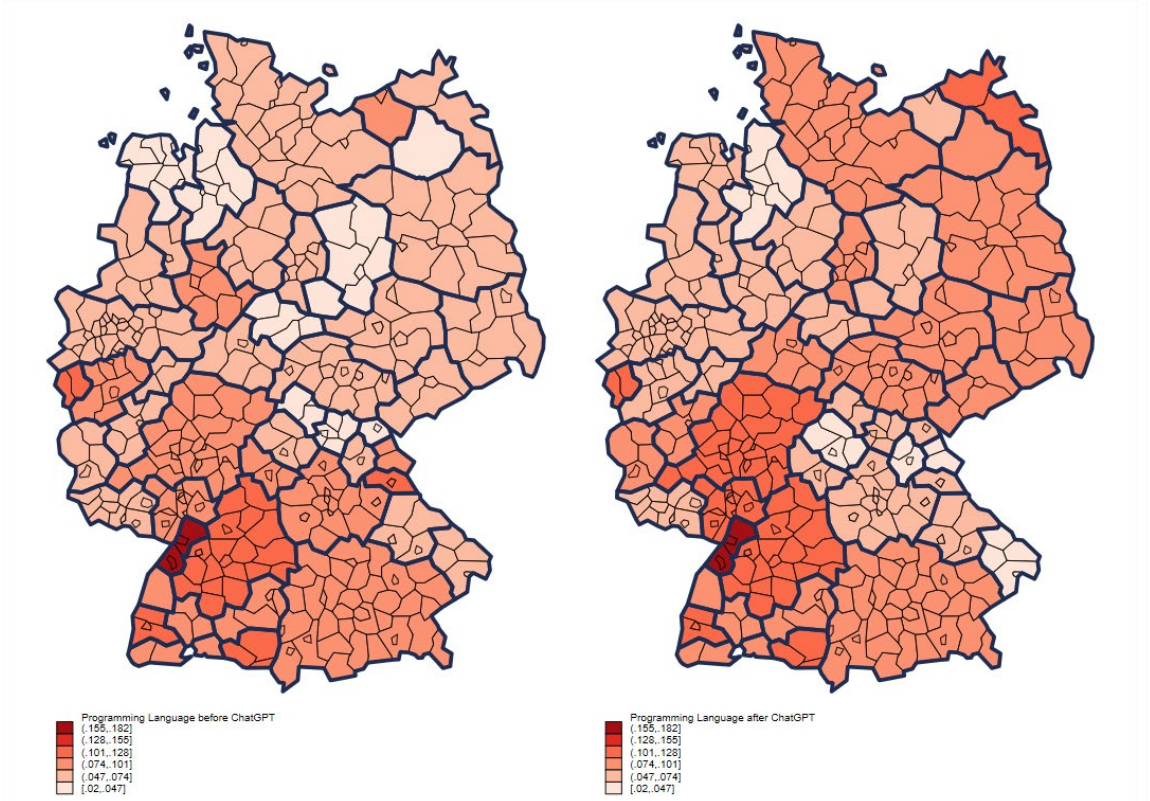
General software



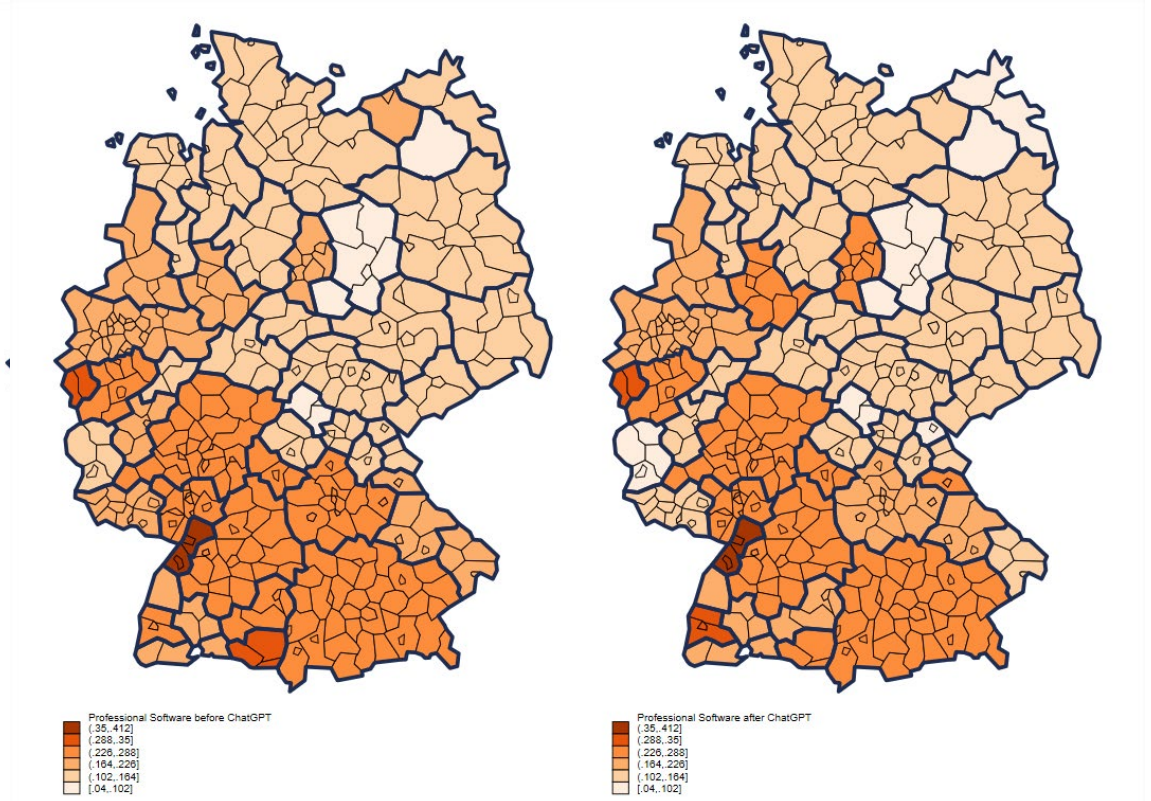
Appendix

Regional disparities

Programming languages



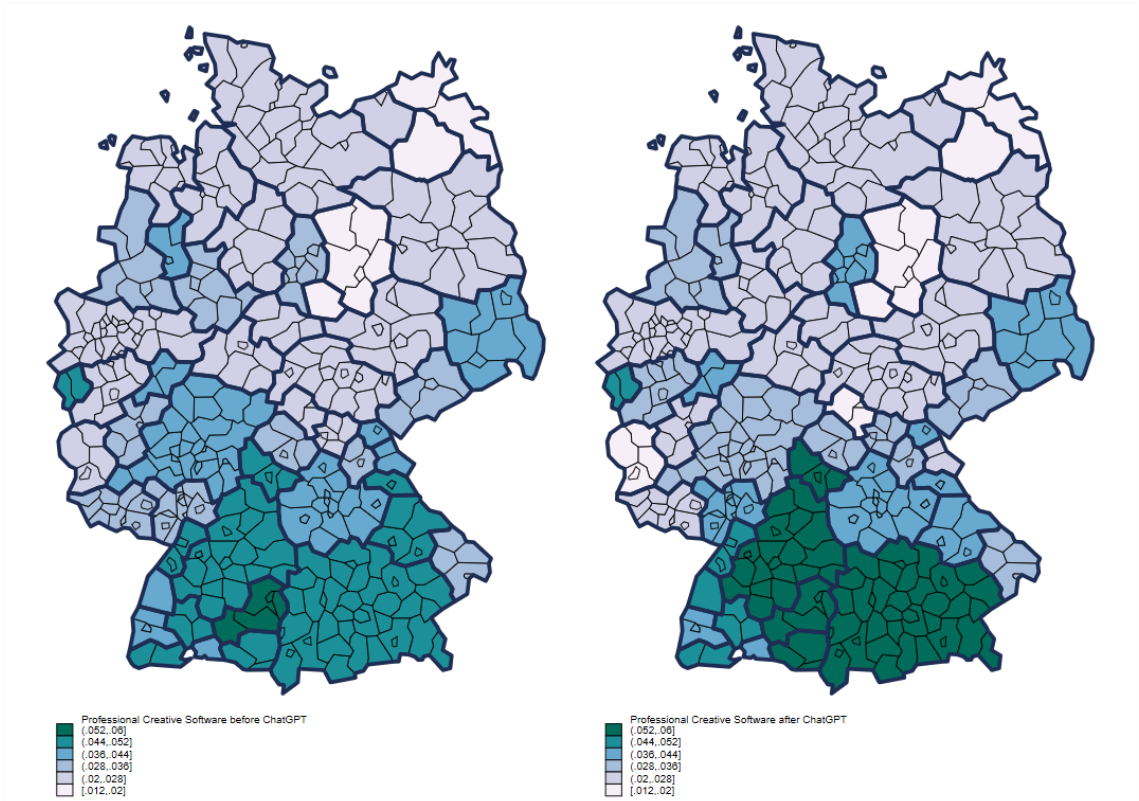
Professional software



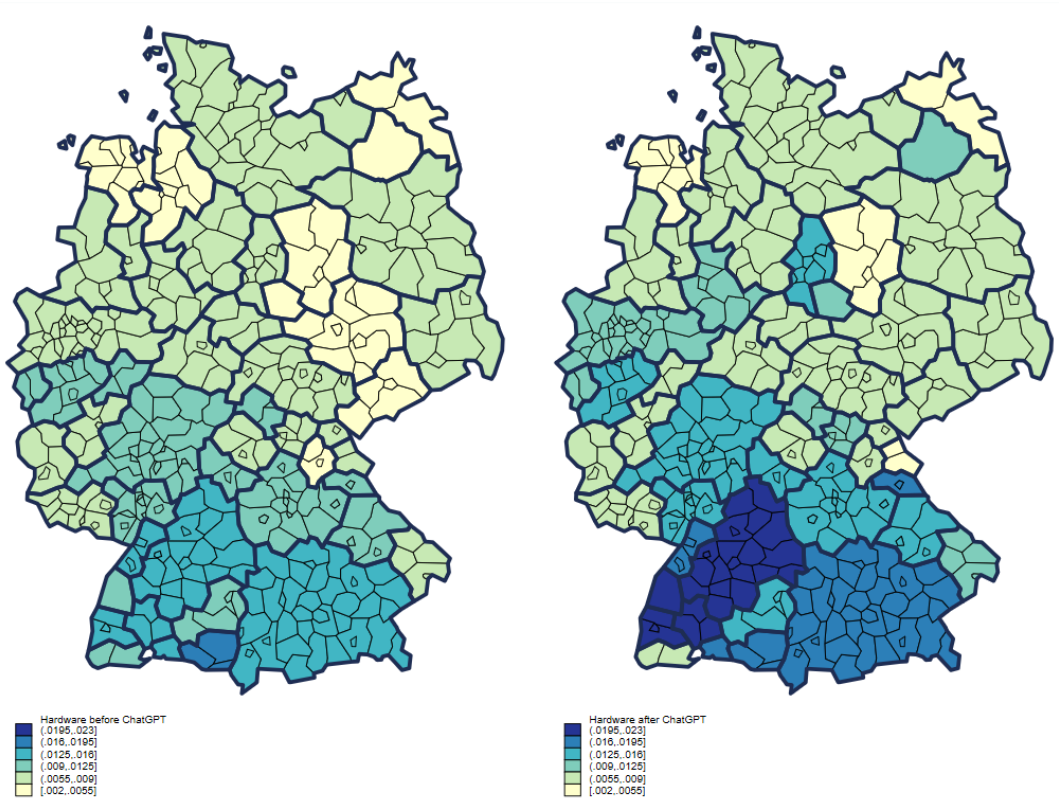
Appendix

Regional disparities

Professional creative software



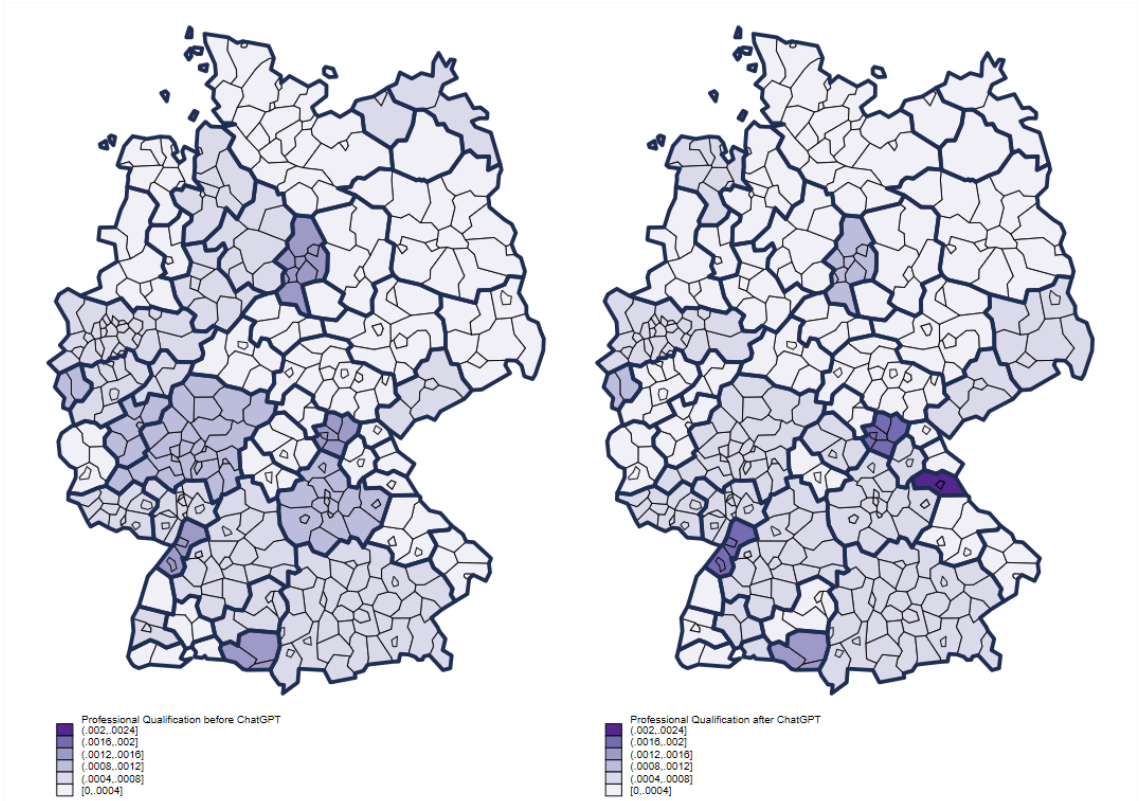
Hardware



Appendix

Regional disparities

Professional qualification



Miscellaneous