An empirical analysis of knowledge Spillover in German robotic innovation - in a spatial context

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Motivation:

Why robotics?

- As one of the most important technologies of the 21st century, robotics could generate massive impact on a country's economy (e.g. improving productivity) and society (e.g. assisting rescue tasks, medical care)

Why knowledge spillover?

- The development of robotics requires highly specialized technologies in various fields, which implies that robotic innovating agents will eventually have to acquire external knowledge resources through knowledge spillover

Why in a spatial context?

- In early studies the analysis of knowledge spillover was limited to single spatial units and knowledge spillover between spatial units was not taken into consideration

Objective:

1. To explore the spatial patterns of the robotic innovation activities in Germany
1. To detect the presence of the knowledge spillover between neighboring regions
2. To examine its influence on regional robotic innovation outcome

Method:

Exploratory Spatial Data Analysis (ESDA)

- Spatial Autocorrelation (SAC)
  - Global Moran's Index

$$Moran's\ I = \frac{n}{S_0} \frac{\sum_{i=1}^{n}\sum_{j=1}^{n} w_{ij}(Y_i - \overline{Y})(Y_j - \overline{Y})}{\sum_{i=1}^{n}(Y_i - \overline{Y})^2}$$

Spatial Regression Analysis

- Spatial Model

$$ROBP_i = \beta_0 + \rho * WROBP_i + \beta_1 TRD_i + \beta_2 SHARE60_i + \beta_3 SHAREICT_i + \beta_4 DBAVARIA + \beta_5 DBW + \beta_6 DHE + \beta_7 DNRW + \varepsilon_i$$

ROBP$_i$: the total number of robotic patents of German NUTS-3 region i (i =1...412)

WROBP$_i$: the weighted average of the robotic patents applied for in the neighboring regions of region i

TRD$_i$: the total R&D expenditures (including industry and university) of region i

SHARE60$_i$: the percentage of the population over 60 years old in region i, which is used here as a proxy, or actually, as an opposite variable for R&D employees

SHAREICT$_i$: the share of information communication technology (ICT) patents of region i

DBAVARIA : region dummy Bavaria

DBW : region dummy Baden-Württemberg

DHE : region dummy Hesse

DNRW : region dummy Nordrhein-Westfalen

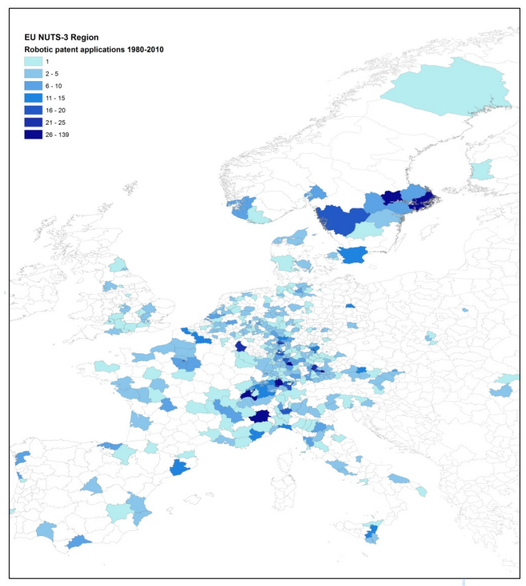
ρ : the spatial autoregressive coefficient and measures the neighboring effect on the robotic patent output of region i

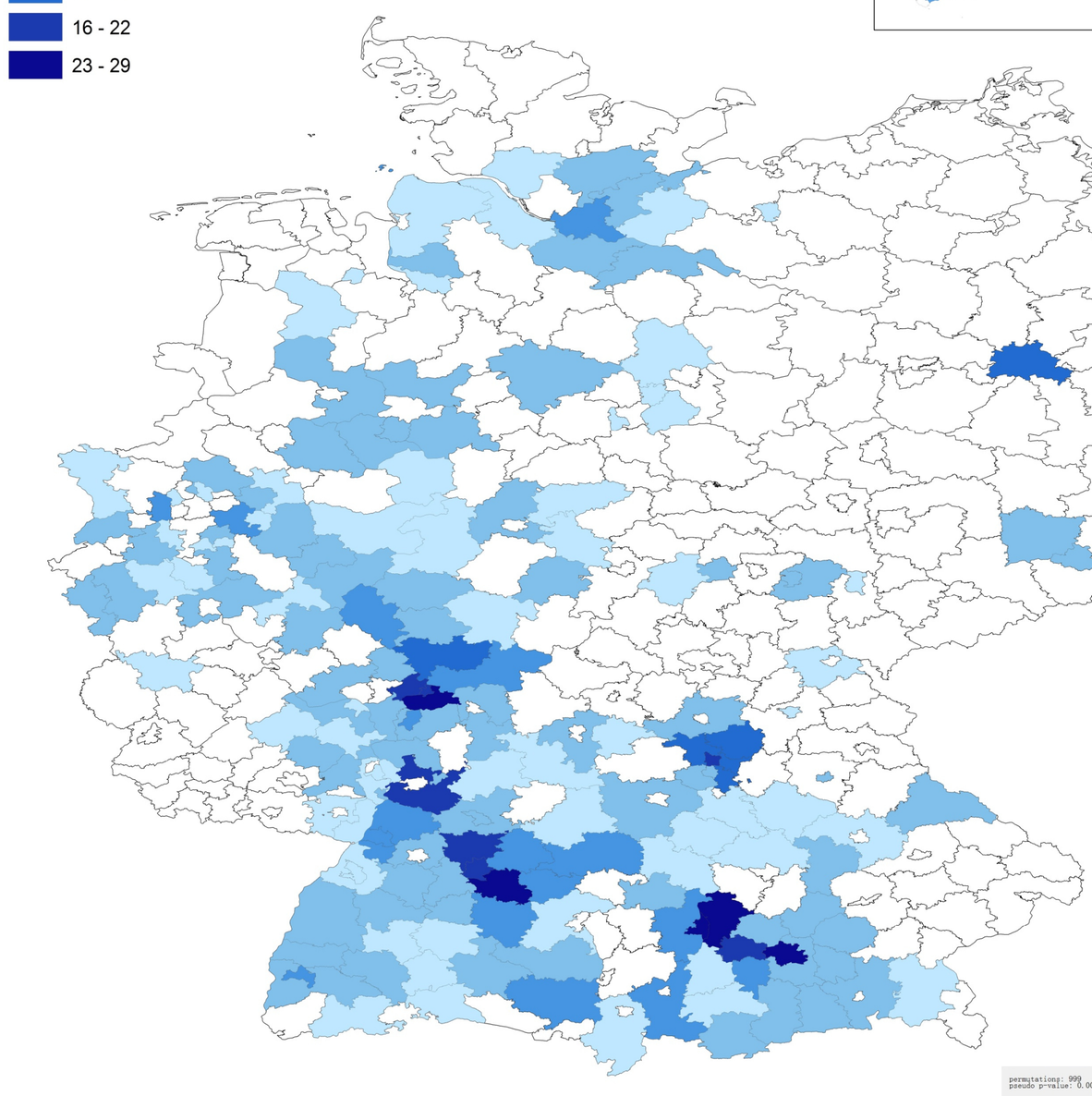
ε$_i$: the error term

- Regression
  - Poisson
  - Negativ Binomial

Merits and demerits of using patent data:

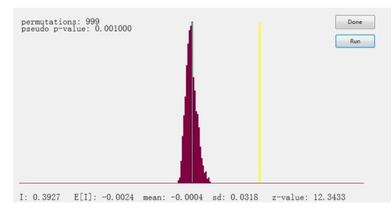
+ a good proxy for innovation output
+ promising data for analyzing the geography of innovations
– missing a portion of innovations which are not patented
– different qualities under patent applications

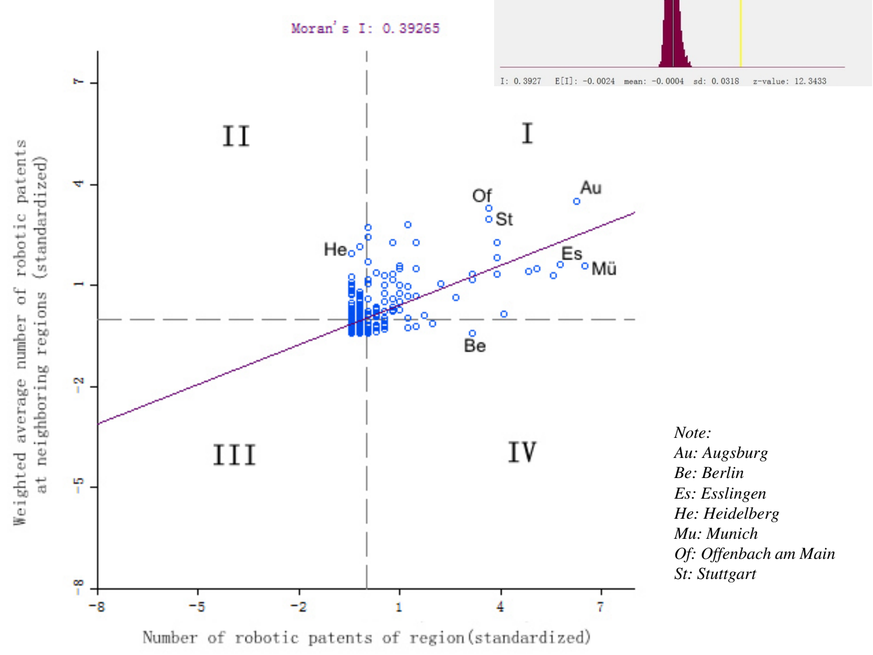




	Model 1	Model 2	Model 3
	Poisson I	Poisson II	Negative Binomial
	Coef. (Std. error)	Coef. (Std. error)	Coef. (Std. error)
Constant	1.190**	1.137*	2.377**
	(0.538)	(0.569)	(1.126)
Weighted average of neighboring robotic patents	-	0.154***	0.221***
	-	(0.009)	(0.032)
Total R&D expenditures (in million EUR)	0.002***	0.001***	0.001***
	(0.0001)	(0.0001)	(0.0004)
Share of population over 60 years old (%)	-10.045***	-5.678***	-14.100***
	(1.851)	(1.969)	(4.012)
Share of ICT patents (%)	6.360***	4.488***	3.673**
	(0.549)	(0.569)	(1.478)
Dummy Bavaria	1.415***	0.926***	0.405*
	(0.135)	(0.136)	(0.238)
Dummy Baden-Württemberg	1.704***	0.984***	0.844***
	(0.136)	(0.143)	(0.266)
Dummy Hesse	2.335***	1.247***	1.000***
	(0.145)	(0.162)	(0.325)
Dummy Nordrhein-Westfalen	1.305***	1.071***	1.087***
	(0.164)	(0.160)	(0.250)
Alpha	-	-	0.247(0.147)*
Log Likelihood	-880.638	-762.551	-572.704
AIC	4.314	3.745	2.829
Pseudo-R^2	0.325	0.416	0.561

*Note:***, **, * indicate statistical significance at the 1%, 5%, and 10% level, respectively.*





Note:
Au: Augsburg
Be: Berlin
Es: Esslingen
He: Heidelberg
Mu: Munich
Of: Offenbach am Main
St: Stuttgart

Main results and conclusions:

The positive and statistically significant spatial autocorrelation (SAC) indicated that in Germany robotic innovation performance at a given region is positively correlated with the performance of its contiguous regions, and showed in space clustering of regions with similar innovation outputs. More importantly, the positive SAC provided the evidence for the existence of knowledge spillover between contiguous regions, since between the contiguous regions knowledge diffusion, especially the transfer of tacit knowledge, becomes efficient, and that contributes to the spatial dependence of robotic innovations. Results of the regressions provided further support to the argument.

Data source: database PATSTAT, REGPAT, and EUROSTAT