

Cooperation between universities and firms from a spatial perspective

An empirical analysis using Bayesian multilevel models

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1. Motivation

- Regional Innovation System
- Tasks of the two main players:
 - **Higher Education Institutions:** Production, accumulation and transfer of knowledge
 - **Firms:** Application of knowledge
- Knowledge transfer → Overcome spatial distance
- Relevance of distance depends on type of transfer channel
 - Very important in the case of the transfer of tacit knowledge (e.g. collaborative research)
- Tacit knowledge is unequally distributed and because of its link to an individual, it is transferable to only a limited degree

2. Research target

- Identification of **factors** which have an influence on the **spatial dimension** of cooperation between HEIs and companies of **different sizes**.
- **Spatial dimension** (dependent variable):
 - Cooperation within the region of the HEI (value = 1)
 - Cooperation outside the region of the HEI (value = 0)
- Companies of **different sizes**:
 1. Small companies – less than 50 employees
 2. Medium-sized companies – 50-250 employees
 3. Big companies – more than 250 employees

3. Approach

- Bayesian Random-Intercept-Logit-Models
- Multi-Level-Approach (3 levels)
- Data received from a survey addressed to all professors in Germany (survey feedback: **7.500**)
 - Conducted in 2013
 - Survey on case study level (feedback: 500; RegTrans; see Dinse et al. 2014)
 - This survey was expanded to 7.500 participants (see Warnecke 2016, PhD-thesis)

3. Approach

- 3 types of companies
- 3 different subsets [(a) all HEIs, (b) universities and (c) polytechnics]
- Leads to 9 different models (1.a, 1.b, ... 3.c)

	Data set	All HEIs	Universities	Polytechnic
Company size				
Small companies		1.a	1.b	1.c
Medium-sized companies		2.a	2.b	2.c
Big companies		3.a	3.b	3.c

4.1 Data

- Three types of variables
- Level 1 [individual variables (professors)]
- Level 2 (HEIs):
 - Variables related to the higher education institutions
 - DeStatis, “*Handbook of universities and polytechnics 2012*”
- Level 3 (federal state):
 - A variable related to the federal states
 - DeStatis

4.2 Variables – Level 1

Level 1:

- **Subjects:** Question “*Which of the following groups of subjects indicates the focus of your Courses? [...]*” (single-choice):

- | | |
|---|--|
| <input type="checkbox"/> Agricultural, Forestry and Food Sciences | <input checked="" type="checkbox"/> Medicine / Health sciences |
| <input type="checkbox"/> Engineering Sciences | <input checked="" type="checkbox"/> Art and Aesthetics |
| <input type="checkbox"/> Mathematics and computer science | <input type="checkbox"/> Natural Sciences |
| <input type="checkbox"/> Law | <input type="checkbox"/> Social Sciences |
| <input type="checkbox"/> Sport | <input checked="" type="checkbox"/> Linguistics and Cultural Studies |
| <input checked="" type="checkbox"/> Veterinary Medicine | <input type="checkbox"/> Economics |
| <input type="checkbox"/> Others | <input type="checkbox"/> Not specified |

4.2 Variables – Level 1

Level 1 (continued):

- **Time budget (metric):** In the survey it was asked: „*Allocate your professional time budget (based on your academic work) to the following activities? - Research and Knowledge Transfer.*“
Response categories: 0 % to 100 % (10 %-steps)

- **Application relevance of research (ordinal):** The professors were asked „*How would you rate the general application relevance of your [...] research?*“

Response categories: Basic orientation (=1) → Fairly Basic orientation (=2) → Mixed (=3) → Fairly Application Based (=4) → Application Based (=5)

- **Number of supervised dissertations (metric)**

4.2 Variables – Level 1

Level 1 (continued):

- **Cooperation intensity with companies (of the related size):** The question was *“How often do you jointly work in research and practical projects with the following groups?”*

Groups: Small companies (<50 employees)
 Medium-sized companies (50-250 employees)
 Big companies (>250 employees)

Response categories:

Never (=1) → Rarely (=2) → Always (=3) → Often (=4) → Very Often (=5)

4.2 Variables – Level 1

Level 1 (continued):

- **Regional fit of the research:** It was asked: „*The University directs its research activity to the needs of the regional economy.*”

Response categories:

Strongly disagree (=1) → 2 → 3 → 4 → Totally agree (=5)

4.2 Variables – Level 2

Level 2:

- **Age of the HEIs (metric):** The age was computed by the use of the founding year of the HEIs, which was taken from “*Handbook of universities and polytechnics 2012*”. The highest age in the dataset is 65, because the year 1949 (foundation of the federal republic of Germany) was used as reference.
- **Number of HEIs within an area of 60 min. by car (metric):** Own calculation based on the addresses of the HEIs published in the “*Handbook of universities and polytechnics 2012*”. The addresses were transformed into georeferences (doi: 10.7802/1158) by the use of “*IC-GeoAddressValidation*”. The number of HEIs within an area was calculated by the use of the Excel-Add-In “*IC-Distance-Analysis*”.

4.2 Variables – Level 2/3

Level 2 (continued):

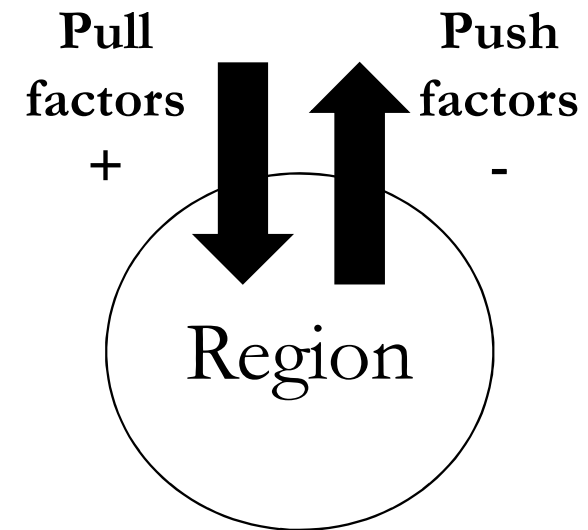
- **Financial resources per professor (metric):** Sum of basic and third-party funds, DeStatis (subject-matter series 11, number 4.3.2, year 2012).

Level 3:

- **R&D-staff within federal state per professor (metric):** Number of R&D-staff within a federal state (e.g. North Rhine-Westphalia), DeStatis

4.3 Hypotheses

Variable	Exp. sign
Level 1	
Subject	+/-
Time budget	-
Application relevance of research	+
Quantity of supervised dissertations	-
Cooperation intensity	+
Regional fit	+
Level 2	
Age of the HEI	+/-
Number of HEIs within an area of 60 min. by car	+/-
Financial resources per professors	-
Level 3	
R&D-staff within federal state	+



4.4 Results – (odds-ratios-1) × 100

	All HEIs			Universities			Polytechnics		
	50	50-250	>250	50	50-250	>250	50	50-250	>250
	1a	2a	3a	1b	2b	3b	1c	2c	3c
Level 1:									
<i>Subject</i>									
Agricultural, forestry, food sciences	-73,601	-75,024	-38,621	-81,639	-84,586	-56,468	-53,705	-67,010	-3,914
Medicine	-53,571	-60,747	-52,342	-61,969	-76,749	-67,911	66,124	19,484	205,984
Engineering sciences	-39,048	-56,945	-37,493	-45,760	-67,547	-46,649	-37,829	-50,016	-25,255
Mathematics/ computer science	33,696	8,455	-1,152	25,149	-29,373	-24,497	57,244	49,682	47,475
Natural sciences	-39,712	-62,164	-43,677	-46,932	-78,097	-57,195	-15,484	-12,862	-17,401
Law	-55,355	-58,602	-77,092	-67,662	-90,092	-86,435	97,937	308,223	-21,593
Social sciences	-29,755	-36,242	-16,966	-30,432	-52,181	-17,930	-27,934	-17,333	-25,096
Art, aesthetics, linguistics	-30,025	-19,801	90,866	-20,896	-42,023	75,692	-68,667	-29,509	106,996
Others	-5,472	-22,714	47,904	-16,569	-48,259	100,749	49,222	20,588	2,858
<i>Time budget for research</i>	-14,042	-8,970	-7,067	-11,269	-2,871	1,880	-17,743	-17,378	-23,962
<i>Application relevance of research</i>									
Fairly basic orientation	38,457	-14,356	-10,459	54,566	3,593	12,884	-30,118	-66,895	-78,302
Mixed	12,157	-14,823	-30,901	29,185	6,364	-21,458	-30,709	-55,109	-29,936
Fairly application based	6,798	-17,829	-36,605	14,162	-3,181	-37,361	-25,465	-52,746	-17,214
Application based	42,889	3,502	-33,806	35,873	4,143	-55,031	8,787	-37,392	-13,754
Number of dissertation	-1,740	-2,795	-5,373	-1,318	-2,449	-5,921	1,056	0,407	0,291
<i>Cooperation intensity</i>									
Rarely	125,389	-26,494	-14,190	167,925	-11,613	19,957	8,065	-21,088	-32,229
Always	138,064	-44,761	-38,378	136,704	-41,547	-18,019	78,878	-22,356	-36,002
Often	102,858	-55,670	-52,121	117,795	-67,420	-32,255	31,046	-24,755	-54,852
Very often	74,506	-56,276	-46,643	124,366	-49,280	-47,173	-2,966	-33,057	-19,596
<i>Regional fit</i>									
Disagree	26,145	12,471	-14,536	29,469	2,229	-18,627	40,500	95,827	0,897
Mixed	48,604	44,860	31,488	52,485	50,907	28,979	91,436	98,427	68,828
Agree	109,967	110,045	108,286	34,874	97,897	85,823	314,368	216,997	179,714
Totally agree	100,934	82,934	161,481	9,078	29,705	155,816	320,156	204,841	241,127
Level 2:									
<i>Age of the HEIs</i>	-0,442	-0,237	-0,050	-0,872	-0,372	-1,339	-0,444	0,118	1,629
<i>No. of HEIs within 60 min.</i>	0,795	0,746	1,676	0,511	0,274	1,408	0,980	1,240	2,044
<i>Financial resources</i>	-0,023	-0,027	-0,032	0,025	-0,017	-0,026	-0,049	0,008	-0,130
Level 3:									
<i>R&D-staff within fed. state</i>	0,3963	2,741	3,286	-1,040	3,925	6,712	0,951	0,974	-1,759

4.4 Results

- There are more often significant influences of the subjects concerning the universities.
- In the case of the big companies there is no significant subject concerning the polytechnics.
- The effects of the subjects are also stronger for universities.
- All significant subjects are a push factor compared to the reference category “economics”

4.4 Results

- Furthermore you see a high a relevance of the time budget for research in case of the polytechnics (negative sign)
- The time budget has also a stronger effect with respect to polytechnics.
- The level 2-variables are significant only for two categories.
- R&D-staff (level 3) is not significant.

5. Conclusion

- The subjects are likely more important for the spatial focus of the cooperation with regard to the universities.
- Maybe the variety of subjects at universities can be the reason.
- The time budget is the dominant factor in the case of the polytechnics.
- That's not surprising because the professors at polytechnics have quite high teaching load.

5. Conclusion

- Level 2: Only two significant categories
Level 3: R&D-staff is not significant
- But according to the VPC (e.g. Goldstein 2011), we see that some proportion of variance in the intercept in the model is explained by level 2 and 3.
- Therefore a multi-level approach is appropriate, beside fact that we have a structured data.

Variance Partition Coefficient			
	1.a	1.b	1.c
Level 2	1,30%	1,03%	4,76%
Level 3	0,80%	0,49%	3,70%
	2.a	2.b	2.c
Level 2	3,21%	2,88%	4,39%
Level 3	1,56%	1,67%	1,48%
	3.a	3.b	3.c
Level 2	9,69%	14,44%	5,41%
Level 3	1,46%	3,68%	1,13%

Thank you for listening!

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