The patterns of scientific collaboration between the doctoral students and their mentors

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Background

Mentoring is conceptualized as crucial for the mentee's subsequent scientific participation, performance, and career path.

WIDER SOCIAL CONTEXT ON MULTIPLE LEVELS

Makro (scientific community)

Mezzo (organization)

Mikro (mentor-mentee)

SCIENTIFIC COLLABORATION

(to achieve a common goal and/or to transfer knowledge)

MENTORSHIP-RELATIONSHIP

(often overlooked form of scientific collaboration in research)

coordinating expectations

planning research projects

adapting of the research environment

shared learning, development of critical thinking

empowerment and engagement in the scientific community

Research questions

Both related to the start of scientific collaboration.

MENTEE-MENTOR

How the mentorship relationship between the mentors and mentees is established and maintained?

aka

Is relationship established just before the start of the doctoral study or it is a continuation of an already existing relationship?

MENTOR-MENTOR

How is mentorship related to scientific collaboration between mentors?

aka

Does co-mentoring connect new mentors and foster long-term scientific collaboration?

Methodology

The same two-step methodology was applied for both research questions.

STEP 01

CLUSTER ANALYSIS

Aim: to reveal groups of mentees-mentors and mentors-mentors with similar patterns of collaboration (operationalized by co-publications).

Hierarchical clustering of symbolic objects.

Symbolic data are empirical probability distributions of collaboration across years.

The package »clamix« for R-programming language was used.

STEP 02

DISCRIMINANT ANALYSIS

Aim: to explain the obtained clusters according to the additional variables.

First research question: scientific field, age of a mentee, mean age of mentors, Young Researcher program, gender homophily, year of publishing a doctoral dissertation, number of mentors.

Second research question: gender homophily, scientific discipline homophily, average age, year.

Data source

The data for the 30-years long period (1991-2020) were obtained from two sources.

Slovenia

~ 2 mio population

Austria, Hungary, Croatia, Italy are neigboring countries.

Slovenian Current Research Information System (SICRIS)

The data about mentees and mentors.

Co-operative Online Bibliographic System & Services (COBISS)

The data about all published bibliographic units.

Exclusion and inclusion criteria

Additional exclusion criteria apply for each research question.

BOTH RESEARCH QUESTIONS

All doctoral theses in the database:	12,970
Written between 1991 and 2020:	10,793
Mentors with researcher ID:	9,984
Excluding Interdisciplinary research:	9,913
Only one author:	9,891
Only one doctorate:	9,881

SOME EXPLANATIONS

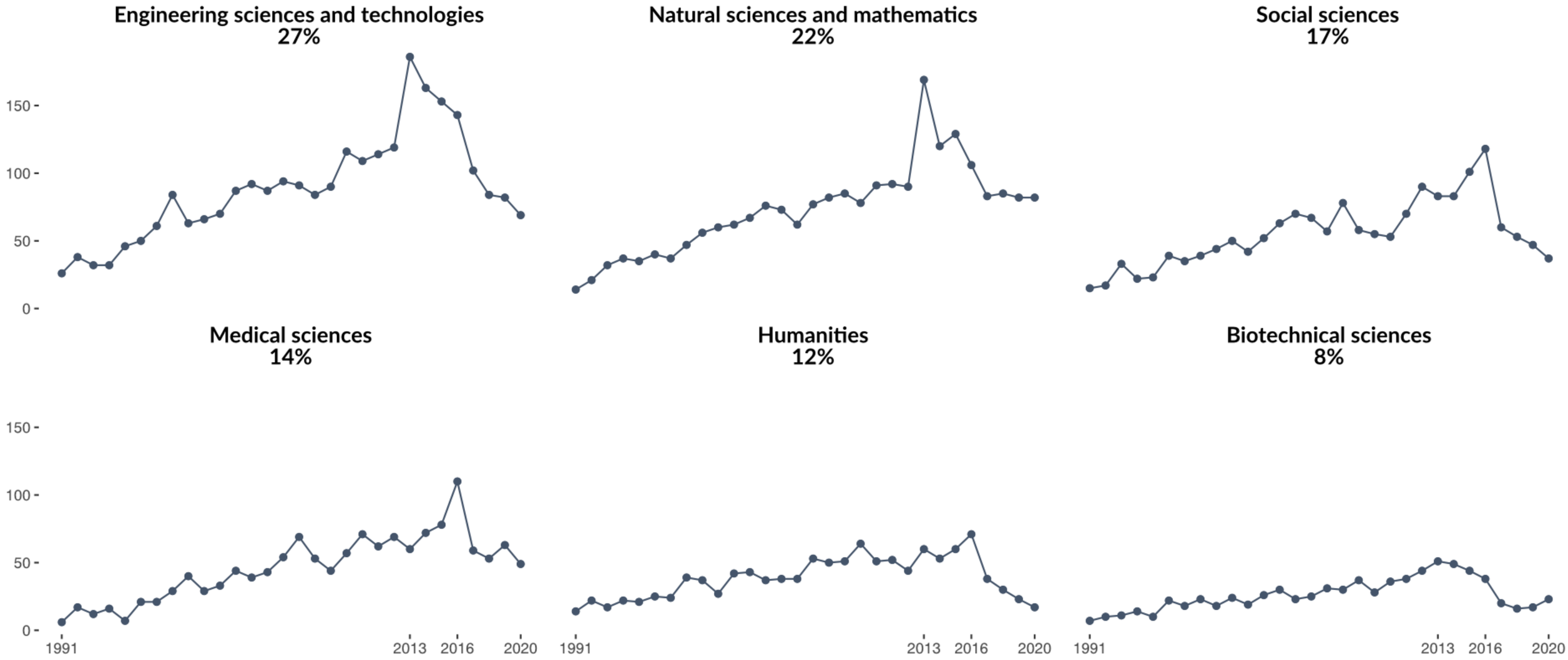
- Almost all researchers in Slovenia have the researcher ID, assigned by the Slovenian Research Agency (SICRISS ID). The exceptions might be foreign researchers.

- The field Interdisciplinary research is an administrative category in the Slovenian Research classification scheme and does not reflect the actual development of the disciplines.

- Doctorates written with several students, and students with several doctorates are rare and specific.

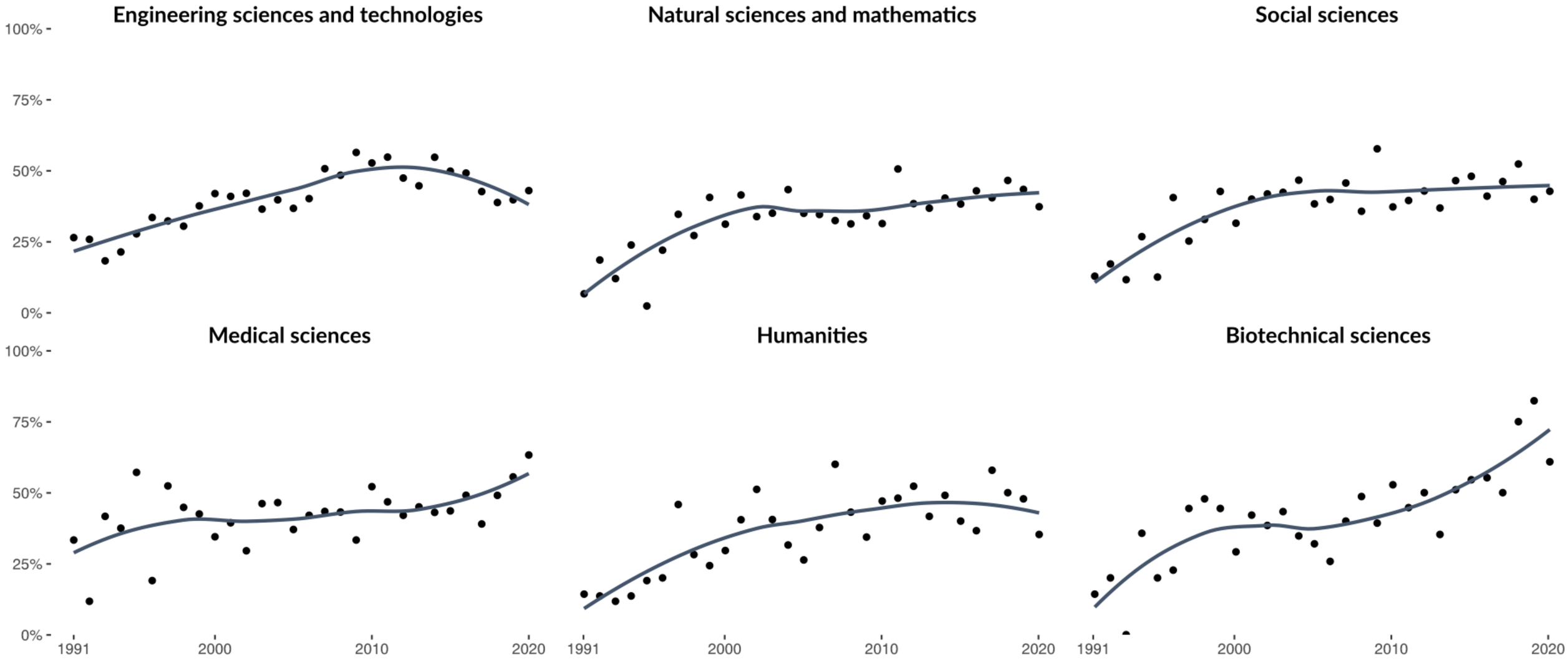
Number of doctorates

The years 2013 and 2016 are related with the Bologna reform.



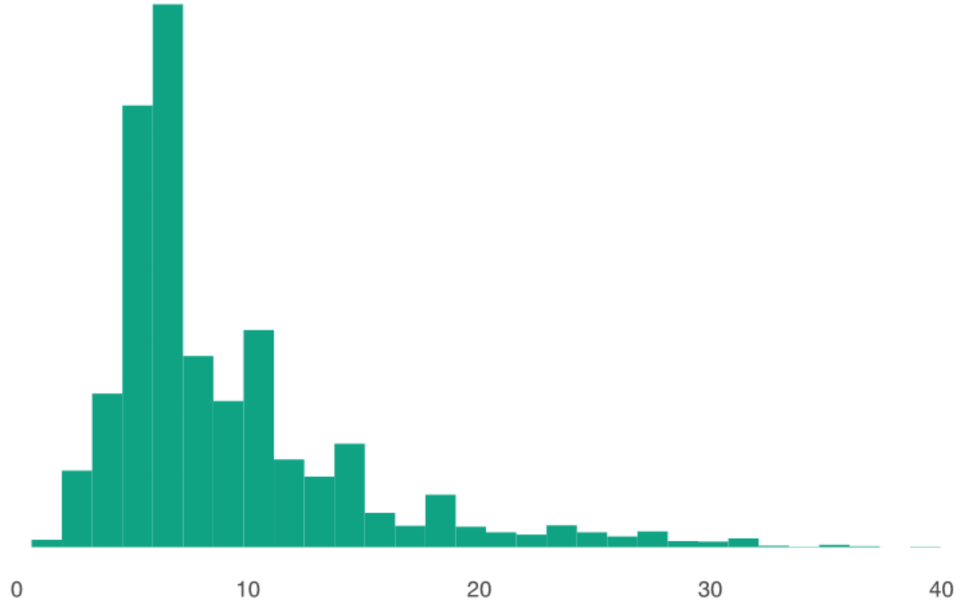
Share of doctorates with co-mentors

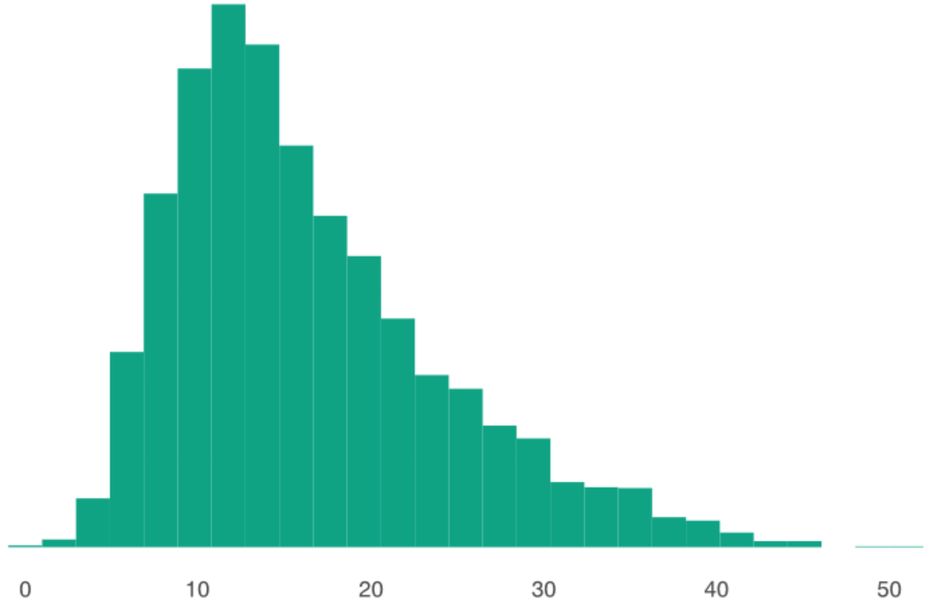
The share stabilizes at around 50% after 2000 in most scientific fields.



Mentee and mentor age

Not biological but scientific age is considered.





Mentee scientific age

Defined as the number of years between the fist publication and the end of a doctoral study.

Close approximation to a biological age.

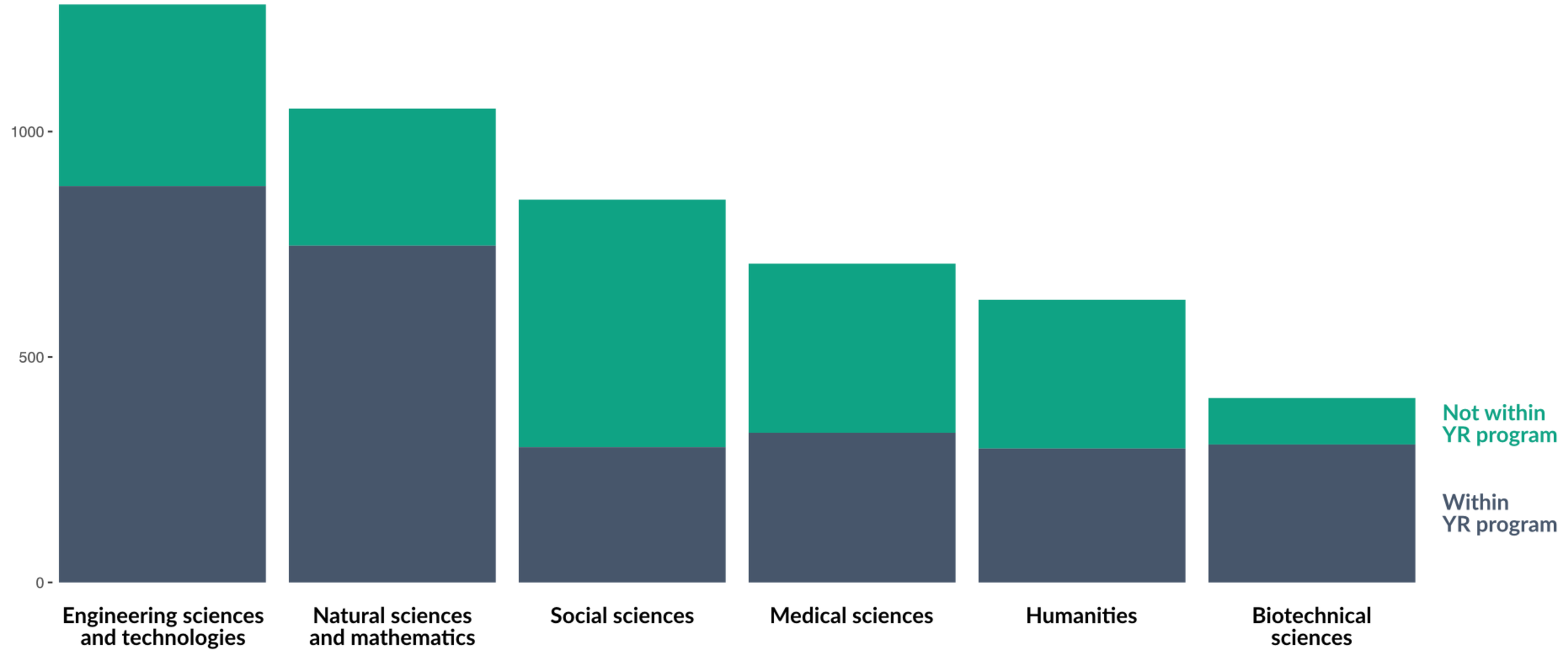
Mentor scientific age

Defined as the number of years between mentors' end of doctoral study and mentees' end of doctoral study.

Completing a doctoral study is a prerequisite for becoming a mentor.

Number of Young Researchers, 1999-2012

Doctoral students in this program receive equal employment rights and stable state funding.



Data consideration (mentee-mentor)

In total 4,960 doctorates were analyzed.

Additional exclusion criteria

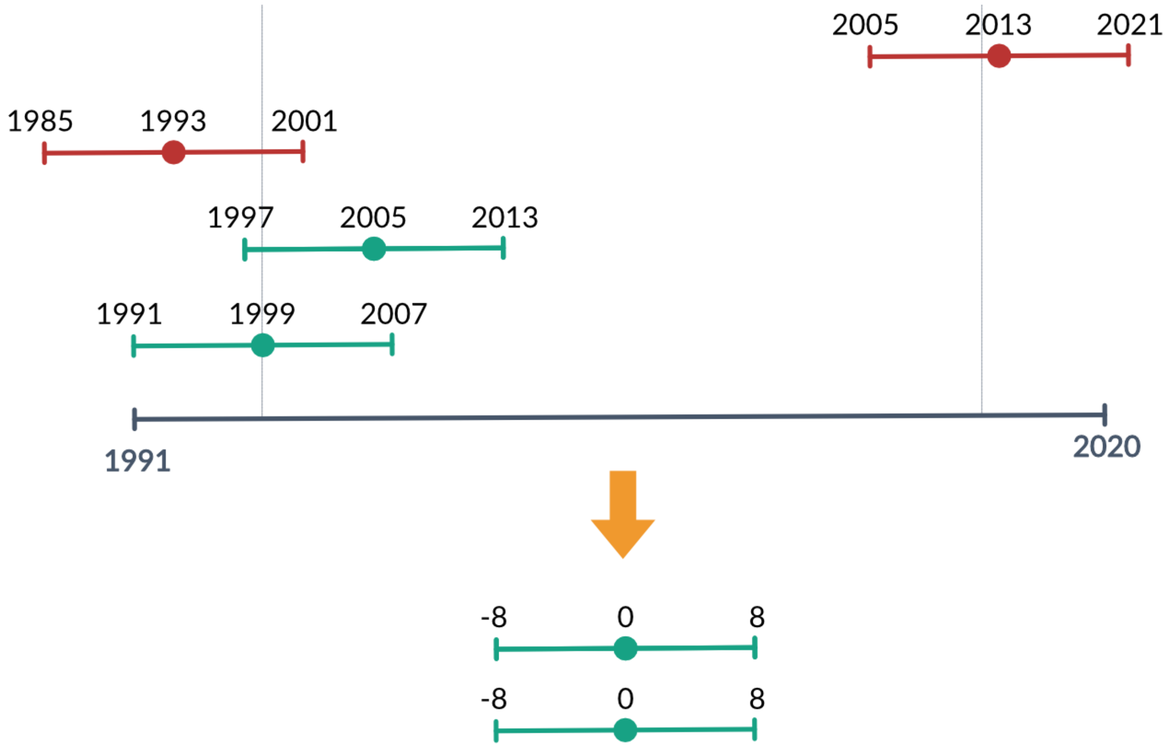
Because the 8-years long time period before and after finishing the doctoral study was considered, only those finished between 1999 and 2012 are considered: 4,960.

Data preparation

We "unify time" so that the completion of a doctoral study represents the beginning of the time count, i.e., time 0.

For each year, we calculated the number of

- joint publications with mentors;
- individual publications or joint publications with others.



Clusters

Clusters were obtained by applying clustering for symbolic data.

Cluster 1

n = 93 (2%)
Median no. publications with mentors = 15
Median no. of publications with others = 0

Cluster 3

n = 1,136 (23%)
Median no. of publications with mentors = 12
Median no. of publications with others = 51

Cluster 5

n = 1,725 (35%)
Median no. of publications with mentors = 18
Median no. of publications with others = 61

Cluster 2

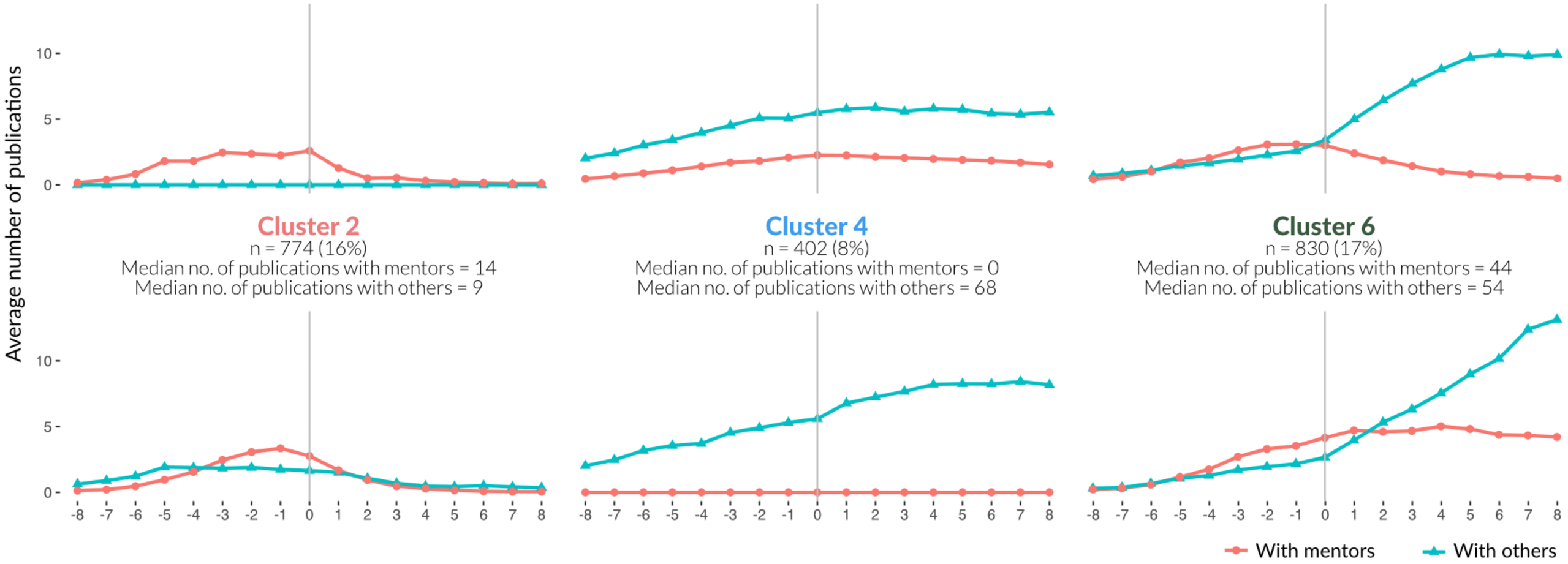
n = 774 (16%)
Median no. of publications with mentors = 14
Median no. of publications with others = 9

Cluster 4

n = 402 (8%)
Median no. of publications with mentors = 0
Median no. of publications with others = 68

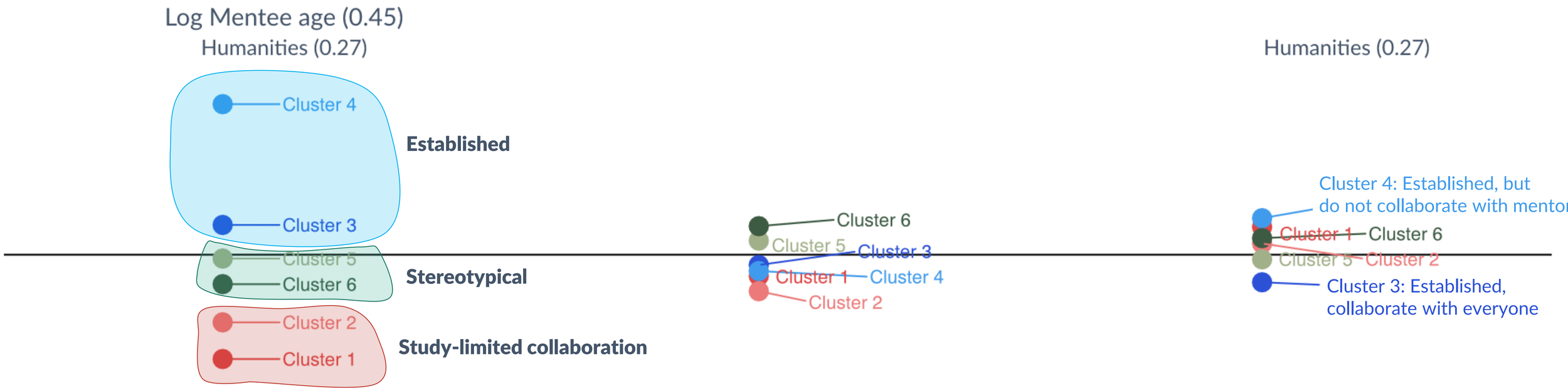
Cluster 6

n = 830 (17%)
Median no. of publications with mentors = 44
Median no. of publications with others = 54



Discriminant analysis results

The centroids of the first three discriminant functions with the corresponding standardized discriminant coefficients.



Engineering sciences and technologies (-0.65)
Natural sciences and mathematics (-0.54)
Young researcher (-0.21)

Wilks lambda = 0.75
F(55, 22707) = 26.6
$p < 0.01$, Squared R_C = 19.7%

Year (-0.81)
Engineering sciences and technologies (-0.51)
Natural sciences and mathematics (-0.46)
Log Mentee age (-0.39)
Humanities (-0.27)

Wilks lambda = 0.93
F(40, 18604) = 8.6
$p < 0.01$, Squared R_C = 3.6%

Medical sciences (-0.69)
Log Mentee age (-0.68)
Natural sciences and mathematics (-0.28)
Engineering sciences and technologies (-0.28)
Biotechnical sciences (-0.27)

Wilks lambda = 0.97
F(27, 14331) = 5.9
$p < 0.01$, Squared R_C = 2.9%

Data consideration (mentor-mentor)

In total 1,452 co-mentoring pairs were analyzed.

Additional exclusion criteria

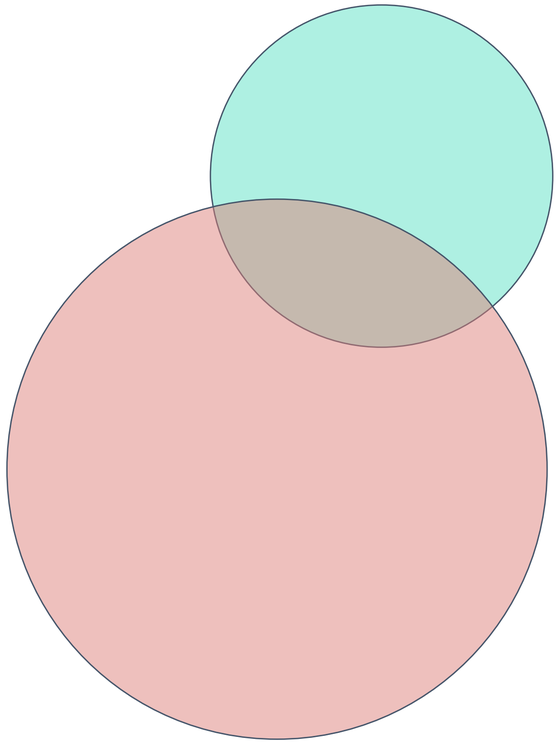
Because the 10-years long time period was considered, only the doctoral dissertations, published between 2000 and 2011 are considered: 4,241.

Additionally, only the doctorates with at least two mentors are considered: 1,363. (resulting in 1,452 mentoring pairs)

Data preparation

All publications are considered, including those published with a mentee.

Assuming that the mentors have different publication capacities, we calculated the proportion of joint collaborations by year for each pair.



John, 12 publications

7 publications with Marija
5 publications with others

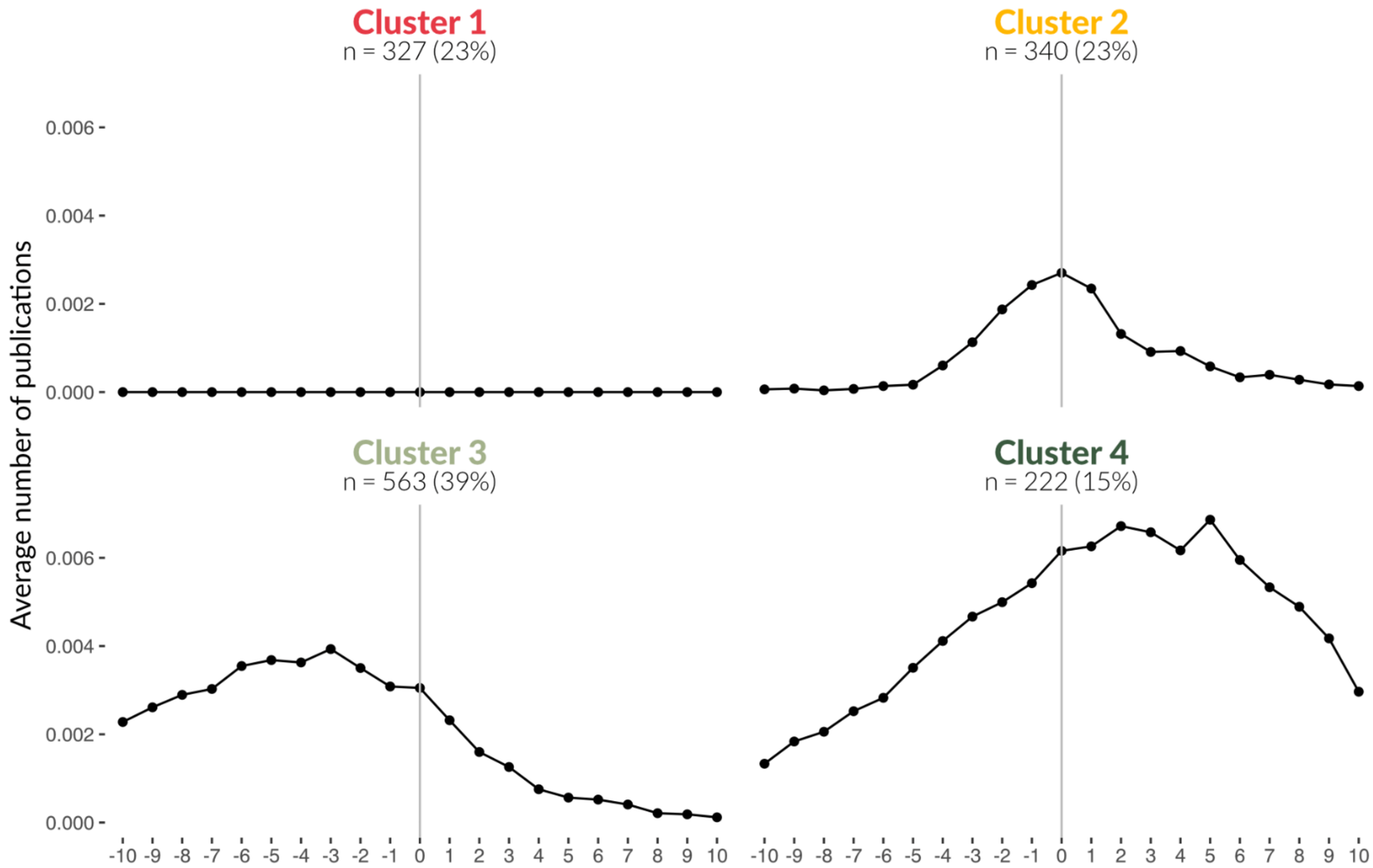
Rose, 28 publications

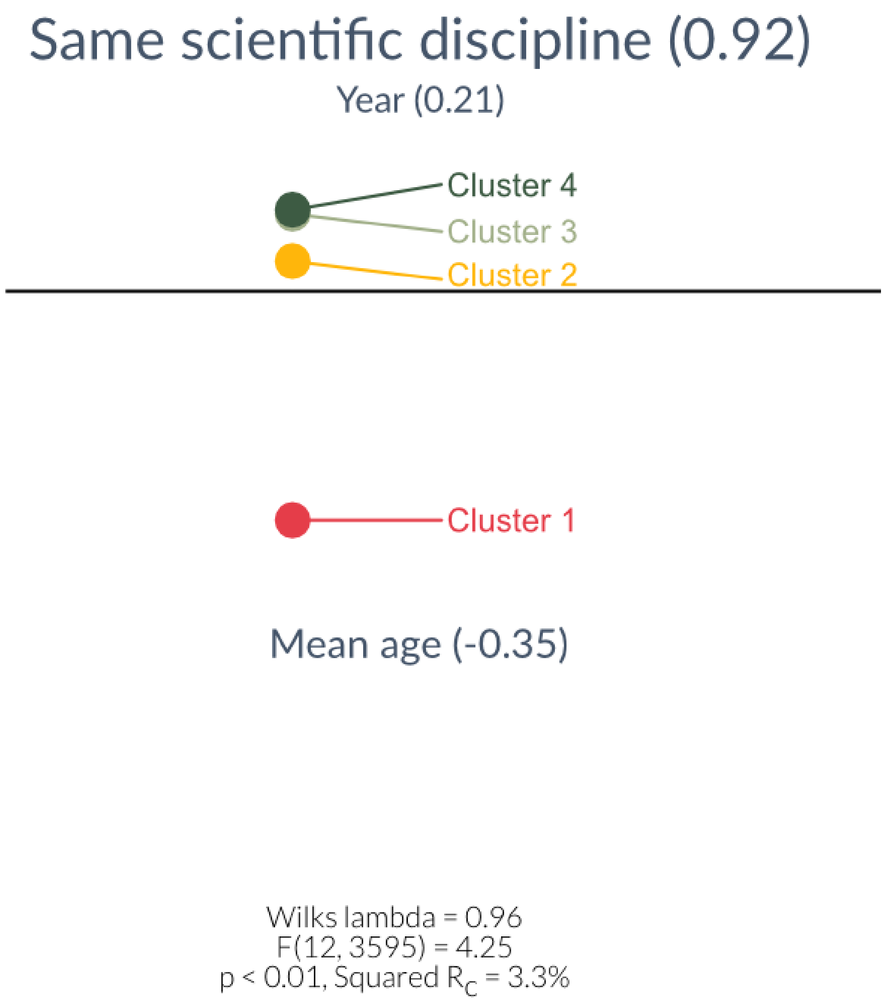
7 publications with Janez
21 publications with others

$$\text{Share of common publications} = \frac{\text{no. of joint publications}}{\text{no. of all publications}} = \frac{7}{40-7} = 21\ \%$$

Clusters and discriminant analysis results

Symbolic data clustering (left figure). Centroids of the first discriminant function and its standardized coefficients (right figure).





Wilks lambda = 0.96
F(12, 3595) = 4.25
$p < 0.01$, Squared $R_C = 3.3\%$

Most start collaborating during the study.

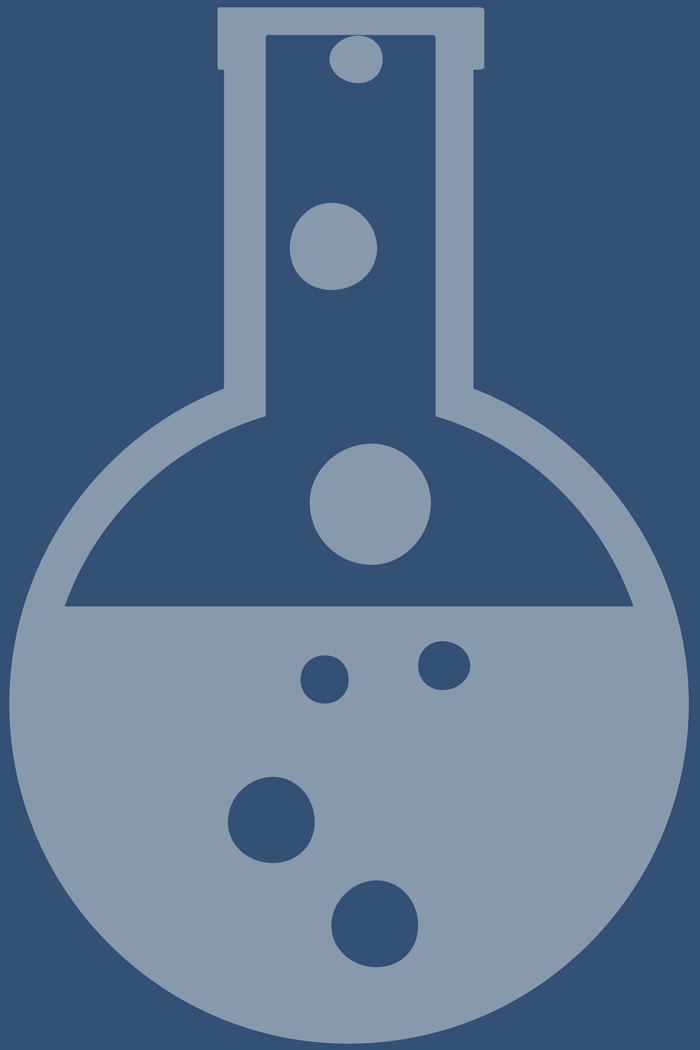
- Only, a quarter of mentor-mentee collaborations are established prior to the start of a doctoral study.
- Study-limited collaborations are increasing. Maybe because of saturation of doctoral students in the academic sphere and/or pursuing doctoral degrees for professional purposes (especially within natural technical sciences).
- Large differences among scientific fields.

Co-mentoring might be pragmatic.

- Co-mentorship does not foster future scientific collaboration as mentors often already have prior collaboration experience before entering co-mentorship.
- Scientific collaboration between the mentors is usually not continued after the end of co-mentoring.
- Collaborations between the mentors are more common for those from the same scientific disciplines.

Other work

Different research questions will be addressed, regarding the mentoring relationship.



COGNITIVE NEWTORK ANALYSIS

How does a researcher's contribution and mentoring affect the shared knowledge space, and how does their position in that space change throughout their career?

IN DEPTH INTERVIEWS

Mentors and mentees: motivations, conflicts, expectations, styles, success perception, research environment etc.

SURVEY

Collecting data for testing the holistic theoretical model of knowledge production.