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The economy as a complex system

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Economics of Networks - GEO3-3805

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structure of lecture

1. relatedness and regional diversification

2. smart specialisation policy

3. role of inter-regional linkages

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references

- Hidalgo, C., Balland, P.A., Boschma, R., Delgado, M., Feldman, M., Frenken, K., Glaeser, E., He, C., Kogler, D., Morrison, A., Neffke, F., Rigby, D., Stern, S., Zheng, S., and Zhu, S. (2018) The Principle of Relatedness, Proceedings of the 20th International Conference on Complex Systems, forthcoming

- Hidalgo, C. A., Klinger, B., Barabasi, A. L., & Hausmann, R. (2007). The product space conditions the development of nations. Science, 317(5837), 482-487.

- Balland, P.A., R. Boschma, J. Crespo and D. Rigby (2019) Smart specialization policy in the EU: Relatedness, knowledge complexity and regional diversification, Regional Studies 53 (9), 1252-1268.

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regional diversification

- regions need to diversify into new activities to secure long-term economic development
- but their capacity to do so differs …..
- how do regions create new activities?: new activities do not start from scratch
- local capabilities (knowledge, skills, networks, institutions) condition which new activities will be feasible to develop in a region
- local capabilities provide opportunities but also set limits to the diversification process in a region

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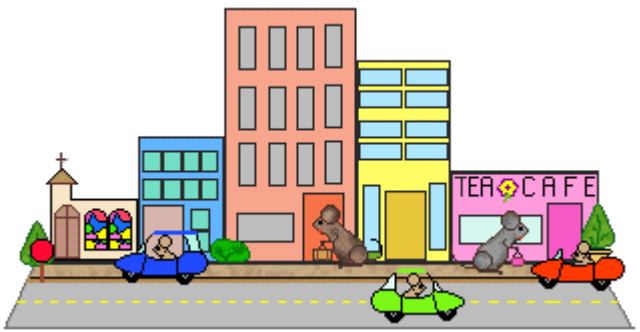
related diversification **unrelated diversification**

region A region B



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studies: **related diversification is rule**, unrelated diversification the exception (Hidalgo et al 2018)

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regional diversification

- Hidalgo, Klinger, Barabasi and Hausmann (2007)

- how countries build CA in new export products

- national capabilities condition which new export products will be feasible to develop

- product space: relatedness between products based on co-occurrence of products in countries' export portfolios

- countries develop new export products that are closely related to existing export products

- countries with related variety have more opportunities to diversify and sustain higher economic growth rates

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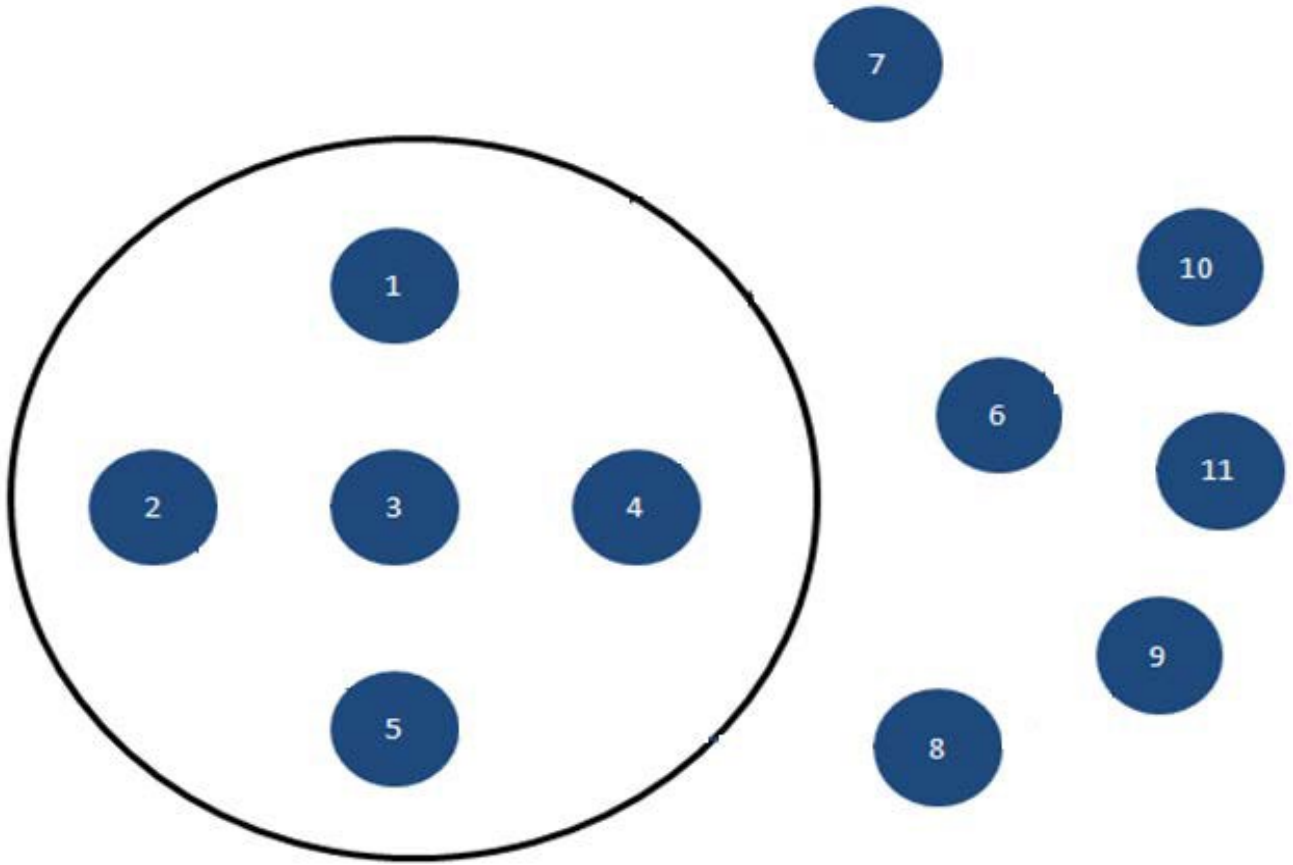
economies as complex systems



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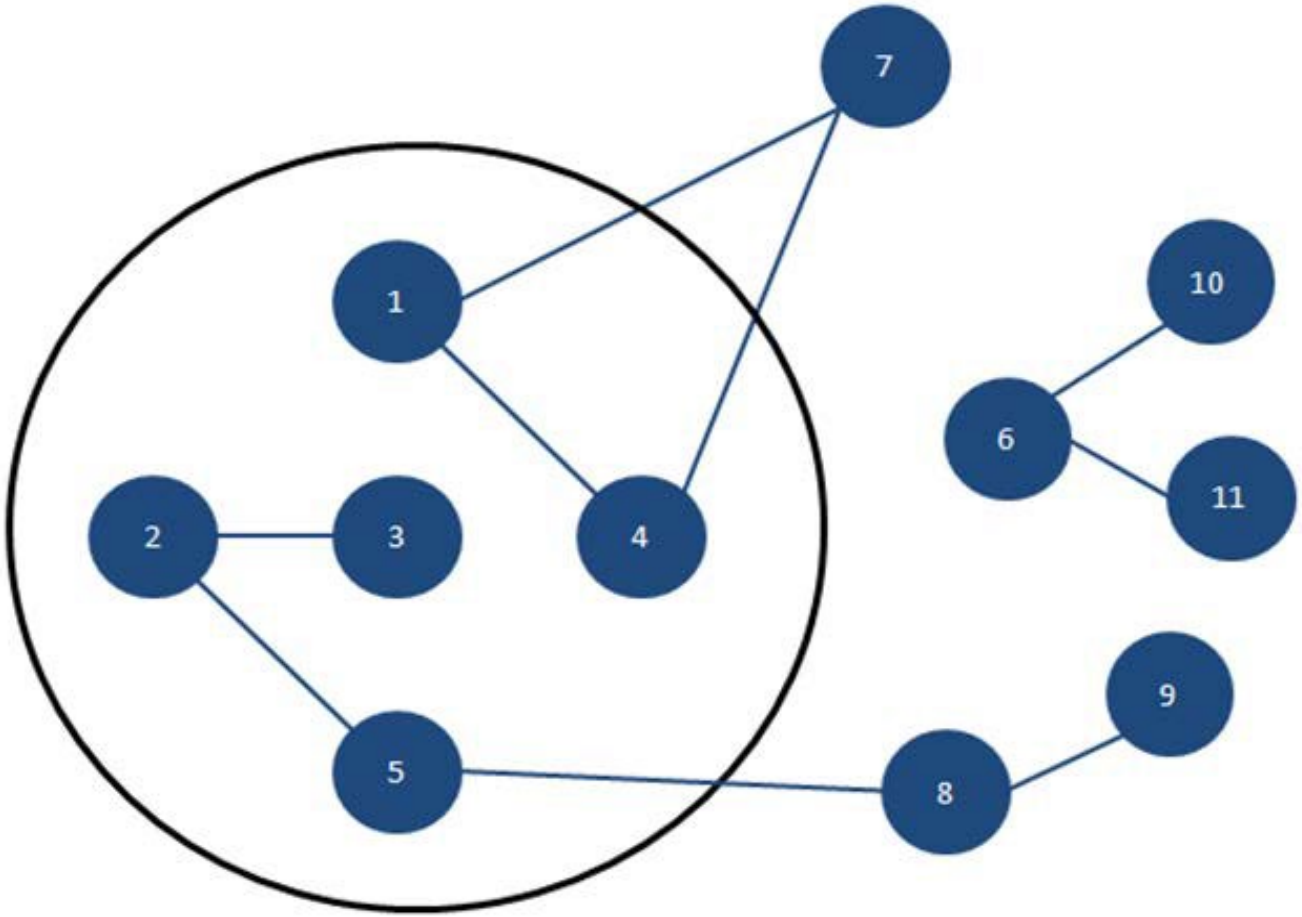
economies as complex systems



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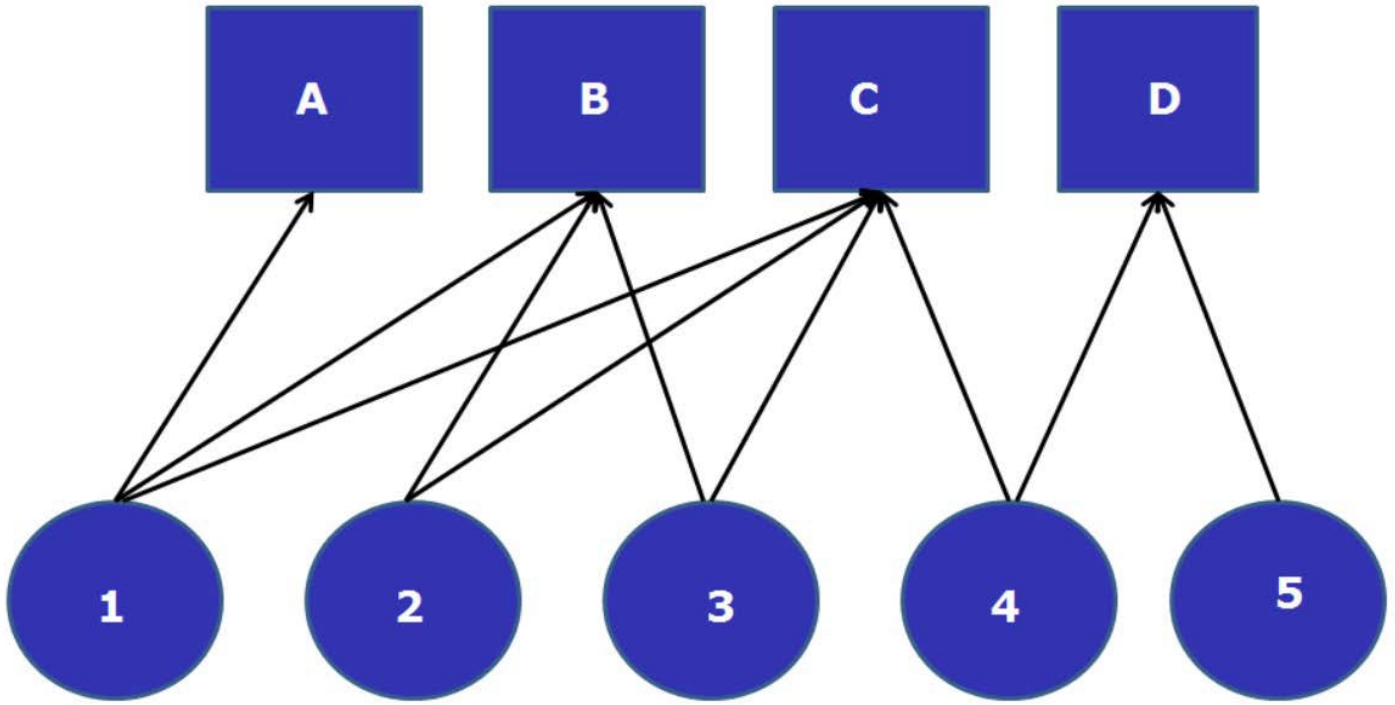
economic systems as 2-mode networks

non-spatial units (economic sectors)



spatial units (cities, states, neighborhoods)

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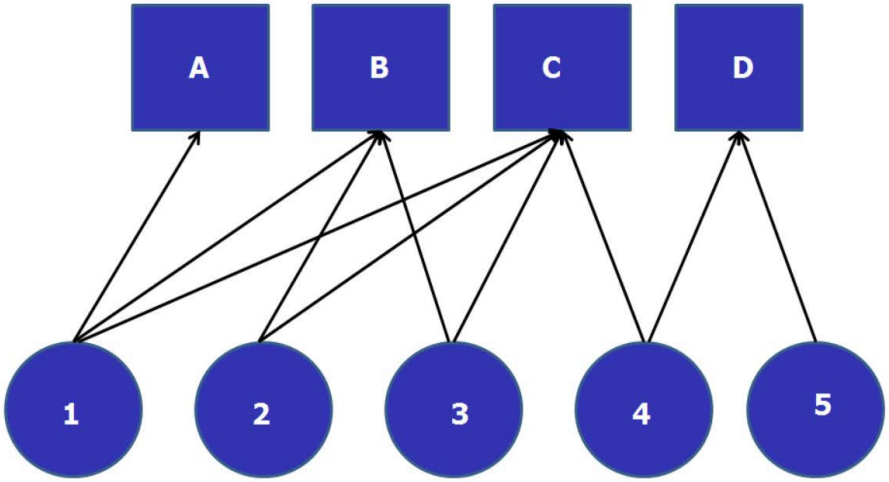
economic systems as 2-mode networks



$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} A\,B\,C\,D \\ \begin{pmatrix} 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \end{array}$$

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compute co-occurrences between non-spatial entities (economic sectors)

$$\begin{array}{c} \\ 1 \\ 2 \\ 3 \\ 4 \\ 5 \end{array} \begin{array}{c} A\,B\,C\,D \\ \begin{pmatrix} 1 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 1 & 1 & 0 \\ 0 & 0 & 1 & 1 \\ 0 & 0 & 0 & 1 \end{pmatrix} \end{array} \Rightarrow \begin{array}{c} \\ A \\ B \\ C \\ D \end{array} \begin{array}{c} A\,B\,C\,D \\ \begin{pmatrix} 0 & 1 & 1 & 0 \\ 1 & 0 & 3 & 0 \\ 1 & 3 & 0 & 1 \\ 0 & 0 & 1 & 0 \end{pmatrix} \end{array}$$

how many times B and C co-occur in the same spatial unit?
= in how many spatial units do B and C co-exist?
response = 3 (in 1,2, and 3)

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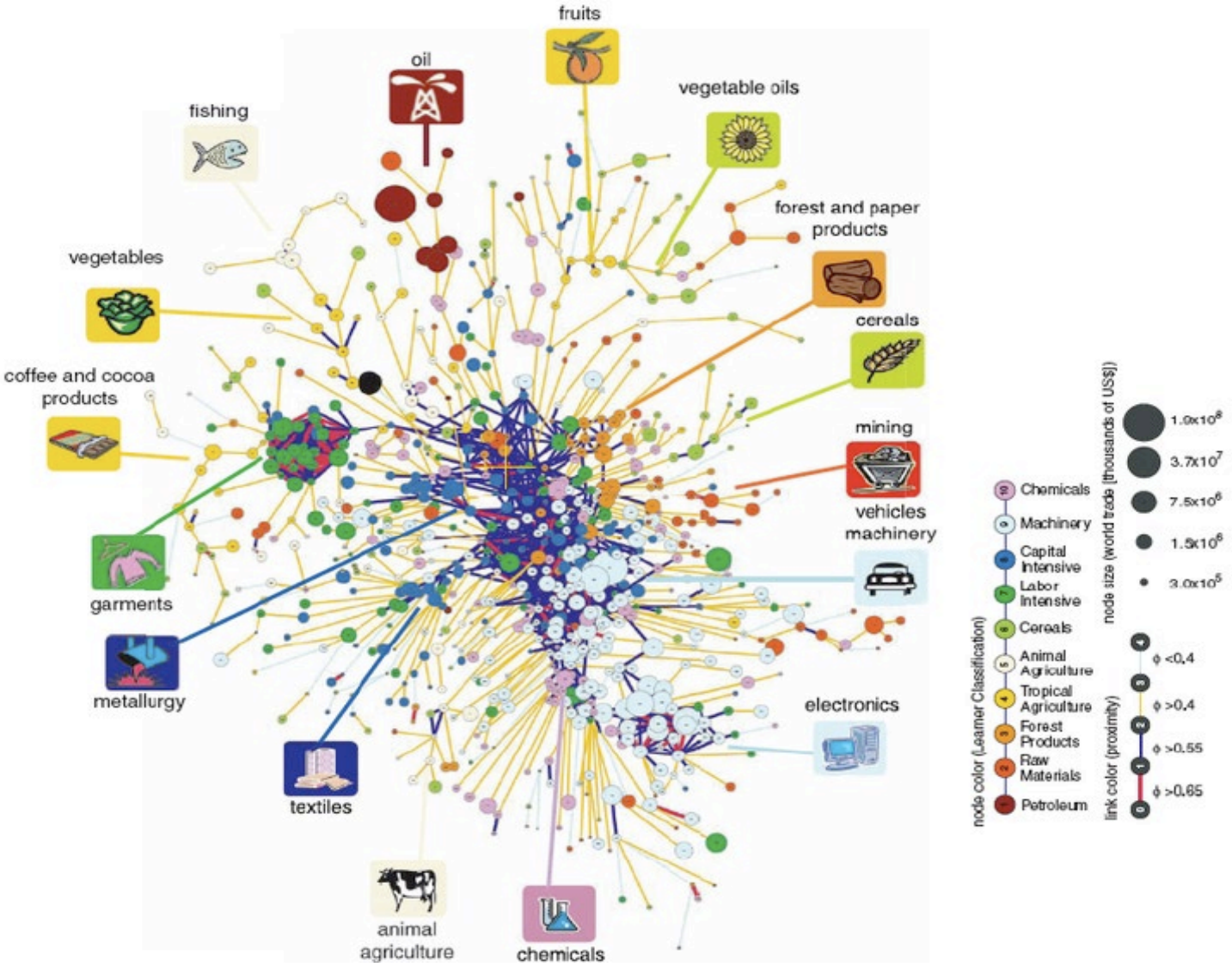
product space



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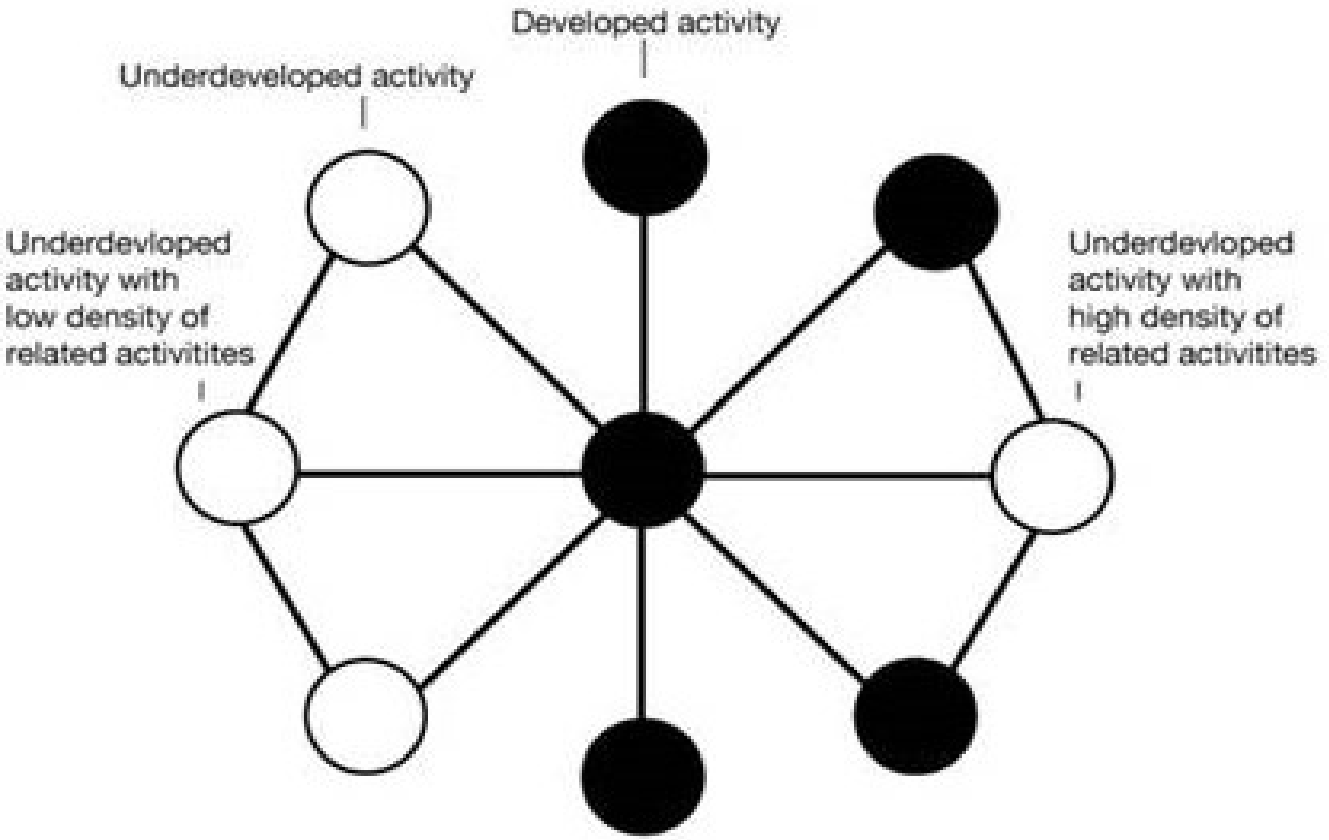
related diversification in regions



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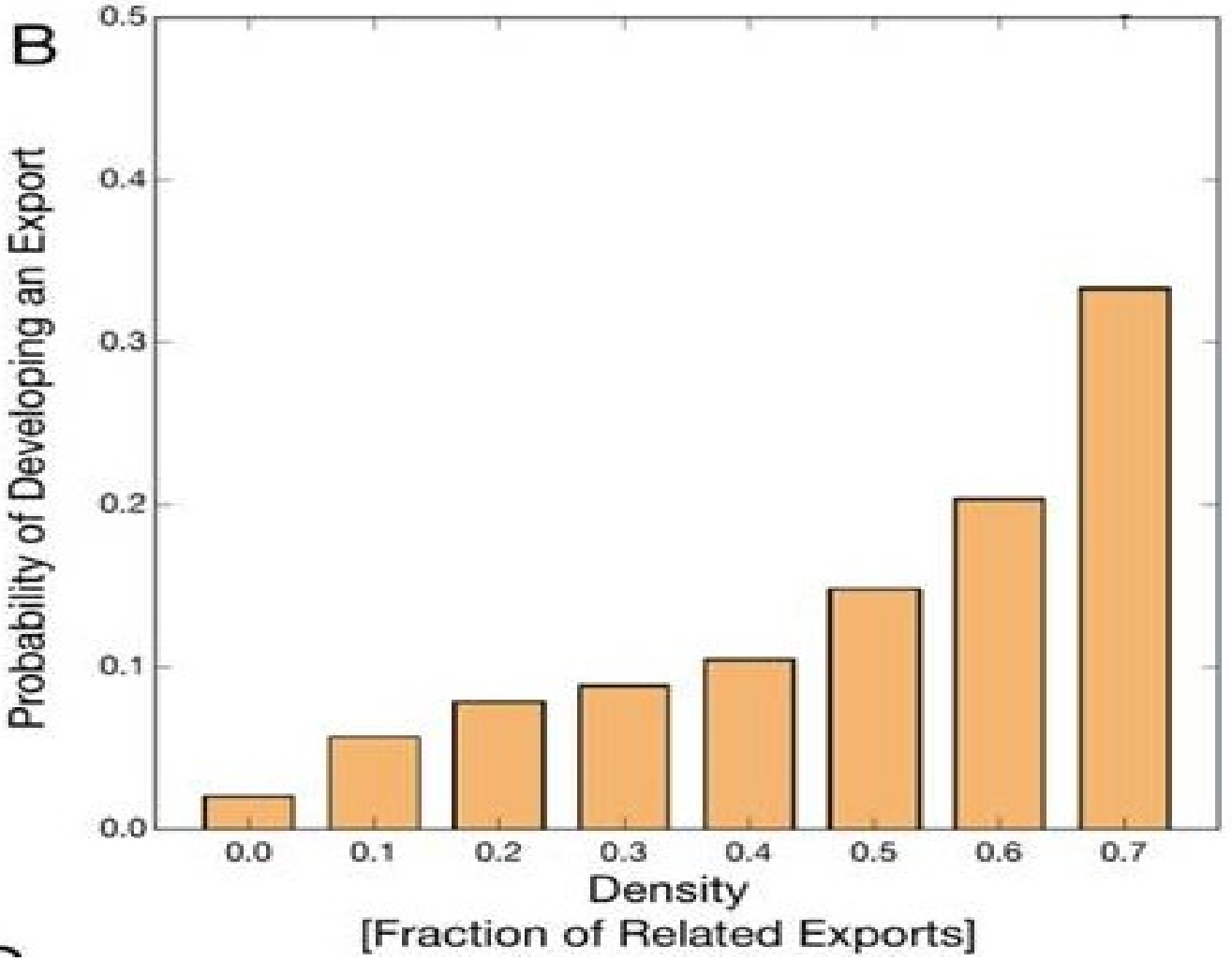
related diversification in regions



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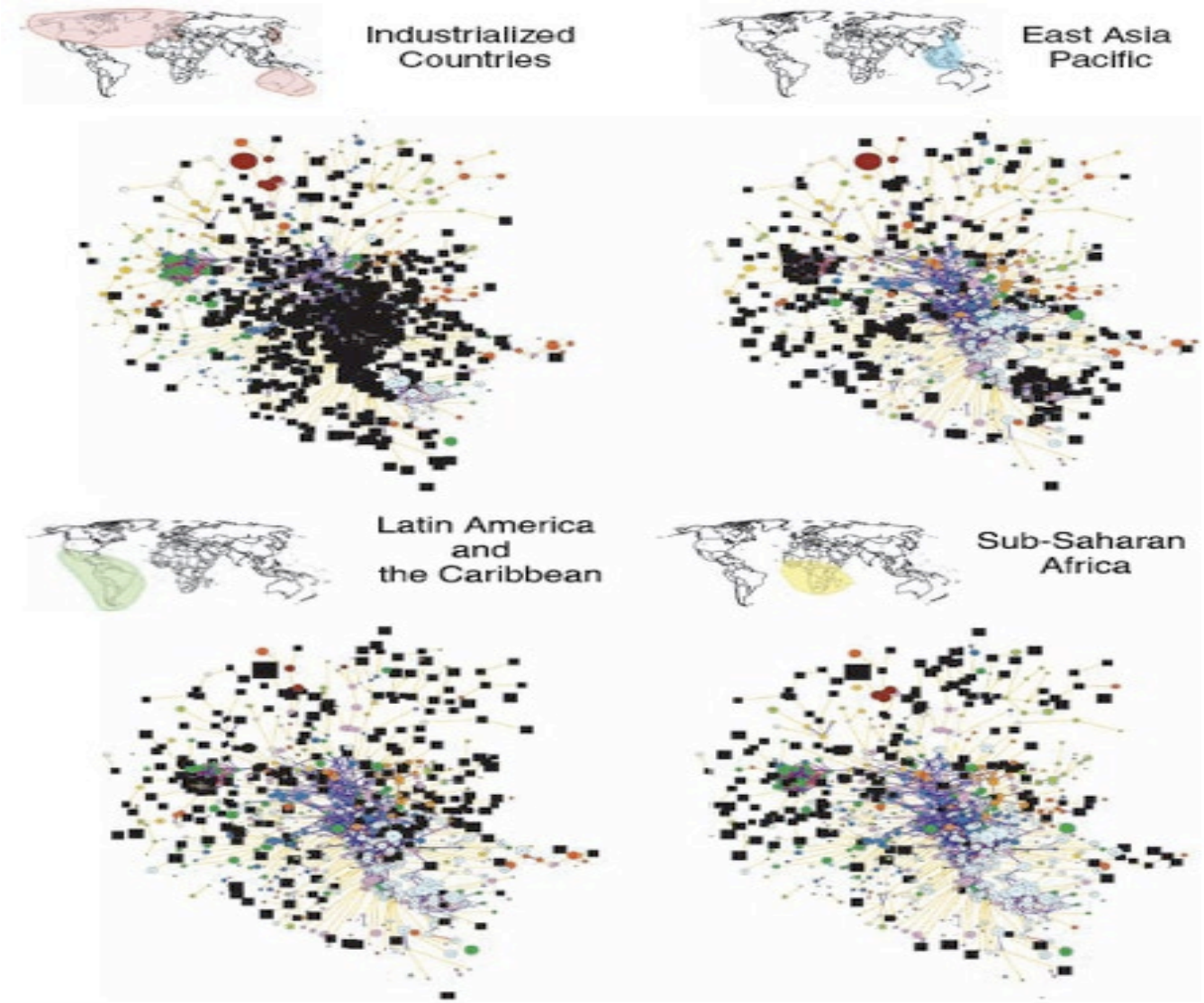
(Hidalgo et al)



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regional diversification

- other relatedness measures (Boschma 2017), e.g.:

- technology space: relatedness between technologies: co-occurrence of technology classes on patent documents

- solar technology space: relatedness between solar technologies and with other technologies

- industry space: relatedness between industries: based on similarities of skills requirements: intensity of labor flows

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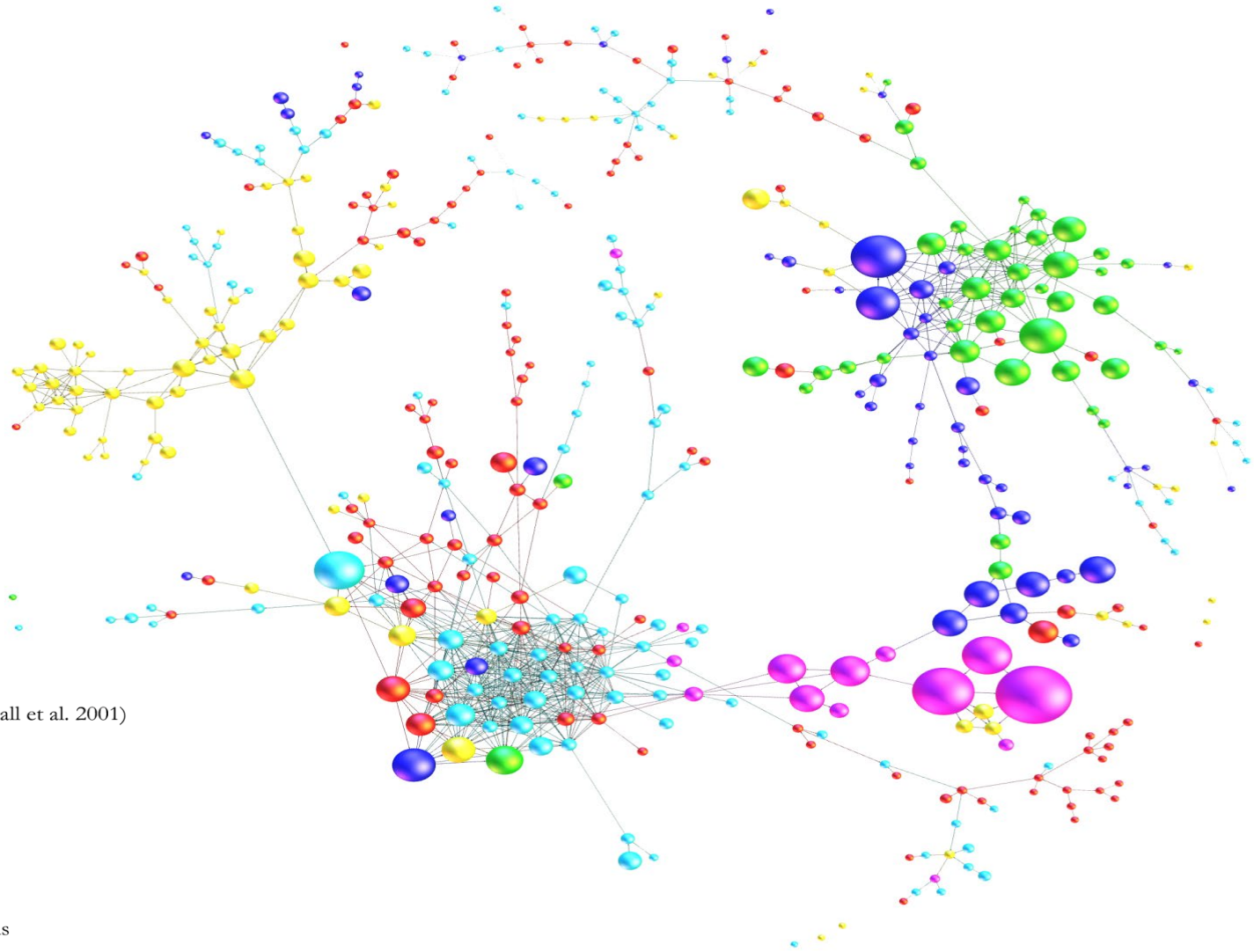
technology space (Boschma et al. 2015)



Node size: # of patents

Node color: USPTO classification (Hall et al. 2001)

- Mechanical
- Chemical
- Drugs and Medical
- Electrical and Electronic
- Computers and Communications
- Others

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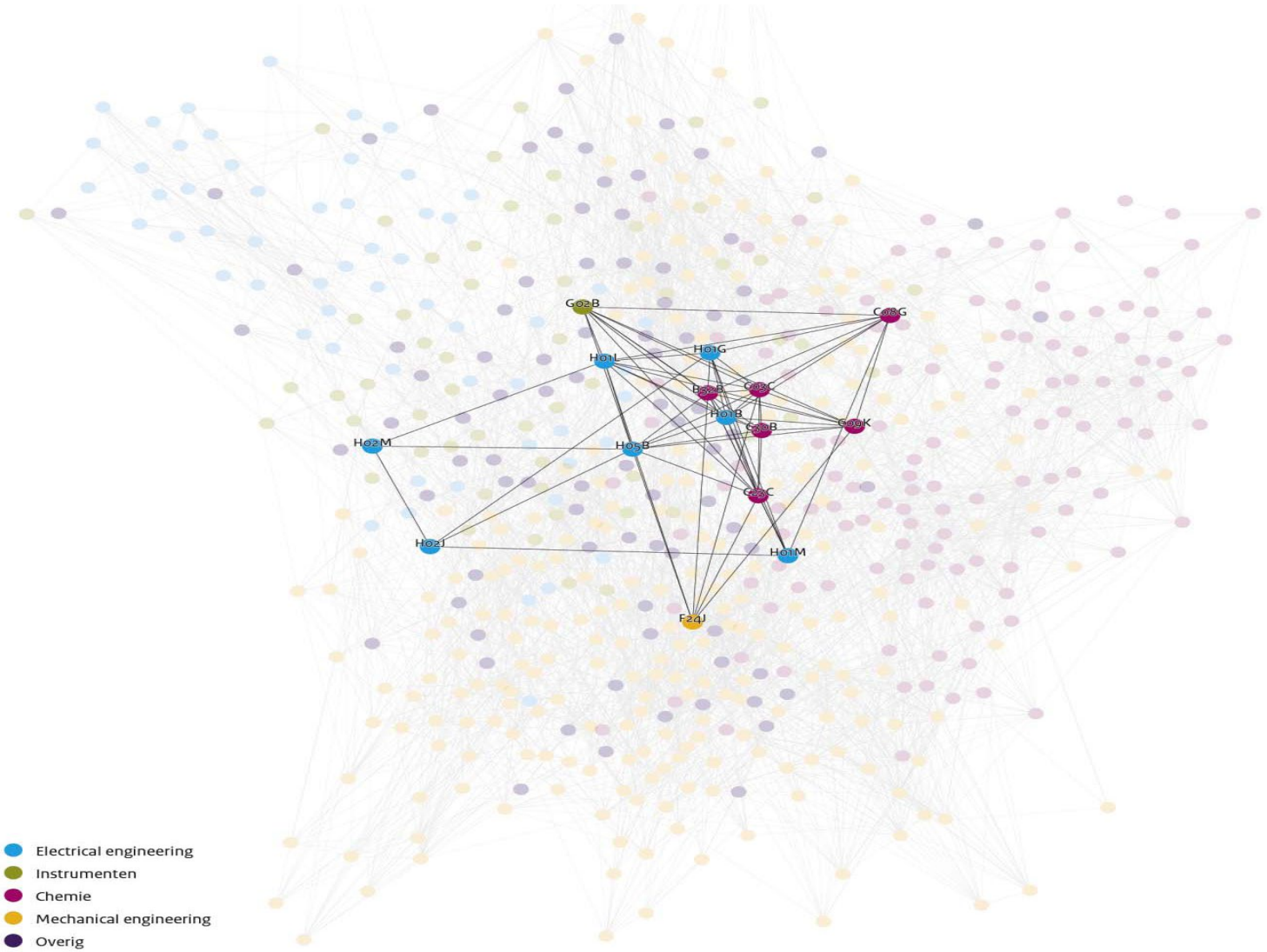
solar technology space



Bron: OECD REGPAT database

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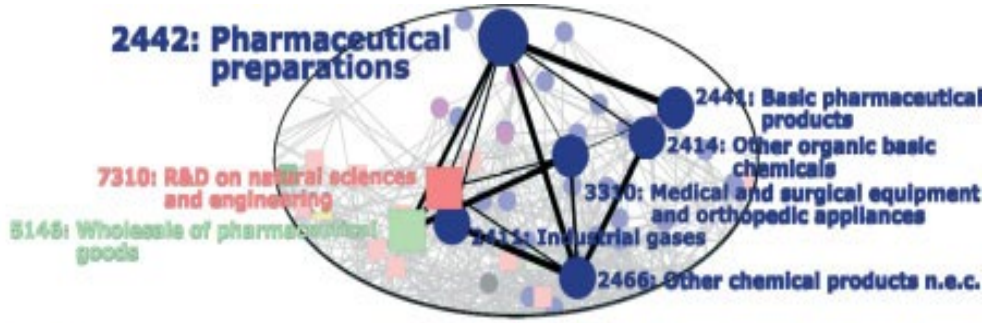
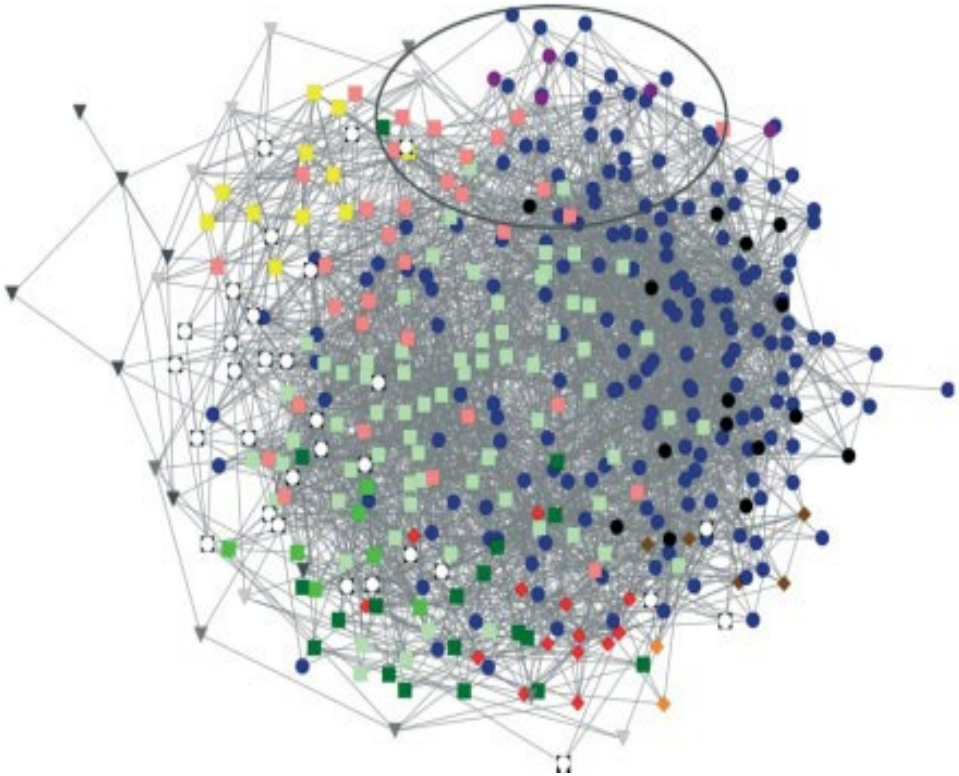
skill space





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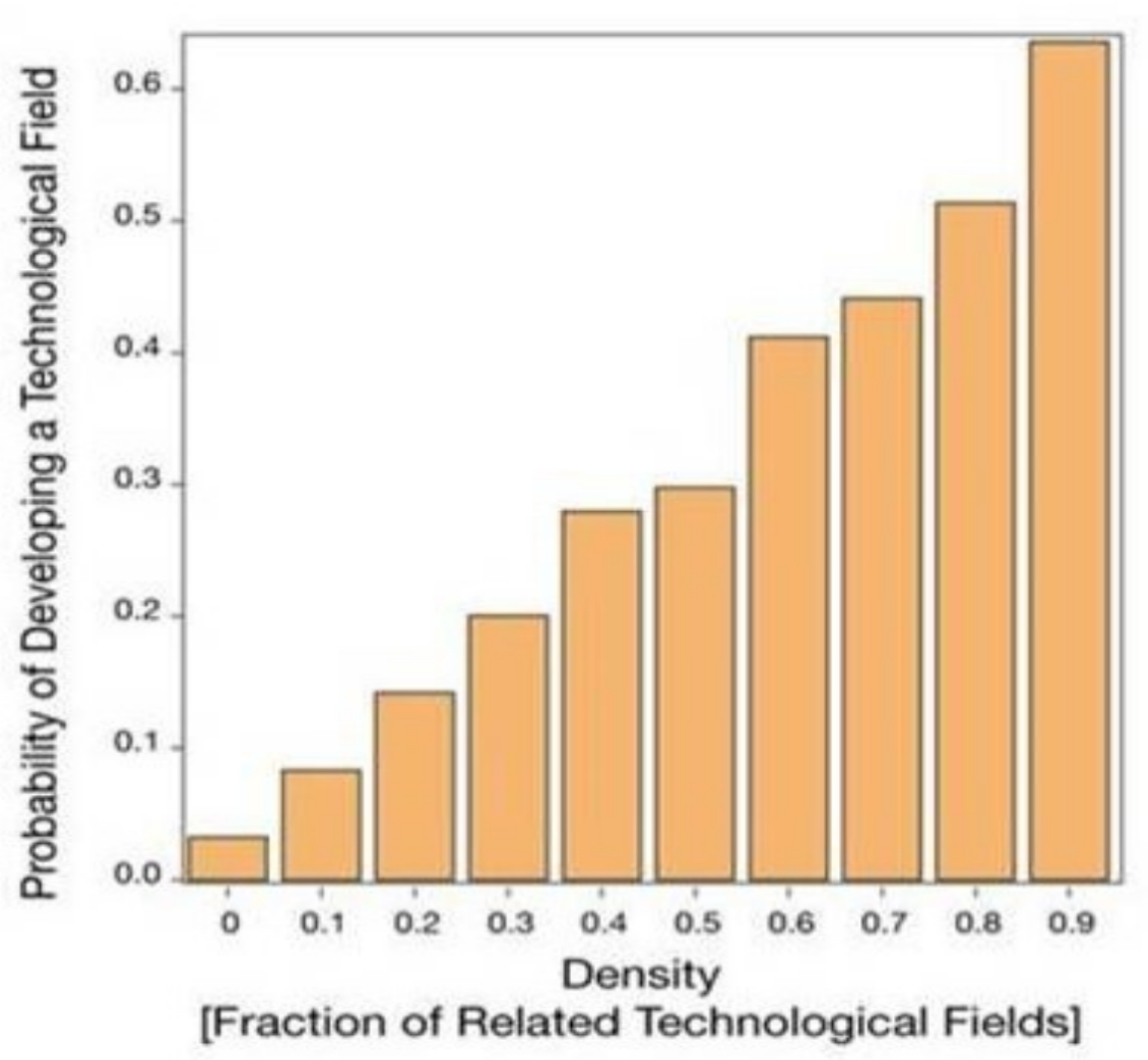
regional diversification



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technological diversification opportunities of regions

- average relatedness density (Balland et al. 2019): the average degree of relatedness between existing technologies in a region and all missing technologies in that region

- the higher that region's score on this measure, the closer, on average, its existing set of technologies to those technologies that are missing in the region: overall average score of a region's potential to develop new technologies

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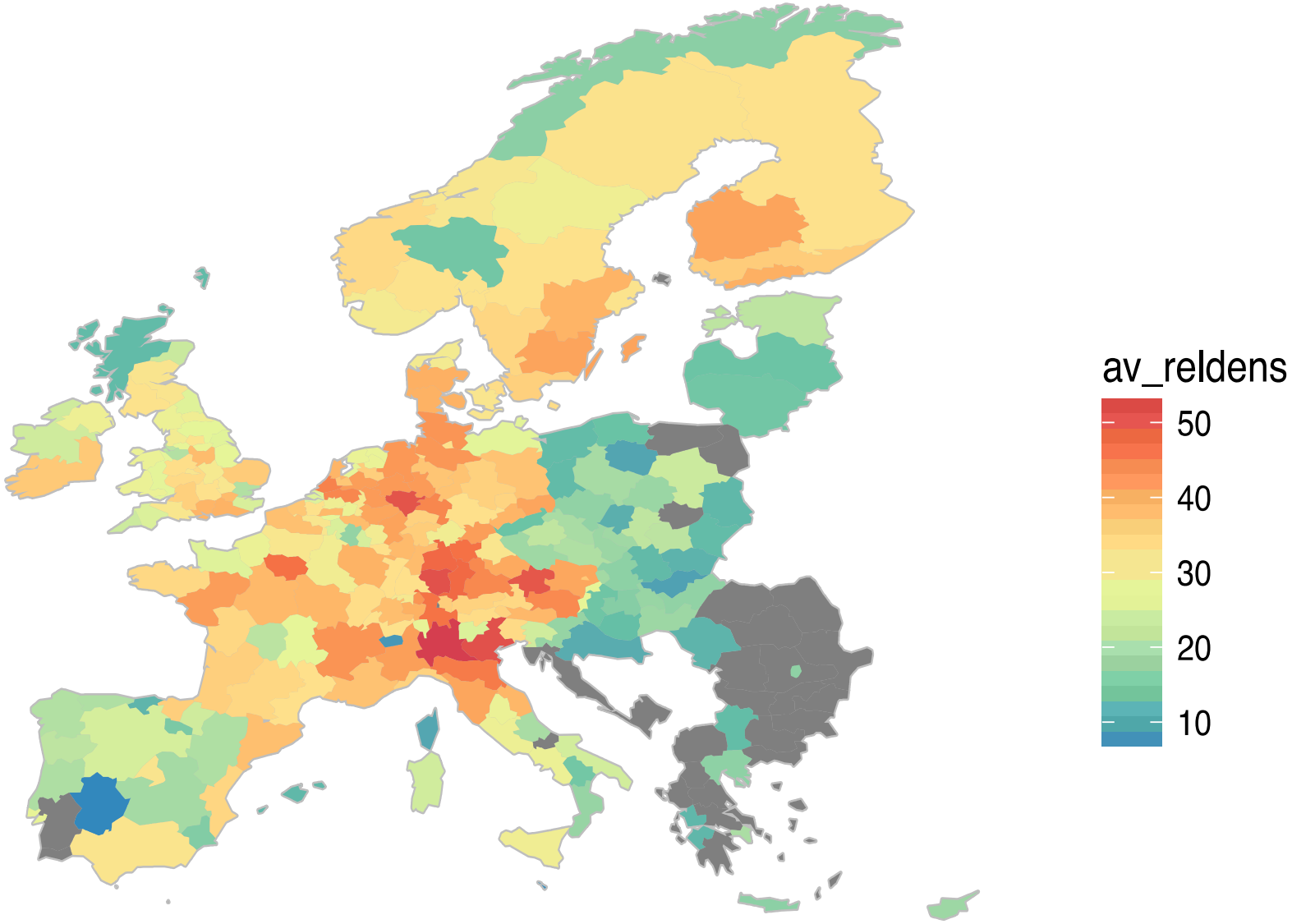
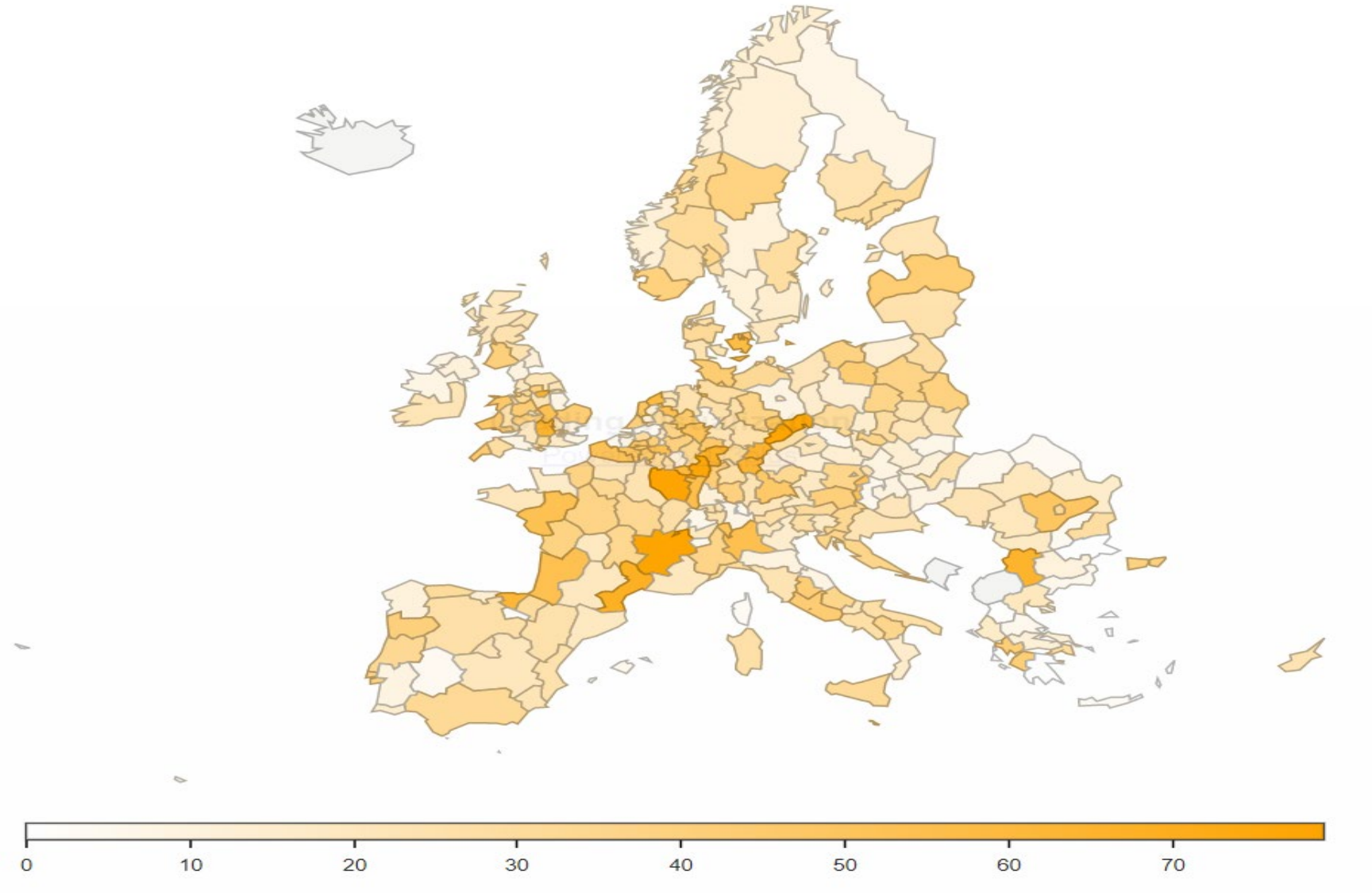
diversification opportunities of European regions



Source: Balland et al. (2019)

diversification potential of European regions in hydrogen technology



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smart specialization policy

- EEG has been influential in the EU: smart specialization policy

- focus on identifying possible diversification strategies for regions, based on their capabilities

- relatedness: to assess potential risks of alternative diversification strategies for regions

- complexity: to assess potential benefits of policy, based on diversity and ubiquity (Hidalgo and Hausmann 2009)

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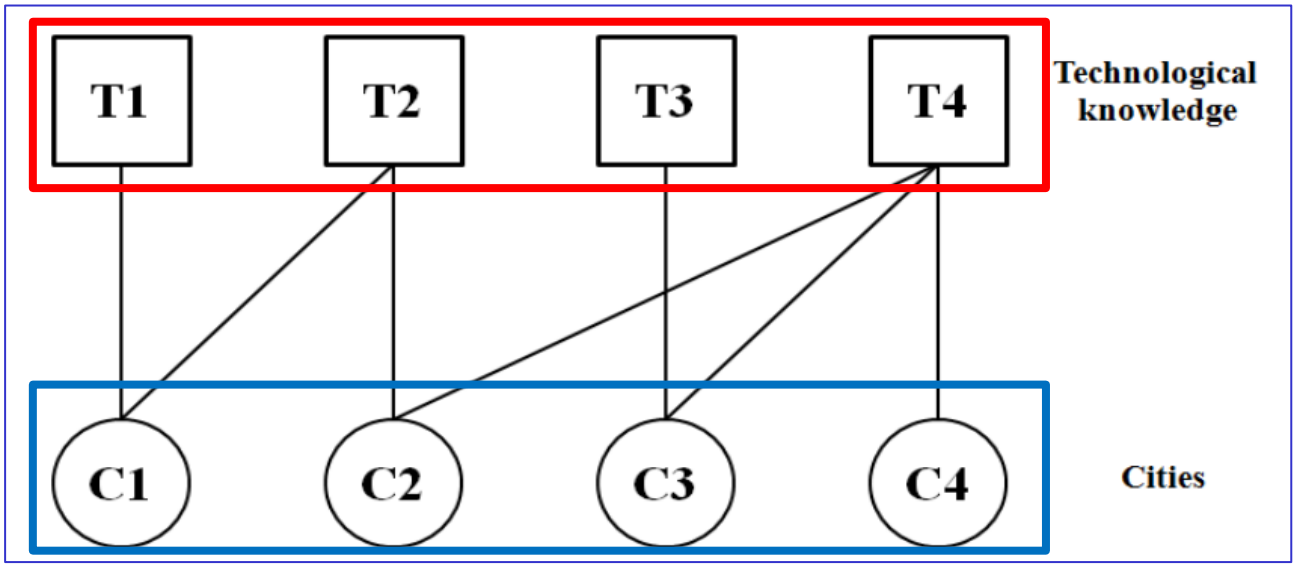
complexity: diversity and ubiquity



diversity is the degree centrality of the spatial units

ubiquity is the degree centrality of the econ/tech units

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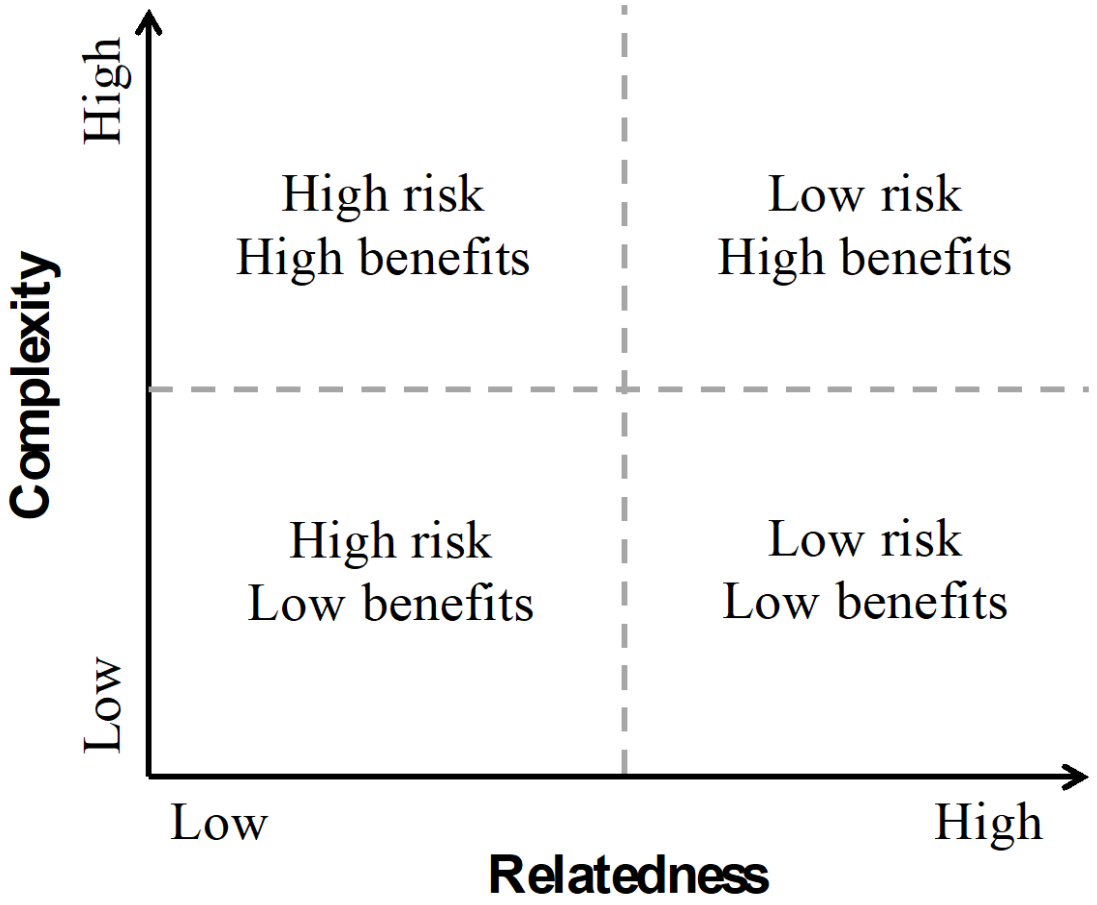
smart specialization policy



Source: Balland et al. (2019)

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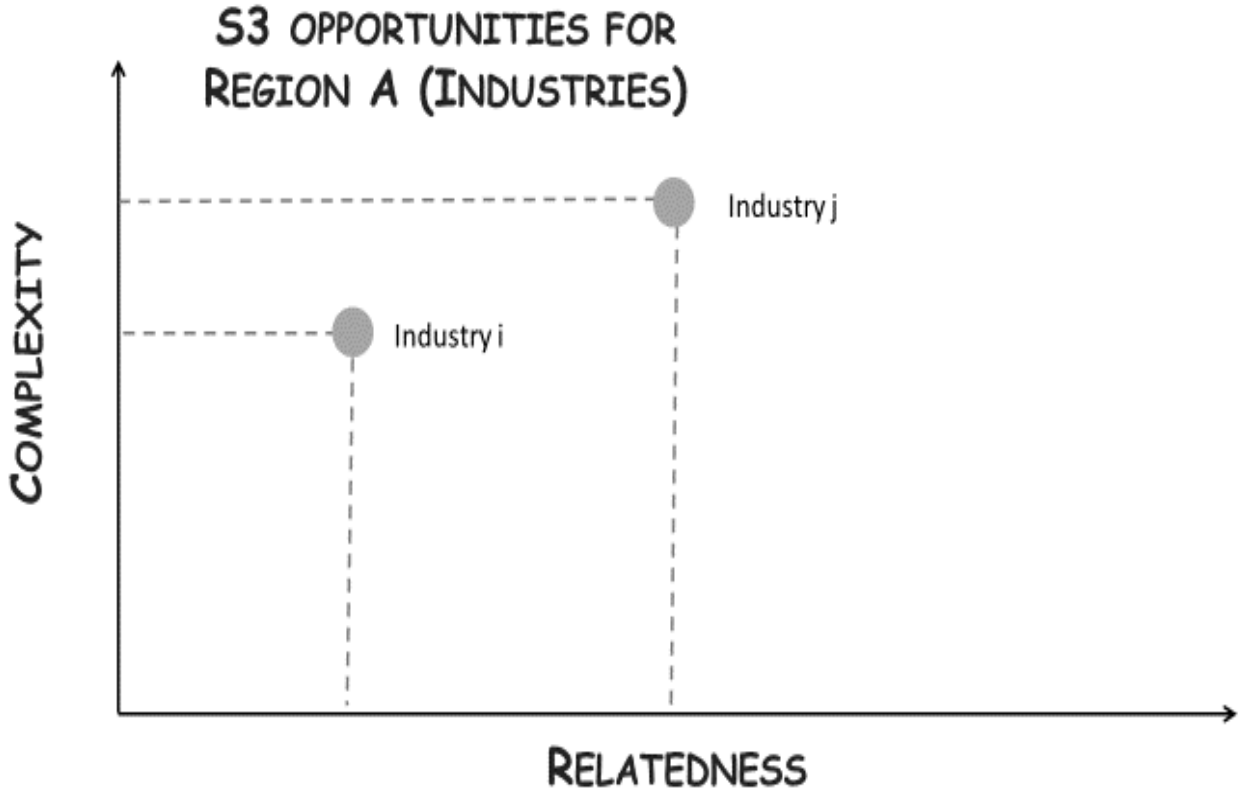
toward a new S3 framework



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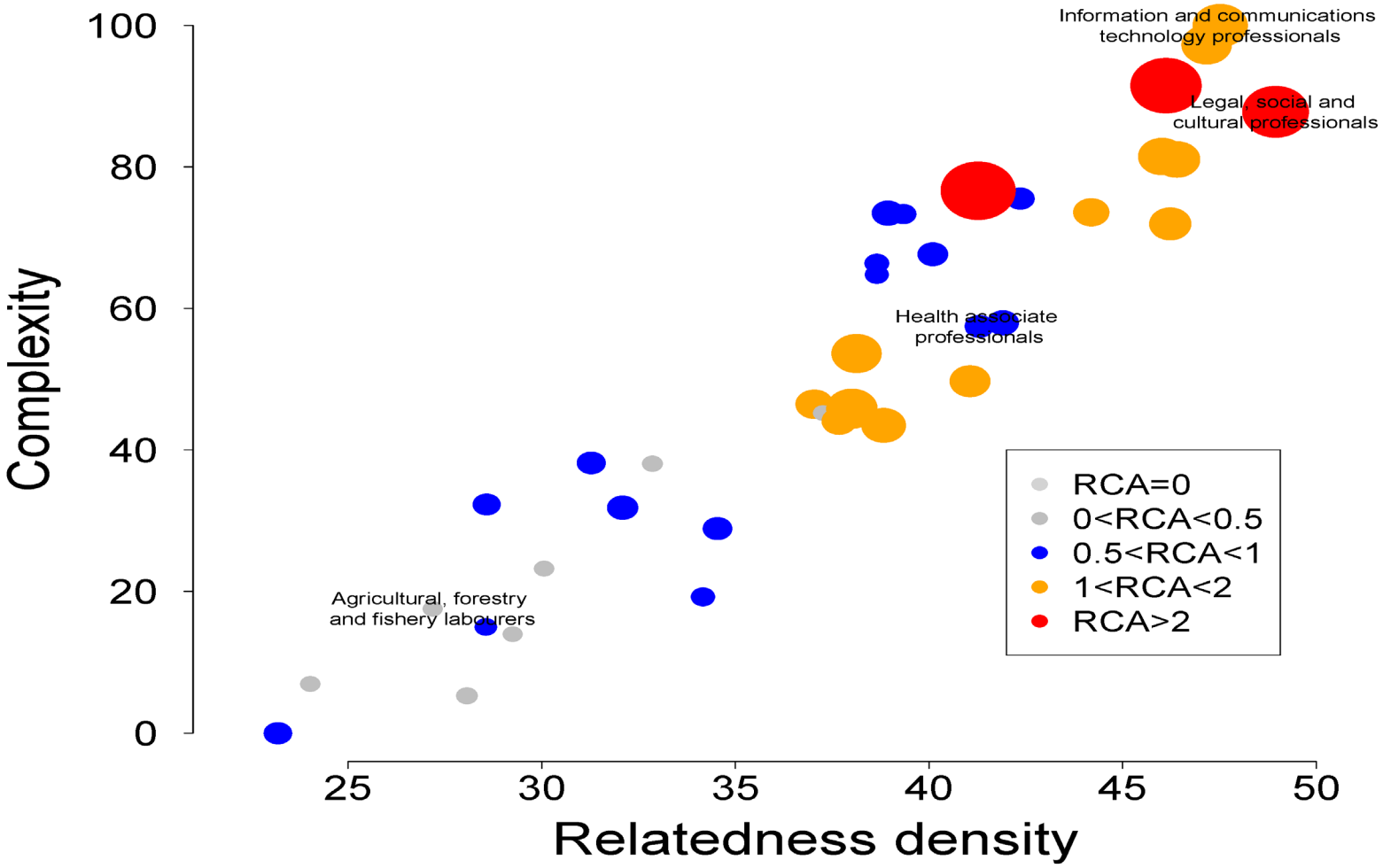
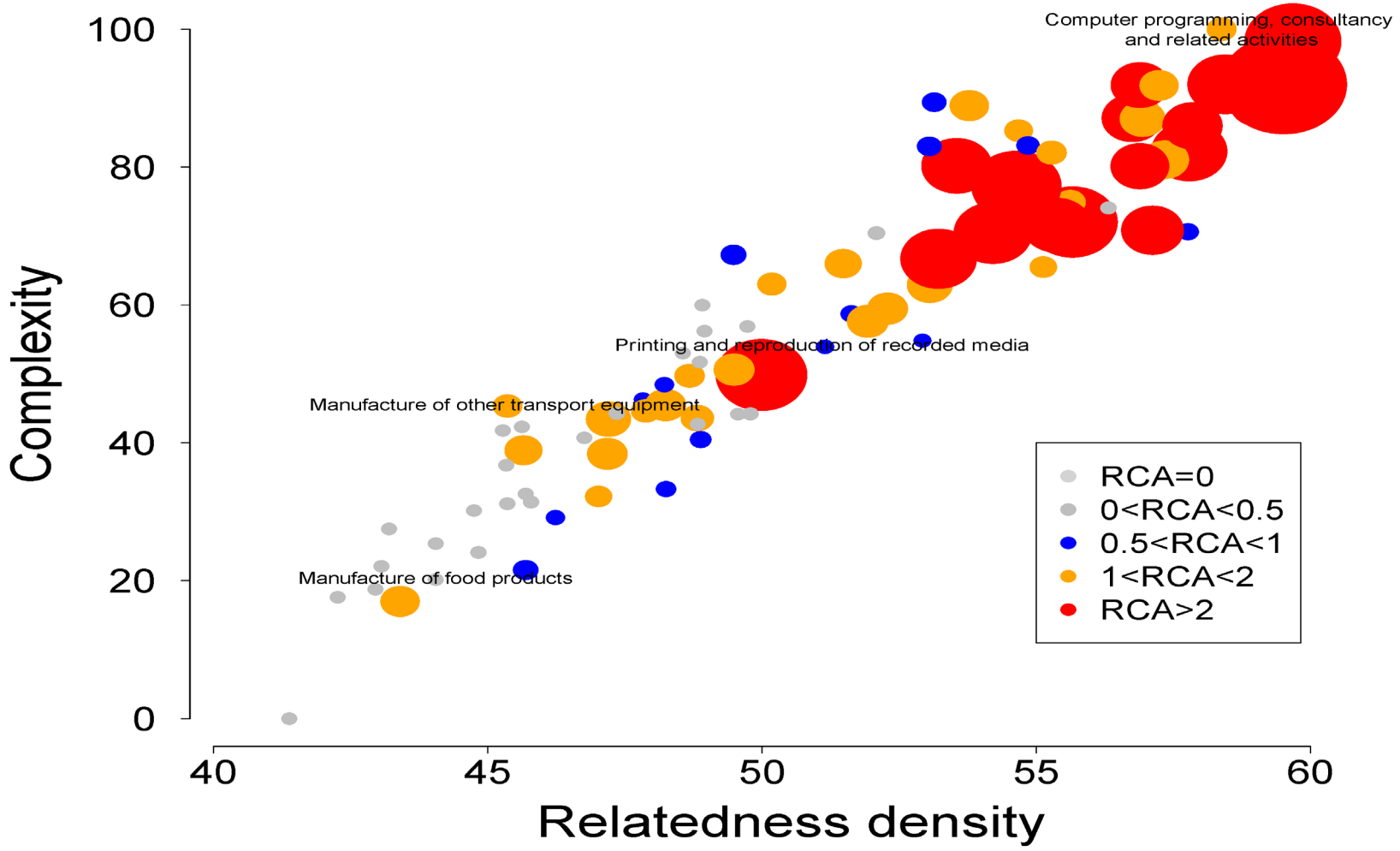
diversification opportunities in occupations

Île-de-France (FR10)



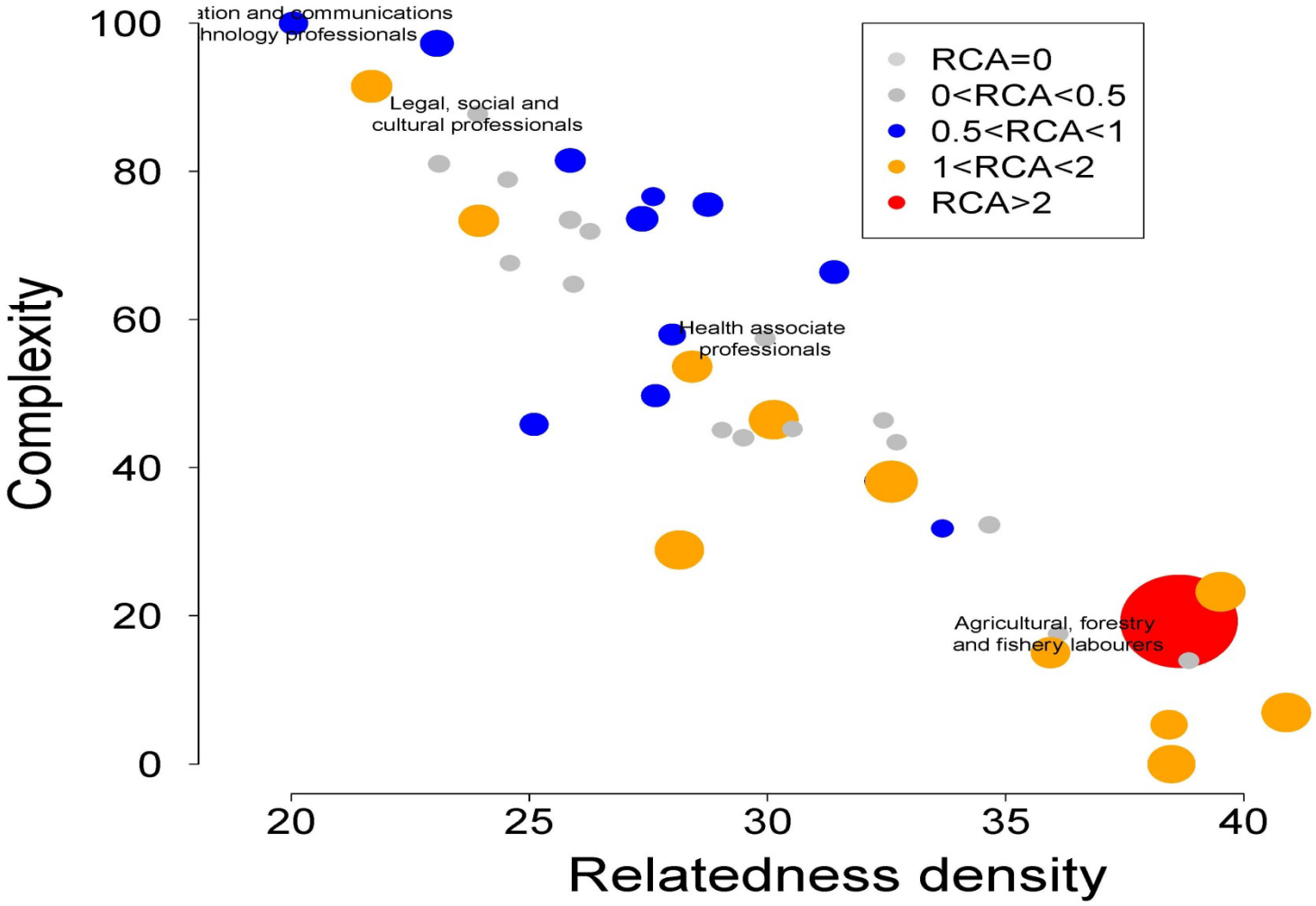
diversification opportunities in sectors

Île-de-France (FR10)



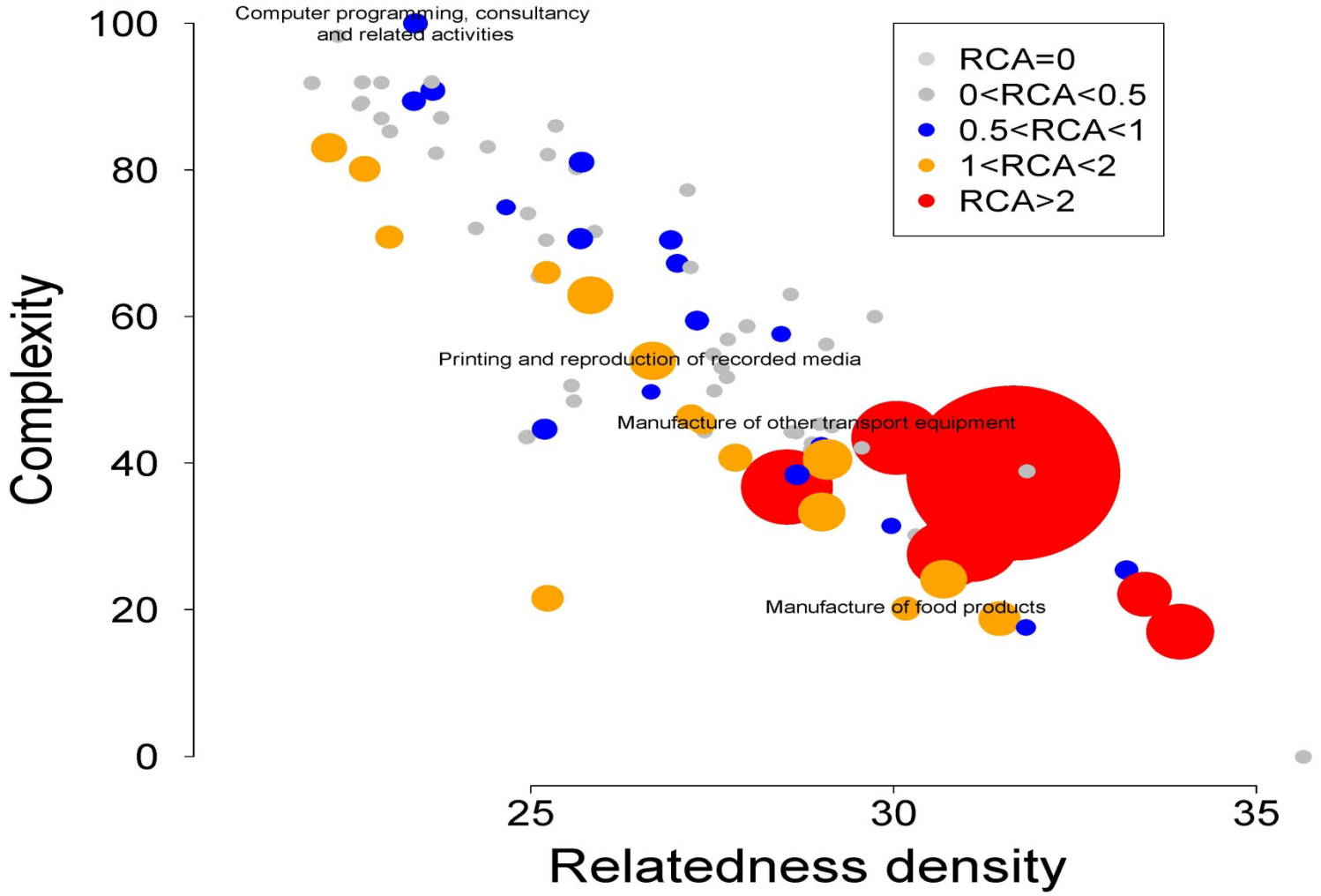
diversification opportunities in occupations

Silesia (PL22)

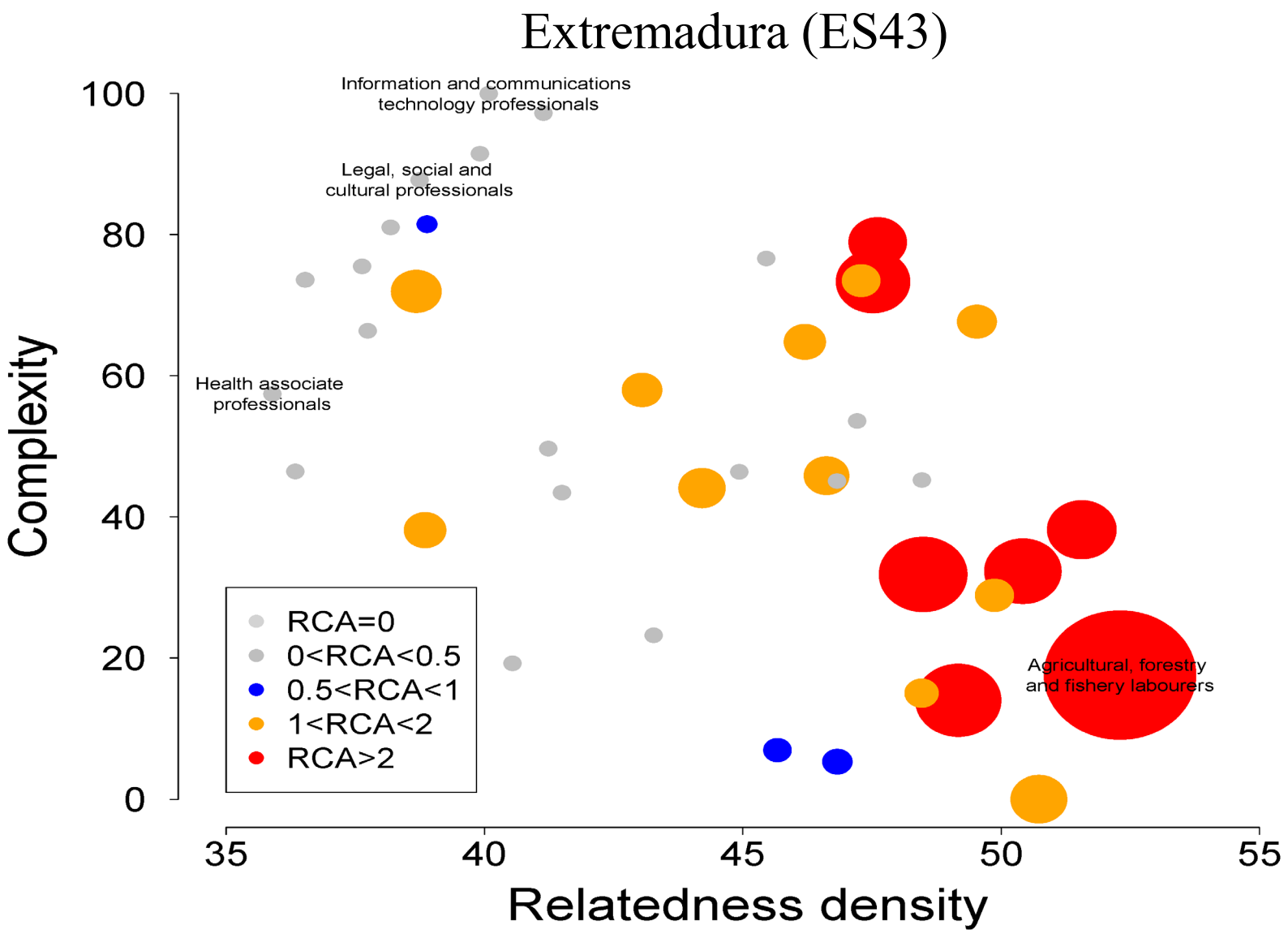


diversification opportunities in sectors

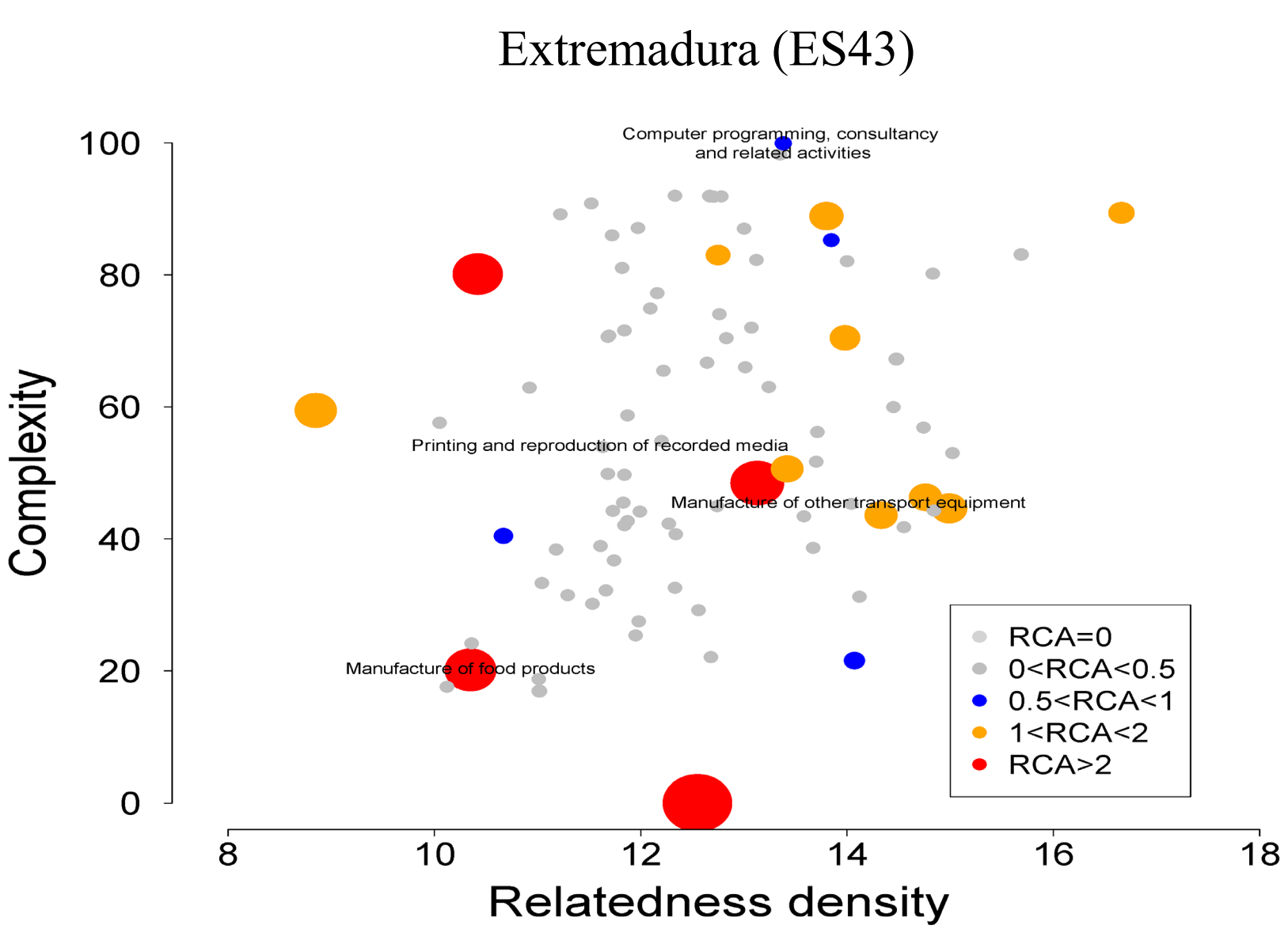
Silesia (PL22)



diversification opportunities in occupations



diversification opportunities in sectors



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inter-regional linkages

- not only regional capabilities may be important, but also inter-regional linkages, to avoid lock-in
- can inter-regional linkages providing access to missing capabilities affect diversification in region?
- need for absorptive capacity to exploit external knowledge: non-local knowledge needs to be related to local knowledge (Boschma and Iammarino 2009)
- Balland, P. and R. Boschma (2021) Complementary inter-regional linkages and Smart Specialisation. An empirical study on European regions, *Regional Studies* 55 (6), 1059-1070.

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inter-regional linkages

- identify diversification opportunities of regions:

- based on their regional capabilities (relatedness)

- but also on the nature of their inter-regional linkages

- we analyze the impact of external linkages on technological diversification in European regions, while controlling for regional capabilities

- we test whether inter-regional linkages that give access to additional capabilities in other regions that are related to existing capabilities of regions have a stronger impact on regional diversification

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inter-regional linkages

- regional diversification model: patent data from the OECD REGPAT dataset: 654 technological classes (CPC) and 292 European regions (NUTS2)
- role of regional capabilities: relatedness density (RD)
- two measures of inter-regional linkages:

- inter-regional linkages: number of ties with inventors in other regions (NL)
- complementary inter-regional linkages: density of related non-local knowledge in which a region can tap in to diversify in a new technology (CL)

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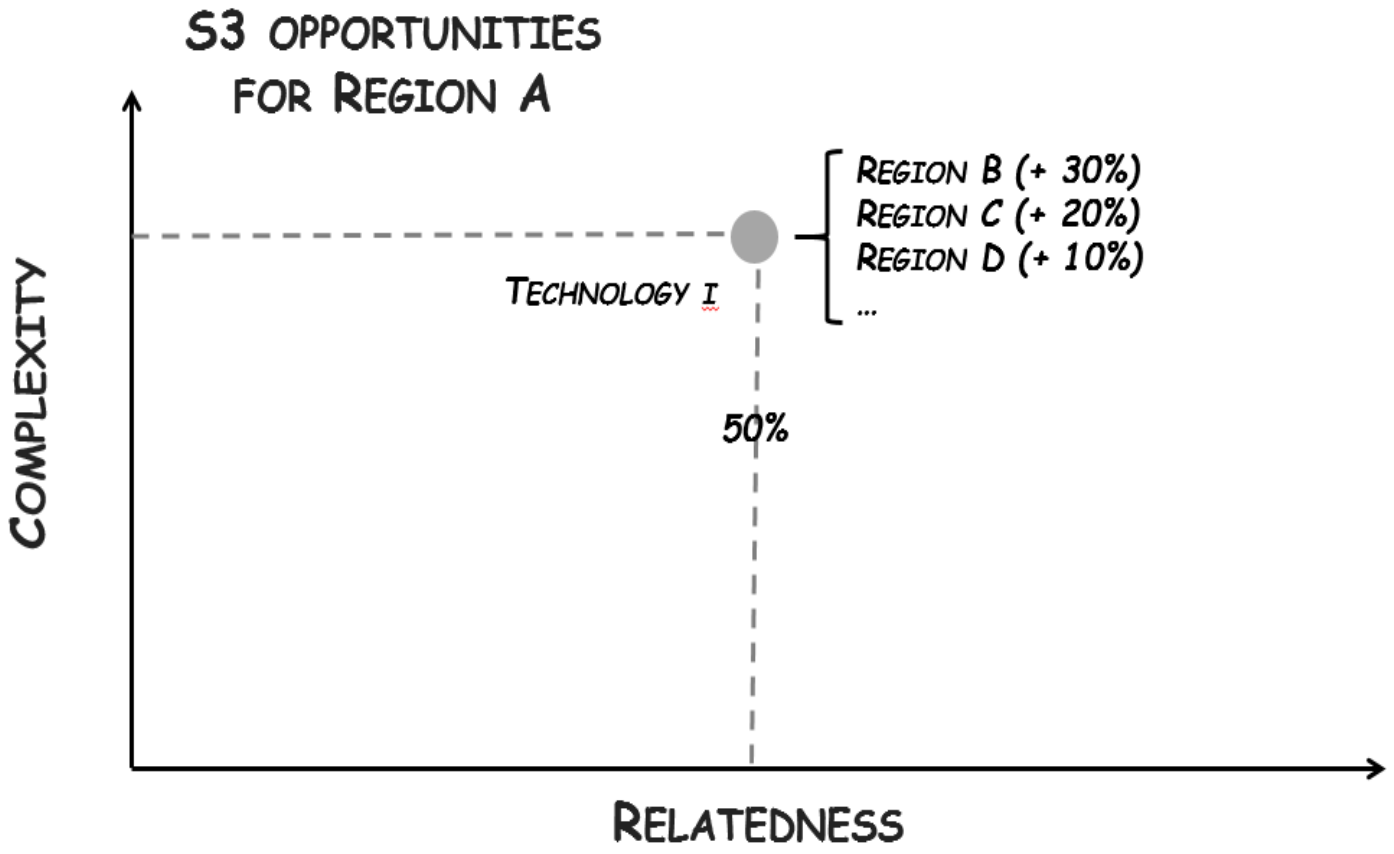
diversification opportunities of region A through complementary linkages with other regions



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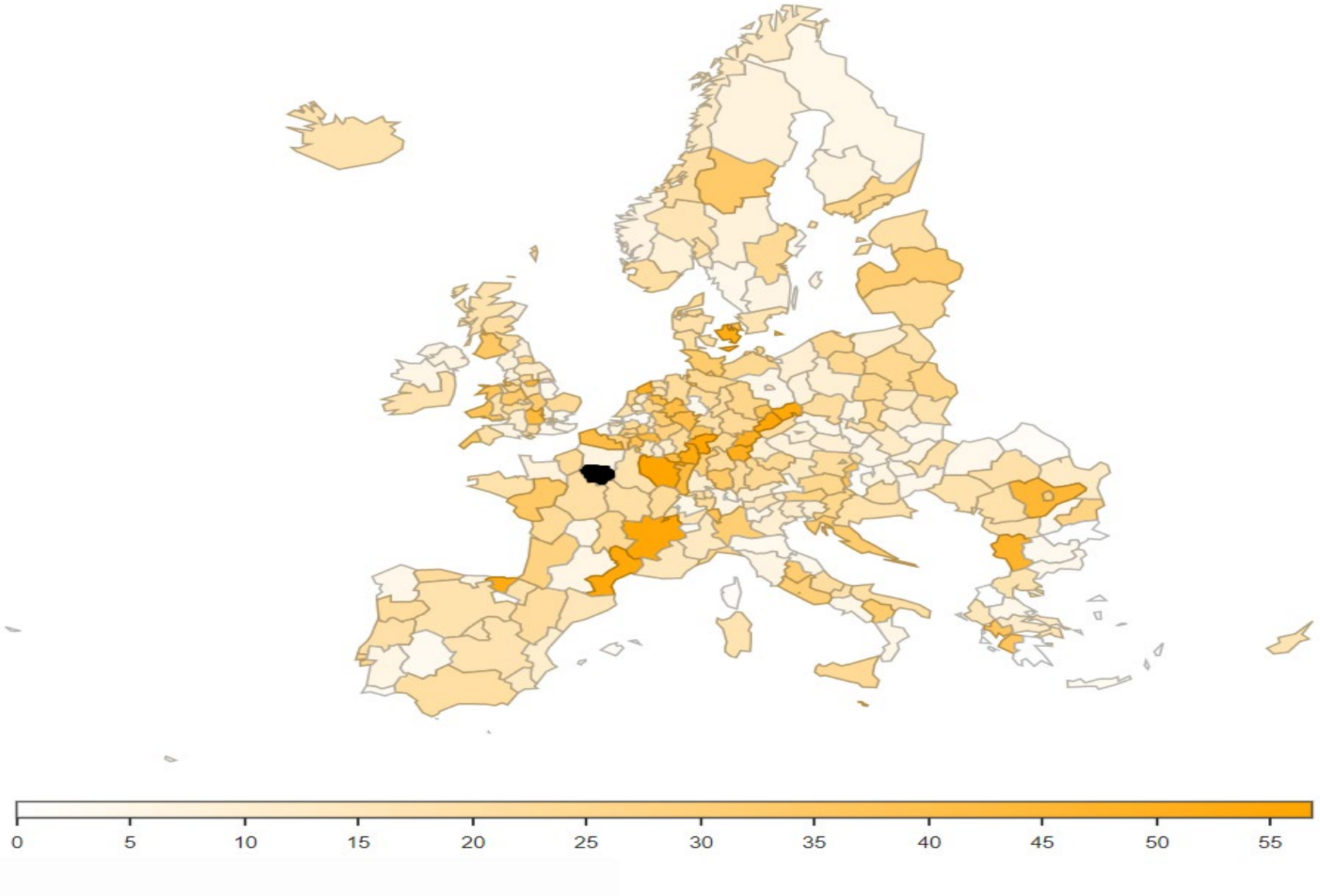
	(1)	(2)	(3)	(4)
Relatedness Density (RD)	0.003***	0.003***	0.004***	0.002***
	(0.00003)	(0.00003)	(0.00004)	(0.0001)
Number of inter-regional linkages (NL)		0.005***	-0.025***	-0.017***
		(0.0003)	(0.001)	(0.001)
Complementarity of inter-regional linkages (CL)			0.027***	0.018***
			(0.001)	(0.001)
RD*CL				0.0002***
				(0.00001)
GDP per capita	0.001***	0.0001	0.0002**	0.0001
	(0.0001)	(0.0001)	(0.0001)	(0.0001)
Population (log)	0.015***	0.010***	0.011***	0.010***
	(0.001)	(0.001)	(0.001)	(0.001)
Period	-0.007***	-0.008***	-0.008***	-0.008***
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	-0.142***	-0.083***	-0.172***	-0.120***
	(0.010)	(0.011)	(0.011)	(0.011)
Observations	379,876	379,876	379,876	379,876
R^2	0.037	0.038	0.044	0.044
Adjusted R^2	0.037	0.038	0.044	0.044
Residual Std. Error	0.318 (df = 379871)	0.318 (df = 379870)	0.317 (df = 379869)	0.317 (df = 379868)
F Statistic	3,658.418*** (df = 4; 379871)	2,970.927*** (df = 5; 379870)	2,885.502*** (df = 6; 379869)	2,522.347*** (df = 7; 379868)

Note: *p**p***p<0.01

map of complementarity of all European regions to Île-de-France region in new hydrogen technologies



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thank you for your attention!

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