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Smart specialization in the EU:

Relatedness, knowledge complexity and regional diversification

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structure of lecture

1. relatedness and diversification
2. knowledge complexity and diversification
3. technological diversification of European regions
4. implications for smart specialization policy

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1. relatedness and diversification

- **smart specialisation** is part of EU regional and innovation policy

- some **critiques**:

- perfect example of policy running ahead of theory

- lacking evidence-base

- building on anecdotal evidence, rather than the application of theoretically grounded methodologies

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1. relatedness and diversification

- objective of **smart specialisation EU policy** is to develop **new activities** in region, rather than to strengthen existing specializations in region

- **some features** of smart specialization policy:

- no ‘one-size-fits all’ policy: bottom-up strategy

- no duplication of policy: not ‘more of the same’

- policy targeting potential new activities based on regional capabilities, rather than just being ‘hot’

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1. relatedness and diversification

- this requires a basic understanding of **how regions diversify**, and **why their capacity** to diversify **differs** between regions

- new specializations are no random events: they are often strongly embedded in **territorial capabilities**

- **local capabilities** condition which new activities will be feasible to develop: they provide **opportunities** but also set **limits** to the diversification process in regions

- **new specializations** grow out of related activities, in which new activities combine and exploit knowledge and skills from **local related** activities

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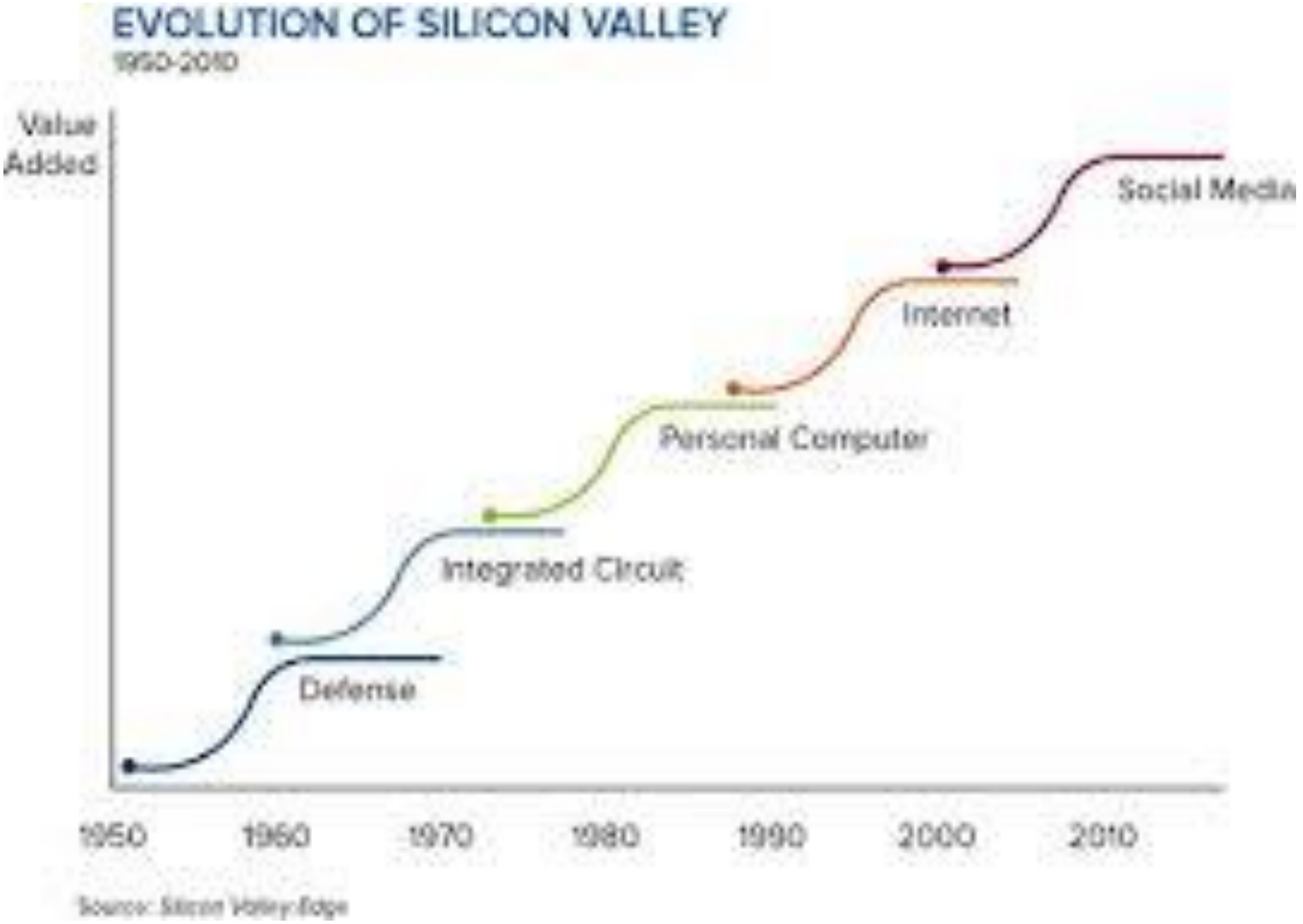
1. relatedness and diversification



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1. relatedness and diversification

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1. relatedness and diversification

- Hidalgo, Klinger, Barabasi and Hausmann (2007): how **countries** build a CA in new export products

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

- countries with **related variety**: more opportunities to diversify and higher economic growth

- Neffke, Henning and Boschma (2011): **industrial diversification** in 70 Swedish **regions** 1969-2002

- industries that are technologically **related** to pre-existing sectors in a region had a higher probability to enter the region

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2. knowledge complexity and diversification

- but smart specialisation is **not only** about developing new specializations in regions that have growth potential due to local related capabilities

- smart specialisation is **also** about developing new specializations in regions that are unique in the world : **more complex** that **upgrade local economy** (Hidalgo and Hausmann 2009)

- **complexity of knowledge** refers to the degree of its sophistication and the number of capabilities required to develop such new technology

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3. technological diversification of European regions

- technological diversification of 282 European NUTS 2 regions (EU 27 + Norway + Switzerland) 1980-2009
- patent data from the European Patent Office (EPO): 617 technology classes (IPC)
- entry-model, where y=1 if a region *r* gains a RTA in technology *i*, otherwise y=0
- RTA= share technology *i* in region *r* > share technology *i* in Europe
- main variables: relatedness density and knowledge complexity

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3. technological diversification of European regions

- **(1) technological relatedness** between knowledge domains: based on frequency of **co-occurrence** of technology classes on patent documents

- **(2) relatedness density**: number of technologies *j* (%) related to technology *i* that are present in region

Region	Technology	Density (%)
Ile de France	Biotech	10
Ile de France	Nanotech	100
Rhone Alpes	Biotech	80
Rhone Alpes	Nanotech	0
...	...	...

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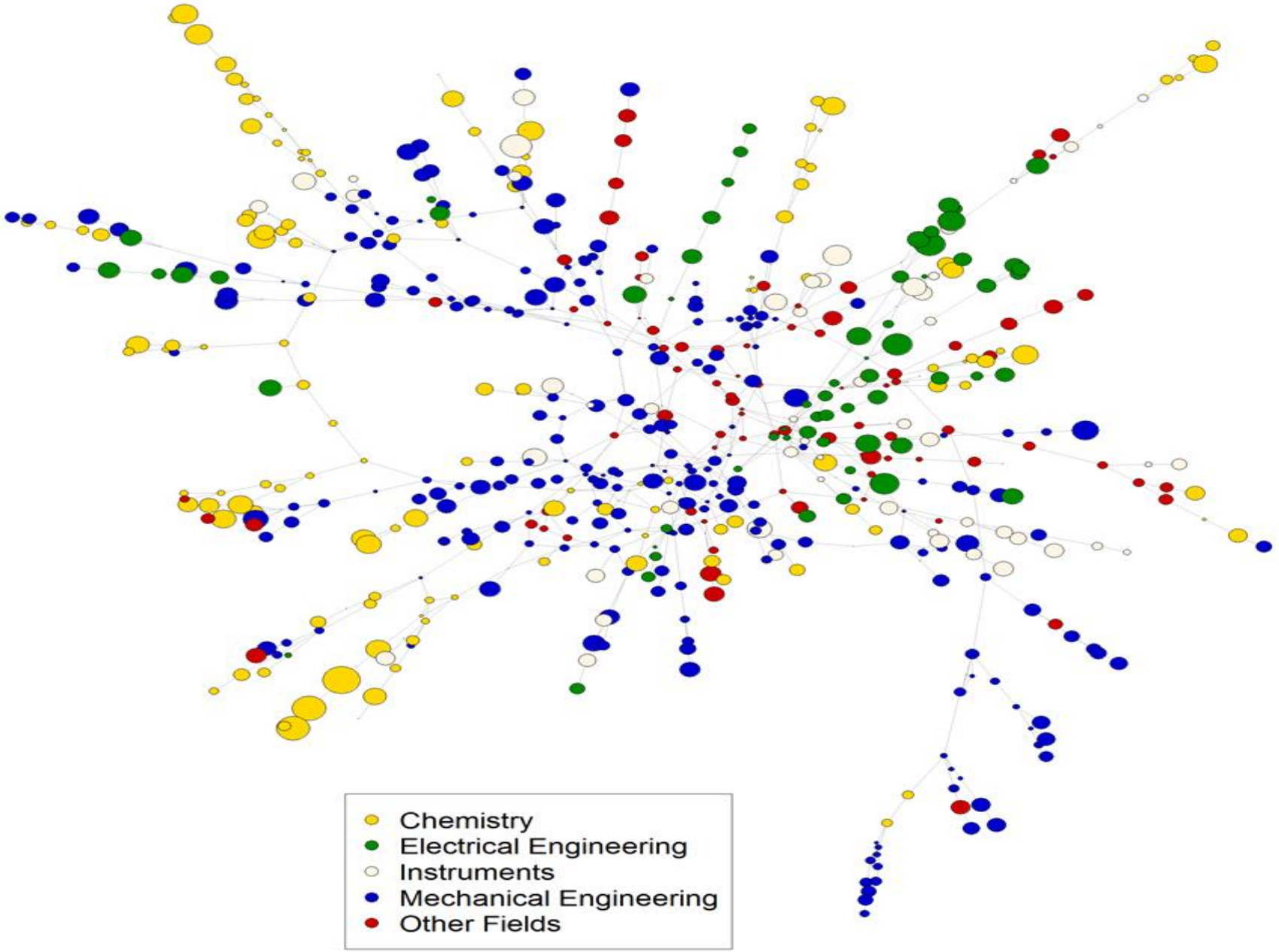
Figure 1. European Knowledge Space



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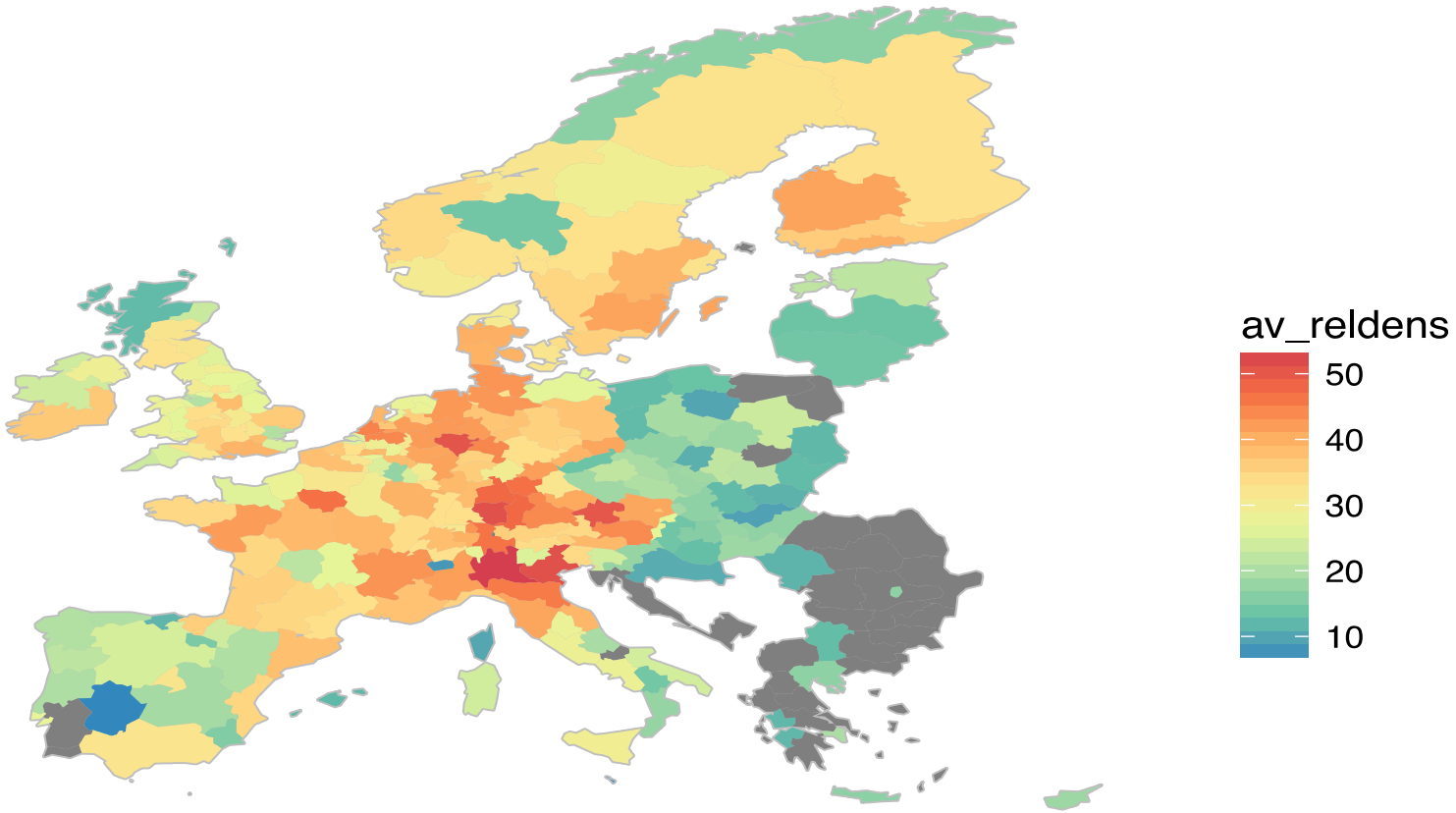
average relatedness of European regions: potential of regions to diversify into new technologies



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3. technological diversification of European regions

- **knowledge complexity index** (KCI) based on method of reflection (Hidalgo & Hausmann 2009)

- **network-based indicator**: 2 mode network linking regions to technologies in which regions have RTA

- KCI combines information on:

- number of technologies in region: **diversity of regions**

- number of regions producing a technology: **ubiquity of technologies**

- **technology complexity** (Balland and Rigby 2016): eigenvector method

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3. technological diversification of European regions

top 15 technologies by complexity

rec.2d	label.2d	label.1d	eigen.2d
4	Digital communication	Electrical engineering	100
3	Telecommunications	Electrical engineering	96.97
6	Computer technology	Electrical engineering	93.94
5	Basic communication process	Electrical engineering	90.91
2	Audio-visual technology	Electrical engineering	87.88
7	IT methods for management	Electrical engineering	84.85
9	Optics	Instruments	81.82
8	Semiconductors	Electrical engineering	78.79
16	Pharmaceuticals	Chemistry	75.76
12	Control	Instruments	72.73
15	Biotechnology	Chemistry	69.7
14	Organic fine chemistry	Chemistry	66.67
10	Measurement	Instruments	63.64
22	Micro-structure and nano-technology	Chemistry	60.61
13	Medical technology	Instruments	57.58

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3. technological diversification of European regions

Table 3. Entry Models - Full Sample

	Dependent variable: Entry (=1) | 1990 – 2009				
	Baseline (1)	Complexity (2)	Controls (3)	Full Model (4)	Full Model (F.E.) (5)
Constant	0.1632872***	0.1632945***	0.1498963***	0.1639320***	-0.0117608
	(0.0005543)	(0.0005543)	(0.0005242)	(0.0005722)	(0.0255653)
Relatedness Density	0.0042477***	0.0042494***		0.0041635***	0.0037696***
	(0.0000388)	(0.0000388)		(0.0000419)	(0.0000449)
Knowledge Complexity		0.0000459*		0.0000354	-0.0000575**
		(0.0000199)		(0.0000211)	(0.0000215)
Population (log)			0.0322163***	0.0172538***	-0.1155466***
			(0.0008129)	(0.0008150)	(0.0148724)
GDP per cap.			0.0000020***	0.0000005***	0.0000017***
			(0.0000001)	(0.0000001)	(0.0000003)
Population Density			-0.0000090***	-0.0000030***	0.0000198
			(0.0000007)	(0.0000007)	(0.0000122)
Tech. stock			-0.0000022***	-0.0000022***	-0.0000023***
			(0.0000001)	(0.0000001)	(0.0000002)
Tech. size			0.0000004**	0.00000005	0.0000013***
			(0.0000002)	(0.0000002)	(0.0000002)
Region fixed effects	No	No	No	No	Yes
Time fixed effects	No	No	No	No	Yes
Observations	498,785	498,785	466,814	466,814	466,814
R^2	0.0303005	0.0303106	0.0040004	0.0306804	0.0371538
Adjusted R^2	0.0302985	0.0303068	0.0039897	0.0306659	0.0366399

Note: The dependent variable entry equals one if a region r gains a new relative technological advantage in a given technology i during the corresponding 5-years window, and equals zero otherwise. All the independent variables are mean-centered and lagged by one period. Coefficients are statistically significant at the * p<0.05, ** p<0.01, *** p<0.001 level. Heteroskedasticity-robust standard errors (clustered at the region and technology level) in parentheses.

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3. technological diversification of European regions

Table 4. Entry Models by Level of Relatedness

	Dependent variable: Entry (=1) | 1990 – 2009					
	High Relatedness (1)	Low Relatedness (2)	High Relatedness (3)	Low Relatedness (4)	High Relatedness (5)	Low Relatedness (6)
Constant	0.3669312***	0.0309562***	0.3614363***	0.0405249***	0.2306594	0.0903739**
	(0.0023488)	(0.0006430)	(0.0026666)	(0.0009141)	(0.1847726)	(0.0327663)
Knowledge Complexity	0.0004628***	-0.0000389	0.0002671*	-0.0000062	0.0002526*	-0.0000359
	(0.0001007)	(0.0000272)	(0.0001127)	(0.0000395)	(0.0001124)	(0.0000419)
Population (log)			0.0433384***	0.0224518***	-0.0657516	0.0488210*
			(0.0044990)	(0.0014247)	(0.0934813)	(0.0200723)
GDP per cap.			0.0000004	0.0000015***	0.0000016	0.0000002
			(0.0000004)	(0.0000001)	(0.0000016)	(0.0000005)
Population Density			0.0000016	-0.0000057***	0.0000252	-0.0000202
			(0.0000034)	(0.0000015)	(0.0000569)	(0.0000281)
Tech. stock			-0.0000026***	0.0000002	-0.0000036***	0.0000003
			(0.0000004)	(0.0000002)	(0.0000007)	(0.0000004)
Tech. size			0.0000088***	0.0000021**	0.0000139***	0.0000018*
			(0.0000012)	(0.0000007)	(0.0000013)	(0.0000007)
Region fixed effects	No	No	No	No	Yes	Yes
Time fixed effects	No	No	No	No	Yes	Yes
Observations	42,164	72,557	34,309	47,029	34,309	47,029
R^2	0.0005119	0.0000281	0.0053447	0.0127176	0.0584039	0.0334063
Adjusted R^2	0.0004882	0.0000143	0.0051707	0.0125916	0.0515479	0.0282820

*Note: High relatedness models only include the top 10% region - technology observations in terms of relatedness density. Low relatedness models only include the bottom 10% region - technology observations in terms of relatedness density. The dependent variable entry equals one if a region r gains a new relative technological advantage in a given technology i during the corresponding 5-years window, and equals zero otherwise. All the independent variables are mean-centered and lagged by one period. Coefficients are statistically significant at the * p<0.05, ** p<0.01, *** p<0.001 level. Heteroskedasticity-robust standard errors (clustered at the region and technology level) in parentheses.*

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3. technological diversification of European regions

Table 5. Growth Models - Full Sample

	Dependent variable: Technological growth | 1990 – 2009				
	Baseline (1)	Complexity (2)	Controls (3)	Full Model (4)	Full Model (F.E.) (5)
Constant	13.7038900***	13.7207500***	13.5505400***	13.5218000***	73.6810700***
	(0.1707395)	(0.1707130)	(0.1773364)	(0.1767446)	(7.4333840)
Relatedness Density	0.4642356***	0.4650504***		0.3519811***	0.2038730***
	(0.0101046)	(0.0101016)		(0.0113171)	(0.0119662)
Knowledge Complexity		0.2083142***		0.1811793***	0.1236107***
		(0.0079042)		(0.0082521)	(0.0079222)
Population (log)			15.6830000***	13.9970400***	57.4033100***
			(0.2933130)	(0.2957986)	(4.4582030)
GDP per cap.			0.0004739***	0.0003251***	0.0000061
			(0.0000201)	(0.0000205)	(0.0000892)
Population Density			-0.0039671***	-0.0033924***	-0.0031405
			(0.0002246)	(0.0002242)	(0.0032979)
Tech. stock			-0.0004838***	-0.0005061***	-0.0051211***
			(0.0000325)	(0.0000326)	(0.0001068)
Tech. size			0.0010760***	0.0007250***	0.0016523***
			(0.0000560)	(0.0000565)	(0.0000584)
Region fixed effects	No	No	No	No	Yes
Time fixed effects	No	No	No	No	Yes
Observations	556,721	556,721	521,175	521,175	521,175
R^2	0.0039793	0.0055811	0.0072392	0.0103975	0.0671133
Adjusted R^2	0.0039775	0.0055776	0.0072297	0.0103842	0.0666674

Note: The dependent variable growth corresponds to the rate of technological growth (growth in the number of claims) of a technology i in a region r from period t to period t+1. All the independent variables are mean-centered and lagged by one period. Coefficients are statistically significant at the * p<0.05, ** p<0.01, *** p<0.001 level. Heteroskedasticity-robust standard errors (clustered at the region and technology level) in parentheses.

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3. technological diversification of European regions

Table 6. Growth Models by Level of Relatedness

	Dependent variable: Technological growth | 1990 – 2009					
	High Relatedness	Low Relatedness	High Relatedness	Low Relatedness	High Relatedness	Low Relatedness
	(1)	(2)	(3)	(4)	(5)	(6)
Constant	53.7695700***	-6.0870230***	49.6868700***	-8.4233190***	-31.0214900	-10.3398200
	(0.7609844)	(0.1377738)	(0.8003883)	(0.2020142)	(60.1171500)	(5.9970820)
Knowledge Complexity	0.3256727***	-0.0096395	0.2581051***	-0.0107926	0.2276855***	-0.0305587**
	(0.0340018)	(0.0069824)	(0.0361123)	(0.0104075)	(0.0344880)	(0.0101187)
Population (log)			28.4596000***	-3.3740520***	-26.7761900	-2.6496500
			(1.4859160)	(0.3181761)	(31.0434900)	(4.0115730)
GDP per cap.			0.0001111	-0.0003621***	0.0037211***	0.0001280
			(0.0001073)	(0.0000220)	(0.0005146)	(0.0000970)
Population Density			-0.0048569***	0.0006342*	-0.0729367***	-0.0052360
			(0.0009146)	(0.0002874)	(0.0144477)	(0.0046896)
Tech. stock			-0.0020091***	-0.0001944*	-0.0080889***	-0.0015154***
			(0.0001021)	(0.0000909)	(0.0003040)	(0.0002594)
Tech. size			-0.0012314***	-0.0013100***	0.0001989	-0.0011047***
			(0.0001257)	(0.0002712)	(0.0001165)	(0.0002697)
Region fixed effects	No	No	No	No	Yes	Yes
Time fixed effects	No	No	No	No	Yes	Yes
Observations	63,797	74,199	54,992	48,659	54,992	48,659
R^2	0.0017529	0.0000365	0.0115695	0.0155464	0.1329042	0.0509171
Adjusted R^2	0.0017372	0.0000230	0.0114617	0.0154250	0.1289760	0.0460551

*Note: High relatedness models only include the top 10% region - technology observations in terms of relatedness density. Low relatedness models only include the bottom 10% region - technology observations in terms of relatedness density. The dependent variable growth corresponds to the rate of technological growth (growth in the number of claims) of a technology i in a region r from period t to period t+1. All the independent variables are mean-centered and lagged by one period. Coefficients are statistically significant at the * p<0.05, ** p<0.01, *** p<0.001 level. Heteroskedasticity-robust standard errors (clustered at the region and technology level) in parentheses.*

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4. implications for smart specialization policy

- **objective**: develop a smart specialization policy framework that is **evidence-based,** and that can assist policy makers to **identify possible diversification strategies** for regions, depending on their existing capabilities

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

- **complexity**: to assess **potential benefits** of policy

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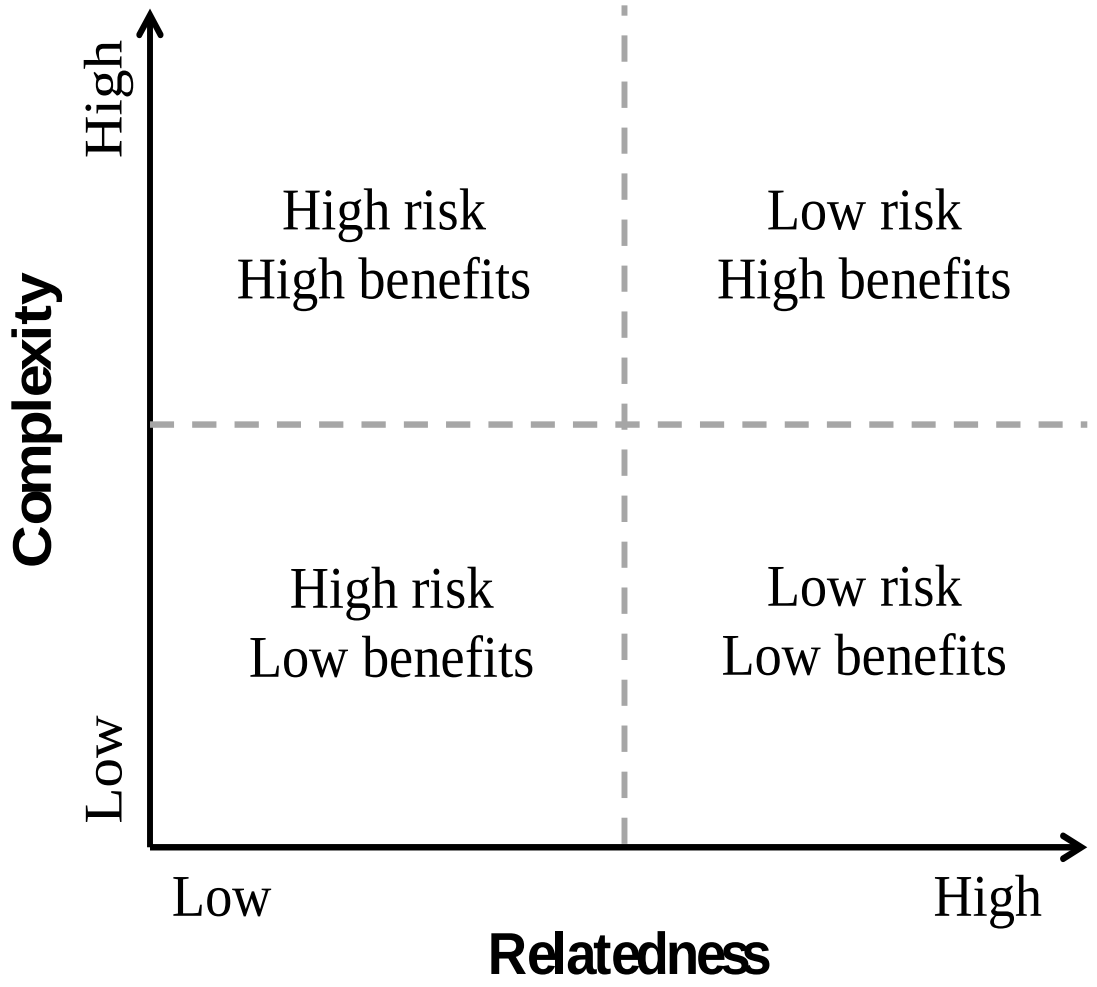
4. implications for smart specialization policy



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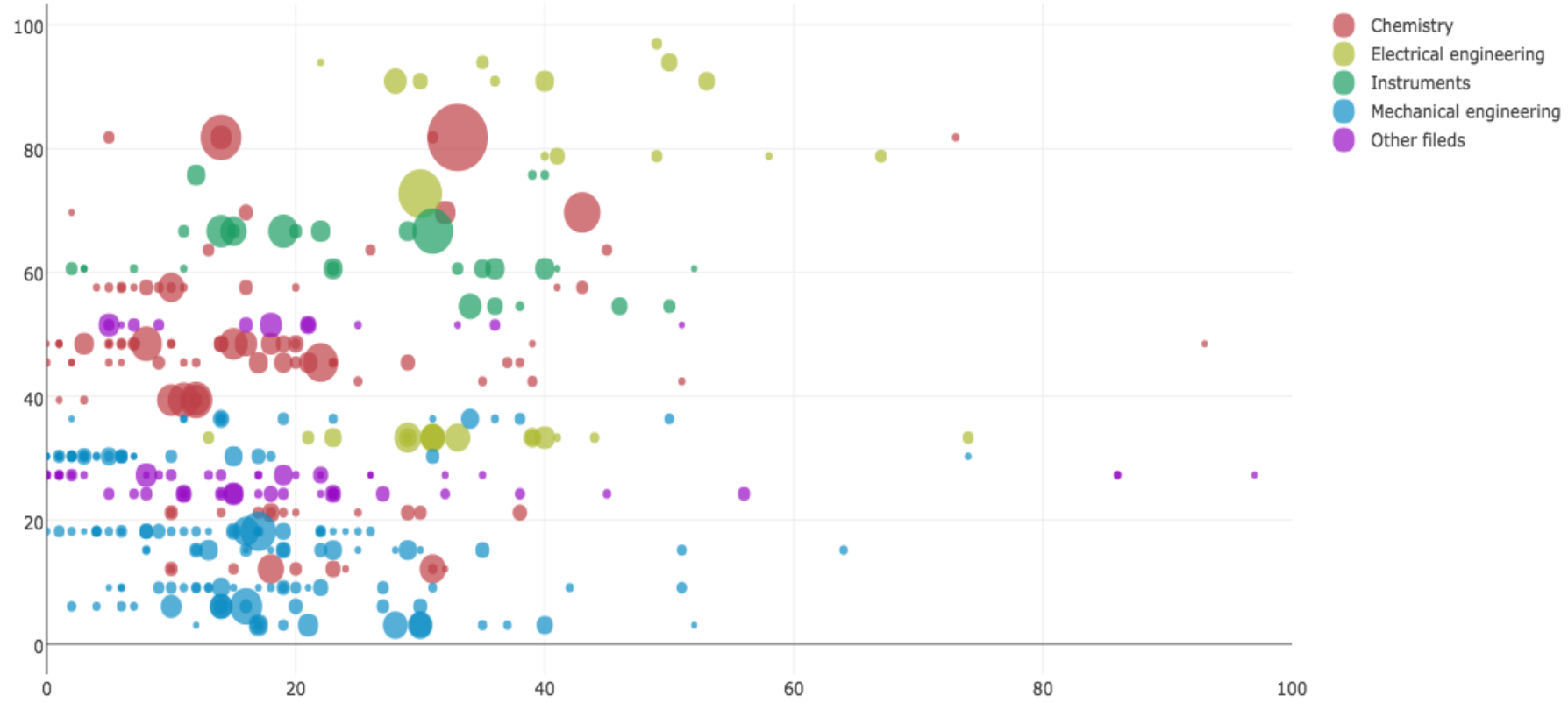
Ile de France region



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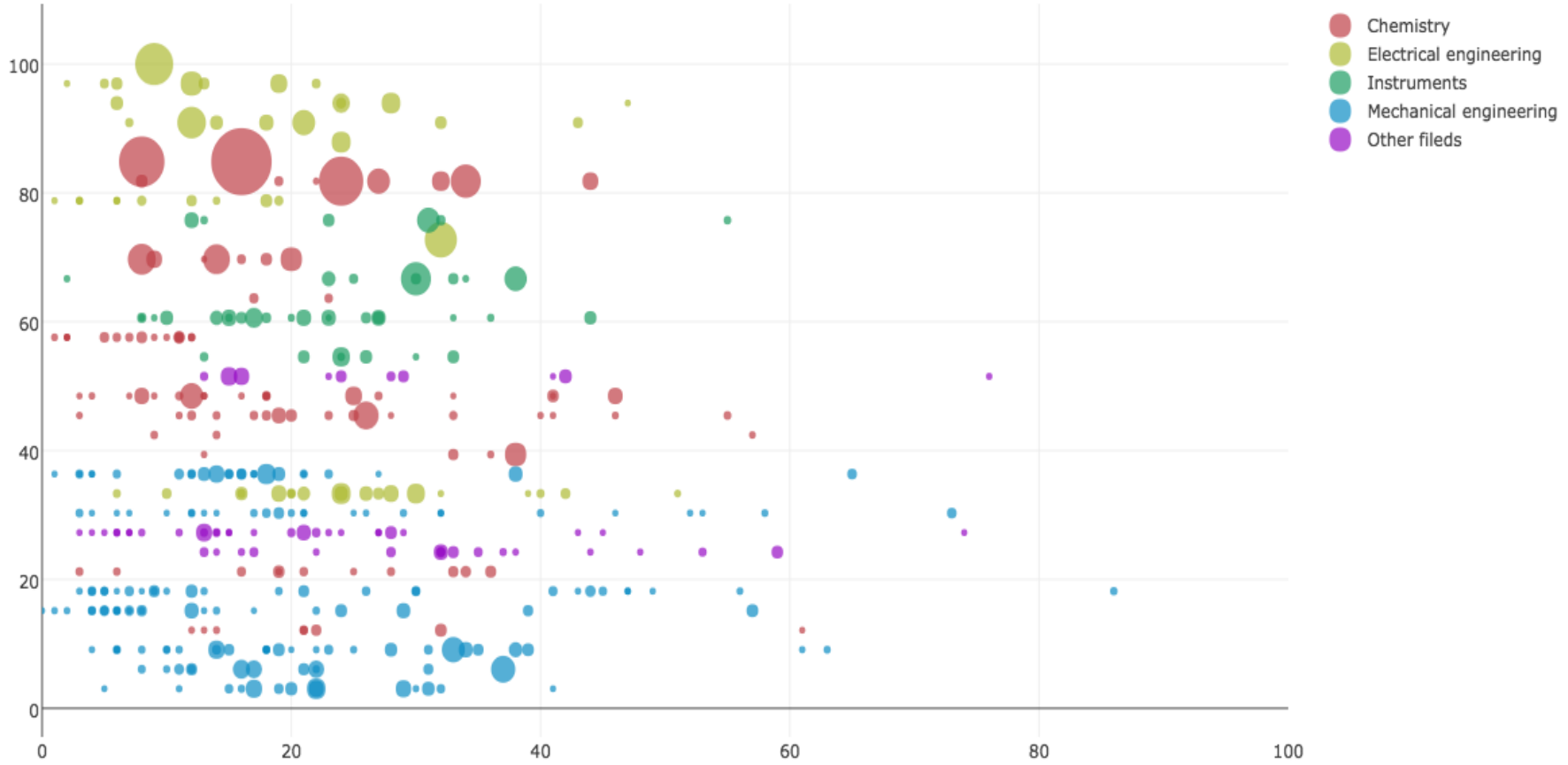
Lancashire region



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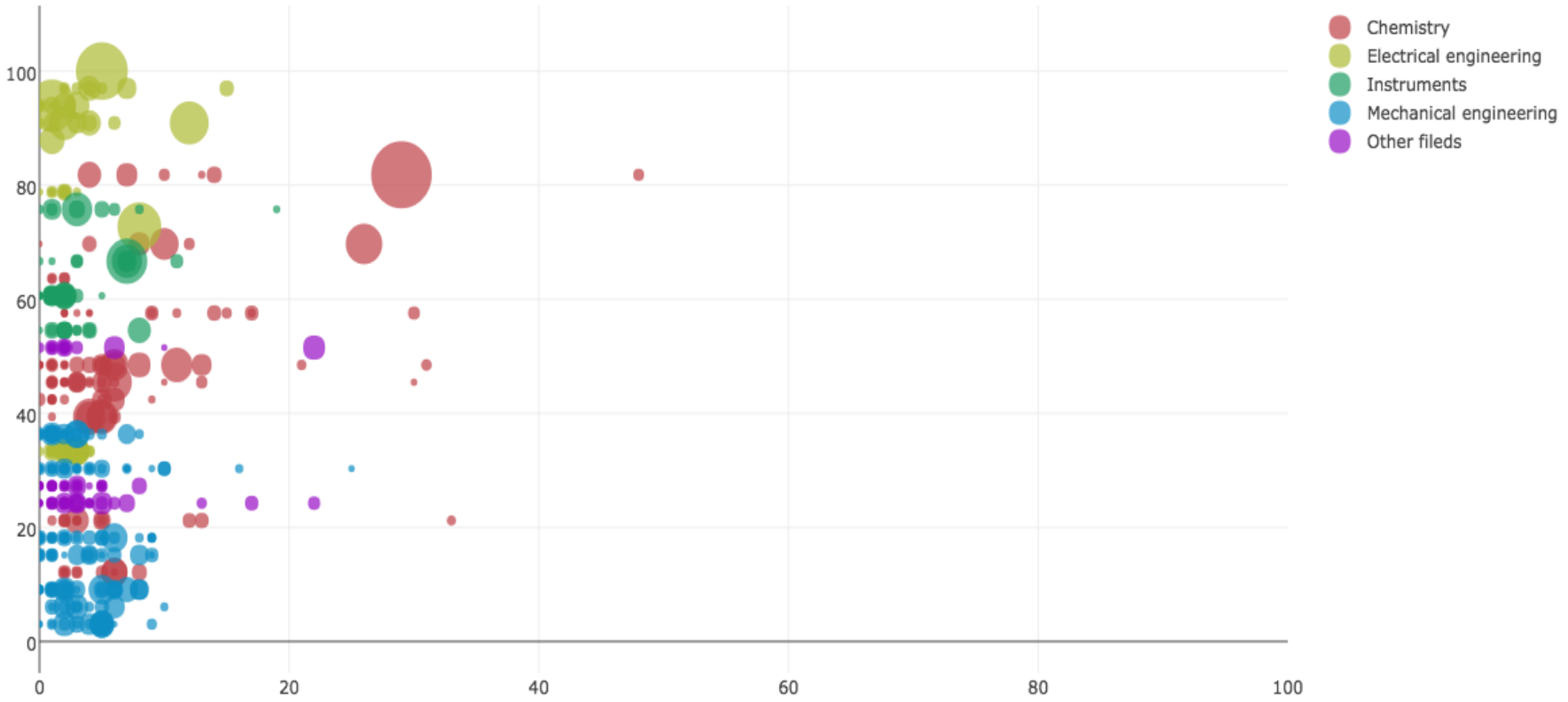
Extremadura region



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5. concluding remarks

- **objective**: to tackle the perceived **lack of a strong theoretical and empirical foundation** for smart specialization policy in Europe

- **policy framework** is in line with features of smart specialization policy: (1) no ‘one-size-fits all’ policy: bottom-up strategy; (2) policy targeting potential new activities based on regional capabilities, rather than just being ‘hot’; (3) no duplication of policy efforts

- policy framework is **evidence-based**: assesses the **potential risks** (based on **relatedness**) and **potential benefits** (based on **complexity**) of alternative diversification strategies of regions

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5. concluding remarks

- **evidence-based**: follows **findings** on study on regional diversification in Europe:

- **positive** effect of **relatedness** on the **entry** probability and **growth** of new technology in region

- **no** or **negative effect** of complexity of technology on **entry** probability of that technology in region

- **positive effect** on **entry** when complex technology **related** to existing technologies in region

- **positive effect** on **growth** when complex technology **related** to existing technologies in region

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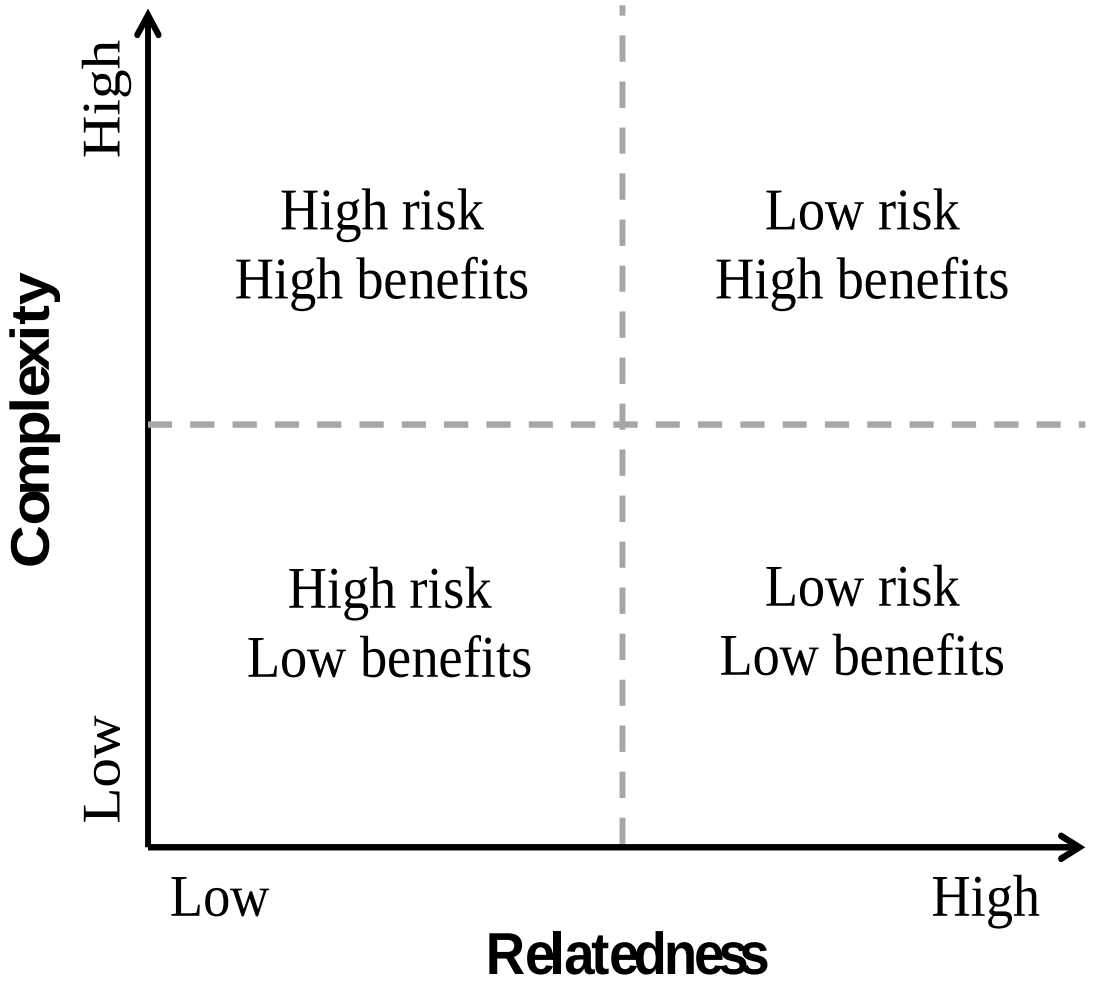
5. concluding remarks



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5. concluding remarks

- yet, we are still **far from** comprehensive policy framework:

- **design** and implementation of smart spec policy?

- relevant for **peripheral regions**: bring it in line with objectives of Cohesion Policy?

- inherent **tension** between prioritising based on relatedness in our policy framework and reliance on decentralized entrepreneurial discovery process

- besides regional capabilities, what is role of **extra-regional linkages**?

- should smart specialisation enable **jumps** or not?

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thank you for your attention!

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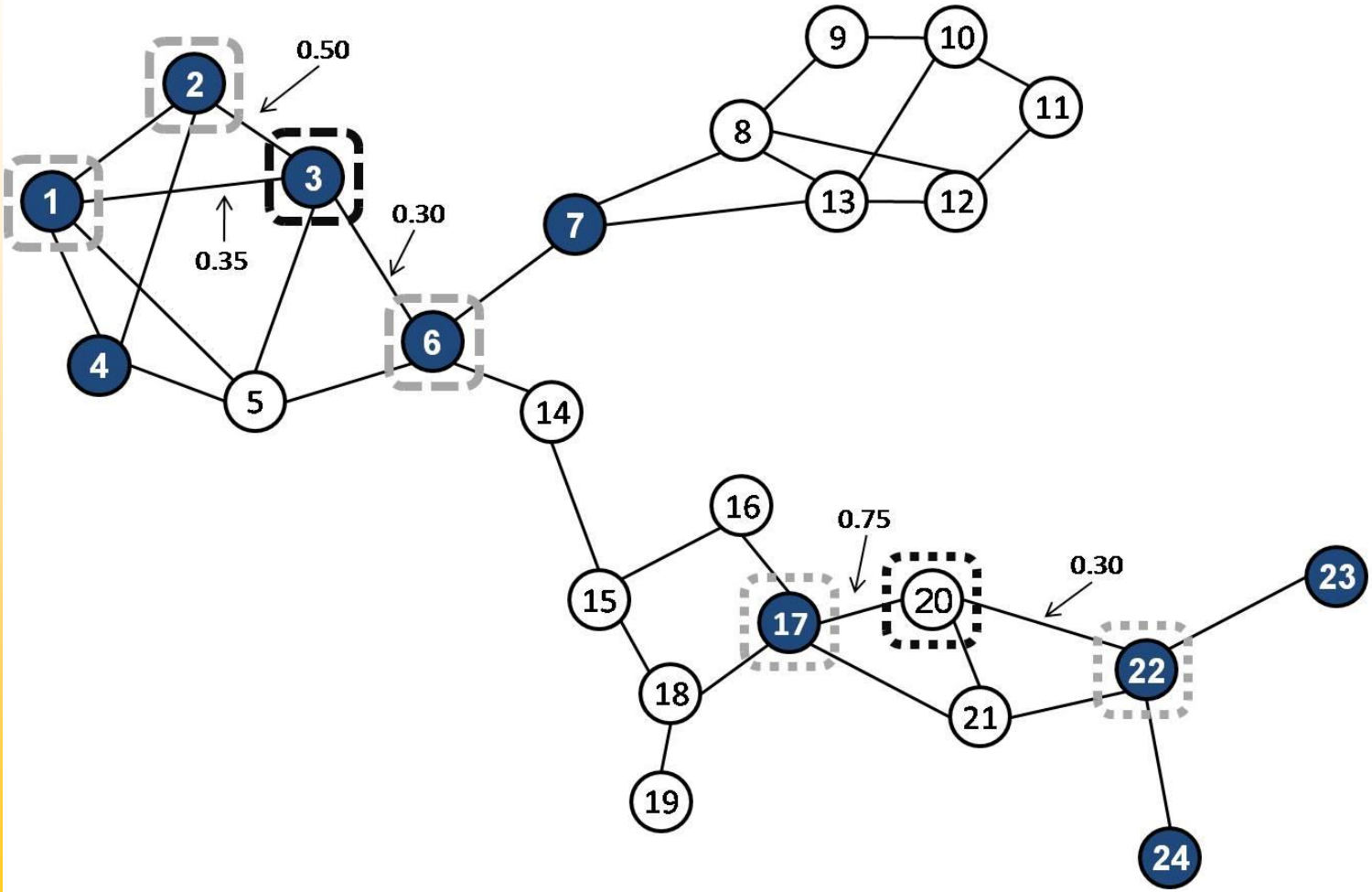
where to intervene in the industrial structure of a region?



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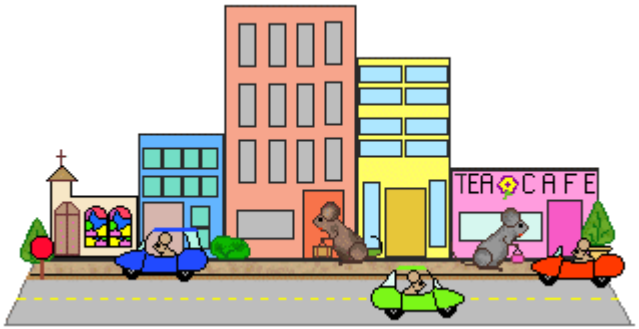
related and unrelated regional diversification

region A

region B



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