R&D Policy and Technological Trajectories of Regions: Evidence from the EU Framework Programmes

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STI 2017: Location Based Approaches

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Motivation

- Regions can not be too dependent on existing specializations (e.g. vulnerability to shocks)

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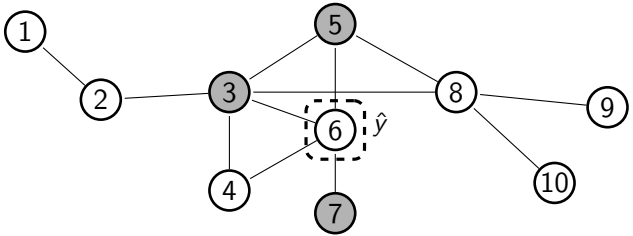
- Policy efforts to foster the development of new economic activities in regions (e.g. European Cohesion policy)
- Importance of availability of different knowledge and capabilities for alternative specialisations

Related Diversification and Technological Change



- New specializations build on previously acquired knowledge that is transferred to new fields
- Regions are constrained in their ability to develop new activities

$\Rightarrow$ *Technological Relatedness as a driver of diversification*

Policy Perspective

- Diversification patterns also depend on
  - Development stage (Petralia et al., 2017)
  - Institutions (Boschma & Capone, 2015; Cortinovis et al., 2016)
  - Industrial and innovation policy (Rodrik, 2004; Foray, 2009; Mazzucato, 2013)

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  - Industrial and innovation policy (Rodrik, 2004; Foray, 2009; Mazzucato, 2013)
- Increasing policy interest also by means of instruments intending to support diversification capabilities, in particular at a regional level, e.g.: Smart Specialisation Strategy of the EC
- Also past efforts to stimulate knowledge spillovers to foster innovation capabilities of regions: EU Framework Programmes (FP)

Intended Effects of Collaborative R&D Projects

- Subsidizing collaborative R&D projects in a certain technology leads to higher patenting activity in the respective technology

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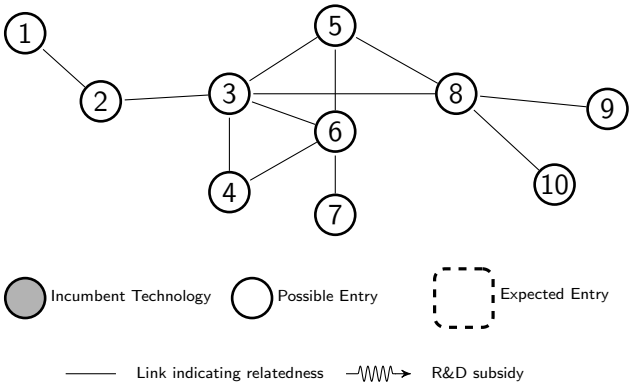
- Additional financial resources
- Potential knowledge spillover from collaboration partners
- STI policy can direct undertaken research

Hypotheses


1
2
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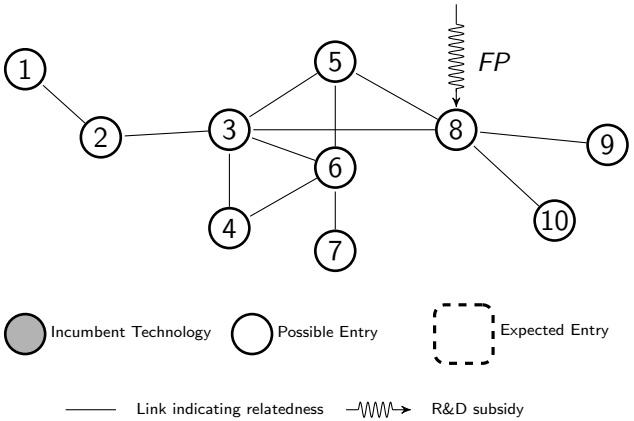
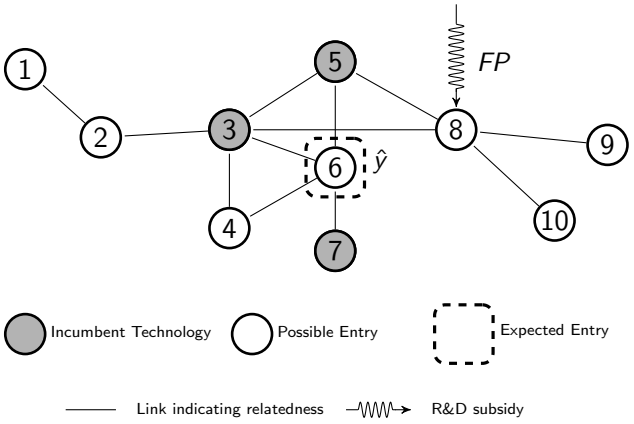
Incumbent Technology
Possible Entry
Expected Entry
Link indicating relatedness
R&D subsidy

Hypotheses



H_1 Regions are more likely to specialise in technologies for which they receive R&D subsidies

Hypotheses



H_1 Regions are more likely to specialise in technologies for which they receive R&D subsidies

H_2 Funding tends to compensate for a lack of related capabilities

Data Sources

FP Data (EUPRO*)

- FP5; FP6; FP7
- Patent relevant sub-programmes focusing on collaboration
- 15,983 projects
- Participants classified on NUTS2 regions

Patent Data (REGPAT)

- Patent applications, fractionalized by inventor
- 282 NUTS2 Regions, 613 IPC Classes

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- Patent relevant sub-programmes focusing on collaboration
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Technology Fields (Schmoch, 2008)

- Aggregation of IPC classes
- Balanced field sizes
- Distinct field contents

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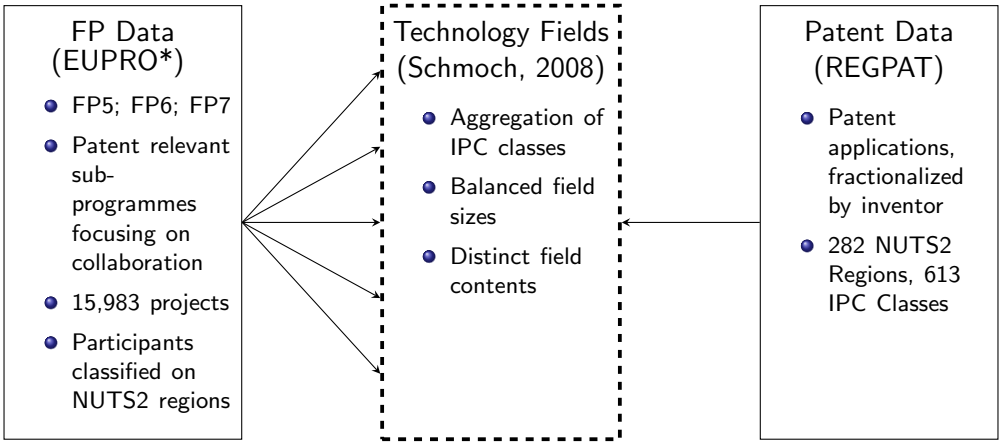

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Empirical Setting

- 3 Periods: (1999–2002); 2003–2006; 2007–2010
- $ENTRY_{i,r,t}$: Emergence of a new specialization in a region

$$ENTRY_{i,r,t} = \begin{cases} 0, RCA_{i,r,t} < 1 \wedge RCA_{i,r,t-1} < 1 \\ 1, RCA_{i,r,t} \geq 1 \wedge RCA_{i,r,t-1} < 1 \end{cases}$$

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- $RD_{i,r,t}$: Relatedness Density
  1. Technological relatedness based on co-occurrences on patent files
  2. Determine **Relatedness Density**: For each technology in a region, share of existing related technologies on all related technologies

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- $FP_{z,r,t}$: Number of Participations weighted by technologies and periods

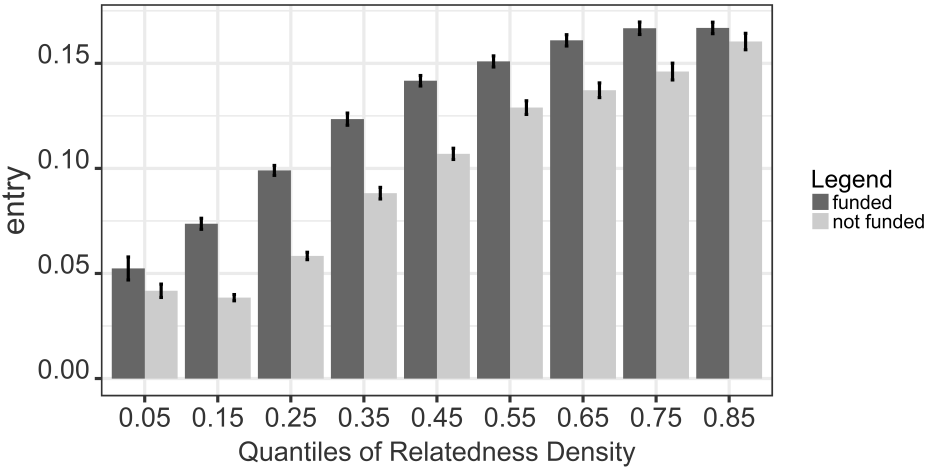
Empirical Model

$$ENTRY_{i,r,t} = \underbrace{\beta_1 FP_{z,r,t-1}}_{\text{FP Participation}} + \underbrace{\beta_2 RD_{i,r,t-1}}_{\text{Relatedness Density}} + \underbrace{\beta_3 REG + \beta_4 TECH}_{\text{Controls}} +$$

$$+ \underbrace{\beta_5 FP_{z,r,t-1} \times RD_{i,r,t-1}}_{\text{Interaction Effect}} + \underbrace{\phi_r + \psi_i + \alpha_t}_{\text{Fixed Effects}} + \varepsilon_{i,r,t}$$

i: technology
z: technology field
r: regions
t: time

Differences in the Mean of Entry Probabilities



Results I

	Dependent variable: entry				
	Pooled FP	Pooled RD	Baseline	Full Model	Full Model F.E.
	(1)	(2)	(3)	(5)	(6)
log(FP)	0.0242***		0.0174***	0.0083***	0.0171***
	(0.0007)		(0.0008)	(0.0010)	(0.0020)
RD		0.0033***	0.0031***	0.0022***	0.0003***
		(0.00004)	(0.00005)	(0.0001)	(0.0001)
Controls	No	No	No	Yes	Yes
log(FP)×RD			−0.0010***	−0.0007***	−0.0005***
			(0.0001)	(0.0001)	(0.0001)
Fixed Effects	No	No	No	No	Yes
Constant	0.1067***	0.1067***	0.1097***	0.1101***	
	(0.0006)	(0.0006)	(0.0006)	(0.0007)	
Observations	284,508	284,508	284,508	212,751	212,751
Adjusted R^2	0.0047	0.0197	0.0220	0.0260	0.0632

Results Different Levels of RD

	Dependent variable: entry								
	Low RD	Low RD	Low RD	Mid RD	Mid RD	Mid RD	High RD	High RD	High RD
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
log(FP)	0.0115	−0.0035	−0.0006	0.0133***	0.0089***	0.0164***	−0.0004	−0.0048*	0.0291***
	(0.0087)	(0.0118)	(0.0142)	(0.0021)	(0.0028)	(0.0047)	(0.0022)	(0.0028)	(0.0055)
Controls	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
Fixed Effects	No	No	Yes	No	No	Yes	No	No	Yes
Constant	0.0449***	0.0466***		0.1276***	0.1283***		0.1648***	0.1628***	
	(0.0028)	(0.0032)		(0.0018)	(0.0022)		(0.0022)	(0.0026)	
Observations	5,636	4,400	4,400	33,155	23,400	23,400	27,566	20,023	20,023
R^2	0.0003	0.0057	0.0995	0.0013	0.0048	0.0952	0.000001	0.0018	0.0911
Adjusted R^2	0.0001	0.0044	0.0288	0.0012	0.0046	0.0618	−0.00004	0.0015	0.0530

Conclusions and Discussion

- Participations in collaborative R&D projects weakly associated with an increase the entry probability
  - 10% increase of project participations will only be associated with a 2% increase of the mean probability of a technology to enter the region's portfolio

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- Impact of R&D subsidies is highest if the level of relatedness density is neither too high nor too low

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- Participations in collaborative R&D projects weakly associated with an increase the entry probability
  - 10% increase of project participations will only be associated with a 2% increase of the mean probability of a technology to enter the region's portfolio
- Participations can to a certain extent compensate for a lack of relatedness
- Impact of R&D subsidies is highest if the level of relatedness density is neither too high nor too low

- Need for more research to investigate exact mechanisms and causality
- Do study on micro level, e.g. using publication data

Thank your for your attention!

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EMAIL

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Annex I

	Dependent variable:					
	entry					
	(1)	(2)	(3)	(4)	(5)	(6)
log(FP)	0.0242***			0.0159***	0.0065***	0.0156***
	(0.0007)			(0.0008)	(0.0009)	(0.0018)
RD		0.0033***		0.0030***	0.0023***	0.0003***
		(0.00004)		(0.00005)	(0.0001)	(0.0001)
FP Dens			0.0018***		0.0011***	0.0006***
			(0.00004)		(0.00005)	(0.0001)
GDP/CAP			1.6743***		0.5452***	−3.3205***
			(0.0656)		(0.0714)	(0.9437)
Pop Dens			−0.00001***		−0.000003***	−0.0001
			(0.000001)		(0.000001)	(0.0001)
GERD (mio)			−0.00001***		−0.00001***	−0.000001
			(0.000001)		(0.000001)	(0.00001)
Tech Grth			0.0001***		0.0001***	0.0001***
			(0.00001)		(0.00001)	(0.00002)
log(FP)×RD				−0.0010***	−0.0007***	−0.0004***
				(0.0001)	(0.0001)	(0.0001)
Constant	0.1080***	0.1115***	0.1079***	0.1150***	0.1133***	
	(0.0006)	(0.0006)	(0.0007)	(0.0006)	(0.0007)	
Observations	284,508	284,508	230,650	284,508	230,650	230,650
Adjusted R^2	0.0047	0.0197	0.0212	0.0220	0.0274	0.0654
Note:						*p<0.1; **p<0.05; ***p<0.01

descriptives

Descriptive statistics

Statistic	N	Mean	St. Dev.	Min	Max
entry	284,508	0.1	0.3	0	1
FP	345,732	2.9	11.5	0.0	485.0
RD	345,732	17.8	12.9	0	100

Control variables

- $TECH_{i,t-1}$:
  - Funding Density: Share of related industries that receive funding
  - Technology growth: Growth rate of a technology in the previous period

- $REG_{r,t-1}$:
  - GDP per capita
  - Population Density
  - Gross expenditure for research and development (GERD)

Text Classification Strategy

Classify $>$ 1000 projects manually and use as trainig data

Make a document term matrix

- Used text: Titles + Project Abstract + Objective + Achievements + Title of Subprogramme + Titles of Resulting Documents
- Preprocessing: Remove short terms ($<$2), stop words (and, or, etc.), non-alphanumerical terms, weight terms by Tfidf

Fit a maximum entropy classifier

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Fit a maximum entropy classifier

Apply classifier to test data

- Use L2 regularizer to prevent over fitting
- Classifiy each project to 5 TFs based on probablility scores

External verification using an inventory of 295 patents from FP7 ICT projects

Logit and Probit Specification

Logit and Probit: Entries of New Technologies (33 Tech. Fields) (2002-2010)

Dependent var. is ENTRY	Model 1 Logit	Model 2 Probit
Intercept		
log(FP)	0.443940 ***	0.2361080 ***
FP Density	−0.009639 ***	−0.0050260 ***
Density	0.027360 ***	0.0156848 ***
log(FP) * Density	−0.007595 ***	−0.0042357 ***
Region F.E.	Yes	Yes
Technology F.E.	Yes	Yes
Time F.E.	Yes	Yes
AIC	16130	16123
N	18,840	18,840

$***p < 0.001$, $**p < 0.01$, $*p < 0.05$

Results Cross Sectional OLS

	Dependent variable:			
	entry			
	(1)	(2)	(3)	(4)
log(FP)	0.0256***		0.0373***	0.0209***
	(0.0011)		(0.0021)	(0.0028)
Relatedness (RD)		0.0035***	0.0038***	0.0011***
		(0.0001)	(0.0001)	(0.0001)
log(FP)×RD			−0.0011***	−0.0006***
			(0.0001)	(0.0001)
Constant	0.0981***	0.0513***	0.0400***	
	(0.0009)	(0.0011)	(0.0011)	
Observations	140,023	140,023	140,023	140,023
Adjusted R^2	0.0048	0.0213	0.0235	0.0602
Note:				*p<0.1; **p<0.05; ***p<0.01