Are knowledge flows all Alike? Evidence from EU regions (preliminary results)

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Summary

- **Main aims** **(based on some stylised facts)**
- **Theoretical and empirical background**
- **Data, methodology and variables**
- **Econometric results**
- **Conclusions and policy implications** **(tentative and preliminary)**

Main Aims

- Firstly, we compare the dynamics concerning three types of knowledge flows across regions in Europe in the last decade,
  - citations,
  - applicant-inventor links
  - co-inventorships

Some stylised facts

- Secondly, we look for evidence on the moderating role of technological and relational proximities on the impact of geographical distance.
- Finally, we follow the intuition by Lafourcade and Paluzie (2010), who show that border regions, which often appear to be disadvantaged areas because of their peripheral position within the country, may experience a counter effect due to the fact that they are the closest regions to other countries.

Previous literature

- An increasing body of theoretical literature has focused on the analysis of patterns of knowledge flows across nations and regions based on Romer (1986), Arthur (1991), Krugman (1991) and Grossman and Helpman (1991).
- Most literature has focused on geographical proximity, but more recently the French school of proximity and Boschma (2005) introduce other proximity dimensions, such as institutional, technological/cognitive and social/relational proximity.
- Picci (2010) discusses the extent and the determinants of the internationalization of European inventive activity by distinguishing collaborations among inventors and relationships among inventors and applicants, that is firms.
- Maggioni et al. (2011) provide a similar analysis but at a more disaggregated territorial level, i.e. Italian provinces.
- More recently, Cappelli e Montobbio (2013), study how knowledge diffuses across European regions by using inventor collaborations compared to citation flows.
- Microeconometric evidence (Giuri and Mariani, 2013; Belenzon and Schankerman, 2013)

Theoretical backroung

- Collective knowledge, systemic innovation and the role of knowledge spillovers
- Distinction between tacit and codified knowledge (the flow of tacit knowledge requiring physical proximity more than other types of knowledge)
- NEG and the distinction between core and peripheral regions

Originality

- The paper’s contribution to the field is three-fold:

1. we compare the dynamics concerning three indicators of knowledge flows across regions in Europe in the last decade, i.e. citations, applicant-inventor links and co-inventorship, in order to ascertain if knowledge flows are all alike in terms of their dependence on distance.
2. we investigate the differential patterns of core and peripheral regions.
3. we provide evidence of the moderating role of technological and relational proximities on the effect of geographical distance.

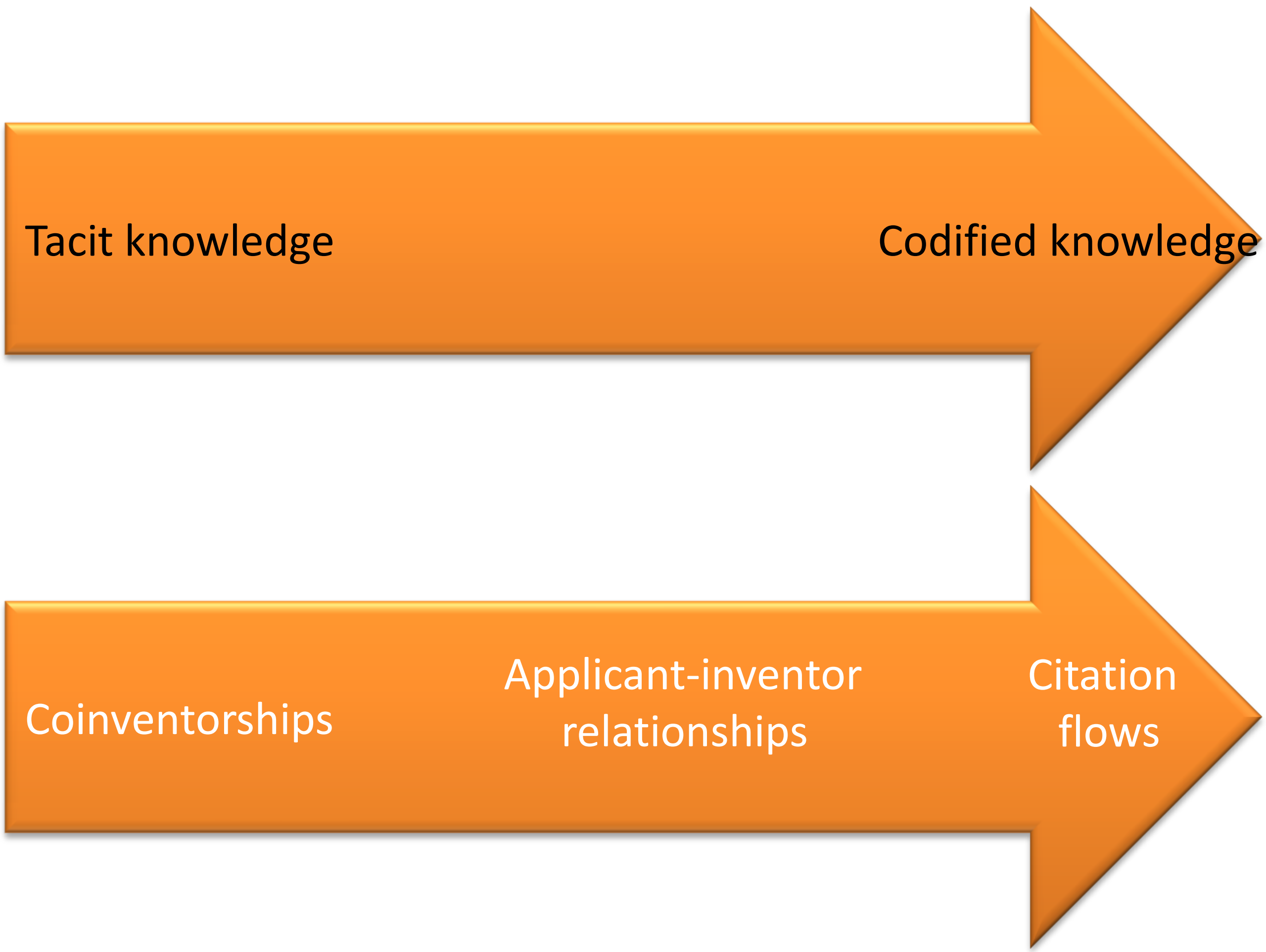
Dataset

- We measure knowledge flows by using information contained in the OECD RegPat Database, and in particular data on co-inventorships, applicant-inventor links, and citation flows for 276 European regions in 29 countries (EU27+2).
- The empirical strategy builds upon the traditional gravity model applied to knowledge flows as in Maurseth and Verspagen (2002), Usai and Paci (2009), Picci (2010), Maggioni et al. (2011).

Typologies of knowledge flows

- Co-inventorship collaboration
  - a collaboration between the region *i* and the region *j* is identified when, in a patent developed by more than one inventor, at least one co-inventor is resident in region *i* and at least one co-inventor is resident in region *j.*
- Applicant-inventors relationships
  - An applicant-inventor link is identified whenever a patent has (at least) one inventor in region *i* and one applicant (which is usually a firm) resident in another region *j*
- Citation flows
  - citation from region *j* to region *i* occurs when the citing patent as at least one inventor residing in the region *j* and the cited patent has at least one inventor residing in the region *i*

From tacit to codified knowlegde



Methodology

- We adopt a **gravity model** to study the determinants of the intensity of knowledge flows between pairs of region, i.e. flows between two regions are assumed to increase in their economic size, and decrease as a function of distance.
- The empirical analysis also accounts for different dimensions of proximity other than the **geographical** one (Boschma, 2005). We therefore introduce **institutional, technological/cognitive and social/relational** proximity as other potential dimensions which may affect the quantity of knowledge flowing from one region to another.
- We introduce an important distinction across knowledge flows in terms of both their typology and the regions involved in the exchange….

Regional patterns of knowledge flows

KNOWLEDGE FLOWS BETWEEN REGION i AND j

REGIONS i AND j ARE NOT CONTIGUOUS

REGIONS i AND j ARE CONTIGUOUS

WIITHIN COUNTRY CONTIGUITY

(REGIONS i AND j BELONG

TO THE SAME COUNTRY)

CROSS-BORDER CONTIGUITY

(REGIONS i AND j BELONG TO

TWO DIFFERENT COUNTRIES)

Econometric estimation

$$kf_{ij}^{s} = f(distances_{ij}, contiguities_{ij},$$
$$regional\ \ features_{i,} regional\ \ features_{j})$$

- *kf*: citations flows, applicant-inventors links, coinventorships
- *distances*: geographical, technological, relational, institutional
- *contiguities*: cross-border, within border
- *regional features*: rd expenditure, patent stock, tertiary education, population density

Technological proximity

- The technology proximity amongst sampled regions is based upon Jaffe’s cosine index (Jaffe, 1986 and 1989).
- First of all we computed a measure of proximity amongst all observed technologies in our sample of patents, i.e. the cosine index. We count the joint occurrences to all possible pairs of classification codes in each patent and we obtain a square symmetrical matrix of co-occurrences. This is the basic info to compute the cosine index, calculated for each pair of technologies.
- The idea behind the calculation of this index is that two technologies *x* and *y* are similar to the extent that they co-occur with a third technology *z*. It is equal to one for pairs of technological fields with identical distribution of co-occurrences with all the other technological fields, while it goes to zero if vectors of co-occurences are orthogonal (Breschi et al., 2003).
- Once the technology proximity index has been calculated, we can use it to measure the technological proximity amongst any pair of regions. The technological proximity amongst regions is defined as the weighted average of the proximity amongst the technologies observed in the two regions.

Social proximity

- Direct and indirect relationships in the past provide a facilitating environment for sharing knowledge in the future.
- Thus the degree of social proximity decreases with the geodesic distance which measures the shortest path between two nodes (i.e. firms or regions) (Autant-Bernard et al., 2007; Usai et al., 2013). Two nodes are directly linked when they have met in the past, as a result their geodesic distance is one. When two nodes have never met in the past, nor any of their direct and indirect partners, their shortest path is infinite.
- As a result, we use the inverse of the geodesic distance, which goes from zero (infinite geodesic distance) to one (shortest path equal to unity)

Institutional proximity

- We use a dummy variable (samecountry) which takes value 1 when regions i and j are within the same country and zero otherwise

Econometric results/1

	1			2		
VARIABLES	lncoinv	lnappinv	lncit	lncoinv	lnappinv	lncit
geo dist	-0.325***	-0.280***	-0.212***	-0.187***	-0.185***	-0.178***
	-0.001	*-0.002*	*-0.003*	*-0.001*	*-0.001*	*-0.003*
cont				0.423***	0.291***	0.104***
				0.043	*0.042*	*0.044*
cont-crsbrd						
cont-wtnbrd						
techprox						
relprox_s						
instprox	yes	yes	yes	yes	yes	yes
regional features	yes	yes	yes	yes	yes	yes
Observations	29,403	58,806	57,360	29,403	58,806	57,360
R-squared	0.212	0.2	0.631	0.378	0.279	0.641
R^2 adj	0.211	0.199	0.631	0.377	0.278	0.641
Log-likelihood	-1550	-19272	-62068	1922	-16240	-61277

a) The table shows standardized coefficients.

b) Region-clustered standard errors in italics

Econometric results/2

	3			4		
VARIABLES	lncoinv	lnappinv	lncit	lncoinv	lnappinv	lncit
geo dist	-0.149***	-0.144***	-0.138***	-0.150***	-0.145***	-0.138***
	-0.001	*-0.001*	*-0.002*	*-0.001*	*-0.001*	*-0.002*
cont	0.401***	0.263***	0.092***			
	0.043	*0.041*	*0.043*			
cont-crsbrd				0.076***	0.031***	0.023***
				0.066	*0.046*	*0.073*
cont-wtnbrd				0.416***	0.284***	0.092***
				0.05	*0.048*	*0.049*
techprox	0.029***	0.022***	0.036***	0.029***	0.023***	0.036***
	0.018	*0.021*	*0.049*	*0.018*	*0.02*	*0.049*
relprox_s	0.196***	0.235***	0.282***	0.190***	0.230***	0.281***
	0.003	*0.004*	*0.008*	*0.003*	*0.004*	*0.008*
instprox	yes	yes	yes	yes	yes	yes
regional features	yes	yes	yes	yes	yes	yes
Observations	29,161	58,324	57,360	29,161	58,324	57,360
R-squared	0.415	0.331	0.698	0.432	0.342	0.699
R^2 adj	0.414	0.33	0.698	0.431	0.342	0.699
Log-likelihood	2684	-14143	-56285	3121	-13630	-56230

a) The table shows standardized coefficients.

b) Region-clustered standard errors in italics

Robustness tests

- Results are the same when flows are represented by integer and the Poisson Maximum Likelihood estimation method is implemented
- Results are similar when we distinguish between regions which are on the national border with other countries and those regions which are within nations which share a border with another country…another way to test for the presence of a compensation for peripheral regions thanks to their international border status

Conclusions/1

- Our results show that the three different knowledge flows under examination are affected by contiguity and proximities to different extents.
- Moreover, contiguity, institutional, technological and relational proximity moderate the impact of pure geographical distance.
- Geographical distance has almost the same impact on knowledge flows across regions when contiguity is taken into account.
- Being contiguous is more important when the two regions are within the same national borders rather than when they are contiguous but across national borders.

Conclusions/2

- The highest impact of contiguity (both within and across countries) is registered for co-inventorship collaborations, that is those flows which are more based on tacit knowledge, cooperation and trust and are facilitated by face to face contacts.
- Facial contacts, and therefore contiguity, are less important for applicant-inventors links and are the least important for citations flows, since they are less dependent on personal contacts
- For citation flows, both technological and relational proximities have the highest impact. This seems to confirm that some knowledge flow within epistemic communities which share codified knowledge thanks to some rules for knowledge diffusion and they convey messages to whatever distance and independently from contiguity (see Breschi and Lissoni, 2001)

Tentative and preliminary policy implications

- Since kf's are diverse and based on different behaviours and relationships among actors, policies aimed at knowledge diffusion have to take such differences into account
- Since peripheral regions can emerge as more central thanks to their cross-border nature, policies should not overlook this counter-effect with respect to the usual advantages of core regions
- Since several dimensions of proximity (other than the geographical one) affect kf's, policies should balance their action by considering all potential moderating factors.

Things to do in the future…still many

- In general, more robustness checks
  - Spatial econometrics
  - Directional flows (for applicant-inventor links and citation flows)
  - Interactive effects (between proximities and between types of knowledge flows)
  - Different sample of regions (EU15, NMS12)
  - Different time periods (2005-07)

Citation flows

	citations			
	Same country	of which contigous	Cross-country	of which contigous
AT	9%	5%	91%	4%
BE	19%	12%	81%	1%
BG	0%	0%	100%	0%
CH	17%	12%	83%	5%
CZ	4%	2%	96%	0%
DE	56%	16%	44%	1%
DK	7%	4%	93%	0%
ES	7%	2%	93%	0%
FI	7%	5%	93%	0%
FR	24%	6%	76%	1%
GR	3%	1%	97%	0%
HU	2%	2%	98%	0%
IE	1%	1%	99%	0%
IT	23%	13%	77%	1%
NL	14%	9%	86%	2%
NO	5%	4%	95%	1%
PL	0%	0%	100%	0%
PT	3%	2%	97%	0%
RO	0%	0%	100%	0%
SE	9%	5%	91%	0%
SK	2%	0%	98%	6%
UK	21%	8%	79%	0%
average	**36%**	**12%**	**64%**	**1%**

Applicant inventors links

	appinv			
	Same country	of which contigous	Cross-country	of which contigous
AT	40%	27%	60%	3%
BE	47%	28%	53%	1%
BG	38%	2%	62%	0%
CH	31%	25%	69%	14%
CZ	46%	31%	54%	0%
DE	83%	36%	17%	1%
DK	46%	25%	54%	0%
ES	52%	11%	48%	0%
FI	61%	48%	39%	0%
FR	73%	17%	27%	0%
GR	80%	23%	20%	0%
HU	51%	39%	49%	0%
IE	12%	12%	88%	0%
IT	81%	41%	19%	0%
NL	31%	23%	69%	2%
NO	48%	25%	52%	1%
PL	57%	12%	43%	0%
PT	39%	33%	61%	0%
RO	60%	16%	40%	40%
SE	43%	17%	57%	0%
SK	26%	18%	74%	0%
UK	80%	28%	20%	0%
average	**67%**	**29%**	**33%**	**2%**

Co-inventorships

	coinv			
	Same country	of which contigous	Cross-country	of which contigous
AT	48%	33%	52%	8%
BE	60%	43%	40%	4%
BG	0%	0%	100%	0%
CH	49%	41%	51%	20%
CZ	36%	21%	64%	2%
DE	85%	52%	15%	2%
DK	53%	38%	47%	1%
ES	29%	10%	71%	0%
FI	68%	56%	32%	0%
FR	69%	26%	31%	4%
GR	20%	1%	80%	0%
HU	48%	32%	52%	0%
IE	41%	41%	59%	0%
IT	66%	36%	34%	2%
NL	64%	46%	36%	2%
NO	51%	29%	49%	2%
PL	25%	8%	75%	0%
PT	31%	26%	69%	0%
RO	0%	0%	100%	0%
SE	60%	35%	40%	0%
SK	17%	4%	83%	7%
UK	72%	35%	28%	0%
average	**73%**	**43%**	**27%**	**3%**

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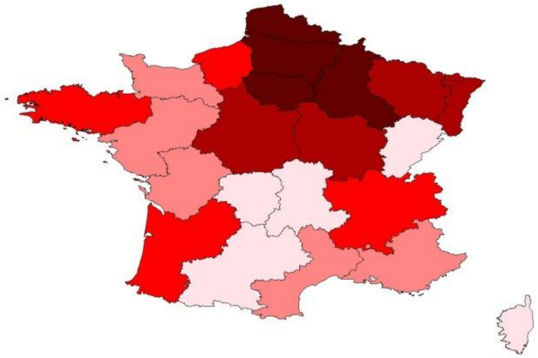
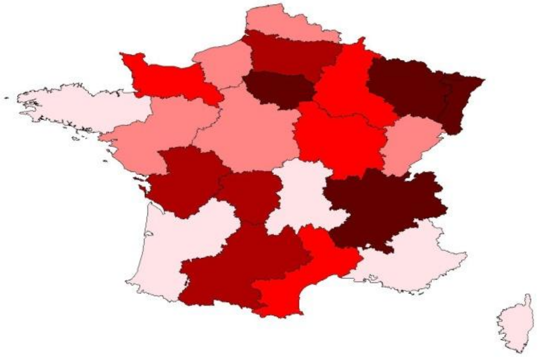
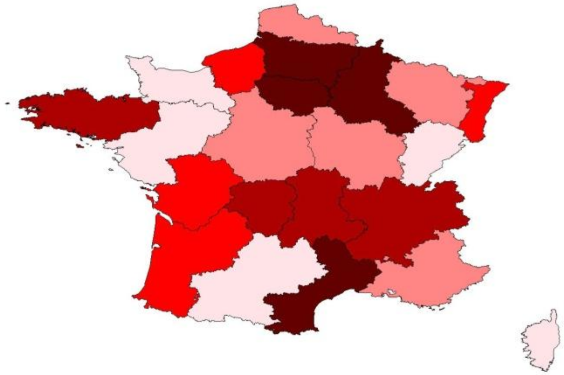
Stylised facts 1: French citations to- Other countries' patents



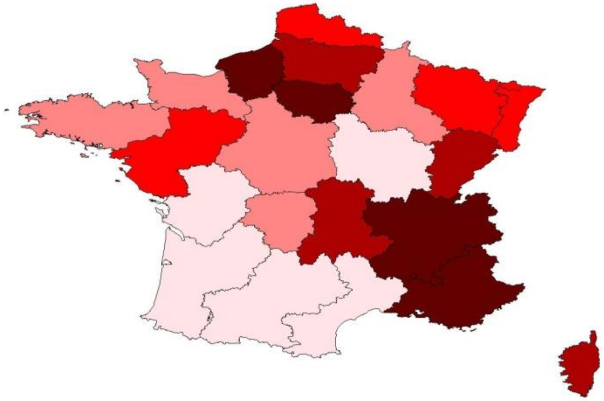
Belgium and Netherlands



Germany

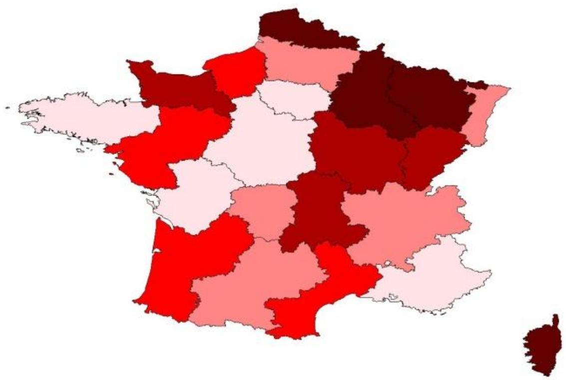


Spain

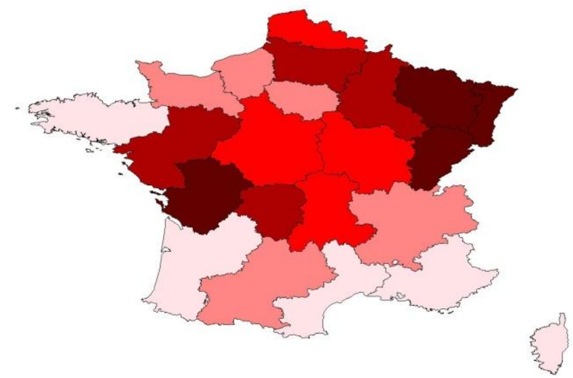


Italy

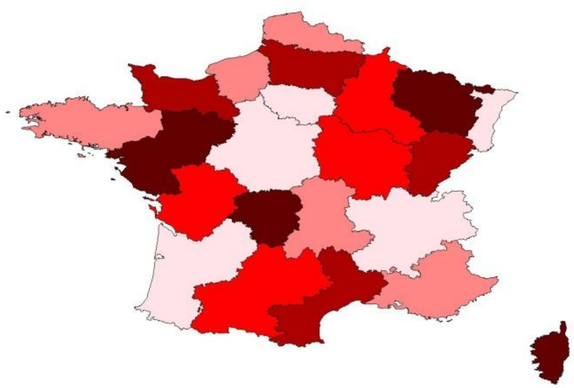
Stylised facts 2: French Applicant and- Other country inventors



Belgium and Netherlands



Germany



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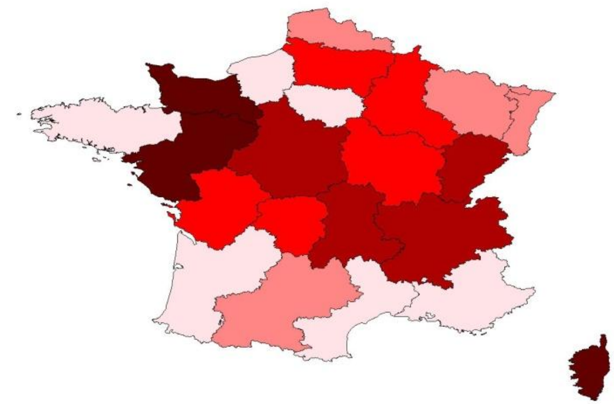
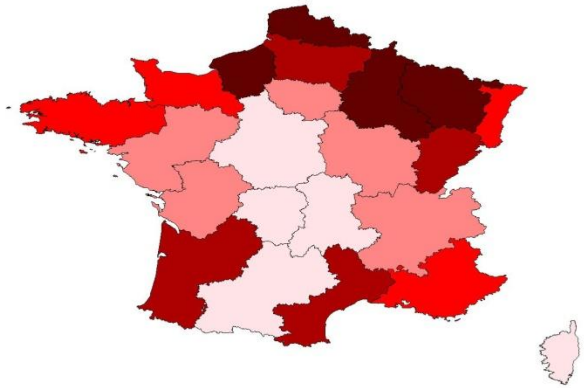
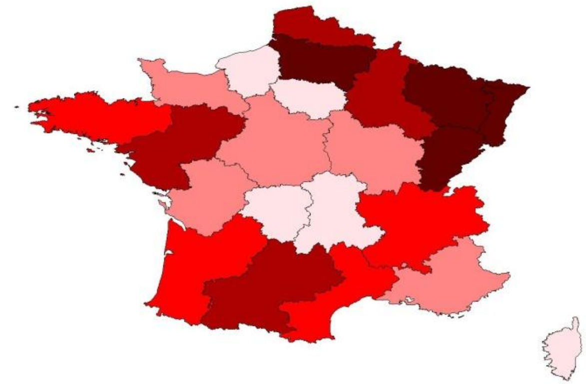


Italy

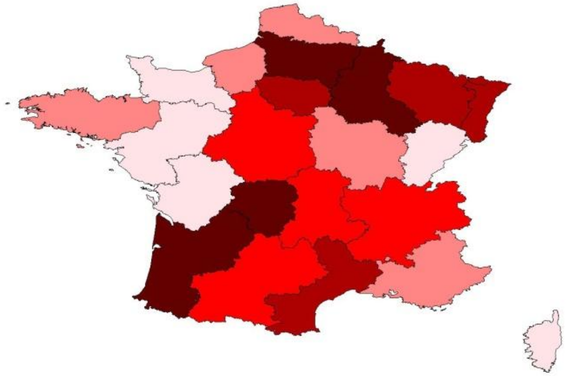
Stylised facts 3: French and- Other country co-inventors



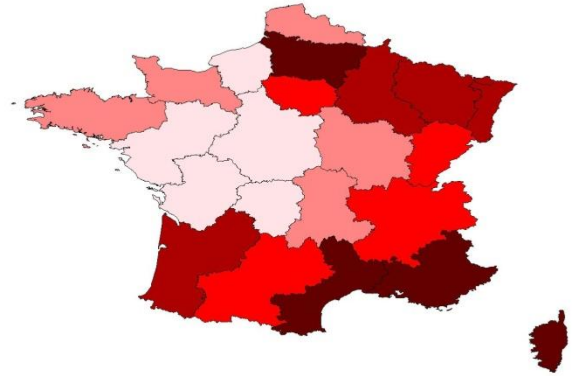
Belgium and Netherlands



Germany



Spain



Italy

Back to main aims