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How external linkages and social capital enable green innovation in EU regions

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- Sustainable transition is a policy priority for EU regions
- Green technologies are key factors in an environmental mitigation strategy
- However, regions might be locked in fossil modes of production that impede to develop green related capabilities and technologies.
- External sources of knowledge can help regions to access the knowledge they need

Theoretical background: green innovation

- Green knowledge requires the combination of highly diversified sets of competencies (Zeppini and van der Bergh, 2011).
- Green technologies tend to be more complex than non green ones (Barbieri, et al 2020).
- Green technological diversification is strongly path dependent (Montresor and Quatraro 2020).
- Green technological diversification benefit from external collaboration (co-inventorship) (Corrocher et al. 2024) and FDI (Castellani et al. 2022).

Theoretical background: migration and innovation

- Migrant inventors are associated with higher-quality patents via increased diversity at the team level (Ferrucci & Lissoni, 2019).
- Migrants inventors act as knowledge brokers by connecting distant places (Miguelez and Lissoni, 2024; Morrison, 2023).
- Immigrant inventors generate positive knowledge spillovers in host regions and favour both related (Caviggioli et al 2020) and unrelated diversification (Miguelez and Morrison, 2023).

Theoretical background: social capital

- Bridging social capital refers to trusty relations built with heterogeneous agents and facilitates knowledge exchanges in open networks
- Bonding social capital tends to be associated with strong ties and homogeneous network. It tends to isolate firms from external contacts and can lead to cognitive lock in (Muringani et al., 2021)
- Trust and civic cooperation is associated with better economic outcomes (Knack & Keefer, 1997)
- Informal institutions and bridging - rather than bonding – social capital are positively associated with regional diversification (Cortinovis et al., 2017; Antonietti and Boschma, 2020)

Social capital and migration

- social trusters have altruistic preferences (Mansbridge, 1999).
- High social trust tends to be associated with positive attitudes towards immigration and facilitates integration (Herreros, Criado, 2009)
- However, social trust might be confined to people with the same cultural or ethnic background as the trusters.
- High bonding SC, which is trust in people you already know, might be consistent with low acceptance of immigrants
- Instead, high bridging SCR, which is trust in strangers, is associated with higher acceptance of immigrants.

Our paper

- Migrant inventors contribute to green technological diversification in EU regions
- Impact is stronger in regions with high social capital
  - Impact is stronger for bridging social capital
  - Impact is weaker for bonding social capital
- Impact is stronger in regions that welcome migrants

Data: OECD-REGPAT

- Climate change mitigation technologies: CPC codes OECD-ENVTECH (4 and 6 digits)-> 63 (264) technologies in total
- 257 NUTS 2 regions (22 EU countries + Iceland, Norway and the UK)
- Time span 1990-2019
- five non-overlapping-year of 6 year-window each: 1988 to 1993, 1994-2000, 2001-2006; 2007-2012; 2013 to 2019.

Data: Inventor Migrants

- Miguelez & Finck (2013) & Pellegrino, Penner, & Piguet (2022)
- PCT patents, inventor's nationalities (until 2011)
- nationality and the address of 153.500 inventors residing in Europe, representing 64.447 green patents.

Data: Social capital

- European Value Survey: 4 waves, from 1989-2009
- NUTS2 level (but Germany NUTS1)

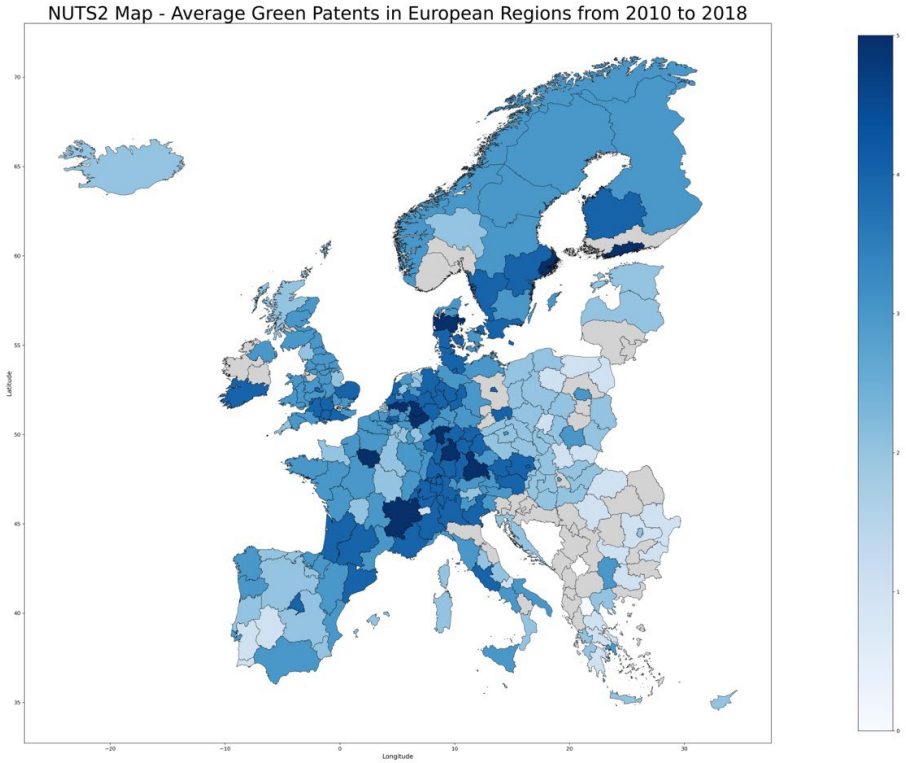
Olson-type associations
(Bonding SK)

- People belonging to:
  - Labour Union Associations;
  - Professional Associations;
  - Political Parties' associations.

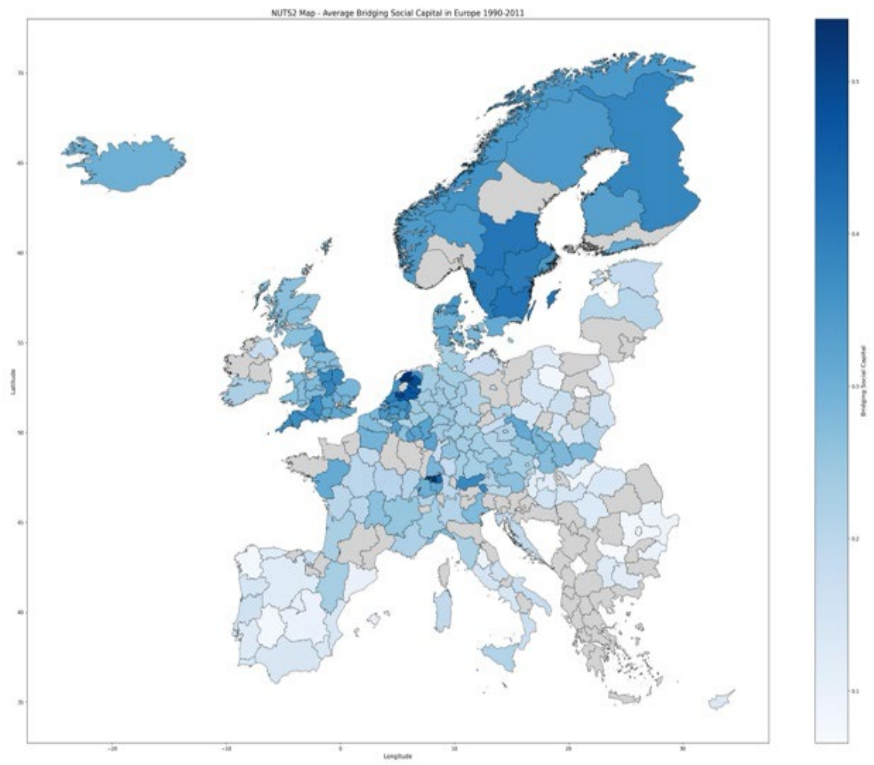
Putnam-type associations
(Bridging SK)

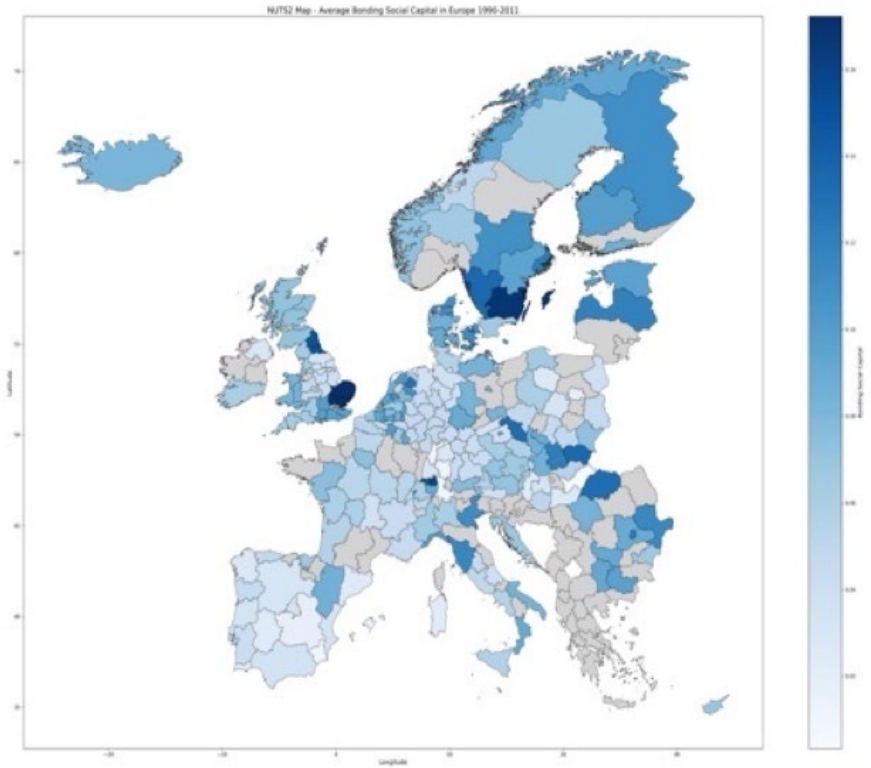
- People belonging to:
  - Cultural, education, arts and/or music associations;
  - Youth work;
  - Religious associations;
  - Women Groups;
  - Peace Groups.

Green patents



Bridging and Bonding Social Capital





Methods & variables

$$Yentry_{rft} = \beta_0 + \beta_1 Migrants_{rft-1} + \beta_2 RDensity_{rft-1} + \delta X' + \varphi_r + \gamma_f + \varepsilon_{rft}$$

- Linear probability model with 2-way fixed effects (time, region)
- Y_{entry}= 1 if Relative Technological Advantage $(RTA)_{r,f,t} \geq 1$ & $RTA_{r,f,t-1} < 1$
- Migrants= number of migrant inventor in the region at t-1
- RDensity= Relatedness Density (Boschma et al. 2015)
- X= control variables
  - GDP per capita , Total population, Population density, total number of patents, total number of immigrants

Social capital variables

- Bridging SC: share of respondents associated to bridging groups
- Bonding SC: share of respondents associated to bonding groups
- Trust: share of respondents trusting each others in a region
- Networks Social Capital: PCA of bridging and bonding social capital

Results

Table 4: OLS Regression on the likelihood of Regions entering into a new technological field for top and bottom tercile social capital regions measured by Trust

VARIABLES	(1) Full Sample	(2) High Trust	(3) Low Trust
is_migrant = L,	0.004**	0.018***	0.008
	(0.019)	(0.001)	(0.626)
density = L,	1.304***	1.311***	1.900***
	(0.000)	(0.000)	(0.000)
Total Patents = L,	0.000***	0.000***	0.000***
	(0.000)	(0.000)	(0.000)
log_pop = L,	-0.064***	-0.103***	-0.104***
	(0.000)	(0.000)	(0.000)
log_gdp = L,	0.009	-0.021	-0.010
	(0.232)	(0.636)	(0.685)
log_pd = L,	-0.013***	0.003	-0.036***
	(0.001)	(0.851)	(0.005)
Constant	0.754***	1.438***	1.497***
	(0.000)	(0.001)	(0.000)
Observations	43,007	4,457	6,766
R-squared	0.050	0.045	0.078
Period FE	YES	YES	YES
Regions FE	YES	YES	YES

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table Entry: OLS Regression on the likelihood of Regions entering into a new green technological field for the top and bottom quartile of region's social capital measured by Trust.

Results

Table 5: OLS Regression on the likelihood of Regions entering into a new technological field for top and bottom tercile social capital in regions measured by Social Networks

VARIABLES	(1) Full Sample	(2) High Networks' SK	(3) Low Networks' SK	(4) High Bridging SK	(5) Low Bridging SK	(6) High Bonding SK	(7) Low Bonding SK
is_migrant = L,	0.004**	0.014**	0.005	0.015***	-0.020*	0.022	0.017*
	(0.019)	(0.016)	(0.724)	(0.008)	(0.091)	(0.183)	(0.096)
density = L,	1.304***	1.276***	1.214***	1.654***	1.607***	2.187***	1.633***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Total Patents = L,	0.000***	0.000***	0.000	0.000***	-0.000***	0.000***	0.000**
	(0.000)	(0.000)	(0.216)	(0.000)	(0.000)	(0.000)	(0.016)
log_pop = L,	-0.064***	-0.099***	-0.052***	-0.103***	-0.032**	-0.184***	-0.122***
	(0.000)	(0.000)	(0.001)	(0.000)	(0.046)	(0.000)	(0.000)
log_gdp = L,	0.009	-0.056	0.023	-0.063**	0.034	-0.066**	-0.009
	(0.232)	(0.114)	(0.349)	(0.039)	(0.210)	(0.032)	(0.768)
log_pd = L,	-0.013***	0.013	-0.043***	0.009	-0.047***	0.007	0.004
	(0.001)	(0.301)	(0.000)	(0.552)	(0.000)	(0.572)	(0.710)
Constant	0.754***	1.708***	0.570*	1.734***	0.644*	2.829***	1.502***
	(0.000)	(0.000)	(0.088)	(0.000)	(0.069)	(0.000)	(0.000)
Observations	43,007	4,936	6,525	5,316	6,518	5,145	6,524
R-squared	0.050	0.044	0.062	0.058	0.069	0.079	0.057
Period FE	YES	YES	YES	YES	YES	YES	YES
Regions FE	YES	YES	YES	YES	YES	YES	YES

Robust pval in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: OLS Regression on the likelihood of regions entering a new green technological field for the top and bottom quartile of regions' social capital measured by social networks.

Robustness

- logit regression
- different thresholds of social capital
- cumulative count of migrant inventors in regions

Sum up of preliminary results

We find:

- positive association between inventor migrants and green patenting
- positive association between green technological diversification and inventor migrants
- Impact is stronger in regions with high social capital (Networks)
- Impact is stronger in regions with low bonding social capital
- Impact is stronger in regions with high bridging social capital

Discussion and contribution

- We confirm that inventor migrants represent a channel to access external green knowledge (like MNEs or R&D collaboration)
- However, institutional factors (i.e. social capital) can amplify their impact
- Creating or strengthening informal institutions that favour the participation and the acceptance of foreigners can in turn also impact on the diffusion of knowledge and facilitate the break out of carbon lock ins

Thanks

Relatedness Density

- $$RD_{frt} = \frac{\sum_{j\ r,\, j \neq f} \phi_{fj} * \mathrm{RTA}}{\sum_{j \neq f} \phi_{fj}} * 100$$

- RD_{frt} takes values between 0 and 100.
- It is 0 when there are no technologies related to technology f in region r at time t

Variables

Variable	Explanation	Source
Share_pat	Total number of green patents. Count.	OECD Regapt
Entry	Takes value 1 if a region – technology has entered into a new technologucal field and 0 otherwise.	Own calculation following Hidalgo et al. (2007).
Is_migrant	Number of migrant inventors in region r at time t in technology f. Continuos.	Miguelez & Finck (2013).
Relatedness Density (RD)	The extent to which technology f in region r and time t is related to any other technology in Europe as a whole and its density. It takes values from 0 to 100.	Own calculation following Hidalgo et al. (2007)
Bridging SK	Share of respondants associated to a Putnam Group. Share from 0 to 1.	EVS.
Bonding SK	Share of respondants associated to an Olson Group. Share from 0 to 1.	EVS
Trust SK	Share of respondants declaring they trust others. Share from 0 to 1.	EVS
PCA Networks' SK	The principal component metric uses components of both the Putnam and Olson groups. Share from 0 to 1.	Own calculation following EVS
Log_gdp	GDP per capita in its log form.	ARDECO
Log_pop	Total population in its log form.	ARDECO
Pop_density	Population density. Continuos.	EUROSTAT