Proximity, Network Formation and Inventive Performance: In Search of the Proximity Paradox

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Motivation

- Technological collaborations are largely supported by regional, national and EU policies
- Research has emphasized the role of industrial cluster, localized spillovers and networks
- Recent stream of literature :
  - Investigates the respective impact of proximity and networks
  - Raises the proximity paradox (Torre & Rallet, 2005; Boschma & Frenken, 2009)
- Better understand the interplay between proximity and networks and assess its impact on the performance of innovation

Theoretical background

- **Geographical proximity and networks**
  - Knowledge flows are highly localized to the extent that individuals are not mobile (Lissoni & Breschi, 2009 – Ter Wal, 2011)
  - Individuals and firms need to be embedded in networks to benefit from knowledge flows – minimize the role for geography (Autant-Bernard, et al. 2007; Maggioni et al. 2007)
  - Organizational, social and geographical proximity are substitutes (Cassi & Plunket, 2012)

  Findings: Performance is higher when partners are geographically close; inter-regional linkages reduce firm performance (Fornahl, Broekel & Boschma, 2011)

Theoretical background

- **The position of actors in the network**

(Coleman, 1988; Burt, 1992; Fleming et al. 2007, Baum et al., 2012…)

  - **Closure positions**: Strong cohesive ties (Coleman, 1988)
    - Share social proximity - Promote trust and collaboration / Redundant ties: similar knowledge bases and technological skills
  - **Bridging positions**: Weak ties = Brokerage position (Burt, 1992)
    - Enable access to new knowledge and resources/Difficult to manage

  Findings: Network position (degree centrality, intensive R&D) does not increase performance (Fornah, et al. 2011)

- **Technological proximity**
  - Optimal level of cognitive proximity: inverted U shape (Mowery, et al. 1998; Nootebom et al. 2007)
  - Exploration (favoring distance ?) versus exploitation (favoring proximity?)

  Findings: Too much cognitive performance harms innovation: proximity paradox with respect to cognitive distance (Fornhal et al. 2011 & Broekel and Boschma, 2012)

Our contribution

Extend previous findings:

1. European collaborations: EU 15 + Switzerland & Norway (1990-2006) in genomics

2. Explore Network positions: Social Network Analysis to account for the actors' centrality and the partners relative position within the network (closure vs bridging ties)

3. Explore the interplay of network and proximity variables to explain collaborations and the innovative performance of these collaborations

Data and descriptive statistics

- **Patent data:** 12,968 patents in Genomics, 4,406 distinct applicants and 24,708 inventors (Patstat)
- **Unit of analysis**: co-inventor dyads between active inventors
- **Geographical proximity**:
  - +50% of inventors are located in France, Germany and UK
  - 86% of collaborations are within countries, 35% are within NUTS3 regions
- **Organizational proximity**:
  - 58% are inter-organization among which 55% are between companies and 40% company-public research collaborations
- **Network position**:
  - 41% of closure ties: intra-component ties for which geodesic distance = 2 or 3
  - 55% of bridging ties – collaborations across separate network components
  - Closure ties are mainly local (42% vs 29%) and within organizational (60% vs 25%) ties
  - Bridging ties more international (18% vs 9%) and inter-organizational (75% vs 40%)

Dependent variables and estimation

We contrast network formation and innovative performance:

- **Network formation**: case-control for forming a tie versus not forming a network tie
  - Rare event logit (Sorenson et al; 2006; King and Zeng, 2001)
- **Performance measure**: forward (family) patent citations net of self-citations (Martinez, 2010)
  - Proxy for technological quality of inventions and economic value (Albert et al. 1991; Trajtenberg, 1990; Harhoff et al. 1999; Gambardella et al. 2008
  - Negative binomial with robust errors adjuster for (patent) intra-group correlation of errors

Table 2 – Estimation of Tie formation and Citations

VARIABLES	(1a) Tie Formation	(1b) Citations	(2a) Tie Formation	(2b) Citations
Closure			2.398***	0.075
			[18.00]	[0.27]
Geographical proximity	0.591***	-0.004	0.611***	0.174+
	[37.52]	[-0.09]	[20.48]	[1.89]
Technological proximity	1.197+	6.128*	0.857	6.827*
	[1.67]	[2.13]	[1.22]	[2.34]
Technological proximity sq	0.702	-3.808+	0.694	-4.331*
	[1.32]	[-1.82]	[1.31]	[-2.05]
Same type	-0.072	1.105***	0.046	-0.017
	[-1.17]	[3.77]	[0.22]	[-0.03]
Same applicant	2.473***	0.700*	-0.091	0.141
	[21.47]	[2.30]	[-0.42]	[0.33]
Geographical proximity x Same type			0.040	-0.319**
			[1.09]	[-2.92]
Geographical proximity x same applicant			-0.533***	-0.146
			[-11.57]	[-1.35]
Degrees - Avrg	-0.043	0.862**	-0.472***	0.835**
	[-0.59]	[3.05]	[-5.75]	[2.65]
Degrees - Abs.diff.	0.010	-0.383*	0.121*	-0.416*
	[0.21]	[-2.52]	[2.18]	[-2.57]
Border	-1.264***	-0.815+	-1.180***	-0.838+
	[-13.49]	[-1.80]	[-11.74]	[-1.76]
# inventors per patent	-0.995**	-0.643	-1.097***	-0.723+
	[-3.14]	[-1.53]	[-3.58]	[-1.72]
Originality		1.630*		1.763*
		[1.99]		[2.17]
Constant	-7.966***	-6.922***	-6.964***	-6.356***
	[-12.13]	[-3.76]	[-10.61]	[-3.44]
Alpha (overdispersion)		2.577***		2.552***
		[12.39]		[12.23]
Observations	23,206	1,988	23,206	1,988
Log Likelihood	.	-855.5	.	-852.1
D.F.	19	20	22	23
Chi2	.	63.63	.	84.91

Robust z-statistics in brackets *** p<0.001, ** p<0.01, * p<0.05, + p<0.1

- Geographical and social proximity does not benefit patent quality
- Organizational proximity (Inter-firm and within-organization) yield higher performance compared to Firm-academia collaborations
- Technological proximity has an inverted u-shape suggesting the existence of an optimal level and supporting the proximity paradox
  - Optimal level = .8 (44% of all ties and 47% of closure ties and 41% of bridging ties)

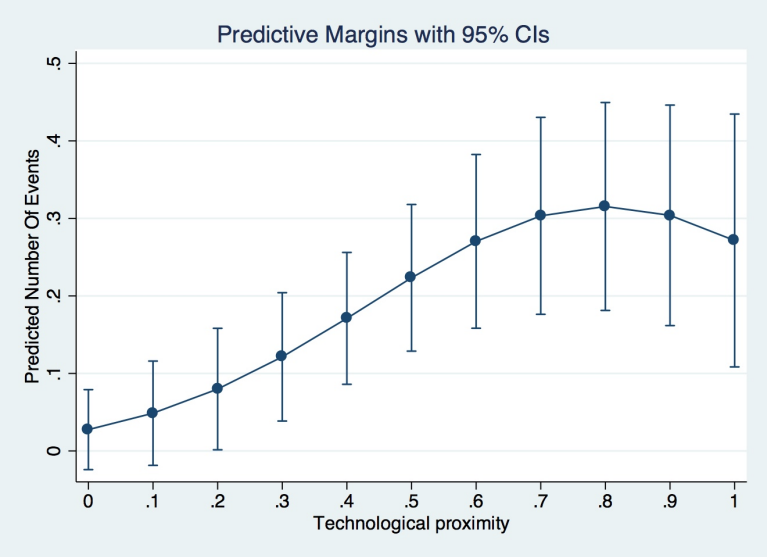
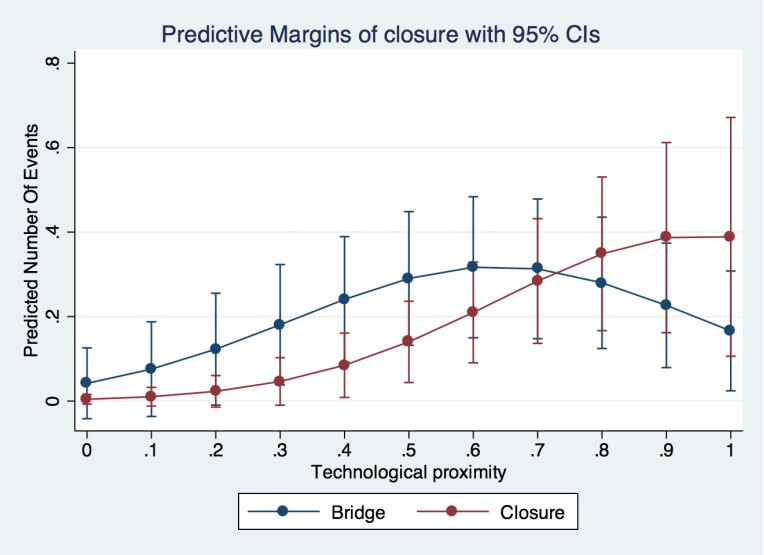
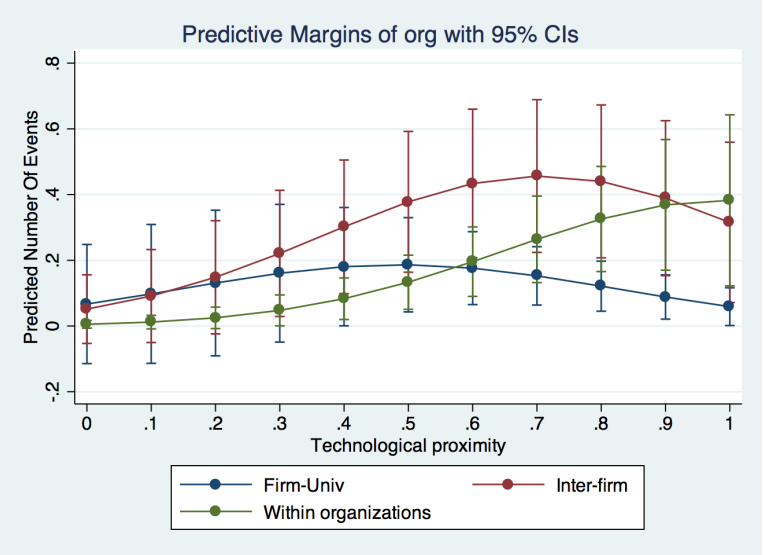


Table 2 – Estimation of Tie formation and Citations

VARIABLES	(3a) Tie Formation	(3b) Citations	(4a) Tie Formation	(4b) Citations	(5a) Tie Formation	(5b) Citations
Closure	2.575***	0.057	2.302***	-2.029*	2.577***	0.070
	[20.15]	[0.20]	[4.47]	[-2.15]	[20.09]	[0.25]
Geographical proximity	0.540***	-0.005	0.540***	-0.006	0.540***	-0.000
	[32.30]	[-0.12]	[32.44]	[-0.14]	[32.27]	[-0.01]
Technological proximity	1.095	6.088*	1.110	6.082*		4.152
	[1.47]	[2.12]	[1.50]	[2.07]		[1.29]
Technological proximity sq	0.540	-3.798+	0.496	-4.558*	1.104***	-4.335*
	[0.97]	[-1.82]	[0.89]	[-2.09]	[6.19]	[-2.08]
Same type	-0.127*	1.104***	-0.127*	1.133***	-0.510*	-0.282
	[-2.03]	[3.77]	[-2.02]	[4.00]	[-2.29]	[-0.26]
Same applicant	1.656***	0.695*	1.657***	0.717*	1.442**	-2.559*
	[13.09]	[2.26]	[13.10]	[2.35]	[3.19]	[-2.15]
Closure x Technological proximity			0.379	2.832*		
			[0.56]	[2.27]		
Same type x Technological proximity					0.548+	1.966
					[1.78]	[1.35]
Same applicant x Technological proximty					0.295	4.427**
					[0.48]	[2.87]
Degrees - Avrg	-0.422***	0.830**	-0.422***	0.767*	-0.412***	0.875**
	[-5.29]	[2.66]	[-5.27]	[2.55]	[-5.16]	[2.89]
Degrees - Abs.diff.	0.102+	-0.373*	0.103+	-0.327*	0.101+	-0.357*
	[1.88]	[-2.35]	[1.88]	[-2.09]	[1.86]	[-2.28]
Border	-1.175***	-0.818+	-1.177***	-0.772+	-1.172***	-0.792+
	[-12.21]	[-1.80]	[-12.18]	[-1.72]	[-12.13]	[-1.72]
# inventors per patent	-1.150***	-0.647	-1.152***	-0.671	-1.161***	-0.703+
	[-3.51]	[-1.54]	[-3.51]	[-1.60]	[-3.55]	[-1.68]
Originality		1.624*		1.276		1.458+
		[1.99]		[1.52]		[1.80]
Constant	-7.413***	-6.869***	-7.391***	-6.079**	-6.939***	-5.157*
	[-10.99]	[-3.80]	[-10.92]	[-3.27]	[-10.75]	[-2.44]
Alpha (overdispersion)		2.576***		2.552***		2.558***
		[12.38]		[12.30]		[12.44]
Observations	23,206	1,988	23,206	1,988	23,206	1,988
Log Likelihood	.	-855.5	.	-852.9	.	-851.6
D.F.	20	21	21	22	21	23
Chi2	.	64.08	.	72.75	.	89.61

- Proximity paradox with respect to technological proximity only holds when there is a lack of social or organizational proximity
- Inventor's network position does play a role relative to the technological needs
  - When actors need some technological distance they rather seek outside their network and company (bridging ties)
  - When actors need technological proximity, they benefit from searching in their close neighborhood (closure ties)
  - Highest performance for inter-firm collaborations for some technological distance but for technological proximity, highest performance within organizations

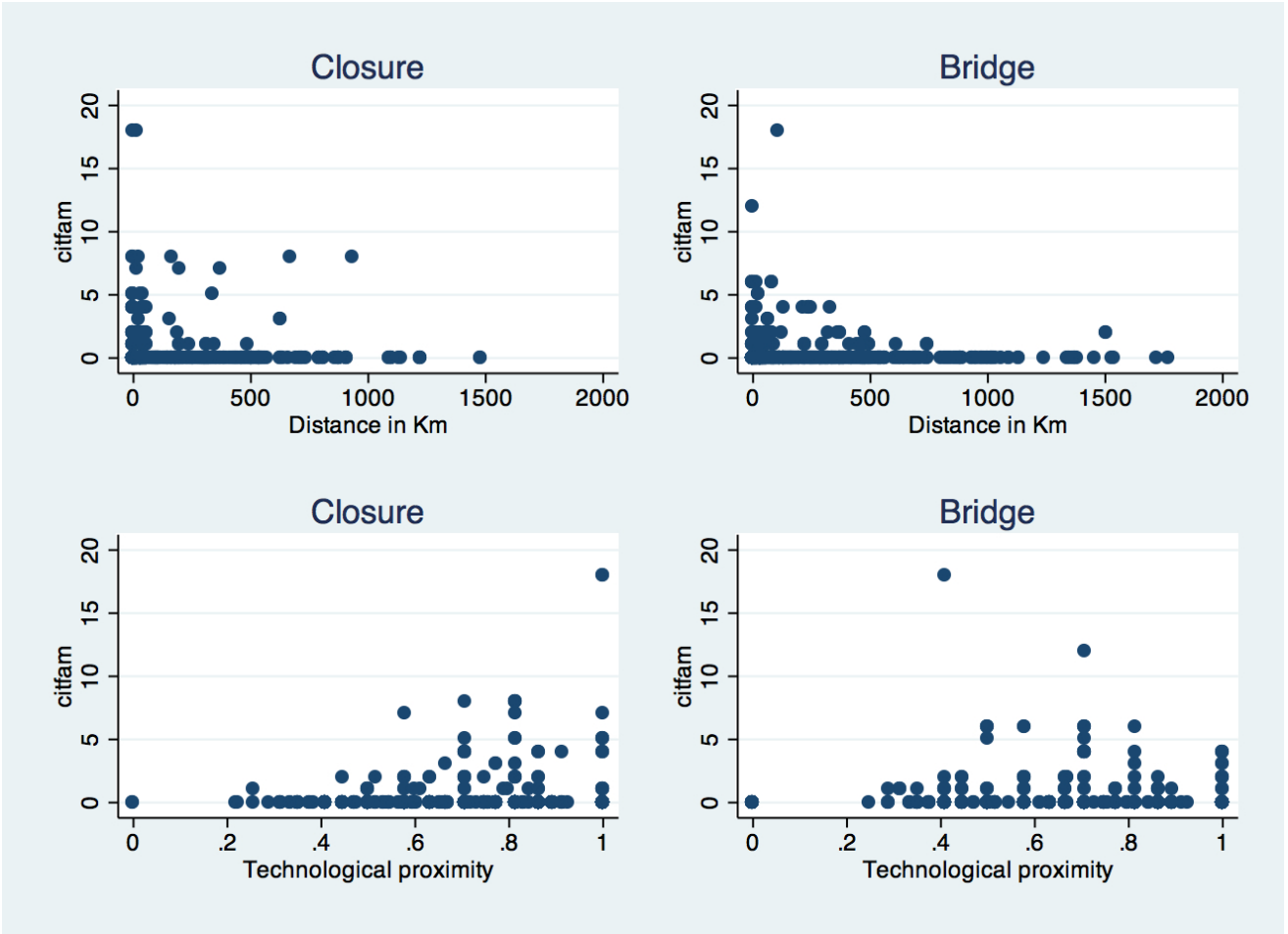




Findings

- Geographical proximity and network position per se does not influence performance
- Proximity paradox is partly supported and affects only technology
  - Network position and organizational proximity are key!
    - The paradox does not hold when social and technological are both high
    - The paradox does not hold for intra-firm collaborations
- Bridging ties are able to manage effective collaborations at an optimal technological distance and for inter-organizational collaborations
- **Policy recommendation**
  - When considering the quality of patents/performance:
    - when searching for specialization (exploitation ?) effects, already existing networks should be favored
    - When searching for diversification (exploration ?) effects, inter-firms should be favored, exploring new network links through bridging ties

Thank you for your attention!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