GRAN SASSO SCIENCE INSTITUTE
SCHOOL OF ADVANCED STUDIES
Scuola Universitaria Superiore

Multinational networks and local innovativeness

Economic Geography - MEMOTEF
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This talk

- Introduction
- Local vs. non-local sources of knowledge
  - Local specialisation and extra-regional linkages
  - Knowledge gatekeepers
- An empirical application on the case of Italy
  - Data requirements and methodological challenges
  - Some results
- Conclusions

Introduction

- A long-standing tradition of scholars emphasize the idea that a successful innovation process is spatially-bounded within region
  - Untraded interdependencies [Storper, 1997]
  - Regional systems of innovation [e.g. Iammarino, 2005]
  - Evolutionary Economic Geography [Boschma & Frenken, 2007]
  - ....

- The ability of regions to capture, absorb and re-use external knowledge is a fundamental element to sustain and refine the local profile of specialisation [Pyke et al., 1990; Ernst & Kim, 2002; Bathelt et al., 2004]

Introduction

- While regional specialization and external linkages can be theoretically considered as complementary for local innovativeness, the empirical evidence is still scant, as scholars have mainly focused on one or the other aspect [Li et al., 2016; Balland et al., 2017]
- *Can external networks foster local innovation? Are external linkages complementary or substitute of internal innovation efforts?*

- 'Reverse mercantilism' in FDI policy [Iammarino, 2018]
- From the political standpoint, growing skepticism towards the internationalization of local companies, perceived as a factor hindering local economic development, instead of something complementary to local specialization.

An open research area

- We analyse the regional innovation process resulting from the joint action of the internal specialisation of regions and their external global networks, with the aim of understanding if they are complementary and under which circumstances they produce the most favourable conditions.

- Extant evidence is limited to interregional linkages, migration flows, proximities
  [Marrocu et al., 2013; Miguelez & Moreno 2015; 2018; Capello & Caragliu, 2018]

Conceptual background: local specialisation

- Long-standing debate on the spatiality of new knowledge creation.
  - Innovative processes bounded in space [e.g. Amin & Thirft, 1994; Cooke et al., 1998; Balland & Rigby, 2017]
  - Regions as *loci* where firms accumulate competences, learn and generate new knowledge [e.g. Becattini, 1990; Oinas & Malecki, 2002; Iammarino, 2005]
- Incremental and cumulative process of territorial specialisation.
  - Marshallian industrial districts [Bagnasco, 1977; Piore & Sabel, 1984; Cucculelli & Storai, 2018]
  - Agglomeration economies [Glaeser et al., 1992; Henderson et al., 1995]
  - Evolutionary economic geography [Frenken et al., 2007]
- Only a limited number of spatial units produce large shares of innovation [Porter, 1990; Kemeny & Storper, 2015]

Conceptual background: extra-regional linkages

- Regional ability to capture and absorb external knowledge [Pyke et al., 1990;Ernst & Kim, 2002; Bathelt et al., 2004]
  - Opportunities to develop novel trajectories of specialisation and upgrade extant competences [Owen-Smith & Powell, 2004; Boschma & Iammarino, 2009]
  - Avoid stagnation and lock-in resulting from over-embeddedness [e.g. Uzzi, 1996; Visser & Boschma, 2004; Bathelt, 2007]
- Regions are not necessarily able to generate innovation as isolated systems [Gertler & Levitte, 2005]
  - Trans-local linkages necessary to connect distant knowledge communities [Simmie, 2003; Coe & Bunnell, 2003]

Conceptual background: MNE network

- Regions do not establish linkages, access and learn new knowledge *per se*.
  - Knowledge gatekeepers [Morrison, 2008; Rychen & Zimmerman, 2008]

- EG-IB perspective on economic globalization.
  - MNEs as key actors connecting knowledge at multiple geographical scales [Iammarino & McCann, 2013; Iammarino, 2018]
  - Trans-local ownership networks to source knowledge [Bathelt & Li, 2014; Turkina & van Assche, 2018]
  - Accumulation and acquisition of novel capabilities shift towards foreign subsidiaries [Rugman & Verbeke, 2001; Cantwell & Mudambi, 2005; Ascani, 2018]

Data

- Unit of analysis: 21 Italian NUTS-2 regions
- Years: 2007-2012
- Novel dataset: EPO patent appl. in 577 IPC classes with related NACE-classification (manufacturing only)
- We collapse patents data into 9 NACE-sectors
- 1,134 observations (21*9*6)
- Dep. var.: Number of Patents/Population by region in each region/Nace-category/year

Regional innovation

Table 1: Number of patents – Summary statistics by region (2007-2012)

Region	N	mean	sd	min	max
Abruzzo	54	206.667	32.43	165	258
Basilicata	54	35.167	10.033	21	46
Bolzano	54	158.333	29.34	120	202
Calabria	54	64.833	22.202	43	105
Campania	54	369.667	50.559	290	446
Emilia-Romagna	54	2633.667	251.113	2254	2924
Friuli-Venezia Giulia	54	611.5	79.104	488	746
Latium	54	821.667	74.263	681	907
Liguria	54	400.167	42.918	335	465
Lombardy	54	5084.833	228.498	4796	5358
Marche	54	445	29.59	403	483
Molise	54	11.333	13.208	2	40
Piedmont	54	1720.667	165.992	1398	1908
Apulia	54	256.5	48.994	210	355
Sardinia	54	83.833	26.453	38	115
Sicily	54	177.5	29.398	120	205
Tuscany	54	1215.833	118.611	1027	1376
Trento	54	118.833	26.632	85	166
Umbria	54	158	22.336	134	190
Aosta Valley	54	15.5	6.963	3	25
Veneto	54	1890.667	73.77	1796	2029

Note: *N* indicates the number of observations per region, i.e. 54, that is, 9 manufacturing macro-sectors over 6 years. The reported figures are averages over time and sectors.

External networks

- We make use of data at firm-level (Amadeus)

- Networks established by Global Ultimate Owners (GUOs) – located into Italian Nuts-2 region *i* and operating in the Nace-sector *s* - which own at least a subsidiary into a EU-28 country, except Italy
  - Local GUOs play the role of regional knowledge gatekeepers, with the ability to establish extra-regional linkages through subsidiaries

Networks' dimensions

- Intensity: sum of GUOs (by region/GUO's Nace-category/year) and their subsidiaries

$$IntensityTOT_{ist} = \sum_{ist} (GUO_{ist} + SUB_{ist}) \qquad (1)$$

- GUOs and subsidiaries have different but complementary roles:
  - GUOs collects knowledge sourced in different knowledge contexts and can diffuse it in its geographical area.
  - Subsidiaries access, absorb and generate knowledge in distant locations.

Geography of business networks

Table 3: Network intensity by region

Region	N	Percent	Cum.	N	Percent	Cum.	N	Percent	Cum.
	IntensityTOT			IntensityGUO			IntensitySUB		
Abruzzo	32	.3	.3	10	.6	.6	22	.3	.3
Basilicata	0	0	.3	0	0	.6	0	0	.3
Bolzano	38	.4	.7	10	.6	1.3	28	.3	.6
Calabria	0	0	.7	0	0	1.3	0	0	.6
Campania	94	1	1.7	28	1.8	3.1	66	.8	1.4
Emilia-Romagna	1584	16.3	18	244	15.6	18.7	1340	16.5	17.9
Friuli-Venezia Giulia	194	2	20	32	2	20.1	162	2	19.9
Latium	512	5.3	25.3	42	2.7	23.5	470	5.8	25.6
Liguria	34	.4	25.7	12	.8	24.3	22	.3	25.9
Lombardy	3724	38.4	64.1	602	38.6	62.9	3122	38.5	64.3
Marche	400	4.1	68.2	56	3.6	66.5	344	4.2	68.5
Molise	28	.3	68.5	6	.4	66.9	22	.3	68.8
Piedmont	1116	11.5	80	150	9.6	76.5	966	11.9	80.6
Apulia	60	.6	80.6	12	.8	77.3	48	.6	81.2
Sardinia	44	.5	81.1	16	1	78.3	28	.3	81.6
Sicily	54	.6	81.7	12	.8	79.1	42	.5	82.1
Tuscany	490	5.1	86.8	84	5.4	84.5	406	5	87.1
Trento	30	.3	87.1	14	.9	85.4	16	.2	87.3
Umbria	46	.5	87.6	18	1.2	86.5	28	.3	87.6
Aosta Valley	0	0	87.6	0	0	86.5	0	0	87.6
Veneto	1218	12.4	100	210	13.5	100	1008	12.4	100
Total	9698			1558			8140		

Note: *N* indicates total number, which is computed on the basis of 54 observations per region (9 manufacturing macro-sectors over 6 years)

Networks' relatedness

- Related/Unrelated sectoral composition, computed on the basis of the Nace-sector of the subsidiaries (at 2 and 4 digits level):

$$SectUnrelVar_{ist} = \sum_{g=1}^{G} P_g \ln\left(\frac{1}{P_g}\right) \qquad (2)$$

  - where P_g represents the share of GUOs and subsidiaries operating in the 2-digit class g, over the total number of firms that contribute to form the regional network.

$$SectRelVar_{ist} = \sum_{g=1}^{G} P_g H_g \qquad (3)$$

  - where

$$H_g = \sum_{i \in S_g} \frac{p_i}{P_g} \ln\left(\frac{1}{p_i / P_g}\right) \qquad (4)$$

  - where S_g is a 2-digit class, P_g is a 2-digit class share over the entire set of 2-digit classes (the number of which is G), and p_i is the 4-digit share

Networks' geography

- Geographical dispersion, computed on the basis of the countries of destinations of local MNEs;

$$GeoDisp_{ist} = \sum_{r=1}^{m} P_i^r \ln\left(\frac{1}{P_i^r}\right) \qquad (5)$$

  - where *r* refers to EU-countries, except Italy, and *m* is the total number of foreign countries, i.e. EU-28 minus Italy. is the proportion of subsidiaries operating in the *r-th* country to the total number of foreign subsidiaries in the EU.

Other determinants

Table A3: Other controls: Description and sources

Variable	Description	Aggregation level	Source
LUR	Long Unemployment rate	Region/year	OECD
R&D	Regional R&D expenditure over GDP	Region/year	OECD
URB	Proportion of urban waste over total waste production	Region/year	ISTAT
HumanCap	Principal Component Analysis (PCA) on the basis of three indicators: percentage of people with tertiary education, attractiveness of the university system (i.e. students' net migration rate), lifelong learning (i.e. percentage of adults 25-64 who attend educational and/or professional courses over total population 25-64)	Region/year	ISTAT
SPEC	Absolute employment	Region/year/sector	ISTAT
Trade	Imports plus exports over GDP	Region/year	EUROSTAT
InFDI	N. of employees of local foreign-owned firms	Region/year	ISTAT
AdvTec	Percentages of foreign affiliates located in technologically advanced EU-28 countries, except Italy.	Region/year/sector	AMADEUS, EIS

Methodology

- We estimate a Fixed-Effects model in a traditional KPF setting:

$$Y_{ist} = \alpha + NET_{ist}\beta + X_{it}\gamma + \delta_i + \delta_s + \delta_t + \delta_{st} + \varepsilon_{ist} \qquad (6)$$

i : region
s : sector
t : time

NET : vector of external network characteristics
X : vector of controls

- Standard errors clustered by region.
- We use standardized scores (z-values with average zero and a standard deviation of 1) in order to assess the relative effect of independent variables.
- We augment this model by interacting network and internal specialisation

Interactions

- We reparameterize the model so that coefficients on the original variables have an interesting meaning (see Wooldridge, 2012 p.198);

- The model takes the following shape:

$$Y_i = \alpha + \beta_1 X_1 + \beta_2 X_2 + \beta_3 (X_1 - \mu_i)(X_2 - \mu_i) + \varepsilon_i$$

- Where β_1 is the partial effect of X_1 on Y at a specific value of X_2;

- Where β_2 is the partial effect of X_2 on Y at a specific value of X_1;

- We fix μ at the following values: 10*th*, 25*th*, 50*th*, 75*th*, 90th percentiles.

Endogeneity issues

- We estimate a Fixed-Effects model in a traditional KPF setting:

$$Y_{ist} = \alpha + NET_{ist}\beta + X_{it}\gamma + \delta_i + \delta_s + \delta_t + \delta_{st} + \varepsilon_{ist} \qquad (6)$$

i : region
s : sector
t : time

NET : vector of external network characteristics
X : vector of controls

- Time varying omitted variables → error can be correlated with *NET* and *Y*.
- Reverse causality → regional innovativeness makes local firms more prone to go global ≈ self-selection into FDI [e.g. Helpman et al. 2004]

Instrumental variable strategy

- Weighted average of the sector dependence on external finance with regional weights consisting of the local availability of expansion venture capital.

$$Z_{ist} = \sum_s EFD_{st} \times (-VC_{iT}) \qquad (7)$$

i : region
s : sector
t : time

EFD : external finance dependence
VC : venture capital

- EFD based on US firms from Compustat, i.e. demand for capital [c.f. Rajan & Zingales, 1998]
- Regional VC based in ISTAT. Different timing strategies for *T*

Instrumental variable conditions

- Relevance →
  - Firm internationalization depends on demand for capital and local availability of finance.

- Exogeneity →
  - EFD calculated on US firms, exogeneous to the Italian manufacturing context
  - Long time lags for VC (8 years and start-of-the-period)
  - Innovation in Italy mostly financed through banking [Bugamelli et al., 2012]
  - VC largely taken pre-crisis: strong evidence that most pre-crisis financial links and behaviours are disrupted [Campello et al., 2010; Bricongne et al., 2012; Iyer et al., 2014]

Results

- Baseline without external network
- Baseline with external network
- Interplay between internal specialisation and external networks
- Geographical dispersion by development & by technology
- IV estimations
- Role of outliers

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Table 5: Baseline regression results

	(1) Patent	(2) Patent	(3) Patent	(4) Patent	(5) Patent	(6) Patent	(7) Patent
SPEC	26.984***	26.949***	26.954***	26.949***	26.928***	26.934***	26.931***
	(7.843)	(7.842)	(7.842)	(7.844)	(7.849)	(7.861)	(7.865)
R&D		19.438*	17.828**	17.125**	16.545**	15.972*	15.989*
		(9.379)	(8.097)	(7.314)	(7.433)	(7.906)	(7.929)
HumanCap			3.387**	3.327***	3.371***	3.464***	3.472***
			(1.378)	(1.142)	(1.113)	(1.020)	(1.025)
URB				6.135**	5.779**	5.999***	5.942***
				(2.250)	(2.132)	(2.056)	(2.037)
LUR					-1.340	-1.390	-1.463
					(1.126)	(1.112)	(1.140)
Trade						0.886	1.048
						(1.630)	(1.718)
InFDI							-0.447
							(1.355)
Obs.	1134	1134	1134	1134	1134	1134	1134
R-squared	0.596	0.597	0.597	0.597	0.597	0.597	0.597
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are in parenthesis, clustered by regions.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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Table 6: Network regression results

	(1) Patent	(2) Patent	(3) Patent	(4) Patent	(5) Patent
R&D	22.025**	19.302**	21.275**	21.074**	21.180**
	(9.648)	(8.462)	(10.076)	(8.955)	(8.616)
HumanCap	3.750***	3.964***	3.807***	4.308***	4.172***
	(1.183)	(1.176)	(1.189)	(1.187)	(1.249)
LUR	-3.256***	-3.030***	-3.200***	-3.385***	-2.869***
	(1.017)	(0.932)	(0.962)	(0.802)	(0.949)
URB	4.072*	5.921***	4.321*	6.182**	6.018***
	(2.033)	(1.716)	(2.204)	(2.295)	(2.104)
Trade	2.265	3.369	2.372	3.123	2.767
	(2.654)	(2.902)	(2.767)	(3.205)	(2.926)
InFDI	-3.272	-3.420*	-3.431	-1.589	-1.730
	(2.148)	(1.867)	(2.183)	(2.211)	(2.537)
SPEC	23.171***	20.627***	22.927***	23.062***	22.735***
	(6.427)	(5.813)	(6.257)	(6.032)	(5.837)
IntenistyTOT	12.995***		12.614***	12.264***	12.270***
	(2.824)		(3.033)	(2.863)	(2.892)
IntensitySUB		4.361**			
		(1.928)			
IntensityGUO		13.533***			
		(4.127)			
SectTotVar			1.171		
			(3.311)		
SectRelVar				8.787***	6.713***
				(1.812)	(1.761)
SectUnrelVar				-5.407*	-10.024**
				(2.889)	(3.716)
GeoDisp					6.983
					(7.114)
Obs.	1134	1134	1134	1134	1134
R-squared	0.639	0.656	0.640	0.654	0.657
Region dummies	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes	Yes	Yes

Standard errors are in parenthesis, clustered by region.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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Table 7: Regression results by specialization percentiles (IntensityTOT)

Specialisation percentiles	.1	.25	.5	.75	.9
	Patent	Patent	Patent	Patent	Patent
	(1)	(2)	(3)	(4)	(5)
R&D	22.940**	22.566**	22.917**	22.853**	22.617**
	(9.899)	(9.870)	(9.868)	(10.077)	(10.024)
HumanCap	3.922***	4.071***	4.072***	4.058***	3.928***
	(1.091)	(1.075)	(1.091)	(1.135)	(1.171)
LUR	-3.595***	-3.505***	-3.503***	-3.506***	-3.407***
	(1.062)	(1.014)	(1.037)	(1.047)	(1.120)
URB	3.666*	3.878*	4.143**	4.287**	4.090*
	(2.085)	(1.977)	(1.970)	(1.992)	(2.077)
Trade	1.331	1.625	1.707	2.180	2.144
	(2.310)	(2.347)	(2.441)	(2.783)	(2.839)
InFDI	-2.879	-2.745	-2.638	-3.017	-3.276
	(1.893)	(1.908)	(1.933)	(2.104)	(2.237)
SPEC	20.799***	21.295***	21.982***	23.991***	24.631***
	(5.581)	(5.703)	(6.046)	(6.807)	(7.370)
IntensityTOT	-4.715	2.865	6.479***	14.598***	16.345***
	(4.506)	(2.217)	(1.584)	(2.051)	(4.407)
Obs.	1134	1134	1134	1134	1134
R-squared	0.660	0.662	0.662	0.654	0.643
Region dummies	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes	Yes	Yes

Standard errors are in parenthesis, clustered by region.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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Table A6: Global networks in high-income and low-income destination countries

	(1) Patent	(2) Patent	(3) Patent
R&D	19.827**	20.805**	21.816**
	(9.177)	(9.515)	(9.579)
HumanCap	4.239***	3.020**	3.857***
	(1.329)	(1.079)	(1.256)
LUR	-3.176***	-2.224**	-3.298***
	(1.055)	(1.036)	(1.037)
URB	5.729***	3.215	4.264**
	(2.012)	(2.384)	(2.025)
Trade	3.908	-0.492	2.564
	(3.710)	(1.269)	(2.924)
InFDI	-2.799	-2.001	-3.247
	(2.185)	(1.742)	(2.175)
SPEC	23.826***	25.061***	23.333***
	(6.613)	(7.208)	(6.468)
IntensityTOT(>median)	11.421***		9.442***
	(2.851)		(2.545)
IntensityTOT(<median)		7.388***	4.622***
		(1.856)	(0.919)
Obs.	1134	1134	1134
R-squared	0.627	0.617	0.627
Region dummies	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes

Standard errors clustered by region in parenthesis. IntensityTOT indicates the number of firms that connect the Italian region *i* to: (column 1) foreign locations in EU countries with a per-capita GDP above the EU median; (column 2) foreign locations in EU countries with a per-capita GDP above the EU median. Column (3) shows the two above variables jointly.

****p*<0.01, ***p*<0.05, **p*<0.1*

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Table 8: The interplay between geographical dispersion and the technological competences of foreign locations

AdvTec percentiles	.1	.25	.5	.75	.9
Dependent Variable: Patents	(1)	(2)	(3)	(4)	(5)
R&D	12.798	12.793	12.735	12.168	12.001
	(8.123)	(8.109)	(8.020)	(8.305)	(8.069)
HumanCap	4.051***	4.055***	4.008***	4.266***	4.162***
	(1.242)	(1.242)	(1.215)	(1.195)	(1.216)
LUR	-1.086	-1.074	-1.040	-1.138	-0.856
	(0.944)	(0.950)	(0.971)	(1.053)	(1.002)
URB	6.501***	6.572***	6.472***	5.507**	6.042**
	(2.072)	(2.042)	(2.012)	(2.405)	(2.234)
Trade	1.576	1.533	1.451	1.603	1.612
	(2.187)	(2.165)	(2.105)	(2.258)	(2.136)
InFDI	-1.828	-1.775	-1.853	-2.181	-2.351
	(1.794)	(1.754)	(1.695)	(1.526)	(1.593)
SPEC	24.788***	24.766***	24.743***	24.826***	24.878***
	(7.339)	(7.324)	(7.329)	(7.347)	(7.382)
AdvTec	0.720	0.674	0.567	0.741	0.310
	(1.103)	(1.073)	(0.987)	(0.956)	(0.983)
GeoDisp	4.063	4.444	5.524	7.097*	9.895**
	(5.448)	(5.160)	(3.856)	(3.534)	(4.684)
Obs.	1134	1134	1134	1134	1134
R-squared	0.611	0.611	0.611	0.615	0.613
Region dummies	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes	Yes	Yes

Note: *SPEC*: absolute specialization (total employment in each manufacturing macro-sector); *R&D*: R&D expenditure as % of regional GDP; *HumanCap*: regional endowment of human capital; *URB*: urbanization externalities; *LUR*: long-run unemployment rate; *Trade*: regional trade over GDP; *InFDI*: Inward FDI in each region and macro-sector; *AdvTec*: % of foreign subsidiaries in technologically advanced EU countries; *GeoDisp*: geographical dispersion of network. Standard errors are in parenthesis, clustered by region.

***$p<0.01$, **$p<0.05$, *$p<0.1$

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1st stage

Table 9: IV-Regression results

	Instrument with lagged regional weights			Instrument with fixed regional weights		
	(1)	(2)	(3)	(4)	(5)	(6)
	Patent	Patent	Patent	Patent	Patent	Patent
2nd stage results						
IntensityTOT	9.033**	9.008**	9.004**	12.412**	12.422**	12.461**
	(4.514)	(4.521)	(4.525)	(5.704)	(5.705)	(5.694)
R&D	20.194**	20.182**	18.535**	21.763**	21.768**	20.038**
	(8.711)	(8.711)	(8.588)	(9.097)	(9.098)	(9.053)
HumanCap	3.665***	3.664***	3.411***	3.737***	3.737***	3.469***
	(1.051)	(1.051)	(1.045)	(1.100)	(1.100)	(1.082)
LUR	-2.714***	-2.711***	-2.502***	-3.180**	-3.182**	-2.966***
	(1.041)	(1.040)	(1.158)	(1.250)	(1.251)	(1.361)
URB	4.640**	4.644**	4.176**	4.154**	4.152**	3.649**
	(1.988)	(1.988)	(1.783)	(2.000)	(2.001)	(1.627)
Trade	1.891	1.889	1.617	2.208	2.209	1.924
	(2.065)	(2.063)	(2.271)	(2.399)	(2.399)	(2.591)
InFDI	-2.413	-2.408	-2.219	-3.148	-3.150	-2.959
	(1.949)	(1.949)	(2.141)	(2.075)	(2.075)	(2.232)
SPEC	24.232***	24.240***	24.248***	23.256***	23.253***	23.249***
	(6.610)	(6.613)	(6.612)	(6.107)	(6.106)	(6.105)
SD EFD		0.824	0.824		0.756	0.756
		(0.631)	(0.632)		(0.639)	(0.639)
Regional Business Services			0.980**			1.041**
			(0.424)			(0.430)
Obs.	1134	1134	1134	1134	1134	1134
R-squared (1st stage)	0.290	0.290	0.290	0.330	0.330	0.330
R-squared (2nd stage)	0.199	0.199	0.199	0.205	0.205	0.205
Under-identification	1.724	1.725	1.725	4.477**	4.776**	4.776**
Weak identification:						
Kleibergen-Paap Wald F-stat	29.32	29.36	29.36	10.48	10.51	10.52
Stock-Yogo 10%	16.38	16.38	16.38	16.38	16.38	16.38
Stock-Yogo 15%	8.96	8.96	8.96	8.96	8.96	8.96
Endogeneity Test	.537	.536	.535	.995	.998	.997
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are in parenthesis, clustered by region.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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2nd stage

Table 9: IV-Regression results

	Instrument with lagged regional weights			Instrument with fixed regional weights		
	(1) Patent	(2) Patent	(3) Patent	(4) Patent	(5) Patent	(6) Patent
1st stage results						
IV	-1.247***	-1.247***	-1.247***	-4.231***	-4.231***	-4.231***
	(0.230)	(0.230)	(0.230)	(1.307)	(1.306)	(1.304)
R&D	-0.336	-0.336	-0.305	-0.401	-0.401	-0.391
	(0.306)	(0.306)	(0.300)	(0.288)	(0.288)	(0.281)
HumanCap	-0.008	-0.008	-0.003	0.014	0.014	0.015
	(0.032)	(0.032)	(0.028)	(0.031)	(0.031)	(0.028)
LUR	0.121*	0.121*	0.117*	0.089	0.089	0.088
	(0.073)	(0.073)	(0.071)	(0.059)	(0.059)	(0.058)
URB	0.097	0.097	0.106	0.118	0.118	0.121
	(0.121)	(0.121)	(0.112)	(0.108)	(0.108)	(0.107)
Trade	-0.075	-0.075	-0.070	-0.059	-0.058	-0.057
	(0.125)	(0.125)	(0.124)	(0.122)	(0.122)	(0.122)
InFDI	0.173**	0.173**	0.170**	0.201**	0.201**	0.199**
	(0.075)	(0.075)	(0.076)	(0.085)	(0.085)	(0.086)
SPEC	0.263*	0.263*	0.263*	0.254*	0.254*	0.254*
	(0.150)	(0.150)	(0.150)	(0.136)	(0. 136)	(0. 136)
SD EFD		-0.0001	-0.0001		0.031***	0.031***
		(0.011)	(0.011)		(0.011)	(0.011)
Regional Business Services			-0.019			-0.006
			(0.017)			(0.030)
Obs.	1134	1134	1134	1134	1134	1134
R-squared (1st stage)	0.290	0.290	0.290	0.330	0.330	0.330
R-squared (2nd stage)	0.199	0.199	0.199	0.205	0.205	0.205
Under-identification	1.724	1.725	1.725	4.477**	4.776**	4.776**
Weak identification:						
Kleibergen-Paap Wald F-stat	29.32	29.36	29.36	10.48	10.51	10.52
Stock-Yogo 10%	16.38	16.38	16.38	16.38	16.38	16.38
Stock-Yogo 15%	8.96	8.96	8.96	8.96	8.96	8.96
Endogeneity Test	.537	.536	.535	.995	.998	.997
Region dummies	Yes	Yes	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes	Yes	Yes

Standard errors are in parenthesis, clustered by region.

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

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Table 10: Robustness checks: the role of outliers

Dependent Variable: patent	(1)	(2)	(3)	(4)
R&D	22.120**	22.615**	21.819**	15.169**
	(9.318)	(9.636)	(9.238)	(6.668)
HumanCap	4.114***	4.308***	4.468***	3.484***
	(1.248)	(1.276)	(1.330)	(1.186)
LUR	-3.018**	-3.480***	-3.236**	-2.174***
	(1.116)	(1.091)	(1.166)	(0.712)
URB	5.009**	4.820*	5.507**	6.914***
	(2.093)	(2.347)	(2.351)	(2.086)
Trade	0.682	0.156	0.755	-1.740*
	(2.168)	(2.368)	(2.764)	(0.851)
InFDI	-1.357	-0.879	-0.443	1.342
	(2.463)	(2.482)	(2.566)	(1.007)
SPEC	21.088***	19.177***	19.457***	17.505***
	(5.743)	(5.195)	(5.602)	(5.457)
IntenistyTOT	14.768***	18.463***	20.611***	17.620**
	(4.672)	(3.051)	(2.219)	(8.220)
SectRelVar	7.319***	7.666***	8.859***	7.291**
	(1.926)	(2.357)	(2.101)	(2.697)
SectUnrelVar	-8.452*	-8.504*	-12.274***	-11.821*
	(4.214)	(4.800)	(4.209)	(5.580)
GeoDisp	4.296	2.728	6.805	10.395
	(7.598)	(8.735)	(8.764)	(8.311)
Obs.	1080	1026	972	918
R-squared	0.634	0.624	0.610	0.560
Region dummies	Yes	Yes	Yes	Yes
Time dummies	Yes	Yes	Yes	Yes
Sector dummies	Yes	Yes	Yes	Yes
Time/Sector dummies	Yes	Yes	Yes	Yes

Note: *SPEC*: absolute specialization; *R&D*: R&D expenditure as % of regional GDP. *HumanCap*: regional endowment of human capital; *URB*: urbanization externalities; *LUR*: long-run unemployment rate; *Trade*: regional trade over GDP; *InFDI*: Inward FDI in each region and macro-sector; *IntensityTOT*: total number of firms participating in the network; *SectRelVar*: relatedness of the network; *SectUnrelVar*: sectoral unrelatedness of the network; *GeoDisp*: geographical dispersion of networks.
Standard errors in parenthesis, clustered by region. Column (1) excludes Lombardy; column (2) excludes Lombardy and Piedmont; column (3) excludes Lombardy, Piedmont and Veneto; column (4) excludes Lombardy, Piedmont, Veneto and Emilia-Romagna.
***$p<0.01$, **$p<0.05$, *$p<0.1$

Conclusions (I)

- Both regional internal specialisation and external networks matter.
- The role of external networks varies according to the structure of the network, the location of foreign subsidiaries and the specialisation level of the regional economy.
- We support a view of regional innovation as an interactive process where local resources are integrated with external inputs → complementary roles.

Conclusions (II)

- Policy implications: regional openness and internationalisation of local companies can be a catalyst of regional success.
- The anti-globalisation narrative may be detrimental for highly specialized regions/sectors, that benefits the most from internationalizing.
- Regional innovation possibilities can revolve around place-based gatekeepers:
  - Organisations with the capacity to connect knowledge at multiple geographical scales.
  - Important to have subsidiaries but it is probably more important to have many GUOs.

- Some future research/limitations:
  - Incorporating MNE strategic motivations.
  - Dissecting the composition of the effect between GUO and other regional actors.

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Thank you

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