Metropolisation, peripheries and funding of nano sciences & technologies production in Europe

STI 2017, 07/09/2017
Lionel Villard, François Perruchas, Thomas Scherngell, Michael Barber, Philippe Larédo and Jordi Molas-Gallart
Background and objectives

First works in nano S&T field demonstrated some interesting findings:

– a **very fast rate** of growth (14% yearly) fitting with Bonaccorsi’s approach (Bonaccorsi, 2008).

– secondly, it highlighted a **strong agglomeration** effects where over 80% of world knowledge production is located in few places (Robinson, D. K. et al., 2007, Delemarle et al., 2009).

Does the European funding play a role?

Does it drive collaborations across urban areas in Europe?
Unit of analysis as a proxy to link analytical dimensions: Functional Urban Areas

Traditional approaches are usually based on **administrative boundaries** (NUTS, municipalities) and make difficult to reflect the **geographical continuity** of socio-economic phenomena of S&T productions.

Functional Urban Areas (Brezzi, OECD, 2012):
- At a municipality scale
- With a core (density of population) and an hinterland (based mainly on a commuting data)

688 FUA in Europe (EU-28 and associated countries) and some other countries (Japan, USA, Canada...).
Nanotechnology sciences & technologies
Funding, exploration, exploitation
(Belderbos, Faems, Leten, & Van Looy, 2010)

- **EUPRO database**
  European Funding – FP 5-7
  ≈ 1100 nano proj. – €4bn
  2000 - 2011

- **NANOPAT database**
  Exploitation
  ≈ 32 000 Priority Pat.
  2000 - 2011

- **NANOPUB database**
  Exploration
  ≈ 550 000 Pub.
  2000-2010

- **ETER database**
  Scientific capabilities
  (PhD Graduates - 2011)

- **GeoNames database**
  Population
  (2012 – 2016)

- **OECD Reg. database**
  Economical capabilities
  (2001 – 2011)

- **EUROSTAT database**
  R&D capabilities (GERD)
  (2000 – 2011)
## Estimation results I

<table>
<thead>
<tr>
<th></th>
<th>Exploration (publications)</th>
<th>Exploitation (patents)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean marg. effect</td>
<td>sign.</td>
</tr>
<tr>
<td><strong>EU funding</strong></td>
<td>1.334 ***</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>2.265 ***</td>
<td></td>
</tr>
<tr>
<td><strong>GDP per capita</strong></td>
<td>1.080</td>
<td></td>
</tr>
<tr>
<td><strong>R&amp;D expenditures</strong></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>PhD students</strong></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>Overdispersion</strong></td>
<td>2.915 ***</td>
<td></td>
</tr>
<tr>
<td><strong>LR (NegBin)</strong></td>
<td>420.56 ***</td>
<td></td>
</tr>
</tbody>
</table>

Based on Negative Binomial Regression; Mean marginal effects indicate elasticities (percent changes) of the dependent variable to changes in the independent variables, holding all other variables at their mean; *** significant at the 0.01 level, ** significant at the 0.05 level, * significant at the 0.1 level;
Findings from the 1st model

- **Positive and statistically significant EU funding effects** on both knowledge **exploration** and **exploitation**
- Effects are slightly, but statistically significant **higher for exploration in all model versions**.
- The full model (controlling for R&D expenditures and Phd students) predicts for a 1% increase of EU funding a 1.23% increase in publications, while a 1.16% increase in patenting
- Results stay robust when **controlling for R&D expenditures**; these turn out to be not significant for exploration, but significant and highly influential for exploitation (for exploitation, GDP per capita becomes insignificant when adding R&D expenditures, pointing to a high correlation between the two variables)
- **PhD students** are a significant and important driver for exploration, but insignificant for exploitation
## Estimation results II

<table>
<thead>
<tr>
<th></th>
<th>Exploration (Top 10% publications)</th>
<th>Exploitation (Top 10% patents)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>mean marg.effect</td>
<td>sign.</td>
</tr>
<tr>
<td><strong>EU funding</strong></td>
<td>1.401 ***</td>
<td></td>
</tr>
<tr>
<td><strong>Population</strong></td>
<td>2.097 ***</td>
<td></td>
</tr>
<tr>
<td><strong>GDP per capita</strong></td>
<td>2.755 ***</td>
<td></td>
</tr>
<tr>
<td><strong>R&amp;D expenditures</strong></td>
<td>-</td>
<td></td>
</tr>
<tr>
<td><strong>PhD students</strong></td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td><strong>Overdispersion</strong></td>
<td>1.971 ***</td>
<td>1.910 ***</td>
</tr>
<tr>
<td><strong>LR (NegBin)</strong></td>
<td>529.87 ***</td>
<td>435.49 ***</td>
</tr>
</tbody>
</table>

Based on Negative Binomial Regression; Mean marginal effects indicate elasticities (percent changes) of the dependent variable to changes in the independent variables, holding all other variables at their mean; *** significant at the 0.01 level, ** significant at the 0.05 level, * significant at the 0.1 level;
Main findings in terms of quality

• **EU funding effects** increase when looking at quality for knowledge exploration, but slightly decrease for exploitation.

• **R&D expenditures** become a highly significant determinant for knowledge exploration when looking at quality, and also increases its importance markedly for exploitation.

• **Phd students** are still important at the same level for exploration in terms of quality.

• The remaining patterns of estimates stay the same between the ‘quantity’ and the ‘quality’ models.
Top10% in exploration AND exploitation
Top10% in exploration OR Top10% in exploitation
Low exploration and exploitation
Cores and peripheries analysis

Three different networks:

- EU Funding (link: same European project)
- Knowledge Exploration (link: same scientific publication)
- Knowledge Exploitation (link: same priority patent)

Traditional approaches: **coreness as a continuous phenomenon** through space (Borgatti and Everett 1999, and after).

Challenges: real-world networks, may have multiple cores (Yan and Luo 2015).

![Diagram of network structures](image)
Cores and peripheries analysis

Two steps to identify core and peripheral FUAs:

1. Community detection (Louvain algorithm Blondel et al. 2008)

2. Inside each community, with a Nodal flow approach (Beauguitte, Giraud, & Guerois, 2016; Nystuen & Dacey, 1961) we identified:
   - Peripheral FUAs – nodes dominated in all their relations
   - Intermediary FUAs - nodes dominating peripheral nodes but dominated by other cores.
   - Core FUAs – nodes dominating all the nodes of their community
Main findings from the network of participations

- Collaborations through time do not build community.

- Strong interdependency of main hubs: FUA linked at the European level (Paris, Munich, Roma, and London) which are also driving strong participations with other FUA.

- Paris is dominating these hubs in term of participations (and funding).

- Dense second league of FUA in term of funding in the central part of Europe.
Main findings from the collaboration network of authors (exploration)

• More geographically distributed.

• A strong community pattern, with 16 subnetworks (and 21 cores):
  – Nationally structured with the capital city as a core (FR, DE, IT, BE)
  – Language structure for English (UK with AU, CAN, US) and Spanish (ES with Mex, Chile, Colombia)
  – Some others more transnational in Europe (Austria with Finland, Hungary ... Poland with Czech, Republic...)

• A set of cores interlinked FUA (Paris, Berlin, Munich, Roma ...), mainly capital city. They are also driving strong international extra-European relations. There are irrigating intra-national sub-networks intermediary (Grenoble) and with peripheral FUA.

• Intra-national networks in the Southern (Madrid and Roma), Eastern (Greece, Warszawa and Vienna) and the Northern (Stockholm and Helsinki) parts of Europe: articulated around FUA (mainly core) with the capital city linked with regional intermediary and peripheral FUA.
Main findings from the collaboration network of inventors (exploitation)

• Also 16 communities (and 22 cores):
  – Two strong nationally structured (France, with two in Germany, but Berlin is not a core);
  – But other communities are much more trans-European (i.e. three communities take place in Italia, where two of them are densely link with others countries).

• A strong “belt” in the central part of Europe, with some core FUA (and sub-national networks), and strong international extra-European collaborations.

• Nearly empty spaces, with peripheral and intermediary FUA, in the southern and Eastern parts of Europe.

• Some European subnetworks are driven and linked by core FUA in US (San-Francisco, Chicago).
Conclusion

• EU Funding plays a role in exploration and exploitation
• EU Funding effect is higher on exploration, specifically on high quality exploration
• Funding, exploration and exploitation networks are different (communities, concentration)
• Other determinants to explain the FUA’s performances in exploration / exploitation
Further developments

• Estimation of spatial spillovers between FUAs by means of a spatial econometric extension
• Using yearly data to specify a dynamic model accounting for time effects on the role of EU funding
• Using yearly data to analyse the evolution of the networks over time
Thank you