Production of knowledge in European large firms in Chemicals and Pharma/biotech sectors: where is the knowledge produced?

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Alfredo Yegros (CWTS), Philippe Larédo (UPE & UoM)
Outline

• Introduction
• Research questions
• Data
• Results
  Countries of knowledge production
  Modes of collaboration of research activities (publications) and technology developments (patents)
    • Share of collaborative activities
    • Geography of collaboration
    • Institutional partnership
• Conclusion
Introduction

• MNEs set up R&D laboratories abroad for:
  – adapting technologies and products developed at home to local market conditions
  – for tapping into the knowledge and technological resources in centres of scientific excellence located worldwide
    (Dunning and Narula, 1995; Kuemmerle, 1999; Kumar, 2001; von Zedwitz and Gassmann, 2002)

• Evidence that the geographic diversification of EU large firms benefits their R&D productivity
  (Cincera, IPTS Working Paper, 2011)
Introduction

• Collaborative R&D can facilitate access to technologies developed by partners; sharing of resources and capabilities may open up new technological trajectories (Doz & Hamel, 1997; Hagedoorn, 1993; Teece, 1986)

• Higher level of collaboration in explorative technology activities compared to exploitative activities (Belderdos et al., 2010)

• When technological activities are essential for its existing core business, the firm exert full control over such activities (Das & Teng, 2000; Hagedoorn & Dusters, 2002)
Research questions

• To which extent do firms engage in partnerships to carry out scientific (exploring) and technology (exploiting) activities?

• What type of institutions participate in these collaborations?

• Where are the partners located?
Data

- **Transnational priority patent applications** (PATSTAT) and **scientific publications** (WoS) produced by **115 firms** with the largest R&D investments from **5 EU countries** (FR, DE, UK, NL, CH) in Chemicals and Pharma-Biotech (using a **consolidated perimeter of the industrial groups** (ORBIS))

<table>
<thead>
<tr>
<th>Industrial sectors</th>
<th>Number of firms</th>
<th>Number of scientific publications (2001-2010)</th>
<th>Number of transnational priority patents (2001-2008)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>36</td>
<td>18 733</td>
<td>22 750</td>
</tr>
<tr>
<td>Pharma - biotech</td>
<td>79</td>
<td>69 232</td>
<td>13 175</td>
</tr>
<tr>
<td>Total</td>
<td>115</td>
<td>87 965</td>
<td>35 925</td>
</tr>
</tbody>
</table>

- **Data treatment & indicators**
  - Harmonisation of names; classification according to their institutional affiliations; firm entities are singled out
  - **Indicators**: Collaborations: copublications, coapplications; Geography of knowledge production: Countries of scientific and technological activities
Germany plays a leading role for R&D knowledge production in Europe

EU large firms rely on R&D knowledge produced in Europe but also in the US
Collaboration in scientific activities (publications)

Distribution of the type of institutions in the publications

- Increasing level of collaboration in scientific activities over time
- Growing collaborations with institutions from the public sector
- Collaborations with non CIB firms
## Collaboration in scientific activities

<table>
<thead>
<tr>
<th>chemistry</th>
<th>modes of collaboration</th>
<th>Internal to the firm</th>
<th>External collaborations</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>single R&amp;D center</td>
<td>several R&amp;D centers</td>
<td>total</td>
<td></td>
</tr>
<tr>
<td>national (firm home country)</td>
<td>10%</td>
<td>2%</td>
<td>12%</td>
<td>3%</td>
</tr>
<tr>
<td>national (not firm home country)</td>
<td>10%</td>
<td>1%</td>
<td>10%</td>
<td>1%</td>
</tr>
<tr>
<td>international</td>
<td>2%</td>
<td>2%</td>
<td>4%</td>
<td>5%</td>
</tr>
<tr>
<td>Total</td>
<td>20%</td>
<td>4%</td>
<td>24%</td>
<td>9%</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Pharma-biotech</th>
<th>modes of collaboration</th>
<th>Internal to the firm</th>
<th>External collaborations</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>single R&amp;D center</td>
<td>several R&amp;D centers</td>
<td>total</td>
<td></td>
</tr>
<tr>
<td>national (firm home country)</td>
<td>6%</td>
<td>1%</td>
<td>8%</td>
<td>1%</td>
</tr>
<tr>
<td>national (not firm home country)</td>
<td>10%</td>
<td>3%</td>
<td>13%</td>
<td>4%</td>
</tr>
<tr>
<td>international</td>
<td>3%</td>
<td>3%</td>
<td>6%</td>
<td>32%</td>
</tr>
<tr>
<td>Total</td>
<td>17%</td>
<td>7%</td>
<td>24%</td>
<td>11%</td>
</tr>
</tbody>
</table>
Collaboration in scientific activities

• High level of collaborations with external partners (76% of the publications)

• Universities are the main external partners (present in 60% of the publications)

• International partnership matters (> 1/3 of publications)
  Involving HQ home country (Chemicals > Pharma) or other countries (Chemicals < Pharma)

• National collaborations between internal & external entities take place:
  – in the firm home country (Chemicals (21%) > Pharma (11%))
  – in a foreign country where the firm has set internal facilities (Chemicals (11%) < Pharma (27%))
Collaboration in scientific activities

- Universities represent between 65% and 75% of the external partners in the different modes of collaboration (national & international)

<table>
<thead>
<tr>
<th>Collaboration</th>
<th>chemicals</th>
<th></th>
<th>pharma-biotech</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>national collaboration</td>
<td>international</td>
<td>national collaboration</td>
<td>international</td>
</tr>
<tr>
<td></td>
<td>firm home country</td>
<td>not firm home country</td>
<td></td>
<td>firm home country</td>
</tr>
<tr>
<td>intra firm</td>
<td>8%</td>
<td>5%</td>
<td>5%</td>
<td>11%</td>
</tr>
<tr>
<td>inter firm</td>
<td>7%</td>
<td>15%</td>
<td>18%</td>
<td>7%</td>
</tr>
<tr>
<td>univ</td>
<td>74%</td>
<td>67%</td>
<td>75%</td>
<td>68%</td>
</tr>
<tr>
<td>other entities</td>
<td>14%</td>
<td>15%</td>
<td>22%</td>
<td>16%</td>
</tr>
<tr>
<td>Total</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
<td>100%</td>
</tr>
</tbody>
</table>

- Location of the universities

<table>
<thead>
<tr>
<th>Chemicals</th>
<th></th>
<th>Pharma-biotech</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Countries of university</td>
<td>Share (%)</td>
<td>Countries of university</td>
<td>Share (%)</td>
</tr>
<tr>
<td>DE</td>
<td>25,5</td>
<td>US</td>
<td>31,8</td>
</tr>
<tr>
<td>US</td>
<td>20,3</td>
<td>GB</td>
<td>16,1</td>
</tr>
<tr>
<td>GB</td>
<td>11,9</td>
<td>DE</td>
<td>10,6</td>
</tr>
<tr>
<td>NL</td>
<td>7,9</td>
<td>SE</td>
<td>5,9</td>
</tr>
<tr>
<td>FR</td>
<td>7,4</td>
<td>FR</td>
<td>5,8</td>
</tr>
</tbody>
</table>
– Top non EU external partners

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Pharma-biotech</th>
</tr>
</thead>
<tbody>
<tr>
<td>University of California</td>
<td>University of California</td>
</tr>
<tr>
<td>University of Florida</td>
<td>Harvard University</td>
</tr>
<tr>
<td>United States Government</td>
<td>Scripps Research Institute</td>
</tr>
<tr>
<td>University of Texas</td>
<td>Duke University</td>
</tr>
<tr>
<td>University of Toronto</td>
<td>Stanford University</td>
</tr>
<tr>
<td>Procter and Gamble</td>
<td>University of Pennsylvania</td>
</tr>
<tr>
<td>Harvard University</td>
<td>University of Texas</td>
</tr>
<tr>
<td>University of North Carolina</td>
<td>Johns Hopkins University</td>
</tr>
<tr>
<td>Cornell University</td>
<td>University of Washington</td>
</tr>
<tr>
<td>Alcoa</td>
<td>University of Toronto</td>
</tr>
</tbody>
</table>

- Partnership with US universities:
  Dominant mode of collaboration is a national collaboration, i.e. a US firm entity and US universities:
  - 62% of US univ-EU firms in Chemical
  - 72% of US univ-EU firms in Pharma-biotech
Collaboration in technological activities (patents)

- Technological knowledge is mostly produced internally

<table>
<thead>
<tr>
<th>Share of co-applications in firm's patent applications (%)</th>
<th>Total</th>
<th>internal to large firms</th>
<th>between large firms</th>
<th>with public sector</th>
<th>with other firms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemicals</td>
<td>5,1</td>
<td>1,4</td>
<td>1,1</td>
<td>1,4</td>
<td>1,2</td>
</tr>
<tr>
<td>Pharma-biotech</td>
<td>15,6</td>
<td>10,0</td>
<td>1,7</td>
<td>1,8</td>
<td>2,1</td>
</tr>
</tbody>
</table>
Collaboration in technological activities

- Technological knowledge is produced through national collaborations of inventors

<table>
<thead>
<tr>
<th>Share (%)</th>
<th>Single firm applicant (one applicant)</th>
<th>Co-applications</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>national collaborations (inventors)</td>
<td>international collaborations (inventors)</td>
<td>national collaborations (inventors)</td>
</tr>
<tr>
<td>Chemicals</td>
<td>78,3</td>
<td>16,9</td>
<td>3</td>
</tr>
<tr>
<td>Pharma-biotech</td>
<td>65,2</td>
<td>19,6</td>
<td>10,8</td>
</tr>
</tbody>
</table>

- in the firm’s home country (Chemicals)
- outside the firm’s home country (Pharma-biotech)
Interpretation/Conclusion

- While scientific research is mostly carried out in collaboration with outside partners, technology development is mostly internal to firms.

- European firms rely widely on research collaborations with US universities.

- This dominant collaboration with US universities goes through the European firm’s US subsidiaries.

- Sectors differ significantly in their level of internationalisation: Pharma-biotech is far more internationalised than Chemicals.
Thank you for your attention