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

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SEVENTH FRAMEWORK PROGRAMME

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# 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?

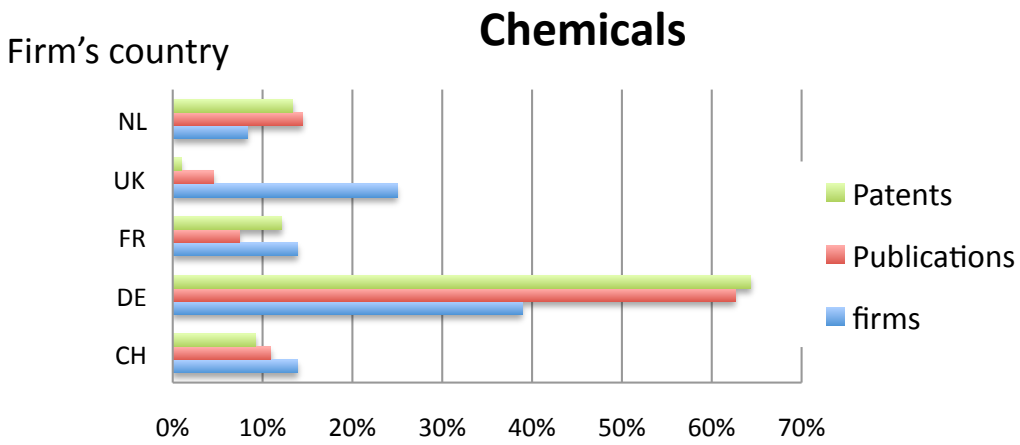
# Data

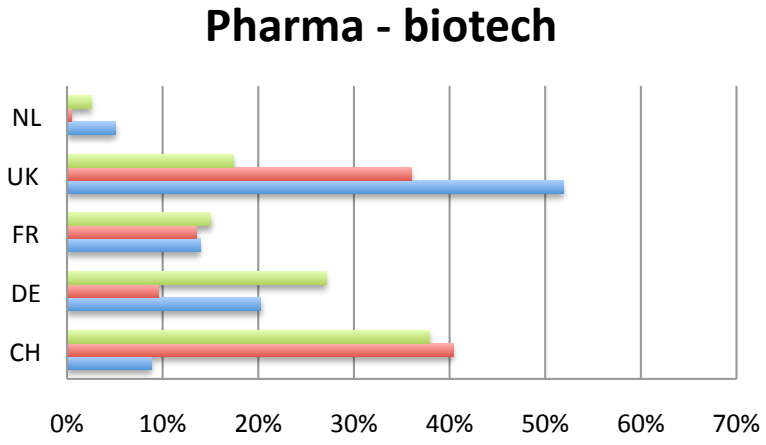
- T**ransnational priority patent applications** (PATSTAT) and **scientific publications** (WoS) produced by **115 firms** with the largest R&D investments from **5 EU countries** (FR, DE, UK, NL, CH) in Chemicals and Pharma-Biotech (using a **consolidated perimeter of the industrial groups** (ORBIS))

| Industrial sectors | Number of firms | Number of scientific publications (2001-2010) | Number of transnational priority patents (2001-2008) |
|---|---|---|---|
| Chemicals | 36 | 18 733 | 22 750 |
| Pharma - biotech | 79 | 69 232 | 13 175 |
| Total | 115 | 87 965 | 35 925 |

- **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

# Countries of knowledge production



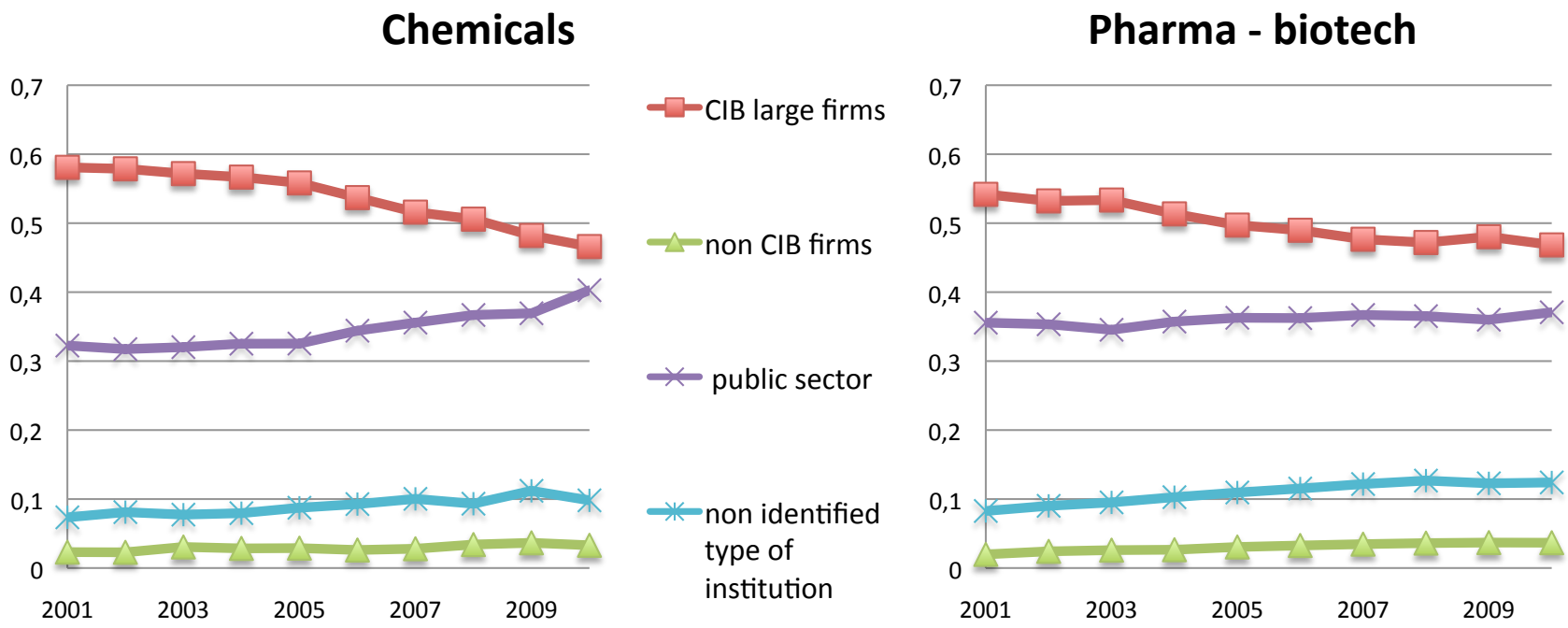

| Patents | | Publications | |
|---|---|---|---|
| Inventor's country | Share (%) | Author's country | Share (%) |
| DE | 61,3 | DE | 33,2 |
| US | 11,2 | US | 22,3 |
| FR | 8,9 | UK | 10,6 |
| NL | 4,2 | NL | 7,3 |
| CH | 3,8 | FR | 7 |
| Others | 10,6 | Others | 19,6 |

| Patents | | Publications | |
|---|---|---|---|
| Inventor's country | Share (%) | Author's country | Share (%) |
| DE | 33,1 | US | 35,4 |
| US | 22,9 | UK | 15,2 |
| FR | 10,7 | DE | 9,4 |
| CH | 8,9 | CH | 8 |
| UK | 8,7 | FR | 7,6 |
| Others | 15,9 | Others | 24,3 |

- 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

| **Chemicals** | | **modes of collaboration** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Internal to the firm | | | External collaborations | | | | Total |
| | | single R&D center | several R&D centers | total | firms | univ | others | total | |
| **geography of collaboration** | national (firm home country) | 10% | 2% | 12% | 3% | 17% | 3% | 21% | 33% |
| | national (not firm home country) | 10% | 1% | 10% | 1% | 13% | 3% | 19% | 29% |
| | international | | 2% | 2% | 5% | 29% | 8% | 36% | 38% |
| | Total | 20% | 4% | 24% | 9% | 59% | 14% | 76% | 100% |

| **Pharma-biotech** | | **modes of collaboration** | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Internal to the firm | | | External collaborations | | | | Total |
| | | single R&D center | several R&D centers | total | firms | univ | others | total | |
| **geography of collaboration** | national (firm home country) | 6% | 1% | 8% | 1% | 8% | 2% | 11% | 18% |
| | national (not firm home country) | 10% | 3% | 13% | 4% | 19% | 5% | 27% | 40% |
| | international | | 3% | 3% | 6% | 32% | 10% | 39% | 42% |
| | Total | 17% | 7% | 24% | 11% | 58% | 17% | 76% | 100% |

# 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)

| Collaboration | chemicals | | | pharma-biotech | | |
|---|---|---|---|---|---|---|
| | national collaboration | | international | national collaboration | | international |
| | firm home country | not firm home country | | firm home country | not firm home country | |
| intra firm | 8% | 5% | 5% | 11% | 9% | 8% |
| inter firm | 7% | 15% | 18% | 7% | 14% | 15% |
| univ | 74% | 67% | 75% | 68% | 64% | 75% |
| other entities | 14% | 15% | 22% | 16% | 16% | 23% |
| Total | 100% | 100% | 100% | 100% | 100% | 100% |

- Location of the universities

| Chemicals | | Pharma-biotech | |
|---|---|---|---|
| Countries of university | Share (%) | Countries of university | Share (%) |
| DE | 25,5 | US | 31,8 |
| US | 20,3 | GB | 16,1 |
| GB | 11,9 | DE | 10,6 |
| NL | 7,9 | SE | 5,9 |
| FR | 7,4 | FR | 5,8 |

– Top non EU external partners

| Chemicals | Pharma-biotech |
|---|---|
| University of California | University of California |
| University of Florida | Harvard University |
| United States Government | Scripps Research Institute |
| University of Texas | Duke University |
| University of Toronto | Stanford University |
| Procter and Gamble | University of Pennsylvania |
| Harvard University | University of Texas |
| University of North Carolina | Johns Hopkins University |
| Cornell University | University of Washington |
| Alcoa | University of Toronto |

- **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

| Share of co-applications in firm's patent applications (%) | Total | internal to large firms | between large firms | with public sector | with other firms |
|---|---|---|---|---|---|
| Chemicals | **5,1** | **1,4** | 1,1 | **1,4** | 1,2 |
| Pharma-biotech | **15,6** | **10,0** | 1,7 | **1,8** | 2,1 |

# Collaboration in technological activities

- Technological knowledge is produced through national collaborations of inventors

| **Share (%)** | **Single firm applicant (one applicant)** | | **Co-applications** | | **Total** |
|---|---|---|---|---|---|
| | national collaborations (inventors) | international collaborations (inventors) | national collaborations (inventors) | international collaborations (inventors) | |
| Chemicals | **78,3** | 16,9 | **3** | 1,9 | 100 |
| Pharma - biotech | **65,2** | 19,6 | **10,8** | 4,4 | 100 |

  - in the firm's home country (Chemicals)
  - outside the firm's home country ( Pharma-biotech)

| Share (%) | Single firm applicant (one applicant | | | |
|---|---|---|---|---|
| | National collaborations | | International collaborations | total |
| | inventors in HQ home country | inventors abroad | international inventors | |
| Chemicals | 58,8% | 23,3% | 17,9% | 100,0% |
| Pharma - biotech | 33,9% | 42,8% | 23,3% | 100,0% |

# 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