The technology sourcing of Spanish biotechnology firms

Adelheid Holl
IPP
CCHS-CSIC
National Research Council of Spain
adelheid.Holl@cchs.csic.es

Ruth Rama
Institute of Economics, Geography and Demography
CCHS-CSIC
National Research Council of Spain
ruth.rama@cchs.csic.es

International Conference "Tentative Governance in Emerging Science and Technology. Actor Constellations, Institutional Arrangements & Strategies", October 28-29 2010, University of Twente, The Netherlands.

The data

Spanish Technological Innovation Panel (PITEC) conducted by the Spanish National Statistics Institute

- 2007 data
- 12,000 firms
- 407 biotechnology firms

Objectives

We analyse the spatial patterns of R&D sourcing in Spanish biotechnology firms and attempt to understand whether their networks display some specificity.

Two forms:

- External sourcing of R&D trough contracts, etc. (we study the nature and location of technology suppliers)
- R&D collaboration (we study the nature and location of partners in cooperation networks)

Which form is more likely to take an international dimension?

Table 1. Bio-technology firms by type of company

	No	*%*
Public	16	3.9
private national	314	77.2
private multinational	55	13.5
research association	22	5.4
Total	407	100

Table 2. Bio-technology firms by type of activity

	No	*%*
Agriculture	42	10.3
Food and drinks	57	14.0
Paper	4	1.0
Chemical products	38	9.3
Farmaceutical products	40	9.8
Rubber and plastic materials	2	0.5
Non-metalic mineral products	2	0.5
Machinery and mecanical equipment	3	0.7
Machinery and electrical equipment	1	0.3
Medical instruments, optical and precisión equipment	8	2.0
Reciling	1	0.3
Production and distribution of energy	6	1.5
Construction	4	1.0
Wholesale trade	20	4.9
Retail trade	1	0.3
Accomodation	2	0.5
Finance	1	0.3
Software	2	0.5
Other computer programming activities	1	0.3
Research and development	91	22.4
Architecture and engineering activities	11	2.7
Testing and technical analysis	23	5.7
Other Business activities	5	1.2
Education	1	0.3
Other health and social activities	41	10.1
Total	407	100

Table 3. External R&D sourcing

A: Bio-technology firms:	*No*	*%*
No external R&D sourcing	178	43.7
Only domestic external R&D sourcing	181	44.5
Only foreign external R&D sourcing	6	1.5
Domestic and foreign external R&D sourcing	42	10.3
Total	407	100.0
B: Non bio-technology firms:		
No external R&D sourcing	8.505	76.0
Only domestic external R&D sourcing	2.265	20.2
Only foreign external R&D sourcing	127	1.1
Domestic and foreign external R&D sourcing	290	2.6
Total	11.187	100.0

Results: External technology sourcing

Biotechnology firms seem more prone than other firms to:

- Source R&D externally
- Source externally in foreign countries, notably in the USA and "Other locations"

Table 4. Domestic versus international external R&D sourcing relations (all bio-technology firms versus non bio-technology firms)

	domestic		foreign		Total
Type of R&D supplier	*No*	*%*	*No*	*%*	
A: Bio-technology firms:					
Intra-group	21	77.8	6	22.2	27
other companies	127	77.4	37	22.6	164
public administration	47	90.4	5	9.6	52
Universities	62	81.6	14	18.4	76
private non-profit organisations	115	96.6	4	3.4	119
other international organisations	18	90.0	2	10.0	20
Total	390	85.2	68	14.8	458
B: Non bio-technology firms:					
Intra-group	248	65.4	131	34.6	379
other companies	587	69.4	259	30.6	846
public administration	552	97.9	12	2.1	564
universities	170	82.1	37	17.9	207
private non-profit organisations	800	98.0	16	2.0	816
other international organisations	186	93.0	14	7.0	200
Total	2543	84.4	469	15.6	3012

Note: multiple responses; categories are not exclusive.

Patterns of external technology sourcing

Compared to the average firm, patterns of biotech firms are more international with regard to three aspects:

- Sourcing within the company
- Sourcing from other private companies
- Sourcing from universities

Table 5. Firm characteristics of external R&D outsourcers, domestic, and foreign outsourcers: mean difference tests

	R&D sourcing		*sig*	R&D sourcing		*sig*	R&D sourcing (without within-group)		*sig*
	no	**yes**		**only domestic**	**foreign**		**only domestic**	**foreign**	
Firm characteristics									
number of employees	267.5	204.6		191.8	252.8		199.5	216.8	
number of R&D employees	**15.4**	**23.8**	**	**18.4**	**44.5**	*	**18.3**	**36.4**	*
firm belongs to a group	0.4	0.47		**0.43**	**0.63**	*	**0.37**	**0.53**	**
multinational company	0.16	0.12		**0.1**	**0.19**	**	**0.1**	**0.18**	***
headquarter in Spain	**0.25**	**0.34**	**	**0.31**	**0.46**	**	**0.26**	**0.37**	***
sales per employee	11.4	11.6		11.6	11.7		11.5	11.6	
investment per employee	**8.4**	**9**	*	9	9.2		9	9.2	
firms that have applied for patents: 2005-2007	**0.16**	**0.38**	*	**0.32**	**0.6**	*	**0.3**	**0.61**	*
number of patents applied for 2005-2007	**0.54**	**2.86**	**	**1.38**	**8.46**	*	1.2	1.9	
Markets									
firms operating in local markets	0.08	0.07		0.08	0.04		0.07	0.05	
firms operating in the national market	**0.28**	**0.19**	**	**0.21**	**0.10**	***	0.21	0.13	
firms operating in the european market (mdoue)	**0.62**	**0.72**	**	**0.69**	**0.83**	**	0.69	0.79	
firms operating in the Europe market (not other)	0.23	0.23		0.24	0.19		0.24	0.13	
firms operating in other markets than Europe	**0.41**	**0.51**	**	**0.47**	**0.67**	*	**0.47**	**0.68**	*
firms engaged in exporting (dummy)	**0.35**	**0.47**	**	**0.43**	**0.60**	**	**0.43**	**0.61**	**
firms that have received Europe financing	**0.10**	**0.23**	*	**0.21**	**0.31**	***	**0.20**	**0.34**	**
firms participating in FP6 framework programme	**0.06**	**0.14**	*	0.14	0.15		0.14	0.13	
Location									
Madrid	0.12	0.15		0.14	0.19		0.15	0.13	
Cataluña	**0.22**	**0.3**	**	**0.24**	**0.52**	*	0.23	0.53	
Pais Vasco	**0.05**	**0.14**	*	**0.17**	**0.02**	**	**0.16**	**0.03**	**
Valencia	0.12	0.1		0.1	0.1		0.1	0.13	
firms with international cooperation for innovation	**0.37**	**0.58**	*	0.57	0.60		0.57	0.63	

Note: Significance at the 1%, 5% and 10% level is indicated by *, **, ***.

What types of firms source technology externally?

- They have more R&D employees
- Tend to be Spanish
- Greater investment per employee
- Operate in the European market
- Have received EU financing
- Have participated in FP6 programmes
- Have applied for patents
- Tend to be located in Catalonia or Basque Country

What types of firm source externally in foreign countries?

- They have more R&D employees
- Belong to groups or multinational networks
- Have their headquarters in Spain
- Operate in the European market
- Have received EU financing
- Greater mean no. of patents
- Tend to be located in Catalonia

Table 6. Cooperations for innovation among innovation active firms

A: Bio-technology firms:	*No*	*%*
No cooperation for innovation	161	41.0
Only domestic cooperations for innovation	14	3.6
Only foreign cooperations for innovation	120	30.5
Domestic and foreign cooperations for innovation	98	24.9
Total	393	100.0
B: Non bio-technology firms:		
No cooperation for innovation	5.555	66.8
Only domestic cooperations for innovation	453	5.4
Only foreign cooperations for innovation	1.238	14.9
Domestic and foreign cooperations for innovation	1.070	12.9
Total	8.316	100.0

Results: R&D cooperation

Compared with the average firm, biotechnology firms seem more prone to:

- Cooperate
- Engage in international R&D cooperation

Table 7a. Domestic versus international cooperations for innovation - biotechnology

Biotechnology	domestic	C%	R%	Europe	C%	R%	USA	C%	R%	other	C%	R%	Total
intra-group	46	26.0	14.6	68	33.3	21.6	89	24.7	28.3	112	42.6	35.6	315
Supplier	19	10.7	18.1	27	13.2	25.7	33	9.2	31.4	26	9.9	24.8	105
Client	9	5.1	30.0	4	2.0	13.3	12	3.3	40.0	5	1.9	16.7	30
competitor or other firms in the sector	1	0.6	4.0	11	5.4	44.0	7	1.9	28.0	6	2.3	24.0	25
private R&D labs	56	31.6	16.2	52	25.5	15.1	150	41.7	43.5	87	33.1	25.2	345
Universities	29	16.4	22.7	33	16.2	25.8	44	12.2	34.4	22	8.4	17.2	128
public research organisations	12	6.8	37.5	6	2.9	18.8	13	3.6	40.6	1	0.4	3.1	32
technology centres	5	2.8	20.8	3	1.5	12.5	12	3.3	50.0	4	1.5	16.7	24
Total	177	100	17.6	204	100	20.3	360	100	35.9	263	100	26.2	1004
non-bio-technology													
intra-group	535	22.7	20.6	745	39.9	28.7	763	32.2	29.4	550	30.1	21.2	2593
Supplier	242	10.3	32.7	251	13.5	34.0	152	6.4	20.6	94	5.2	12.7	739
Client	57	2.4	42.2	50	2.7	37.0	19	0.8	14.1	9	0.5	6.7	135
competitor or other firms in the sector	49	2.1	34.8	57	3.1	40.4	16	0.7	11.3	19	1.0	13.5	141
private R&D labs	1011	42.9	27.4	490	26.3	13.3	1176	49.7	31.8	1017	55.7	27.5	3694
Universities	352	14.9	40.6	206	11.0	23.8	192	8.1	22.2	116	6.4	13.4	866
public research organisations	66	2.8	53.2	28	1.5	22.6	23	1.0	18.5	7	0.4	5.6	124
technology centres	44	1.9	35.8	39	2.1	31.7	27	1.1	22.0	13	0.7	10.6	123
Total	2356	100	28.0	1866	100	22.2	2368	100	28.1	1825	100	21.7	8415

Note: multiple responses; categories are not exclusive.

Table 7b. Comparing location of cooperation partner for bio and non bio firms by type of cooperation

	domestic	sig.	Europe	sig.	USA	sig.	other	sig.
intra-group	0.528		0.658		0.649		**0.000**	***
supplier	0.097		1.000		**0.000**	***	**0.000**	***
client	1.000		**0.096**	*	**0.001**	***	0.163	
competitor or other companies in the sector	**0.003**	***	1.000		0.116		0.765	
private R&D labs	**0.000**	***	0.564		**0.000**	***	1.000	
universities	**0.001**	***	0.727		**0.000**	***	0.293	
public research organisations	1.000		1.000		**0.006**	***	1.000	
technology centres	0.315		0.109		**0.022**	**	1.000	

Note: multiple responses; categories are not exclusive. Significance is based on Pearson chi2 p-value: *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

Table 7c. Comparing type of cooperation partner for bio and non bio firms by location of cooperation partner

	domestic	sig.	Europe	sig.	USA	sig.	other	sig.
intra-group	1.000		1.000		1.000		**0.000**	***
supplier	1.000		1.000		**0.003**	***	**0.000**	***
client	0.207		1.000		**0.000**	***	**0.017**	**
competitor or other companies in the sector	1.000		0.164		**0.011**	**	0.221	
private R&D labs	**0.004**	***	1.000		0.122		**0.000**	***
universities	1.000		**0.010**	***	**0.000**	***	0.247	
public research organisations	**0.018**	**	0.431		**0.000**	***	1.000	
technology centres	1.000		1.000		**0.000**	***	0.644	

Note: multiple responses; categories are not exclusive. Significance is based on Pearson chi2 p-value: *** significant at the 1% level; ** significant at the 5% level; *significant at the 10% level

Geographic patterns of R&D cooperation

If we compare biotechnology and non-biotechnology firms with regard to the geographic distribution of different types of R&D collaborations (rows on Table 7 a), biotechnology firms show the following patterns:

- Intra-group cooperation: Biotech firms show greater collaboration with partners located in "other locations" (35.6% of the biotech firms which cooperate within their group cooperate with partners who are in "other locations" versus only 21.2% of non biotech firms)
- Cooperation with suppliers: Biotech firms are more inclined to cooperate with suppliers located in "other locations" (24.8% of biotech firms vs. only 12.7% of non-biotech firms) or in the USA (31.4% of the biotech firms which cooperate with suppliers vs. only 20.6%)
- Cooperation with clients: Biotech firms are more inclined to cooperate with clients located in the USA (40.0% of biotech firms vs only 14.1%). By contrast, these types of partners are less likely to be located in the EU (only 13.3% of biotech firms vs. 37.0%)
- Cooperation with competitors and other firms: Biotech firms are less likely to cooperate with domestic partners (4.0% vs 34.8%)
- Cooperation with private labs: Biotech firms are less likely to cooperate with domestic partners (16.2% vs. 27.4%). By contrast, they are more likely to cooperate with partners located in the USA (43.5% vs. 31.8%)
- Cooperation with universities: Biotech firms are less likely to cooperate with Spanish Universities (22.7 of biotech firms vs. 40.6%). By contrast among the biotech firms which cooperate with universities, 34.4% cooperate with US universities (versus only 22.2% of non biotech firms).

If we compare preferences by location, we also find that biotechnoly firms show some specificity (columns on Table 7a)

- Collaborations with Spanish partners

In this location, biotech firms display greater interest in public research organisations (6.8% vs. only 2.8% of non biotech firms) but less interest in private R&D labs (31.6% vs 42.9%)

- Collaborations with EU partners

Biotech firms tend to cooperate to a greater extent with EU universities (25.8% vs. only 11.0% of non-biotech firms)

- Collaborations with US partners

In this respect, biotech firms displays the greatest differences with non biotech firms because biotech firms are more likely to cooperate with US suppliers, clients and competitors or other companies, universities, public research organisations and technology centres.

- Collaborations with other partners

Biotech firms are more likely than non-biotech firms to cooperate with: intra-group partners, suppliers, clients and private R&D labs

Table 8. Characteristics of firms with and without cooperations for innovation; domestic, and foreign cooperations: mean difference tests

	Cooperations		*sig*	Cooerations		*sig*	Cooperations (without within-group only firms)		*sig*
	no	yes		domestic	Only foreign		domestic	Only foreign	
Firm characteristics									
number of employees	**158.0**	**289.10**	***	**512.70**	**80.45**	*	**539.81**	**77.59**	*
number of R&D employees	**14.00**	**25.30**	*	**32.50**	**18.60**	*	**34.29**	**19.90**	**
firm belongs to a group	**0.39**	**0.47**	**	**0.67**	**0.28**	*	**0.64**	**0.26**	*
multinational company	0.16	0.11		0.13	0.09		0.14	0.10	
headquarter in Spain	**0.24**	**0.34**	**	**0.48**	**0.20**	*	**0.45**	**0.18**	*
sales per employee	11.60	11.40		**11.68**	**11.18**	*	**11.70**	**11.14**	*
investment per employee	8.83	8.79		8.89	8.69		8.90	8.74	
firms that have applied for patents: 2005-2007	**0.20**	**0.35**	*	0.40	0.31		0.42	0.34	
number of patents applied for 2005-2007	1.01	2.53		4.23	0.94		4.53	1.07	
Markets									
firms operating in local markets	**0.11**	**0.05**	**	0.05	0.05		0.05	0.06	
firms operating in the national market	**0.26**	**0.18**	**	**0.13**	**0.23**	***	**0.12**	**0.20**	***
firms operating in the European market (mdoue)	**0.61**	**0.75**	*	0.79	0.71		**0.82**	**0.72**	***
firms operating in the Europe market (not other)	**0.22**	**0.24**	**	0.27	0.22		0.27	0.23	
firms operating in other markets than Europe	**0.42**	**0.53**	**	0.54	0.51		0.57	0.51	
firms engaged in exporting (dummy)	**0.37**	**0.47**	**	0.50	0.44		0.53	0.46	
EU financing	**0.07**	**0.25**	*	0.29	0.22		0.31	0.23	
firms participating in FP6 framework programme	**0.04**	**0.16**	*	0.20	0.12		**0.21**	**0.11**	**
Location									
Madrid	0.12	0.16		**0.21**	**0.11**	**	**0.21**	**0.11**	**
Cataluña	0.29	0.26		0.30	0.23		0.32	0.22	
Pais Vasco	**0.06**	**0.13**	**	0.12	0.15		0.13	0.14	
Valencia	0.12	0.10		0.11	0.09		0.11	0.76	
firms with international R&D outsourcing	**0.07**	**0.14**	**	0.17	0.12		**0.18**	**0.10**	***

Note: Significance at the 1%, 5% and 10% level is indicated by *, **, ***.

Characteristics of firms engaged in R&D cooperation
(compared to firms with no cooperation for innovation)

- Are larger
- Have more R&D employees
- Belong to a group
- Have their headquarters in Spain
- Operate more often in the EU market
- Have received EU financing
- Have participated in FP 6 programmes
- Have applied for patents
- Are located in the Basque country

Characteristics of firms which only cooperate with foreign partners

- Tend to be smaller
- Have fewer R&D employees
- Only one industrial establishment (as opposed to groups)
- They are less often located in Madrid

Comparison of external technology sourcing and R&D cooperation

- External technology sourcing is more localised (domestic)
- Cooperation for innovation is to a greater extent within the same group
- External technology sourcing occurs mainly with other companies