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The Roles of Research at Universities and Public Labs in Innovation Systems: a Perspective from the Italian Faculties of Agriculture

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Presentation outline

- the literature review;
- the issues of this paper;
- the methodology;
- the data of the Food and Drink (F&D) industry and of the faculties of agriculture;
- the results.

Literature review

Traditional roles of universities: research and teaching - expertise offered to the local labour market especially relevant for small and medium firms

Universities as incubators of new technology-based firms through spin-off effects, attraction of external investments and technology transfer: Mansfield, 1991; Rosenberg and Nelson 1994

Triple-helix model of university-industry-government relations: Etzkowitz and Leydesdorff, 2000; Etzkowitz, 2004

The theoretical prescription

Geographical proximity to centres of research excellence relevant for university-firm collaboration aimed at technology transfer

the relationship is not linear

(D'Este& Iammarino, 2010)

since:

Tacit *vs* codified knowledge

geographical proximity especially relevant:

- in the transmission of tacit knowledge, which is personal and context-dependent (Morgan, 2004)
- in the presence of cognitive gaps (de Jong and Freel, 2010)
- in the presence of information asymmetry between researchers and research users
- for small and medium firms (Audretsch and Vivarelli, 1996; Piergiovanni *et al.*, 1997)
- for certain groups of disciplines, such as applied research and social sciences (Mansfield&Lee, 1996; Audretsch *et al.*, 2005)

Other determinants of university-firm collaboration

University and department size (number of researchers, percentage of time devoted to research activities) or R&D intensity

University faculty/discipline composition or academic scientific specialisation

Technology transfer office

Regional location of university for tacit-knowledge-intensive industries

Age, carrier status and gender of scholars

Firm size and ownership, public subsidies and multi-purpose nature of university-firm collaboration

The issues that this paper addresses

How does geographical proximity explain the choice of R&D university-industry collaboration?

Which type of innovation is more sensitive to geographical proximity?

How does academic research quality affect university-industry collaboration and innovation?

How does codified knowledge affect product and process innovation?

Which is the impact of training at universities on university-industry collaboration?

Methodology: trivariate probit regression

$$\begin{cases} y_{1i}^{*} = \mathbf{x}_{1i}'\boldsymbol{\beta}_1 + \epsilon_{1i} \\ y_{2i}^{*} = \gamma_{21}\, y_{1i}^{*} + \mathbf{x}_{2i}'\boldsymbol{\beta}_2 + \epsilon_{2i} \\ y_{3i}^{*} = \gamma_{31}\, y_{1i}^{*} + \mathbf{x}_{3i}'\boldsymbol{\beta}_3 + \epsilon_{3i} \end{cases}$$

y_1^* = presence of R&D collaboration with University or pubblic research lab

y_2^*= presence of firm product innovation

y_3^*= presence of firm process innovation

x, z variable vectors which influence those probabilities for firm *i*

$(F_{un}, F_{inn1}, F_{inn2})_i$ trivariate variable associated to (y_1^*, y_2^*, y_3^*)

Firm data

Capitalia survey on innovation in Italian manufacturing firms

representative of firms with at least 10 employees

From 7th (1995-'97), 8th (1998-2000), 9th (2001-'03) and 10th waves (2004-'06) -> a pool of 1,744 Food&Drink firms

Turnover classes defined in ml (2006-based) €:

very small < 5
small ≥ 5 - 25
medium ≥ 25 - 50
large ≥ 50-100
very large ≥ 100

Geographical proximity

The questionnaire asked whether R&D was in-house or acquired from external sources of which from universities and public research labs.

From the municipality in which the firm is located, three distances, as the crow flies, have been downloaded from the three closest faculties of agriculture.

Distance from the faculties of agriculture	**Mean**
1st distance (km)	48
2nd distance (km)	109
3rd distance (km)	145
Dummy for distance > 150 km from the 1st closest faculty	0.02

Faculty reputation

Of the the 1st closest faculty, different characteristics have been gathered

Research quality indicators

- VQR grades for 2001-2003 and 2004-2010

national evaluation of the public research output using both bibliometric analysis and informed peer review

- Codified knowledge indicators

built through the medians of the ISI-Scopus indexed scientific production of the populations of full professors of the Italian faculties of agriculture grouped by scientific discipline over the 2002-2012 period

- Censis research grade

based on the number of research projects financed by national and international institutions

- Censis international grade

based on the international mobility of scholars and students

Faculty data

University characteristics	Mean	Std. Dev.
No. regional bachelor biotechnologist courses	0.61	0.49
N. of regional faculties of agriculture	1.53	1.00
Dummy for public university	0.97	0.18
Dummy for technological transfer office	0.22	0.41
Faculty characteristics		
Dummy for extra-regional faculty of agriculture	0.12	0.32
Dummy for food technologist bachelor 3-year degree	0.54	0.50
Dummy for food technologist bachelor 5-year degree	0.42	0.49
Faculty of agriculture's age (years)	50.00	24.93
N. of researchers/professors	109.93	51.55
N. of graduates	166.77	127.02
Women on full professors (%)	10.74	9.85
Researchers on total scholars (%)	34.56	10.39
Average age of scholars	48.19	4.68
N. of scientific disciplines' groups	5.56	1.81
Industrial engineers on total scholars (%)	0.63	1.53
Biologists on total scholars (%)	8.53	10.79
Chemicals on total scholars (%)	5.98	8.03
Physicians on total scholars (%)	1.03	3.71
Geologists on total scholars (%)	1.11	2.08
International grade	64.62	28.39
Research grade	82.46	16.49
Codified knowledge indicator (No. journal articles)	18.57	1.76
VQR grade	68.43	9.03
Food science dept.' VQR grade	68.80	22.16
Chemistry dept.' VQR grade	70.85	20.61
Agronomy dept.' VQR grade	59.17	22.48
Plant science dept.' VQR grade	50.95	23.39
Animal science dept.' VQR grade	63.57	21.62
Entomology dept.' VQR grade	58.39	18.81

Goodness of fit

	model 1	*model 2*	*model 3*	*model 4*	*model 5*	*model 6*	*model 7*
N. obs.	1535	1535	1535	1535	722	722	722
LogL	-2083	-2082	-2049	-2042	-946	-946	-934
rho21	-0.03	-0.03	-0.01	-0.01	0.17	0.15*	0.15
rho31	-0.14*	-0.14	-0.12	-0.11	0.17**	0.16**	0.17**
rho32	0.42***	0.42***	0.43***	0.43***	0.55***	0.55***	0.55***
LR	105	103	103	104	88	88	84

The likelihood ratio test, which was conducted on the hypothesis that rho_{21} and rho_{31} are jointly null, supports the trivariate framework

Results (1)

Firm characteristics

Positive determinants of R&D university-firm collaboration are: R&D collaboration with private firms, skilled employees, R&D intensity and subsidies.

Very small-sized firms and coops don't collaborate

Geographical proximity

Firms, which are more than 150 km away from the closest faculty of agriculture, choose to collaborate with it.

Faculty characteristics

The 5-year food technologist course is a channel for R&D university collaboration.

Faculty size is significant and positive only in absence of academic research quality indicators.

The absence of gender segregation induces R&D university collaboration.

The codified knowledge indicator is positive and significant while the VQR is weakly significant

Marginal effects for the dependent variable R&D university and public research labs-firm collaboration

Variables	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx
	model 1	*model 2*	*model 3*	*model 4*	*model 5*	*model 6*	*model 7*
R&D collaborations with private firms	0.08***	0.08***	0.09***	0.09***	0.07**	0.07**	0.07**
Skilled employees	0.002**	0.002**	0.002**	0.002**	0.003***	0.003***	0.003***
R&D intensity	0.01**	0.01**	0.01**	0.01**	0.00	0.00	0.00
Co-op firm	-0.05**	-0.05**	-0.05**	-0.05**	-0.04*	-0.04*	-0.04*
Subsidies	0.05***	0.05***	0.05***	0.05***	0.05**	0.05**	0.05**
Non standard jobs	0.03***	0.03***	0.02**	0.02**	-0.01	-0.02	-0.02
Firm age	0.00	0.00	0.00	0.00	0.0005**	0.0005**	0.001**
Very small-sized firm	-0.09**	-0.07***	-0.08**	-0.08**	-0.10***	-0.10***	-0.11***
1st distance	0.00						
Distance > 150 km		0.06***	0.05***	0.05***	0.04	0.04	0.04
Biotechnologist courses			-0.01	-0.02	-0.08**	-0.06*	-0.06*
Food technologist bachelor 5-year course			0.07***	0.07***	0.04**	0.03**	0.04
Food technologist bachelor 3-year course			-0.04***	-0.05***	-0.02	-0.04**	-0.08**
Extra-regional faculty of agriculture			0.00	0.00	0.02	0.01	0.01
Faculty of agriculture 's age			-0.002**	-0.002**	-0.001	0.00	0.00
N. of researchers/professors			0.001**	0.001*	0.00	0.00	0.002*
Biologists on total scholars			0.00	0.00	0.004**	0.00	0.00
Chemicals on total scholars			-0.004***	-0.01***	-0.01**	-0.01	0.00
Physicians on total scholars			0.0003**	0.00	0.01	0.01	0.01
Geologists on total scholars			0.01**	0.01**	0.01	0.01	0.02
Women on full professors			0.002***	0.002***	0.00	0.003***	0.005***
Researchers on total researchers/professors			-0.002**	-0.003**	0.00	0.00	0.00
N. of regional faculties of agriculture			-0.002**	-0.02**	0.00	-0.03**	-0.02
Public univerisity			-0.13**	-0.12**	-0.11	-0.19**	-0.24**
Research grade				0.0001*			
Codified knowledge indicator				0.01**			
VQR grade					0.005*		
Food science dept.' s VQR grade						0.001*	0.003*
Plant science dept.' s VQR grade							-0.001*
Agronomy dept.' s VQR grade							0.003*

Results (2)

Firm characteristics

Positive determinants of product innovation are: R&D collaboration with private firms, skilled employees, R&D intensity and subsidies.

Very small- and small-sized firms and coops don't innovate

Geographical proximity

Firms, which are more than 150 km away from the closest faculty of agriculture, have 0.19 less probability of product innovation.

Faculty characteristics

The 3-year food technologist course is a channel for product innovation.

The number of regional faculties of agriculture is significant and positive.

The codified knowledge indicator is negative and highly significant.

Marginal effects for the dependant variable product innovation

Variables	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx
	model 1	*model 2*	*model 3*	*model 4*	*model 5*	*model 6*
R&D university-firm collaboration	0.09	0.10	0.08	0.09	-0.10	-0.13
R&D collaborations with private firm	0.13***	0.13***	0.13***	0.13***	0.08*	0.09*
R&D intensity	0.02**	0.02**	0.02**	0.02**	0.02*	0.02*
Skilled employees	0.003**	0.003**	0.003**	0.003**	0.00	0.00
Co-op firm	-0.04**	-0.05**	-0.05**	-0.05**	-0.04	-0.03
Subsidies	0.17***	0.17***	0.17***	0.18***	0.33***	0.33***
Very small-sized firm	-0.09**	-0.10**	-0.09**	-0.08**	-0.08	-0.08
Small-sized firm	-0.06**	-0.06**	-0.05	-0.05*	-0.02	-0.02
North	-0.03	-0.03	-0.05	-0.07*	-0.10	-0.13
South	-0.02	-0.02	0.04	0.04	0.06	0.08
Agricultural district	-0.04	-0.06**	-0.06**	-0.07**	-0.18**	-0.17
1st distance	-0.001**					
Distance > 150 km		-0.16***	-0.19***	-0.19***	-0.07	-0.05
Biotechnologist courses			0.00	0.00	0.10	0.07
Food technologist 5-year course			0.02	0.01	0.09**	0.09*
Food technologist 3-year course			0.05**	0.05**	0.01	0.04
No. of researchers/professors			-0.001*	-0.001*	-0.001	-0.001*
No. of graduates			0.00	0.00	0.00	0.00
Biologists on total scholars			0.00	0.00	0.00	0.00
Chemicals on total scholars			0.00	0.004***	0.00	0.00
Geologists on total scholars			0.01	0.01	0.01	0.01
N. of scientific macro-fields			0.03**	0.03***	0.02	0.02
N. of regional faculties of agriculture			0.03***	0.04***	0.02	0.04***
International grade				0.00		
Research grade				-0.002**		
Codified knowledge indicator				-0.03***		
VQR grade					-0.005	
Food science dept.' VQR grade						0.00

Results (3)

Firm characteristics

Positive determinants of process innovation are: R&D university and public research labs-firm collaboration, R&D collaboration with private firms, R&D intensity, subsidies and sales through distribution chains.

No size effect is significant.

Geographical proximity

Distance doesn't affect process innovation.

Faculty characteristics

The number of scientific macro-fields is significant.

The research grade indicator is positive and significant.

Marginal effects for the dependant variable process innovation

Variables	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx	dF/dx
	model 1	*model 2*	*model 3*	model 4	*model 5*	*model 6*
R&D university-firm collaboration	0.26**	0.26**	0.26***	0.24**	0.02	0.02
R&D collaborations with private firm	0.11*	0.11*	0.10*	0.11*	0.10*	0.10
R&D intensity	0.03***	0.03***	0.03***	0.03***	0.03***	0.03***
Skilled employees	0.00	0.00	0.00	0.00	0.00	0.00
Sales through distribution chain	0.0005***	0.0005***	0.0005*	0.0005***	0.001**	0.001*
Subsidies	0.20***	0.20***	0.20***	0.21***	0.24***	0.24***
Very small-sized firm	-0.06	-0.06	-0.06	-0.06	-0.05	-0.05
North	-0.07*	-0.07	-0.07**	-0.06*	-0.07	-0.09
South	-0.02	-0.02	-0.02	-0.01	-0.11*	-0.11
Agricultural district	0.02	0.01	0.01	0.00	-0.11***	-0.11***
1st distance	0.00					
Distance > 150 km		-0.11	-0.10	-0.09	-0.19	-0.19
Biotechnologist courses			-0.01	0.00	-0.09	-0.11**
Biologists on total scholars			0.00	0.00	-0.01***	-0.01***
Physicians on total scholars			0.00	0.00	0.02**	0.02**
N. of scientific macro-fields			0.02**	0.02**	0.05***	0.05***
Public univerisity			-0.26***	-0.26***	-0.42**	-0.42**
International grade				0.00		
Research grade				0.002**		
Codified knowledge indicator				0.00		
VQR grade					0.00	
Food science dept.' VQR grade						0.00

Concluding remarks

In the Italian F&D industry of the 1995-2006 period:

- Geographical proximity to faculty of agriculture affects the choice of R&D university-firm collaboration only for isolated firms (which are more than 150 km away from the closest faculty);
- Codified knowledge production of the closest faculty of agriculture affects R&D university-firm collaboration.
- Training is a channel for R&D university collaboration.
- Product innovation is a tacit knowledge-intensive process since geographical proximity (within 150 kms) to a faculty of agriculture enhances innovation
- Process innovation is a codified knowledge-intensive process since R&D university ad public research labs collaboration is a significant determinant of innovation