

# Enhancing University–Industry collaboration: the role of intermediary organizations

Fernando Alexandre, Hélder Costa, Ana Paula Faria and Miguel Portela  
GPEARI/GEE 93° Seminar

NIPE/University of Minho

April 17, 2024

# Motivation

- In the so-called third mission, universities have been developing several strategies to facilitate knowledge transfer between academia and firms (i.e., TTOs, CRCs, incubators and science parks).
- Interface institutions' main purpose is to avoid systemic failures by establishing linkages among actors of the innovation system - universities, firms and government agencies.
- The purpose of this paper is to examine the role played by intermediary organizations in U-I interactions by exploring firms' differences across two institutional modes of interaction.
  - U-I links are a critical strategic response to global competition, and particularly important to regional growth, where systems of small - and medium-sized firms are located.
  - The general view is that intermediary organizations are particularly important to small sized firms.

## Motivation

- This study builds on industrial organization and proximity approach literatures to examine firm-specific characteristics as well as motives, benefits from and barriers that underly U-I interactions.
- We employ original U-I R&D collaboration data collected from a mid-range university located in Northern Portugal for the period 2009–2016, which we combine with different data sources—census data, survey data and interviews.
- These allow deeper insights regarding drivers, benefits and barriers of U-I links.
- This paper thus provides evidence, from mid-level universities and regions, particularly regarding U-I links, as much of existing literature focuses on strong research universities situated in developed high-tech entrepreneurial environment.

## Brief literature overview

- Empirical evidence consistently shows that R&D collaboration with universities is mostly used by large-sized firms that vertically integrate R&D activities.
  - As stronger investors in R&D, larger firms are more prone to have absorptive capabilities, more capable at combining both internal and external knowledge and interact with universities (Aristei et al. (2016); Bekkers and Freitas (2008); Cassiman and Veugelers (2002); W. M. Cohen et al. (2002); Fontana et al. (2006)).
- Nevertheless, small firms also seek R&D collaboration with universities. Cost sharing is a particularly important determinant among SMEs, which do not always have enough internal funds or collaterals to support their innovative activities.
  - Recent evidence has shown that technology transfers from universities is particularly beneficial for small-sized and resource-constrained firms (García-Vega and Vicente-Chirivella (2020); Spanos (2021)).

## Research design and data

- We follow a strategy of analysis based on three steps:
  - In the first step, we identify the characteristics of firms involved in U-I links, using data from reports and census data.
  - In the second step, we use survey data to analyse firms' perspectives on key drivers, benefits and barriers in U-I partnerships.
  - In the final step, using information from semi-structured interviews with the directors of the intermediary organizations we discuss the barriers and outcomes in the U-I interactions.

Step 1:

# Profiling firms in U-I links

# Data

- We collected data for the period 2009–2016 referent to R&D projects by the University of Minho, the university's TTO and three CRCs.
  - 282 university–industry R&D projects.
  - These projects include a total of 397 partners, 354 of which are firms and 185 are based in Portugal.
  - There were 157 R&D projects executed directly by the University of Minho and 125 R&D projects executed through the intermediary organizations, corresponding to 162 million euros and 22 million euros R&D investment, respectively.
- This information was complemented with the *Sistema de Contas Integradas das Empresas* and *Quadros de Pessoal* database.
  - From these datasets we collected data on firm's number of employees, turnover, exports, industry, location and labour force and management team education.

# Data

- We defined three subsets of firms:
  - Firms developing R&D partnerships directly through the university's research centres (164 firms).
  - Firms developing R&D partnerships through university-based intermediary organizations (47 firms).
  - A comparable set of firms, that we call the 'rest of the economy' that do not participate in R&D partnerships with universities, based on firm's location, industry classification, turnover, gross added value, number of employees and exports as categorical variables (4585 firms).

## Econometric strategy

- In order to determine whether intermediary organizations play a key role in the U-I interactions, we defined two econometric models.
  - A specification that uses as dependent variable a dummy which assumes the value 1 if the firm has a R&D collaboration with University of Minho, either via university or via intermediaries; and 0 otherwise.
  - A specification that uses as dependent variable a categorical indicator that assumes the value of 0 if a firm doesn't have a R&D collaboration with University of Minho, a value of 1 if the firm has a R&D collaboration via university, and 2 if a company has a R&D collaboration via intermediaries.

## Econometric strategy

$$\begin{aligned}
 \text{Collaboration} = & \beta_0 + \beta_1 \text{Size} + \beta_2 \text{Turnover} + \beta_3 \text{R \& D} \\
 & + \beta_4 \text{WorkerEduc} + \beta_5 \text{ManagerEduc} \\
 & + \beta_6 \text{TechOpenness} + \beta_7 \text{Export} + \beta_8 \text{Solvency} \\
 & + \beta_9 \text{Region} + \beta_{10} \text{Industry} + \beta_{11} \text{Year}
 \end{aligned} \tag{1}$$

- *Size* assumes the value 1 if a firm has less than 10 employees; 2 if between 10 and 49 employees; 3 if between 50 and 249 employees; and 4 if has 250 or more employees.
- *Turnover* is the logarithm of operating revenue.
- *R&D* takes the value 1 if the firm had R&D spending.
- *WorkerEduc* and *ManagerEduc* assume the value 1 if average years of schooling is up to 6; the value of 2 if between 7 and 9; the value of 3 if between 10 and 12; and a value of 4 if more than 12.
- *TechOpenness* is measured by the ratio of intangible assets to the firm's total assets.
- *Export* is defined by ratio of firm's exports over operating revenue.

# Results

Table 1: Probit model estimation of probability of firms to engage on U-I joint R&D collaboration by interaction mode

Variable name	All firms	Firms interacting via university
Small	0.007** (0.001)	0.006*** (0.001)
Medium	0.029*** (0.003)	0.026*** (0.003)
Large	0.0745*** (0.014)	0.061*** (0.012)
R&D	0.186*** (0.030)	0.147*** (0.026)
WorkerEduc: up to 6 years	-0.037*** (0.004)	-0.027*** (0.003)
WorkerEduc: 7-9 years	-0.033*** (0.004)	-0.026*** (0.003)
WorkerEduc: 10-12 years	-0.025*** (0.004)	-0.020*** (0.003)
ManagerEduc: up to 6 years	-0.015*** (0.001)	-0.012*** (0.001)
ManagerEduc: 7-9 years	-0.015*** (0.001)	-0.013*** (0.001)
ManagerEduc: 10-12 years	-0.010*** (0.001)	-0.009*** (0.001)
TechOpenness	0.036*** (0.005)	0.026*** (0.004)
Export	0.006*** (0.002)	0.003 (0.004)
Centro region	0.001 (0.001)	0.003* (0.001)
Lisboa region	-0.008*** (0.001)	-0.007*** (0.001)
Other regions	0.011** (0.007)	0.018*** (0.008)

## Results

Table 2: Multinomial probit model estimation of U-I joint R&amp;D collaboration by interaction mode

Variable name	Rest of the economy	Via university	Via intermediary
Small	- 0.007*** (0.001)	0.006*** (0.001)	0.001** (0.000)
Medium	- 0.027*** (0.003)	0.023*** (0.003)	0.004*** (0.001)
Large	- 0.073*** (0.013)	0.063*** (0.011)	0.025*** (0.006)
R&D	- 0.251*** (0.029)	0.204*** (0.026)	0.046*** (0.013)
WorkerEduc: up to 6 years	0.035*** (0.004)	- 0.025*** (0.003)	- 0.010*** (0.002)
WorkerEduc: 7-9 years	0.031*** (0.004)	- 0.024*** (0.003)	- 0.007*** (0.002)
WorkerEduc: 10-12 years	0.024*** (0.004)	- 0.018*** (0.003)	- 0.006*** (0.002)
ManagerEduc: up to 6 years	0.015*** (0.001)	- 0.012*** (0.001)	- 0.003*** (0.001)
ManagerEduc: 7-9 years	0.016*** (0.001)	- 0.014*** (0.001)	- 0.003*** (0.001)
ManagerEduc: 10-12 years	0.010*** (0.001)	- 0.0091*** (0.001)	- 0.001 (0.001)
TechOpenness	- 0.035*** (0.005)	0.026*** (0.004)	0.009*** (0.002)
Export	- 0.007*** (0.002)	0.004*** (0.002)	0.003*** (0.001)
Other regions	0.003*** (0.001)	- 0.001 (0.001)	- 0.002*** (0.001)

Step 2:

Identifying firms' motives, benefits and barriers  
in U-I links

## Methodology

- We use a survey aimed at all firms that participate in joint R&D with University of Minho.
- The questionnaire was designed to obtain data on firms' perspectives on key drivers, benefits and barriers in partnerships with University of Minho.
  - The key advantage of the survey is that we can collect much more refined information on these dimensions.
- The questionnaire was launched between September/November 2020.
- Given its non-compulsory nature, the questionnaire's response rate was roughly 20%, with 41 valid responses.
- Firm directors or R&D department managers answered the survey.

## Methodology

- Firms were asked to indicate the motives for collaborating with the University of Minho from eight options.
- The benefits from collaborations from 12 options, and the barriers to collaboration from eight options.
- The questions were based on four-level scale ranging from 'no important' to 'very important'.
- The main analysis performs a principal components analysis in order to identify in each group of questions those factors that are most relevant to firms.

## Results

Table 3: Summary statistics of the principal components variables, N = 41

Variable	Mean	SD	Min	Max
<i>Motives to collaborate</i>				
Cost sharing	1.561	1.266	0	3
Access to labs	2.024	1.172	0	3
Recruit human capital	2.121	0.980	0	3
Access to funding	1.512	0.978	0	3
Geographic proximity	1.780	1.084	0	3
Visibility	1.658	1.174	0	3
Social ties	2.341	0.855	0	3
<i>Benefits from collaboration</i>				
Improve knowledge	1.634	1.157	0	3
Knowledge source	1.732	1.119	0	3
Obtain patents	0.829	0.863	0	3
Problem solving	1.415	1.024	0	3
Recruit human capital	0.683	0.820	0	3
Training	1.244	1.261	0	3
Reduce costs	1.098	0.970	0	3
Time	1.073	0.985	0	3
Access to funding	1.122	0.954	0	3
Geographic proximity	1.122	1.030	0	3
Innovation	1.049	0.921	0	3
Increase sales	1.171	1.138	0	3
<i>Barriers to collaboration</i>				
Knowledge too theoretical	1.268	1.001	0	3
Knowledge too generic	1.122	0.954	0	3
Organizational differences	1.293	1.146	0	3
Cultural differences	0.805	0.980	0	3
Too costly	1.122	0.900	0	3
Weak appropriation	0.976	1.037	0	3
Overheads too high	1.122	1.053	0	3

## Results

- In terms of motives, for firms interacting via intermediary organizations the main motivations are related to (in order of importance): resources and proximity, both social and geographic.
- As for the group of firms interacting via university, the most relevant motive to collaborate with the university are related to (in order of importance):
  - Strategy (increase visibility);
  - Resources (access to labs);
  - Geographic proximity.

## Results

- In terms of benefits, both groups of firms identify resources such as costs, R&D knowledge and human capital as benefits, although they value these benefits differently.
- Firms interacting via intermediary organizations identify, in order of importance, hiring, costs reduction and time saving.
- Firms interacting via university identify, in order importance, human training, product innovation and costs reduction.

## Results

- In terms of barriers, results show that barriers in the U-I interaction are mostly related to cognitive and relational distances.
- Firms interacting via university appear to suffer more from cultural and organizational barriers than firms interacting via an intermediary organization.
  - This is a somewhat surprising result because the conventional wisdom is that these barriers are more severe among small firms.
- The most prominent barriers for firms interacting via intermediaries are overhead costs and knowledge related.

Step 3:

# Intermediaries perspectives of the U-I links

## Methodology

- Performed four semi-structured interviews with the directors of the intermediary organizations.
- The interviews' objective was to gain knowledge on the intermediary organization perspective of the U-I links.
- Our main focus was in finding out whether there were barriers in the interactions between academia and industry and, if so, what type of barriers.
- We also aimed to find out if the projects' outcomes were attained, i.e., if the U-I links proved to be successful.
- The directors of the intermediary organizations were asked about the firms' profiles, particularly their size, who initiated the contact—the firm or the intermediary -, the main drivers for interactions, and the average number of ongoing R&D projects per year.

## Main findings

- All Directors mentioned that they deal with firms of all sizes and from other regions. However, two deal mostly with small-medium size firms, and one intermediary is approached by larger firms. The TTO deals with all firm sizes.
- We observe more pronounced differences regarding the U-I interactions.
  - In two the intermediary takes the first step most of the times, whereas in one the initiative usually comes from the firms.
  - In the TTO case the perception is that the initiative comes from both parts.
  - There is a clear divide in that all intermediaries, except one, have a very positive perspective of their interactions.
  - Specifically, they consider that the project's aims are overall attained and they do not experience any barriers in their communication, whatever the type.
  - One intermediary had a quite different perspective, saying that quite frequently the project results are not attained and that cultural and organizational differences are indeed a barrier.

## Concluding remarks

- Firms interacting via intermediaries are structurally different from firms interacting directly with the university departments.
- Intermediaries are playing an important role in developing U-I linkages mainly through the support to small-sized, with less knowledge capabilities and local firms.
- Firms interacting via intermediaries – smaller ones, face mostly cognitive and cost barriers.
- Firms interacting directly with the university departments – larger ones, face mostly cultural/organizational barriers, i.e., relational barriers.
- Resources and geographic proximity are the most relevant factors for firms interacting via intermediary organizations.
- Increased visibility and access to labs are the most relevant for firms collaborating directly with the university.

Thank you!

hascosta@eeg.uminho.pt

## Appendix

Table 4: Factor loadings of firms' motives for U-I joint R&amp;D collaboration, by interaction mode

Group of motives	Individual	Firms' interaction mode					
		Via intermediary			Via university		
		Factors			Factors		
		1	2	3	1	2	3
Resources	Cost sharing	0.57					
	Access to funding	0.56					
	Access to labs						0.83
Proximity	Geographic proximity			0.92			0.77
	Social proximity		0.76				
Strategic	Visibility				0.50		
Variance explained by the component		2.280	1.335	1.087	2.778	1.274	1.110
Total variance extracted by the factors		67%			74%		
Kaiser-Meyer-Olkin		0.73			0.74		
Cronbach's Alpha		0.69					
N		17			24		

Extraction method: principal components; rotation method: varimax with Kaiser normalization factor loading with absolute value  $\geq 0.5$ . Cronbach's Alpha calculated for all 41 firms.

## Appendix

Table 5: Factor loadings of firms' benefits from University-Industry joint R&amp;D by interaction mode

Group of benefits	Individual benefit	Firms' interaction mode										
		Via intermediary					Via university					
		Factor					Factor					
		1	2	3	4	5	1	2	3	4	5	
Resources	Cost related	Cost		0.65						0.72		
		Time		0.57						0.51		
	R&D knowledge	Access to funding				0.55	0.57					
		Knowledge improvement							0.57			
	Human capital	Knowledge source				0.57						
		Knowledge solving					0.60					
Proximity	Performance	Hiring			0.66							
		Training			0.61					0.78		
		Geographic Innovation	0.66									
		Sales increase	0.56				0.64	0.56				0.77
Variance explained			2.360	2.021	1.972	1.956	1.732	3.152	2.398	2.004	1.527	1.319
Total variance extracted by the factors			84%					87%				
Kaiser-Meyer-Olkin			0.30					0.70				
Cronbach's Alpha			0.85					0.85				
N			17					24				

Extraction method: principal components; rotation method: varimax with Kaiser normalization factor loading with absolute value  $\geq 0.5$ . Cronbach's Alpha calculated for all 41 firms.

## Appendix

Table 6: Factor loadings of barriers among firms in University-Industry R&amp;D collaboration, by type of interaction mode

Group of barriers	Individual	Firms' interaction mode			
		Via intermediary		Via university	
		Factor	Factor	Factor	Factor
		1	2	1	2
Cost	Overheads	0.511			
Cognitive	Knowledge too theoretical	0.536			0.533
	Knowledge too general				0.733
Institutional	Cultural		0.633	0.583	
	Organizational		0.521	0.537	
	Weak appropriation		0.547		
Variance explained		3.016	2.021	3.035	1.888
Total variance extracted by the two factors		72%		70%	
Kaiser-Meyer-Olkin		0.56		0.61	
Cronbach's Alpha		0.84			
N		17		24	

Extraction method: principal components; rotation method: varimax with Kaiser normalization factor loading with absolute value  $\geq 0.5$ . Cronbach's Alpha calculated for all 41 firms.