The Governance of University-Industry Interactions

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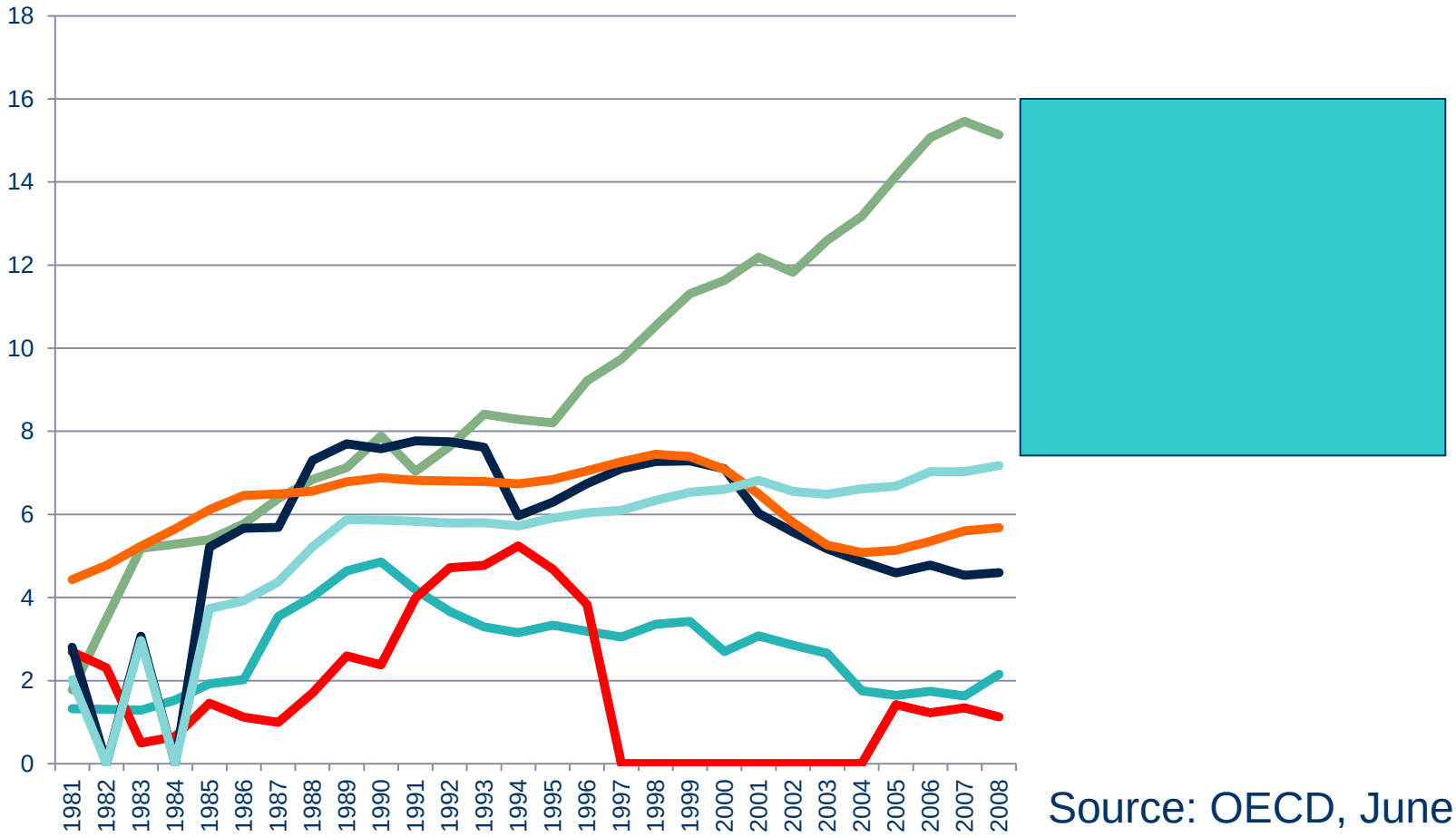
Content

- The university-industry complex – what we know (Reinhide did most of this!)
- The Governance of UNI-IND: Different system at work.
- UNIV-IND Relationships in Piedmont:
  - The firm perspective: UIPIE survey;
  - The inventor perspective: PIEMINV survey.

The university-industry complex

Share HERD financed by Business



Source: OECD, June 2011

What do we know?

- 30 years after ….. many policy initiatives to create more incentives for universities (less so for companies) to collaborate:
  - Industry still only accounts in most countries for **around 6%** of university research funding (up just 0.7% since 1990)

% of HERD financed by industry

	1981	1985	1990	1995	2000	2006	2008
France	1.3	1.9	4.9	3.3	2.7a	1.6	2.1
Germany	1.8	5.4	7.9	8.2	11.6	14.2	15.1
Italy	2.7	1.5	2.4	4.7		1.2 c	1.1 c
Japan	1.0m	1.5m	2.3m	2.4	2.5	2.9	3.0
UK	2.8	5.2a	7.6	6.3	7.1	4.8	4.6
US	4.4j	6.1j	6.9.j	6.8j	7.1j	5.4j	5.7
EU-27	..	..	..	6.0b	6.6b	6.6	7.0
EU15	2.0b	3.7b	5.9b	6.6b	6.6b	6.7b	7.2 b
OECD	2.9b	4.2b	5.8b	6.2ab	6.6b	6.3b	6.5 b

Source : OECD, Main Science and Technology Indicators, June 2011

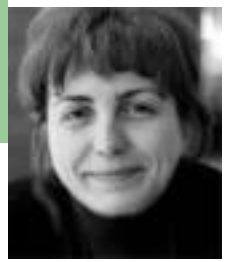
What do we know?

- 30 years after the start of the *institutionalisation* (with policy support) of uni-ind relationships we know something but not yet enough to have a consolidated understanding (conflicting results):
  - Firm characteristics
  - Researcher characteristics
  - University characteristics

What we do not know yet?

- We still know too little about the governance of the process;
- Data sources (problems).

The Governance of UNI-IND Relationships





References - Coauthors

- (with F. Rossi and C. Fassio) The Contribution of Academic Knowledge to the Value of Industrial Inventions: Micro level evidence from patent inventors, LEI&BRICK Working Paper Series, Working paper No.8 /2014.
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- (with I.M. Bodas Freitas and F. Rossi) 'Finding the Right Partners: Institutional and Personal Modes of Governance of University-Industry Interactions', *Research Policy*, Vol. 42, pp. 50-62, 2013.
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Governance systems

- There are *two different governance systems of the interactions* between academic and industrial scientists:
  1. those mediated by universities for example through their technology transfer offices or knowledge transfer organisations: **Institutional Collaborations**
  2. those that take place via direct contracts between the academic scientists and the company: **Personal Contractual Collaborations**

Governance systems: Institutional collaboration

1. **Institutional Collaboration** :
   - Mediated by Knowledge Transfer Organisations (KTOs) within the uni responsible for the management of KT activities;
   - Service and research contracts;
   - New roles for the uni (economic development);
   - Downsizing of company labs (see Bell labs) and small companies R&D;
   - Professors considered more as employees.

Governance Systems: Personal contractual collaborations

1. The traditional "**Personal Contractual Collaborations**" model:
   - Individual scientist;
   - Advisers / problem solver usually not informal, but defined in binding contracts and agreements;
   - Based on some form of trust, sometimes also due to sharing of the same educational background (e.g. alumni associations);
   - Based on participation in the same social and professional networks;
   - High level of professor independence.

Governance Systems:
Personal contractual collaborations

- Not just **informal interactions**, as the literature often assumes, but usually formalized through contracts and agreements.
- Most often subsumed under **consultancy** and always assumed to be “soft”. **BUT** not only **applied work** also original research not soft consultancy.

The key characteristics of institutional and personal contractual interactions

Contractual personal collaborations	Institutional collaborations
Individual scientist is hired as external consultant to work on the firm's project	Firm contracts with the university for the realization of a project.
Scientist works on the project as a self-employed external consultant	Scientist works on the project as a university employee
Firm decides scope and content of the project	Firm needs to organize scope and content of the project so that it is acceptable to university organization
Firm organizes and monitors project activities	Firm and university jointly organize and monitor project activities
Firm "fully" appropriates the results of the project	Firm negotiates with the university the results of the project that are going to be publicly diffused and the ones that the firm will "appropriate"

PIEMINV survey: *in order to make your inventions, how important were the following ways of accessing university knowledge?*

Effectiveness of institutional and personal collaborations with university across innovative objectives

Objectives:	*Institutional collaborations more effective (%)*	*Personal contracts more effective (%)*	*Both equally effective (%)*
Non-competitive (basic research) projects	32.2	21.3	34.2
Applied research projects to develop new products	14.2	50.4	25.8
Applied research projects for production activities	12.2	49.3	25.1
To identify the best students for recruitment	20.7	42.2	26.9
To keep up to date on new knowledge developments	28.2	17.3	41.1
To get ideas for new product development	15.3	34.2	37.3

It is not an Italian peculiarity!

- PICKME SURVEY (2012) EPO Inventors 3 regions:

Formal channels of interaction	PIEDMONT	CATALONIA	MIDLANDS
Institutional Collaboration	49,1	59,4	63,4
Personal Collaboration	37,3	61,4	68,3

UNIV-IND Relationships in Piedmont

- The firm perspective: UIPIE survey;
- The inventor perspective: PIEMINV survey.

The firm perspective: UIPIE survey

Research questions

How firm characteristics may affect the choice between institutional and personal contractual modes of governance for interaction with university researchers?

Data: The UIPIE Survey

- The UIPIE questionnaire was circulated in October/November 2008:
  - *1052 valid responses* (representative sample manufacturing firms with more than 10 employees in the Piedmont region, validated by the local Chamber of the Commerce).

Data: The UIPIE Survey

- Survey asked about
  - whether firms engaged in institutional or personal collaborations in the last three
  - for non-collaborators: reasons for not collaborating
  - for institutional collaborators: which universities they collaborated with, objectives of the collaboration, amount of money spent

Institutional v Personal contractual collaborations

The firm was engaged in institutional interactions (through contracts and agreements signed by university organizations)		9.9%
The firm only engages in collaborations with individual researchers (payment is made directly to the researcher or to his/her own firm)		8.6%

In the previous three years

Methodology: Models 1,2&3

- A firm does not decide to collaborate and then select the "best" governance structure to collaborate, *institutional* or *personal*.
  - A firm may not collaborate (either it has internal competences to solve the technological problem or does collaborate with other partners);
  - Collaborate with a *personal contract* with a researcher;
  - Develop an *institutional* collaboration.
- We start with a Multinomial Logit model and then we check our results by running a series of Logit models (to exploit more detailed info on institutional collaborations).

Methodology: Model 1

- *Governance* takes the values 0 if the firm did not interact at all, 1 if the firm maintained only personal interactions with individual researchers, and 2 if the firm had institutional interactions with universities.
- Firms specific explanatory variables: Absorptive capacity, Technological openness, Size, Market characteristics of firms (Outsource, Multinational, Export).

Methodology: Model 2

For those firms that ***did not*** engage in institutional collaborations with universities in the last three years:

- the choice of *establishing personal collaborations vs. not collaborating*
  - Logit model.
  - Dependent variable: personal collaboration vs. no collaboration at all.
  - Firms specific explanatory variables: Absorptive capacity, Technological openness, Size, Market characteristics of firms (Outsource, Multinational, Export).
  - Reasons for not collaborating institutionally.

Methodology: Model 3

- Are firms engaging in *institutional collaborations* with universities significantly different from those that either do not cooperate or cooperate with university researchers through *personal contract*?
  - Logit model.
  - Dependent variable: institutional collaboration vs. no institutional collaboration.
  - Dependent variable: institutional collaborations vs personal contracts.
  - Firms specific explanatory variables as in previous model.

Results

Model 1: Multinomial

	Personal contractual versus no interaction	Institutional versus no interaction	Institutional versus personal contractual|
Absorptive Capacity	0.32	0.87***	0.54
	(0.26)	(0.25)	(0.349
Technology Openness	0.68**	-0.12	-0.8***
	(0.28)	(0.26)	(0.35)
Size	0.19	1.45***	1.26*
	(0.60)	(0.53)	(0.76)
Square Size	-0.04	-0.09	-0.06
	(0.07)	(0.06)	(0.09)
Multinational	-0.17	-0.27	-0.10
	(0.41)	(0.44)	(0.57)
Export	0.51*	0.40	-0.11
	(0.29)	(0.29)	(0.39)
Outsourcing	0.00	0.00	0.00
	(0.01)	(0.01)	(0.029
Intercept	-3.1***	-6.52***	-3.42**
	(1.15)	(1.13)	(1.52)
Industry dummies	YES	YES	YES

MODEL 2: Logit Model Estimation of Probability of non-institutional collaborators to engage in personal collaborations with Universities

0 if the firm does not interact 1 if the firm interact personal contracts

	Personal contractual interaction versus no interaction
Absorptive Capacity	-0.0249
	(0.425)
Technology Openness	0.476
	(0.435)
Size	-1.153*
	(0.695)
Square Size	0.109
	(0.0852)
Multinational	-0.0387
	(0.611)
Export	0.0125
	(0.560)
Outsourcing	0.0198
	(0.0129)
Difficult and Costly	1.084***
	(0.359)
Alternative Sources	1.531***
	(0.283)
No need	0.416
	(0.440)
Intercept	-2.104
	(1.286)
Industry dummies	YES

	Factor analysis		Independent variables used		
	1	2	F_Need	F_Other	F_Cost
The firm has no need for collaborations	-0.45	-0.51	+		
The firm already has the advanced internal competences it needs	-0.05	0.63		+	
The firm acquires the necessary knowledge from other partner firms	0.04	0.58		+	
The firm collaborates with external non-university research centres	0.03	0.62		+	
The firm may be interested in collaborating with universities. but it lacks the resources for this kind of investment	0.76	-0.06			+
The firm only engages in collaborations with individual researchers (payment is made directly to the researcher or to his/her own firm)	0.39	0.27			
The firm finds it difficult to contact universities	0.74	-0.07			+
Share of Variance explained	24.5%	17.3%			
Eigen value	1.7	1.2			

Min			0	0	0
Max			1	2	3
Average			0.613	0.192	0.358
Std. Deviation			0.487	0.470	0.626

MODEL 3: Logit Model
Institutional Collaboration with Universities (1)

	Institutional versus non-institutional collaboration	Institutional versus personal- contractual
Absorptive Capacity	0.832***	0.679*
	(0.252)	(0.409)
Technology Openness	-0.192	-0.962**
	(0.258)	(0.433)
Size	1.434***	1.246
	(0.524)	(0.776)
Square Size	-0.087	-0.0525
	(0.057)	(0.089)
Multinational	-0.252	-0.360
	(0.437)	(0.660)
Export	0.350	0.0584
	(0.285)	(0.421)
Outsourcing	0.002	0.019
	(0.0139)	(0.0206)
Intercept	-6.546***	-3.556**
	(1.129)	(1.666)
Industry dummies	YES	YES

Conclusions UIPIE– M1,2&3

- In line with results from other empirical literature: large firms making innovative efforts (R&D or design activities) are generally more likely to collaborate with universities.
- However, by distinguishing between institutional and personal contractual collaborations, we find that they are both important channels of knowledge transfer and they seem to involve firms with different research strategies.

Conclusions UNPIE– M1,2&3

Firms that maintained only *contractual personal collaboration* with university researchers were found:

– to invest more into the acquisition of external knowledge than firms that *collaborated institutionally*,

– and to be more likely to rely on external sources of technological knowledge than firms that did not collaborate at all.

– These firms also tend to be smaller!!

The inventor perspective: PIEMINV survey

The data: PIEMINV survey (2009)

Industrial inventors (at least one EPO patent application between 1998 and 2005) resident in the Italian region of Piedmont

- 2,583 inventors, 938 valid responses (36%)
  - General information about the inventors and their inventive activity
  - University-industry interactions
  - Economic impact of university knowledge
- Additional sources: firms and inventors additional informations (for a reduced sample).

Inventors' main characteristics

- Mean age: 48.
- 8.2% women, lower average age (41).
- Low education level (40% only secondary); younger inventors (under-40s) on average more educated.
- Low career mobility.
- 40% of inventors work in large firms (>250 employees).
- Most frequent technology classes: Mechanical Engineering (34%), Electronics (25.6%).
- 40% 1-2; 30% 3-5; 15% 6-10; 15% >11

Education and interaction

	UNIVERSITY OF GRADUATION							
	University of Turin		Politecnico of Turin		Other Italian university		Foreign university	
No. of graduates	87		208		92		19	
No. interacting with the following universities:	N	%	N	%	N	%	N	%
• University of Turin	57	25.8%	36	9.8%	23	6.3%	1	4.3%
• Politecnico of Turin	59	26.7%	157	42.9%	41	21.9%	10	43.5%
• University of Western Piedmont	15	6.8%	11	3.0%	13	6.3%	0	0.0%
• Other Italian University	50	22.6%	93	25.4%	63	43.8%	4	17.4%
• Foreign university	40	18.1%	69	18.9%	42	21.9%	8	34.8%
Total no. of interactions	221	100%	366	100%	182	100%	23	100%

Contribution of academic knowledge to inventions:

- 66.3%: no contribution.
- 24.4%: contributed to less than 50% of their inventions.
- 9.3%: contributed to more than 50% of their inventions.

How do industry inventors collaborate with academic researchers?

Research question

- What are the determinants of the choice of governance form for formal interactions between firms and universities?
- The choice is driven by firms' search for efficient and effective governance mechanisms according to the web of social interactions and routines of industry inventors.

Research question

- In this context, we explore a number of possible determinants related to the ***social network of the industry inventor*** involved, and the nature of the collaborative project, controlling for numerous features of the collaborating firm and inventor.

Hyp: Social network of the inventor (Local education & Age)

- *Local secondary education* measures the inventor's embeddedness in local networks of relationships based on completion of secondary education in Piedmont (80% of inventors). Particularly for older inventors (*Age*) less likely to have tertiary education and for which secondary education affiliation still important.

Hyp: Social network of the inventor (Alumni)

- *Alumni* captures the inventor's closeness to the university awarding their highest degree. An inventor has greater social, relational and cultural proximity to university researchers in her *alma mater.*

Empirical strategy (1)

- We want to estimate the probability of using institutional (*Shared-governance*) v personal contractual (*Unilateral-governance*) in the relationship with university researchers.

741 inventors		number	%
No university knowledge channels used		225	30.7%
Some university knowledge channels used	Selection variable	516	69.3%
Formal governance forms		300	58.1%
shared governance	Dependent variable	216	41.9%
unilateral governance	Dependent variable	196	38.0%
Only shared governance		104	20.2%
Only unilateral governance		84	16.3%
Both		112	21.7%

Empirical strategy (2)

- Bivariate probit maximum with Maximum Simulated Likelihood Method using the GHK simulator (Gates, 2006);
- Selection equation for any contractual collaboration with the university.
- In the model estimation, the correlation across the two types of governance forms is significant, supporting their joint estimation.

		Marginal Effects of 2nd Stage			
	1st stage Collab.	$Pr(y_{shared}=1, y_{unilat}=1)$	$Pr(y_{shared}=0, y_{unilat}=1)$	$Pr(y_{shared}=1, y_{unilat}=0)$	$Pr(y_{shared}=0, y_{unilat}=0)$
Local Education		0.002	0.061*	-0.068*	0.005
		(0.037)	(0.036)	(0.038)	(0.051)
Age	0.004	0.000	0.004***	-0.004***	0.000
	(0.006)	(0.002)	(0.001)	(0.002)	(0.002)
Generality		0.102**	0.048	-0.010	-0.140**
		(0.049)	(0.060)	(0.066)	(0.069)
Complexity		0.027	-0.026	0.040	-0.041
		(0.052)	(0.046)	(0.050)	(0.072)
Forward Citations		-0.003	-0.001	-0.000	0.005
		(0.010)	(0.011)	(0.012)	(0.014)
Backward Citations		0.015***	-0.005	0.012**	-0.022***
		(0.006)	(0.006)	(0.006)	(0.008)
Medium firm	0.171	-0.070	-0.046	0.022	0.094
	(0.170)	(0.053)	(0.053)	(0.059)	(0.074)
Large firm	0.477***	-0.040	-0.049	0.037	0.052
	(0.142)	(0.049)	(0.048)	(0.053)	(0.069)
Gender (Female)	0.244	-0.084	-0.000	-0.035	0.119*
	(0.227)	(0.052)	(0.050)	(0.054)	(0.072)
Education	0.433***				
	(0.115)				
Productivity	0.090***				
	(0.028)				
University work experience	0.326				
	(0.217)				
Foreign Company	0.104				
	(0.184)				
Technological dummies	***Yes***	***Yes***	***Yes***	***Yes***	***Yes***

Older inventors who completed their secondary education in Piedmont are more likely to develop collaborations governed unilaterally by the firm

Consistent with the previous literature, highly educated inventors with high levels of technological productivity who work in larger firms, have a higher probably of being involved in interactions with university researchers.

Results: Alumni

	1st stage Collab.	Marginal Effects of 2nd Stage $Pr(y_{shared}=1, y_{unilat}=1)$	$Pr(y_{shared}=0, y_{unilat}=1)$	$Pr(y_{shared}=1, y_{unilat}=0)$	$Pr(y_{shared}=0, y_{unilat}=0)$
Alumni		0.146***	0.046	0.008	-0.200***
		(0.035)	(0.034)	(0.037)	(0.047)
Alumni_Uni To		0.187***	0.104**	-0.038	-0.254***
		(0.057)	(0.046)	(0.049)	(0.078)
Alumni_Poli To		0.115***	0.030	0.014	-0.159***
		(0.041)	(0.037)	(0.040)	(0.056)
Alumni_Other		0.137***	0.019	0.035	-0.191***
		(0.045)	(0.052)	(0.055)	(0.062)

All estimations include technology dummies and all variables
All other results unchanged.

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The Contribution of Academic Knowledge to the Value of Industrial Inventions

WITH

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Research Questions

How does academic knowledge contribute to the development of economically valuable inventions?

- Which type of academic knowledge leads to more valuable inventions in the economy?
- Which are the specific governance forms that allow for a more profitable use of academic knowledge?
- What are the inventor's characteristics (absorptive capacity) that allow her to transform academic knowledge in innovative value?

Hypotheses 1: Theoretical Knowledge

- Inventions that allow for the development of more radical/brand new innovations lead to more valuable inventions (the role of novelty and specialization).
- Theoretical knowledge provide you that general capacity to better develop technology (firms need a general knowledge to solve a practical and specific technological problem)

→ ***interactions in which the transfer of basic, theoretical knowledge is involved lead to more valuable inventions***

Hypotheses 2: Personal contractual collaborations

Easiness in the transfer of tacit knowledge: through direct personal interactions in which trust is important (personal contractual relationships), the transfer of tacit knowledge is easier and leads to more valuable inventions

→ ***direct personal collaborations between researchers and inventors are correlated with more valuable inventions***

Hypotheses 3: Inventor's absorptive capacity

- **Inventor's absorptive capacity**: the capacity of an inventor to transform academic knowledge in innovative value (Cockburn and Henderson, 1998; ; Gittelman, 2005; Cassiman et al., 2012)

→ ***inventor's education, previous exposure to the methods and practices of academic research, and experience in collaborations are correlated with more valuable inventions.***

Empirical strategy

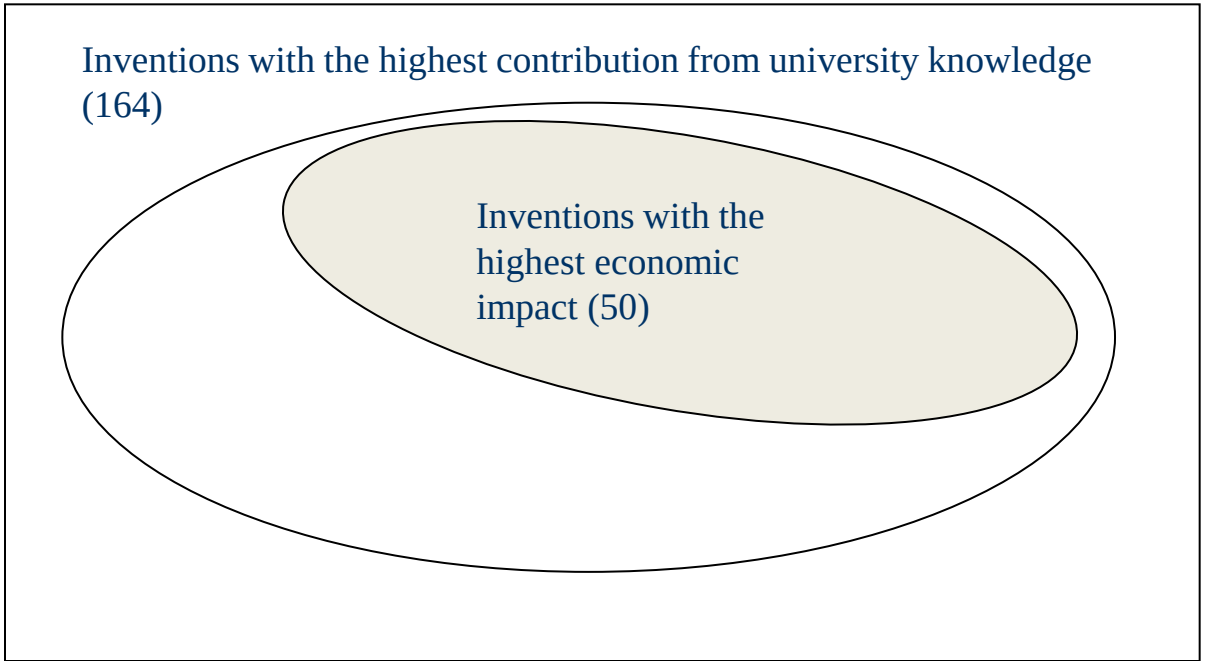
Empirical strategy: constructing measures of invention value

- Two inventions (inventors with 2 or more)
  - Highest contribution from university knowledge
  - Highest economic impact
- For each of them, information about
  - Whether the two inventions were the same (or not)
  - Monetary value of the invention (in thousand €, current prices)
    - "*Suppose that, on the day in which the invention was completed (or, if the invention has been patented, on the day in which the patent was granted) a potential competitor had expressed an interested in purchasing it: what is the minimum price that the invention's owner would have asked for it?*"

Dependent variables: two relative measures of invention value

Uniecon: whether invention with highest contribution from university knowledge is also that with highest economic impact (>25%)

- excluding inventors who have only one invention



Dependent variables: two relative measures of invention value (2)

***ratio**:* value of invention with highest contribution from university knowledge relative to value of invention with highest economic impact

- 87 observations; values between 0 and 1

– **Why considering the ratio rather than the actual value?**

- **Lack of comparability of invention values across inventors (highly subjective)**
- **Respondents may have used the wrong unit of measurement**

Econometric model

A simple model

$$y_i = c + b\, Int_i + g\, Kn_i + \sum_k d_k INV_{ik} + \sum_m q_k FIRM_{im} + v_i$$

- *y*: value of the invention with the highest university contribution
- *Int:* type of interactions between inventor and university
- *Kn*: type of knowledge that the inventor found most useful for inventions
- *INV* and *FIRM:* inventors and firm level variables
- v_i : idiosyncratic error term.

Main independent variables

Type of academic knowledge

Theories: 55%

Methodologies: 50%

Applied: 61%

Contacts: 60%

Main channels used to access academic knowledge

Contract based Collaboration: 48%

Institutional collaborations with the university: 28%

Personal Contractual Collaboration: 23%

Econometric strategy

Selection bias: Probit with sample selection and Tobit type II (Anemya, 1984):

- The inventors able to benefit from university knowledge are not a random sample.
- *select:* 1 if some of the inventors' inventions have received an important contribution from academic knowledge.

Endogeneity in the selection of the organizational form: IV with factors explaining why inventors have chosen personal contractual collaborations: the importance of social network (only local secondary education, university education at poli to, co-publishing with authors in other Italian regions)

Results

Selection equations

VARIABLES	(1) *select*	(2) *coll.*
HEducation	0.184***	0.303***
	(0.035)	(0.042)
University Work Experience	0.230***	0.248***
	(0.074)	(0.077)
Age	-0.023	0.035*
	(0.015)	(0.019)
Age^2	0.000*	-0.000*
	(0.000)	(0.000)
Technological Productivity	0.013*	0.030***
	(0.007)	(0.009)
Male	0.046	-0.080
	(0.056)	(0.080)
Firm characteristics		
Small Firm	-0.082	0.181*
	(0.065)	(0.108)
Medium Firm	-0.071	0.137
	(0.065)	(0.097)
Large Firm	0.009	0.246***
	(0.060)	(0.076)
Foreign	-0.027	-0.011
	(0.054)	(0.071)
Technological capability	-0.001	0.001
	(0.000)	(0.000)
Technological dummies		
Electrical engineering	0.030	0.053
	(0.046)	(0.055)
Process Engineering	-0.036	-0.044
	(0.055)	(0.070)
Instruments	0.142**	0.192***
	(0.069)	(0.071)
Chemicals	0.084	0.248***
	(0.081)	(0.089)
Pharmaceuticals	0.193	0.216
	(0.168)	(0.170)
Consumer goods	-0.103	-0.039
	(0.064)	(0.094)
Observations	657	657
pseudo-Rsquared	0.105	0.165
Log-likelihood	-330.3	-377.5

Reported coefficients are marginal effects (at the sample means) from a probit. The reference category for the size dummies are micro-companies and individual inventors. Mechanical Engineering is the reference category for technological dummies. Standard errors robust to heteroskedasticity. *** p<0.01, ** p<0.05, * p<0.1

Selection results consistent with previous literature

Similar results in the model using one or the other selection equations

Unicon, probit and IV

	(1) probit	(2) probit	(3) IV
Theories	0.169*	0.169*	0.154*
	(0.092)	(0.094)	(0.083)
Methods	-0.009	-0.007	-0.006
	(0.084)	(0.083)	(0.070)
Applied	-0.106	-0.105	-0.072
	(0.095)	(0.095)	(0.090)
Contact	0.074	0.067	0.060
	(0.094)	(0.093)	(0.085)
Collab	0.106		
	(0.083)		
PContracts		0.155	0.597*
		(0.102)	(0.308)
Institutional		0.024	0.098
		(0.096)	(0.102)
age	-0.059**	-0.055**	-0.056**
	(0.029)	(0.027)	(0.023)
Age^2	0.001**	0.001**	0.001***
	(0.000)	(0.000)	(0.000)
Publications	-0.006	-0.006	-0.003
	(0.004)	(0.004)	(0.002)
male	-0.092	-0.109	-0.139
	(0.162)	(0.165)	(0.153)
Firm Characteristics			
Small Firm	-0.044	-0.061	-0.114
	(0.206)	(0.198)	(0.197)
Medium Firm	0.058	0.039	-0.042
	(0.196)	(0.196)	(0.201)
Large Firm	-0.146	-0.151	-0.233
	(0.165)	(0.169)	(0.167)
Technological capability	0.001**	0.001**	0.001*
	(0.000)	(0.000)	(0.000)
Technological dummies	***yes***	***yes***	***yes***

IV: tests Ok, though a bit weak

First stage			
Local Education			0.458**
			-0.196
Alumni_polito			0.239*
			(0.122)
Shitaly Pubs			0.324**
			(0.153)
Underid. test (Kleibergen-Paap rk LM statistic):			9.184
p-value			0.026
Angrist-Pischke F test of excluded instruments:			4.02
Prob>F			0.008
Hansen J statistic (overid. test of all instruments):			0.092
χ^2 P-value			0.954
athanrho	-0.192	-0.165	-
	(0.403)	(0.393)	-
Observations	657	657	164
Uncensored obs.	164	164	-

Ratio, Tobit and IV

	(1) tobit	(2) tobit	(3) IV	(4) IV
Theories	0.175*	0.178*	0.180*	0.180*
	(0.095)	(0.091)	(0.097)	(0.097)
Methodos	0.114	0.141	0.186*	0.186*
	(0.113)	(0.106)	(0.104)	(0.106)
Applied	0.011	0.007	0.021	0.022
	(0.108)	(0.108)	(0.124)	(0.122)
Contact	0.045	0.043	0.017	0.016
	(0.100)	(0.100)	(0.110)	(0.112)
Collabo	0.055			
	(0.089)			
PContracts		0.163*	0.470*	0.478*
		(0.094)	(0.283)	(0.279)
Institutional		-0.090	-0.023	-0.021
		(0.094)	(0.129)	(0.129)
Age	-0.040	-0.043	-0.049	-0.050
	(0.041)	(0.041)	(0.040)	(0.043)
Age^2	0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Publications	-0.003*	-0.003	-0.003	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Male	0.184	0.221	0.250	0.252
	(0.272)	(0.239)	(0.235)	(0.234)
Firm Characteristics				
Small Firm	-0.027	-0.090	-0.146	-0.147
	(0.182)	(0.183)	(0.195)	(0.190)
Medium Firm	-0.182	-0.254	-0.288	-0.290
	(0.184)	(0.190)	(0.206)	(0.204)
Large Firms	-0.256*	-0.311*	-0.377**	-0.380**
	(0.153)	(0.162)	(0.192)	(0.192)
Technological Capability	0.001*	0.001**	0.001**	0.001**
	(0.000)	(0.000)	(0.000)	(0.000)
Technological Dummies	**yes**	**yes**	**yes**	**yes**

IV: tests Ok, though a bit weak

First stage				
Local education			0.795***	0.688***
			(0.202)	(0.183)
Alumni_polito			0.334	-
			-0.203	-
Shitaly pubs			0.116	-
			(0.2224)	-
Underid. test (Kleibergen-Paap rk LM statistic):			6.172	3.996
p-value			0.103	0.045
Angrist-Pischke F test of excluded instruments:			5.28	14.00
Prob>F			0.003	0.00
Hansen J statistic (overid. test of all instruments):			0.086	0.912
χ^2 P-value			0.958	0.633
athanrho	0.867*	0.788**	-	-
	(0.480)	(0.356)	-	-
Observations	580	580	87	87
Uncensored obs.	87	87	-	-

3 FINAL TAKE HOME POINTS

- Official statistics on UNI-IND are incomplete and they miss an important part of the picture.
- Firms and inventors with different characteristics organize their interactions with university researchers according to different governance modes.
- One of these, personal contractual, that is not usually measured, seems also to be linked to the most valuable inventions.

And the really last one!

- The most valuable contribution of university knowledge to the inventions consists in the transfer of **theoretical basic knowledge**, rather than solutions to technical problems.