Public R&D Funding–Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

Regional differences

Methodology

Open issues

Final remarks

Some references

Public R&D Funding and Innovation Strategies: Evidence from Italy

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Università Cattolica del Sacro Cuore and Università dell'Insubria

Regional Studies Association
Piacenza, 25 May 2015

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Motivation

- Innovation is generally considered a cornerstone of sustainable economic growth and prosperity, as well as a key to business success and to the development of emerging economies and peripheral regions.
- This may justify the policy of subsidizing scientific and entrepreneurial activities that could lead to innovation,
- The blow out of the crisis in 2007 has revamped in many states (in particular within European Union) the policy of providing subsidies to R&D activities.

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

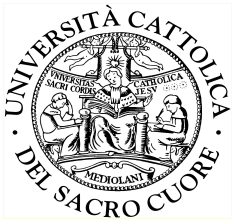
Contribution

This paper analyzes the effect of Public support on the **innovative behaviour** of Italian firms, with the use of a unique dataset which combines the information of the CIS with balance sheet data

Questions

What is the relation between Public Funding and R&D strategy?
Are Public Funds used and targeted effectively?
Which strategy do they foster?

For R&D strategy we intend whether firms decide to conduct 'in house R&D' (*make*), rather than 'outsourced R&D' (*buy*) or the combination of both (*make&buy*).
The **Italian case** is relevant in the international comparison because Italian firms are usually characterized by a low level of innovation activities (Hall et. al, 2013). In Italy only large firms assign a high priority to formal R&D activities (*internal R&D*) while SMEs resort mostly to external R&D, in the form of intermediate and capital goods (Santarelli&Sterlacchini, 1990).



Outline

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

1 Related literature

2 Dataset

3 Variables

4 Descriptive Statistics

5 Methodology

6 Open issues

7 Final remarks

8 Some references

Related literature: Public funding

The effect of public initiative to support innovation is analysed through three different perspectives:

- **R&D Inputs – R&D Expenditure**: complementarity and substitution between private and public funds (e.g. David et al., 2000; Garcia-Quevedo, 2004; Loof&Hesmati, 2005, for extensive review)
- **R&D Output – Different measures of output**: sales growth, return on assets, factor productivity, patents, etc. . . (see, e.g., Klette et al., 2005, for a survey).
- **Innovation behavior – Different R&D strategies** (e.g. Bayona-Sáez et al., 2013; Cruz-Cazares et al., 2013)

Related literature: R&D strategy selection and innovation performance

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

- **Theoretical arguments**: the buy strategy outperforms the make strategy since it allows risk calculation a priori, speeds the access to new technology, allows access to new knowledge areas (West, 2002). Negative aspects: external dependences, functional inequalities, and coordination problem. In contrast, in house R&D facilitates the information flow between departments, unique source of knowledge, reduces transaction costs (Kotable et al., 1999; Narula, 2001)
- **Empirical Evidence**: it is quite controversial. The buy strategy usually has negative impact on innovation. The make strategy presents the higher impact on innovation product (e.g. Santamaria et al., 2009; see Cruz-Cazares et al., 2010 for a survey)

- **The open innovation approach**: combining internal and external knowledge creates synergies that end with a better innovative performance. Products are complex. It is not possible to develop everything in house. The main innovations come from the combination of internal and external knowledge (Chesbrough, 2003; Cassiman&Veugelers, 2006; Cruz-Cazares et al. 2010). Absorptive capacity: it stresses the complementarity between the make and buy strategy. Recently, it has been defined as the firms' ability to recognize the value of external knowledge and to assimilate and apply it to commercial ends (Li et al., 2009). This result is also partially confirmed empirically (Cassiman&Veugelers, 2006, Cruz-Cazares et al., 2010, 2013)
- **Geography**: Vivarelli&Catozzella, 2014 (Italy), Cruz-Cazares et al., 2013 (Spain), Da Rin&Penas, 2007 (the Netherlands), Loof&Hesmati 2005 (Germany), Antonioli et al., 2014 (regional analysis Emilia Romagna)

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Dataset

- The Italian Community Innovation Survey (CIS7) –3 year period 2008-2010– firm level survey – firms with more than 10 employees
- AIDA dataset, by Bureau VanDijk, balance sheet data
- We have conducted the analysis on the merged dataset restricted to the firms belonging to the manufacturing sector
- Once cleaned for outliers, we remained with a representative sample of 3016 firms.

Public Funding (Treatment variable)

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

- Question reported in the CIS7: "Has your enterprise received any kind of public support for innovation-related activities in the last 3 years?"
- Variable available only for innovative firms
- Variable affected by important limitations such as the lack of the amount received, but it is referred to the 3 years preceding the time of the survey (year 2010).
- This feature mitigates the obvious limitations due to the cross sectional nature of the dataset

Innovation Strategies (Outcome variables)

MAKE:	1 if the firm has conducted only intra muros R&D activities
BUY:	1 if the firm has conducted only extra muros R&D activities
MAKE&BUY:	1 if the firm has conducted both R&D activities

We consider both the dummy variables (extensive margins) and the respective intensities (intensive margins) calculated as percentage of R&D expenditure on Sales.

Variables available only for innovative firms

Innovation strategies

Public R&D Funding– Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

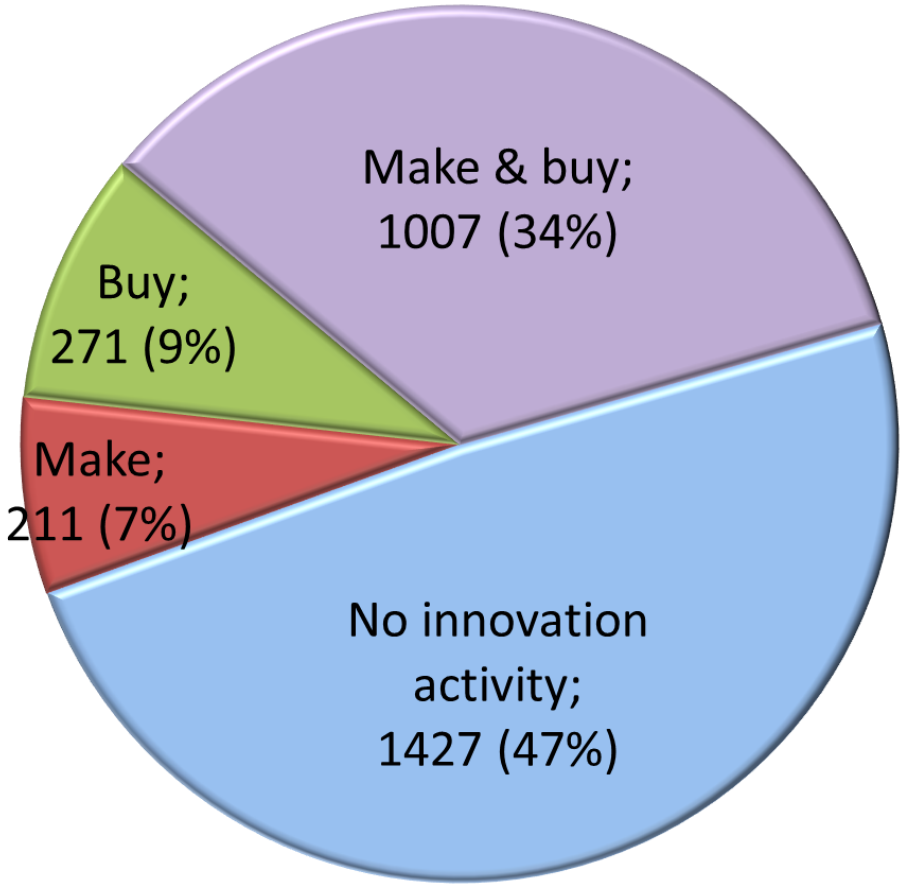
Regional differences

Methodology

Open issues

Final remarks

Some references



Public Support and Innovation Strategies

Public R&D Funding– Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

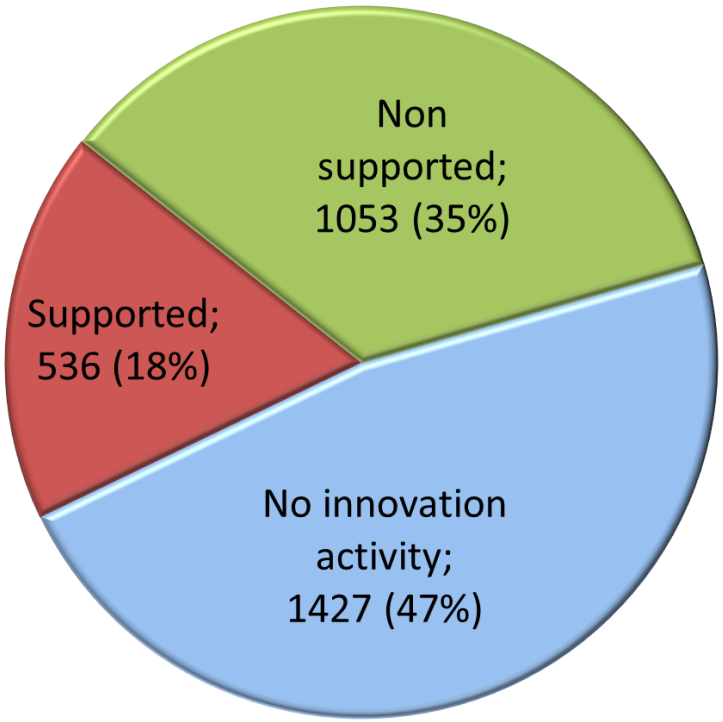
Regional differences

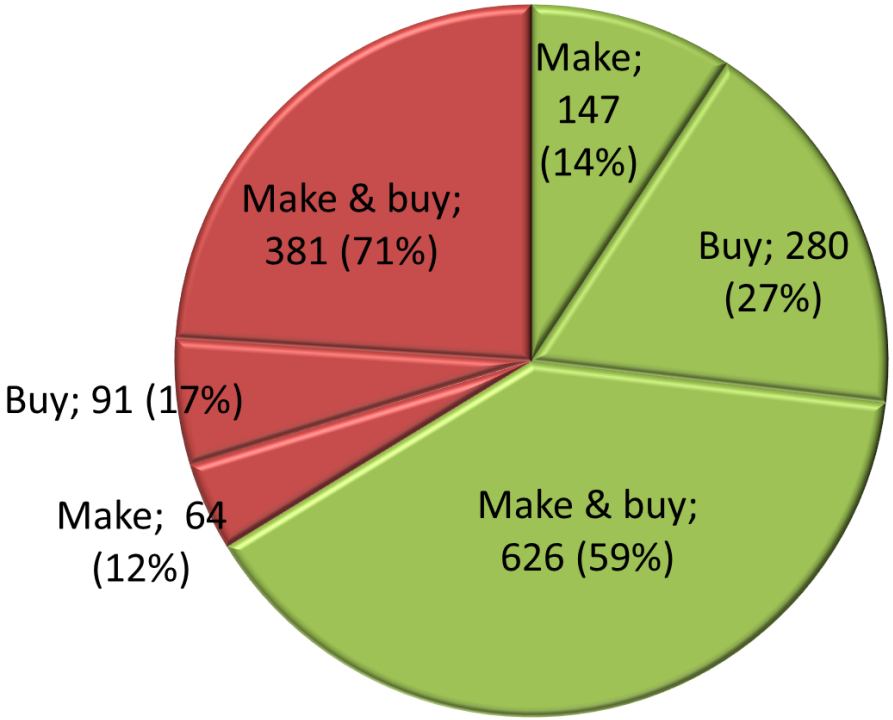
Methodology

Open issues

Final remarks

Some references





Regional differences

Public R&D Funding– Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

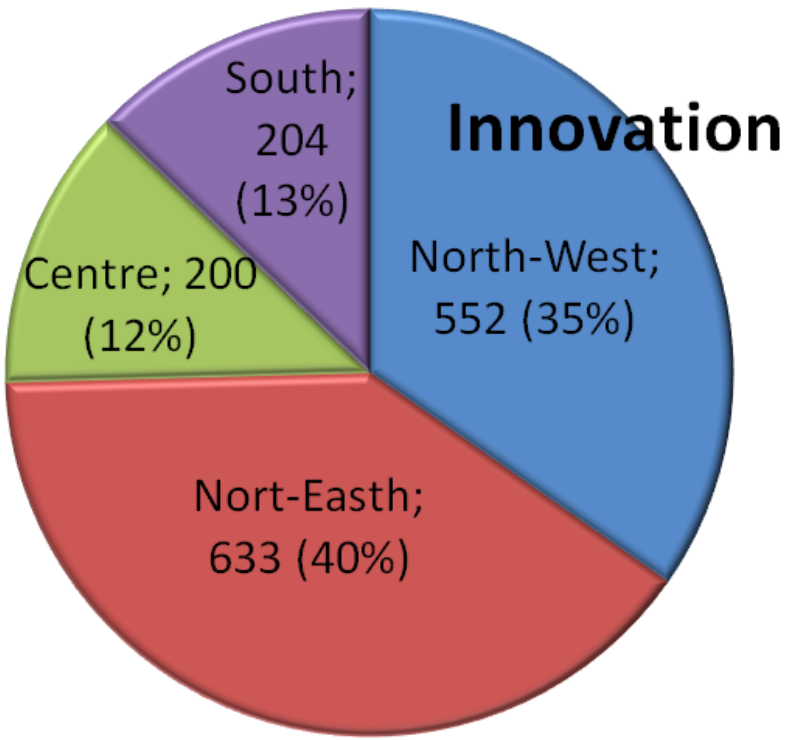
Regional differences

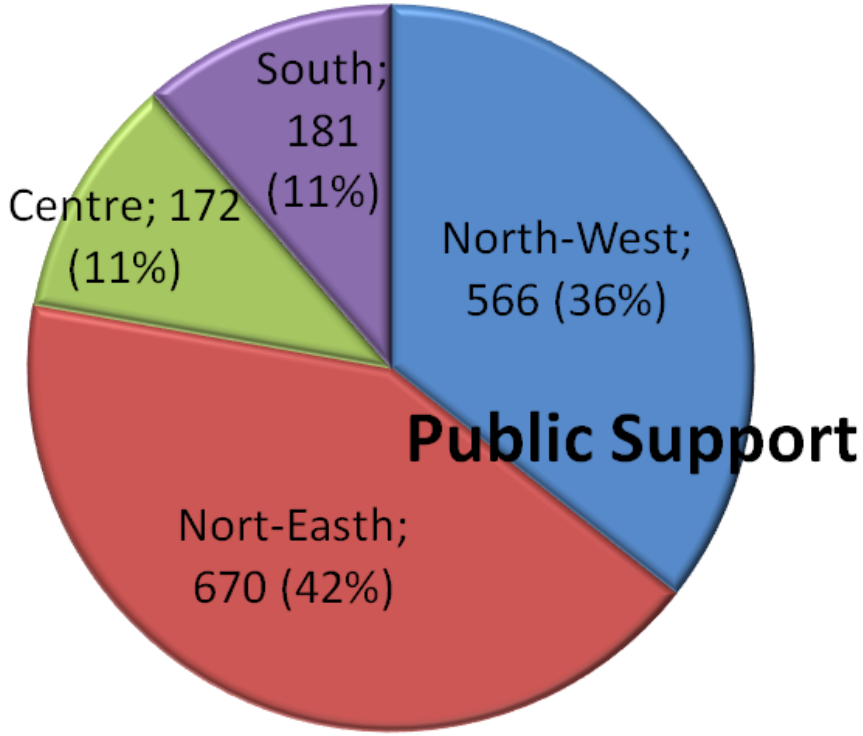
Methodology

Open issues

Final remarks

Some references





Unconditional Effect of the Subsidy

	Sample means			Mean differences		
	All firms	**Non-supported**	**Supported**	**Difference**		**%Difference**
Number of obs	1589	1053	536			
Make	0,133	0,140	0,119	0,020	(0.018)	14,286
Buy	0,233	0,266	0,170	0,096***	(0.021)	36,090
Make&Buy	0,634	0,594	0,711	0,116***	(0.013)	19,529
	Make=1					
Number of obs	211	147	64			
Intensity Make	0,030	0,027	0,037	-0,010*	(0.030)	37,037
	Buy=1					
Number of obs	371	280	91			
Intensity Buy	0,038	0,036	0,044	-0,008	(0.007)	-22,222
	Make&Buy=1					
Number of obs	1007	626	381			
Intensity Make&Buy	0,064	0,055	0,078	-0,022***	(0.007)	-40,000

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Methodological issues

The table presented in the previous slide does not address three different endogeneity issues that arise in this study:

1. The first is related to the sample selection coming from the structure of the dataset
2. The second is related to a potential **omitted variable bias**: the subsidy assignment could be correlated with unobservable firms characteristics, failing to satisfy the randomness property of *pure social experiments*.
   - If characteristics of the supported and non-supported firms ex ante differ systematically, one difficulty in this type of evaluation is the potential selection bias;
   - "Better" firms are probably more able to detect and select proper government schemes;
   - On the other hand the public agency might deliberately choose the "worst" firms to enhance their chances of picking up.
3. Finally, the endogeneity issue due to a potential simultaneity between *subsidy assignment* and *strategy decision* should be taken into account.

Sample Selection Issue

Public R&D Funding–Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

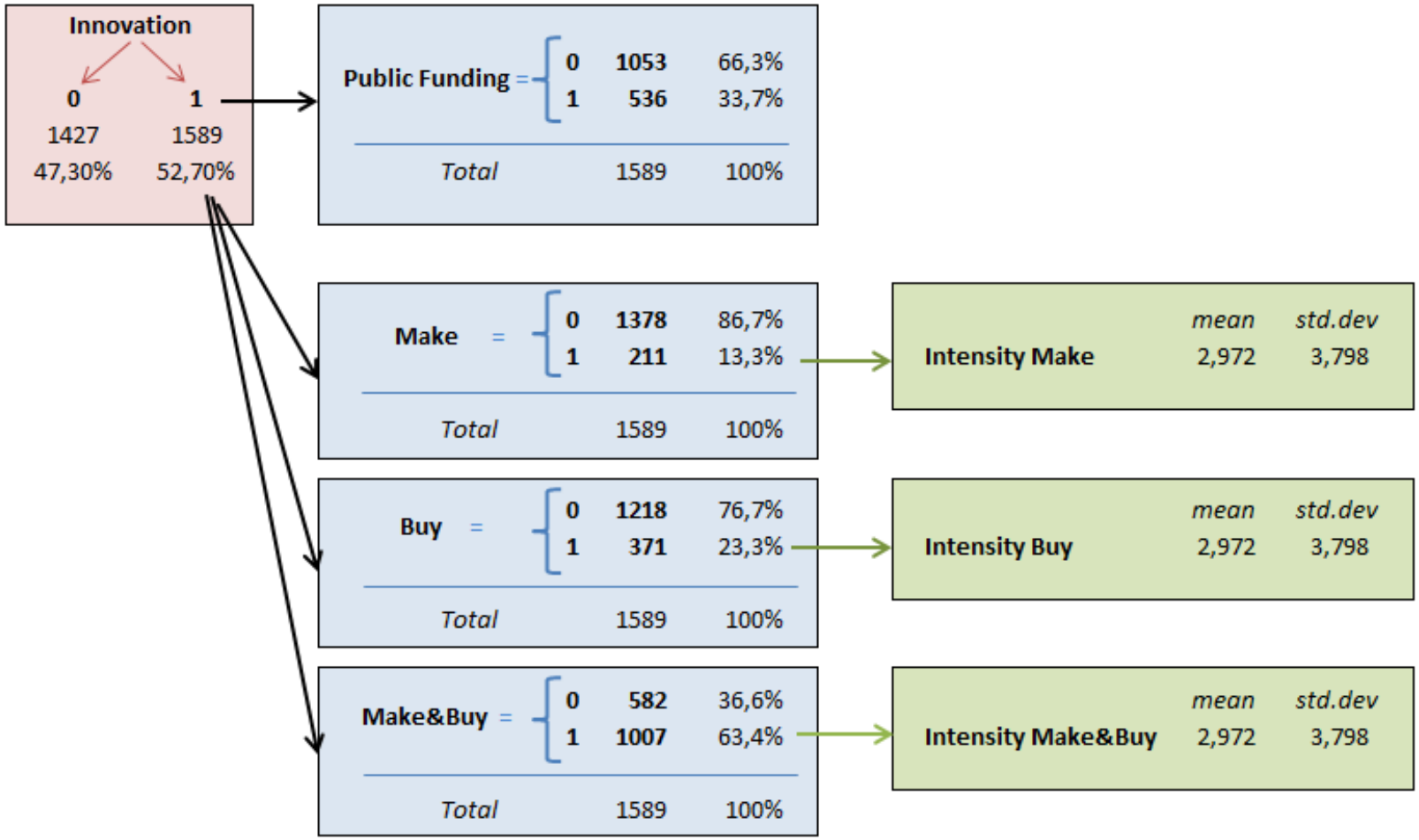
Regional differences

Methodology

Open issues

Final remarks

Some references



Empirical Strategy

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

In order to solve the aforementioned problems we follow this procedure:

1. We estimate a selection equation for the innovation status and calculate an inverse Mills ratio that will augment all the following equations;
2. In order to calculate the extensive margin we estimate a bivariate probit where the first equation estimates the probability of receiving Public Funds, the second the probability of choosing each R&D strategy. To account for the endogeneity issue we introduce in the first equation a set of instrumental variables;
3. In order to calculate the intensive margin we estimate a 2SLS, where in the first stage we obtain the fitted probabilities from the probit on Public Funding and we use them as the instrument for Public Funding in the second stage that is estimated with OLS.
4. We augment the second stage with the inverse Mills ratio to account for the sample selection which derives from the fact that we calculate the R&D intensity only for the firms that choose a particular strategy.

Results on Selection Equation (Innovation)

Public R&D Funding– Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

Regional differences

Methodology

Open issues

Final remarks

Some references

	Innovation	
	coefficient	standard dev
Firms characteristics		
Firm Size	0,111 ***	0.029
Age	-0.023	0.050
Firm Growth	0,224 **	0.093
% of skilled labor	0,121 ***	0.020
# of exporting firms	0,587 ***	0.056
Return on Investment	-0.069	0.043
Perceived obstacles		
Perceived internal	-0.166 **	0.066
Perceived external	0,313 ***	0.068
Perceived skilled	0.070	0.085
Organizational	0,673 ***	0.078
New price policies	0,504 ***	0.080
Geographical and sectorial dummies		
North East	0,085	0.059
Center	-0.071	0.078
South	-0.216 ***	0.078
Sectorial dummies	yes	
constant	-0.907 ***	0,200
N	3016	
Log-likelihood	-1794,341	
LR test	chi2 (29) = 518.37***	
Pseudo R2	0,140	

Results on Strategies

	Public funding		Make		Buy		Make and Buy	
	coefficient	Std.error	coefficient	Std.error	coefficient	Std.error	coefficient	Std.error
Public funding			-1,252 ***	0,198	-1,505 ***	0,070	1,511 ***	0,060
Firms characteristics								
Firm Size	0,107 **	0,044	0,063	0,045	-0,038	0,039	0,007	0,037
Age	0,046	0,074	-0,037	0,080	-0,046	0,070	0,062	0,066
% of skilled labor	0,086 ***	0,029	0,102 ***	0,030	-0,023	0,030	-0,028	0,026
# of exporting firms	0,217 *	0,117	0,529 ***	0,143	0,012	0,113	-0,207 *	0,106
Return on investment	0,021	0,070	0,076	0,070	0,018	0,064	-0,047	0,058
Capital Stock/ Employment	0,061 *	0,036	-0,020	0,040	0,065 *	0,033	-0,025	0,032
Equity/Employment	-0,016	0,037	0,031	0,041	-0,011	0,034	-0,011	0,033
Debt/Employment	-0,007	0,050	0,098 *	0,053	-0,065	0,047	-0,004	0,044
Perceived obstacles								
Perceived internal Financial constraint	-0,038	0,092	0,017	0,092	-0,123	0,091	0,083	0,081
Perceived external financial constraint	-0,061	0,095	0,241 **	0,103	-0,064	0,093	-0,096	0,084
Perceived skilled constraint	-0,121	0,123	-0,069	0,132	-0,019	0,115	0,038	0,108
Perceived importance of external information	0,050	0,057						
Perceived importance of internal information	0,219 ***	0,066						
Cooperation								
Belonging to a group	-0,072	0,090						
Firm ownership	0,221	0,153						
External Cooperation	0,448 ***	0,113	0,035	0,147	-0,346 *	0,171	0,128	0,110
Geographical and sectorial dummies								
NE	0,046	0,078	-0,054	0,083	-0,020	0,076	0,063	0,070
C	-0,088	0,114	-0,224 *	0,128	0,084	0,100	0,045	0,099
S	-0,187	0,119	-0,408 ***	0,133	-0,028	0,112	0,209 *	0,105
food	0,333 **	0,151	0,114	0,167	0,216	0,154	-0,164	0,143
textiles	0,053	0,144	0,100	0,149	-0,105	0,129	0,041	0,121
wood	0,282 **	0,134	-0,069	0,152	0,346 ***	0,120	-0,228 *	0,115
machine	0,356 ***	0,110	0,095	0,123	0,139	0,103	-0,103	0,096
other	0,117	0,126	-0,058	0,138	-0,002	0,118	0,071	0,112
lambda_inn	0,330 *	0,186	0,609 ***	0,211	0,595 ***	0,180	-0,781 ***	0,166
const.	-2,548 ***	0,696	-2,897 ***	0,754	-0,025	0,641	0,700	0,603
N	1582		1582		1582		1582	

Public R&D Funding– Innovation Strategies

L.Barbieri, D.Bragoli, F.Cortelezzi, G.Marseguerra

Motivation

Related literature

Dataset

Variables

Public Funding

Innovation Strategies

Descriptive Statistics

Innovation strategies

Public Support and Innovation Strategies

Regional differences

Methodology

Open issues

Final remarks

Some references

Results on Outcomes (Intensities)

	Intensity make		Intensity buy		Intensity buy	
	coefficient	Std.error	coefficient	Std.error	coefficient	Std.error
score_PF	-0,023	0,050	0,091	0,076	-0,004	0,062
Firms characteristics						
Firm Size	-0,007 **	0,003	-0,002	0,004	-0,021 ***	0,004
Age	-0,004	0,005	0,000	0,008	-0,009	0,006
% of skilled labor	0,006 *	0,004	-0,003	0,003	0,016 ***	0,004
# of exporting firms	0,013	0,014	-0,008	0,008	-0,021	0,015
Return on investment	-0,006	0,004	0,004	0,004	-0,008	0,007
Capital Stock/ Employment	0,000	0,003	0,000	0,004	0,007 *	0,004
Equity/Employment	-0,004	0,004	-0,004 *	0,002	-0,004	0,004
Debt/Employment	0,003	0,004	-0,008 **	0,004	-0,023 ***	0,004
Perceived obstacles						
Perceived internal Financial constraint	0,000	0,007	-0,003	0,007	0,004	0,008
Perceived external financial constraint	0,024 ***	0,008	0,005	0,007	0,005	0,007
Perceived skilled constraint	-0,002	0,009	-0,007	0,008	-0,009	0,008
Perceived importance of external information	-0,004	0,010	-0,032 **	0,014	0,026 *	0,014
Geographical and sectorial dummies						
NE	0,001	0,005	-0,012	0,008	-0,005	0,007
C	-0,015 *	0,008	-0,012	0,009	-0,015	0,011
S	-0,010	0,014	0,009	0,011	-0,025 *	0,013
food	-0,009	0,009	-0,007	0,014	-0,001	0,019
textiles	0,020 **	0,010	-0,028 ***	0,009	-0,013	0,009
wood	0,006	0,010	0,011	0,013	0,028	0,019
machine	0,013	0,009	-0,007	0,014	0,002	0,012
other	0,010	0,010	-0,005	0,010	-0,016	0,010
lambda_inn	0,037 *	0,020	-0,014	0,016	0,016	0,021
lambda_make	0,027	0,016	-0,006	0,015	0,002	0,032
const.	-0,027	0,084	0,192 **	0,079	0,407 ***	0,054
Obs.	209		369		1004	
F-stat	1,72**		3,7***		4,17***	
R-squared	0,185		0,119		0,110	

Open issues

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

In order to solve the aforementioned problems we follow this procedure:

- Alternative specification of the model as robustness check: we do not consider in this model the joint effect of public funding on strategies
- A deep regional and sectorial analysis

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Final remarks

We show that

- Public funding is a factor that determines the firm's choice of R&D strategies, i.e. whether it opts for in-house R&D, outsourced R&D or a combination of the two.
- Public funding positively impacts the composite strategy while having a negative effect on the single ones. If it is true that combining internal and external knowledge creates synergies that end with a better innovative performance rather than the single strategies (absorption capacity and open innovation theory), we can conclude that in Italy public support is allocated to the most promising form of R&D strategy.
- The receipt of public funding does not have any impact on R&D intensity.

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Thanks for your attention. . .

Some references

- Antonioli, D., Marzucchi, A., and Montresor, S. (2014), "Regional innovation policy and innovative behaviour: Looking for additional effects", *European Planning Studies*, Vol.22(1), 64-83.
- Bayona-Sáez, C., Cruz-Cázares, C., and García-Marco, T. (2013), "Public R&D funding: does the source determine the strategy?", *Technology Analysis & Strategic Management*, Vol.25(2), 235–248.
- Cassiman, B., and Veugelers, R. (2006), "In search of complementarity in innovation strategy: Internal R&D and external knowledge acquisition", *Management science*, Vol.52(1), 68–82.
- Chesbrough, H.W. (2003), *Open innovation: The new imperative for creating and profiting from technology*, Harvard Business Press.
- Cruz-Cázares, C., Bayona-Sáez, C., and García-Marco, T. (2010), "R&D strategies and firm innovative performance: A panel data analysis", *International Journal of Innovation Management*, Vol.14(06), 1013–1045.
- Cruz-Cázares, C., Bayona-Sáez, C., and García-Marco, T. (2013), "Make, buy or both? R&D strategy selection", *Journal of Engineering and Technology Management*, Vol.30(3), 227–245.
- Da Rin, M., and Penas, M. F. (2007), "The effect of venture capital on innovation strategies" (No. w13636). National Bureau of Economic Research.

Motivation
Related literature
Dataset
Variables
Public Funding
Innovation Strategies
Descriptive Statistics
Innovation strategies
Public Support and Innovation Strategies
Regional differences
Methodology
Open issues
Final remarks
Some references

Some references

- David, P.A., Hall, B.H and Toole, A. (2000), "Is public R&D a complement or substitute for private R&D? A review of the econometric evidence", *Research Policy*, Vol.29(4), 497–529.
- Garcí-Quevedo, J. (2004), "Do public subsidies complement business R&D? A meta-analysis of the econometric evidence", *Kyklos*, Vol.57(1), 87–102.
- Hall, B.H., Lotti, F, and Mairesse, J. (2013), "Evidence on the impact of R&D and ICT investments on innovation and productivity in Italian firms", *Economics of Innovation and New Technology*, Vol.22(3), 300–328.
- Klette, T.J., and Raknerud, A. (2005), "Heterogeneity, productivity and selection: an empirical study of Norwegian manufacturing firms", *mimeo*.
- Lööf, H. and Heshmati, A. (2005), "The impact of public funds on private R&D investment: New evidence from a firm level innovation study", *MTT Discussion Papers*, Vol.3, 1–26.
- Narula, R. (2001), "Choosing between internal and non-internal R&D activities: some technological and economic factors", *Technology Analysis & Strategic Management*, Vol.13(3), 365-387.

Some references

- Santamaría, L., Nieto, M.J., and Barge-Gil, A. (2009), "Beyond formal R&D: Taking advantage of other sources of innovation in low-and medium-technology industries", *Research Policy*, Vol.38(3), 507–517.
- Santarelli, E. and Sterlacchini, A. (1990), "Innovation, formal vs. informal R&D, and firm size: some evidence from Italian manufacturing firms", *Small Business Economics*, Vol.2(3), 223–228
- Catozzella, A., and Vivarelli, M. (2014), "The possible adverse impact of innovation subsidies: some evidence from Italy", *International Entrepreneurship and Management Journal*, 1–18.