

R&D discontinuity and intensity: An analysis of Italian firms

Davide Antonioli¹, Ugo Rizzo²

AISRE, September, 17-19, 2018
Bolzano

September 18, 2018

¹University of Chieti-Pescara

²University of Ferrara

Outline

- 1 Motivation and Background Literature
- 2 Data and Preliminary Evidence
- 3 Comments

Inspiring motives and aim

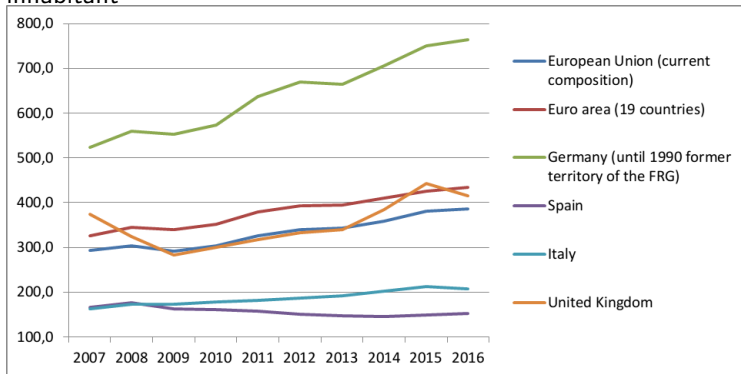
Aim: Exploring the intensity and trend in firms' R&D effort by firms characteristics (e.g. Small vs. Large; HighTech vs. LowTech), territorial specificities and strategies for a sample of Italian firms

Research questions:

- 1 Which firm level factors are associated to R&D (stagnating/declining) trend?
- 2 Which kind of firm level factors are associated to R&D
- 3 Is there a specific firm typology that is more likely to decrease or suspend the R&D activity?

Some stylised facts for selected EU countries

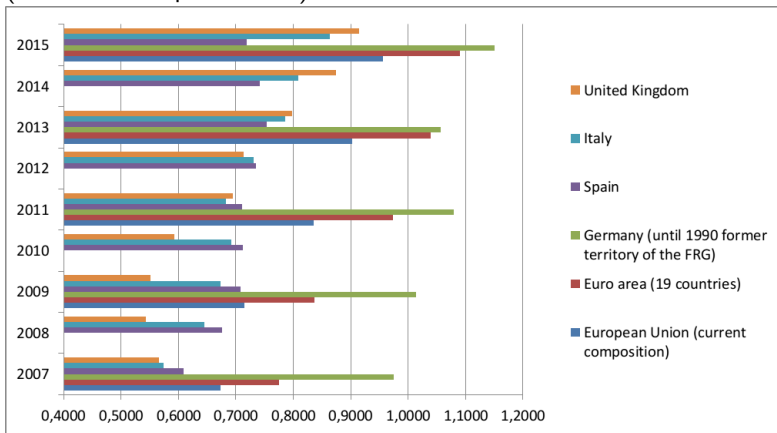
Business expenditure on R&D (BERD) by NACE Rev. 2 - Euro per inhabitant



Source: Eurostat 2018

Some stylised facts for selected EU countries

Percentage of total employment - numerator in head count (HC)
(Business enterprise sector)



Source: Eurostat 2018

Background literature

For Italy Sterlacchini (2017) illustrates the **gap of the Italian business R&D intensity with other EU countries**: mainly due to a decline in large firms R&D expenditure.

For corporates, some authors (Mowery, 2009; Arora et al., 2018) point out an overall trend in reducing R&D effort: especially true for the R part of R&D, while the D part reveals to be less affected (patenting activities of firms is overall increasing; innovation remain important determinant of competitive advantage and growth).

Reasons:

- short-termism for expected benefits,
- substitution between public and private research and between start-ups and incumbents R&D,
- increased cost of internal R&D and decreasing returns of R&D

Background literature

The **determinants behind firms' investment in R&D and innovation** has been extensively addressed in the literature (e.g. Filippetti and Archibugi 2011; Piva and Vivarelli 2007) along with the literature on NIS and RIS.

We are in front of a very complex set of linkages since **R&D intensity has manifold determinants behind** (Falk 2006), but....

.....internal strategies are under-researched

→ We aim to shed light on this issue looking at R&D employment intensity, which can be influenced by diverse managerial strategies: e.g. Teirlinck et al (2010) show the complex relation among R&D employment intensity and R&D outsourcing; Thomson and Jensen (2013) investigate the relation between R&D employment and government subsidy;

....it might be the case that **behind R&D trend (with a particular focus on R&D suspension)**, once controlled for institutional factors, some specific **internal strategies** are at work in influencing R&D suspension

→ We aim to investigate firm's internal strategies in order to add further evidence on the determinants of R&D trend and suspension.

Data

We rely on **MET dataset**: ("Monitoraggio Economia e Territorio") survey (<http://www.met-survey.com/>) on the population of Italian industrial firms (see Brancati et al., 2015)

Recurring surveys on a representative sample of Italian firms "filtered" by:

Industry → manufacturing (no business services);

Size → at least 10 employees (no micro-firms).

Survey used for the present analysis:

2011 → that covers the period 2008-2010 (6704 filtered observations)

2013 → that covers the period 2011-2013 (9144 filtered observations)

Merging the two waves provides a balanced working sample of 3144 observations ($N=3144; T=2$).

R&D

R&D 2011 distribution

RD_2011	Freq.	Percent
1	1,831	27.31
0	4,873	72.69
Total	6,704	100

R&D 2013 distribution

RD_2013	Freq.	Percent
1	2,808	30.71
0	6,336	69.29
Total	9,144	100

R&D 2011-2013 balanced panel distribution

	Overall		Between		Within
RD	Freq.	Percent	Freq.	Percent	Percent
0	4265	67.83	2317	73.70	92.04
1	2023	32.17	1196	38.04	84.57
Total	6288	100	3513	111.74	89.5

Measuring R&D trend I

Dependent variable I

How to measure R&D intensity?

We use a proxy exploiting information on the amount of workers involved in R&D activities

Survey question-1:

Can you indicate the number of persons dedicated to the R&D activities and the intensity of their engagement in such activities?

N....Full time

N....Half time

N....Less than 25% of time

Construction of a dummy variable $\text{FullTime}=1$ if there is presence of full time personnel on R&D activities; 0 otherwise.

Preliminary evidence I

Transition matrix for FullTime dummy variable
2008-2010→2011-2013

FullTime	0	1	
0	93.54	6.46	100
1	19.58	80.42	100
Total	77.80	22.20	100

Preliminary evidence I

Construction of the share of R&D personnel as proxy for R&D intensity (RD_Int): sum of employees indicated in Survey question-1/total employment

Descriptive statistics for RD_Int

RD_Int	Mean	Std	Min	Max	
Whole sample	0.042	0.099	0	1	
SMEs	0.042	0.101	0	1	
Large	0.044	0.075	0	1	

Although the mean for SMEs and Large is similar the median is 0 for SMEs and 0.105 for Large firms; the latter group also has 35% of firms with no R&D personnel, while SMEs without R&D personnel are the 71%

Measuring R&D trend II

Dependent variable II

How to measure the trend in R&D activity?

We use a direct question on the R&D expenditure trend (RD_Trend).

Survey question:

With respect to R&D expenditure can you indicate the variation in the last triennium?

Highly augmented ($>15\%$)

Augmented ($5-15\%$)

Essentially stable ($+/-5\%$)

Reduced ($-5/-15\%$)

Highly Reduced ($-5/-15\%$)

Preliminary evidence II

Transition matrix for RD_Trend (%)
2008-2010→2011-2013

RD_Trend	(1)	(2)	(3)	(4)	(5)	Total
Highly augmented (1)	33.33	33.33	33.33	0	0	100
Augmented (2)	0	77.78	22.22	0	0	100
Essentially stable (3)	0.3	3.89	95.06	0.6	0.15	100
Reduced (4)	0	0	31.58	67.79	2.63	100
Highly Reduced (5)	0	0	100	0	0	100
Total	0.36	14.27	81.62	3.51	0.24	100

Preliminary evidence II

Transition matrix for RD_Trend in SMEs (%)
2008-2010→2011-2013

RD_Trend	(1)	(2)	(3)	(4)	(5)	Total
Highly augmented (1)	0	50	50	0	0	100
Augmented (2)	0	75.28	24.72	0	0	100
Essentially stable (3)	0.4	4.19	94.41	0.8	0.2	100
Reduced (4)	0	0	31.25	65.63	3.13	100
Highly Reduced (5)	0	0	100	0	0	100
Total	0.33	14.24	81.12	4	0.32	100

Preliminary evidence II

Transition matrix for RD_Trend in Large firms (%)
2008-2010→2011-2013

RD_Trend	(1)	(2)	(3)	(4)	(5)	Total
Highly augmented (1)	100	0	0	0	0	100
Augmented (2)	0	86.96	13.04	0	0	100
Essentially stable (3)	0	3.55	96.45	0	0	100
Reduced (4)	0	0	25	75	0	100
Highly Reduced (5)	0	0	0	0	0	100
Total	0.33	14.24	81.12	4	0.32	100

Independent variables

Table : Description of independent variables (x_{it}) and Strategies

Name	Description	Nature
x_{it}		
Sector	NACE_Rev.2 two digit sector dummies	Binary(1,0)
SMEs	1 if the firm is a small or medium enterprise; 0 otherwise	Binary(1,0)
Group	1 if the firm belong to a group; 0 otherwise	Binary(1,0)
Exp	1 if the firm export its products; 0 otherwise	Binary(1,0)
CoopUni and CoopResOrg	1 if the firm cooperate for R&D with universities or research organisation; 0 otherwise	Binary(1,0)
PubSuppRes	1 if the firm received public support to research projects; 0 otherwise	Binary(1,0)
TurnTrend	Discrete ordinal variable ranging from 1 (Highly diminished) to 5 (highly augmented)	
MacroRegions	Firms geographical location: North, Center, South and Isles	
Market Strategies		
Alliances	1 if the firm forms and alliance with other firms; 0 otherwise	Binary(1,0)
NewInvestEff	1 if the firm does new investments to improve efficiency; 0 otherwise	Binary(1,0)
RDInno	1 if the firm intensifies its activities in R&D; 0 otherwise	Binary(1,0)
SectChange	1 if the firm move to other sectors or diversifies its production; 0 otherwise	Binary(1,0)

Modelling R&D determinants

A first attempt to specify R&D_Int model:

$$RD_Int_{it}^* = x_{i,t}\beta + \gamma Strategies_{i,t} + u_{it} \quad (1)$$

where $x_{i,t}$ refers to the vector of standard R&D determinants;
 $Strategies_{i,t}$ refers to the internal strategies adopted by the firms to accelerate their growth; u_{it} error term.

x: Size; Group; Export; Public support to R&D; Turnover trend;
Cooperation for R&D with universities and research organisation; Sectors (2 digit); Macro regions.

Strategies: Alliances with other firms; New investments to improve efficiency; Intensification of R&D activity; Diversification through sector changes; other strategies.

We estimate equation (1) through a simple random effect model

First econometric evidence

Table : Random effect model

	(1)	(2)
	Baseline: standard controls	Baseline + Managerial strategies
RD_Int		
SMEs	0.018*** (0.005)	0.018*** (0.005)
Large Group_	ref. 0.003 (0.003)	ref. 0.003 (0.003)
Exp_	0.017*** (0.003)	0.016*** (0.003)
PubSuppRes_	0.080*** (0.008)	0.077*** (0.008)
TurnTrend_	0.001 (0.001)	0.001 (0.001)
CoopUni_	0.061*** (0.006)	0.057*** (0.006)
CoopResOrg_	0.075*** (0.006)	0.070*** (0.006)
Center	0.006 (0.004)	0.004 (0.004)
North	0.009** (0.004)	0.008** (0.004)
South	ref.	ref.
Alliances_		-0.015*** (0.005)
NewInvestEff_		-0.015*** (0.004)
RDInno_		0.031*** (0.004)
SectChange_		0.002 (0.005)
StratOther_		-0.015*** (0.004)
_cons	-0.010 (0.008)	0.002 (0.009)
N	6288	6288
sigma_u	0.070	0.069
rho	0.568	0.568
chi2	753.995	867.204
df_m	18.000	23.000
ll		
ll_0		

Standard errors in parentheses; Sectors included: Machinery, Chemicals and TranspMech positive and significant

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Preliminary considerations

The transition matrix for R&D personnel show some decreasing trend in the full time personnel allocated in R&D activities (about 20% of firms with full time employees in R&D reallocate the personnel, from 2011 to 2013 survey, so that no more full time R&D employees are employed)

General low level of R&D intensity and the intensity of R&D is lower in SMEs than in Large firms as expected

The transition matrix for the trend in R&D expenditure evidences some not negligible shares of firms that reduces its R&D expenditure with respect to the preceding triennium: with some differences between SMEs and Large firms

The preliminary evidence shows there is room for investigations on the subject at stake: R&D determinants in the crisis and in its aftermath

There is some evidence of 'substitution' effects between R&D activity and other firms' strategies

Further analysis

Further steps:

- Providing a conceptual framework within which to analyse the role of managerial strategies as R&D determinants (e.g. are they mediators of usual determinants?)
- Looking at potential differences in transition matrices by firm category: Small vs. Large; HighTech vs. LowTech
- Refining the strategical variables in horizontally (including more strategies) and vertically (trend in the intensity of the strategy adopted)
- Control for endogeneity
- Include balance sheets variables

Thank you for your attention !