



INTERNATIONAL RTI POLICY EVALUATION CONFERENCE

# **EVALUATION OF THE IMPACT OF R&D SUBSIDIES USING A MATCHING APPROACH**

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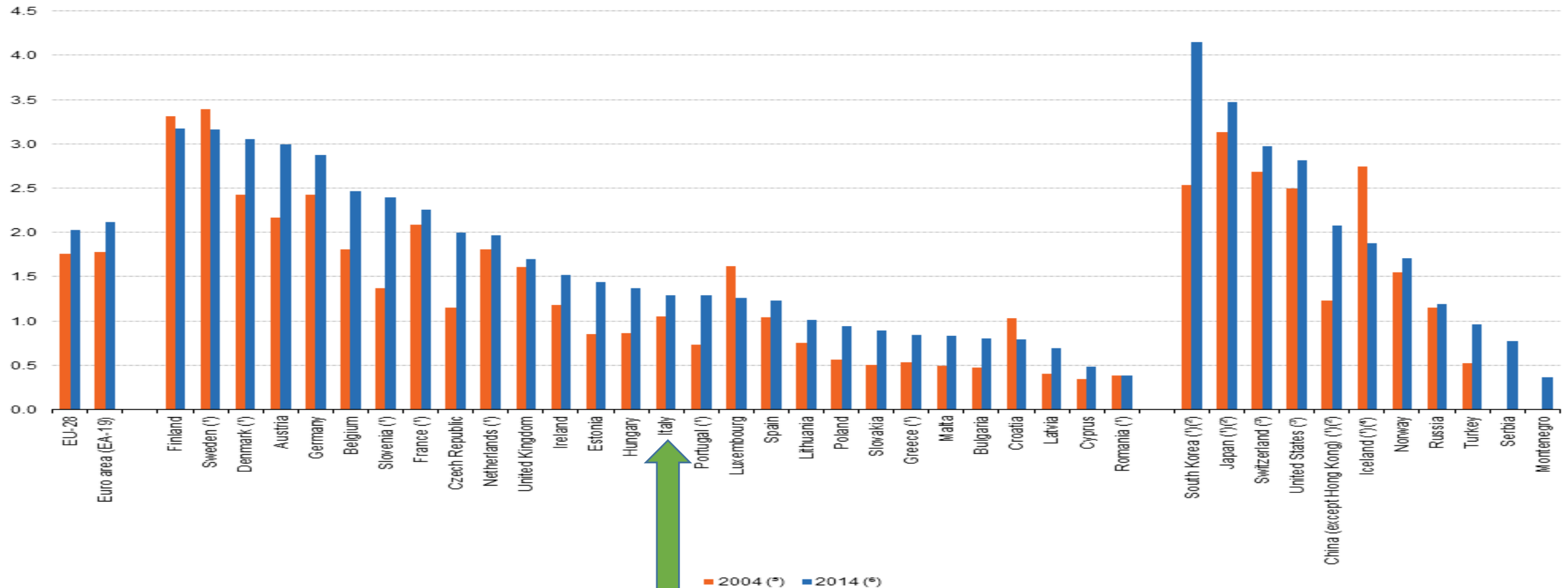
During the last couple of decades, EU has been encouraging increasing levels of investment, in order to provide a stimulus to the EU's competitiveness.

One of the five key targets of the Europe 2020 strategy is to devote 3 % of gross domestic product to R&D activities. This is a long-standing objective for the EU and it was part of the Lisbon Strategy.

Since 2000, the Lisbon Strategy has accelerated the growth rate of public R&D support.

# Gross domestic expenditure on R&D, 2004 and 2014 (% of GDP)

Source: Eurostat



(\*) Break in series.

(\*) 2013 instead of 2014.

(\*) 2012 instead of 2014.

(\*) 2003 instead of 2004.

(\*) Portugal and Sweden: estimates. South Korea and the United States: definition differs.

(\*) EU-28, EA-19, Belgium, the Czech Republic, Denmark, Germany, Ireland, France, Italy, Cyprus, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Austria, Portugal, Sweden, the United Kingdom and the United States: estimates or provisional. The United States: definition differs.

Note: when definitions differ, see [http://ec.europa.eu/eurostat/cache/metadata/en/rd\\_esms.htm](http://ec.europa.eu/eurostat/cache/metadata/en/rd_esms.htm).

Source: Eurostat (online data codes: t2020\_20 and rd\_e\_gerdtot)

***In 2014, Italian R&D investment (1.3% of GDP) under the European average (2.1%).***

- Spurred by the increasing share of public resources devoted to supporting innovation activity, a growing body of literature has investigated the effectiveness of R&D subsidies.
- The findings of empirical analysis are mixed.
- David et al. (2000) revise the results of forty years of empirical studies and find that there is no conclusive evidence in favour of public support.
- The unconvincing empirical results could mainly be explained by:
  - the difficulties in isolating the impact of innovation subsidies from the **confounding effects** induced by other factors.
  - the participation in these programs is generally endogenous and the selection bias is pervasive in the impact estimation.

- 1) Asymmetric information
- 2) Absence of additionality
- 3) Less positive externalities for SME
- 4) Crowding out effect of private spending

Research question: What happens when Italian firms receive R&D subsidies? Are there benefits?

Aim:

- explore if public R&D incentives have been effective for Italian firms;
- highlight the effects of innovation on employment and verify additionality of the instrument.
- The study evaluate the impact of public R&D subsidies on firms' performance and R&D expenditure in Italian industry using a counterfactual approach based on a non-experimental method.
- It compares subsidized firms with not subsidized ones using a counterfactual approach based on a MDID -Matching Difference-in Differences- estimator.

## The law 46/82

Promote private investment in the field of research and innovation in Italy

It defines two instruments:

- a) Fund for Research Credit
- b) Fund for Technological Innovation (FTI)

The current FTI is the results of several revisions, the last one reorganized the Fund in 2001.

- Subsidize manufacturing sectors or independent research centre
- Advantage for larger firms in the Northern regions
- Selection process through an enquiry of a commission who decide if firms are qualified to get financial support
- No deadline for applications and selection in chronological order of entry
- Each project can get one grant by public funds



## Limits

The selection procedure does not consider explicitly the risk of no additionality, this is the case in which firms would have realized the project also in the absence of incentives.

The time between the application date and the first payment is long, in average firms wait for 3 years.

The dataset for the analysis is composed by a sample of R&D projects approved by the Ministry of Industry in the years between the 2003-2010 regarding manufacturing firms and services activities.

Sources:

- Administrative archive of R&D projects (Ministry of Economic Development)
- balance sheet (Aida - Bureau van Dijk)
- Time span of projects: 2003-2010

Variables:

name, address, tax number, planned R&D expenditure, subsidy, starting date and conclusion date (eligible projects).

We link the FTI archive with the 2000-2010 firms balance sheet from AIDA database (realized by Bureau Van Dijk society) to get economic variables for each firms that describe firms before the investment and after the investment.

***Table 1 - Summary of the main covariates in the final dataset before starting investment***

	Not treated	Treated	Total sample
<b>Variables</b>	Median	Median	Median
Employment	57	62	59
Turnover	8371.4	9447.6	9101.0
Total Fixed Assets	2080.5	2648.172	2345.1
Intangible Assets	142.2	247.8	191.4
Tangible Assets	1439.5	1702.9	1538.0
ROI	8.7	5.7	6.9
Value added per capita	46.1	48.92	47.155
Labor cost per capita	28.1	28.7	28.3
Ebitda	587.3	720.269	646.1
Turnover per capita	150.2	169.9	160.4

The treated group is composed by firms that are a little bigger, more profitable and more capital intensive.

- Selection bias: subsidized firms are not randomly chosen
- Risk: no additionality
- Challenge: a good counterfactual (what the firm would have done without the incentives)
- Two conditions:
  - 1) at time  $t_0$  the control group is analogous to the treated group;
  - 2) group of non treated units, good to control the selection process.
- PSM Matching

- Matching : Match participants to non-participants with the same observed characteristics.
- The difference in the outcome variable between the two should only be due to the treatment status.
- Problem:

As the number of characteristics determining selection increases it is more and more difficult to find comparable firms.

Propensity score methods is used to minimize selection bias ([Rosenbaum and Rubin \(1983\)](#)),

to “balance” treated and comparison groups on a set of baseline characteristics

The matching estimator assumes that selection can be explained purely in terms of observable characteristics.

- high number of covariates, it may be difficult to identify a non subsidized firm:  
Propensity Score Matching
- Matching with a DID estimator

- We estimate ATT by Matching Diff-in-Diffs.
- MDID (Smith and Todd, 2005; Blundell and Costa Dias, 2009)

consists of **first-differencing outcomes** with respect to a pre-program period to remove selection on **time-invariant unobservables**, and to **compare** these first-differentiated outcomes for participants with those of **observationally identical non-participants** in order to remove selection on observables.

- The validity of Matching and MDID requires three statistical assumptions
  1. (SUTVA; Rubin, 1977), SUTVA Stable Unit Treatment Value Assumption which assumes that each individual's potential outcomes are not affected by the treatment assignments of any other subjects, and that there is only one "version" of the treatment and one "version" of the control.

Programme do not to have any effects on non participants. This assumption is credible for our analysis because the subsidized firms account less than 1% of the total manufacturing firms.

Another issue for the validity of the SUTVA hypothesis relies on the fact that the **public calls refer to a short time** and the **time span to realize project** (2.7 years) is **not enough long to develop spill-over effects** and however they should be negligible from an empirical point of view.



2. CIA conditional independence of increments: average variations identical among T and NT. In the absence of the program, average variations of pre-program outcomes are identical among treated and untreated firms.
  3. assumption of common support: the set of treated for which there exists a sufficient density of non-treated with the same value for the propensity score [Smith and Todd, 2005]
- The effect of the treatment on the treated firms can be estimated over the common support of the covariates, using the matching diff-in-diffs estimator (Blundell and Costa Dias, 2009).
  - In the stratification matching, the common support is divided into a set of intervals, and average treatment impacts are calculated through simple averaging within each interval. We implement also kernel matching and nearest neighbour matching estimation as robustness check.

The first step of the estimation procedure  
estimation of a logit model of the treatment dummy  
variable, where control variables are included as  
explaining variables

Variables	Coefficient	Std. Error
Dummy for southern regions	0.546	0.245
Dummy for economic sector (2 digit Ateco)	-0.002	0.004
Dummy for small firm	-0.322	0.232
Dummy for medium firm	-0.558	0.258
Total Fixed Assets/Sales	0.194	0.372
Share of labour cost on sales per capita	-0.070	0.216
Interaction of dummy variable for small firm with share of Fixed Assets on Sales	-0.190	0.372
Interaction of dummy variable for medium firm with share of Fixed Assets on Sales	0.395	0.490
Interaction of dummy variable for southern regions with Intangible assets	7.00E-05	6.00E-05
Costant	0.146	0.237

Number of obs = 1336

LR chi2(9) = 28.10

Prob > chi2 = 0.0009

Log likelihood = -908.824

Pseudo R2 = 0.0152

- Size is controlled with dummies for medium or small firms. Localization is controlled with a dummy on the southern regions.
- The adopted specification also reflects that the **selection procedure** is **not linearly based** on the three main indicators and the interaction between the main indicators and dimension is introduced.
- **Sector dummies** capture both the productive heterogeneity of firms and potential specific sector shocks. Dummy related to the localization of the project is also considered.
- The ratio labour cost and turnover per capita at time zero is used to control for pre-program firm productivity, approximating unobserved management ability.
- The estimate is highly statistically significant and the coefficients have the expected signs.

- Splitting the sample by propensity score into six blocks, we verify that the balancing hypothesis is satisfied, following the procedure proposed in Becker and Ichino (2002).
- This number of blocks ensures that the mean propensity score is not different for treated and controls in each blocks.
- As a further check of the conditional mean independence assumption required for the application of propensity score matching, we test the mean outcome equality between subsidized and non subsidized groups at time zero, for each of the propensity score blocks.
- The tests are performed on the outcome variables not included in the propensity score function but used to evaluate L. 46/82 effects. Test results confirm that the mean variable differences for every outcome variable are not significantly different from zero. Hence, homogeneity of firms within blocks is assured and the matching hypotheses are satisfied.

<i>Outcome variable (compound annual growth rate)</i>	Number of Treated Unit	Number of Control Unit	ATT	S.E.	t-test
Turnover	422	568	<b>-0.011</b>	0.008	-1.419
VA p.c.	355	466	<b>-0.008</b>	0.006	-1.334
Employment	357	489	<b>0.011</b>	0.005	1.947
Tot. Fixed Assets	429	579	<b>0.022</b>	0.010	2.159
Labor cost p.c.	360	481	<b>0.002</b>	0.004	0.524
Intangible assets	407	526	<b>0.001</b>	0.026	0.022
Turnover/Employment	364	479	<b>-0.012</b>	0.007	-1.583
Research, advertising cost	107	125	<b>0.087</b>	0.052	1.680
*EBIDTA/turnover ratio	350	487	<b>-0.239</b>	0.297	-0.805

\* Absolute change  $t_1 - t_0$

<i>Outcome variable (compound annual growth rate)</i>	Number of Treated Unit	Number of Control Unit	<b>ATT</b>	<b>S.E.</b>	t-test
Turnover	423	260	<b>-0.012</b>	0.009	-1.419
Employment	358	221	<b>0.017</b>	0.013	-1.334
Tot. Fixed Assets	430	269	<b>0.024</b>	0.036	1.947
Intangible assets	408	249	<b>-0.028</b>	0.009	2.159
Turnover/Employment	365	221	<b>-0.017</b>	0.073	0.524
Research, advertising cost	107	73	<b>0.05</b>	0.026	0.022
Gross margin/Turnover	364	229	<b>-0.597</b>	0.37	-1.583
ROI	107	43	<b>1.99</b>	1.14	1.816

<i>Outcome variable (compound annual growth rate)</i>	Number of Treated Unit	Number of Control Unit	ATT	S.E.	t-test
Turnover	423	567	-0.012	0.008	-1.644
Employment	358	488	0.014	0.005	2.539
Tot. Fixed Assets	438	578	0.025	0.009	2.628
Intangible assets	408	525	0.011	0.02	0.554
Turnover/Employment	365	478	-0.017	0.007	-2.385
Research, advertising cost	108	124	0.086	0.051	1.699
Gross margin/Turnover	350	487	-0.238	0.272	-0.875
ROI	87	85	1.576	0.765	2.059



- FTI has a significant positive effects on total fixed assets, employment and research and advertising cost of the sample of subsidized firms.
- We do not find significant positive effects on turnover, intangible assets and productivity.
- This highlights the absence of additionality of the subsidy.
- The positive effect on employment can be regarded as the increasing demand of high skilled workers employed in R&D activities.
- The results by Nearest Neighbour matching Estimation and by Kernel Matching Estimation confirm the previous analysis.

	Only manufacturing				
	Treated*	Control**	ATT***	S.E.	t-test
Turnover	346	462	-0.017	0.007	2.415
Employment	298	409	0.004	0.006	0.642
Fixed assets	349	465	0.025	0.010	2.602
Intangible assets	332	427	0.019	0.027	0.709
Turnover/E mployment	298	407	-0.009	0.007	-1.234
Research and advertising cost	90	110	0.103	0.062	1.663
Gross margin/Turn over	286	399	-0.145	0.306	-0.473
ROI	63	73	1.069	0.863	1.240

## Impact of FTI by area (stratification matching)

	Only North and Centre				
	Treated*	Control**	ATT	S.E.	t-test
Turnover	391	545	-0.014	0.007	-1.987
Employment	336	468	0.01	0.005	1.864
Fixed assets	400	551	0.024	0.009	2.545
Intangible assets	381	499	0.018	0.023	0.815
Turnover/Em ployment	342	461	-0.01	0.008	-1.283
Research and advertising cost	95	115	0.072	0.061	1.183
Gross margin/Turno ver	325	462	-0.193	0.275	-0.704
ROI	75	79	1.792	0.838	2.138

## Impact of FTI by firm dimension (stratification matching) medium

	Treated*	Control**	ATT	S.E.	t-test
Turnover	150	216	-0.018	0.01	-1.808
Employment	140	208	0.009	0.008	1.170
Fixed assets	153	216	0.033	0.015	2.167
Intangible assets	150	199	0.041	0.042	0.991
Turnover/Employment	146	202	-0.008	0.088	-0.709
Research and advertising cost	40	63	0.191	0.107	1.786
Gross margin/Turnover	129	185	-0.361	0.437	-0.826
ROI	37	48	2.363	0.883	2.676

- Only medium firms gain the advantage of the subsidy as shown by Return on investment
- large firms can realize their project also in the absence of the incentives.
- manufacturing sector: positive impact of subsidy on fixed assets and on 'research and advertising cost'
- The northern and central regions show better results than the whole country; the impact is significant positive on employment, turnover, fixed assets and ROI. This effect depend on the different territorial distribution of innovative Italian firms.