XXXIII CONFERENZA ITALIANA DI SCIENZE REGIONALI

ARE THE R&D SUBSIDIES EFFECTIVE? AN EMPIRICAL ANALYSIS FOR ITALY

DE CASTRIS MARUSCA[1]

SUMMARY

Draft – not to be reproduced or quoted without the authors' permission

Empirical evidence on the effects of public subsidies to R&D at firm level is mixed and contradictory. The paper presents new empirical results based on new dataset, that integrates administrative archives with a balance sheet dataset containing longitudinal information on sales, fixed assets, value added, employment. The impact of incentives is estimated using different samples by dimension, sectors and geographic area. A DID Matching estimator is applied, considering the presence of selection on observables and non observables The results suggests the presence of significant effect on employment and investment, but not on sales and productivity.

JEL classification: O38; L1; C21
Keywords: R&D; Subsidies; DID Matching.

[1] Department of Political Institution and Social Science, University of Rome "Roma Tre", Via Gabriello Chiabrera, 199, 00145 Roma, e-mail: m.decastris@uniroma3.it.

1 Introduction

Both academic scholars and policy makers are debating the effectiveness of incentive system that boost firms' competition enhancing innovation and research and development (R&D) efforts. In the last 10 years, the objectives of the Lisbon Strategy (the objective of increasing R&D expenditure to 3% of GDP) have accelerated the growth rate of public R&D support but the sign and the size of the effects on firms' R&D expenditure and performances is an open question. 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 are mixed and controversial. 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. In particular, participation in these programs is generally endogenous and the selection bias is pervasive. Economists and econometricians deal with the problem of inferring the effect of a policy by using different evaluation methods, depending basically on the type and quality of available data and on the policy "assignment rule'' (Blundell-Dias, 2009). Only recently an interesting literature on econometric evaluation methods for non-experimental data; also in the field of public support to private R&D has arisen.
The paper is cast in this new stream of literature. The study analyzes the effect of public R&D subsidies on firms performance and innovative efforts in Italian industry using a counterfactual approach based on a non-experimental method. The main concern is to assess the effectiveness of public R&D support on firm's performances analyzing whether the sign and the size of the effects depend on the size of the firms and on its technological level.

The aim of the paper is to evaluate a policy instrument used to subsidize private projects on R&D, the Fund for Technological Innovation (FTI). The study compares subsidized firms with non subsidized ones using a counterfactual approach based on a MDID (Matching Differences-in Differences) estimator. The empirical analysis is carried on a new detailed and informative database including companies awarded at least one R&D grant during the years 2002-2010; for each company we have data on the size of subsidies, from the administrative archive, and balance sheet data from Bureau Van Dijk database. We estimate the impact of the subsidies on revenues, material and immaterial investment, value added, employment, labour productivity and profitability.

2 Theoretical motivation

In 1950, Schumpeter emphasized the role of innovation as driver of economic growth. His theory has been the starting point of lots of studies on the economic effects of technological innovation; most of them recognize a relative advantage of large firms over small business in the supply of

innovation. Size emerges as a determinant to drive technological innovation: large firms can get cheaper credit for carrying out risky R&D projects in the financial market (Cohen and Levin, 1989) moreover the large size is a prerequisite to attract high skill workers required to achieve a successful innovation process (Corsino et al., 2011). Infact, only firms that dispose of resources with technical expertise can hold a "temporary monopoly power" linked to their innovative products. Unfortunately, the amount of financial resource devoted to R&D is often not enough to insure the undertaking of innovation products for the private units.
In this context, the role of government funding becomes essential to overcome market failures and stimulate innovation. Over the past two decades, OECD governments have contributed to the R&D expenditure with almost one third of the total expenditure. In Europe, we observe different economic policies that use grants, procurement, tax incentives and direct funding on business R&D.

The presence of market failures related with R&D activities motivates government interest to sustain R&D investment. The reason of these market failures has been deeply discussed. Firms achieve lower (private) rate return to R&D than the social marginal return since they don't have power over the diffusion of knowledge of their technological innovation and so a positive spill over effects arise; the uncertain of research activities discourage firms, especially small ones for which high risk is a barrier to take on new innovation activities. For this reason, in general, the private amount invested in R&D is below the optimal point (Arrow, 1962). Government action can help to overcome the hurdles reducing the cost and uncertainty of private R&D, increasing knowledge of technological opportunities. If public policies are effective then public and private funding may be complementary such that the increase of public funds may boost the private ones.

However there are strong impediments to the effectiveness of public funding .First of all asymmetric information that generates distortions in resources allocation between different fields of research. Market driving force can allocate resources more efficiently then public operators thanks to more or superior information on the economic and social features of the project and its feasibility. The main consequence of this asymmetry is the absence of additionality for public funds. Firms can substitute private money with public support and realize the same research that they will be realized. Sometimes the funding of a private project discourage other firms in the same sector that were planning to do a similar project, this is a further case of no additionality at aggregate level.

In general, positive externalities take place when the firm undertakes an innovative project, but this effect is less intense for SMEs. In fact, small firms, usually, must face stronger liquidity constraints compared to larger ones. In addition, the present value of a R&D investment also depends on the possibility the firm has of preventing other competitors from having access to the investment's innovative results. This is clearly related to patenting normative yet it also depends on the firm's market power. Smaller firms are often ineffective in internalizing innovation activities' benefits

(Cohen and Klepper (1996)). A government intervention could then directly solve these issues, decreasing firms' costs and increasing welfare. Moreover, there could be indirect benefits. First of all, if the public funded project involves upgrading general research facilities, the fixed costs of undertaking private.

Moreover, a potential crowding out effect of private spending can arise. David et al (2000) assert that also if the total amount of R&D increase, as result of the sum of public and private funds, the real amount of R&D remains low because the presence of public funding bring on an higher labour cost of research., given a major competition on all research inputs. Not-withstanding, Wolf and Reinthaler (2008) show a positive impact of R&D subsidies on private innovation activity.

Empirical analysis on the effectiveness of R&D subsidies has been carried out by several scholars with dissimilar and ambiguous results as highlighted by David et al.(2000) in their review of econometric evidence. Certainly, evaluation of the impact of public funds to private sector has to tackle the complexity of identification strategy as long as public funding is endogenous with regard to innovation. This bring to a wrong estimation of the real impact of subsidies that could be over or under estimated depending on the selection of firms, healthy firms which invest anyway in R&D or unhealthy firms that use public funds to support business. in the meantime in which the investment is realized, several factors can act modifying the size or the sign of the dependent variable, object of the estimation. The challenge of empirical evaluation is to detach such factors separating confounding effects from the subsidies effect.
Over the last three decades, several studies were interested on the casual effect of policies developing different methods to tackle the problem in different way that take into account the policy assignment rule and the type of available data. Beginning from the consideration that in economic policy the treatment's assignment is not randomized, a lot of non experimental methods have been developed to overcome estimation problem due to the nature of data.

3 Law 46/1982: the Fund for Technological Innovation

Among R&D subsidies to firms, law 46/1982 is one of the most relevant law to promote private investment in the field of research and innovation in Italy. The law creates two instruments to found R&D and innovation: the Fund for Research Credit and one that regards specifically the institution of a Fund for Technological Innovation (FIT).

The Fund for Technological Innovation was revised several times and it was fully reorganized in 2001. The FIT is oriented to R&D investment that, in Italy, is under the European average: it represent only 0.67% of GDB versus 1.25 of European Community. It is considered the most important policy measure in Italy. Subsidized support is available for firms that have productive

units in Italy and operate in the manufacturing sectors such as industrial activities to produce goods and services, craftsmanship to produce goods, transportation activities. Moreover the fund is directed to research centre characterized by independent legal status.

The instrument operate following two ways: a direct subsidy to investment and an indirect subsidy for subsidized credit.

Since 2002, the subsidies for investment are of about 770 (€/millions) and the paid out grants are 580 (€/millions). The southern regions of Italy have got only the 14% of the grants. The subsidized credit for reduction in interest rate is of about 1.700 (€/millions) which only 11% in the Southern regions, the paid out grants are 1.240 (€/millions).

The specific aim of the fund is the support of innovative firms programme which intend to introduce relevant technological innovation. The innovation considers both the production of new goods as new productive processes or also to improve existing goods or processes. The programme regards the planning of product realization, the design and development, experimentation, production of industrial prototype. It excludes customer-related processes and marketing of the products. Moreover the fund grant the promotion of innovation activities and the implementation of industrial research results. It is directed to increase R&D expenditure of firms. The aims of the fund advantage large firms in Northern regions, operating in technologically advanced sectors and expert in the development of large research projects.

The selection procedure of the benefited firms is carried out by the Ministry of Industry. Firms apply demand and project and, through a procedure of enquiry, the competent office of the Ministry ascertain which firms satisfy the conditions required to get financial support.
If a project is rejected, the Ministry explains the reasons to the firm on the base of the committee judgement. There is no deadline for applications, every proposal is evaluated in chronological order of receipt.
Every firm declares that it does not have grants from other public funds for the same goal. The grant amount established for each firm is paid out in several steps, during the undertaking of the project thanks to a verification procedure that control if the firms use public funds to realize the program. The procedure makes use of a penalties when firms do not respect the programme interrupting the funding and forcing them to return the received amounts. The procedure does not consider the risk of non-additionality, that is the hypothesis in which firms would have carried out the project in any case, also in the absence of public incentives.

4 The identification strategy

L. 46/82 uses a planned selection process because subsidies are assigned to projects, and so to firms, following policy's criteria. This means that treated and non treated firms are different respect to their structural and financial dimension. Only a randomized assignment of subsidies could ensure that the two groups are not different. We are conscious that the selection system produces some types of selection bias that certainly influence the average outcome of treated and non treated firms. For example, larger firms characterized by high profit and capital intensive may achieve better results also in the absence of subsidy. Moreover, the possibility of being subsidized increases if the firm has better relationship with banks, has an effective management and the project is clear and well structured. Each factor can influence firm performance. For these reasons, the evaluation strategy aims to decrease the selection bias associated with a firm's observable and non observable characteristics.

The main observable characteristics which affect selection bias are the factors considered more important to be eligible by the policy makers. For innovation project, economic sector and firm size can be relevant in the selection mechanism. EU rules assure higher incentives share to SMEs because the low size reduces the likelihood of access to credit.

In order to control for these effects, in the analysis we utilize information on firm size (measured by the number of employees).

Management ability and inclination to innovate are the major non observable characteristics.

We assume that other local factors are constant over time, and the effect can be captured by a firm fixed effect. In this set we also include other non observable variables affecting the decision to participate, such as the quality of firm management and its propensity to risk, the quality of the R&D produced by the firm and productivity effects related to the geographical location of the firms, which are only partially captured by the previous covariates. These factors are all intrinsically related to each firm, and can be considered invariant over the analyzed period of time.

5 The evaluation model

To identify the impact of L.46 using a matching technique we need that the control group satisfy two main conditions: (a) before the policy, the control group is very similar to the treated group (b) the control group is a very good control for the selection process.

We assume that the time dimension (the time when firm presents the project) and the space dimension (regions) are not relevant in respect to the selection problem. Under this hypothesis (which we verify below with several robustness checks) we pool projects across different regions and different competitive tenders. In this way, an overlapping area of firms with the same propensity to be subsidized (they are in both the treated group and the control group) is available and a matching estimator is a feasible instrument to determine the effects of L. 46.

The matching estimator assumes that selection can be explained purely in terms of observable characteristics. In this case the conditional independence assumption (CIA) holds, it means that the outcomes of non treated units are independent from the participation status conditioned to the observables. The consequence of CIA is that for each subsidized unit, observations of not subsidized unit on outcome variable with the same covariates realization constitute the correct counterfactual.

The ability of matching to reproduce an experimental framework depends on the availability of the counterfactual. Hence, the second matching assumption is that all treated units have a counterpart in the non treated population and any one constitutes a possible participant. The main advantage offered by the matching method is that it does not require any assumption on the functional form of the dependency between the outcome variable and the observed covariates. On the other hand, if there are a high number of covariates, it may be difficult to identify a non subsidized firm to match with every subsidized firm, unless the sample is huge. This obstacle is overcome with the Propensity Score Matching (Rosenbaum and Rubin, 1983). The correct use of a propensity score also requires that firms with the same propensity score must have the same distribution of observable (and non observable) characteristics independent to the treatment status.

This hypothesis is called the “balancing hypothesis” and can be tested using the approach presented in Becker and Ichino (2002).

In the case of L. 46, the weak unconfoundedness (CIA) hypothesis is theoretically not satisfied because we do not know the selection procedure. To implement the matching technique, we define the treatment group as the set of firms subsidized by L. 46 and the control group is made up of the rejected applicant firms. The outcome of interest, Y, is the (compound annual growth rate) performance, profitability and employment indices; the variable X refers to observed firm characteristics such as size, activity sector and research cost.

Even after conditioning on observables, there may be systematic differences between participant and non participant outcomes. This is the case in our pool of subsidized and non subsidized firms, where different regional or time fixed effects can affect their outcomes. To overcome this potential source of selection bias we assume that differences between tenders and across regions are considered constant over time. The hypothesis is tested using a robustness analysis.

Under this assumption a possible strategy to correctly evaluate the impact of L. 46 is to combine Matching with a DID estimator (MDID).

MDID 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 (Smith and Todd, 2005; Blundell and Costa Dias, 2009). The MDID allows for temporally invariant differences (individual fixed effects and trend effects) in performances between subsidized and non subsidized firms. In other words, it weakens the identifying assumption for matching by allowing non-observed time-invariant variables to influence performance (Bryson et al., 2002).

The validity of Matching and MDID requires three statistical assumptions. The first assumption is the Stable Unit Treatment Value Assumption (SUTVA), which requires the program not to have any effects on non participants. This assumption is credible for our analysis because, on the average of the two tenders, subsidized firms account for only around 1% of the total manufacturing firms in the south. We can assume, on that basis, that the overall spill-over effect is negligible (Bernini and Pellegrini, 2011). Another issue supporting the validity of the SUTVA hypothesis relies on the fact that the tenders are very temporally close with respect to the average project time span (2.7 years) and the spill-over effects cannot be fully developed in the time span we observed for the subsidized and non subsidized firms. Even if supply or demand spill-overs are theoretically possible, from an empirical point of view they should be negligible. As shown in De Castris and Pellegrini (2012), for the main regional development policies in the southern regions of Italy (Law 488 and Contratti di Programma), spill-overs are small and negative across areas, suggesting the presence of modest spatial crowding out where subsidized regions attract employment and firms from neighboring areas.

The second assumption, regarding only the MDID, is the conditional independence of increments, that is, in the absence of the program, average variations in practices from pre-program levels are identical among participants and non-participants.

The main matching hypothesis is then stated in terms of the before–after change instead of levels. If it is verified, it means that controls have evolved from a pre to a post program period in the same way treated firms would have done if they had not been treated. This happens both on the observable component of the model and on the non observable time trend. The assumption is reasonable for the treated firms that share several common characteristics with the non treated ones.

Finally, the assumption of common support requires that there be observationally identical non-participants for each participant.

The effect of the treatment on the treated firms can now be estimated over the common support of X, using the matching diff-in-diff 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.

6 Data

The database of the analysis is composed by a sample of R&D projects approved by the Ministry of Industry in the years between the 2000-2010 regarding manufacturing firms and services activities. The sample considers projects that were considered eligible by a commission of experts of the Ministry of Industry (2904).

We had a 26% of drop-outs from the sample to take in account that:

- each firm can present projects in different tenders and so we dropped out 343duplicates from the database;

- a group composed by 173 firms saw their grant revoked;
- a group of 245 firms had not concluded their investment at the moment of the evaluation. We consider that the project is realized when we have a final decree of the ministry about it or if the firm has got the 90% of the subsidy.

The final sample is composed by 2143 firms(939 of which subsidized).

For each firm the archive includes the following information: name, address, tax number, amount of the planned R&D expenditure, amount of the subsidy. Only for the eligible projects, it is also available the project's starting date and conclusion date. 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. Unfortunately, the linking procedure based on the firm identifier (tax number) can fail, the unavailability of balance-sheet data for the entire period, and standard data cleaning reduce the sample and the final number of units depends on the variable that we want analyze.

Each firm start its investment on the depending on the time of application and the time of granting and so we have different time spans. The data set contains information on the years of beginning and end of investment and we consider the time between the year before the start and the year after the end to estimate the impact of the subsidy. This choice depend on the fact that the time span is different for each project. For the evaluation we consider as pre-treatment year, the previous year of the beginning of the investment and as post-treatment year, the year after the year of ending.

For not subsidized firms we consider that the end date is equal to the sum of the start date (mean in the group of subsidized firms) and the average investment period calculated from the sample of subsidized firms.

Moreover, an important check of data regards the consistency of the control group with respect to the treated group. We evaluate the two sample comparing the main economic indicators before the start of the project. The characteristics of the firms in the two sub-set before starting investment is relevant to build up the counterfactual analysis. The table 1 shows a substantial homogeneity between the two groups. The treated group is composed by firms a little bigger, more profitable and more capital intensive. We checked also for the year after the end of investment and we found homogeneity.

Table 1 - Summary of the main covariates in the final dataset.

	Median		
	Not Financed	Financed	Total
Employment	57	62	59
Turnover	8371.375	9447.55	9101.02
Total Fixed Assets	2080.462	2648.172	2345.054
Intangible Assets	142.164	247.884	191.358
Tangible Assets	1439.459	1702.861	1538.033
Research and advertising	0	0	0

cost			
ROI	8.64	5.66	6.89
Value added per capita	46.11	48.92	47.155
Labor cost per capita	28.1	28.73	28.295
Ebitda	587.291	720.269	646.147
Turnover per capita	150.2231	169.9142	160.4124

Source: Elaboration on L.46 and Aida data.

7 Results

The first step to estimate the impact of the policy is the specification of the propensity score model. We adopt a Logit specification of the treatment dummy variable (T), which is 1 if firm i has received the subsidy and zero otherwise. For the identification of covariates, we consider variables on fixed assets, sales, labour cost. Size is also 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 final specification of the Logit model for propensity score and the parameter estimates are shown in Table 2. The estimate is highly statistically significant and the coefficients have the expected signs.

Table 2 Logit Estimate: baseline model

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	-0.190	0.372

small firm with share of Fixed Assets on Sales		
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

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 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.

ATT is estimated using the MDID technique, implemented by a Stratification matching estimator. The presence of some anomalous data (as signaled by the large difference between median and mean across indicators) indicates a need to trim the subsidized and the non subsidized firm samples at the 5 and 95 percentiles. We impose the common support restriction in all the estimations in order to improve the quality of the matches. The standard errors of the ATT are estimated by the bootstrap procedure (100 replications) described in Becker and Ichino (2002). The estimates of ATT for the full sample are presented in Table 3.

L. 46 has a significant positive effects on total fixed assets, employment and Research and advertising cost of the sample of subsidized firms.

In general, the study doesn't 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, especially to design the proposal project.

Table 3 Results of Stratification Matching Estimation.

Compound annual growth rate	Number of Treated Unit	Number of Control Unit	ATT	S.E.	t-test
Turnover	422	568	-0.011	0.008	-1.419
Value added per capita	355	466	-0.008	0.006	-1.334
Employment	357	489	0.011	0.005	1.947
Total Fixed Assets	429	579	0.022	0.010	2.159
Labor cost per capita	360	481	0.002	0.004	0.524
Intangible assets	407	526	0.001	0.026	0.022
Turnover/Employment	364	479	-0.012	0.007	-1.583
Research and advertising cost	107	125	0.087	0.052	1.680
*EBIDTA/turnover ratio	350	487	-0.239	0.297	-0.805

* Absolute change of the variable between time t0 and t1.

As robust check we estimated the ATT using the MDID technique, implemented by a Nearest Neighbour matching estimation and by Kernel Matching Estimaton and the results in table 4 confirm the previuos analysis.

Table 4. Impact of FIT on the full sample

	Nearest Neighbour matching estimation					Kernel Matching Estimaton				
	Treated*	Control**	ATT***	S.E.	t-test	Treated*	Control**	ATT	S.E.	t-test
Turnover	423	260	-0.012	0.009	-1.067	423	567	-0.012	0.008	-1.644
Employment	358	221	0.017	0.007	2.368	358	488	0.014	0.005	2.539
Fixed assets	430	269	0.024	0.013	1.868	438	578	0.025	0.009	2.628
Intangible assets	408	249	-0.028	0.036	0.760	408	525	0.011	0.02	0.554
Turnover/Employment	365	221	-0.017	0.009	-1.859	365	478	-0.017	0.007	-2.385
Research and advertising cost	108	73	0.05	0.073	0.685	108	124	0.086	0.051	1.699
Gross margin/Turnover	350	229	-0.597	0.377	-1.585	350	487	-0.238	0.272	-0.875
ROI	87	43	1.992	1.114	1.816	87	85	1.576	0.765	2.059

Notes: *Number of treated firms; ** Number of control units; ***For turnover, value added, employment, fixed assets, labour productivity, TFP, debt charges/debt stock and debt charges/turnover, ATT are given as the difference in growth rates between Treated and Control firms, for the other variables as the difference in levels.

Table 5 presents the average effect on the treated by size. Only medium firms gain the advantage of the subsidy as shown by Return on investment, while the large firms can realize their project also in the absence of the incentives.

Table 5. Impact of FIT by firm dimension (stratification matching)

Small firms

	Treated*	Control**	ATT***	S.E.	t-test
Turnover	191	275	-0.014	0.01	-1.371
Employment	142	212	0.009	0.008	1.173
Total Fixed assets	196	283	0.035	0.019	1.825
Intangible assets	179	255	0.033	0.042	0.771
Turnover/Employment	139	206	-0.026	0.012	-2.257
R&D and marketing costs	41	40	0.042	0.103	0.412
Gross margin/Turnover	152	235	0.272	0.475	0.573
ROI	32	21	1.972	1.528	1.291

Medium firms

	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

Large firms

	Treated*	Control**	ATT	S.E.	t-test
Turnover	77	75	-0.003	0.012	-0.253
Employment	75	70	-0.015	0.014	1.047
Fixed assets	75	79	0.006	0.016	0.389
Intangible assets	76	73	-0.001	0.029	-0.025
Turnover/Employment	74	72	0.009	0.013	0.705
Research and advertising cost	22	27	-0.054	0.104	-0.520
Gross margin/Turnover	66	69	-0.649	0.685	-0.947
ROI	19	17	1.636	2.296	0.713

Notes: *Number of treated firms; ** Number of control units;

***For turnover, value added, employment, fixed assets, labour productivity, TFP, debt charges/debt stock and debt charges/turnover, ATT are given as the difference in growth rates between Treated and Control firms, for the other variables as the difference in levels.

Table 6 presents the impact on manufacturing sector where we detect a 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.

Table 6. Impact of FIT by area and sector (stratification matching)

	Only manufacturing					Only North and Centre				
	Treated*	Control**	ATT***	S.E.	t-test	Treated*	Control**	ATT	S.E.	t-test
Turnover	346	462	-0.017	0.007	2.415	391	545	-0.014	0.007	-1.987
Employment	298	409	0.004	0.006	0.642	336	468	0.01	0.005	1.864
Fixed assets	349	465	0.025	0.010	2.602	400	551	0.024	0.009	2.545
Intangible assets	332	427	0.019	0.027	0.709	381	499	0.018	0.023	0.815
Turnover/Employment	298	407	-0.009	0.007	-1.234	342	461	-0.01	0.008	-1.283
R&D and marketing costs	90	110	0.103	0.062	1.663	95	115	0.072	0.061	1.183
Gross margin/Turnover	286	399	-0.145	0.306	-0.473	325	462	-0.193	0.275	-0.704
ROI	63	73	1.069	0.863	1.240	75	79	1.792	0.838	2.138

Notes: *Number of treated firms; ** Number of control units; ***For turnover, value added, employment, fixed assets, labour productivity, TFP, debt charges/debt stock and debt charges/turnover, ATT are given as the difference in growth rates between Treated and Control firms, for the other variables as the difference in levels.

8 Conclusions

This article provides new evidence on the impact of public R&D funds highlighting some positive effects still not came out of previous studies. It is analyzed if the participation to FTI program leads on average to higher performance at the firm level. By means of a non parametric approach, we compare the outcome of subsidized firms to a matched control group of non subsidized firms. The information collected in our dataset covers not only administrative data but also balance sheet data for the time before the investment and for the time following the investment. This has allowed for a deepen analysis of the casual effect of public R&D subsidies. The casual effect identified is significantly positive for employment while it is significantly negative on productivity.

In general, the study doesn't find significant positive effects on turnover, intangible assets and R&D costs. 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.

9 References

Arrow K. J. (1962) "Economic Welfare and the Allocation of Resources for Invention", in Nelson, R. R. (ed.), *The Rate and Direction of Inventive Activity*, Princeton University Press.

Becker, S.O., Ichino, A., 2002. Estimation of average treatment effects based on propensity scores. *The Stata Journal* 2 (4), 358–377.

Bernini C., Pellegrini G. (2011) How are growth and productivity in private firms affected by public subsidy? Evidence from a regional policy. *Regional Science and Urban Economics*, 41 (3), 253-265.

Blundell R, Costa Dias M. (2009). Alternative approaches to evaluation in empirical microeconomics. *Portuguese Economic Journal* 1(2): 91–115.

Cohen, W.M. and Klepper, S., (1996) A Reprise of Size and R&D, *Economic Journal*, 106, 925-951.

Cohen, W.M., and R.C. Levin. (1989) Empirical studies of innovation and market structure. In The handbook of industrial organization, vol. II, ed. R. Schmalensee and R.D. Willig, 1059–107. North-Holland: Elsevier Science Publishers B.V.

Corsino M., Espa G. et Micciolo R. (2011) R&D, firm size and incremental product innovation. *Economics of Innovation and New Technology*, 20:5, 423-443.

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*, 29, 497-529.

David, P. and Hall, B., (2000), Heart of Darkness: Modelling the Public-Private Funding Interactions Inside the R&D Black Box, *Research Policy*, 29, 1165-1183.

De Castris M., Pellegrini G. (2012), Evaluation of Spatial Effects of Capital Subsidies in the South of Italy, *Regional Studies*, Volume 46, Number 4, 1 April 2012 , pp. 525-538(14)

Georghiou, L., Roessner, D., (2000) Evaluating technology programs: tools and methods. *Research Policy* 29, 657–678.

Guellec D. et Van Pottelsberghe De La Potterie B. (2003) The impact of public R&D expenditure on business R&D, *Economics of Innovation and New Technology*, 12:3,225-243.

Rosenbaum, P., Rubin, D.B., 1983. The central role of the propensity score in observational studies for causal effects. *Biometrika* 70, 41–55.

Schumpeter, J.A. (1950). *Capitalism, socialism, and democracy*. 3rd ed. New York, NY: Harper.

Smith, J., Todd, P., 2005. Does matching overcome LaLonde's critique of nonexperimental estimators. Journal of Econometrics 125 (1–2), 305–353.

Wolff, G.B. and Reinthaler, V., (2008), The effectiveness of subsidies revisited : Accounting for Wages and Employment Effects in business R&D, *Research Policy*, 37, 1403-1412.