Evaluating the Effect of Public Subsidies on firm R&D activity: an Application to Italy Using the Community Innovation Survey[1]

Giovanni Cerulli and Bianca Potì
CERIS-CNR
Via dei Taurini 19
00185 Rome, Italy
g.cerulli@ceris.cnr.it; b.poti@ceris.cnr.it

ABSTRACT. The aim of the paper is twofold: to verify a full policy failure of public support on private R&D effort, when in presence of a potential plurality of public incentives; to compare the most recent econometric methods used for the analysis of the input additionality.

Compared to previous studies our work wants to trace out an advance in two directions: adding more robustness by comparing results from various econometric techniques and providing an analysis of the R&D policy effect behind the average results. A by-product of the paper is a taxonomy of the econometric methods used in the literature, according to the structure of the models, the type of dataset and the available policy information.

We exploit the third wave of the Community Innovation Survey for Italy (1998-2000) with a sample size of 1,221 supported and 1,319 non-supported firms. Given the used type of data, the article presents two main limits: first, we do not know the level of the subsidy, so that we can control only for the presence of a total crowding-out; second, we can check only the short-run effect of the supporting policy, while an increase in the private R&D effort could be more likely in the medium term.

Our results suggest that: 1. the main factors influencing the probability to participate to the incentive policy are R&D experience, human skills, liquidity constraints, but also foreign capital ownership; 2. on average, the total substitution of private funding by the public one is excluded for Italy as a whole, although some cases of total crowding-out are found: low knowledge intensive services, very small firms (10-19 employees) and the auto-vehicle industry. We get, on average, 885 additional thousand Euros of R&D expenditure per firm with a ratio equal to 4.62: it means that if a generic control unit does 1 thousand Euros of R&D expenditure a matched treated does 4.62 thousand Euros. The additionality for the R&D intensity is about 0.014 with a ratio of about 2.67.

KEYWORDS: Business R&D; Public Incentives; Econometric Evaluation
JEL-CODES: O32, C52, O38

[1] This paper is part of the FIRB 2005-2008 strategic project on “Models and tools for evaluating the short and medium term impact of firm R&D investments on the Italian productive system” financed by the Italian Ministry of University and Research. We wish to thank all the FIRB members for their useful suggestions and Elisa Barbieri and Roberto Gabriele for their very accurate and punctual review of the paper.

WORKING PAPER CERIS-CNR
Anno 10, N° 9 – 2008
Autorizzazione del Tribunale di Torino
N. 2681 del 28 marzo 1977

Direttore Responsabile
Secondo Rolfo

Direzione e Redazione
Ceris-Cnr
Istituto di Ricerca sull'Impresa e lo Sviluppo
Via Real Collegio, 30
10024 Moncalieri (Torino), Italy
Tel. +39 011 6824.911
Fax +39 011 6824.966
segreteria@ceris.cnr.it
http://www.ceris.cnr.it

Sede di Roma
Via dei Taurini, 19
00185 Roma, Italy
Tel. 06 49937810
Fax 06 49937884

Sede di Milano
Via Bassini, 15
20121 Milano, Italy
tel. 02 23699501
Fax 02 23699530

Segreteria di redazione
Maria Zittino e Silvana Zelli
m.zittino@ceris.cnr.it

Distribuzione
Spedizione gratuita

Fotocomposizione e impaginazione
In proprio

Stampa
In proprio

Finito di stampare nel mese di Dicembre 2008

CONTENTS

1. THE IMPACT EVALUATION OF R&D FINANCIAL SUBSIDIES: PROBLEMATIC ISSUES AND OUR AIM

The evaluation of the effect of a public subsidy to private R&D projects is a difficult task. The "input additionality" related to public incentive for industrial R&D is the political core issue. Governments are first of all interested in assessing how much firms have increased private funded R/D as an effect of some public funded instrument. This evaluation needs information on the cost of each specific policy instrument as well as it needs to isolate one instrument from the others. Generally firms benefit of more than one public incentive and therefore for a policy maker a frequent trade-off can be envisaged between the availability of information/data on a specific instrument (assuming the strong hypothesis that it is the only incentive the firm benefit of), and less focused information/data on an aggregated pool of instruments (such as in our case), which doesn't inform on which instrument works and what is the relation among them. We are aware of these problems, that remind also to a critical question for policy makers: planning the evaluation ahead of time, when a policy measure is designed, and collect the right data.

Moreover policy makers are confronted with other problems related to the selection of projects: for a public agency it is difficult to identify ex-ante when the project is a "marginal" one or when it is an "inframarginal" one, i.e., a project that would be privately profitable even in absence of a public subsidy.

The ex-post controls by public agency rarely includes demonstrating the additional character of the incentive, that is, the marginal effect[2]; they are mainly focused on the measurement of project outputs[3] or often they only rely on qualitative surveys asking firms for whether they would have developed the R&D project without the public support.

The "additionality" question has a specific rationale: looking at how much additional private resources for R&D are mobilised by the incentive, where the relation to be explored is between public and private investment in R&D, rather than between public incentive and final private performance. The question has been largely explored by economic scholars, trying to answer to the questions: how do firms react to the public subsidies? Do public subsidies become a substitute of private R&D investment and in what cases? The effect of public funding on R&D private funding is an obligatory passage for identifying its impact on the firm final performance.

As Wallsten (2000, p. 84) wrote: "the problem of the government is to finance the best projects among those that cannot receive adequate funds from other sources". The purpose of government of course is larger than the firm one's: it is that of increasing the social return from private R&D activity and this asks for including an assessment of the "spillover effects" (i.e., social indirect effects), which are larger when the R&D project has a more generic or pre-competitive character.

In this paper we look only at the additionality effect at firm level, starting from the consideration that the "marginal" effect (additional R&D) is a basic condition also for increasing knowledge spillovers and social benefits.

As it has been found out in the literature, according to the type of instrument the impact should be more or less the following:

[2] See Jaffe (1998) cited in Wallsten (2000, p. 85): "government technological programs have never been designed to include comprehensive economic evaluation, making it almost impossible to identify marginal effects".

[3] In Italy examples of industrial policy evaluation concern mostly incentives to capital formation (made on the behalf of the Ministry of Economic Development) and very few examples concern R/D incentives. The independent organization of research evaluation (CIVR) had within its institutional tasks the evaluation of some research programmes (FIRB), but the established criteria of evaluation have not been still operationalised. In the past a private body (IMI) in charge of the management of the main public fund for industrial applied research (FAR) developed an ex-post evaluation based on qualitative questionnaire; now the reform of the applied research incentive FAR (L 297/99), managed by MUR, includes an ex-post evaluation in two steps (at the end of the project and two years later). This is a compelling task for firms, which cannot present a new demand of fund, if they do not follow this rule. But this ex-post evaluation too, is of a qualitative type, based on questionnaire and focused on an analysis of R/D project output (firm increase of sales and productivity).

- *R&D contracts*, which are less developed in Europe, include a double public action, on the R&D project cost side and on the firm's return from the R&D project, given that they impact also on the firm's sales (the government is the final buyer of the R&D results, new processes or new products)[4];
- *R&D mission oriented programs*, based on a bid programs, which became more important since 80's in Europe[5], impact on the R&D cost side; they do not include a government role as "final consumer", but they are often collaborative projects, acting on R&D "appropriability" aspects (internalization of knowledge externalities within different agreement design, as emphasized in the literature on R&D joint ventures); therefore, they can have an effect on sales and R&D return that needs to be specifically explored;
- *R&D grants* for bottom-up projects are the oldest and most diffused instruments of public R&D project funding in Europe; this type of incentive impacts mainly on the R&D cost side and does not influence directly the marginal return schedule in the short-run.

Studies on the financial subsidy impact are characterised by the difficulty of distinguishing within the combined effect of different instruments, either if they analyse a specific instrument[6] or a set of them. The latter is also our case: we can know only the "gross effect" of a combination of public incentives supporting private R&D, since we exploit a data source (the third Italian Community Innovation Survey) that doesn't allow to distinguish among them. Data include three governance levels of R&D subsidy allocation (national, regional and EU) and for each level a combination of incentives[7]. For example, at national level the mix of instruments, which our 1998-2000 data refer to, includes mainly national grants for Applied research bottom-up projects, R&D fiscal incentives for SMEs, national funds for R&D projects on a bid procedure for investments in the Ob. 1 regions (mainly Southern regions) and pre-competitive development projects. The weight of this mix of national instruments in 2002 was the following (2002 Main Government R&D appropriation in million Euros)[8]:

- *FAR Bottom-up projects* (for applied research): 573.9 (of which 64.3% to large firms);
- *FIT Bottom up projects* (for pre-competitive development activities): 1,630.7 (of which 1,125.8 as refundable loans);
- *R&D tax credit*: 86.35 (to SMEs);
- *PON R&D Programmes*: 110 (specifically for investment in the Ob. 1 regions).

The CIS mix of instruments includes European projects: they are co-funded, but as Klette and Møen (1998, p. 6) have observed, matching grants do not exclude a neutral or partial crowding-out effect.

The different amount of the public contribution to the R&D cost can have a different impact, but some source of data doesn't allow to know the "level" of public funding (see analysis using CIS data and see also Busom, 2000); in our work data include only binary information on the presence/absence of at least one public fund at firm level during a three year period (1998-2000).

Public agencies use "systematic selection criteria" based on project quality and feasibility plus some social aims, such as: encouraging SMEs, which have problem of limited internal funds, R&D fixed costs and low access to external fund and capital risk, or promoting sectors with larger spillover effect. But they can also be oriented to a "picking-the-winners" strategy: financing marginal projects implies risks of failure and public agencies could prefer projects with returns less complex to estimate.

Among the reasons causing the failure of public R&D incentive policy, the following ones have been most mentioned in the literature:

[4] See David, Hall and Toole (2000).

[5] See Potì and Reale (2007).

[6] Also when studying the subsidy effect of a single program it is necessary to know if firms benefit of other R/D policy instruments.

[7] CIS data offer an aggregated but exhaustive information on R/D incentives; it allows to disentangle incentives at the most by the three governance levels, although it could be possible to control also for all possible combinations of them without identifying specific incentives "within" each governance level.

[8] See Centro Studi Confindustria (2004).

- *firm opportunistic behaviour* (see Wallsten 2000, p. 85; Antonelli, 1989, p. 76): firms apply for infra-marginal projects, since public funding is less costly then other "external" sources fund and public agency does not check for this aspect, while firms wish to improve their chance of getting an aid;
- *time substitution*: firms receiving a subsidy can wish to anticipate projects planned for the future (Bronzini and De Blasio, 2006, p. 3)[9];
- *institutional characters of funding procedure*: if the government transfer of funds to the public instruments is characterised by important ups and downs, firms cannot include public subsidy among the effective stimulus of an investment; their R&D decision are often independent from subsidy expectation, with an effect of crowding-out when public fund is available (Cannari, D'Aurizio and De Blasio, 2007)[10];
- the third component deals with the *effect of a cost increase in the R&D factor supply* (i.e. salaries of researchers and engineers) when inputs' demand increases, given an higher R&D activity. This general equilibrium effect is more relevant for large R&D contracts and when the incentive affects a large number of firms;
- differences in the effect of public subsidy can be due also to *differences in the structure of firm's R&D capital cost and R&D return*. In particular, as to capital cost, firms have to anticipate R&D project funding, after getting a public commitment, and they are refunded on their expenditures; firms could not have enough liquidity (especially SMEs) to follow this path and the announcement of getting a public subsidy cannot significantly affect equity holders' or banks' conditions in supporting R&D investments (especially in absence of a developed venture capital market); this is the case of an inelastic R&D capital marginal cost function;
- another case can be that of a *perfectly inelastic cost functions*, where firms are "asset constrained", given their inability to access to external sources of funds (debt or equity finance) or given the high cost of downstream activities, complementary to R&D[11].

Finally, another relevant element to be taken into consideration is that one of the output of an additional R&D activity is the creation of new capabilities, whose effect can be seen only in a medium-long term; therefore, even if in the short-run the effect of a public subsidy could be neutral or a (partial) crowding-out, in the long-run the effect can be relevant. Klette e Møen (1998) showed for R&D programs in Norway that public subsidies can produce no effects in the short-run, but positive effects in the long-run even after an interruption of the instrument; the today funded research activity, if realised and even if with a partial crowding-out (since the project was included in the firms' portfolio) can positively impact on firm's future R&D, by a "learning" effect that increases R&D productivity. Antonelli (1989) advanced the hypothesis for Italy that a short-run substitution effect of the main R&D financial incentives[12], due to the divergent characters between the subsidy (erratic) and the R&D activity (auto regressive and rigid) was then followed by a increase (even if low) of the R&D privately funded investment in the medium term. Cross-section analyses, of course, have the limit to be unable to look at effects distributed along time.

As it will be clearer later, given our data constraints, the objective of our analysis is quite limited compared to the complexity of the subject; nevertheless it includes:

- an empirical path for testing the presence of a crowding-out effect on private R&D expenditure at firm level in the short-run; we share

[9] The authors investigated the behaviour of firms subsidized by fixed capital grants through a panel analysis and found out that firms tend to anticipate future planned investments, reducing their investment in the years following the subsidised program. This inter-temporal substitution has been studied in the literature mainly for capital investment and purchasing of durable goods.

[10] The authors have conducted a survey where recipient firms evaluated the role of the public incentives on fixed capital investment: 74% would have carried out exactly the same amount of investment and 17% would simply have postponed it (*time substitution* effect).

[11] See Stead (1976, p. 2-9), cited in Antonelli (1989, p. 54).

[12] Firms followed their programmes at short term and only at medium term new R/D investments were visible.

with other applications in the literature the limits of a "binary policy variable", but we add more robustness to our analysis by checking and comparing results through the use of various econometric techniques;

- an analysis of the R&D policy effect by disaggregated firm size, sector and geographical area, since differences in the funding gap and in technological opportunities impact on R&D investment behaviour.

The paper is organized as follows: section 2 presents a concise overview of the literature focusing on: the comparison of various evaluation methods, the treatment of the endogeneity problem and works sharing some similarities with our application; section 3 provides an exposition of the econometric methodology used in our paper (see also appendix A for more formal details); section 4 presents the dataset, the variables used, and some descriptive statistics for our sample; section 5 shows and comments the econometric results for all Italian firms and for various subgroups of them; section 6 concludes the paper by summarizing results, discussing the limits of our application and suggesting some potential future improvements.

Table 1 shows some representative studies we met in the literature according to this classification.

TABLE 1. R&D policy evaluation studies according to the type of specification, dataset and policy variable

METHOD	TYPE OF MODEL		TYPE OF DATASET		TYPE OF POLICY VARIABLE		REPRESENTATIVE STUDIES
	Structural	Reduced-form	Cross-section	Longitudinal	Binary	Level	
CF-OLS		X	X			X	Lichtenberg (1987)
MATCHING		X	X		X		Almus and Czarnitzki (2003)
SELECTION	X		X		X		Busom (2000)
DID		X		X	X		Lach (2000)
IV	X		X			X	Wallsten (2000)

Note: CF-OLS: OLS estimation based on a control function;
MATCHING: matching models;
SELECTION: Heckman selection model;
DID: difference-in differences;
IV: instrumental variables (2SLS or 3SLS) estimation.

2. A SHORT OVERVIEW OF THE LITERATURE

The literature on the issue is very large and the main problem is how to organise a review; given that some excellent reviews (at macro and micro level) have already been realized (David, Hall and Toole, 2000; Busom, 2000; Klette, Møen and Griliches, 2000), our contribution will be addressed to three main aspects:

1. differences and similarities among different approaches;
2. the way in which the *endogeneity* of the policy variable has been treated;
3. a brief look at those studies we find the most similar to our application.

2.1 Differences and similarities among approaches

To begin with, it seems useful to classify R&D policy evaluation studies according to three analytical dimensions:

1. *type of specification*: models adopting a *structural-analytical* approach, where the outcome equation and the selection-into-program equation are separately modelled in a system of simultaneous equations, and *non-structural* models where only the outcome equation (the so-called "reduced form") is estimated, once controlling for some specific covariates[13];
2. *type of data used*: models based on a *cross-section* dataset and models exploiting a *longitudinal* one (allowing also for dynamic and long-run analysis);
3. *type of policy variable*: models using a *binary* policy variable (generally in the form of "subsidized" versus "non-subsidized" units), and models using the policy variable in *levels* (i.e., in a continuous form).

The grey area in the table identifies the methods we compare in our application even if, as it will be made clear in the next section, some hypotheses to reach comparability have to be added.

The literature studying the "additionality" effect at micro level using a continuous policy variable (such as Lichtenberg 1987; 1988) generally looks at the elasticity effect of private R&D expenditure to the variation in the subsidy level. When looking at the effect of a public financial subsidy on the private behaviour in R&D we can distinguish among the following four cases:

- *neutrality effect*: when the private R&D expenditure, compared to what firm would have done in absence of the grant, increases only of the grant amount;
- *partial crowding-out*: when the private R&D expenditure, compared to what firm would have done in absence of the grant, increases only of a part of the received public fund;
- *total crowding-out*: when the private R&D, compared to what firm would have done in absence of the grant, remains the same;
- *additionality*: when the private R&D expenditure, compared to what firm would have done in absence of the grant, increases more than the grant amount. This can be the case of a firm that would not have made any R&D project in absence of the public grant or of a firm which would have not done the incremental project or would have done a more modest R&D project.

Analytical models explaining the rationale of these different (potential) subsidy effects refer to a firm profit maximising behaviour in the choice of R&D investment level, given the cost of R&D factors in a perfectly competitive market (Klette and Møen, 1998); or, if a marginal cost of R&D capital "which reflect the opportunity cost of investment funds at different level of R&D investment" is included, to a profit maximising firm which would choose the R&D investment level where R&D capital marginal

[13] As it will be clearer later, this distinction between structural and non-structural (or reduced-form) models couples with that between model taking into account endogeneity due to both "selection on observables" and "selection on un-observables" (the structural models), and those dealing with endogeneity due only to "selection on observables" (the non-structural or reduced-form models).

cost and R&D marginal return are equalized[14] (David, Hall and Toole, 2000, p. 504).

The background of analytical models refers to a "different-from-externality" problem for private R&D investment: the gap between the private rate of return and the cost of capital, when the investing firm and the investors are different entities (see also Hall, 2002)[15]; the opportunity cost of capital is described by an upward sloping schedule where, even if the firm uses only retained earnings for funding R&D investment, at the margin, when R&D investments increase, firm has to look for external investors for other projects (for instance tangible capital acquisition); in fact, financing R&D outlay by using capital from sources such as equity or debt is more costly. In other words, different structures of the R&D capital cost schedule and of the pre-grant optimal level of R&D investment, can explain different firm reactions to a given public subsidy.

If the hypothesis of a "marginal" demand of public fund is retained, the neutrality effect can be the case of a firm with an inelastic (vertical) R&D capital cost curve (that is, an asset constrained firm): in this case the public grant shifts the cost curve to the right exactly of the grant amount[16].

The (partial) crowding-out can be the case of a firm with an upward sloping R&D marginal cost curve, where the public grant produces an increase in R&D expenditure lower than the grant amount substituting for more costly external sources; the elasticity of R&D expenditure changes along the capital cost curve: the more distant the optimal pre-grant level of R&D is from investment funded by "internally generated funds", the higher the crowding-out effect.

Positive cases, therefore, can be identified when at the pre-grant equilibrium a firm's marginal return curve cuts the marginal cost curve in the horizontal portion (where internal fund are available, at a constant cost of capital), or in a portion of the cost sloping curve where elasticity to fund supply is still high. David, Hall and Toole (2000, p. 507) give this explication: in this case public grants provide a signal for the equity holders and the cost of the firm's fund is shifted down, with a substantial increase of R&D investment; thus, the higher the amount of the grant, the more important the signal effect[17]. The effect on non public source of fund can also be different by country: for instance in the US the grant agency review of R&D proposals represents a trustable certification and can positively impact on the total spending of grant recipients[18]. The shape of the R&D capital cost curve depends on the presence of other technological policy measures (fiscal treatment of R&D expenditure or of capital gain) and on the cost of private funding.

As to the marginal return curve, it can be more or less sensible to expected future demand signals or to expected other projects success and it is function of a set of variables such as market conditions, technological opportunities and appropriability conditions.

Few econometric experiments make use of a complete analytical approach; generally, very simplified structural models have been provided such as, for instance, that of Lichtenberg (1987) estimating the following reduced form equation from a system of equations reminding to the David, Hall and Toole (2000) model:

$$R^* = h(\mathbf{X}, \mathbf{Z})$$

where R^* is the private R&D expenditure, expressed as function of variables **X** related to R&D cost (such as public subsidy) and variables **Z** related to R&D returns (such as firm sales); this "early" model did not deal with the problem of endogeneity (see below), assuming the policy variable as strictly exogenous.

[14] A firm derives its R/D marginal return curve when "rationally considers the expected cost and benefit streams for each project", given the technological innovation possibility set (David, Hall and Toole, 2000, p. 503).

[15] The unitary cost of R/D capital is based on a R/D investment fund demand and supply and it increases with the level of R/D and the type of source of funds.

[16] A case of asset constrained firm could be that of firms with a high ratio between the cost of other internal functions (design, engineering, marketing, commercialisation) and the cost of the R/D internal function (Stead, 1976); in these cases firms are more cautious in positively reacting to public subsidies.

[17] Indeed, the additional financial input could be used for other kind of investments, since R/D projects includes a premium to marginal cost for the risk and are in competition with other projects within a firm.

[18] See Diamond (1998) and Jaffe (2002) cited in Lööf and Heshmati (2005, p. 5).

A "later" Lichtenberg model (1988) recognised the "endogenous" character of public subsidy and used an instrumental variable estimation[19]. Wallsten (2000) followed a path similar to Lichtenberg (1988), but he estimated a system of three equations, improving estimation efficiency by 3SLS.

Another type of approach always drawn on a analytical background is the *selection model*, as proposed by Heckman (1978); this kind of model is used to take into account the possibility that "unobservable" variables affect both the outcome measure and the "being subsidized" status; it is composed of two (correlated) equations, one for the outcome and the other for the selection equation. Busom (2000) provides a compelling application of this approach; this system of equations models can work with a cross-section as well as a longitudinal dataset and is especially suitable for a binary policy variable[20].

Differently from the foregone models, the most part of applied works in the field of R&D policy evaluation make use of a more empirical viewpoint: matching methods and difference-in-differences approaches are the most commonly used; in particular, the matching method is a non-parametric estimation procedure (more in the next section) which reduces the group of non subsidized firms to a sub-sample of units with characteristics more homogeneous to the subsidized ones. These methods avoid to specify structural equations, while they start from a reduced form equation, where theory enters only the choice of variables aimed at homogenizing subsidized and control firms[21].

2.2 The issue of endogeneity

The endogeneity issue is a central aspect of R&D policy evaluation: assuming the policy variable (subsidy) to be exogenous, in fact, could be seriously misleading, since the funding choice operated by the government are not independent of the level of firm private R&D expenditure; both R&D outlay and subsidy are, in fact, codetermined and many firms' characteristics are likely to be highly correlated with the non-random choice operated by the government[22]; the simple comparison between R&D expenditure average values of subsidized and non subsidized firms fails to estimate consistently the additional effect of the incentive; controlling for the probability of receiving a grant/subsidy allows to check for factors influencing both the firm's project application and the agency selection; nevertheless only instrumental variables and selection models (i.e., the structural models) can deal with both "selection on observables" and "un-observables", while control function and matching can only control for "selection on observables"; understanding what type of selection mechanisms is at work (dependent on not dependent on unknown-to-the-observer factors) remain in any case a non-testable prior on the side of the analyst.

2.3 Related studies

The third and last aspect of our short review deals with looking at problems and results for those empirical works we find closer to our application. We first refer to two studies using, as we do, the Community Innovation Survey (CIS) as dataset and the matching procedure as evaluation method; we then discuss a third paper, the work of Busom (2000), applying a "selection model", a method that we also include in our application in order to enhance robustness.

Roughly speaking, all these studies answer the question: "what would a subsidized firm, with given characteristics, have done if it had not been subsidized?"; they use a cross-section

[19] Lichtenberg (1988), in particular, instrumented the public subsidy variable by the "value of competitive contracts potentially awardable" to the firm.

[20] Both binary and in-level structural models take into account the presence of "selection on unobservables" into the support program.

[21] For the effect of public subsidy on business R&D or on innovative performance using matching methods see: Almus and Czanitzki (2003), Duguet (2003), Aerts and Czanitzki (2004), Kaiser (2004), Lööf and Heshmati (2005) and Bérubé and Mohnen (2007).

[22] On the Government side, a random choice can be present in the "automatic procedure" for fiscal R/D support in Italy, where the amount of public budget and the eligible firms' order of application are the factors of selection.

analysis with a binary policy variable; in this setting they can control only for the presence of a "total crowding-out". Indeed, without knowing the level of the received subsidy, it cannot be possible to estimate the presence and degree of additionality: this is a limit shared by all works using a binary R&D subsidy variable (included our application); in this sense, when we find that a subsidized firm presents an R&D expenditure significantly higher than a non-subsidized one, we can only say that "at least some part of the subsidy has been used to do research"[23]. Two types of results can be checked in this kind of studies:

- factors affecting the net effect of being incentive beneficiaries (where factors can have different relevance for the two underlying unobservable equations representing the firm expected profitability of applying for R&D subsidy and the public agency value of funding a project);
- the private R&D effort induced by the subsidy, conditional to the fact of being beneficiaries.

Aerts and Czarnitzki (2004) used the third wave of the CIS (1998-2000) for Flanders to study the relation between R&D subsidies and R&D activities through a nearest-neighbor matching method; they covered manufacturing sectors and some service sectors (computer, R&D and business related services) on two kinds of samples: one including also non innovative[24] firms in the control group, and the other (like we did) only using innovating firms. CIS data have been matched with information from a database containing annual account data of Belgian firms and information on all patent applications, used as one of the outcome variables. Moreover, patent data are used to control for the presence of R&D activity in the previous years (R&D experience), by building a knowledge capital stock (based just on patents). Some results are the following:

- the most important variables driving firm participation to the incentives are size, patent stock and export activity; authors also underline that the public agencies probably follow a "picking the winner" strategy;
- in the full sample the crowding-out effects for R&D can be rejected, but this result could be influenced by the presence of non-innovators in the control group;
- the result is confirmed also for the innovating firms sample: without subsidies firms would have exhibited a significantly smaller R&D intensity of about 2.2% on average.

Lööf and Heshmati (2005) use the third Community Innovation Survey for Sweden, both on manufacturing sector and business services, merged with data on firms' annual accounts, for studying the effect of public funding on private R&D expenditure. On average 20.8% of firms participated in public R&D schemes, all included. Many cross sector differences are present in terms of percentage of public fund beneficiaries. The authors use a matching approach with two estimators (the Nearest Neighbour and the Kernel estimator). Many differences are found between subsidized and non subsidized firms: the first group is characterised on average by higher R&D intensity, larger gross physical investment per employees (capital intensive firms), larger amount of equity capital, larger indebtedness per employees. But the probability of receiving public funds decreases with the firms' size and increases for firms showing a lack of an appropriate source of finance as an innovation hampering factor, while the degree of indebtedness has not a relevant impact. The target variable is the R&D per employee. Results are slightly different when comparing samples including or non including small firms. In the first case the two estimation methods, the Nearest Neighbour approach and the Kernel matching, give evidence that the average subsidized firm has greater R&D expenditure per employee; but when small firms (10-50 employees) are dropped out of the sample, the difference between supported and non supported firms is positive, but becomes statistically

[23] We can exclude a total crowding out but we cannot say if this part is higher, equal of lower than the subsidy amount, so we cannot measure the actual level of subsidy additionality on private R&D effort.

[24] The authors sustain that including only innovating firms can bring to underestimate the treatment effect, since firms can change their status from non innovator to innovator due to the receipt of a subsidy.

significant only for the Kernel matching method (see Lööf and Heshmati, 2005, p. 16). The authors conclude that they can exclude a crowding-out effect only for firms with less than 50 employees.

Busom (2000) uses a cross section sample of 154 Spanish firms doing R&D in 1998 and partly (45%) receiving public funding by an agency of the Spanish Ministry of Industry. Firms could apply for national or European fund[25] and could conduct more than one project. Information about subsidy are of a binary type. She uses a structural model, a Heckman system of two equations of participation in a public R&D programme and of R&D private effort, conditional to the participation status. Some factors have a significant net effect on the probability of getting national public funding: firm experience (age) and R&D experience (number of previous patents), public participation in the ownership and being in two sectors (chemicals or pharmaceuticals). Factors reducing the probability of getting a subsidy are large size and the presence of foreign capital. Busom uses various measure of effort (R&D expenditure and personnel, in level and intensity) and introduces a dummy to control also for participation in European funded programmes. She uses four types of procedures (OLS on the whole sample; OLS distinguishing between participants and non participants to the incentive programme; the Heckman two steps procedure; the maximum likelihood for the two joint equations). In absence of public funding the R&D effort is explained by the firm size or sector, while participating to EU funds does not bring increased expenditure. Results show that public funding induced more R&D effort, but it is not possible to measure the presence of "partial" crowding-out.

In sum, some aspects can be underlined:

- using more than one econometric test is a good practice, although it does not always give convergent results; in this last case authors conclude that a crowding-out effect cannot be totally excluded. It should be necessary to get more robust results and identify crowding-out cases;
- factors which influence "being an incentive beneficiary" change by country: in some cases size and "picking the winner" are key aspects (Flanders), in other cases R&D experience and experience (age) emerge as relevant; internal finance constraints, differently from indebtedness, is highly related to participation. Some factors are probably more linked to the firm decision (i.e., the export intensity), while other can depend more on public agency's aim (i.e., foreign owned firms doing research in the country);
- the pooled sample level can give results that needs a deeper check. Looking at the outcome by subgroups of firms can offer a clearer answer on the performance of the public agents rules and in particular to the question on whether incentives help firms to overcome their R&D weakness (SMEs, low tech sectors).

3. THE ECONOMETRIC ESTIMATION OF THE ADDITIONALITY EFFECT: "MATCHING" *VERSUS* "SELECTION MODEL" APPROACH

In this section we provide only a brief non-technical sketch of the methods used to estimate the presence of public subsidy additionality on our data; more technical details are presented in appendix A.

The main estimation problem arising in non-experimental statistical designs is that the traditional estimation procedure based on the simple comparison between average values of treated and untreated individuals (in our case: subsidized and non subsidized firms) fails to estimate consistently the hypothesis of "additionality" of treatment on a certain target variable.

In non-experimental designs, in fact, treatment is "non-random", since firms can (at least to some extent) decide their status of participation (*self-selection*), as well as

[25] The author applies the model to the national incentive program, but also to the possibility of getting two types of fund (national and European). She found out that there is not a joint probability of getting the two types of incentives and then examines separately the probability of participating to the European funding that, differently from national programs, is linked to the firm size.

government can select to finance particular subjects according to specific objective functions (for ex., by adopting the principle of "aiding-the-poor" or, on the contrary, of "picking-the-winner").

In econometric terms it means that the treatment variable *w* (assuming the value 1 for treated and 0 for untreated units) and the outcome variable *y* (assuming the value y_1 for treated and y_0 for untreated units) are stochastically *dependent*; in this case we cannot trust the usual approach of classical inference.

To overcome this estimation problem econometricians have suggested different approaches under specific hypotheses: OLS in a control function specification, matching, instrumental variables and sample selection methods are the most known. All these approaches are alternatively suitable according to the underlying process generating data, sharing in turn differential advantages and drawbacks[26].

Implementing an instrumental variables approach solves the problem of *selection on unobservables*[27]. In this case, nevertheless, the researcher needs to know a full set of exogenous variables (the instruments) correlated with the treatment variable *w* and at the same time uncorrelated with the outcome *y*, in order to build a 2SLS estimation of the evaluation equation. Generally specking, as in many other field of econometrics, finding appropriate instruments is not easy and asks also for some degree of arbitrariness (especially in a *just-identified* setting). The sample selection approach (as in the Heckman (1978) two-stage selection model) is a powerful method to deal, as in the case of the instrumental variables, with selection on unobservables, but it requires some specific distributional hypotheses than other models do not need (see, again, appendix A).

The control function and the matching estimators, on the contrary, ask for less requirements to be applied than the previous methods, but are not suitable to deal with important aspects such as the selection on unobservables. They are reliable just in the case of *selection on observables*[28]. In fact, they both start from the idea that the treatment status is correlated with specific *observed characteristics* of firms that, once controlled for, restore the condition of a randomised experiment; this hypothesis is known in the literature as *ignorability of treatment* and has been proposed for the first time by Rubin (1977). Hence, by conditioning on these observable characteristics, these methods consistently estimate the total *average treatment effect* (ATE) and *average treatment effect on treated* units (ATET) even in case of *treatment's non-observable heterogeneity* and *selection on results*[29]. Although their limit, if the researcher has at his disposal a wide set of observed variables (as in our case) the problem of selection on unobservables should be attenuated; for this reason the majority of studies in the field of microeconometric policy evaluation makes use of OLS and matching.

Matching, nonetheless, seems to be preferable to OLS for at least three reasons. First, it is a non-parametric estimation procedure, so that it does not require to specify a particular parametric relation between the dependent variable and its regressors as in the case of OLS (where an additive/linear form is assumed); second, the matching procedure considers only treated and non treated units in the *common support* by dropping all the controls whose variables' value is higher or smaller than that of the treated. Third and more importantly, matching reduces the number of non-treated to a sub-sample (the *selected controls*) with characteristics more homogeneous to those of treated units. These properties of the matching method prevent further biases in the *ATE* and

[26] For a concise review see Heckman (2001).

[27] We have *selection on unobservables* when idiosyncratic characteristics unobservable to the researcher are correlated with the treatment status variable. Without controlling for these characteristics, estimates can be inconsistent since these features can behave as potential confounders (see Heckman, Urzua and Vytlacil, 2006).

[28] We have *selection on observables* when only characteristics observable to the researcher are correlated with the treatment status variable so that, controlling opportunely for them, treatment effects can be estimated consistently.

[29] We have *treatment's non-observable heterogeneity* when the effect of treatment is different in different treated units. We have *selection on results* when treatment's non-observable heterogeneity is correlated with the treatment variable.

ATET estimation than simple control function based on OLS estimation (Cameron and Trivedi, 2005, p. 871-878).

To appreciate the economic and statistical meaning of our methodology, we present a very concise and non-technical overview of the two methods we apply in this work to estimate the average treatment effect on treated units: the matching procedure (to deal with selection on observables), and the sample selection approach (to deal with selection on unobservables).

Different kinds of matching estimators have been proposed in the literature. Among them the most applied (as in our paper) are those based on *propensity scores* (propensity score matching). Defined as the probability for an individual to get treated, conditional on a certain numbers of observable characteristics, the propensity score is an index function summarizing in a single number (the score) the wide set of observable characteristics affecting the probability of becoming treated. It is obtained from a probit regression where *w*, the treatment status, is the dependent variable and observable characteristics are the regressors. The propensity score approach solves the *dimensionality problem* arising when the number of covariates is high and exact matching is not possible (see, for example, Dehejia and Wahba, 2002 and Ichino, 2006)[30].

In a cross-section dataset (as in our case) the idea behind the matching procedure is to estimate the counterfactual $E(y_0 \mid w=1)$, i.e., the average outcome of treated firms "if they had not been treated", using non treated units that are "similar" to treated ones. This similarity can be checked according to several firms characteristics such as size, turnover, sector in which the firm operates and so on. When for each treated unit one (or more than one) similar non-treated unit(s) has been selected among all potential non treated units a comparable sub-sample is produced and it can be proved that the *ATET* is consistently estimated; in other words, we estimate $E(y_0 \mid w=1)$ with those non-treated firms that are like "twins" of the treated ones (see appendix A for formulas). The general protocol adopted in this work is implemented through the following steps:

1. we specify a probit regression on a given set of covariates (x) estimating the propensity scores $\hat{p}(x)$;
2. according to the estimates obtained in the previous step, we test the *balancing property* taking the specification satisfying it, and reducing observations on treated units to those in the *common support*;
3. according to the considered matching method and for each treated unit, we select the potential control(s), that is, those non-treated units more similar to the treated ones;
4. once obtained the matched comparison group, we calculate the estimated *ATET* using the appropriate formula.

Of course, different matching methods require different formulas for the calculus of the *ATET*. In our work we compare the following seven matching procedures: 1. stratification, 2. one-to-one nearest neighbour, 3. three-nearest neighbours, 4. kernel, 5. radius (with a calliper of 0.001), 6. radius (with a calliper of 0.0001), 7. radius (with a calliper of 0.00001).

As pointed out above, matching (as well as OLS) can produce nevertheless misleading estimates of the *ATET* (as well as the *ATE*) in the case of "selection on un-observables". If some unobservable variables affect simultaneously the outcome and the treatment status, even by conditioning on the right observables, the estimation of the ATET could be inconsistent since, by definition, *w* and *y* are still correlated. To take into account the presence of selection on un-observables, we will make use of the Heckman-Maddala (Heckman, 1978 and Maddala, 1983) selection model, comparing its results with those coming from the matching procedures.

Very concisely, the model is composed of two (correlated) equations: one for the outcome

[30] Instead of the propensity score, another class of matching estimators uses a specific metric (such as the Mahalanobis or the Euclidian one) to measure the distance between a treated and an untreated unit. Recently, also hybrid approaches have been developed using, for example, a Mahalanobis metric whose arguments are contemporaneously the covariates and the propensity score (see, for example, Lechner, 2001). It is not clear, however, which is the efficiency gain of hybrid models (see Zaho, 2004).

and one for the selection equation, and takes the following form:

$$\begin{cases} y_i = \mu + \gamma x_i + \alpha w_i + u_i \\ w_i^* = \eta + \beta z_i + v_i \\ w_i = \begin{cases} 1 & if \quad w_i^* \geq 0 \\ 0 & if \quad w_i^* < 0 \end{cases} \\ Cov(u_i ; v_i) = \rho \neq 0 \end{cases}$$

where x and z are covariates and u and v are unobservable components (error terms) with zero unconditional mean, but supposed to be correlated. Under this assumptions $E(w_i \cdot u_i) \neq 0$ so that the OLS estimate of the outcome equation is inconsistent; it is easy to show that inconsistency of OLS on the outcome equation (the first one in the previous system) is due to an "omitted variable specification error"; in appendix A we show technically how to restore consistency.

Observe that the sign of ρ shows whether non-observables in the participation and non-observables in the outcome are positively or negatively correlated and that, to make our results by various methods the most comparable, we hold $x = z =$ matching covariates: in this way we reduce any arbitrariness in choosing different sets of *x* of *z* in the two equations.

4. DATASET AND DESCRIPTIVE STATISTICS

The dataset employed in this work comes from the third wave of the Italian Community Innovation Survey (CIS3) referring to the years 1998-2000 and collecting 149 variables for 15,512 manufacturing and service firms. Although rich in information, this dataset has many limits for the purpose of our study; in particular, it does not allow for disentangling different kinds of incentive instruments: the CIS questionnaire, in fact, is built in such a way that fiscal incentives, grants and contracts are all pooled; this is a serious drawback, since different type of instruments can have very different effects on the firm R&D investment decision; we can only distinguish among national, regional or supranational level of Government source of fund. Moreover, the CIS does not provide the "level of subsidy", but only a "binary" information on the presence or absence of public support.

The CIS dataset is then merged with firm balance sheet variables coming from the Italian Chamber of Commerce civil accounts; this dataset contains all information on firm accounting variables and on the statement of assets and liabilities. We take into consideration the presence of at least one subsidy received in a three year period (from 1998 to 2000), while firm R&D expenditure refers to 2000. We define a treated (or supported) firm as one answering at least one "yes" to the questions regarding R&D funding from central and local government and from the EU within the period 1998-2000, as well as from EU IV° (1994-2008) and V° (1998-2002) Framework Program[31]; respectively, it is considered as "potential control" a firm answering "no" to all those questions. Since only innovating firms answer to the CIS funding questions, the total sample drop to 5,672 units whose number of supported firms is 2,347 (41%) and that of non-supported ones is 3,325 (59%).

Table 2 shows the distribution of public subsidies according to the type of financing sources[32]. Firms receiving a "Government" fund represent about 61% of our sample; reporting this value to the industrial population, by using sample weights, there is a decrease of treated firms under 50%; firms receiving "local" funds are about 44% in our sample, value that doesn't change too much when reported to the entire population; firms supported by EU funds are about 21%, while firms getting a Framework programme funds, finally, are about 12%. It is worth to note that receiving or not a certain type of funds does not exclude to benefit from one of the other funds.

[31] Questions 9.1a, 9.1b, 9.1c and 9.2 of the CIS3 questionnaire.

[32] Throughout this work, when we use sample weights we do not correct for potential outliers, since each unit becomes representative of a part of the whole population; when we do not use sample weights, on the contrary, we choose to cut the 1% of observations on the right-tail of R&D intensity variable.

TABLE 2. Distribution of public subsidies according to different sources for financing

Local funds - un-weighted				**Government funds - un-weighted**			
	Freq.	Percent	Cum.		Freq.	Percent	Cum.
0	683	55.94	55.94	0	470	38.49	38.49
1	538	44.06	100	1	751	61.51	100
Total	1221	100		Total	1221	100	
Local funds - weighted				**Government funds - weighted**			
	Freq.	Percent	Cum.		Freq.	Percent	Cum.
0	3027	44.95	44.95	0	3439	51.07	51.07
1	3707	55.05	100	1	3295	48.93	100
Total	6734	100		Total	6734	100	
EU funds - un-weighted				**FP funds - un-weighted**			
	Freq.	Percent	Cum.		Freq.	Percent	Cum.
0	969	79.36	79.36	0	1072	87.80	87.80
1	252	20.64	100	1	149	12.20	100
Total	1221	100		Total	1221	100	
EU funds - weighted				**FP funds - weighted**			
	Freq.	Percent	Cum.		Freq.	Percent	Cum.
0	5522	81.99	81.99	0	6199	92.06	92.06
1	1212	18.01	100	1	534	7.94	100
Total	6734	100		Total	6734	100	

Note: 0 = receiving;
1 = non- receiving

As to the main variables characterizing firm structure as well as the selection mechanism (we will use in our probit specification), we distinguish between endogenous and exogenous variables:

DEPENDENT VARIABLES

R&D expenditure 00: intra-muros R&D in thousand Euros in 2000;

R&D intensity 00: ratio between R&D expenditure and firm turnover in 2000;

R&D per employees 00: ratio between R&D expenditure and firm number of employees in 2000;

Innovative turnover 00: the share of the innovative turnover on total turnover in 2000.

EXOGENOUS VARIABLES

EMP 98: this is the number of firm employees in 1998. Size is commonly recognized as a leading variable in explaining firm ability in attracting financing: scale economies and a richer set of perceived opportunities generally increase with size;

EMPSKILL 00: this is the share of employees with a degree or university diploma on total employees in 2000. A higher human capital should positively affect the probability of attracting financing. More skilled workers should enhance the capacity of writing projects, promoting fund rising strategies and improving knowledge of opportunities;

EXPINT 98: this is the share of turnover stemming from exportations on total firm turnover in 1998. It is supposed that more internationalised firm operate under a more competitive pressure leading to search for a diversified strategies portfolio to attract innovative capacity such as applications for public funds;

CAPINT 98: this is the capital stock (from balance sheet) per employee in 1998. The more a firm presents higher capital intensity (lower labour intensity), the more it should have an incentive to search for a lifelong technological upgrading by exploiting, among various possibilities, also public subsidies;

CASHINT 98: this is the cash-flow per employee in 1998. A large cash flow identifies a necessary condition for augmenting firm self-financing: the greater its level, the lower the need to depend on external resources;

DEBTINT 98: this is the share of the firm total stock of debt on total liabilities in 1998. An higher debt represents a financial constraint for the firm that can find increasing difficulties to finance its activity by either further indebtedness or equity. In this case, firm can turn to attract non-market funds such as public subsidies;

KNOWLEDGE 98: this is the value of intellectual property rights (such as patents) and capitalized R&D expenditures per employee in 1998. The idea behind the choice of this variable is that past innovative performances matter in attracting current subsidies especially when government implements a policy aimed at awarding previous winners. Nevertheless, immaterial assets are not exact measures of the firm knowledge stock for at least two reasons: first, it does not consider knowledge obsolescence, since it is a gross (rather than net) measure of immaterial objects (moreover, even if we use the net counterpart, we know that accountable depreciation differs from economic depreciation); second, it is a quite variegate ensemble of items (R&D expenditures, patents and other intellectual property rights acquired by third party or produced in-house) that is sometimes subjectively defined[33]. A more correct procedure should be building a capital knowledge stock using a perpetual inventory method with a prefixed rate of obsolescence (either by R&D expenditures or using number of patents), but we do not have a sufficiently long time-series of these variables to do that. Therefore, we use balance sheet data by acknowledging their limits;

FOREIGN: this is a dummy variable tacking one if the firm belongs to a foreign group and zero otherwise. The nationality of the mother-firm could be determinant in providing incentives for applying for public subsidies;

AGE: this is a dummy variable assuming value one whether the firm was set up between 1998 and 2000 (and zero otherwise). Experience can be an important feature for attracting subsidy opportunities;

GROUP: this is a dummy variable tacking value one if the firm belongs to a group of firms and one otherwise. A firm belonging to a group can be more able than others in receiving information on possible financing opportunities.

Finally, three dummy variables have been introduced to control for firm geographical position (GEO), sectoral specialization (SECTOR) and dimension (SIZE)[34]:

GEO: this is the geographic stratification variable splitting the sample into 10 Italian macro regions;

SECTOR: this is the sectoral stratification variable according to the two-digit Nace Rev. 1 classification;

SIZE: this is the dimensional stratification variable splitting the sample into four dimensional groups: small (10-19 employees), medium-small (20-49), medium-large (50-249) and large (250 and more).

Table 3 displays a test on mean difference for the exogenous variables. The average size of non-supported firms is similar to that of the funded ones (around 250 employees) and the difference is not significant; the average percentage of skilled employees is again similar between the two groups and around 11%; export intensity, on the contrary, is different in the two groups: 21% in the financially supported and about 14% in the non-treated units; capital intensity is not significantly different, while the cash flow intensity (per employee) between the two groups is significantly different: according to our predictions non-supported firms present a larger cash flow intensity, about 6 thousand Euros per employee against 4 thousand Euros of the others; the debt intensity (on total liabilities) is significantly different, but the distance between the two groups is not too strong; the immaterial assets (knowledge) identifies a significant difference between the two groups of firms with supported firms showing a greater level of knowledge accumulation; finally *AGE*, *FOREIGN* and *GROUP*[35] identify all significant differences with supported firms generally older, owned by a foreign company and non belonging to a group.

[33] For example, deciding which share of total R&D expenditures have to be capitalized is a choice of the firm management.

[34] According to the Italian CIS3, those are the stratification variables adopted in sampling firms (see "Nota metodologica" in ISTAT, 2004, p. 45-46).

[35] The variable group is not shown in table 1 since it gives problem to satisfy the "balancing property"; nevertheless, we found that the difference of this variable in the two groups is significant, with non-supported firms, on average, more characterized by belonging to a group of firms.

TABLE 3. Descriptive statistics for the exogenous variables

Group	*Obs*	*Mean*	*Std. Err.*	*Pr(|T| > |t|)*
		EMP 98		
0	3405	264	60.8253	
1	2369	254	38.14663	
Overall	5774	260	39.13261	
Difference		10	79.56307	0.9016
		EMPSKILL 00		
0	2391	0.115	0.003	
1	1754	0.110	0.004	
Overall	4145	0.113	0.003	
Difference		0.005	0.005	0.3008
		EXPINT 98		
0	3405	0.139	0.004	
1	2369	0.215	0.006	
Overall	5774	0.170	0.003	
Difference		-0.076	0.007	0.000
		CAPINT 98		
0	2427	63.13	13.22	
1	1959	49.61	3.57	
Overall	4386	57.09	7.49	
Difference		13.52	15.06	0.370
		CASHINT 98		
0	2427	5.66	0.857	
1	1959	3.72	0.343	
Overall	4386	4.79	0.499	
Difference		1.94	1.003	0.0535
		DEBTINT 98		
0	2427	0.653	0.004	
1	1959	0.642	0.004	
Overall	4386	0.648	0.003	
Difference		0.011	0.006	0.0689
		KNOWLEDGE 98		
0	1867	1.89E+08	2.07E+07	
1	1541	1.48E+09	8.11E+08	
Overall	3408	7.71E+08	3.67E+08	
Difference		-1.29E+09	7.37E+08	0.0809
		AGE		
0	3405	0.038	0.003	
1	2369	0.026	0.003	
Overall	5774	0.033	0.002	
Difference		0.012	0.005	0.0105
		FOREIGN		
0	3405	0.884	0.005	
1	2369	0.936	0.005	
Overall	5774	0.905	0.004	
Difference		-0.052	0.008	0.000

As to the target variables (the endogenous variables of our application), table 4 puts on evidence some interesting aspects. R&D expenditures in 2000 presents a strong difference between supported (969 thousands Euros) and non-supported firms (129 thousand Euros); also the R&D intensity reveals a strong diversity between the two groups with a value of 0.6% for non-supported and a value of 2% for supported units; the R&D per employees is again very diverse in the two groups with treated units performing about 2.7 thousand Euros of R&D per employees and non-supported firms about 0.8 thousand Euros; innovative turnover is also significant, but the difference is not so strong; nevertheless, a cautious approach is preferable since this last variable represents a final output rather than an additional R&D effort.

In sum, the group of supported firms is a selective one: it is characterised by a greater knowledge capital stock, while not by greater size or a larger capital intensity (differently, for instance, from the Sweden CIS-based analysis); moreover funded units have a stronger propensity to export, a relatively older age and the fact of being, on average, part of a foreign group (but not part of a group in general); in terms of external financial sources (equity and debts) the two group's distance is not too strong (again differently from the Sweden case), differently from what we find for the cash-flow intensity (strong divergence).

If we report all the sample values to the industry population we will find out that our CIS sample overestimate the variables means, since it excludes firms from 1 to 9 employees and the sample stratification is probably unbalanced towards larger firms. Using sample weights we could correct for this overestimation.

TABLE 4. Descriptive statistics for the endogenous variables

Group	*Obs*	*Mean*	*Std. Err.*	*Pr(|T| > |t|)*
		R&D expenditure 00		
0	3405	129.1	14.97	
1	2369	969.6	214.05	
Overall	5774	473.9	88.42	
Difference		-840.5	179.4316	0.000
		R&D intensity 00		
0	3405	0.006	0.001	
1	2369	0.020	0.001	
Overall	5774	0.012	0.001	
Difference		-0.014	0.001	0.000
		R&D per employee 00		
0	3405	0.848	0.056	
1	2369	2.715	0.144	
combined	5774	1.614	0.069	
diff		-1.868	0.138	0.000
		Innovative turnover 00		
0	3405	0.265	0.005	
1	2369	0.295	0.006	
Overall	5774	0.277	0.004	
Difference		-0.030	0.008	0.0002

TABLE 5. Probit regression of treatment on exogenous variables to identify propensity scores. Sectoral, geographical and dimensional dummies included

TREATMENT	*Coefficient*	*Std. Err.*	*ey/ex*	*Std. Err.*	*P > | z |*
EMP 98	9.28e-08	8.94e-06	0.00001	0.0015	0.992
*EMPSKILL 00 ****	0.82	0.082	0.072	0.0072	0.000
*EXPINT 98 ****	0.22	0.045	0.043	0.0089	0.000
*CAPINT 98 ****	-0.00009	0.00003	-0.006	0.0019	0.002
*CASHINT 98 **	-0.001	0.00056	-0.0044	0.0023	0.057
DEBTINT 98	0.0003	0.05889	0.0002	0.0353	0.995
*KNOWLEDGE 98 ****	1.10e-10	1.99e-11	0.027	0.0049	0.000
FOREIGN	0.60	0.045	-	-	0.000
AGE	-1.035	0.1108	-	-	0.000
CONS	-6.5078	0.7242	-	-	0.000
*SECTOR ****					0.000
*GEO ****					0.000
*SIZE ****					0.000
Number of obs	2574				
LR chi2	2472.43				
Prob > chi2	0.000				
Pseudo R2	0.118				
Log likelihood	-9211.25				

Note: * = significant at 10%; ** = significant at 5%; *** = significant at 1%. The regression takes into account sampling weights.

TABLE 6. Descriptive statistics for the estimated propensity scores

Basic moments		*Percentiles*		*Range of variation*	
# of obs.	5100	1%	0.045	Smallest	Largest
Mean	0.444	5%	0.112	0.035	1
Std. Dev.	0.199	10%	0.170	0.036	1
Variance	0.040	25%	0.291	0.038	1
Skewness	0.008	50%	0.451	0.038	1
Kurtosis	2.366	75%	0.590		
		90%	0.703		
		95%	0.762		
		99%	0.884		

TABLE 7. Optimal number of blocks with treated and control units according to the algorithm testing for the balancing property of the estimated propensity scores

Blocks	*Controls*	*Treated*	*Total*
0	0	3	3
1	187	39	226
2	398	233	631
4	488	475	963
5	229	404	633
6	17	67	84
Total	*1319*	*1221*	*2540*

5. ECONOMETRIC RESULTS

The specification of our probit regression used to estimate the propensity scores is based on the previous set of covariates finding a large agreement in the R&D financing literature[36]. The probit is used for identifying the propensity scores: this is an instrumental passage, which give anyway rich information.

The probit equation is estimated by using sampling weights, so that we obtain parameters valid for the entire population. The number of sample observations drop to 2,574 (compared to the available 5,672 units because of the great number of missing values in balance sheet variables). The regression fits quite well since the Chi-square test is highly significant for the overall regression and the pseudo R-square is about 12%; in the probit specification the variable "group" has been ruled out, since it didn't satisfy the "balancing property", while all other variables are included.

Following table 5 covariate by covariate, we briefly comment the "elasticity value" (ey/ex), calculated holding all variables equal to their sample mean: *EMP* is not significant, with an elasticity around zero; *EMPSKILL* is highly significant with a positive sign and an elasticity around 7% : it means that if the *EMPSKILL* number double then the probability to become treated increase of about 7%; *EXPINT* is highly significant, positive and with an elasticity of about 4%; *CAPINT* is significant with a negative and low elasticity; *CASHINT* is negative according to our prediction and significant too; *DEBTINT* is not significantly different from zero; *KNOWLEDGE* is significant and positive with an elasticity of about 3%: if the knowledge capital stock doubles, the probability of becoming supported increases of 3%; *FOREIGN* is significant with a positive sign; *AGE* is significant with a negative sign; finally, the CIS stratification variables, *SECTOR*, *GEO* and *SIZE* are all highly significant.

In sum the probability of receiving a public fund[37] goes with a high knowledge capital stock and better human capital, while it is accompanied by a low capital intensity (although with a minor elasticity), being part of a foreign group (differently, for example, from the Sweden case) and with a lower internal source of funding (cash flow); the degree of indebtedness is not relevant: as such, it can be considered both a positive sign of access to external sources or a negative sign of dependence from an external one.

Table 6 illustrates the main characteristics of the estimated propensity scores. As expected the mean is around 0.5, the skewness is very low while the kurtosis is quite high (fat tails). The distribution looks anyway very close to a Normal one.

Table 7 shows the optimal number of blocks, according to the algorithm testing for the "balancing property" of the estimated propensity scores; in each block the number of controls is always greater of treated groups; the selected number of treated is 1,221 firms and the "selected" total number of controls is 1,319: total observations are 2,540.

Tables from 8 to 13 (in appendix B) show the test of the balancing property for our probit specification; in each table, i.e., in each block, the difference of the mean between the propensity scores and all the other variables is tested. We accept differences until a 10% of statistical significance: according to this assumption, it can be easily seen that each variable, including the propensity scores, is balanced in each block.

Figure 1 shows a graphical representation of the propensity scores distribution of treated and untreated firms before and after the "one-to-one nearest neighbour" matching; we show this figure just to put into evidence the improvement of the balance between treated and controls we get after doing matching (even though it should be possible to form this figure for all matching methods we use).

[36] See, for example: Bérubé and Mohnen (2007), Busom (2000), and the work of Aerts and Czarnitzki (2004).

[37] The probit applied to CIS data shows the probability of receiving a subsidy, rather than the probability of choosing to enter or not in a R/D programmes, since we do not know if firms without subsidies have presented a demand, which has not been accepted by the public agency, or if they have not presented any demand at all.

TABLE 14. Estimation of the Average Treatment Effect on Treated (ATET) according to seven different Matching procedures, OLS (weighted and unweighted) and the Heckman selection model

Evaluation Procedure	*Endogenous variable*	*Number of treated*	*Number of control*	*ATET (Sample)*	*ATET (Population)*	*S.E.*	*Δ (or ρ)*	*T-value*
				Matching				
1. Stratification	R&D intensity ***	1218	3879	0.016	0.012	0.002	-	**6.69**
	R&D expenditure ***	1218	3879	1245.3	340.9	392.7	-	**3.16**
	R&D per employee ***	1218	3879	2.172	1.514	0.302	-	**7.20**
	Inn. turnover **	1218	3879	0.027	0.024	0.013	-	**2.11**
2. One-to-one Nearest Neighbour	R&D intensity ***	1207	650	0.015	0.011	0.002	2.55	**5.65**
	R&D expenditure **	1207	650	1038.9	284.4	382.2	5.49	**2.72**
	R&D per employee ***	1207	650	1.941	1.353	0.034	2.29	**5.66**
	Inn. Turnover	1207	650	0.010	0.009	0.015	1.03	**0.64**
3. Three-Nearest Neighbour	R&D intensity ***	1207	1053	0.016	0.012	0.002	2.88	**6.97**
	R&D expenditure **	1207	1053	1001.7	274.2	381.1	4.73	**2.63**
	R&D per employee ***	1207	1053	2.066	1.440	0.290	2.50	**7.10**
	Inn. turnover **	1207	1053	0.028	0.025	0.013	1.10	**2.02**
4. Kernel	R&D intensity ***	1123	1281	0.013	0.010	0.001	2.71	**6.76**
	R&D expenditure ***	1123	1281	340.3	93.16	55.55	2.98	**6.12**
	R&D per employee ***	1123	1281	1.825	1.272	0.262	2.46	**6.95**
	Inn. turnover *	1123	1281	0.026	0.023	0.012	1.09	**2.00**
5. Radius (r = 0.001)	R&D intensity ***	1113	1133	0.013	0.010	0.002	2.62	**6.49**
	R&D expenditure **	1113	1133	693.4	189.8	302.8	3.91	**2.29**
	R&D per employee ***	1113	1133	1.932	1.347	0.283	2.56	**6.81**
	Inn. turnover *	1113	1133	0.026	0.023	0.013	1.09	**1.88**
6. Radius (r = 0.0001)	R&D intensity ***	336	337	0.010	0.008	0.002	2.42	**3.85**
	R&D expenditure	336	337	1351.7	370.0	981.4	6.17	**1.38**
	R&D per employee ***	336	337	1.514	1.055	0.474	2.17	**3.19**
	Inn. Turnover	336	337	0.032	0.028	0.023	1.12	**1.35**
7. Radius (r = 0.00001)	R&D intensity *	36	38	0.014	0.011	0.007	2.85	**1.78**
	R&D expenditure	36	38	525.2	143.8	442.6	4.43	**1.19**
	R&D per employee ***	36	38	2.097	1.462	0.814	2.93	**2.58**
	Inn. Turnover	36	38	0.020	0.018	0.073	1.11	**0.28**
				OLS				
8. OLS Regression (unweighted)	R&D intensity ***	1308	1319	0.014	0.011	0.0017	-	**8.00**
	R&D expenditure ***	1308	1319	1127.6	308.7	397.8	-	**2.83**
	R&D per employee ***	1308	1319	1.897	1.322	0.231	-	**8.19**
	Inn. Turnover	1308	1319	0.020	0.018	0.0116	-	
9. OLS Regression (weighted)	R&D intensity ***	1308	1319	0.010	0.010	0.0005	-	**18.18**
	R&D expenditure ***	1308	1319	538.7	538.7	108.2	-	**4.98**
	R&D per employee ***	1308	1319	1.29	1.29	0.064	-	**20.01**
	Inn. turnover ***	1308	1319	0.014	0.014	0.005	-	**2.87**
				Selection model				
10.Heckman (ML)	R&D intensity	1308	1319	0.014	0.011	0.010	ρ = 0.002	**1.30**
	R&D expenditure ***	1308	1319	2618.1	716.7	755.1	ρ = -0.1*	**3.47**
	R&D per employee ***	1308	1319	2.338	1.630	0.658	ρ = - 0.05*	**3.55**
	Inn. turnover ***	1308	1319	0.36	0.316	0.038	ρ =- 0.66***	**9.40**
				Average on Matching				
Average (over 1-7)	R&D intensity ***	891	1196	0.014	0.011	0.002	2.67	**5.45**
	R&D expenditure ***	891	1196	885.1	242.3	419.7	4.62	**2.78**
	R&D per employee ***	891	1196	1.935	1.349	0.351	2.49	**5.64**
	Inn. Turnover	891	1196	0.024	0.021	0.023	1.09	**1.46**

Note: Δ = Ratio of the value of the endogenous variable calculated on treated to that calculated on control units;
ρ = correlation between the outcome and the selection equations;
* = significant at 10%,
** = significant at 5%,
*** = significant at 1%.
The ATET for the population is calculated by a proportional rule

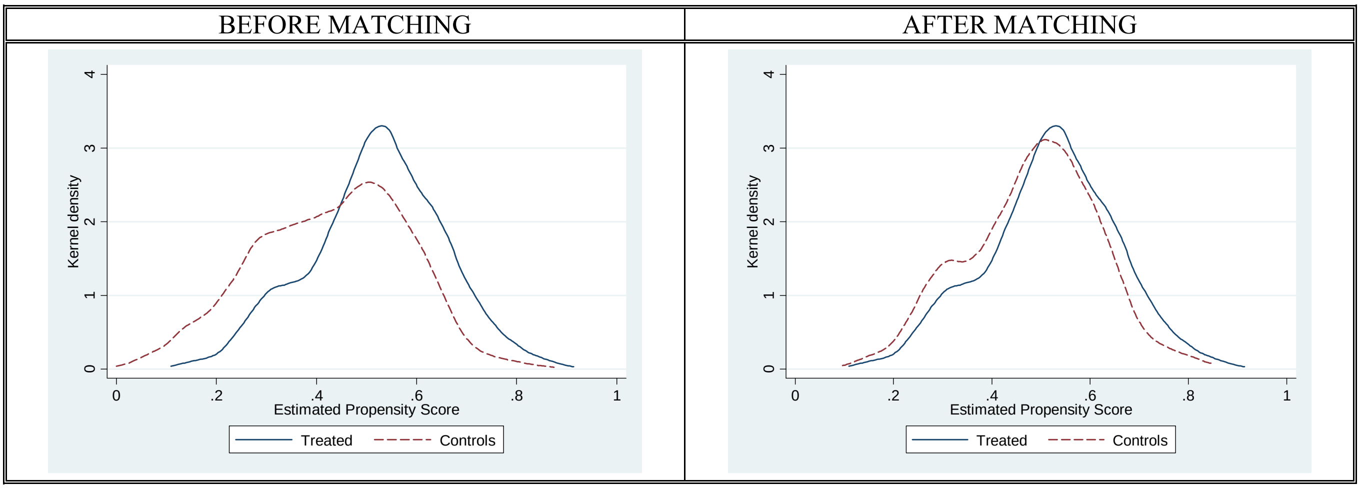

FIGURE 1. Graphical representations of the propensity scores distribution of "treated" and "untreated" firms *before* and *after* the One-to-One Nearest Neighbour matching

Table 14 shows the estimation of the Average Treatment Effect on Treated (ATET) according to seven different Matching procedures, weighted OLS (using sample weights), un-weighted OLS and the Heckman selection model. We indicate with the symbol Δ the ratio of the value of the endogenous variable calculated on treated to that calculated on control units, and with *ρ* the correlation between the unobservables in the outcome and in the selection equations within the Heckman method; we also distinguish between the ATET calculated within the sample and that calculated for the whole population, obtained using a simple proportional rule[38].

The number of observations by type of matching decreases according to the increase in "selectivity" of the methods applied. Matching 7 (Radius with a calliper of 0.00001) is the most selective and the number of treated drops to 36 units; there is, of course, a trade-off between the number of treated (size of sample) and precision: if we want a better precision of our estimation we have to renounce to a larger sample size.

We comment table 14 limiting our attention to the "sample" results. Within the matching methods, the difference in the ATET for the R&D expenditure ranges from a minimum of 340 in the Kernel method to a maximum of 1,351 thousand of Euros in the Radius number 6; the greatest value is anyhow reached by the Heckman method (2,618 thousand Euros); on average on matching methods it gets 885 thousand Euros with a Δ ratio equal to 4.62: it means that if a generic control unit does 1 thousand Euros of R&D expenditure a matched treated does 4.62 thousand Euros.

The difference in ATET for R&D intensity among the seven matching procedures is negligible since they give very similar results; only for Radius with a calliper of 0.0001 there is a little lower value (0.010) compared to the matching mean (0.014) where, according to the Δ ratio, the R&D intensity level of treated firms is 2.67 times that of the control units.

The ATET on the R&D per employee brings to similar results as to the R&D intensity: no significant differences can be found among the various methods: the average of matching methods is around 1.9 with a Δ ratio of 2.49, while the Heckman procedure brings to a value of 2.33; as expected, finally, the results on innovative turnover are not significant.

OLS regressions are reported only for the sake of comparison; nevertheless, results of OLS regressions on sample are quite identical to those of the average matching methods; Indeed the ATET for R&D intensity, for example, is

[38] Our population results are obtained by a proportional rule based on the Italian industry population structure. For the endogenous variable Y (such as, for example, the R&D intensity) the ATET in the population ($ATET_P$) is obtained according to: $Y_P:Y_S = ATET_P:ATET_S$. Since it is a heuristic rule, population values have to be taken purely as an indication.

equal to 0.014 as before: it seems that the OLS bias due to linearity and lack of similarity in the control group is quite negligible in our application (a result shared with Aerts and Czarnitzki, 2004).

More surprisingly, also the Heckman selection model conveys identical results on R&D intensity, while on R&D expenditure both OLS regressions and Heckman bring to substantial differences when compared with matching (for OSL, the ATET is 1,127 and for the Heckman method it is 2,618 thousand Euros, while for the average matching methods, as saw before, it gets 885). For the Heckman selection model the ρ is negative and quite low: it means that the unobservable factors influencing the selection-into-program equation are negatively correlated with the unobservable factors influencing the firm R&D decision, even though this correlation seems very low.

TABLE 15**.** Comparison of the propensity scores' means between treated and non-treated firms *before* and *after* the One-to-one nearest neighbour matching

Group	*Before/after Matching*	*Mean of treated*	*Mean of control*	*Difference*	*S.E.*	*P-value*
Geographical patterns						
North	Before	0.51	0.4	0.11	0.007	0.000
	After	0.51	0.51	0.0000	0.008	0.998
Centre	Before	0.54	0.38	0.15	0.020	0.000
	After	0.54	0.54	0.0001	0.024	0.994
South	Before	0.55	0.39	0.15	0.037	0.000
	After	0.55	0.55	-0.0008	0.045	0.986
Sectoral patterns						
H-T	Before	0.65	0.45	0.19	0.026	0.000
	After	0.62	0.62	0.002	0.03	0.943
M-H-T	Before	0.62	0.47	0.146	0.015	0.000
	After	0.61	0.61	-0.0001	0.021	0.996
M-L-T	Before	0.56	0.48	0.086	0.013	0.000
	After	0.55	0.55	0.0009	0.017	0.956
L-T	Before	0.51	0.42	0.089	0.015	0.000
	After	0.5	0.49	0.002	0.018	0.911
KIS	Before	0.46	0.24	0.22	0.03	0.000
	After	0.37	0.37	0.001	0.036	0.978
LKIS	Before	0.38	0.22	0.16	0.024	0.000
	After	0.37	0.36	0.009	0.039	0.806
Dimensional patterns						
Small	Before	0.50	0.29	0.213	0.034	0.000
	After	0.50	0.50	0.001	0.052	0.974
Madium-Small	Before	0.51	0.35	0.163	0.017	0.000
	After	0.50	0.50	0.002	0.020	0.913
Medium-Large	Before	0.57	0.42	0.014	0.010	0.000
	After	0.57	0.57	0.0006	0.013	0.963
Large	Before	0.61	0.38	0.220	0.020	0.000
	After	0.59	0.59	0.0006	0.026	0.979
Specific sectoral patterns						
Chemicals	Before	0.59	0.38	0.211	0.033	0.000
	After	0.56	0.55	0.002	0.036	0.934
Mechanics	Before	0.63	0.48	0.15	0.028	0.000
	After	0.6	0.6	-0.003	0.031	0.909
Auto-vehicles	Before	0.65	0.26	0.39	0.065	0.000
	After	0.61	0.61	0.001	0.091	0.983

TABLE 16**.** Estimation of the Average Treatment Effect on Treated (ATET) according to the Stratification and to the One-to-one Nearest Neighbour Matching for different geographical, sectoral and dimensional patterns

Group	*Matching Procedure*	*Number of treated*	*Number of control*	*ATET (sample)*	*ATET (Population)*	*Δ*	*S.E.*	*T-value*
Geographical pattern								
North	Stratification ***	1059	3650	0.012	0.009	-	0.002	7.59
	One-to-one N-N ***	1061	596	0.0118	0.009	3.22	0.0016	7.34
Centre	Stratification **	229	775	0.018	0.014	-	0.008	2.22
	One-to-one N-N *	229	116	0.0169	0.013	2.01	0.009	1.72
South	Stratification **	88	460	0.028	0.021	-	0.014	2.08
	One-to-one N-N **	89	46	0.029	0.022	3.90	0.014	1.99
Sectoral pattern								
H-T	Stratification ***	155	177	0.03	0.023	-	0.008	3.92
	One-to-one N-N ***	157	60	0.031	0.023	2.82	0.007	4.06
M-H-T	Stratification ***	350	555	0.008	0.006	-	0.001	6.31
	One-to-one N-N ***	350	150	0.009	0.007	2.80	0.001	6.27
M-L-T	Stratification ***	327	954	0.007	0.005	-	0.001	5.23
	One-to-one N-N ***	328	181	0.0078	0.006	3.33	0.001	5.91
L-T	Stratification ***	264	1021	0.007	0.005	-	0.002	3.24
	One-to-one N-N ***	264	158	0.006	0.005	2.5	0.002	2.85
KIS	Stratification ***	95	405	0.085	0.064	-	0.02	4.25
	One-to-one N-N ***	96	53	0.06	0.045	4.15	0.02	2.94
LKIS	Stratification	91	983	0.001	0.001	-	0.00	1.16
	One-to-one N-N	91	72	0.0003	0.000	1.38	0.001	0.34
Dimensional pattern								
Small	Stratification	103	598	0.016	0.012	-	0.016	0.94
	One-to-one N-N	103	61	0.005	0.004	1.18	0.014	0.40
Medium-Small	Stratification ***	247	1075	0.025	0.019	-	0.006	4.15
	One-to-one N-N ***	247	143	0.025	0.019	4.57	0.006	4.00
Medium-Large	Stratification ***	594	1674	0.012	0.009	-	0.003	3.94
	One-to-one N-N ***	594	295	0.011	0.008	2.48	0.003	3.28
Large	Stratification ***	268	456	0.014	0.011	-	0.003	5.28
	One-to-one N-N ***	270	116	0.013	0.010	4.25	0.002	5.02
Three specific sectors								
Chemicals	Stratification **	93	189	0.019	0.014	-	0.009	2.00
	One-to-one N-N *	95	55	0.016	0.012	3.71	0.009	1.95
Mechanics	Stratification ***	150	172	0.009	0.007	-	0.002	4.65
	One-to-one N-N ***	150	67	0.007	0.005	1.87	0.002	3.54
Auto-vehicles	Stratification	28	64	0.004	0.003	-	0.003	1.45
	One-to-one N-N	29	14	0.001	0.001	1.15	0.005	0.26

Note: Δ = Ratio of the value of the endogenous variable calculated on treated to that calculated on control units;
* = significant at 10%,
** = significant at5%,
*** = significant at 1%

We now go on by showing results by subgroups of firms, at geographical, sectoral and dimensional level. In table 15 we report the test controlling, in each sub-group, for the difference in the mean propensity scores between treated and selected controls; after matching, as we can see, the difference in propensity scores is no longer significant[39].

Table 16 presents results according to each different sub-group. We only use the R&D intensity as outcome variable and only the "stratification" and "one-to-one nearest neighbour" as matching method.

We start with groups that show a total crowding-out effect: low knowledge intensive services (LKIS), very small firms (10-19 employees), and the auto-vehicle sector; in particular, very small firms can be considered an example of asset constrained firms and, since they are generally not engaged in formal R&D activities, they could have used R&D incentives as substitutes for other type of investments. The crowding-out of the auto-vehicle sector behaviour could reflect the Fiat Group crisis in the early 2000s, derived by a previous reduction on R&D investments.

Now, we look at groups showing no crowding-out effect, sorting them by decreasing statistical significance. We found that South-Italy, Centre-Italy and Chemicals are significant but only at 10/5% depending on the methods; all the other groups present a value of the ATET significant at 1%; South-Italy shows the greatest level of Δ ratio (3.90) among the geographical groups, even if with a lower significance, given the lower number of observations (only 88 matched treated units).

Looking at the Δ ratio, among the more significant groups, the Medium-Small seized firms (20-49 employees) have the greatest value of 4.57; in the second position we find Large firms (>250 employees) with a value of 4.25 and, in the third position, the knowledge intensive sector (KIS[40]) with a value of 4.15.

As to sectors, the most significant Δ ratio, after KIS, is got by Medium-Low-Tech firms with a Δ ratio of 3,33 followed by the High-Tech and Medium-High-Tech sectors with a same Δ ratio of around 2.8; finally, Medium-Large firms (50-249 employees) perform a lower value of 2.48.

6. CONCLUSIONS

The weight of the public funding of private R&D investment is still high in EU, notwithstanding the EU Commission recurrent requests for member States reduction of the State aid. We examined the effect of R&D subsidies and R&D fiscal measure[41] in Italy on the manufacturing and services R&D expenditure in the period 1998-2000. CIS policy instrument mix includes also Regional and European R&D incentives, where the first ones, even if concerning a high percentage of firms in the sample (40%), are usually less consistent in size, and the second has a less diffused number of beneficiaries; therefore, we can assume that what we find out is mainly the effect of the national incentive system[42].

We decided not to go for disentangling the incentive by the three governance level (the only observable data) since in any way each level remained a combination of incentives (see also paragraph 1). Factors influencing the probability of firm participation change by instrument; think simply to size: the incentive which was introduced the first in Italy (for bottom-up projects of Applied research) registers still a concentration of large firms as beneficiaries (around 64% in 2002), while R&D automatic fiscal measures (included in the CIS data) are devoted to small firms. So, our analysis (and the same for scholars using CIS) does not give a clear indication to a policy maker, but a sort of pooled evaluation of the average resulting factors influencing the probability of participation (i.e., the net effect of the private

[39] Also for these groups we test, as before, the balancing property; only in few cases we have had to change our specification in order to satisfy this property.

[40] See Appendix C for the groups' definition.

[41] An automatic measure only for SMEs.

[42] 1998-2000 has been a period of change in the national R/D incentive system, bringing to a rationalization, whose aspects have became more clear later (since 2001) with the Decree of application of the reform; therefore, our analysis refers mainly to the pre-existing national incentive system.

agent decision and the public agent selection) and the conditioned impact on private R&D effort.

The question of the input additionality effect implies the capacity of public incentives to modify firm R&D investment behaviour by adding projects that otherwise should not have been undertaken: more risky projects, which should have found extra-firm financing with more difficulty; larger scope or also larger scale R&D project (relevant when a policy aim is to reinforce SMEs participation to R&D). As we said at the beginning of the paper, given our dataset characteristics, we can only control for the presence of a total crowding-out, occurring when subsidized firms fully substitute public funds to internal funding due to opportunistic behaviour, to internal fund and/or asset constraints or to the lack of efficiency in the incentive process implementation.

The full crowding-out effect concerns a pool of instruments, as we said at the beginning, and therefore it could be more rare to be found out, even though we compensate this "aggregated effect" by looking at different subgroups of beneficiaries.

The "total crowding-out" phenomenon (which represents a full failure for an incentive policy) is not so irrelevant, when looking beyond the average results. For example, in the above examined study for Sweden, authors found out that a total crowding-out effect cannot be excluded for firms with more than 50 employees; Busom (2000) found out that for 30% of the subsidized firms a total crowding-out cannot be excluded.

In Italy at the end of '80s the concentration of national R&D public funds on a small number of products brought out limited multiplicative effect, all subsidized firms considered (Antonelli, 1989). Since then some changes have been introduced in the national R&D incentive regulation in Europe, such as the necessary justification for demand of subsidy higher than an established threshold and for large firms (additionality condition), even if the cumulativeness of demands and subsidized projects for the same firm is not excluded. The "incentive" character of the project has to be demonstrated ex ante. Italian government has recently followed this regulatory address (D.M. 593/2000) and one of the eligibility condition concerns the "incentive" character of the grant demanded by large firms (>250 employees) and over a threshold.

From our analysis it results that what discriminates to be a subsidized firms (on average, for a pool of instruments) is not the size, but the human capital skills (capacity and project feasibility), the knowledge capital accumulation (R&D experience), together with a low internal cash flow (internal liquidity constraints). Indebtedness is not a discriminating variable (for instance, small firms can have problems in collecting funds from external sources). The positive role of foreign capital ownership is also an interesting and different from other studies result. It is the confirmation of the application of existing measures: in fact, our national R&D incentive regulation includes among the potential beneficiary foreign owned firms localised under the condition of not overcoming a threshold of subsidy (less than 20% of the project cost)[43].

As to the impact of the R&D incentives, our analysis excludes a total crowding-out on average, when we look at the outcome of the aggregated group of subsidized firms. This is a statistically very robust result, since it is confirmed by all the different econometric tests applied, including a control for unobservable variables effect (by a selection model *à la* Heckman). In particular: in our sample, on average on matching methods, we get 885 additional thousand Euros of R&D expenditure with a Δ ratio equal to 4.62: it means that if a generic control unit does 1 thousand Euros of R&D expenditure a matched treated does 4,62 thousand Euros; in the population this value drops to 242 thousand Euros. The additionality for the R&D intensity is, according to an average on various methods, about 0.014 in the sample with a Δ ratio of about 2.67, while in the population the ATET value drops to 0.010.

[43] Non European owned firms can benefit of national R/D incentives if it is demonstrated the difficulty of finding a peculiar competence within the European area. When foreign owned firms participate for more than 10% to a R/D project they are allowed to benefit of a 10% further financial support. Of course if a firm is part of a MNC, even if it has a low number of employees, it is taken as a large firm and it has to fulfil the same conditions.

When looking at more disaggregated sub-samples of subsidized firms, at dimensional, sectoral and geographical level, some cases of total crowding-out appear for low knowledge intensive service sectors, very small firms (10-19 employees) and the auto-vehicle industry in the considered period.

Moreover it is possible to get a rank of the positive effects (according to the Δ ratio), even if it has to be borne in mind that this ratio can include different amount of public financial contributions and that probably relative smaller public contributions can produce a lower impact on private R&D effort. In our case the highest incentive impact is found for medium-small (20-49 employees) and large firms, followed by firms in knowledge intensive services, and those located in the South; this latter group is then followed by the medium low tech firms and those located in the North.

Even though we do not know how much private fund is added to the level of the received subsidy, neither what kind of subsidy or subsidy mix has been more successful, we take as a first positive result finding out that "participation" to subsidy programs allow firms to be less conditioned by hampering factors, such as low size or low technology. Typically less R&D intensive groups of firms, such as medium-small firms, medium low-tech[44] and also firms located in the South, have invested more in R&D, compared with their non subsidized controls. It sounds like a relatively positive message to policy makers, inviting them to sustain R&D of this kind of firms and their "better R&D projects". Moreover, at a first look, it seems that the inclusion of the "additionality" requirement for large firms and higher R&D subsidy demand in the national regulation has produced good results.

The main limit of this type of analysis is the fact that the measure of the differential effect, summarized in our work by the Δ ratio, includes the subsidy received, without getting any information on the degree of this impact. Other limits of this type of analysis, with contrasting (mainly augmenting) effects on our resulting measure of additionality, are the following:

- Matching methods underestimates the additionality in presence of spillover effects generated by subsidies (see Klette, Moen and Griliches, 2000); indeed, we cannot exclude spillover effects on treated units also in our work; therefore, the results should be taken as "lower bounds".
- The CIS R&D expenditures data we refer to is not the whole R&D value, since some components included in the national R&D statistics (following the Frascati Manual) are not included in this survey (R&D not directly devoted to innovation projects); indeed, we do not know the effect on the whole R&D investment.
- The values of our estimated ATETs are generally high: it is so also because our non treated units are chosen as not receiving any support for three consecutive years.
- We were not able to include non-innovating firms, and therefore we do not know if a financial incentive can produce new starting R&D activities.

More informed analysis at micro level are asked for controlling for these first results and we plan to go further by using data for a longitudinal analysis (panel data) looking also at the dynamic structure of subsidy effects; we plan also to analyse the effect of specific national incentive program at firm level.

REFERENCES

Aerts K. and Czanitzki D. (2004), "Using Innovation Survey Data to Evaluate R&D Policy: the Case of Belgium", *ZEW Discussion Paper*, n. 04-55.

Almus M. and Czarnitzki D. (2003), "The effects of public R&D subsidies on firms' innovation activities: The case of Eastern Germany", *Journal of Business and Economic Statistics*, 21, 226-236.

Antonelli C. (1989), "Il finanziamento pubblico alle attività di ricerca delle imprese. Un ten-

[44] Low tech sectors in Italy invest less in R/D than the same industry in other European country such as Germany; these fact seems also linked to the smaller size of our firms. See: Pensa, Rodà and Segni (2008).

tativo di valutazione", in Antonelli C. e Pennacchi L. (eds), *Poltiche per l'innovazione e sfida europea*, F. Angeli, Milano.

Becker S. and Ichino A. (2002), "Estimation of Average Treatment Effects Based on Propensity Scores", *The Stata Journal*, 2(4), 358-377.

Bérubé C. and Mohnen P. (2007), "Are Firms That Received R&D Subsidies More Innovative?", *UNU-MERIT Working Paper Series*, no. 015.

Bronzini R., De Blasio G. (2006), "Evaluating the impact of investment incentives: the case of Italy law 488/1992", *Journal of Urban Economics*, 60, 327-349.

Busom I. (2000), "An empirical Evaluation of the Effects of R&D Subsidies", *Economics of Innovation and New Technology*, 9(2), 111–148.

Cameron A.C. and P.K. Trivedi (2005), *Microeconometrics: Methods and Applications*, Cambridge, University Press.

Cannari L., D'Aurizio L. and De Blasio G. (2007), *The effectiveness of investment subsidies: evidence from survey data*, Bank of Italy, Economic Research Department.

Centro Studi Confindustria (2004), "Benchmarking delle politiche di agevolazione alla ricerca e all'innovazione", *Documenti di lavoro*, n.1, Roma, Settembre.

David P.A., B.H. Hall and A.A. Toole (2000), "Is public R&D a complement or substitute for private R&D? A review of the econometric evidence", *Research Policy*, 29, 497–529.

Dehejia R.H. and Wahba S. (2002), "Propensity Score-Matching Methods For Nonexperimental Causal Studies", *The Review of Economics and Statistics*, 84(1), 151-161.

Diamond A. M. (1998), "Does Federal Funding 'Crowd In' Private Funding of Science", *Contemporary Economic Policy*, 16, 423-31.

Contemporary Economic Policy, 16, 423-31. Duguet E. (2003), "Are R&D Subsidies a Substitute or a Complement to Privately Funded R&D? Evidence from France using Propensity Score Methods for Non-Experimental Data", *University of Paris I Cahier de la MSE EUREQua, Working Paper*, no. 2003.75.

Hall B.H. (1992), "Investment and research and development at the firm level: does the source of financing matter?", *NBER Working Paper*, n. 4096, MA, June.

Hall B.H. (2002), "The financing of research and development", *NBER Working Paper*, n. 8773, MA, Feb.

Heckman J.J. (1978), "Dummy endogenous variables in a simultaneous equation system", *Econometrica*, 46(4), 931-59.

Heckman J.J. (2001), "Micro Data, Heterogeneity, and the Evaluation of Public Policy: Nobel Lecture", *Journal of Political Economy*, 109(4), 673-748.

Heckman J.J., Urzua S. and E. Vytlacil (2006), "Understanding Instrumental Variables in Models with Essential Heterogeneity", *The Review of Economics and Statistics*, 88(3), 389-432.

Ichino A. (2006), *The Problem of Causality in the Analysis of Educational Choices and Labor Market Outcomes, Slides for Lectures*, European University Institute and CEPR.

ISTAT (2004), *Statistiche sull'innovazione nelle imprese*. Anni 1998-2000, Collana Informazioni.

Jaffe A. (1998), "Measurement Issues" in Branscomb L.M. and Keller J.H. (eds), *Investing in innovation*, Cambridge MA, MIT Press.

Jaffe A. (2002), "Building programme evaluation into design of public research support programme", *Oxford Review of Economic Policy*, 18 (1), 22-34.

Kaiser U. (2004), "Private R&D and Public R&D subsidies: Microeconometric Evidence from Denmark", *CEBR Discussion papers*, no. 2004-19.

Klette T. and Møen J. (1998), "R&D investment responses to R&D subsidies: a theoretical analysis and a microeconometric study", Mimeo, Presented at the *NBER Summer Institute*.

Klette T.J., J. Møen und Z. Griliches (2000), "Do Subsidies to Commercial R&D Reduce Market Failures? Microeconometric Evaluation Studies", *Research Policy*, 29, 471–495.

Lach S. (2000), "Do R&D Subsidies Stimulate or Displace Private R&D? Evidence from Israel", *NBER Working Papers*, n. 7943, Cambridge, MA.

Lechner M. (2001), "Identification and estimation of causal effects of multiple treatment under the conditional independance asumption", in Lechner M. and F. Pfeiffer (eds), *Econometric Evaluation of Labour Market Policies*, Physica-Verlag.

Lichtenberg F.R. (1987), "The effect of government funding on private industrial research and development: a re-assessment", *The Journal of Industrial Economics*, 36, 97–104.

Lichtenberg F.R. (1988), "The private R&D investment response to federal design and technical competitions", *American Economic Review*, 78, 550–559.

Lööf H. and A. Heshmati (2005), "The Impact of Public Funds on Private R&D Investment: New Evidence from a Firm Level innovation Study", in Heshmati A., Y-B. Sohn and Y-R. Kim (eds), *Commercialization and Transfer of Technology: Major Country Case Studies*, Nova Science Publishers.

Maddala G. S. (1983), *Limited dependent and qualitative variables in econometrics*, Cambridge University Press.

Pensa C., Rodà M, Segni L. (2008), "Le trasformazioni del made in Italy: alcune evidenze empiriche", Report prepared for the *IV Joint Workshop Luiss Lab- CEPS*, January.

Potì B. and Reale E. (2007), "Changing allocation models for public research funding: an empirical exploration based on project funding data", *Science and Public Policy*, 34(6), 417-430, July.

Rosenbaum P. and D. Rubin (1983), The Central Role of the Propensity Score in Observational Studies for Causal Effects, *Biometrika*, 70, 41–55.

Rubin D.B. (1977), "Assignment to Treatment Group on the Basis of a Covariate", *Journal of Educational Statistics*, 2, 1-26.

Stead H. (1976), "The cost of technological innovation", *Research Policy*, 5.

Wallsten S.J. (2000), "The Effects of Government–Industry R&D Programs on Private R&D: The Case of the Small Business Innovation Research Program", *The RAND Journal of Economics*, 31(1), 82-100.

Wooldridge J.M. (2002), *Econometric Analysis of cross section and panel data*, MIT Press.

Zhao Z. (2004), "Using Matching to Estimate Treatment Effects: Data Requirements, Matching Metrics, and Monte Carlo Evidence", *Review of Economics and Statistics*, 86(1), 91-107.

APPENDIX A – METHODOLOGICAL ISSUES

Before getting into formulas, it seems of worth to better clarify what kind of statistical problem we face in our setting. As we said, we are interested in estimating the *average treatment effect on treated* (ATET) defined as:

$$ATET = E(y_1 - y_0 \mid w=1) = E(y_1 \mid w=1) - E(y_0 \mid w=1).$$

As it is clear, whereas we can observe the quantity $E(y_1 \mid w=1)$ since it is equal to the outcome of treated units when they were treated, we "do not observe" the quantity $E(y_0 \mid w=1)$. From observation, in fact, we only know the variable $E(y_0 \mid w=0)$, i.e., the (average) level of the outcome for non treated units. Knowing what would have been the outcome for treated units if they had not been treated is impossible, since we can see only one of the two participation status for each single unit. This falls into the general statistical setting of a "missing observation".

As we said, the idea behind the matching procedure is to estimate $E(y_0 \mid w=1)$ using non treated units that are "similar" to treated units; more precisely we hold:

[A1] $$E(y_0 \mid w=1, X=x) = E(y_0 \mid w=0, X=x),$$

where $E(y_0 \mid w=0, X=x)$ is observable. Relation [A1] is valid only under *conditional independence assumption* (Rubin, 1977): conditional on some pre-treatment observables (the variables *X*), we assume *y* and *w* to be independent[45]. In this case, the conditional (on covariates) *ATET* estimate becomes:

[A2] $$ATET (x) = E(y_1 \mid w=1, X=x) - E(y_0 \mid w=0, X=x).$$

MATCHING

Equation [A2] allows for identifying "cells" within which *y* and *w* are independent. To clarify this point, suppose that *X* is formed by two dichotomous variables *A* and *B* taking modalities *a1, a2* and *b1, b2* respectively. In this case four cells can be built. According to the *conditional independence assumption*, within each of these cells the experimental setting is restored and the "difference-in-mean estimator" consistently estimate the ATET(*x*). To obtain the ATET overall estimation we have only to integrate on *X* (obtaining its marginal distribution). It means that we have to take the mean of the various *ATET(x)* calculated in each cell weighted by the distribution of *X* conditional on *w=1*. If *X* is a discrete random variable:

$$ATET = \sum_x ATET(x) \cdot Pr(X = x \mid w = 1)$$

When X is highly dimensional or is a continuous variable, an exact matching is not possible. In general too many cells have to be built, running the risk of obtaining a large number of cells with zero observations. To avoid this drawback (the dimensionality problem), Rosenbaum and Rubin (1983) proposed to match individuals according to a single variable: the propensity score. As said above, it is obtained from a probit regression with regressors equal to the variables contained in *X*. Each treated and untreated unit has its own propensity score, and units with close propensity score are matched. In practise, the authors propose a procedure to form strata according to the propensity

[45] "Conditional-independence-assumption" is another name to call the already cited "ignorability of treatment". In any case, to obtain consistent matching estimate, we only needs "conditional-mean-independence" that is a less restrictive hypothesis (Wooldridge, 2002, p. 607).

score in which is tested the so called "balancing property": in each stratum and for each variable (included the propensity score) the mean on treated and not treated has to be equal. This procedure generates the optimal number of strata as soon as the balancing property is satisfied in each stratum. Once obtained this partitioning we can averaging on the "difference-in-mean estimator" on strata obtaining a consistent estimation of the ATET[46]; this procedure is called the "Stratification matching".

Even if we make use of matching procedures other than the Stratification matching, the balancing property has always to be satisfied. Therefore, we have first to test this property on our data (in order to ascertain that our probit specification for the calculus of propensity scores is correct) and then applying each matching procedure.

Different matching methods require different formulas for the calculus of the *ATET*; in our work we compare the following *seven* matching procedures: 1. stratification, 2. one-to-one nearest neighbour, 3. three-nearest neighbours, 4. kernel, 5. radius (with a calliper of 0.001), 6. radius (with a calliper of 0.0001), 7. radius (with a calliper of 0.00001).

We have already qualitatively explained in which way the stratification matching works; the corresponding formula for the estimated ATET is:

$$ATET^{S} = \sum_{b=1}^{B} ATET_{b}^{S} \cdot \left[\frac{\sum_{i \in I(b)} w_i}{\sum_{i} w_i} \right] \quad \textbf{with:} \quad ATET_{b}^{S} = \frac{1}{N_b^T} \sum_{i \in I(b)} y_{1i} - \frac{1}{N_b^C} \sum_{j \in I(b)} y_{0j} \, ,$$

where: *I(b)* is set of units present in block *b*, N_b^T is the number of treated units in block *b*, N_b^C is the number of control units in block *b*.

Other matching methods deserve some further explanation. In the case of the one-to-one nearest neighbour each treated is matched with only one control (always in the common support), whose propensity score is the closest to that of the treated one according to some specific metric (for example, the Mahalanobis metric). In this case the set of control units is defined as:

$$C(i) = \left\{ \; j \;\; | \;\; \min_{j} \left\| p_i - p_j \right\| \; \right\}$$

that, for each unit *i* is a singleton unit *j* (or three units in the case of the three-nearest neighbours). Instead, the set of control units in the case of the "radius" matching is:

$$C(i) = \left\{ \; j \;\; | \;\; \left\| p_i - p_j \right\| < r \; \right\}$$

representing all the non-treated units falling (always in terms of their propensity score) in the radius of dimension *r*. A general formula for all these matching methods is the following:

[A3]
$$ATET^{M} = \frac{1}{N^T} \sum_{i \in T} \left[y_i^T - \sum_{j \in C(i)} \omega_{ij} y_j^C \right]$$

where $0 < \omega_{ij} < 1$ is the weight given to the control unit *j-th* in the comparison with the unit *i-th*

[46] See, Becker and Ichino (2002) for a software implementation.

(with: $\sum_{j\in C(i)} \omega_{ij} = 1$). For each treated unit *i*, the sum in the square brackets is thus a weighted average of its (selected) control units. In the case of the "arithmetic mean", the weights become $\omega_{ij} = 1/N_i^C$ and the previous formula reduces to:

$$ATET^{ArM} = \frac{1}{N^T}\sum_{i\in T}\left[y_i^T - \frac{1}{N_i^C}\sum_{j\in C(i)} y_j^C\right].$$

Therefore, for the nearest neighbour matching, since $N_i^C = 1$ (so that $j=i$), the formula becomes:

$$ATET^{NN} = \frac{1}{N^T}\left(\sum_i y_i^T - \sum_i y_i^C\right),$$

while for the three-nearest neighbours, it takes the following form:

$$ATET^{3NN} = \frac{1}{N^T}\sum_{i\in T}\left[y_i^T - \frac{1}{3}\sum_{j\in C(i)} y_j^C\right].$$

Furthermore, the kernel matching comes up from equation [A3] when:

$$\omega_{ij} = \frac{K(p_j - p_i)}{\sum_{j=1}^{N_i^C} K(p_j - p_i)},$$

where *K* is the kernel function.

Finally, provided that outcomes are considered independent across units, it can be proved that the analytical variance of the estimator in equation [A3] is equal to:

$$Var\left(ATET^M\right) = \frac{1}{(N^T)^2}\sum_{j\in T} Var(y_i^T) + \sum_{j\in C}(\omega_j)^2 Var(y_j^C)$$

where $\omega_j = \sum_i \omega_{ij}$. It is quite clear that there is a penalty for using the same controls more than one time.

The selection model

As we saw in section 3, the selection model is composed of two (correlated) equations: one for the outcome and one for the selection equation, and takes the following form:

[A4]
$$\begin{cases} y_i = \mu + \gamma x_i + \alpha w_i + u_i \\ w_i^* = \eta + \beta z_i + v_i \\ w_i = \begin{cases} 1 & if \quad w_i^* \geq 0 \\ 0 & if \quad w_i^* < 0 \end{cases} \\ Cov(u_i; v_i) = \rho \neq 0 \end{cases}$$

where *x* and *z* are covariates and *u* and *v* are unobservable components (error terms) with zero unconditional mean, but supposed to be correlated. Under this assumptions $E(w_i \cdot u_i) \neq 0$ so that the OLS estimate of the outcome equation is inconsistent. We could rewrite the first equation of [A4] in the two different regimes:

$$\begin{aligned} w_i = 1: &\quad y_i = \mu + \gamma x_i + \alpha + u_i \\ w_i = 0: &\quad y_i = \mu + \gamma x_i + u_i. \end{aligned}$$

It would seem possible to run two OLS regressions on them, obtaining α as the difference between the two (estimated) intercepts. The problem of this procedure, unfortunately, is that under both the regimes the error term has not zero unconditional mean; in fact:

$$\begin{aligned} E(u_i \mid v_i \geq -\eta - \beta z_i) \neq E(u_i) = 0 \\ E(u_i \mid v_i < -\eta - \beta z_i) \neq E(u_i) = 0. \end{aligned}$$

This is a typical case of "omitted variable specification error", that can be solved by adding the non-zero means into the equations, obtaining:

[A5]
$$\begin{aligned} w_i = 1: &\quad y_i = \mu + \gamma x_i + \alpha + [u_i - E(u_i \mid v_i \geq -\eta - \beta z_i)] \\ w_i = 0: &\quad y_i = \mu + \gamma x_i + [u_i - E(u_i \mid v_i < -\eta - \beta z_i)] \end{aligned}$$

Now, the errors terms in the squared brackets have zero mean. The problem is that we cannot observe $E(u_i \mid v_i \geq -\eta - \beta z_i)$ and $E(u_i \mid v_i < -\eta - \beta z_i)$. Nevertheless, we can estimate them by using the participation equation and the joint normality of u and v. From the joint normality it can be proved that:

$$E(u_i \mid v_i \geq -\eta - \beta z_i) = -\lambda_1 M_{1i}$$
$$E(u_i \mid v_i < -\eta - \beta z_i) = -\lambda_0 M_{0i}$$

where: $M_{1i} = \phi(-\eta - \beta z_i)/[1 - \Phi(-\eta - \beta z_i)]$ and $M_{0i} = \phi(-\eta - \beta z_i)/[\Phi(-\eta - \beta z_i)]$ are known as *Mill's ratios* (with ϕ and Φ being the normal density function and its cumulative respectively), while $\lambda_1 = \sigma_u \cdot \sigma_{u,v}$ and $\lambda_0 = -\sigma_u \cdot \sigma_{u,v}$.

We can estimate equations [A5] by a two-step procedure or via maximum likelihood (Maddala, 1983). In the two-step we first estimate M_{1i} and M_{0i} (once obtained a consistent estimation of η and β from a probit regression of the participation equation); secondly, with these estimations at hand, we can estimate λ_1 and λ_0 by simple OLS (taking standard errors corrected for generated regressors); we might then estimate also the coefficient of correlation ρ between u and v (since $\rho = \lambda_1 / \sigma_u^2$). Since, under joint normality of (u, v) this method becomes fully parametric a partial maximum likelihood approach can be used to estimate consistently all parameters.

APPENDIX B – TESTING THE *BALANCING PROPERTY* WITHIN BLOCKS

TABLE 8**.** Test of the "balancing property" for the model adopted. Note: the algorithm used rejects equality in the means of the variables just at a level of significance smaller than 1% (see Becker and Ichino, 2002)

Block 1	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	187	0.132	-0.004	0.612
	1	39	0.137	-	-
EMP 98	0	187	171.59	-119.9962	0.203
	1	39	291.59		
EMPSKILL 00	0	187	0.125	-0.033724	0.263
	1	39	0.159		
EXPINT 98	0	187	0.083	-0.0813	0.036
	1	39	0.16		
CAPINT 98	0	187	152.06	73.37	0.752
	1	39	78.68		
CASHINT 98	0	187	18.04	7.25	0.620
	1	39	10.79		
DEBTINT 98	0	187	0.66	0.055	0.141
	1	39	0.6		
KNOWLEDGE 98	0	187	8.65E+07	-1.84E+08	0.015
	1	39	2.70E+08		
AGE	0	187	0.06	-0.043	0.320
	1	39	0.10		
FOREIGN	0	187	0.598	-0.195	0.020
	1	39	0.794		

TABLE 9. Test of the "balancing property" for the model adopted. Note: within each block, the algorithm used accepts quality in the means of the variables just at a level of significance less than or equal to 1%

Block 2	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	202	0.251	-0.004	0.309
	1	77	0.255		
EMP 98	0	202	1059	916.6	0.541
	1	77	142.3		
EMPSKILL 00	0	202	0.111	-0.016	0.434
	1	77	0.128		
EXPINT 98	0	202	0.126	-0.008	0.783
	1	77	0.134		
CAPINT 98	0	202	135.5	4.89	0.975
	1	77	130.6		
CASHINT 98	0	202	5.95	-1.9	0.692
	1	77	7.86		
DEBTINT 98	0	202	0.62	0.012	0.644
	1	77	0.61		
KNOWLEDGE 98	0	202	1.35E+08	2.29E+07	0.801
	1	77	1.12E+08		
AGE	0	202	0.014	-0.024	0.216
	1	77	0.038		
FOREIGN	0	202	0.702	-0.089	0.135
	1	77	0.792		

TABLE 10. Test of the "balancing property" for the model adopted. Note: within each block, the algorithm used accepts equality in the means of the variables just at a level of significance less than or equal to 1%

Block 3	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	196	0.352	0.001	0.862
	1	156	0.351		
EMP 98	0	196	176.3	-56.48	0.143
	1	156	232.8		
EMPSKILL 00	0	196	0.118	0.007	0.686
	1	156	0.111		
EXPINT 98	0	196	0.168	-0.018	0.533
	1	156	0.187		
CAPINT 98	0	196	66.5	5.68	0.741
	1	156	60.8		
CASHINT 98	0	196	8.14	4.21	0.333
	1	156	3.92		
DEBTINT 98	0	196	0.63	0.028	0.191
	1	156	0.6		
KNOWLEDGE 98	0	196	1.56E+08	2.41E+07	0.634
	1	156	1.32E+08		
AGE	0	196	0.005	-0.007	0.435
	1	156	0.012		
FOREIGN	0	196	0.78	0.067	0.142
	1	156	0.71		

TABLE 11. Test of the "balancing property" for the model adopted. Note: within each block, the algorithm used accepts equality in the means of the variables just at a level of significance less than or equal to 1%

Block 4	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	488	0.500	-0.006	0.076
	1	475	0.506		
EMP 98	0	488	180.1	-40.2	0.209
	1	475	220.3		
EMPSKILL 00	0	488	0.076	-0.01	0.224
	1	475	0.087		
EXPINT 98	0	488	0.259	-0.015	0.384
	1	475	0.275		
CAPINT 98	0	488	42.2	-4.154	0.233
	1	475	46.4		
CASHINT 98	0	488	5.23	1.01	0.307
	1	475	4.21		
DEBTINT 98	0	488	0.61	-0.008	0.513
	1	475	0.62		
KNOWLEDGE 98	0	488	1.34E+08	-7.76E+07	0.029
	1	475	2.11E+08		
AGE	0	488	0	-0.004	0.151
	1	475	0.004		
FOREIGN	0	488	0.91	-0.014	0.405
	1	475	0.92		

TABLE 12. Test of the "balancing property" for the model adopted. Note: within each block, the algorithm used accepts equality in the means of the variables just at a level of significance less than or equal to 1%

Block 5	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	229	0.675	-0.010	0.021
	1	404	0.685		
EMP 98	0	229	198.5	-78.3	0.214
	1	404	276.9		
EMPSKILL 00	0	229	0.09	-0.007	0.567
	1	404	0.1		
EXPINT 98	0	229	0.34	-0.036	0.132
	1	404	0.38		
CAPINT 98	0	229	38.6	-0.39	0.936
	1	404	39		
CASHINT 98	0	229	3.65	0.91	0.302
	1	404	2.73		
DEBTINT 98	0	229	0.63	-0.007	0.623
	1	404	0.64		
KNOWLEDGE 98	0	229	3.35E+08	-7.47E+06	0.924
	1	404	3.42E+08		
AGE	0	229	*dropped*	*dropped*	*dropped*
	1	404	*dropped*	*dropped*	*dropped*
FOREIGN	0	229	0.97	-0.002	0.862
	1	404	0.98		

TABLE 13. Test of the "balancing property" for the model adopted. Note: within each block, the algorithm used accepts equality in the means of the variables just at a level of significance less than or equal to 1%

Block 6	*Group*	*Number*	*Mean*	*Difference*	*P-value*
Propensity score	0	17	0.841	-0.024	0.103
	1	67	0.865		
EMP 98	0	17	280	-1156.4	0.196
	1	67	1436.4		
EMPSKILL 00	0	17	0.26	0.008	0.916
	1	67	0.25		
EXPINT 98	0	17	0.3	-0.087	0.293
	1	67	0.39		
CAPINT 98	0	17	53.5	3.52	0.83
	1	67	50		
CASHINT 98	0	17	-25.8	-26.14	0.055
	1	67	0.25		
DEBTINT 98	0	17	0.55	-0.081	0.142
	1	67	0.63		
KNOWLEDGE 98	0	17	2.16E+09	-2.30E+09	0.299
	1	67	4.46E+09		
AGE	0	17	*dropped*	*dropped*	*dropped*
	1	67	*dropped*	*dropped*	*dropped*
FOREIGN	0	17	0.94	-0.028	0.571
	1	67	0.97		

APPENDIX C – MACRO-SECTORS' DEFINITION

High-technology manufacturing Pharmaceuticals Office machinery and computers Radio, TV and communication equipment Instrument engineering Manufacture of aircraft and spacecraft	*Medium-high-technology manufacturing* Chemicals Chemicals, excluding pharmaceuticals Machinery and equipment Electrical machinery Motor vehicles Other transport equipment, excluding ships and aerospace Other transport equipment	*Medium-low-technology manufacturing* Coke, refined petroleum products and nuclear fuel Rubber and plastic products Other non-metallic mineral products Basic metals Fabricated metal products Building and repairing of ships and boats
Low-technology manufacturing Food and beverages Tobacco products Textiles Clothing Leather products Wood products Pulp and paper products Publishing and printing Manufacturing n.e.c. Recycling	*Knowledge-intensive services* Water transport Air transport Post and telecommunications Computer and related activities Other business activities	*Less knowledge-intensive services* Motor trade Wholesale trade Retail trade Hotels and restaurants Land transport Auxiliary transport activities

WORKING PAPER SERIES (2008-1993)

2008

1/08 *Nouveaux instruments d'évaluation pour le risque financier d'entreprise*, by Greta Falavigna

2/08 *Drivers of regional efficiency differentials in Italy: technical inefficiency or allocative distortions?,* by Fabrizio Erbetta and Carmelo Petraglia

3/08 *Modelling and measuring the effects of public subsidies on business R&D: theoretical and econometric issues,* by Giovanni Cerulli

4/08 *Investimento pubblico e privato in R&S: effetto di complementarietà o di sostituzione?*, by Mario Coccia

5/08 *How should be the levels of public and private R&D investments to trigger modern productivity growth? Empirical evidence and lessons learned for italian economy*, by Mario Coccia

6/08 *Democratization is the determinant of technological change,* by Mario Coccia

7/08 *Produttività, progresso tecnico ed efficienza nei paesi OCSE*, by Alessandro Manello

8/08 *Best performance-best practice nelle imprese manifatturiere italiane*, by Giuseppe Calabrese

9/08 *Evaluating the effect of public subsidies on firm R&D activity: an application to Italy using the community innovation survey*, Giovanni Cerulli and Bianca Potì

10/08 *La responsabilité sociale, est-elle une variable influençant les performances d'entreprise?*, by Greta Falavigna

2007

1/07 *Macchine, lavoro e accrescimento della ricchezza: Riflessioni sul progresso tecnico, occupazione e sviluppo economico nel pensiero economico del Settecento e Ottocento*, by Mario Coccia

2/07 *Quali sono i fattori determinanti della moderna crescita economica?Analisi comparativa delle performance dei paesi*, by Mario Coccia

3/07 *Hospital Industry Restructuring and Input Substitutability: Evidence from a Sample of Italian Hospitals*, by Massimiliano Piacenza, Gilberto Turati and Davide Vannoni

4/07 *Il finanziamento pubblico alla ricerca spiazza l'investimento privato in ricerca? Analisi ed implicazioni per la crescita economica dei paesi*, by Mario Coccia

5/07 *Quanto e come investire in ricerca per massimizzare la crescita economica? Analisi e implicazioni di politica economica per l'Italia e l'Europa*, by Mario Coccia

6/07 *Heterogeneity of innovation strategies and firms' performance*, by Giovanni Cerulli and Bianca Potì

7/07 *The role of R/D expenditure: a critical comparison of the two (R&S and CIS) sources of data*, by Bianca Potì, Emanuela Reale and Monica Di Fiore

8/07 *Sviluppo locale e leadership. Una proposta metodologica*, by Erica Rizziato

9/07 *Government R&D funding: new approaches in the allocation policies for public and private beneficiaries*, by Bianca Potì and Emanuela Reale

10/07 *Coopération et gouvernance dans deux districts en transition*, by Ariel Mendez and Elena Ragazzi

11/07 *Measuring Intersectoral Knowledge Spillovers: an Application of Sensitivity Analysis to Italy*, by Giovanni Cerulli and Bianca Potì

2006

1/06 *Analisi della crescita economica regionale e convergenza: un nuovo approccio teorico ed evidenza empirica sull'Italia*, by Mario Coccia

2/06 *Classifications of innovations: Survey and future directions*, by Mario Coccia

3/06 *Analisi economica dell'impatto tecnologico*, by Mario Coccia

4/06 *La burocrazia nella ricerca pubblica.* PARTE I *Una rassegna dei principali studi*, by Mario Coccia and Alessandro Gobbino

5/06 *La burocrazia nella ricerca pubblica.* PARTE II *Analisi della burocrazia negli Enti Pubblici di Ricerca*, by Mario Coccia and Alessandro Gobbino

6/06 *La burocrazia nella ricerca pubblica.* PARTE III *Organizzazione e Project Management negli Enti Pubblici di Ricerca: l'analisi del CNR*, by Mario Coccia, Secondo Rolfo and Alessandro Gobbino

7/06 *Economic and social studies of scientific research: nature and origins*, by Mario Coccia

8/06 *Shareholder Protection and the Cost of Capital: Empirical Evidence from German and Italian Firms*, by Julie Ann Elston and Laura Rondi

9/06 *Réflexions en thème de district, clusters, réseaux: le problème de la gouvernance*, by Secondo Rolfo

10/06 *Models for Default Risk Analysis: Focus on Artificial Neural Networks, Model Comparisons, Hybrid Frameworks*, by Greta Falavigna

11/06 *Le politiche del governo federale statunitense nell'edilizia residenziale. Suggerimenti per il modello italiano*, by Davide Michelis

12/06 *Il finanziamento delle imprese Spin-off: un confronto fra Italia e Regno Unito*, by Elisa Salvador

13/06 SERIE SPECIALE IN COLLABORAZIONE CON HERMES: *Regulatory and Environmental Effects on Public Transit Efficiency: a Mixed DEA-SFA Approach*, by Beniamina Buzzo Margari, Fabrizio Erbetta, Carmelo Petraglia, Massimiliano Piacenza

14/06 *La mission manageriale: risorsa delle aziende*, by Gian Franco Corio

15/06 *Peer review for the evaluation of the academic research: the Italian experience*, by Emanuela Reale, Anna Barbara, Antonio Costantini

2005

1/05 *Gli approcci biologici nell'economia dell'innovazione*, by Mario Coccia

2/05 *Sistema informativo sulle strutture operanti nel settore delle biotecnologie in Italia*, by Edoardo Lorenzetti, Francesco Lutman, Mauro Mallone

3/05 *Analysis of the Resource Concentration on Size and Research Performance. The Case of Italian National Research Council over the Period 2000-2004*, by Mario Coccia and Secondo Rolfo

4/05 *Le risorse pubbliche per la ricerca scientifica e lo sviluppo sperimentale nel 2002*, by Anna Maria Scarda

5/05 *La customer satisfaction dell'URP del Cnr. I casi Lazio, Piemonte e Sicilia*, by Gian Franco Corio

6/05 *La comunicazione integrata tra uffici per le relazioni con il pubblico della Pubblica Amministrazione*, by Gian Franco Corio

7/05 *Un'analisi teorica sul marketing territoriale. Presentazione di un caso studio. Il "consorzio per la tutela dell'Asti"*, by Maria Marenna

8/05 *Una proposta di marketing territoriale: una possibile griglia di analisi delle risorse*, by Gian Franco Corio

9/05 *Analisi e valutazione delle performance economico-tecnologiche di diversi paesi e situazione italiana*, by Mario Coccia and Mario Taretto

10/05 *The patenting regime in the Italian public research system: what motivates public inventors to patent*, by Bianca Potì and Emanuela Reale

11/05 *Changing patterns in the steering of the University in Italy: funding rules and doctoral programmes*, by Bianca Potì and Emanuela Reale

12/05 *Una "discussione in rete" con Stanley Wilder*, by Carla Basili

13/05 *New Tools for the Governance of the Academic Research in Italy: the Role of Research Evaluation*, by Bianca Potì and Emanuela Reale

14/05 *Product Differentiation, Industry Concentration and Market Share Turbulence*, by Catherine Matraves, Laura Rondi

15/05 *Riforme del Servizio Sanitario Nazionale e dinamica dell'efficienza ospedaliera in Piemonte*, by Chiara Canta, Massimiliano Piacenza, Gilberto Turati

16/05 SERIE SPECIALE IN COLLABORAZIONE CON HERMES: *Struttura di costo e rendimenti di scala nelle imprese di trasporto pubblico locale di medie-grandi dimensioni*, by Carlo Cambini, Ivana Paniccia, Massimiliano Piacenza, Davide Vannoni

17/05 *Ricerc@.it - Sistema informativo su istituzioni, enti e strutture di ricerca in Italia*, by Edoardo Lorenzetti, Alberto Paparello

2004

1/04 *Le origini dell'economia dell'innovazione: il contributo di Rae*, by Mario Coccia

2/04 *Liberalizzazione e integrazione verticale delle utility elettriche: evidenza empirica da un campione italiano di imprese pubbliche locali*, by Massimiliano Piacenza and Elena Beccio

3/04 *Uno studio sull'innovazione nell'industria chimica*, by Anna Ceci, Mario De Marchi, Maurizio Rocchi

4/04 *Labour market rigidity and firms' R&D strategies*, by Mario De Marchi and Maurizio Rocchi

5/04 *Analisi della tecnologia e approcci alla sua misurazione*, by Mario Coccia

6/04 *Analisi delle strutture pubbliche di ricerca scientifica: tassonomia e comportamento strategico*, by Mario Coccia

7/04 *Ricerca teorica vs. ricerca applicata. Un'analisi relativa al Cnr*, by Mario Coccia and Secondo Rolfo

8/04 *Considerazioni teoriche sulla diffusione delle innovazioni nei distretti industriali: il caso delle ICT*, by Arianna Miglietta

9/04 *Le politiche industriali regionali nel Regno Unito*, by Elisa Salvador

10/04 *Going public to grow? Evidence from a panel of Italian firms*, by Robert E. Carpenter and L. Rondi

11/04 *What Drives Market Prices in the Wine Industry? Estimation of a Hedonic Model for Italian Premium Wine*, by Luigi Benfratello, Massimiliano Piacenza and Stefano Sacchetto

12/04 *Brief notes on the policies for science-based firms*, by Mario De Marchi, Maurizio Rocchi
13/04 *Countrymetrics e valutazione della performance economica dei paesi: un approccio sistemico*, by Mario Coccia
14/04 *Analisi del rischio paese e sistemazione tassonomica*, by Mario Coccia
15/04 *Organizing the Offices for Technology Transfer*, by Chiara Franzoni
16/04 *Le relazioni tra ricerca pubblica e industria in Italia*, by Secondo Rolfo
17/04 *Modelli di analisi e previsione del rischio di insolvenza: una prospettiva delle metodologie applicate*, by Nadia D'Annunzio e Greta Falavigna
18/04 *SERIE SPECIALE: Lo stato di salute del sistema industriale piemontese: analisi economico-finanziaria delle imprese piemontesi*, Terzo Rapporto 1999-2002, by Giuseppe Calabrese, Fabrizio Erbetta, Federico Bruno Rolle
19/04 *SERIE SPECIALE: Osservatorio sulla dinamica economico-finanziaria delle imprese della filiera del tessile e dell'abbigliamento in Piemonte*, Primo rapporto 1999-2002, by Giuseppe Calabrese, Fabrizio Erbetta, Federico Bruno Rolle
20/04 *SERIE SPECIALE: Osservatorio sulla dinamica economico-finanziaria delle imprese della filiera dell'auto in Piemonte*, Secondo Rapporto 1999-2002, by Giuseppe Calabrese, Fabrizio Erbetta, Federico Bruno Rolle

2003

1/03 *Models for Measuring the Research Performance and Management of the Public Labs*, by Mario Coccia, March
2/03 *An Approach to the Measurement of Technological Change Based on the Intensity of Innovation*, by Mario Coccia, April
3/03 *Verso una patente europea dell'informazione: il progetto EnIL*, by Carla Basili, June
4/03 *Scala della magnitudo innovativa per misurare l'attrazione spaziale del trasferimento tecnologico*, by Mario Coccia, June
5/03 *Mappe cognitive per analizzare i processi di creazione e diffusione della conoscenza negli Istituti di ricerca*, by Emanuele Cadario, July
6/03 *Il servizio postale: caratteristiche di mercato e possibilità di liberalizzazione*, by Daniela Boetti, July
7/03 *Donne-scienza-tecnologia: analisi di un caso di studio*, by Anita Calcatelli, Mario Coccia, Katia Ferraris and Ivana Tagliafico, July
8/03 SERIE SPECIALE. OSSERVATORIO SULLE PICCOLE IMPRESE INNOVATIVE TRIESTE. *Imprese innovative in Friuli Venezia Giulia: un esperimento di analisi congiunta*, by Lucia Rotaris, July
9/03 *Regional Industrial Policies in Germany*, by Helmut Karl, Antje Möller and Rüdiger Wink, July
10/03 SERIE SPECIALE. OSSERVATORIO SULLE PICCOLE IMPRESE INNOVATIVE TRIESTE. *L'innovazione nelle new technology-based firms in Friuli-Venezia Giulia*, by Paola Guerra, October
11/03 SERIE SPECIALE. *Lo stato di salute del sistema industriale piemontese: analisi economico-finanziaria delle imprese piemontesi*, Secondo Rapporto 1998-2001, December
12/03 SERIE SPECIALE. *Osservatorio sulla dinamica economico-finanziaria delle imprese della meccanica specializzata in Piemonte*, Primo Rapporto 1998-2001, December
13/03 SERIE SPECIALE. *Osservatorio sulla dinamica economico-finanziaria delle imprese delle bevande in Piemonte*, Primo Rapporto 1998-2001, December

2002

1/02 *La valutazione dell'intensità del cambiamento tecnologico: la scala Mercalli per le innovazioni*, by Mario Coccia, January
2/02 SERIE SPECIALE IN COLLABORAZIONE CON HERMES. *Regulatory constraints and cost efficiency of the Italian public transit systems: an exploratory stochastic frontier model*, by Massimiliano Piacenza, March
3/02 *Aspetti gestionali e analisi dell'efficienza nel settore della distribuzione del gas*, by Giovanni Fraquelli and Fabrizio Erbetta, March
4/02 *Dinamica e comportamento spaziale del trasferimento tecnologico*, by Mario Coccia, April
5/02 *Dimensione organizzativa e performance della ricerca: l'analisi del Consiglio Nazionale delle Ricerche*, by Mario Coccia and Secondo Rolfo, April
6/02 *Analisi di un sistema innovativo regionale e implicazioni di policy nel processo di trasferimento tecnologico*, by Monica Cariola and Mario Coccia, April
7/02 *Analisi psico-economica di un'organizzazione scientifica e implicazioni di management: l'Istituto Elettrotecnico Nazionale "G. Ferraris"*, by Mario Coccia and Alessandra Monticone, April
8/02 *Firm Diversification in the European Union. New Insights on Return to Core Business and Relatedness*, by Laura Rondi and Davide Vannoni, May
9/02 *Le nuove tecnologie di informazione e comunicazione nelle PMI: un'analisi sulla diffusione dei siti internet nel distretto di Biella*, by Simona Salinari, June
10/02 *La valutazione della soddisfazione di operatori di aziende sanitarie*, by Gian Franco Corio, November
11/02 *Analisi del processo innovativo nelle PMI italiane*, by Giuseppe Calabrese, Mario Coccia and Secondo Rolfo, November

12/02 *Metrics della Performance dei laboratori pubblici di ricerca e comportamento strategico*, by Mario Coccia, September

13/02 *Technometrics basata sull'impatto economico del cambiamento tecnologico*, by Mario Coccia, November

2001

1/01 *Competitività e divari di efficienza nell'industria italiana*, by Giovanni Fraquelli, Piercarlo Frigero and Fulvio Sugliano, January

2/01 *Waste water purification in Italy: costs and structure of the technology*, by Giovanni Fraquelli and Roberto Giandrone, January

3/01 SERIE SPECIALE IN COLLABORAZIONE CON HERMES. *Il trasporto pubblico locale in Italia: variabili esplicative dei divari di costo tra le imprese*, by Giovanni Fraquelli, Massimiliano Piacenza and Graziano Abrate, February

4/01 *Relatedness, Coherence, and Coherence Dynamics: Empirical Evidence from Italian Manufacturing*, by Stefano Valvano and Davide Vannoni, February

5/01 *Il nuovo panel Ceris su dati di impresa 1977-1997*, by Luigi Benfratello, Diego Margon, Laura Rondi, Alessandro Sembenelli, Davide Vannoni, Silvana Zelli, Maria Zittino, October

6/01 *SMEs and innovation: the role of the industrial policy in Italy*, by Giuseppe Calabrese and Secondo Rolfo, May

7/01 *Le martingale: aspetti teorici ed applicativi*, by Fabrizio Erbetta and Luca Agnello, September

8/01 *Prime valutazioni qualitative sulle politiche per la R&S in alcune regioni italiane*, by Elisa Salvador, October

9/01 *Accords technology transfer-based: théorie et méthodologie d'analyse du processus, by Mario Coccia*, October

10/01 *Trasferimento tecnologico: indicatori spaziali*, by Mario Coccia, November

11/01 *Does the run-up of privatisation work as an effective incentive mechanism? Preliminary findings from a sample of Italian firms*, by Fabrizio Erbetta, October

12/01 SERIE SPECIALE IN COLLABORAZIONE CON HERMES. *Costs and Technology of Public Transit Systems in Italy: Some Insights to Face Inefficiency*, by Giovanni Fraquelli, Massimiliano Piacenza and Graziano Abrate, October

13/01 *Le NTBFs a Sophia Antipolis, analisi di un campione di imprese*, by Alessandra Ressico, December

2000

1/00 *Trasferimento tecnologico: analisi spaziale*, by Mario Coccia, March

2/00 *Poli produttivi e sviluppo locale: una indagine sulle tecnologie alimentari nel mezzogiorno*, by Francesco G. Leone, March

3/00 *La mission del top management di aziende sanitarie*, by Gian Franco Corio, March

4/00 *La percezione dei fattori di qualità in Istituti di ricerca: una prima elaborazione del caso Piemonte*, by Gian Franco Corio, March

5/00 *Una metodologia per misurare la performance endogena nelle strutture di R&S*, by Mario Coccia, April

6/00 *Soddisfazione, coinvolgimento lavorativo e performance della ricerca*, by Mario Coccia, May

7/00 *Foreign Direct Investment and Trade in the EU: Are They Complementary or Substitute in Business Cycles Fluctuations?*, by Giovanna Segre, April

8/00 *L'attesa della privatizzazione: una minaccia credibile per il manager?*, by Giovanni Fraquelli, May

9/00 *Gli effetti occupazionali dell'innovazione. Verifica su un campione di imprese manifatturiere italiane*, by Marina Di Giacomo, May

10/00 *Investment, Cash Flow and Managerial Discretion in State-owned Firms. Evidence Across Soft and Hard Budget Constraints*, by Elisabetta Bertero and Laura Rondi, June

11/00 *Effetti delle fusioni e acquisizioni: una rassegna critica dell'evidenza empirica*, by Luigi Benfratello, June

12/00 *Identità e immagine organizzativa negli Istituti CNR del Piemonte*, by Paolo Enria, August

13/00 *Multinational Firms in Italy: Trends in the Manufacturing Sector*, by Giovanna Segre, September

14/00 *Italian Corporate Governance, Investment, and Finance*, by Robert E. Carpenter and Laura Rondi, October

15/00 *Multinational Strategies and Outward-Processing Trade between Italy and the CEECs: The Case of Textile-Clothing*, by Giovanni Balcet and Giampaolo Vitali, December

16/00 *The Public Transit Systems in Italy: A Critical Analysis of the Regulatory Framework*, by Massimiliano Piacenza, December

1999

1/99 *La valutazione delle politiche locali per l'innovazione: il caso dei Centri Servizi in Italia*, by Monica Cariola and Secondo Rolfo, January

2/99 *Trasferimento tecnologico ed autofinanziamento: il caso degli Istituti Cnr in Piemonte*, by Mario Coccia, March

3/99 *Empirical studies of vertical integration: the transaction cost orthodoxy*, by Davide Vannoni, March

4/99 *Developing innovation in small-medium suppliers: evidence from the Italian car industry*, by Giuseppe Calabrese, April

5/99 *Privatization in Italy: an analysis of factors productivity and technical efficiency*, by Giovanni Fraquelli and Fabrizio Erbetta, March

6/99 *New Technology Based-Firms in Italia: analisi di un campione di imprese triestine,* by Anna Maria Gimigliano, April

7/99 *Trasferimento tacito della conoscenza: gli Istituti CNR dell'Area di Ricerca di Torino,* by Mario Coccia, May

8/99 *Struttura ed evoluzione di un distretto industriale piemontese: la produzione di casalinghi nel Cusio,* by Alessandra Ressico, June

9/99 *Analisi sistemica della performance nelle strutture di ricerca,* by Mario Coccia, September

10/99 *The entry mode choice of EU leading companies (1987-1997),* by Giampaolo Vitali, November

11/99 *Esperimenti di trasferimento tecnologico alle piccole e medie imprese nella Regione Piemonte,* by Mario Coccia, November

12/99 *A mathematical model for performance evaluation in the R&D laboratories: theory and application in Italy,* by Mario Coccia, November

13/99 *Trasferimento tecnologico: analisi dei fruitori,* by Mario Coccia, December

14/99 *Beyond profitability: effects of acquisitions on technical efficiency and productivity in the Italian pasta industry,* by Luigi Benfratello, December

15/99 *Determinanti ed effetti delle fusioni e acquisizioni: un'analisi sulla base delle notifiche alle autorità antitrust,* by Luigi Benfratello, December

1998

1/98 *Alcune riflessioni preliminari sul mercato degli strumenti multimediali*, by Paolo Vaglio, January

2/98 *Before and after privatization: a comparison between competitive firms,* by Giovanni Fraquelli and Paola Fabbri, January

3/98 **Not available**

4/98 *Le importazioni come incentivo alla concorrenza: l'evidenza empirica internazionale e il caso del mercato unico europeo,* by Anna Bottasso, May

5/98 *SEM and the changing structure of EU Manufacturing, 1987-1993,* by Stephen Davies, Laura Rondi and Alessandro Sembenelli, November

6/98 *The diversified firm: non formal theories versus formal models,* by Davide Vannoni, December

7/98 *Managerial discretion and investment decisions of state-owned firms: evidence from a panel of Italian companies,* by Elisabetta Bertero and Laura Rondi, December

8/98 *La valutazione della R&S in Italia: rassegna delle esperienze del C.N.R. e proposta di un approccio alternativo,* by Domiziano Boschi, December

9/98 *Multidimensional Performance in Telecommunications, Regulation and Competition: Analysing the European Major Players,* by Giovanni Fraquelli and Davide Vannoni, December

1997

1/97 *Multinationality, diversification and firm size. An empirical analysis of Europe's leading firms,* by Stephen Davies, Laura Rondi and Alessandro Sembenelli, January

2/97 *Qualità totale e organizzazione del lavoro nelle aziende sanitarie,* by Gian Franco Corio, January

3/97 *Reorganising the product and process development in Fiat Auto,* by Giuseppe Calabrese, February

4/97 *Buyer-supplier best practices in product development: evidence from car industry,* by Giuseppe Calabrese, April

5/97 *L'innovazione nei distretti industriali. Una rassegna ragionata della letteratura*, by Elena Ragazzi, April

6/97 *The impact of financing constraints on markups: theory and evidence from Italian firm level data,* by Anna Bottasso, Marzio Galeotti and Alessandro Sembenelli, April

7/97 *Capacità competitiva e evoluzione strutturale dei settori di specializzazione: il caso delle macchine per confezionamento e imballaggio*, by Secondo Rolfo, Paolo Vaglio, April

8/97 *Tecnologia e produttività delle aziende elettriche municipalizzate,* by Giovanni Fraquelli and Piercarlo Frigero, April

9/97 *La normativa nazionale e regionale per l'innovazione e la qualità nelle piccole e medie imprese: leggi, risorse, risultati e nuovi strumenti,* by Giuseppe Calabrese, June

10/97 *European integration and leading firms' entry and exit strategies,* by Steve Davies, Laura Rondi and Alessandro Sembenelli, April

11/97 *Does debt discipline state-owned firms? Evidence from a panel of Italian firms,* by Elisabetta Bertero and Laura Rondi, July

12/97 *Distretti industriali e innovazione: i limiti dei sistemi tecnologici locali,* by Secondo Rolfo and Giampaolo Vitali, July

13/97 *Costs, technology and ownership form of natural gas distribution in Italy,* by Giovanni Fraquelli and Roberto Giandrone, July

14/97 *Costs and structure of technology in the Italian water industry,* by Paola Fabbri and Giovanni Fraquelli, July

15/97 *Aspetti e misure della customer satisfaction/dissatisfaction,* by Maria Teresa Morana, July
16/97 *La qualità nei servizi pubblici: limiti della normativa UNI EN 29000 nel settore sanitario,* by Efisio Ibba, July
17/97 *Investimenti, fattori finanziari e ciclo economico,* by Laura Rondi and Alessandro Sembenelli, rivisto sett. 1998
18/97 *Strategie di crescita esterna delle imprese leader in Europa: risultati preliminari dell'utilizzo del data-base Ceris "100 top EU firms' acquisition/divestment database 1987-1993",* by Giampaolo Vitali and Marco Orecchia, December
19/97 *Struttura e attività dei Centri Servizi all'innovazione: vantaggi e limiti dell'esperienza italiana,* by Monica Cariola, December
20/97 *Il comportamento ciclico dei margini di profitto in presenza di mercati del capitale meno che perfetti: un'analisi empirica su dati di impresa in Italia,* by Anna Bottasso, December

1996
1/96 *Aspetti e misure della produttività. Un'analisi statistica su tre aziende elettriche europee,* by Donatella Cangialosi, February
2/96 *L'analisi e la valutazione della soddisfazione degli utenti interni: un'applicazione nell'ambito dei servizi sanitari,* by Maria Teresa Morana, February
3/96 *La funzione di costo nel servizio idrico. Un contributo al dibattito sul metodo normalizzato per la determinazione della tariffa del servizio idrico integrato,* by Giovanni Fraquelli and Paola Fabbri, February
4/96 *Coerenza d'impresa e diversificazione settoriale: un'applicazione alle società leaders nell'industria manifatturiera europea,* by Marco Orecchia, February
5/96 *Privatizzazioni: meccanismi di collocamento e assetti proprietari. Il caso STET,* by Paola Fabbri, February
6/96 *I nuovi scenari competitivi nell'industria delle telecomunicazioni: le principali esperienze internazionali,* by Paola Fabbri, February
7/96 *Accordi, joint-venture e investimenti diretti dell'industria italiana nella CSI: Un'analisi qualitativa,* by Chiara Monti and Giampaolo Vitali, February
8/96 *Verso la riconversione di settori utilizzatori di amianto. Risultati di un'indagine sul campo,* by Marisa Gerbi Sethi, Salvatore Marino and Maria Zittino, February
9/96 *Innovazione tecnologica e competitività internazionale: quale futuro per i distretti e le economie locali,* by Secondo Rolfo, March
10/96 *Dati disaggregati e analisi della struttura industriale: la matrice europea delle quote di mercato,* by Laura Rondi, March
11/96 *Le decisioni di entrata e di uscita: evidenze empiriche sui maggiori gruppi italiani,* by Alessandro Sembenelli and Davide Vannoni, April
12/96 *Le direttrici della diversificazione nella grande industria italiana,* by Davide Vannoni, April
13/96 *R&S cooperativa e non-cooperativa in un duopolio misto con spillovers,* by Marco Orecchia, May
14/96 *Unità di studio sulle strategie di crescita esterna delle imprese italiane,* by Giampaolo Vitali and Maria Zittino, July. **Not available**
15/96 *Uno strumento di politica per l'innovazione: la prospezione tecnologica,* by Secondo Rolfo, September
16/96 *L'introduzione della Qualità Totale in aziende ospedaliere: aspettative ed opinioni del middle management,* by Gian Franco Corio, September
17/96 *Shareholders' voting power and block transaction premia: an empirical analysis of Italian listed companies,* by Giovanna Nicodano and Alessandro Sembenelli, November
18/96 *La valutazione dell'impatto delle politiche tecnologiche: un'analisi classificatoria e una rassegna di alcune esperienze europee,* by Domiziano Boschi, November
19/96 *L'industria orafa italiana: lo sviluppo del settore punta sulle esportazioni,* by Anna Maria Gaibisso and Elena Ragazzi, November
20/96 *La centralità dell'innovazione nell'intervento pubblico nazionale e regionale in Germania,* by Secondo Rolfo, December
21/96 *Ricerca, innovazione e mercato: la nuova politica del Regno Unito,* by Secondo Rolfo, December
22/96 *Politiche per l'innovazione in Francia,* by Elena Ragazzi, December
23/96 *La relazione tra struttura finanziaria e decisioni reali delle imprese: una rassegna critica dell'evidenza empirica,* by Anna Bottasso, December

1995
1/95 *Form of ownership and financial constraints: panel data evidence on leverage and investment choices by Italian firms,* by Fabio Schiantarelli and Alessandro Sembenelli, March
2/95 *Regulation of the electric supply industry in Italy,* by Giovanni Fraquelli and Elena Ragazzi, March
3/95 *Restructuring product development and production networks: Fiat Auto,* by Giuseppe Calabrese, September
4/95 *Explaining corporate structure: the MD matrix, product differentiation and size of market,* by Stephen Davies, Laura Rondi and Alessandro Sembenelli, November

5/95 *Regulation and total productivity performance in electricity: a comparison between Italy, Germany and France,* by Giovanni Fraquelli and Davide Vannoni, December
6/95 *Strategie di crescita esterna nel sistema bancario italiano: un'analisi empirica 1987-1994,* by Stefano Olivero and Giampaolo Vitali, December
7/95 *Panel Ceris su dati di impresa: aspetti metodologici e istruzioni per l'uso,* by Diego Margon, Alessandro Sembenelli and Davide Vannoni, December

1994
1/94 *Una politica industriale per gli investimenti esteri in Italia: alcune riflessioni,* by Giampaolo Vitali, May
2/94 *Scelte cooperative in attività di ricerca e sviluppo,* by Marco Orecchia, May
3/94 *Perché le matrici intersettoriali per misurare l'integrazione verticale?,* by Davide Vannoni, July
4/94 *Fiat Auto: A simultaneous engineering experience,* by Giuseppe Calabrese, August

1993
1/93 *Spanish machine tool industry,* by Giuseppe Calabrese, November
2/93 *The machine tool industry in Japan,* by Giampaolo Vitali, November
3/93 *The UK machine tool industry,* by Alessandro Sembenelli and Paul Simpson, November
4/93 *The Italian machine tool industry,* by Secondo Rolfo, November
5/93 *Firms' financial and real responses to business cycle shocks and monetary tightening: evidence for large and small Italian companies,* by Laura Rondi, Brian Sack, Fabio Schiantarelli and Alessandro Sembenelli, December

Free copies are distributed on request to Universities, Research Institutes, researchers, students, etc.
Please, write to:
MARIA ZITTINO, Working Papers Coordinator
CERIS-CNR, Via Real Collegio, 30; 10024 Moncalieri (Torino), Italy
Tel. +39 011 6824.914; Fax +39 011 6824.966; m.zittino@ceris.cnr.it; http://www.ceris.cnr.it