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Regional Innovation Policy and Innovative Behaviour: Looking for Additional Effects

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Abstract *This paper aims to evaluate the additionality of innovation policy in terms of innovative behaviours at the regional level. Innovative behaviours are identified both within and across firm and regional boundaries. The role of policy is evaluated for a sample of firms in the Italian region of Emilia–Romagna (ER), exploiting an original, survey-based data set. Propensity score matching is applied to investigate the effects of an innovation subsidy. Funded firms are found to be more likely to upgrade their competencies, compared with similar non-subsidized firms. On the other hand, in most cases, innovation cooperation with other business partners within or outside the region is not significantly affected by policy. Ultimately, the investigated innovation policy in the ER region seems to show what might be termed "cognitive capacity additionality", rather than "network additionality".*

Introduction

Innovation is a complex process that involves different sets of actors and interactions, within and across different industries and territories. In summary, innovation has a "system" nature (Edquist, 2005). At the local level, this has inspired the notion of regional innovation system (RIS) (Cooke *et al.*, 1997), whose policy implications have been extremely helpful to spur regional growth and competitiveness (Asheim, 2009; Howells, 1999).

From a system perspective, policy interventions directed at innovation need to go beyond the solution to standard market failures. Such failures are due mainly to the public good nature of innovative knowledge and to its imperfect appropriability

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(Arrow, 1962; Nelson, 1959). Research and development (R&D) subsidies are one of the policy instruments to deal with market failures. System failures instead involve missing components in the system—for example, lack of skilled workforce at company level—weak linkages, for example, between science and technology, and poorly defined system boundaries leading to redundancy in regional and national innovative efforts (Metcalfe, 1995). In order to deal with these problems, other policy actions are required (Edquist, 2011). Infrastructure and competition policies, for example, can encourage innovation. However, standard innovation policies—such as R&D subsidies and tax grants—can be used to address system failures and enhance firms' innovation capabilities, competencies and interactions with external actors (Antonioli & Marzucchi, 2012).

These arguments also hold at the regional level, where innovation system failures can be exacerbated by the predominance of small and medium enterprises (SMEs), characterized by traditional specialization patterns, informal cooperation relationships and inward-looking (i.e. mainly local) strategies related to interactions with scientific organizations (Uyarra, 2010).

Form the system perspective, the target of regional innovation policies is not simply to increase the amount of resources that local firms invest in innovation and/or their innovative outputs. R&D grants and tax incentives are also aimed at enhancing innovation opportunities, capabilities and interactions (Metcalfe, 1995, p. 56) or "innovative behaviours". Evaluation of regional innovation policy needs to consider an important dimension, which has been termed "behavioural additionality" (OECD, 2006).

However, such evaluations are rare in science and technology policy studies, because of the problems involved. In assessments of innovative behaviours, it is difficult to identify policy outcomes because they evolve over time (see examples with respect to R&D cooperation given by Lhuillery & Pfister, 2009). On the other hand, what innovation policy "adds" to strategically driven innovative behaviours is difficult to establish. Non-standard econometric techniques are required, such as those used to assess policy to boost firms' innovative inputs (e.g. R&D expenditure) and outputs (e.g. patents) (on the idea of input and output additionality, see Buisseret *et al.*, 1995; Davenport *et al.*, 1998).

As a contribution in order to fill in this gap, we investigate the extent to which regional subsidies for firms' R&D activities promote innovative behaviours, within and outside the firms and the regional boundaries. The underlying rationale is that, by qualifying for and receiving a financial contribution to their internal R&D efforts, the targeted firms are expected not only to increase their innovative inputs and outputs, but also to change the way they engage in the innovation process at the regional level. In particular, a subsidy can be expected to make it possible for firms to implement actions to increase internal human capital and organizational competencies through training programmes and to reduce the costs of acquiring external knowledge through regional and extra-regional business cooperation agreements.

The policy evaluation in this paper refers to the Emilia–Romagna (ER) region, in Italy.[1] We exploit an original, firm-level data set, containing information on pre-policy characteristics and post-policy behaviours and performance and employ propensity score matching (PSM) techniques. The remainder of the paper is organized as follows. The second section briefly discusses the behavioural implications of innovation policy for the regional level. The third section presents the empirical application, and the next section discusses the main results. The final section concludes the paper.

The Behavioural Impact of Regional Innovation Policy

The role of policy in affecting firms' innovative behaviours is particularly important at the regional level. This emerges clearly from regional scoreboard analyses, such as the European Regional Scoreboard (Hollanders *et al.*, 2009). Some regions are lagging in relation to innovative output (e.g. number of regional innovators), innovative inputs/enablers (e.g. the level of regional tertiary education) and especially in the types of innovative activities of firms, such as organizational practices and cooperation with other businesses and research organizations.

In order to "correct" these innovative behaviours, innovation policies act at two levels (Asheim *et al.*, 2007). First, they provide support to regional firms to become more internally "receptive". In other words, regional policy can help local firms to develop the competencies necessary to master technology in house, to satisfy market needs and to integrate it within their broader corporate strategies (Morgan, 1997; Rutten & Boekema, 2007). Education and training are an important policy in this respect, especially within the EU (Markusen, 2008; Mathur, 1999).

Second, regional firms can be supported to be more externally "receptive" through the development of the capabilities to absorb external knowledge and integrate it with existing internal knowledge (Uyarra, 2010). Regional policy schemes that focus on innovation cooperation are important (Hassink, 2002, 2005) for supporting firms' interactions with business partners (Fischer & Varga, 2002) and research organizations (Fritsch & Schwirten, 1999).

These innovative behaviours in regional firms can also be induced by financial support for R&D. This is the idea behind "behavioural additionality" in relation to innovation policy.[2] It implies that such policy schemes can induce "change in a company's way of undertaking R&D" (Buisseret *et al.*, 1995, p. 590) and contribute to the range of firm behaviours.[3]

In conducting publicly funded R&D, regional firms are able and/or required to undertake investments to upgrade or to acquire new competencies, capabilities and organizational routines to promote innovation (Magro *et al.*, 2010; Marino & Parrotta, 2010). Thus, R&D policy can contribute to the costs of regional firms for investing in intangible assets represented by their workforce and by their organizational capital (Florida *et al.*, 2008). It is important to evaluate this behavioural additionality in order to assess the capacity of the policy-makers to close eventual gaps in the construction of the regional knowledge base (Asheim & Coenen, 2005).

In relation to external receptivity, R&D subsidies can stimulate innovation cooperation with the business partners, within and outside the region (Afcha Chávez, 2011; Hall & Maffioli, 2008). Policy can help local firms to support the explicit (e.g. contractual) and implicit (i.e. opportunity) costs of undertaking collaborative innovation activities "within" the region (Asheim & Isaksen, 2002; Busom & Fernandez-Ribas, 2008; Fier *et al.*, 2006). It can also stimulate regional firms to collaborate with firms outside the region by subsidizing the costs involved on distant cooperation. These costs are related to territorial, socio-cultural and techno-economic distance, which can be a barrier to cooperation even in the same national boundaries (Boschma, 2005). Given the role that innovation cooperation has in inserting local firms into global value chains (Humphrey & Schmitz, 2002), evaluating behavioural additionality appears particularly important for the formulation of policies that can

release regional economies from path dependence and transform the RIS into an open RIS (Belussi *et al.*, 2010).

Behavioural Additionality of the ER (Italy) PRRIITT

As an empirical application of the arguments developed in the second section, we evaluate the behavioural additionality of an innovation-policy scheme—PRRIITT, Programma Regionale per la Ricerca Industriale, l'Innovazione e il Trasferimento Tecnologico (Regional Programme for Industrial Research, Innovation and Technology Transfer)—which is the core policy in one of the most innovative regions in Europe, ER in Italy.

The ER region has quite idiosyncratic techno-economic features,[4] which render it a model of local development that has come to be known as the "Emilian model" (Brusco, 1982), and is used by other European and non-European countries as a benchmark (Humphrey, 1995; Molina-Morales, 2001). While Italy is only a moderately innovative country, ER is along with Lombardy (regional capital Milan) the only region that demonstrates the features of medium–high innovation, at the EU27 level.[5]

According to recent empirical evidence, the ER innovation system has some conflicting characteristics. On the one hand, in spite of their typical small–medium-sized and non-high-tech specialization, firms in ER perform relatively well in terms of innovative activities in Europe. On the other hand, the region lacks some strong innovative enablers (e.g. population with tertiary education, participation in life-long learning, public R&D expenditure and broadband access) (Hollanders *et al.*, 2009). ER firms are also characterized by strong networks, both within and outside the region, especially in knowledge-intensive sectors (Belussi *et al.*, 2010). However, the links to business and to science are mainly occasional and rarely develop into long-term, explicit contracts and project agreements. The RIS is described as an "informal learning system" compared with other Italian regions (Evangelista *et al.*, 2002).

Innovation policy is a key driver of development in the ER region and an important element of its innovation system. Policy-makers have promoted innovation and competitiveness through a long tradition of science and technology and industrial policies (Bianchi & Giordani, 1993). Among these actions, the PRRIITT, launched for the first time in 2003, is a pivotal instrument of innovation policy in the region. Indeed, it has been conceived in order to exploit strengths given by regional firms' dynamics and to mitigate weaknesses of the institutional set-up in which they are embedded.[6]

Within the PRRIITT, particularly important is Measure 3.1.A, which supports industrial research and precompetitive development through more dedicated objectives than a general R&D subsidy. The subsidy was conceived to spur, among others, reinforcement of collaboration among components of the RIS.

In the first two calls of Measure 3.1.A (in February and September 2004), on which this application focuses, regional funds were allocated by assessing, through an independent committee of experts, the innovation projects submitted by the firms along four dimensions (each of them with a maximum potential score): technical–scientific (45 points); economic–financial (20 points); managerial (20 points) and regional impact (15 points). The threshold to get funded was then fixed to 75 points.

Eligible firms were subsidized by grants covering up to 50% of total cost of industrial research activities and up to 25% (35% for SMEs) of total cost of precompetitive development activities. The overall number of projects subsidized through the two calls was

529, for a total of 557 recipient firms. Total cost of projects proposed by the beneficiaries was about 236 million Euros. The public funding was about 96 million Euros, covering around 40% of the total cost of the projects, with an average regional contribution of 175,000 Euros per project.

The Data Set

The data set of the application has been obtained through a recent *ad hoc* survey conducted by a research group of the University of Ferrara (Italy) (Antonioli *et al.*, 2011). This survey includes detailed information on the structural–organizational characteristics and the innovation strategies of a random sample of PRRIITT recipient firms. The sample consists of 555 manufacturing firms, with at least 20 employees, located in the ER region. It is stratified by size, province (geographical location at NUTS 3 level) and sector. The information collected mainly refers to the period 2006–2008.

In order to have relevant information (e.g. intramural R&D and advertising) for the pre-policy period (year 2003), this data source has been integrated with balance-sheet data extracted from the AIDA-BureauVanDijk database. The merging of the two data sets resulted in a working sample of 408 firms: 99 subsidized and 309 non-subsidized[7] with the PRRIITT Measure 3.1.A.

Table A1 shows that the sample of treated firms (99 firms) has a distribution by size (SME and large firms) and sector (Pavitt/OECD taxonomy) similar to that of all the manufacturing firms (with more than 20 employees) that received the regional R&D subsidy. Ultimately, the sample is representative and, thus, reliable in the econometric test that we perform.

Innovative Behaviours and Controls

Using the available data set, we built two groups of variables, which account for the impact of the Measure 3.1.A of the PRRIITT on the internal and external receptivity of the funded firms.

As far as the former group is concerned, we obtained three dummies about firms' behaviour in acquiring and upgrading their skills and organizational competencies. COMPUP indicates whether the workers' competencies have been widened as a result of the firm's organizational practices. TRAIN captures whether undifferentiated training programmes have been implemented. TECHTRAIN indicates whether the firm has organized training programmes to improve specific technical/specialized competencies.

TRAIN and TECHTRAIN refer to an explicit use of the R&D subsidy in pursuing an investment in human capital. On the other hand, COMPUP considers the possibility that the policy indirectly improves the firm's competencies through deliberated (e.g. vertical/horizontal "job-loading" of new tasks and dedicated forms of "job-enrichment" and "job-design", see Erez, 2010) and non-deliberated (e.g. learning-by-doing and learning-by-interacting) organizational practices.

As far as the external-receptivity effect of the policy is concerned, we distinguished whether the funded firms did engage in innovation cooperation with different kinds of business partners—namely suppliers (COOPSUP), customers (COOPCUS) and competitors (COOPCOM)—and with other firms under their same common ownership (i.e. of the

same business group, COOPGP), both within and outside the region (subscripts _REG and _EXTRA, respectively). Ultimately, these are eight more dummies.

Given the role that the identity of the partners has in the success (failure) of R&D cooperation (Lhuillery & Pfister, 2009; Mora-Valentin *et al.*, 2004), it is important to consider this distinction in evaluating the effect of the investigated policy. Equally important is the distinction between intra-regional interactions, through which local firms exploit the regional knowledge base, and extra-regional interactions, through which they upgrade it and try to overcome local path dependence from it (Ter Wal & Boschma, 2011). Table A2 presents the main descriptive statistics of these variables.

In order to avoid a selection bias in the econometric estimates, the above-defined variables will be used to compare funded firms with non-funded ones that have the same (or significantly similar) "propensity" of being supported by the policy. In order to do so, proper controls need to be identified, which have affected the participation of the sampled firms in the R&D subsidy scheme.

In order to serve an econometric strategy, all of these variables, except for the time invariants, are considered at a time (2003) before the policy (administrated in 2004), thus attenuating endogeneity problems in the estimates. Furthermore, many of these covariates (i.e. those created upon balance-sheet data) are of a continuous nature, thus, enhancing the quality of the estimates.[8]

First, the innovative profile of the firms is proxied by their expenditures (*per capita*) in intramural R&D and advertising, $RDADV_{2003}$.[9] The innovation history of the firms is expected to spur their decision to apply for public subsidies, in order to make further steps along previous innovation paths.

Second, the financial condition of the firms is proxied by their cash-flow per capita ($CASHFLOW_{2003}$) and short-term debt index ($FINCONST_{2003}$). While the former accounts for the availability of financial resources for the firms to invest in innovation—without resorting to external sources—the latter signals the presence of eventual financial constraints.[10]

Two further sets of dummies are introduced to control for the sectoral classification (á la Pavitt, PAVITT1–PAVITT5) and the size of the firms (in terms of employment, $lnEMP_{2003}$). Size and sector belonging are two important determinants of the firms' innovation activities (Cohen, 2010; Malerba, 2002) and are, thus, also likely to influence the probability for them to participate in an R&D policy scheme. Finally, the intra-RIS heterogeneity of the innovation process (Todtling & Trippl, 2005) and the different ability/willingness of firms of different provinces to access public funding are captured with a set of dummies capturing the firms' locations, in terms of NUTS-3-level provinces.[11]

Table A3 presents the main descriptive statistics of these covariates.

Propensity Score Matching

The econometric literature on the impact of an R&D policy support has been recently growing (Aerts & Schmidt, 2008; Busom & Fernandez-Ribas, 2008; Czarnitzki & Licht, 2006; Fier *et al.*, 2006). One of its main points is that the policy is, in general, non-exogeneous.[12] Given the problems this entails in using an ordinary least-squares model, a viable alternative estimates the average treatment effect on the treated (ATT) of the policy with a PSM technique (Rosenbaum & Rubin, 1983).

Denoting the policy outcome in the presence and absence of the policy treatment with Y_1 and Y_0, respectively, and with D the treatment status ($D = 1$: treated; $D = 0$: untreated), the ATT can be defined as

$$\text{ATT} = E(Y_1 - Y_0|D = 1) = E(Y_1|D = 1) - E(Y_0|D = 1). \quad (1)$$

In Equation (1), $E(Y_1|D = 1)$ can be estimated with a simple mean of the outcome (Y) in the group of funded firms, but $E(Y_0|D = 1)$ is by definition non-observable. In order to overcome this problem, $E(Y_0|D = 1)$ needs to be substituted by referring to a suitable "counterfactual" of non-treated firms. More precisely, in order to control for selection bias on observables, the difference in outcome of the two groups needs to be exclusively due to the policy intervention. One way to achieve this is by choosing non-treated firms in such a way that they match treated firms in terms of their propensity score, $\Pr(D = 1|X)$ (or $P(X)$). In other words, non-treated firms are to have the same probability of being funded than treated ones, given the set of pre-treatment characteristics, X, which are supposed to affect both the treatment and the outcome. The PSM estimate of the ATT is given by

$$\text{ATT}_{\text{PSM}} = E_{P(X)|D=1}\{E[Y_1|D = 1, P(X)] - E[Y_0|D = 0, P(X)]\}, \quad (2)$$

where $P(X)$ is estimated with a standard probit model.

Equation (2) is estimated using different matching procedures,[13] which differ in the way non-treated firms are selected and weighted and in their capacity to trade bias reduction with efficiency in the estimates (Caliendo & Kopeinig, 2008; Smith & Todd, 2005). A comparison of the results obtained with different algorithms provides information on stability and, indirectly, on reliability of the evidence. For all of the implemented matching procedures, the so-called common support condition $P(D = 1|X < 1)$ is imposed.[14] Furthermore, the quality of the matching is checked by controlling that beneficiaries and controls are correctly aligned with respect to the vector of covariates X.[15]

Results

As an introduction to our PSM analysis, let us consider the reliability of the policy propensity predictors we have identified (Table 1).[16]

First of all, the size of firms does not emerge as a significant determinant of their participation in the policy, supporting evidence about the similar sizes of funded and non-funded firms (see also Table A3). Given that SMEs are the main target of the policy intervention (see Table A1), this result suggests that the design of the R&D subsidy has allowed SMEs to participate in the policy, somehow, proportionately to their weight in the regional economic structure.

As expected, the role of the variety of the region in terms of local production systems is confirmed by the significance of a consistent number of geographical dummies at the provincial level (among the GEO1–GEO10).

The technological intensity of the firms results to be important for their likelihood of being funded. The probability of receiving the investigated subsidy increases significantly with the intensity of R&D (and advertising) expenditures of the firms (RDADV_{2003}). Previous experience of innovative investments, and the effect that it has on their absorptive

Table 1. Probit estimation of the propensity score

Covariates	Coefficient	SE
$\ln EMP_{2003}$	0.119	0.083
GEO1	3.420***	1.146
GEO2	1.755*	1.053
GEO3	0.789	1.155
GEO5	1.839*	1.057
GEO6	2.639**	1.096
GEO7	1.531	1.077
GEO8	2.184**	1.083
GEO9	1.849*	1.064
GEO10	1.187	1.122
PAVITT1	0.148	0.29
PAVITT3	1.361***	0.326
PAVITT4	0.575**	0.279
PAVITT5	0.726***	0.255
$FINCONST_{2003}$	−0.881*	0.525
$CASHFLOW_{2003}$	−0.005	0.005
$RDADV_{2003}$	0.162***	0.043
Cons	−2.671**	1.219

Notes: $N = 408$, Pseudo $R^2 = 0.217$, Prob $\geq \chi^2$ 0.000. Variance inflation factor (VIF) test excludes multicollinearity (all VIF values are less than 10).
*10% significance.
**5% significance.
***1% significance.

capacity (Franco *et al.*, 2011), provides the firms of the region with an advantage also in terms of funding. Those firms which have a significant history of engagement in R&D are more willing and able to apply (successfully) for the subsidy.[17] Furthermore, previous experiences in formal innovation activities seem to increase firms' capacity to identify and exploit innovation opportunities lying outside their boundaries (i.e. in this case, the presence of an R&D subsidy).

Also, the sector in which the firms operate is an important determinant for participation in the subsidy scheme. As expected, firms operating in more dynamic and technology-intensive sectors are more likely to be subsidized. In addition to scale-intensive firms (PAVITT4), science-based companies (PAVITT3) and firms operating in the propulsive district core of the region, characterized by specialized supplier sectors (PAVITT5), outperform other industries, in terms of chance of getting funded.

Table 1 also points to the role played by the firms' financial conditions in determining the probability of being subsidized. Although we find no significant effect of the availability of liquid financial resources ($CASHFLOW_{2003}$), the coefficient of the variable capturing the firms' financial constraint ($FINCONST_{2003}$) is significant and negative. In other words, the policy does not seem to be searched by firms for compensating their financial shortage in front of innovation, but rather to complement their financial endowments for it.

Ultimately, the regional policy in this RIS seems to follow a "picking-the-winner" strategy (Cerulli, 2010). This is an important result, which makes the use of a PSM methodology necessary.

Coming to the behavioural additionality of the investigated scheme, a first interesting result refers to the effects that it exerts within the boundaries of the firm, in terms of workers' competencies (Table 2). Compared with similar non-subsidized firms, funded firms are more likely (from +16.6% to +20.0%, depending on the matching procedure) to report organizational changes which led to an upgrading/extension of their workers' competencies (COMPUP).Hence, carrying out funded R&D activities generates a relevant learning process throughout the organization, a result which is consistent with the findings of the work carried out by Autio *et al.* (2008). On the other hand, this learning process does not pass through complementary training schemes. Taking into account both general training programmes (TRAIN) and programmes targeted at technical competencies (TECHTRAIN), the effect of the policy is found to be, generally, not significant. A possible interpretation of this result is that the R&D subsidy enables targeted firms to introduce organizational practices (both within and outside the R&D department), which increase the spectrum of workers' competencies, their learning capacity and their innovation potential.

Unlike innovative behaviours within corporate boundaries, those which are carried out across them, through innovation cooperation with other business players, do not, generally, appear to be significantly affected by the investigated policy scheme (Table 2). Innovative interactions with regional clients, suppliers and firms in the same group (COOPCUS_REG, COOPSUP_REG and COOPGP_REG, respectively) are, in general, not significantly influenced by the policy scheme. Nor does the policy induce additional interactions with business partners across the region (COOPCUS_EXTRA, COOPSUP_EXTRA and COOPCOM_EXTRA), apart from one case (COOPGP_EXTRA).

Given the problems of the region in terms of "innovative enablers" (Hollanders *et al.*, 2009), these results could be thought as a sign of inefficiency of the investigated policy. However, in their interpretation, one cannot exclude that the firms of this RIS could be less affected by interactive problems than what the literature has suggested and, thus, make an alternative use of the scheme. In particular, the informal character that these relationships have in ER (Evangelista *et al.*, 2002), within the notable social milieu of the region (Brusco, 1982), can help to attenuate rivalry problems and cognitive mismatches which often hamper their innovative outcomes (Lhuillery & Pfister, 2009).

The R&D subsidy is able to add innovation cooperation in some special circumstances (Table 2). This is the case, for example, of the policy impact on extra-regional cooperation, which appears significant when the interaction occurs with firms belonging to the same group as the treated firms (COOPGP_EXTRA, from +9.6% to +10.3%). As a tentative explanation for this result, a certain degree of organizational proximity—such as the one guaranteed by information filters and communication channels shared within the group—appears necessary for the policy to spur regional firms to interact across the border, that is, in the absence of geographical proximity.

In the case of other interactions, the R&D subsidy seems to have even a "crowding-out effect" on (i.e. to undermine) innovation cooperation within the region. This is the case of the interaction with the firms' competitors (COOPCOM_REG), which the subsidy significantly reduces (from −7.4% to −10.9%). With respect to this result, two related explanations could be advanced. The possible effect of the subsidy on the trade-off between knowledge protection and knowledge sharing (Olander *et al.*, 2009) should be considered. More specifically, it could be argued that when, due to the subsidy, firms invest in innovation activities, they increase the risk of knowledge leakages with respect to their

Table 2. Behavioural additionality of the regional R&D subsidy

	5NN		Caliper		Kernel		5NN Trim	
	ATT	SE	ATT	SE	ATT	SE	ATT	SE
Acquisition and upgrading of competencies								
COMPUP	0.198***	0.072	0.166**	0.073	0.181***	0.067	0.200***	0.076
TRAIN	0.026	0.055	0.026	0.061	0.052	0.047	0.025	0.059
TECHTRAIN	0.085	0.071	0.072	0.076	0.103*	0.062	0.082	0.081
Innovation cooperation with business partners								
Intra-RIS								
COOPCUS_REG	−0.096	0.067	−0.056	0.067	−0.054	0.059	−0.105	0.071
COOPSUP_REG	−0.109	0.072	−0.089	0.07	−0.058	0.058	−0.112*	0.063
COOPCOM_REG	−0.109**	0.048	−0.089*	0.048	−0.074*	0.045	−0.101*	0.057
COOPGP_REG	0.000	0.056	0.022	0.052	0.037	0.048	−0.006	0.055
Extra-RIS								
COOPCUS_EXTRA	−0.028	0.077	−0.069	0.077	−0.067	0.071	−0.04	0.081
COOPSUP_EXTRA	0.072	0.088	0.073	0.083	0.092	0.071	0.069	0.082
COOPCOM_EXTRA	0.043	0.05	0.043	0.043	0.041	0.043	0.063	0.047
COOPGP_EXTRA	0.096*	0.056	0.098*	0.057	0.099**	0.048	0.103*	0.054
N treated on support	92		92		92		95	
N treated total	99		99		99		99	
N non-treated	309		309		309		309	

Notes: Standard error (SE) is estimated with a 200-replication bootstrap procedure. Methods: five nearest neighbours (5NN), five nearest neighbours with a 0.05 caliper (Caliper), Epanechnikov kernel matching (Kernel) and five nearest neighbours with 1% trim (5NN Trim).

*10% significance.

**5% significance.

***1% significance.

competitors. In order to control this effect, they could adopt a strategy of knowledge protection, which results in a decreased propensity to cooperate. This interpretation seems to be consistent with the fact that SMEs also (the main beneficiaries of the investigated policy), and not only large firms, generally, find secrecy of greater value than patenting in securing the appropriability of their innovative results (Arundel, 2001).

Also, it cannot be excluded that engagement in publicly funded R&D activities could trigger the so-called non-invented-here syndrome by recipient firms (Katz & Allen, 1982), whose organizational team might feel this way with respect to "similar" organizational teams of their competitors (Wastyn & Hussinger, 2011).

Ultimately, the investigated innovation policy in the ER region seems to show what, within the realm of behavioural additionality, has been called "cognitive capacity" (Bach & Matt, 2002; Falk, 2007) or "competence additionality" (IDEA, 2006). In brief, the positive impact that the policy has on the different kinds of individual abilities and organizational capabilities which are required in managing the innovation process (IDEA, 2006, p. 62). On the other hand, the ER region seems to benefit less from "network additionality", as indicated by the impact that public support has on the collaborative behaviour of the firms, in terms of extension and/or continuation of innovation cooperation (IDEA, 2006, p. 58). More precisely, network additionality appears to be a conditional one, dependent on the nature of the business partners. In this respect, while the policy appears to help firms in strengthening their innovative activities by enabling their internal learning effect, it seems to require a further tailoring effort to allow firms to benefit from innovation cooperation.

Concerning the robustness of our empirical findings, two points should be stressed here. First, our results are largely consistent across the matching procedures implemented. The differences that these procedures entail in the selection of non-funded firms to be used as matches, in the weighting of the latter and in the capacity to trade bias reduction with efficiency in the estimates (on these, see Caliendo & Kopeinig, 2008; Smith & Todd, 2005), do not affect the stability of the emerging evidence. Second, our results can also be deemed robust to the potentially concurring effects of other policy interventions. In this respect, one might argue that the (positive) impacts emerging from our estimates (e.g. the impact on the upgrading of competencies) can also have been induced by other policy support schemes, which might have benefited funded firms in our sample. Although in the absence of proper data we cannot control econometrically for this potential bias, some qualitative evidence suggests that this distortion is not a major concern. In particular, in the course of an informal interview, the representatives of the regional policy-makers confirmed that the very large majority of SMEs (the main target of the regional subsidy, see Table A1) funded by the ER subsidy did not apply for other R&D funding schemes.[18]

Conclusions

The hypothesis according to which innovation policy can have a role in stimulating the innovative behaviours of regional firms is not rejected by our empirical application. Innovation policy does have a role in addressing failures that, at the regional level, emerge for more systemic reasons than due to market incapacity to deal efficiently with the properties of innovative knowledge.

In the context of the ER region, in Italy, policy-makers have been able to use a qualified R&D subsidy (within a broader policy action called PRRIITT) to induce some additional behaviours in terms of acquisition/extension of competencies and of innovation cooperation. More precisely, they have been able to do this by tracking those firms which already had an involvement in R&D activities, had benefited from sound financial conditions and were engaged in dynamic and technology-intensive sectors. Indeed, these are the firms that had higher probability of being treated by regional policy-makers, which have in this way shown to follow a "picking-the-winner" strategy, according to which the adage of success breeds success in innovation is pertinent.

The search for additional innovative behaviours induced by the regional policy has yielded different results within and across the boundaries of firms.

Looking at the innovative behaviours internal to the firms, the investigated R&D subsidy seems to have been able to help firms in getting an additional advantage in terms of skills and competencies, although this is not the one for which additional training investments have been carried out. This additionality thus seems to be truly behavioural, rather than an input kind of additionality. The policy implication of the first evaluation is, therefore, quite straightforward. The financial support to R&D can make firms more active as learning organizations, allowing them to be more efficient in terms of extension and/or upgrading of competencies. On the other hand, formal training programmes are apparently "incremented" by policy of a different nature. In the last respect, we may argue that, because of the dynamic correlation in the course of time between training and innovation activities (Acemoglu, 1997; Bauernschuster *et al.*, 2008), policy-makers should complement the policy implemented to sustain innovation with instruments that directly aim to spur diffusion and adoption of training programmes.

As far as external innovative behaviours are concerned, the investigated policy scheme seems to have had a limited impact in stimulating the innovation cooperation of the treated firms in the business realm. The only additional impact here is represented by the capacity that the administration of the policy has to induce local firms to interact across the regional boundaries. This additionality is, however, conditional as it works only if the loss of geographical proximity that it entails is counter-balanced by the presence of that organizational proximity which is guaranteed by firms belonging to the same business group. Another significant impact that the policy has had is a sort of crowding-out effect on the cooperation of treated firms with their regional competitors. In this respect, the policy might have affected the trade-off between knowledge protection and sharing: in carrying out publicly funded R&D activities, firms are induced to avoid risk of knowledge leakages that might benefit their competitors.

Ultimately, the most direct policy implication that we can draw from this evaluation is that regional policy-makers have been unable, at least with a horizontal policy such as an R&D subsidy, to stimulate those interactive behaviours that ER has been found to be in need of as an RIS. However, it cannot be excluded that the typical informal, business relationships of the RIS make rivalry and knowledge mis-match problems in cooperation less severe and then make the recipient firms move the subsidy towards other non-relational kinds of behaviours.

In conclusion, it should be noted that the results presented here might be sensitive to characteristics of context and policy considered in this paper. In particular, the fact that SMEs were the main beneficiaries of the intervention and that the public support was, on average, low should be noted. However, in spite of its idiosyncratic techno-economic

characteristics (Brusco, 1982; Hollanders *et al*., 2009), ER has been found to be a good approximation of the theoretical RIS conceptualization (Evangelista *et al.*, 2002) and a benchmark of an industrial-district kind of local development for other countries (Humphrey, 1995; Molina-Morales, 2001). For this reason, the results of this study can have some general value in both regional and planning studies.

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Notes

1. In order to maintain focus, analysis of input and output additionality in relation to the policy is not addressed. The policy scheme investigated was designed to increase regional firms' cooperation with research organizations (e.g. universities and research institutes). The additionality of this behaviour is also excluded in order to focus only on what we term the "indirect" behavioural effects of policy. The effects of a similar policy related to cooperation with research organizations are investigated in Marzucchi *et al.* (2012).
2. This is an extension of the more standard ideas of "input" additionality and "output" additionality of a policy. In brief, the former refers to the additional resources that targeted firms can be induced to invest in innovation, with respect to non-targeted firms. The latter instead refers to the additional outcomes that targeted firms could be led to have with respect to non-targeted firms (Georghiou & Clarysse, 2006).
3. Falk (2007) distinguishes among the ideas of scope additionality, cognitive capacity additionality, acceleration additionality, challenge additionality, network additionality, follow-up additionality and management additionality.
4. In brief: a high density of SMEs, co-located in specialized local production systems with diffuse social capital (i.e. industrial districts); deep-rooted unionism especially strong in the most industrialized provinces (e.g. Reggio Emilia); and articulated institutional set-up of business and research organizations.
5. Regional Innovation Scoreboard (http://www.proinno-europe.eu/page/regional-innovation-scoreboard) for 2004 and 2006.
6. For an extended illustration of the history of this instrument, see Marzocchi (2009).
7. In defining the group of non-subsidized firms to be used as controls, we did not discriminate between non-successful applicants and non-applicants. Indeed, given that this discrimination is not required by the rationale of the underlying econometric procedure, this allowed us to keep a higher number of observations and, thus, to enrich the information on the counterfactual.
8. As we will see in the next section, these covariates will be used to carry out a probit estimation, which is functional and propaedeutic to the PSM we will undertake. For this reason, this set represents a careful choice among the variables at our disposal. Indeed, it is our theoretically grounded attempt at mediating between two approaches—a conservative (Augurzky & Schmidt, 2001; Bryson *et al.*, 2002) and an inclusive (Rubin & Thomas, 1996) one—which in the literature have been shown to suffer from econometric problems in the estimation of the propensity score. Finally, it should be noted that, although the fact they are measured before the policy implementation reduces endogeneity problems, the lack of a panel data structure in our sample does not allow us to eliminate, completely, issues related to the selection on unobservables (Caliendo & Kopeinig, 2008).

9. Unfortunately, disaggregated data for the two kinds of expenditures were not available. On the other hand, studies have been emerging recently on their complementarity nature in the current open-innovation and demand-led paradigm (Perks *et al*., 2009).
10. Short-term debt is considered here to be probably more relevant than long-term debt, given the contingent nature of the decision to plan an R&D project and, thus, apply for a subsidy.
11. One of the dummies (GEO1) captures firms based outside the regional borders, but having at least a production unit in the region.
12. One just needs to think about its very common "picking-the-winner" strategy (Cerulli, 2010).
13. In particular, the five nearest neighbours, the caliper and the kernel, for which, see Becker and Ichino (2002); Cameron and Trivedi (2009); Smith and Todd (2005); Caliendo and Kopeinig (2008).
14. This guarantees the presence of suitable counterfactual firms for each treated (Caliendo & Kopeinig, 2008; Smith & Todd, 2005). Following Caliendo and Kopeinig (2008), we also impose the common support condition with a "minima and maxima" comparison. In addition, a 1% "trim" is applied to the five nearest-neighbours matching.
15. Drawing on Caliendo and Kopeinig (2008), we employ a set of tests (Pseudo-R^2 test, likelihood-ratio test on joint significance and a regression-based *t*-test on differences in covariate means). These tests largely support the quality of the matching.
16. Given its functional role with respect to the PSM, this is the only aspect of the probit which matters here. On the other hand, the meaning of the coefficients is not the primary interest of this paper. Accordingly, we avoid quantifying the marginal effects of the covariates as well.
17. R&D could equally increase the willingness and capacity of firms to apply for the policy. Unfortunately, we cannot distinguish whether previous engagement in R&D increases awareness of the need to innovate, and thus the interest/propensity to submit projects, rather than the capacity to present more promising and well-planned proposals.
18. On the same occasion, representatives of policy-makers reported that other firms, not necessarily SMEs, resorted to regional funding, being unable to participate in other policy programmes (e.g. because the calls for applications were already closed).

References

Acemoglu, D. (1997) Training and innovation in an imperfect labour market, *The Review of Economic Studies*, 64(3), pp. 445–464.

Aerts, K. & Schmidt, T. (2008) Two for the price of one? Additionality effects of R&D subsidies: A comparison between Flanders and Germany, *Research Policy*, 37(5), pp. 806–822.

Afcha Chávez, S. (2011) Behavioural additionality in the context of regional innovation policy in Spain, *Innovation: Management Policy and Practice*, 13(1), pp. 95–110.

Antonioli, D. & Marzucchi, A. (2012) Evaluating the additionality of innovation policy. A review focused on the behavioural dimension, *World Review of Science, Technology and Sustainable Development*, 9(2–4), pp. 124–148.

Antonioli, D., Bianchi, A., Mazzanti, M., Montresor, S. & Pini, P. (2011) *Strategie di innovazione e risultati economici. Un'indagine sulle imprese manifatturiere dell'Emilia–Romagna* (Milan: FrancoAngeli).

Arrow, K. J. (1962) The economic implications of learning by doing, *The Review of Economic Studies*, 29(3), pp. 155–173.

Arundel, A. (2001) The relative effectiveness of patents and secrecy for appropriation, *Research Policy*, 30(4), pp. 611–624.

Asheim, B. (2009) Next generation regional innovation policy: How to combine science and user driven approaches in regional innovation systems, *Ekonomiaz*, 70(01), pp. 106–131.

Asheim, B. & Coenen, L. (2005) Knowledge bases and regional innovation systems: Comparing Nordic clusters, *Research Policy*, 34(8), pp. 1173–1190.

Asheim, B. & Isaksen, A. (2002) Regional innovation systems: The integration of local sticky and global ubiquitous knowledge, *The Journal of Technology Transfer*, 27(1), pp. 77–86.

Asheim, B., Coenen, L., Moodysson, J. & Vang, J. (2007) Constructing knowledge-based regional advantage: Implications for regional innovation policy, *International Journal of Entrepreneurship and Innovation Management*, 7(2), pp. 140–155.

Augurzky, B. & Schmidt, C. M. (2001) *The propensity score: A means to an end*. IZA discussion paper no 271, Bonn.

Autio, E., Kanninen, S. & Gustafsson, R. (2008) First-and second-order additionality and learning outcomes in collaborative R&D programs, *Research Policy*, 37(1), pp. 59–76.

Bach, L. & Matt, M. (2002) Rationale for science and technology policy, in: L. Georgiou & J. Rigby (Eds) *Assessing the Socio-economic Impacts of the Framework Programme*, pp. 93–120 (Bruxelles: Report to European Commission DG Research).

Bauernschuster, S., Falck, O. & Heblich, S. (2008) *The impact of continuous training on firms' innovations*. CESifo Working paper no 2258, Munich.

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

Belussi, F., Sammarra, A. & Sedita, S. (2010) "Open regional innovation system": A focus on firms' innovation strategies in the Emilia–Romagna life science industry, *Research Policy*, 39(6), pp. 710–721.

Bianchi, P. & Giordani, M. (1993) Innovation policy at the local and national levels: The case of Emilia–Romagna, *European Planning Studies*, 1(1), pp. 25–41.

Boschma, R. (2005) Proximity and innovation: A critical assessment, *Regional Studies*, 39(1), pp. 61–74.

Brusco, S. (1982) The Emilian model: Productive decentralisation and social integration, *Cambridge Journal of Economics*, 6(2), pp. 167–184.

Bryson, A., Dorsett, R. & Purdon, S. (2002) *The use of propensity score matching in the evaluation of labour market policies*. Working paper no 4, Department for Work and Pensions, London.

Buisseret, T., Cameron, H. & Georghiou, L. (1995) What difference does it make? Additionality in the public support of R&D in large firms, *International Journal of Technology Management*, 4(5), pp. 587–600.

Busom, I. & Fernandez-Ribas, A. (2008) The impact of firm participation in R&D programmes on R&D partnerships, *Research Policy*, 37(2), pp. 240–257.

Caliendo, M. & Kopeinig, S. (2008) Some practical guidance for the implementation of propensity score matching, *Journal of Economic Surveys*, 22(1), pp. 31–72.

Cameron, A. & Trivedi, P. (2009) *Microeconometrics Using Stata*, Vol. 5. (College Station, TX: Stata Press).

Cerulli, G. (2010) Modelling and measuring the effect of public subsidies on business R&D: A critical review of the econometric literature, *Economic Record*, 86(274), pp. 421–449.

Cohen, W. (2010) Fifty years of empirical studies of innovative activity and performance, in: B. H. Hall & N. Rosenberg (Eds) *Handbook of the Economics of Innovation,* Vol. 1, pp. 129–213 (London: Elsevier).

Cooke, P., Gomez Uranga, M. & Etxebarria, G. (1997) Regional innovation systems: Institutional and organisational dimensions, *Research Policy*, 26(4–5), pp. 475–491.

Czarnitzki, D. & Licht, G. (2006) Additionality of public R&D grants in a transition economy, *Economics of Transition*, 14(1), pp. 101–131.

Davenport, S., Grimes, C. & Davies, J. (1998) Research collaboration and behavioural additionality: A New Zealand case study, *Technology Analysis & Strategic Management*, 10(1), pp. 55–68.

Edquist, C. (2005) Systems of innovation: Perspectives and challenges, in: R. R. Nelson, D. C. Mowery & J. Fagerberg (Eds) *The Oxford Handbook of Innovation*, pp. 181–208 (Oxford: Oxford University Press).

Edquist, C. (2011) Design of innovation policy through diagnostic analysis: Identification of systemic problems (or failures), *Industrial and Corporate Change*, 20(6), pp. 1637–1643.

Erez, M. (2010) Culture and job design, *Journal of Organizational Behavior*, 31(2–3), pp. 389–400.

Evangelista, R., Iammarino, S., Mastrostefano, V. & Silvani, A. (2002) Looking for regional systems of innovation: Evidence from the Italian innovation survey, *Regional Studies*, 36(2), pp. 173–186.

Falk, R. (2007) Measuring the effects of public support schemes on firms' innovation activities: Survey evidence from Austria, *Research Policy*, 36(5), pp. 665–679.

Fier, A., Aschhoff, B. & Lohlein, H. (2006) Introduction and synthesis, in: OECD (Ed.) *Behavioural Additionality of Public R&D Funding in Germany*, pp. 9–38 (Paris: OECD publishing).

Fischer, M. & Varga, A. (2002) Technological innovation and inter-firm cooperation: An exploratory analysis using survey data from manufacturing firms in the metropolitan region of Vienna, *International Journal of Technology Management*, 24(7), pp. 724–742.

Florida, R., Mellander, C. & Stolarick, K. (2008) Inside the black box of regional development: Human capital, the creative class and tolerance, *Journal of Economic Geography*, 8(5), pp. 615–649.

Franco, C., Marzucchi, A. & Montresor, S. (2011) *The "potential" face of absorptive capacity. An empirical investigation for an area of 3 European countries*. ORKESTRA Working paper 2011-R08WPS, San Sebastian.

Fritsch, M. & Schwirten, C. (1999) Enterprise-university co-operation and the role of public research institutions in regional innovation systems, *Industry and Innovation*, 6(1), pp. 69–83.

Georghiou, L. & Clarysse, B. (2006) Introduction and synthesis, in: OECD (Ed.) *Government R&D Funding and Company Behaviour, Measuring Behavioural Additionality*, pp. 9–38 (Paris: OECD publishing).

Hall, B. & Maffioli, A. (2008) Evaluating the impact of technology development funds in emerging economies: Evidence from Latin America, *The European Journal of Development Research*, 20(2), pp. 172–198.

Hassink, R. (2002) Regional innovation support systems: Recent trends in Germany and East Asia, *European Planning Studies*, 10(2), pp. 153–164.

Hassink, R. (2005) How to unlock regional economies from path dependency? From learning region to learning cluster, *European Planning Studies*, 13(4), pp. 521–535.

Hollanders, H., Tarantola, S. & Loschky, A. (2009) *Regional Innovation Scoreboard (RIS) 2009.* Pro-Inno Europe, INNOMETRICS ISSN 1501-0066, Bruxelles.

Howells, J. (1999) Regional systems of innovation? in: J. Howells, D. Archibugi & J. Michie (Eds) *Innovation Policy in a Global Economy*, pp. 67–93 (Cambridge: Cambridge University Press).

Humphrey, J. (1995) Industrial reorganization in developing countries: From models to trajectories, *World Development*, 23(1), pp. 149–162.

Humphrey, J. & Schmitz, H. (2002) How does insertion in global value chains affect upgrading in industrial clusters? *Regional Studies*, 36(9), pp. 1017–1027.

IDEA (2006) *Study and Evaluation of the Behavioural Additionality of R&D Subsidies*. Final Report on behalf of IWT, IWT: Bruxelles.

Katz, R. & Allen, T. (1982) Investigating the not invented here (NIH) syndrome: A look at the performance, tenure, and communication patterns of 50 R & D project groups, *R&D Management*, 12(1), pp. 7–20.

Lhuillery, S. & Pfister, E. (2009) R&D cooperation and failures in innovation projects: Empirical evidence from French CIS data, *Research Policy*, 38(1), pp. 45–57.

Magro, E., Aranguren, M. & Navarro, M. (2010) Does regional S&T policy affect firms' behaviour? Paper presented at the Regional Studies Association Annual International Conference 2010, May 24–26, University of Pécs, Hungary.

Malerba, F. (2002) Sectoral systems of innovation and production, *Research policy*, 31(2), pp. 247–264.

Marino, M. & Parrotta, P. (2010) Impacts of public funding to R&D: Evidences from Denmark. Paper presented at DRUID Summer Conference 2010, London.

Markusen, A. (2008) Human versus physical capital. Government's role in regional development, in: J. Martinez-Vazques & F. Vallaincourt (Eds) *Public Policy for Regional Development*, pp. 181–208 (Oxford: Oxford University Press).

Marzocchi, C. (2009) *The Evolution of an Innovation Policy in a Local System of Production*. The case of the Regional Programme for Industrial Research, Innovation and Technology Transfer. Eprints UNIFE, Ferrara.

Marzucchi, A., Antonioli, D. & Montresor, S. (2012) Innovation cooperation within and across regional boundaries. Does innovation policy add something? Paper prepared for the DRUID2012 Conference, Copenhagen.

Mathur, V. (1999) Human capital-based strategy for regional economic development, *Economic Development Quarterly*, 13(3), pp. 203–216.

Metcalfe, J. (1995) Technology systems and technology policy in an evolutionary framework, *Cambridge Journal of Economics*, 19(1), pp. 25–46.

Molina-Morales, F. (2001) European industrial districts: Influence of geo-graphic concentration on performance of the firm, *Journal of International Management*, 7(4), pp. 277–294.

Mora-Valentin, E., Montoro-Sanchez, A. & Guerras-Martin, L. (2004) Determining factors in the success of R&D cooperative agreements between firms and research organizations, *Research Policy*, 33(1), pp. 17–40.

Morgan, K. (1997) The learning region: Institutions, innovation and regional renewal, *Regional Studies*, 31(5), pp. 491–503.

Nelson, R. (1959) The simple economics of basic scientific research, *The Journal of Political Economy*, 67(3), pp. 297–306.

OECD (2006) *Government R&D Funding and Company Behaviour: Measuring Behavioural Additionality* (Paris: OECD).

Olander, H., Hurmelinna-Laukkanen, P. & Mahonen, J. (2009) What's small size got to do with it? Protection of intellectual assets in SMEs, *International Journal of Innovation Management*, 13(3), pp. 349–370.

Perks, H., Kahn, K. & Zhang, C. (2009) An empirical evaluation of R&D– marketing NPD integration in Chinese firms: The Guanxi effect, *Journal of Product Innovation Management*, 26(6), pp. 640–651.

Rosenbaum, P. R. & Rubin, D. B. (1983) The central role of the propensity score in observational studies for causal effects, *Biometrika*, 70(1), pp. 41–55.

Rubin, D. B. & Thomas, N. (1996) Matching using estimated propensity scores: Relating theory to practice, *Biometrics*, 52(1), pp. 249–264.

Rutten, R. & Boekema, F. (2007) *The Learning Region: Foundations, State of the Art, Future* (London: Edward Elgar).

Smith, A. & Todd, E. (2005) Does matching overcome LaLonde's critique of nonexperimental estimators? *Journal of Econometrics*, 125(1–2), pp. 305–353.

Ter Wal, A. & Boschma, R. (2011) Co-evolution of firms, industries and networks in space, *Regional Studies*, 45(7), pp. 919–933.

Todtling, F. & Trippl, M. (2005) One size fits all? Towards a differentiated regional innovation policy approach, *Research Policy*, 34(8), pp. 1203–1219.

Uyarra, E. (2010) What is evolutionary about regional systems of innovation? Implications for regional policy, *Journal of Evolutionary Economics*, 20(1), pp. 115–137.

Wastyn, A. & Hussinger, K. (2011) Search for the not-invented-here syndrome: The role of knowledge sources and firm success. Paper prepared for the 2011 DRUID Conference, Copenhagen.

Appendix

Table A1. Sample representativeness

Recipient population distribution	SMEs (<250 employees) (%)	Large (=250 employees) (%)	Total (%)	Total (average)
	Sector			
PAVITT1 (labour intensive)	8.55	0.43	8.97	21
PAVITT2 (resource intensive)	9.83	2.56	12.39	29
PAVITT3 (science based)	11.11	1.28	12.39	29
PAVITT4 (scale intensive)	14.96	4.7	19.66	46
PAVITT5 (specialized suppliers)	39.74	6.84	46.58	109
Total	84.19	15.81		
Total (average)	197	37		234
Recipient sample distribution	SMEs (%)	Large (%)	Total (%)	Total (average)
	Sector			
PAVITT1 (labour intensive)	9.09	1.01	11.11	11
PAVITT2 (resource intensive)	7.07	2.02	9.09	9
PAVITT3 (science based)	15.16	1.01	16.16	16
PAVITT4 (scale intensive)	14.15	7.07	21.21	21
PAVITT5 (specialized suppliers)	34.34	8.08	42.42	42
Total	80.81	19.19		
Total (average)	80	19		99

Table A2. Outcome variables

	Overall mean (408 observations)	Mean subsidized (99 observations)	Mean non-subsidized (309 observations)	Minimum	Maximum
Acquisition and upgrading of competencies					
COMPUP	0.74	0.869	0.699	0	1
TRAIN	0.819	0.879	0.799	0	1
TECHTRAIN	0.718	0.818	0.686	0	1
Innovation cooperation with business partners					
Intra-RIS					
COOPCUS_REG	0.172	0.162	0.175	0	1
COOPSUP_REG	0.184	0.152	0.194	0	1
COOPCOM_REG	0.074	0.04	0.084	0	1
COOPGP_REG	0.1	0.131	0.091	0	1
Extra-RIS					
COOPCUS_EXTRA	0.275	0.263	0.278	0	1
COOPSUP_EXTRA	0.331	0.364	0.32	0	1
COOPCOM_EXTRA	0.076	0.121	0.061	0	1
COOPGP_EXTRA	0.113	0.172	0.094	0	1

Table A3. Covariate variables

Variables	Description	Overall mean (408 observations)	Minimum	Maximum	Mean subsidized (99 observations)	Minimum	Maximum	Mean not subsidized (309 observations)	Minimum	Maximum
Time-invariant survey data										
Geographical location (10 dummies)	GEO1: Extra-region GEO2: Bologna GEO3: Forli'-Cesena GEO4: Ferrara GEO5: Modena GEO6: Piacenza GEO7: Parma GEO8: Ravenna GEO9: Reggio Emilia GEO10: Rimini		0	1		0	1		0	1
Sector (5 dummies)	PAVITT1: labour intensive PAVITT2: resource intensive PAVITT3: science based PAVITT4: scale intensive PAVITT5: specialized suppliers		0	1		0	1		0	1

(*Continued*)

Table A3. Continued

Variables	Description	Overall mean (408 observations)	Minimum	Maximum	Mean subsidized (99 observations)	Minimum	Maximum	Mean not subsidized (309 observations)	Minimum	Maximum
Balance-sheet data										
lnEMP2003	Log number of employees in 2003	4.218	0.693	7.961	4.516	2.639	7.754	4.122	0.693	7.961
$FINCONST_{2003}$	Short-term debt in 2003	0.871	0.32	1	0.838	0.33	1	0.882	0.32	1
$CASHFLOW_{2003}$	Cash-flow p.c. in 2003 (1000 Euros)	0.792	−1.105	185.222	0.183	−0.475	1.555	0.987	−1.105	185.222
$RDADV_{2003}$	Expend. p.c. in R&D and ADV in 2003 (1000 Euros)	0.007	0	0.405	0.016	0	0.326	0.003	0	0.405