New evidence on the impact of public incentives on private R&D in Italy

Andrea Bonaccorsi
University of Pisa

1. Introduction

Within the space of just a few years the theme of the impact of public incentives on firms has changed nature. It has turned from a long-run scientific and methodological exercise into an urgent question of economic policy. Budget restrictions mean that an open-minded examination of the allocation of decreasing resources among alternative programmes cannot be put off any longer. At the same time, the evidence is pitiless in indicating that some of the objectives generally taken as desirable, such as increasing R&D intensity, innovation intensity and productivity remain unattained, no matter what policy tools are adopted.

The paper by Guido de Blasio, Davide Fantino and Guido Pellegrini, "Evaluating the impact of innovation incentives: Evidence from an unexpected shortage of funds," has a number of merits and warrants careful consideration in various forums.

First, the paper crowns a series of contributions on the evaluation of business incentives that have made the counterfactual method the mandatory standard for any rigorous exercise. Pellegrini has worked on a wide range of incentive programmes in the course of the last decade at the Ministry for Economic Development and more recently at the Bank of Italy. These contributions constitute an exemplary methodology and should be adopted as standard operating procedures by the central government departments that are still unaware of them and by the regional governments, especially in assessing the measures financed by Structural Funds.[1]

Second, the paper presents a highly original, powerful version of the counterfactual method. In most cases, these studies compare the firms that have received an incentive (the "treated" cases) with variously constructed samples of otherwise similar firms that have not ("untreated" cases). That is, this is a statistical counterfactual, reconstructed ex post by the researcher using datasets permitting rigorous measurement of the ex ante similarity between treated and control groups. The effect of the incentive is tested by observing the average effect on the outcome variables for the treated group and determining whether this is statistically different from those of the untreated.

[1] See the important recommendations in Dipartimento per le Politiche di Sviluppo e Coesione, *Migliorare le politiche di ricerca e innovazione delle Regioni*, Rome, 2009.

In this paper, the authors compare two groups of firms that applied to the Fund for Technological Innovation (FTI) for financing for R&D projects and that, owing to a bizarre peculiarity of Italian bureaucracy, were in perfectly distinct experimental situations. All the firms considered presented projects, but only those that applied between October 2001 and March 2002 were assessed, while evaluation of projects received after that date was suspended. In other words, the Ministry for Economic Development asked firms to keep on submitting projects as before, pending the refinancing of the programme, and only halted the procedure when the Ministry for the Economy denied additional funding.

Thus the first group included a sub-set of funded (treated) firms, whose subsequent behaviour can be observed (but the group that applied but were rejected cannot be observed). In the second group, none were funded, because the assessment was not carried out. One therefore assumes that the two groups are similar, ex ante, in that the firms were self-selected to submit project applications but assignment to the two groups was random. More precisely, the degree of similarity increases the closer we come, either before or after, the date separating the assessed from the non-assessed. Here, that is, we have not a “statistical” but a “historical” counterfactual study. Such studies are commonly conducted for other assessment contexts but not in the case of government incentives, generally because of the rigidity of the public-law rules for selection. This, then, is an exceptional case, and the authors exploit it in highly original fashion with respect to the international literature.

The findings are very clear. There is no effect of treatment (the incentive), on average, on any of the outcome variables studied:

- tangible investment;
- intangible investment;
- sales;
- profitability;
- financial structure.

The negative result is confirmed even for the firms which, a priori, should have benefited most, such as SMEs, firms with high cost of capital, and firms with large intangible assets.

The findings are striking indeed. In the formulation just now given, they are, in my view, unassailable, save for two modest methodological points that I shall set out below. At the same time, however, I seriously doubt whether, in and of themselves, they can serve as decisive inputs for policy purposes. As I shall seek to show, policy implications can only be derived from the patient collection of studies, none of which, however sound in methodology and sharp in results, can be

decisive. This reflection counsels a more modest approach to policy implications that I see as the only feasible one.

I begin with three minor, essentially methodological comments, in increasing order of importance, before going on to my main statement.

2. Methodological issues

2.1. Data on rejected firms

The methodological discussion has stressed the usefulness of comparing not only treated firms with samples of untreated firms reconstructed ex post but also of comparing, among the firms that submitted projects, those accepted and those rejected. This procedure controls for a priori eligibility for the incentive and for differing motivations for seeking the subsidy, whereas the construction of a sample of matching pairs by ex post statistical methods may not eliminate the suspicion that the observed variables used to construct the pairs may not effectively capture specific similarities vis-à-vis public incentives. There could be subtle, not entirely explicit standards of eligibility or, more often, unobservable differences in the motivation to submit a project that cause problems for a comparison based only on the available statistical variables. These problems are resolved by the accepted/rejected comparison. In the study by De Blasio, Fantino and Pellegrini the problem does not arise, in that the eligibility and motivation of the two groups are comparable by definition. The comparison with rejected applicants would nevertheless be highly informative concerning the subsequent behaviour of the firms that sought but did not receive the public subsidy.

In our case, the data on the firms that submitted projects for subsidy between October 2001 and March 2002 but were rejected are not available, for reasons of confidentiality. The currently accepted interpretation of the law is that the mere divulgation of the fact that a firm has had a project rejected may be a violation of confidentiality. I find this reading totally incongruous. When a firm applies for a public contribution, it automatically subjects itself to a series of minimum rules of transparency and information requirements that cannot but include report of rejection. It would certainly be useful if researchers pressed administrative entities to create databases including the rejected firms.

2.2. Choice of the forcing variable

The authors' methodology assumes that the firms on the two sides of the date separating the two groups are similar, a priori; that is, the firms submitting projects between October 2001 and March 2002 are assumed ex ante similar to those submitting projects in the rest of the period.

In principle this is an acceptable hypothesis. Yet a certain degree of caution might be called for by more detailed analysis of the context of the subsidy programme. The opening of calls for projects for the Fund for Technological Innovation (FTI) in 2001 came at the end of a long wait due to the reform of Law 46/1982 and the whole incentive system begun under the government of Romano Prodi and continued under those of Massimo D'Alema and Giuliano Amato (with Ministers of Industry Pierluigi Bersani and subsequently Enrico Letta). A key feature of the reform was the involvement of the banks in evaluating and managing projects, and this had required lengthy preparation of the conventions and the management of the competitions. By the end of the legislature in 2001, when the operational programmes were finally ready and the budget allocations in place, great expectations among firms and an equally strong intention to mobilize the expenditure on the part of government had been created.

This situation might have resulted in two possible distortions. First, the queuing of applicant firms may have lowered the quality of the projects: projects pending for years may have been submitted quickly, as soon as the competition opened. Second, political objectives, even if only implicit, of speeding up expenditure may have been transmitted to the bureaucracy in the form of laxer standards of project selection. Banks too, in the first phase of implementation, may have adopted screening procedures less strict than necessary. If these conjectures have a basis in fact, then the projects submitted – and accepted – in the first round of applications might not be strictly comparable with subsequent ones; they could be of lower quality.

As far as we know, these conjectures are destined to remained just that, owing in particular to the fact that data on rejected projects are not accessible. Even so, some caution in interpreting the results would probably be appropriate.

2.3. Data on other public subsidies

The firms that applied after March 2002, whose projects were not judged by the ministry, were studied via financial data from independent sources. Can we be sure that they received no other forms of public subsidy? For if they had used another government incentive, they cannot be considered "untreated". In principle, the firms could have been financed by a sister fund managed

by the Ministry for Universities and Research, the Fund for Applied Research (FAR). The reformed rules institute close coordination between FTI and FAR, making it impossible to benefit from both in parallel. However, the possibility of access with two different projects is not precluded, and this possibility should be checked.

More seriously, it is possible that firms, pending the FTI's assessment, and especially after the suspension of funding was announced, may have sought to reutilize their projects for funding elsewhere, such as the EU Commission's Framework Programme and regional funds for research and innovation. This objection appears to be quite serious, and it undercuts the significance of our own results concerning FAR.[2] The problem poses the question of integrating the datasets on incentive programmes of central and regional governments.

3. Outcome variables

Now we come to the main problem. The main outcome variable used to assess the impact of public policies is cumulative total investment from 2001 through 2007 as a ratio to initial capital (in 1999). This can be disaggregated by type of investment (tangible, intangible) and flanked by others, such as sales and profits, but the chief outcome variable for study remains cumulative investment over a reasonably long period following the submission of the firm's project to FTI. The question is: Is this an acceptable gauge of investment in innovation? I see two possible answers. One is that any sort of incentive should result, directly or indirectly, in an increase in firms' investment capacity. The adoption of cumulative investment as the outcome indicator should thus be accepted by policy makers at all levels, practically regardless of sectoral or specific policy objectives. The second response is that the effect of a public incentive on R&D and firms' capacity for innovation is measured directly by investment. In my view, the first response is acceptable but partial, the second unacceptable.

Let us examine the first argument. Taking cumulative investment as the outcome variable means having a strong model of industrial development, one in which tangible or intangible investment is the key to firms' competitiveness and growth. This model ignores the great opportunities offered by lighter forms of organization based on alliances, outsourcing and offshoring, in which value added per employee can rise even when invested capital does not.

[2] See Merito, M., S. Giannangeli and A. Bonaccorsi (2010), "Do incentives to industrial R&D enhance research productivity and firm growth? Evidence from the Italian case", *International Journal of Technology Management,* 49, nos. 1-3, with some new findings by comparison with the Italian version: Merito, M., S. Giannangeli and A. Bonaccorsi (2007), "L'effetto degli incentivi pubblici sulla ricerca e sviluppo delle imprese. Evidenze da dati italiani," *L'Industria,* April; also in G. De Blasio and F. Lotti, eds. (2008), *La valutazione degli aiuti alle imprese* (Bologna: Il Mulino).

Further, there is evidence (as in the Mediobanca time series of R&D expenditure data) that the fixed investment indicator is highly variable over time. Taking cumulative investment over the fairly lengthy period of 2001-2007 attenuates the problem but probably does not completely overcome it. In any case, that represents a clear model. Decision-makers may have differing policy preferences, but at least the model does relate programmes to objectives.

The second line of response is more questionable. In Italy R&D spending can be capitalized, i.e. entered in the balance sheet as intangible assets and depreciated. But experience has shown that this practice is quite uncommon, essentially because there is no tax benefit for doing so. Instead, firms treat R&D spending as employee compensation and charge it entirely to the profit and loss account. The only firms that would have an interest in treating it as an investment – start-ups – are dissuaded by their financiers (banks or investors), by reason of the excessive variability of asset values. And accounting standards oblige firms to describe, in the notes to the accounts, the R&D activities carried out, but only if they treat it as a capital investment.

The end result, in practice, is that R&D expenditure is invisible in firms' accounts. To assume that it will be reflected in intangible investment conflicts with the real state of affairs. This being so, the immediate consequence is that cumulative investment from 2001 through 2007 *does not actually tell us* whether R&D spending was affected by the government incentive. To determine this we need additional information, data that are not available in firms' financial reports. For example, we would need Istat's microdata on R&D spending or the less up-to-date CIS survey of innovation expenditure, as well as external indicators such as number of patents or trademarks. As an alternative, submitting a structured questionnaire to firms receiving the subsidy and to a control sample of firms might deliver important insights, although it is clearly more expensive. This line has been recently pursued by IRPET, on behalf of the Tuscany regional government, for the evaluation of public subsidies funded by European funds, with very interesting results.

The lack of these data, on the contrary, deprives us of the main source of information on the impact of the incentive programme.

4. Policy implications

These observations concerning the outcome variables lead directly to the question of possible policy implications. The power of counterfactual analysis may give rise to a temptation that we must resist, namely to leap from the lack of observed effects to the drastic conclusion of the policy's uselessness. This is a conceptual short-circuit.

First of all, let us recall that the counterfactual method, by reason of the extremely selective criteria used in constructing the control sample, is forced to use only a very small set of outcome variables, owing to the data availability constraint. One especially severe limitation that does not apply to other areas of policy assessment stems from the fact that in Italy the principal outcome variable, i.e. R&D spending after the conferral of the incentive, cannot be observed.

Second, for purposes of assessment we need to know the public decision maker's objective function, which complicates our task still further, as official documents do not generally show a consistent framework of objectives. Consider, for instance, the following policy objectives for programmes of public subsidy to industrial research:

- maintaining the level of R&D spending;
- increasing R&D spending;
- entry of new firms into the group of those performing R&D;
- reducing the cost of capital to fund R&D projects;
- increasing the possible riskiness of R&D projects;
- producing valuable intermediate results (patents);
- introducing new products (product innovation);
- introducing new production techniques (process innovation);
- reducing total costs;
- increasing sales;
- increasing exports or raising the export/sales ratio;
- improving various earnings or profit indicators;
- increasing total employment;
- hiring of skilled staff;
- improving competitiveness in cost and/or quality;
- improving various indicators of factor productivity;
- forming intangible assets (know-how, goodwill, patents);
- increasing total investment;
- expanding firms in size.

Each of the above is a legitimate public policy goal, although the rationale from the standpoint of economic theory may be more or less cogent. Traditionally, the economic theory of public incentives has assumed the market failure argument as the only policy rationale. According to this argument, public intervention is only justified if it corrects market failures in funding innovation efforts, due to the public nature of knowledge, imperfect appropriability, information asymmetries

and excess risk. It follows that public investment is effective if and only if it leads to an *increase* in the R&D expenditure with respect to the level that would be funded by market mechanisms. If this were not the case, it would mean that the private investment is crowded out by the public incentive.

This line of reasoning ignores another, potentially important, policy rationale: that is, any expenditure in R&D produces *positive externalities*. It creates human capital, whose value can be appropriated by investing companies but only partially, and above all it creates spillover effects. One can read the list above as suggesting that the desired outcome is not only an additional expenditure with respect to the private level, but also the creation of potentially large spillovers.

The problem is the trade-offs between the various objectives. For instance, cutting total costs may be compatible with process innovation and enhanced competitiveness, but not with the hiring of skilled staff and product innovation. Another example is the risk profile: the public decision-maker could be interested not in an undifferentiated rise in expenditure but in projects aimed at radical innovation, which may well be at greater risk of failure.

By their nature, moreover, R&D support programmes may have a great range of objectives and an accordingly large number of results indicators. In a review of the literature and various policy documents, Roper, Hewitt-Dundas and Love[3] compile a table classifying the private and social benefits of R&D, maintaining that each one can be one element in the objective vector.

Inventory of private and social benefits from R&D activities

A. Private benefits	**B. Broader social and public benefits**
1. Privately appropriable knowledge	**3. Effects on public knowledge base**
1.1 Findings of basic research 1.2 Findings of applied research 1.3 Development findings	3.1 Findings of basic research 3.2 Findings of applied reserach 3.3 Development findings
1. Products of private R&D	**4. Products of public R&D**
1.1 Enhanced capacity to set objectives for future research 1.2 Development of human resources and research management capacity	4.1 Improvement in technological infrastructure 4.2 Enhanced capacity to set objectives for future publicly funded research

[3] See Roper, S., N. Hewitt-Dundas, and J.H. Love (2003), "An ex ante evaluation framework for the regional benefits of publicly supported R&D projects", Paper presented at the *ERSA 2003 Congress*.

1.3 Reputation and visibility effects 1.4 Enhanced capacity to use current research results 1.5 Sharing of research results **2. Benefits from commercial applications** 2.1 Lower costs of present products/services 2.2 New or improved products/services 2.3 Higher productivity 2.4 Expansion in size 2.5 Increase in profitability	4.3 Development of research skills, human resources and overall capacity for research **5. Rent spillovers** 5.1 Cost benefits for final customers 5.2 Scale economies for suppliers 5.3 Availability of personnel with research capabilities **6. Pure knowledge spillovers** 6.1 Knowledge spillovers with impact on productivity and growth 6.2 Spinouts 6.3 Merger or clustering benefits 6.4 Reputation, image, demonstration effects

Source: Based on S. Roper, N. Hewitt-Dundas and J.H. Love (2003), "An ex ante evaluation framework for the regional benefits of publicly supported R&D projects", Paper presented at the *ERSA 2003 Congress*.

As the table makes clear, it is hard to draw definitive conclusions from studies that assess the impact of policies using at most a few indicators. For instance, cumulative investment could be considered as indicated by the private benefit mentioned in the table.

The problem involves solving a bigger puzzle combining a series of counterfactual results with indications of context, a need that stems from a fundamental methodological observation. Counterfactual methods first arose in fields like clinical medicine and labour economics, where the unit of analysis is the single individual. In these cases the effect on the treated sample is on the patient, the unemployed worker who takes a training course, or the worker. The application of the same method in industrial economics or the economics of innovation cannot avoid grappling with a formidable theoretical problem: how to specify a behavioural model. What is the mechanism through which the public subsidy affects a complex decision such as R&D expenditure? What paths of multiple and indirect causation transfer the presumed impact on R&D spending to other business variables such as investment, innovation, sales and profitability, each of which is itself the resultant of multiple forces, not all under the firm's control?

Matters are complicated still more by the fact that in the economics of innovation, unlike other areas of investment (such as gross fixed capital formation, inventory, financial choices), models of behaviour are quite recent and lack an incontrovertible empirical base. For instance, the model most

commonly used at present (Crépon, Duguet and Mairesse) dates to 1998, scarcely more than a decade ago.

Consequently, I believe the results of these counterfactual exercises need to be placed in a broader theoretical and empirical framework. To be clear, I believe that the question whether industrial R&D incentives requiring evaluation should be eliminated or de-emphasized in favour of automatic tax incentives is *totally insoluble* on the basis of the results of the studies to date. We need to proceed for several years more with evaluation programmes, to streamline the administrative procedures, to continue rigorous impact assessments, and in the meantime to begin phasing in automatic programmes for immediate assessment.

5. Towards the reform of incentives?

Notwithstanding the methodological caveats set out above, we cannot fail to indicate several areas where reform is unquestionably urgent. Some appear to enjoy broad consensus among analysts, and we should be grateful to the Bank of Italy for providing a regular forum, in the past few years, for high-level academic and policy discussion.

5.1. Extending eligibility and differentiating the programmes

The range of potential objectives for industrial R&D support programmes suggests the need to differentiate policy instruments. Generally speaking, international experiences indicate that the incentives should be differentiated to deal with the following situations:

a) small-scale programmes, with low administrative costs and for wide distribution, designed to induce smaller firms and firms that have never performed R&D in the past to begin doing so;

b) programmes of evaluation (including bargained evaluation) for large corporations;

c) high-risk programmes designed to support R&D at start-ups and pioneering projects.

The best criteria for differentiating the main programmes appear to be project size and project risk. The approach to R&D differs profoundly between large corporations with formal research labs and SMEs. To be more precise, it is not firm size per se that makes the difference, but the approach to R&D and the size of the project. However, it is true that large firms develop strategic research plans, make budget allocations, and then seek public funds or negotiated programme agreements. Public funding has a low degree of additionality but together with other policies contributes to a

favourable business environment, especially for multinationals, and helps to retain private investment that can generate significant spillover effects in-country. Small and medium-sized enterprises (but with important exceptions) tend to put R&D investment off indefinitely in the absence of public funding, or else to finance it out of own capital on a deferred basis. For the large firms, therefore, government should be given some discretionary power within a multi-stage procedure, such as that used for the Industry 2015 programme (but enhancing the negotiated component); for smaller businesses, universal and rapid incentive programmes are needed.

The risk criterion institutes a second type of differentiation. Creditworthy firms with good bank access are eligible for all incentives, while start-ups, which by definition do not yet have three years of financial statements or else are loss-making or lacking in collateral, find themselves in great difficulty. The projects submitted by start-up companies are perceived by financiers and government as too risky. Yet the international literature (and in Italy the studies of Massimo Colombo and co-authors) suggests that it is exactly young innovative firms that benefit more (and with true additionality!) from public subsidies. The programmes designed for them need to keep administrative costs low and not be punitive in the case of project failure. Once tested, the same programmes can be applied to especially risky projects submitted by established firms as well.

In redefining incentive categories it would be useful to refer to the Small Business Innovation Research Program in the United States, which has recently been subject to thorough review and critique.

5.2. Shortening bureaucratic procedures

This is the most urgent but also the most challenging task. Today, application processing is unbearably slow at national level, both at the Ministry for Economic Development and at the Ministry for Universities and Research. The Department for Development and Cohesion Policies has begun to map the length of the procedures in some regions, and the partial picture appears to be somewhat better than the national situation.[4] The causes of inefficiency are countless, not all depending on the administration, but in practice the length of the process vitiates any possible virtuous impact on firms' conduct.

We must take into account that firms strategically anticipate the expected duration of administrative procedures. This means that they will not apply for funding for vital projects on

[4] In 2010 the Department began a two-year project together with the national agency for the dissemination of innovation technologies to support regional governments in improving research and innovation policies, including the design of new administrative instruments. Working groups have been formed on the ex ante selection of firms' R&D projects and on bureaucractic streamlining. Initial results will be available in Summer 2011.

which their competitiveness actually depends but only for secondary projects. The disconnect between the strategic importance of the research and the time to funding lowers the quality of the projects funded. When the interval between application and funding is too long, the deadweight loss becomes unacceptably great.

From a methodological point of view, this circumstance makes the results of evaluation exercises problematic. How can we disentangle the lack of effects due to the inefficient length of the administrative procedure from the lack of effects due to the instrument itself? We probably should carry out comparative exercises across regions, or programmes, characterized by different lengths of procedures.

5.3. Renegotiating conventions with banks

The involvement of banks in the incentive procedures was hailed at the turn of the century as a great innovation. There were two main reasons for the reform: to involve a private party interested in administrative efficiency and to diminish informational asymmetry between financier and innovator through risk-sharing on the part of an independent third party. For if the bank was overindulgent in judging the beneficiary's creditworthiness, it might risk compromising its own loan as well. The theoretical underpinnings were certainly worthy.

After nearly a decade of experience, this relationship needs drastic rethinking. Although there are no detailed studies (an ad hoc research effort would be well worthwhile), anecdotal evidence suggests that when the recipient of the funds is also a customer of the bank's, there is some likelihood of less severe assessment. There have been cases in which the convention bank itself becomes the cause of slower procedures, when it fails to assign an adequate number of employees to work in parallel but instead tolerates bottlenecks.

In renegotiating these conventions, a specific definition of expected service levels must be established, with mechanisms for measuring key performance indicators. This will naturally require public administrations to be more credible than in the past.

5.4. Making programme performance more measurable

Experience has shown that great improvement is possible in the extent to which programmes incorporate, from the start, systems to ensure that their performance can be judged after the fact. What follows is a set of possible guidelines in this regard.[5]

5.4.1. Request for evaluation

- The request for evaluation must be drafted by government simultaneously with policies and programmes.
- In the call for applications, the policy objectives must be specified (Article 1).
- In the call for applications, there must be at least a general description of the results indicators deemed suitable to check whether the objectives have been attained.
- As a rule the request for evaluation should adopt a multi-objective model.
- In responding to the evaluation request both counterfactual methods and contextual/qualitative methods should be used.
- Counterfactual analysis shows whether the policy has had the desired effects but does not tell why; it must be supplemented by analysis of the decision-making process within a theoretical framework.
- The evaluation exercise should be based on the active, critical involvement of the public entity requesting it.

5.4.2. Preparation of the information set

- The call for applications should specify the information that eligible candidates must supply for the entire duration of the financing.
- Applicant firms must explicitly accept informational transparency also in case of project rejection; data on rejected candidates will be made available for purposes of the policy impact assessment.
- Government departments will share their datasets.

[5] I have benefited from recurrent discussions in recent years with the expert group that worked with the Department for Development Policies (DPS) in drawing up the Report on research and innovation policies (in particolar Mario Calderini), with the working group of the Consiglio Italiano per le Scienze Sociali on the assessment of public policy measures coordinated by Ugo Trivellato, with the committee for research evaluation of the Province of Trento, and with the group formed by the regional economic planning institute in Tuscany (IRPET) on the assessment of innovation policies.

- Regional governments should agree, under multilateral accords, to integrate their administrative archives on a standardized format.
- For regional calls for projects, or those with a small number of eligible candidates, the control sample must be constructed on an inter-regional or national basis and in any case such as to ensure sufficient size.

5.4.3. Counterfactual evaluation exercises

- The information on the government subsidy must include not only the binary variable (accepted/rejected) but also the level of the financing (intensity of treatment).
- The access of firms (both accepted and rejected) to other sources of public financing (regional, national, European) must be determined.
- The evaluation model must include the firm's decision-making process.
- The outcome variables must take account of how representative the impact studied is of the policy.
- The outcome variables must reflect the existence of multi-objective functions, possibly specified in the policy premises.
- The outcome variables should include, as far as this is possible, spillover effects.
- The date at which the outcome variables are measured must be such as to include lagged effects, specifying the lag model and testing alternative specifications.