Brief notes on the policies for science-based firms

Mario de Marchi, Maurizio Rocchi

National Research Council of Italy
Institute for Economic Research on Firms and Growth (Ceris-Cnr)
Section of research on public research institutions
Via dei Taurini, 19
00185 Roma, Italy
Tel. (+ 39) 064993.7848 (de Marchi)
Tel. (+ 39) 064993.7850 (Rocchi)
Fax (+39) 064455692
demarchi@isrds.rm.cnr.it
rocchi@isrds.rm.cnr.it

Abstract. One of the main reasons why the Italian industry's R&D activities lag behind those of its competitors is often suggested to be the very low weight of high technology firms in that productive system.
Here, we propose a specific measure to correct this anomaly. It aims both to foster the industry's R&D and encourage a closer co-operation of public universities with private companies.
This policy provision would serve a dual purpose: it could be seen as a means of fostering the co-operation between the public research sphere and industry; it could also be a way of financing the research universities do.
We argue that, by submitting additional funding for university research to a judicious evaluation by private sector producers, Italy could increase its prospects of achieving economic returns on academic research.

Keywords: Research policy; Industrial research

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Istituto di Ricerca sull'Impresa e lo Sviluppo

Sede di Torino
Via Avogadro, 8
10121 Torino, Italy
Tel. +39 011 5601.111
Fax +39 011 562.6058
segreteria@ceris.cnr.it
http://www.ceris.cnr.it

Sezione di Ricerca di Roma
Istituzioni e Politiche per la Scienza e la Tecnologia
Via dei Taurini, 19
00185 Roma, Italy
Tel. 06 49937810
Fax 06 49937884

Sezione di Ricerca di Milano
Dinamica dei Sistemi Economici
Via Bassini, 15
20121 Milano, Italy
tel. 02 23699501
Fax 02 23699530

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

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CONTENTS

Introduction

A major reason why the investment in research activities in Italian industry is comparatively low, is often deemed to be the very low weight of those firms whose innovative activities are closely related to Science (Gambardella, Malerba, 1999).

Hereafter, we propose a specific analysis of this anomaly of the Italian innovative system that stresses the need for a closer co-operation of public universities with private companies. Indeed, the very lack of this co-operation is a well-known flaw of the Italian Science system.

To set out our analysis, we have moved from three approaches that are particularly fertile when considering the links between industrial research and public science: (i) the absorption approach; (ii) the so-called "triple helix" approach; (iii) the taxonomic approach to the study of innovating firms.

(I) The absorption approach (first proposed by Cohen and Levinthal in 1989), highlights how the benefits companies derive from research work may go further than the findings and discoveries made directly in the course of their R&D activities. The company can also gain considerably from its resulting capacity to monitor the scientific and technological knowledge that exists outside its own confines. In other words, having an R&D laboratory and highly-qualified research personnel who remain constantly up to speed with the latest scientific and technological advances makes it possible for a company to use R&D as a means by which it can more easily absorb knowledge from the outside world.

(II) The triple-helix approach, which was first proposed by Etzkowitz (1998) recognises and analyses the great changes taking place in the relationship of private sector research to research carried out by public bodies and universities. Traditionally, firms have looked upon universities primarily as a source of human capital, and only secondarily as a source of knowledge that can by deployed in the production of goods and services. Industrial research was generally done inside companies, which kept track of scientific developments in the public sector by consulting with universities, mainly with the aim of solving specific problems and often through participation in joint programmes with the academic world. Recently, following a trend that began in the United States (Lee, 1996), a large number of companies in many countries have begun outsourcing an increasing proportion of their R&D work to the public realm. The result of this complex process is that in general the economic utility of university R&D has increased enormously.

This of course especially concerns those firms that Pavitt (1984), in his well-known Taxonomy, has defined "science-based firms". This category of firms is the one most deeply involved in the phenomenon, because public-sector science is the fountainhead of the sort of knowledge such companies require to do research.

The lack of co-operation between university and industry

It seems inevitable that a policy to support R&D in these companies should go hand-in-hand with measures designed to resolve the long-standing problem of the excessive separation between public-sector and industrial research in Italy, a division that severely limits the economic potential of the former.

The low level of interaction of Italian universities and public research institutes with industrial research has by now become practically a commonplace, backed up with plenty of anecdotal evidence (Gambardella, quoted).

If we want to gain an understanding of the possible future developments and effects of this situation, we ought to compare Italy with other countries.

In recent years, the United States has seen an increasingly marked tendency among industries

to outsource their research activities to universities. In what amounts to a rational division of labour, private corporations in the USA give universities and, especially, public bodies, responsibility for the sort of work that they are best equipped to provide, namely basic research. That circumstance does not mean that the companies outsourcing their R&D activities have given up on pure research completely, because they still have to maintain a significant presence in this functional class of R&D (Mowery, 1998). This is perfectly consistent with the predictions of the developed version of the absorption approach, which places a particular emphasis on the monitoring function that scientists specialising in pure research bring to the company, by enabling it to tap into a world-wide network of scientific centres of excellence (Rosenberg, 1990). All this is achieved by means of a proliferation of collaborative agreements between public research bodies and corporations, and the establishment of many University-Industry Research Center, tasked with carrying out R&D that has both an academic and an economic value. Wherever it occurs, this complex establishment of a triple helix of research (involving the government, universities and private enterprise) has radically changed the system of economic incentives driving public research, and has prompted scientists actively to promote the technological applications of their work.

Table 1 - Coefficients of correlation between some variables at science-based firms in 2001
(P-values within brackets)

	R&D expenditure	*Funding*	*Basic research expenditure*	*Patents*
Patents	0.76 (.0001)	0.50 (.0001)	0.24 (.0001)	1
Basic research expenditure	0.36 (.0001)	0.06 (2.26)	1	
Funding	0.29 (.0001)	1		
R&D expenditure	1			

Source: Istat elaboration RS1-Istat data

This might lead to a greater absorption of knowledge and its transfer from advanced scientific environments to the world of production. Hints of a shift in this direction seem to be discernible in a restricted (though relevant) sector of Italian enterprise, and the commitment to pure research has reached out to include some small-scale companies - a trend that runs counter to Rosenberg's expectations (De Marchi and Rocchi, 2000).

We have made some statistical estimates of the correlation in Italian science-based companies between R&D, basic research, funding for public research activities and the number of patents filed (we have used the last as a measurement of the technological yield of research activities).

The coefficients of correlation between the variables, most of which associated with P-values in the order of 0.00, are contained in a small square matrix shown in Table 1.

We regard the fact that the correlation between R&D expenditure and funding to public research is rather low, though positive, as being consistent with the limited amount of intercourse between private enterprise and the public sector in Italy.

Meanwhile, the surprisingly low correlation between pure research carried out in-house by companies and the funding provided by companies for public research suggests to us that a serious problem, which is also another major anomaly, exists in the Italian system.

A priori, it would have been reasonable to expect the correlation to be closer than that

linking R&D to private funding, given that in advanced economies outsourcing concerns above all pure research activities. Yet, apparently the relationship between industry and public research in Italy is still following the rudimentary pattern whereby companies only turn to public research institutes for direct consultations aimed at resolving specific practical and technological problems (namely, the public sector essentially plays the role of a trouble-shooter).

Table 2 - Coefficients of correlation between some variables at supplier-dominated, scale-intensive and specialised-supplier firms in 2001
(P-values within brackets)

	R&D expenditure	*Funding*	*Basic research expenditure*	*Patents*
Patents	0.34 (.0001)	0.02 (4.45)	0.37 (.0001)	1
Basic research expenditure	0.32 (.0001)	- 0.01 (5.81)	1	
Funding	0.02 (4.56)	1		
R&D expenditure	1			

Source: Istat elaboration RS1-Istat data

Besides, the comparatively tight linkage between the number of patents a company registers and the value of the funds it makes available for public-sector research suggests that a significant proportion of the discoveries made in public sector research are translated into economic goods. In other words, in Italy the situation would allow public policies successfully encouraging science-based companies to exploit scientific and technological resources of the public sector.

As an additional check of our experiment on science-based firms, in Table 2 we provide the reader with the results of similar tests made on the other Italian companies which did research in 2001.

These results are quite interesting and bear out some of the conclusions previously reached when discussing the matrix shown in table 1.

First of all, several sharp differences between estimates in the two tables confirm that the category of science-based firms was well worth singling out. Secondly, the comparatively low correlation between patents and total R&D expenditure is an independent, strong confirmation of the absorption approach: with hindsight, it is not surprising that firms not closely linked with science engage in research to absorb new knowledge rather than produce original one (eventually incorporated in patents). Thirdly, it was only to be expected that the link between public science and industrial research, as measured by the correlation between funding and research expenditure, would be even looser outside the science-based sector.

The public-science factor

These theoretical reflections and empirical findings directly bring our attention to the issue of the production potential possessed by Italy's public science institutes, i.e. the size of the pool of knowledge that academic and public research bodies can provide.

Most academics studying research and innovation accept and widely use a series of indicators that allow them to make objective appraisals of the parameters underpinning productivity in research. The use of these indicators is all the more reasonable when they are applied to entire national research systems and, consequently, to the scientific results produced by a large number or researchers. The broad context of a national system means that any deviations in the scientific quality of a researcher's work will most likely be compensated for by deviations in the other direction by the work of others. Naturally, certain caveats need to be attached to the use of these indicators, though the need for caution

Table 3 – Scientific publications by country (1990-1999)

Country	*1990*		*1999*	
	N.	*%*	*N.*	*%*
United States	179,978	37.56	163,526	30.93
Japan	36,191	7.55	47,826	9.05
United Kingdom	36,671	7.65	39,711	7.51
Germany	27,317	5.70	37,308	7.06
France	21,584	4.50	27,374	5.18
Canada	21,613	4.51	19,685	3.72
Russia	0	0.00	15,654	2.96
Italy	12,295	2.57	17,149	3.24
Australia	12,281	2.56	14,964	2.83
Netherlands	9,585	2.00	10,441	1.98
Spain	6,486	1.35	12,289	2.32
India	8,809	1.84	9,217	1.74
Sweden	7,806	1.63	8,326	1.57
China	4,999	1.04	11,675	2.21
Switzerland	5,550	1.16	6,993	1.32
Israel	4,747	0.99	5,025	0.95
Taiwan	1,993	0.42	5,655	1.07
Other countries	83,308	16.97	75,825	14.34
Total	481,213	100	528,643	100

Source: our elaboration of National Science Foundation data

refers above all to the making of international comparisons or benchmarking operations, where differences may reflect the particular circumstances of one country as opposed to another. Our use of these indicators, however, cannot be censured in this respect, because we are making a diachronic comparison of Italian data only.

We note that in the 1990s an increase took place in the relative volume of Italian research in the scientific literature; this was particularly

true for public-sector research, since most of the publications of the period dealt with the results of research carried out by public institutes (see Table 3). This process happened during a period which and saw an increasing number of competitors, especially scientists from recently developed countries.

The rate at which the Italian public research system is producing fundamental knowledge therefore seems to have increased notably in recent years.

Table 4 – Patents filed in various years by the chief public research institutes and universities of Italy

Research institutes	*1992*	*1995*	*1998*	*2001*
Enea	19	11	18	25
Cnr	64	65	37	53
Infn	0	0	1	0
Infm	-	-	6	13
Universities	5	19	43	100
Total	89	95	105	191

Source: Ceris survey

Yet, as Table 4 below shows, this has not been matched by a corresponding increase in the capacity of public research to convert the fundamental knowledge into technological know-how directly usable by industry. The number of patents produced by Italian public research institutes did indeed grow, but remained tiny, especially if set alongside the 2571 new patents filed in 2001 by 539 of the private companies carrying out R&D.

These findings clearly demonstrate that if we wish to achieve a substantial increase in the contribution our science makes to the system of production and material wealth of the country, we need to take up policies that radically alter the system of incentives for public sector researchers.

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MARIA ZITTINO
Working Papers Coordinator
CERIS-CNR
Via Real Collegio, 30; 10024 Moncalieri (Torino), Italy
Tel. +39 011 6824.914; Fax +39 011 6824.966; m.zittino@ceris.cnr.it; http://www.ceris.cnr.it