

**OECD SCIENCE, TECHNOLOGY AND INDUSTRY OUTLOOK 2004
COUNTRY RESPONSE TO POLICY QUESTIONNAIRE**

ITALY

1. General framework and trends in science, technology and innovation policy in Italy

A new strategy for improving research activities in Italy was defined in the Guidelines for scientific and technological policy, adopted by the Italian Government in 2002. The document outlines a precise design of the priorities which will allow to strengthen the positions already acquired by the Country and to reach excellence in the most technologically promising areas with higher added value.

The new strategic approach is based on the following elements: global competition factors, dynamics of the economic growth in industrialised knowledge-based Countries, analysis of the national innovation system and opportunities provided by EU programmes for scientific research.

Its general goals are:

- 1) support the capacity of the industrial system to exploit the competitive advantage provided by research and innovation;
- 2) improve the ability of the National Research System to favour the modernisation and diversification of the production system and the creation of high-tech companies.

The new approach will be implemented through the following priorities and policy actions:

- Further development of *SMEs' innovation capacity* in order to allow them to take an active part in the global market;
- *Expansion of the traditional manufacturing sectors* through the use of innovative technologies in order to accelerate the transition from a price-based competition to a competition based on the innovation-content of products;
- Creation of *centres of excellence* able to attract Italian and foreign investments in new knowledge-based growth areas;
- Promotion, also by means of innovative finance tools, of the *setting up and development of technology-based enterprises* able to acquire new knowledge;
- Promotion of *academic entrepreneurship of public researchers* in high technology sectors;

- Redefinition of the strategy for the government S&T funding, in order to strengthen the innovative potential of the Southern Italy Regions, mainly through *entrepreneurial activities based on public-private partnerships*;
- Redefinition of the mission of Public Research Institutions, bringing together researchers from private and public sectors and setting up *joint research teams on programmes of high strategic impact*;
- *Increase job opportunities for researchers* both in public and private sectors through a programme aimed at human capital development linked to basic and/or industrial research programmes;
- *Strengthening links between science and business* through a greater mobility of researchers between public and private sectors, the creation of laboratories of public-private technological excellence, research incubators and spin-off companies;
- *Increase quality and quantity of human capital* through an improved University advanced training by means of resources from public research bodies and industrial research laboratories;
- Promotion and support to *independent strategic programmes of Italian universities* aimed at developing scientific excellence; adoption of innovative measures in the advanced training sector

The Guidelines highlight the need to focus on some macro-areas: production systems, informatics and telecommunications, energy, environment, transports, agro-food, health, cultural heritage.

Such areas are characterised by a strong impact: economic (market and employment), social (citizens' need and expectations), on public expenditure (also in terms of reducing costs), and on the competitive position of the national system. Such sectors have to be enriched through the development of specific enabling technologies: biotechnology, advanced informatics, microelectronics and sensors, optoelectronics, laser, biomedical technologies, micro and nanotechnologies, structural and functional materials technologies, chemical technologies and electrochemistry, fluidodynamics and combustion technology, electronics, robotics and advanced planning systems.

The Italian Government has identified four major strategic axis in order to ensure the balanced development of all research activities which concur in generating innovation:

- *Advancing the frontiers of knowledge*: Italy has consolidated and is further strengthening its scientific excellence in basic research areas such as high energy physics, astrophysics, physics of matter, biotechnology, mathematics and optoelectronics. Investments in basic research will improve the scientific standard of the Italian University system and will allow a wider internationalisation of the system itself and of national scientific institutions. The main instruments for allocation of research funds in the first axis are:
 - *Research Programmes of National Interest (PRIN)*: specific research projects yearly funded by the Ministry of Education, University and Research to Italian universities. These projects are co-funded by the University itself, according to a variable percentage that is fixed at the publication of the call. Research activities, contents and methods are freely chosen by proposers.
 - *Fund for the ordinary financing of Public Research Bodies (FOE)*: yearly allocated among bodies and institutions financed by the Ministry for Education, University and Research (MIUR); it includes information concerning the following two years.

- Centres of excellence
 - Research doctorates
 - Post-doc scholarships
 - Large equipment
- *Supporting research activities aimed at developing key multi sector enabling technologies*, through "mission oriented" priority programmes so as to ensure the training of young researchers, an increased exchange of researchers among research networks, the development of joint public/private laboratories, the integration of the national research system in the European Area of networks of excellence, the development of the sector of high added value products for the national industrial system, the development of entrepreneurial capacities within the national research system (spin off). The main instruments for allocation of research funds in this axis are:
 - Fund for Basic Research Investments (FIRB)
 - Special Integrative Fund for Research (FISR): it finances specific actions of strategic interest of different public administrations (Environment, Transport etc.)
 - Fund for the ordinary financing of Public Research Bodies (FOE): yearly allocated among bodies and institutions financed by MIUR; it includes information concerning the following two years.
 - Bilateral Agreements
 - Centres of excellence
 - Research doctorates
 - Post-doc scholarships
 - Large equipment
 - *Strengthening industrial research and technological development*: the strategic importance of strengthening industrial research is linked to the need of the national industry to pursue sustainable competitiveness in order to meet the challenge of globalisation. It is therefore necessary supporting the spontaneous technological growth and innovative capacity of the national industry through tax and financial incentives; re-launching negotiated planning in order to reach a technological leadership in strategic sectors of the national industry (instrumental goods, transport, agro-food industry, cultural heritage, environmental protection); defining programmes in co-operation with regional authorities in order to increase local SMEs system competitiveness. The main instruments for allocation of research funds in the third axis are:
 - *Fund for Research Facility (FAR)*: managed by MIUR, it provides financial incentives to research programmes carried out by industry
 - *Fund for Technological Innovation (FIT)*: managed by the Ministry of Productive Activities to finance research activities linked to technological innovation
 - *Centres of excellence*
 - *Research doctorates*
 - *Post-doc scholarships*

- *Large equipment*
- *Promoting SMEs' innovation capacity in processes and products:* Regions will be involved in the adoption process of the National Research Plan in order to take into account the specific requirements of each area, creating and developing innovation networks across the Country, and increasing the exploitation of the research results in economic and social fields. *Instruments:* the main instruments for allocation of research funds in this axis are:
 - Programme agreements and other actions to implement collaborative projects at local level.

On the basis of the Guidelines, the National Research Plan will be published in the first semester of 2004 (maybe on April).

2. Public sector research and public research organisations

The new approach sets out some guidelines aimed at promoting research and excellence in universities. It foresees increased investments for University Research Plans of National Interest (PRIN), public calls for tender open to professors and researchers, international mobility of researchers, increased grants and benefits for doctorate and post-doctorate courses to be funded within national and international research projects, new doctorate courses providing also highly specialised training for industry, agriculture and the advanced tertiary sector.

Furthermore, new rules and regulations to foster participation, also in financial terms, of industry in the accreditation of doctorate courses, and incentives to create offices for technology transfer and to promote co-operation with private companies, will be introduced. Eventually, financial rewards for universities attaining excellence in basic and applied research and in technology transfer, in partnership with enterprises, will be developed.

As concerns public research institutes, a more clear definition of their role in the National Innovation System seems necessary. The new approach is intended to use knowledge and experience of public research institutes to satisfy the socio-economic system needs. In particular, these bodies should focus on medium-long term objectives and specific priorities in order to achieve a significant pool of resources. Furthermore, a balance between the need of creating spin off and interact with industry, and that of developing basic research, will be also necessary.

The approach to be followed with regard the funding system aims at moving away from current funding practice, based almost exclusively on annual allocations, by separating funds to cover running costs from those deriving from the development of specific research projects. Management aspects of research activities will have to be emphasised. Mechanism allowing the financial participation by other partners, in addition to the public funding, will be activated; besides, activities carried out by inter-university and public-private consortiums in priority sectors will be supported.

3. Government support for private-sector R&D and innovation

The strategy outlined by the Guidelines (2003-2006) aims at encourage actions to overcome some problems of the Italian industrial system. Such system is, in fact, fragmented, specialised in traditional sectors and referred to local market which often does not provide enough stimulus to innovate. Moreover, private research activities are taken forward only by a small number of firms – companies with less than 50 employees carry out 3,2% of the total industrial research.

To overcome such problems, some actions have been identified:

- a stimulus to innovation and the dissemination of technical information, advice and assistance services for firms; the provision of incentives for the creation of industry liaison offices in universities and public research institutes;
- specific funding for universities and public research institutes related to the number of projects in collaboration with industry and according to the quality of results;
- fiscal benefits to firms collaborating with universities, public research institutes and high quality private research centres;
- increased incentives for the recruitment of research doctorates;
- increased incentives for the temporary or permanent transfer of researchers from university to industry;
- funding of joint initiatives between central Government, Regions, provinces, municipalities, and industry, aiming at encouraging new start-ups and spin-offs in high technology sectors.

As regards fiscal benefits, the “*Tecno-Tremonti*” decree was approved by the Italian Parliament on 30th September 2003. It foresees, for the 2004 fiscal period, the tax exception of the enterprise income corresponding to 10% of research and development costs (applied research), recorded among immaterial immobilizations, for product, process and organizational innovations.

Such exception is also applied to expenses for stage in firms destined to higher education and university students, to graduates for which no more than one year passed from the end of the study course.

Furthermore, the decree establish fiscal benefits to Italian researchers resident in foreign Countries, aimed at facilitating their re-entry and beginning of research activities in the next five years. Earnings or payments to manager or researchers will be taxable only of 10% with regard to direct taxation, and totally excepted as concerns the IRAP (Regional Tax for Productive Activities) as they will not concur to the net production. Such benefit is applicable in the tax period in which the researcher becomes resident, in fiscal terms, in Italy and in the two following periods.

4. Policy evaluation

Institutions for evaluation

MIUR is responsible for the evaluation of R&D carried out by public institutions and agencies. The ministry carries out this activity through various means:

- institutional organisations set up by the ministry such as the National Committee for the Evaluation of the University System (CNVSU) and the Committee for R&D Steering and Evaluation (CIVR),
- select committees in charge of the evaluation of research proposals submitted to MIUR in the framework of various R&D financing schemes managed by the ministry,
- experts charged of individual evaluations (the ministry holds a Directory of national and international referees).

CNVSU, which is an official organ on MIUR, has the task to define the general criteria for the evaluation of the university system, as well as to carry our evaluations of their teaching and R&D activities. CNVSU works in co-operation with Evaluation Committees set up in each university. The main output of CNVSU is endorsed in the MIUR yearly report on Italian universities.

CIVR, whose members are appointed by government, promotes R&D evaluation and the setting up of evaluation criteria specifically geared to public research agencies. It carries out yearly evaluations of research agencies supervised by MIUR; such evaluations are based on hearings of agencies' high officials and on self-evaluation reports prepared by each agency. CIVR submits to the minister a yearly Report on agencies' strengths and weaknesses, as emerging from the evaluation process. At the end of 2003 CIVR received a boost to their activities through the approval by the minister of a set of evaluation guidelines and procedures.

Evaluation of university research projects

Until 1993 research in university was financed by MURST (Ministry for University and Scientific and Technologic Research) (the forerunner of MIUR) through two channels: the first one was managed at the local level (60% of the total) and the other one (40%), which was used for the support of inter-university projects of national relevance, was managed by the Scientific Discipline Advisory Committees of MURST's National University Council (CUN). The allocation of the latter turned out to be inefficient in the sense of poor average quality and too many small projects because the selection was left to university professors elected by the constituency who was supposed to receive the funds.

A new procedure has been introduced in 1997 which envisages that project proposals are evaluated by a Committee of national guarantors (7 experts) and 2 or 3 anonymous referees, both national and foreign. This was the first time ever that the Italian university system was systematically reviewed. The new system implied that a Directory of referees was drawn up, project proposals had to be submitted both in Italian and in English, and a telematic procedure was adopted in order to ensure a confidential and quick communication between the guarantors and the referees.

In 1998 1,645 projects were submitted to the Ministry involving some 10,000 research groups and, on average, 44 researchers per project. Projects were reviewed by some 2,000 experts out the 12,000 included in the Directory (4,300 Italian and 7,700 foreign ones). Comparing the results achieved in 1998 with those of the previous year, some positive adjustments have been achieved in terms of improving the "quality" of the proposals submitted:

- a 20 per cent decrease of proposals submitted;
- a significant decrease of the number of research groups per programme, as recommended by the Ministry with the aim of building specific research groups rather than thematic networks;
- a 12 per cent decrease of the total financing requested, even though the maximum share of financing from MURST was raised from 60 to 70 per cent.
- Overall, the system has unanimously been considered a success for various reasons:
- it has made it possible to concentrate the resources on a limited number of large projects, selected on the basis of quality;
- it has helped improve the ability of Italian academics to compete for funding on the basis of international standards;
- it has shown that good evaluation can be introduced in universities, while in the past there was scepticism and even opposition to the spread of evaluation procedures;
- it has helped to diffuse the telematic tools among university teachers and departments which, in many cases, were not appropriately equipped. This has also allowed to avoid using and sending out paper forms in the refereeing process.

- It may be expected that in the coming years the evaluation system, which has been considered as a model in other countries, will undergo a continuous process of improvement and adjustment to changing needs.

5. Human Resources for S&T

Reforming S&T education

The recent university reform supports a better relationship with the labour market through the massive introduction of stages in companies as for many fields of study. In addition, a new post-secondary education path has been created (Integrated Technical and Professional Higher Education – FIS) which is supposed to represent a more professionalizing alternative to the university connecting professional training to secondary school and the university at regional level. In addition, it should be noticed that regular Ph.D. training include one year of “external experiences”, in some fields corresponding to professional training outside the university milieu.

The major problems in the doctorate system have been up to now linked to the length of doctoral studies (from the beginning of university as undergraduate to the end as a PhD, not less than 8 years) and to the extreme specialisation of studies and therefore to a scarce flexibility in terms of labour market demands. The industrial sector moreover, has not shown a particular interest in hiring PhDs, often considered too specialised and so too 'expensive' and old. PhD has in fact been traditionally mostly, if not exclusively, oriented to academic career.

The possible solution is to reactivate existing multidisciplinary structures, shorten training periods and to promote a more flexible training relying on association of universities to public research institutions working in new sectors, as it is stated in the reforms of universities and research institutions, and in the National Research Plan. Both these reforms and the Plan strongly underline the necessity of bridging the gap between academy, research and production. The application of these reforms has still to face some obstacles mostly for the difficulty of a sufficient awareness of the technical, scientific and socio-economic complexities linked to any interdisciplinary activity.

Local arrangements have been done in partnership to support graduates to do part of their training in industry by Universities and public research institutions. The Conference of Rectors (Cru) and the Association of Italian Industrialists (Confindustria) have signed a formal agreement that commits both organisations on common activities to foster co-operation between university and industry.

A relevant example of networking in the university sector can be found in the Network of centers of excellence set up by different Advanced Schools operating in various fields. This network is active with many institutions. The aims of the network are to foster the co-operation of the various School in research activities also through: the joint recruitment of temporary professors that may teach in more than one of the different seats, the temporary mobility of full and associate professors and of students within the network; the joint organisation of undergraduate and graduate courses also in co-operation with public or private institutions; the joint participation in national or international research programmes.

Recent statistics

The newly enrolled in Italian universities in 2003-04 have been 347.000 units. The newly enrolled in scientific disciplines after a long continuous decline until 2000-01 register an increase in 2003-04 compared to the previous academic year: 16% in bio-sciences, 14,6% in earth sciences, 10% in chemistry. The trend is opposite for physics – 4,7%.

In the a.y. 2001-02 there were 4.665 students enrolled in PhD courses in sciences, mathematics and physics and 783 PhD were awarded. Since 1990 the number of PhDs in sciences has constantly grown: from 325 in 1990 to 821 in 2000.

As far as employment is concerned the case of physics in Italy is especially interesting being a particularly well monitored one and can be taken as a test case. We have data spanning over four decades and we can focus on the evolution of the employment of physics graduates. Particularly noteworthy is that the labour market (industry, commerce, banks, finance and insurances etc.) absorbs nowadays nearly half the physics graduates while it was barely 10% in the late Fifties. Conversely, University, research and teaching careers have gone down from over 70% in the Fifties (85% in the Sixties) to slightly over 35% (of which 25% in research and University). The latter data refer to the year 2001 (the last for which we have detailed information).

As already mentioned, Physics is just taken as a test case but the evolution of employment is very much similar in many other scientific careers in Italy.

The conclusion is that scientific studies have a high return in terms of job opportunities not only on the labour market but also as far as world-wide research opportunities go. Furthermore, a closer inspection shows that the quality of job careers is on the medium-high level for mathematical, chemical and physical students (this is not necessarily so in other scientific areas). Therefore, it may be argued that barriers and disincentives in S&T education and career are due to different motivations.

Reducing gender gaps

Although the proportion of women in higher education has continued to increase over the past decades, even to the point of surpassing the share of men attaining tertiary higher education, they still remain under-represented in science and technology. Italy though, has one of the highest share of women among S&E PhDs in OECD Countries.

Analysed from the gender perspective, scientific research in Italy appears governed by mechanisms that do not make the best use of its human resources and professional/intellectual talents. Italian women invest a great deal in their education, studying, obtaining an excellent preparation (they often obtain better results than men), but the labour market doesn't still seem fully aware of their potential.

When they enter the scientific career, it is more likely they remain in lower position longer than man. It is clear that there is a progressively growing gap between men's and women's careers: this is the so-called career "scissors" effect, one of the most constant and regular phenomena that can be measured statistically. The presence of women declines progressively passing from one grade to the other, until they end up being a minority in the top positions. Equal opportunities commissions have been set up in major research Institutions and in most universities there is a "Rector's delegate" for equal opportunities. At the moment no special policy measures have been taken to increase the representation of women inside the science system.

Improving public understanding of science

The commitment to develop a better understanding of experiences and to maintain relations with technical and policy experts involved to make the world better can be assured by science. Science can contribute to establish public credibility, achieve public accountability, and accomplish its missions also through the dissemination of a wide variety of important public health and environmental information. Dissemination of information and training opportunities can be provided by scientists and research institutions. One of the objectives connected with the enhancing of public understanding of science in Italy

is the capacity of making the general public and youth in particular, aware of the importance of preserving the national cultural, scientific and technical heritage.

A co-ordinated effort of public policies for the diffusion of scientific culture and the development of public understanding of science has been set up in 1991. A law has been approved for a proper structure and specific funds aimed at the diffusion of scientific culture (L. 28 marzo 1991, n.113). By the means of that law it has been possible to reorganise and implement the existing activities. Since then the plans for the reorganisation of scientific research prepared by the Minister of Education, Universities and Scientific and Technological Research, has indicated as both the central and local authorities for science policy have to implement the activities concerning the diffusion of science, scientific culture and public awareness.

Most of the Italian scientific and cultural institutions have an explicit policy for the diffusion of science, knowledge and the scientific results they reach, which include the enhancing of public awareness of science. Sometimes this policies may be more implicit than explicit and are embedded in their day to day activity. Some of the most visible initiatives are those linked to the *Science weeks*. Each year an entire week is devoted to the diffusion of scientific culture simultaneously by a great number of institutions. The Ministry of Education, Universities and Scientific and Technological Research co-ordinates all the activities widespread all over Italy, organized by the single participant.

In 2004, during the 14th edition of the Science Week, more than 2000 institutions have been involved: universities, research centres, museum and schools, through initiatives like 'open doors', visits to the laboratories, conferences etc. The specific topics for the 2004 edition have been: Climate change, Energy and Society, Ageing: questions and problems of an ageing population.

One of the last years edition, the 11th, thematic subject was: "One thousand years of Science and Technology". The Ministry suggested a number of topics, leaving to the autonomy of each participant to add any new one. The topics were: history of science and technology, ethical and political implications of scientific and technological research, orienting the media for the diffusion and public understanding of science, new methods for continuing education (life-long learning), teachers' training for science, scientific culture in the schools, the use of new technologies for cultural heritage, for didactic, training and for health.

The National Research Council (CNR) has carried out a number of initiatives to promote and improve public understanding of science. Within the celebrations for its 80th year since the foundation, CNR has organized in 2004 its participation to the Science Week with open laboratories: some 25 thousand students were involved in more than 300 high schools, over 100 CNR Institutes participated in conferences, guided tours of CNR laboratories etc. This year CNR participated also by establishing the "CNR in Tour" programme with and the co-operation of CNR scientists in diffusion activities in over 120 schools

Policies related to international migration and mobility

Italy has recently introduced the "Reverse Brain Drain Project", which is aimed both at attracting foreign professors and scientists and at facilitating the repatriation of Italian scholars abroad.

The program has been set up by the Ministry of Education University and Research (MIUR) also to encourage the return home of Italian scholars who have been operating abroad for at least three years offering a substantial financial incentive to the Universities both for creating openings on stable basis and/or for the temporary research and teaching contracts lasting from a semester to three years period. The Italian government funded additional positions with EUR 20 million per year. Over 100 foreign scholars have been employed in Italian universities, most of them in the fields of mathematics and physics (51%)

and engineering. Also, 63 Italian scholars benefited from the project. The Italian government will continue this project in the coming year.

Though immigration of foreign talent is an issue only recently directly addressed at central level, it should be noticed anyway that the recruitment of foreign talent using the temporary research contract schemes is extensively done by research institutions as for instance by the National Institute for Nuclear Physics, that hires most of its foreign talents from non EU countries.

Tab. 1 Italian graduates in 2002

	Number of graduates	Female
	Total	
Agriculture, forestry and fishery	2.548	887
Architecture and building	9.385	4.591
Arts	3.403	2.528
Business and administration	28.448	13.792
Computing	2.314	469
Education science	8.027	7.370
Engineering and engineering trades	24.426	4.016
Environmental protection	884	517
Health	22.559	15.242
Humanities	235.441	18.986
Journalism and information	3.093	2.160
Law	25.769	15.080
Life sciences	6.726	4.368
Manufacturing and processing	1.328	670
Mathematics and statistics	3.338	2.013
Personal services	4.323	2.221
Physical sciences	3.451	1.433
Security services	1.377	25
Social and behavioural science	18.568	11.701
Social services	2.752	2.532
Teacher training	421	257
Transport services	440	241
Veterinary	1.584	899
TOTAL	198.705	111.998

Source: Miur, 2004

Tab. 2 Number of PhD enrolled in Italian Universities in A.Y. 2001/2002

Sector			
	Male	Female	Total
Agriculture	721	905	1.626
Architecture	473	639	1.112
Biomedicine	698	1.334	2.032
Economics and Statistics	876	767	1.643
Pharmacy	164	407	571
Law	873	805	1.678
Engineering	2.809	996	3.805
Humanities	1.630	2.511	4.141
Medicine and Veterinary	1.009	1.820	2.829
Mathematics Physics and Natural sciences	2.370	2.295	4.665
Political sciences	369	350	719
Other sectors	381	495	876
Total	12.373	13.324	25.697

Source: CNR-Irpps
elaboration on Miur
figures, 2004.

Tab. 3 - Number of PhDs awarded in Italian Universities in 2001

Sector			
	Male	Female	Total
Agriculture	149	187	336
Architecture	76	83	159
Biomedicine	100	187	287
Economics and Statistics	145	147	292
Pharmacy	19	54	73
Law	156	118	274
Engineering	394	182	576
Humanities	214	345	559
Medicine and Veterinary	175	263	438
Mathematics Physics and Natural sciences	392	391	783
Political sciences	29	30	59
Other sectors	31	56	87
Total	1.880	2.043	3.923

Source: CNR-Irpps
elaboration on Miur
figures , 2004.

Table 4 Reverse Brain Drain Project: Italian scholars coming back to Italian universities from abroad. 2002

Agriculture	2
Architecture	4
Economics and Statistics	4
Law	3
Engineering	6
Humanities	14
Medicine and Veterinary	12
Mathematics Physics and natural sciences	16
Political sciences, Sociology	1
Other sectors	1
Total	63

Source: Miur

Table 5 Reverse Brain Drain Project: foreign scholars coming to Italian universities. 2002

Agriculture	3
Architecture	2
Economics and Statistics	5
Law	1
Engineering	15
Humanities	9
Medicine and Veterinary	7
Mathematics Physics and natural sciences	52
Political sciences, Sociology	8
Other sectors	1
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Total	103
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Source: Miur