National Research Council

Statistics on Research and Innovation
ITALY

2007

CERIS

INSTITUTE FOR ECONOMIC RESEARCH ON FIRMS AND GROWTH

This document is published by Ufficio Pubblicazioni e Informazioni Scientifiche - CNR
Director: Mario Apice

Various staff of the Research team on “Institutions and Policies for Science and Technology” of the Rome office of CERIS, most notably, the researchers R. Azzaro, C. Basili, M. De Marchi, E. Lorenzetti, B.M. Potì, E. Reale and M. Rocchi have contributed to the preparation of this publication.

Anna Maria Scarda (associated with CERIS), in addition to her role of supervision participated, with Mario De Marchi, in the planning of the work and in the selection and development of the most significant indicators. All of which effort has found in the considerable and arduous labour of Cinzia Spaziani, who took care of the collection and elaboration of data, not to mention the preparation of diagrams and tables, its just completion. Sincere thanks are extended to all of them by their colleagues.

Foreword

It is my pleasure to present this statistical publication with data on science and technology in Italy in the international context. It is both an information and a work tool. For this reason it presents, where possible, recent data on the human and financial resources employed without carrying out further elaboration to permit analysis of various aspects and utilisation of various methods. In completion of the quantitative picture of research the publication of other indicators, patent applications and patents granted, exchange of technology balance of payments and high technology products, scientific publications in the most important international journals, the operating financial instruments and the principal characteristics of innovative manufacturing companies in Italy.

The entirety of the information on the scale, characteristics and evolution of science and technology shows the commitment of the country to a sector which is of extreme importance for social and economic development and constitutes the basis from which to launch and support fruitful debate.

Angelo Guerrini
Director General of CNR

The Nature and Significance of Indicators on Research and Innovation

The study of indicators on science and technology has constituted one of the traditional veins of research at the Rome office of the Institute for Economic Research on Firms and Growth (CERIS) since the research group was still part of the Institute for Studies on Scientific Research and Documentation (ISRDS).

In this publication a selected collection of the principal indicators traditionally used to describe a state's commitment to research are gathered together. This selection is the fruit of well established conventions and methodological choices regarding, principally, the nature of research and development (R&D), the classification for expenditure on R&D and the scale of a state's economic potential.

For the measurement of this activity precise criteria have been elaborated, by the Organisation for Economic Cooperation and Development among others, which have been uniformly adopted by both member and non-member states. This uniformity is a guarantee of comparability of statistical information on research between states.

According to the Frascati Manual[1] the term research indicates "creative work undertaken on a systematic basis with the aim of increasing the fund of knowledge and the use of that knowledge in devising new applications". This all-embracing definition is sufficient at first analysis to characterise the activity which determines scientific progress and which, in the long term, forms the basis for technological change and development.

Overall internal expenditure on research and development by a statistical entity- be it a state, economic sector or company- is a useful indicator in evaluating the scale and potential of commitment to research. Absolute values

[1] *Ibidem,* OECD, Paris, 2002

for expenditure on research and development are also reported here in terms of constants, that is deflated on the basis of indices related to determined base years. For reasons of simplicity and verifiability this will be done, as is normal and particularly in this case by resorting to the same deflator used for gross domestic product.

As far as regards international comparison of overall volumes of expenditure, we may add to the problem of inflation or deflation of monetary value within each country that of the frequently conspicuous difference between market exchange rates between currencies (which depend also on fickle changes in exchange rate speculation) and the relationship between their effective purchasing powers. This problem is solved by calculating relationships of ideal exchange on the basis of the effective purchasing power of the currency of each country based on a basket of goods common to each country.

5 To make a realistic and balanced evaluation of the degree of effort supported by a state we must take into account the economic size and potential of the state which carries the burden of that effort. Amongst the various measures of the economic potential of a state proposed by economists, that which appears most suitable in considering expenditure on research and development, in order to pass from an absolute value of commitment to research to one of relative intensity, is, in the view of many experts, gross domestic product.

At the systemic level the sources of finance for and the sectors carrying out research are multiple, generating a complex network of inward and outward flows between groups of operators in the research system who are normally schematised in central or local public administration, in the business sector, in the non-profit sector or abroad.

Finally, given that technology is increasingly subject to international exchange in a modern knowledge-based economy, information on balance of payments regarding them are conveniently presented alongside domestic production.

Maurizio Rocchi
Head of Research Unit
"Institutions and Policies for Science and Technology"

Glossary

Research and Experimental Development (R&D) comprise creative work undertaken on a systematic basis in order to increase the stock of knowledge, including knowledge of man, culture and society, and the use of this stock of knowledge to devise new applications.

> *Basic research* is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts, without any particular application or use in view.
>
> *Applied research* is also original investigation undertaken in order to acquire new knowledge. It is, however, directed primarily towards a specific practical aim or objective.
>
> *Experimental development* is systematic work, drawing on knowledge gained from research and practical experience, that is directed to producing new materials, products and devices; to installing new processes, systems and services; or to improving substantially those already produced or installed.

R&D expenditure is all expenditure for R&D carried out within a research unit or sector of the economy, whatever the source of funds. It includes both current and capital expenditures.

Public funding of R&D includes government financing of R&D performed in universities, state agencies and research institutes, other public bodies, non-profit institutions, the business sector, abroad and in international agencies.

R&D appropriations include the funds allocated by central and local governments to R&D units.

Research personnel include three groups of personnel: researchers, technicians and other supporting staff.

- *Researchers* are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned.

- *Technicians* and equivalent staff are persons whose main tasks require technical knowledge and experience in one ore more fields of engineering, physical and life sciences or social sciences and humanities. They participate in R&D by performing scientific and technical tasks, involving the application of concepts and operational methods, normally under the supervision of a researcher. Equivalent staff performs the corresponding R&D tasks under the supervision of researchers in the social sciences and humanities.

- *Other supporting staff* includes skilled and unskilled craftsmen, secretarial and clerical staff participating in R&D projects or directly associated with such projects.

Full-time equivalent (FTE): the number of research personnel performing R&D on a part time basis is reduced to the equivalent number of full-time personnel.

Human resources in science and technology (HRST) identifies the number of people employed or qualified to work in R&D, where a post-secondary or tertiary degree be necessary.

The *Government* sector includes:

- ministries and agencies which depend directly on central Government;
- public research agencies and institutes with budget autonomy;

- local authorities and other public bodies which fund or carry out R&D.

The number of teachers, university students and doctoral students in Italy always refers to an academic year, the number reported by OECD and other international organisations refers to solar years.

Small and medium enterprises (SME) are companies employing up to 249 persons and which satisfy specific financial parameters.

Scientific publications are those included in data bases used by the NSF and consist of scientific and engineering articles published in the set of 5,315 (in 2003) journals covered by the Thomson ISI (Institute of Scientific Information) Science Citation Index (SCI) and Social Science Citation Index (SSCI).

The *patent* for industrial invention represents the right of the inventor to exclusive industrial and commercial use for a limited period and a given country.

The *Technological balance of payments (TBP)* measures the "invisible" transactions in a country's balance of payments. These relate to the purchase and sale of technological know-how and information, such as patents, licences, trademarks, designs, know-how and closely related technical services (including technical assistance) and for industrial R&D carried out abroad.

Data on *technological innovation* refer to those Italian manufacturing firms which have introduced, in the period 2002-2004, technologically new or substantially improved products or processes, defined as those requiring changes or advances in the underlying technology. Technology is defined as knowledge, competence, entrepreneurial capaci-

ty, equipment, procedures and technical solutions necessary for the production of a good.

The *Gross domestic product (GDP)* includes the total production of goods and services of a country's economy in a given year, less intermediate consumption and plus indirect taxation on imports.

The *GDP deflator* is the ratio between GDP at current prices and GDP at constant prices. The basis year is 2000.

Purchasing power parities (PPP) are exchange rates measuring the ratio of purchasing power in terms of a basket of goods and services between two currencies. In this data book the OECD purchasing power parities have been used.

The 15 EU countries are: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Italy, Ireland, Luxembourg, Netherlands, Portugal, United Kingdom, Spain, Sweden.

China (which shows a significant development in its scientific activity) and Israel (which traditionally invests a remarkable share of its national income in research) have sometimes been added to selected OECD countries.

ABBREVIATIONS

CNR	Consiglio nazionale delle ricerche (*National Research Council*)
CNVSU	Comitato nazionale per la valutazione del sistema universitario (*National Committee for the Evaluation of the Research System*)
EPO	European Patent Office
ESA	European Space Agency
EUROSTAT	*Statistical Office of the European Community*
EVCA	European Private Equity & Venture Capital Association
ISTAT	Istituto nazionale di statistica (*National Institute of Statistics*)
JPO	Japanese Patent Office
MIUR	Ministero dell'università e della ricerca (*Ministry of University and Research*), MUR since the 18 of May 2006
NSF	National Science Foundation
OECD	Organisation for Economic Co-operation and Development
EU	European Union
UIC	Ufficio italiano dei cambi (*Italian Exchange Office*)
USPTO	United States Patent and Trademark Office

TABLE OF CONTENTS

1. R&D data

2. Government sector

3. University

4. Business enterprise sector

5. Policy measures for science and technology in Italy

6. R&D personnel in Italy

7. Patents

8. Articles and citations

9. Technological Balance of Payments

10. Trade in high-technology products

11. Innovation

1. R&D data

Data presented in this section are necessary to estimate the amount of R&D activity in the country and place it in the international context; data sources are the National Institute of Statistics (ISTAT) for Italy and OECD for international comparisons. Since 2002 ISTAT has been identifying the non-profit sector, setting it alongside the other institutional sectors made up of government, university and firms.

In this section, the role of the institutional expenditure sectors and financing sources is emphasised. Furthermore Figure 1.1 allows the reader to estimate the trend of R&D expenditure since 1980. Figure 1.2 presents the expenditure over the last decade, broken down into the principal institutional sectors; Figure 1.3 highlights investment by various institutional sectors into basic research, applied research and experimental development. The human and financial resources of the Italian regions for scientific activity are also shown (Figures 1.4, 1.5, 1.6).

The R&D expenditure over GDP ratio represents the size of investment in science over the wealth generated by a country. It is the most widely used indicator in international comparisons (Table 1.3).

Also in international comparisons, we refer to institutional sectors of R&D expenditure (Figures 1.7, 1.8) and funding (Figure 1.9). Figures 1.10 and 1.11 show the situation in 2004 regarding financial and human resources in several countries.

Table 1.4 presents a set of performance indicators concerning the economy and knowledge in Italy and other

large European countries, which are useful in comparing a country's technological and economic evolution in a recent period.

Figure 1.12 shows expenditure on research, higher education and software (net of duplications) incurred by several OECD countries. These expenses are considered fundamental for economic growth generating new jobs and achieving a higher standard of living.

Table 1.1 - R&D expenditure in Italy, 1975-2006

(million current euros)

Institutional sectors	*1975*	*1980*	*1985*	*1990*	*1995*	*1996*	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*	*2005(a)*	*2006(a)*
Government sector	135	372	1,126	1,839	1,949	1,976	2,093	2,316	2,213	2,356	2,493	2,565	2,582	2,722	2,738	2,869
Research agencies					*1,618*	*1,618*	*1,675*	*1,863*	*1,757*	*1,886*	*1,923*	*2,115*	*2,113*	-	-	-
Other public institutions					*331*	*358*	*418*	*453*	*456*	*470*	*570*	*450*	*469*	-	-	-
University	132	241	904	1,821	2,349	2,625	3,319	3,595	3,627	3,865	4,418	4,792	5,000	5,004	-	-
Private non-profit institutions												186	208	233	282	304
Business	336	883	2,686	5,120	4,928	5,292	5,377	5,533	5,684	6,239	6,661	7,057	6,979	7,293	7,806	8,101
Total	603	1,496	4,717	8,780	9,226	9,893	10,789	11,444	11,524	12,460	13,572	14,600	14,769	15,252	-	-
Total (2000 constant prices)	5,257	5,900	9,571	12,738	10,555	10,758	11,441	11,829	11,754	12,460	13,178	13,714	13,461	13,507	-	-

Notes: Since 1995 only intramural R&D expenditure is considered. (a) ISTAT estimate on provisional data released by enterprises, public institutions, private non-profit institutions.
Source: ISTAT

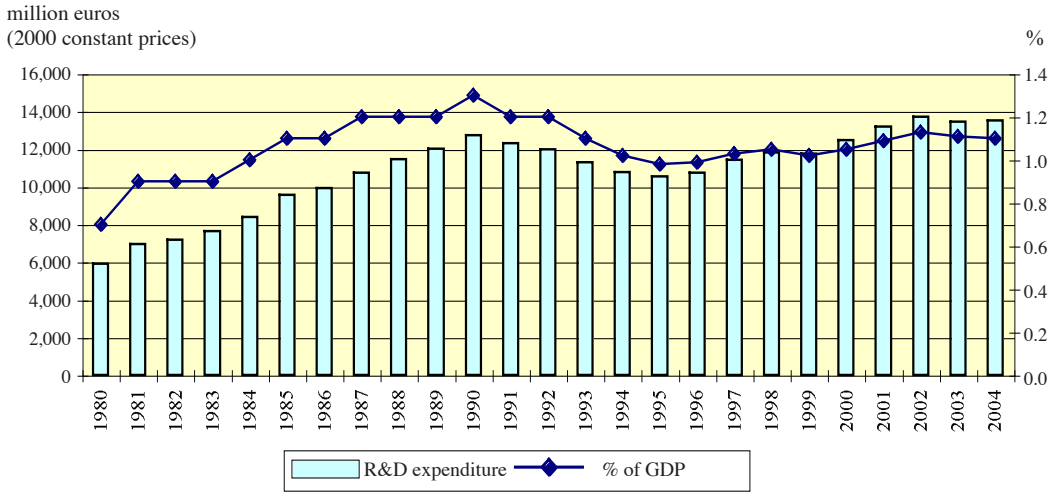
Table 1.2 - R&D expenditure by source of funds in Italy, 1997-2004

(percentages)

Source of funds	*1997*	*1998*	*1999*	*2000*	*2001*	*2002*	*2003*	*2004*
				Government sector expenditure				
Business enterprise sector	1.4	1.1	1.1	1.7	3.5	3.4	1.2	2.9
Government	93.3	94.6	94.8	93.3	87.0	90.5	92.2	88.2
University	0.1	0.0	0.1	0.1	0.3	0.3	0.1	0.1
Private non-profit sector	2.7	1.2	1.3	1.1	5.2	1.6	1.7	3.0
Abroad	2.5	3.0	2.8	3.8	4.0	4.3	4.9	5.8
Total million euros (2000 constant prices)	2,220	2,394	2,258	2,356	2,421	2,409	2,353	2,411
				Business sector expenditure				
Business enterprise sector	77.5	80.8	78.7	80.5	78.2	77.4	76.1	75.1
Government	13.1	11.0	13.0	11.0	14.9	12.2	14.1	13.8
University	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0
Private non-profit sector	0.4	0.2	0.2	0.3	0.3	0.1	0.1	0.1
Abroad	9.0	8.1	8.1	8.2	6.6	10.3	9.6	11.0
Total million euros (2000 constant prices)	5,702	5,719	5,799	6,239	6,468	6,629	6,361	6,459
				Private non-profit institutions expenditure				
Business enterprise sector	-	-	-	-	-	12.7	9.5	9.7
Government	-	-	-	-	-	44.1	36.0	34.5
University	-	-	-	-	-	0.5	0.3	0.2
Private non-profit sector	-	-	-	-	-	36.8	48.2	48.8
Abroad	-	-	-	-	-	5.9	6.0	6.8
Total million euros (2000 constant prices)						175	190	206

Note: Data for private non-profit sector are available from 2002 onward. Data concerning university are not available.
Source: ISTAT

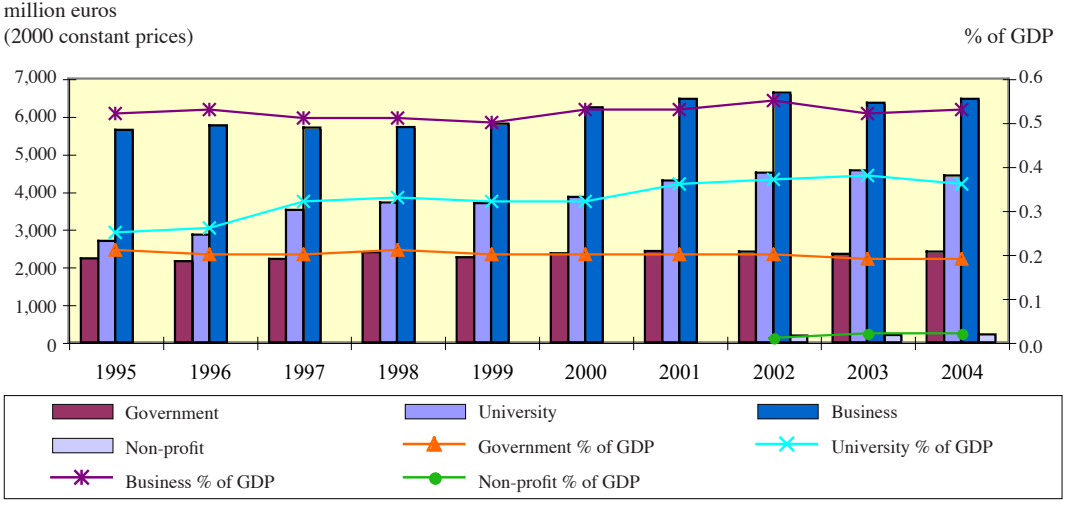
Figure 1.1 - R&D expenditure over GDP in Italy, 1980-2004



Note: Since 1995 only intramural R&D expenditure is considered.

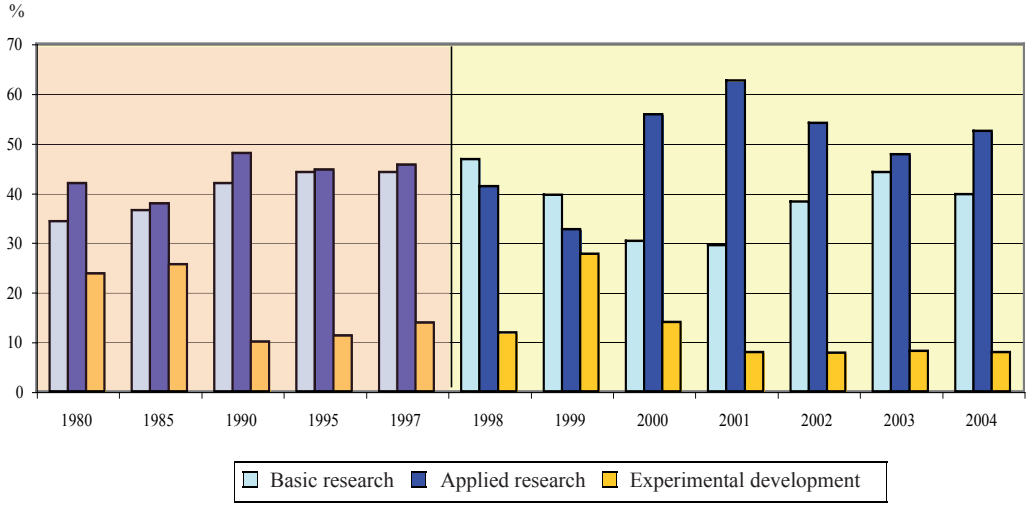
Source: CERIS-CNR elaboration on ISTAT data

Figure 1.2 - R&D expenditure by institutional sector over GDP in Italy, 1995-2004



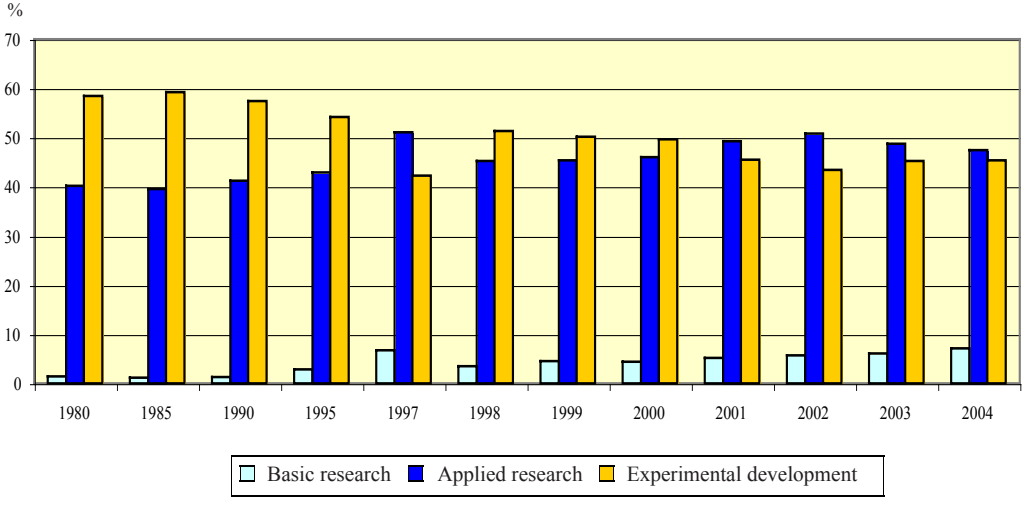
Source: CERIS-CNR elaboration on ISTAT data

Figure 1.3a - Governmental R&D expenditure by type of research in Italy, 1980-2004



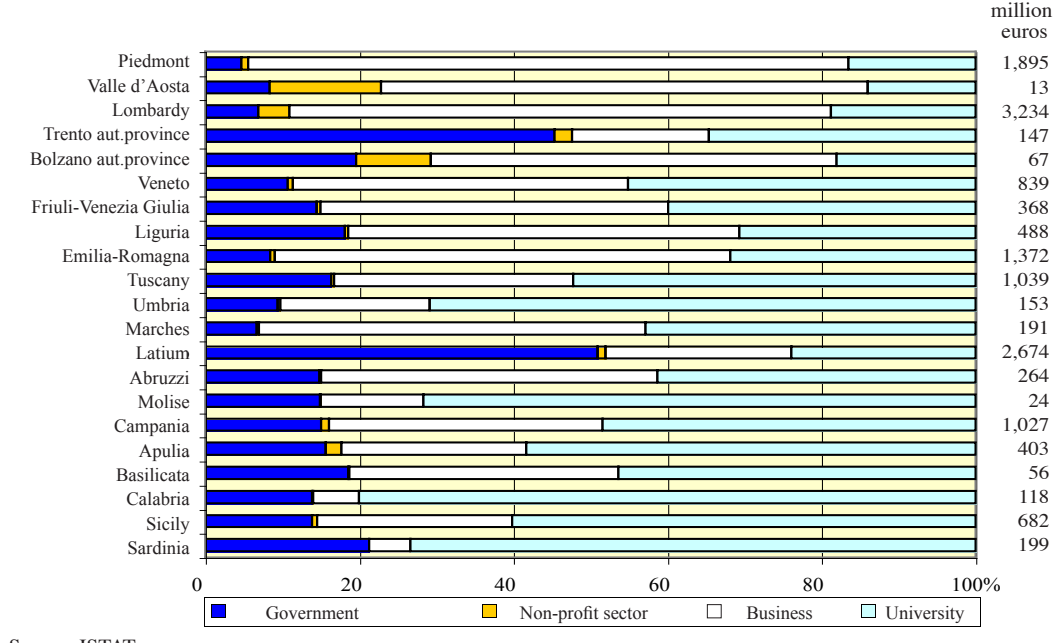
Note: In 1980-1997 university R&D expenditure is included too. Comparisons with subsequent values are not possible.
Source: CERIS-CNR elaboration on ISTAT data

Figure 1.3b - Company R&D expenditure by type of research in Italy, 1980-2004



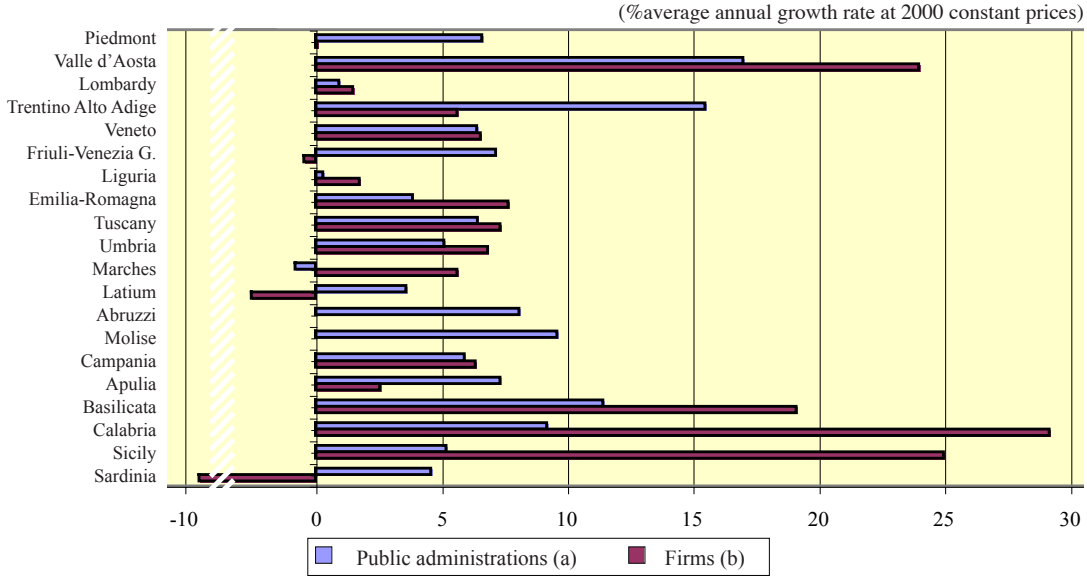
Note: Since 2002 the business sector includes R&D expenditure by private non-profit institutions.
Source: CERIS-CNR elaboration on ISTAT data

Figure 1.4 - R&D expenditure by institutional sector and region in Italy, 2004



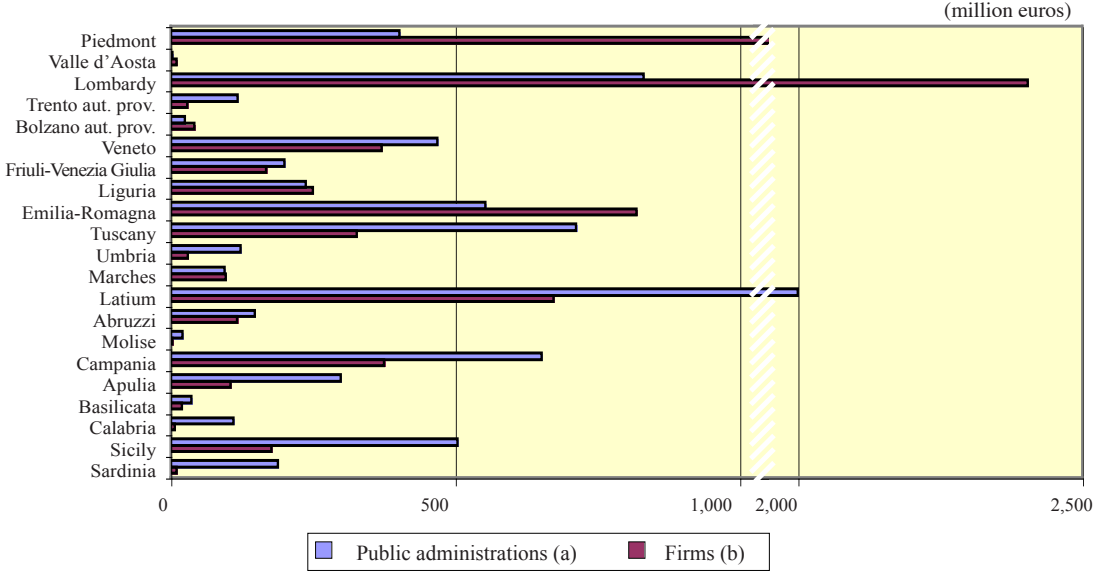
Source: ISTAT

Figure 1.5 - Trends in R&D government and company expenditure by region in Italy, 1997-2004



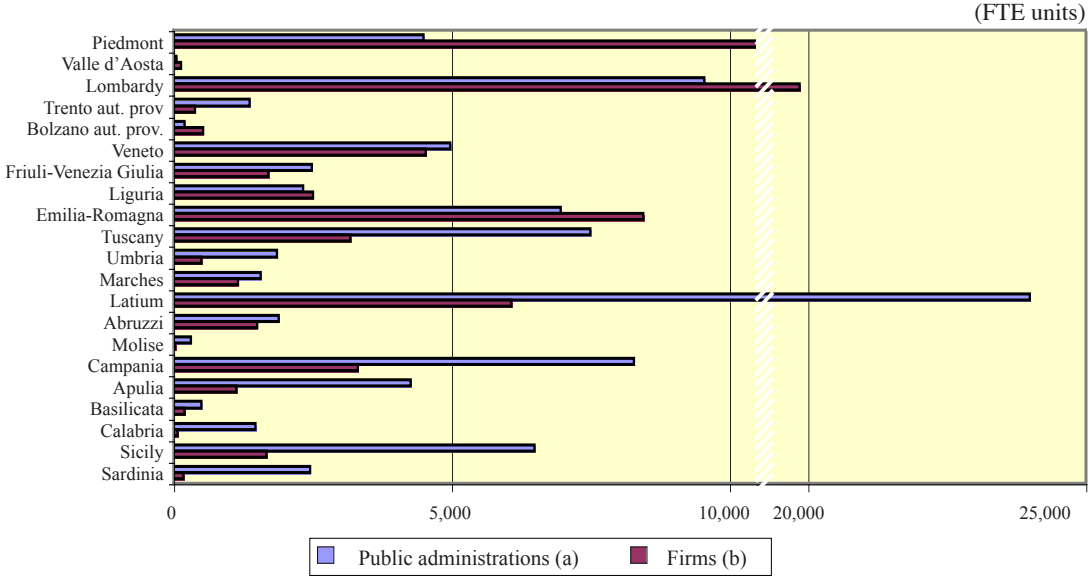
Notes: (a) sum of university and public administrations; (b) sum of firms and private non-profit institutions.
Source: CERIS-CNR elaboration on ISTAT data

Figure 1.6a - R&D expenditure by main institutional sector and region in Italy, 2004



Notes: (a) sum of public administrations and university; (b) sum of firms and private non-profit institutions.
Source: ISTAT

Figure 1.6b - Research personnel by main institutional sector and region in Italy, 2004



Notes: (a) sum of public administrations and university; (b) sum of firms and private non-profit institutions.
Source: ISTAT

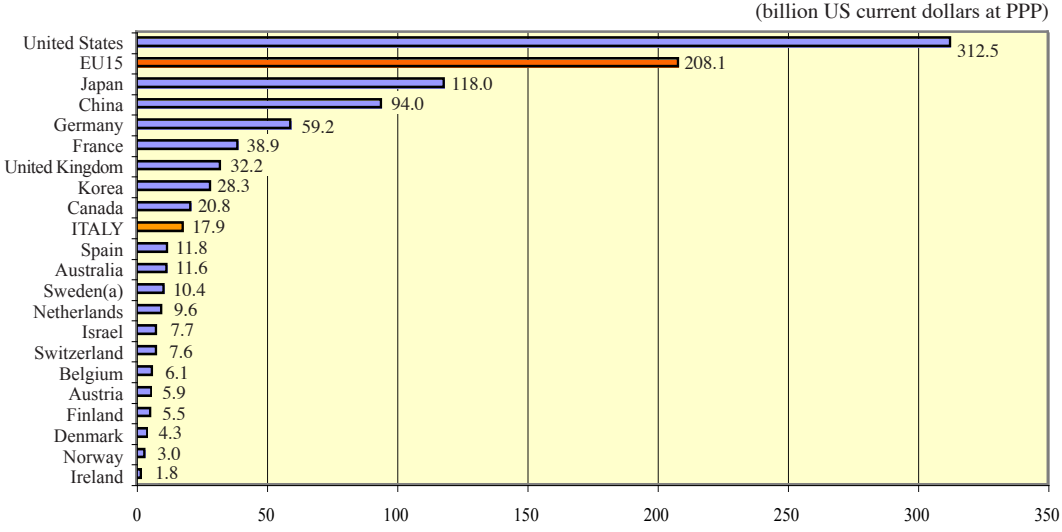
Table 1.3 - R&D expenditure in several OECD countries, China and Israel, 1981-2005

(million US dollars - 2000 constant prices and PPP)

	1981	1985	1990	1995	2000	2001	2002	2003	2004	2005(a)
Australia	2,589	..	4,704	..	7,931	..	9,491	..	10,585	..
Austria	1,573	1,863	2,436	3,063	4,404	4,719	4,961	5,223	5,392	5,833
Belgium	..	2,999	..	3,994	5,383	5,726	5,442	5,328	5,383	5,343
Canada	6,286	8,067	9,874	12,094	16,724	18,570	18,666	18,671	19,371	19,613
Korea	..	..	..	14,679	18,387	20,659	21,607	23,151	26,228	28,686
Denmark	999	1,316	1,840	2,430	..	3,697	3,902	4,010	3,964	4,016
Finland	968	1,447	2,049	2,422	4,514	4,576	4,725	4,916	5,130	5,311
France	19,266	23,655	30,040	31,327	33,800	35,214	36,111	35,488	35,880	36,076
Germany	29,551	34,827	41,004	41,621	51,543	52,323	52,941	53,547	53,751	54,525
Japan	42,795	58,297	80,360	83,546	98,804	101,599	103,280	105,807	107,719	..
Ireland	266	331	449	871	1,232	1,276	1,359	1,484	1,614	1,770
ITALY	8,600	11,839	15,754	13,054	15,412	16,300	16,961	16,649	16,708	..
Norway	1,071	1,520	..	2,015	..	2,621	2,685	2,812	2,809	2,856
Netherlands	4,718	5,593	6,846	7,289	8,241	8,303	7,942	8,118	8,393	..
United Kingd.	21,470	22,637	25,466	25,092	27,991	28,237	28,762	28,846	28,819	..
Spain	1,929	2,689	5,164	5,509	7,700	8,046	8,911	9,769	10,233	11,098
United States	123,164	165,392	186,741	199,884	267,768	271,286	265,122	274,791	285,575	..
Sweden	3,519	4,837	..	6,819	..	10,356	..	9,977	..	10,386
Switzerland	3,463	..	..	..	5,622	..	..	..	6,633	..
EU15	96,330	114,738	141,066	145,053	175,885	181,915	185,237	186,464	189,221	192,286
China	..	..	..	18,895	44,775	51,066	62,706	73,072	87,290	104,661
Israel	..	..	..	3,258	6,996	7,440	7,434	7,010	7,279	8,154

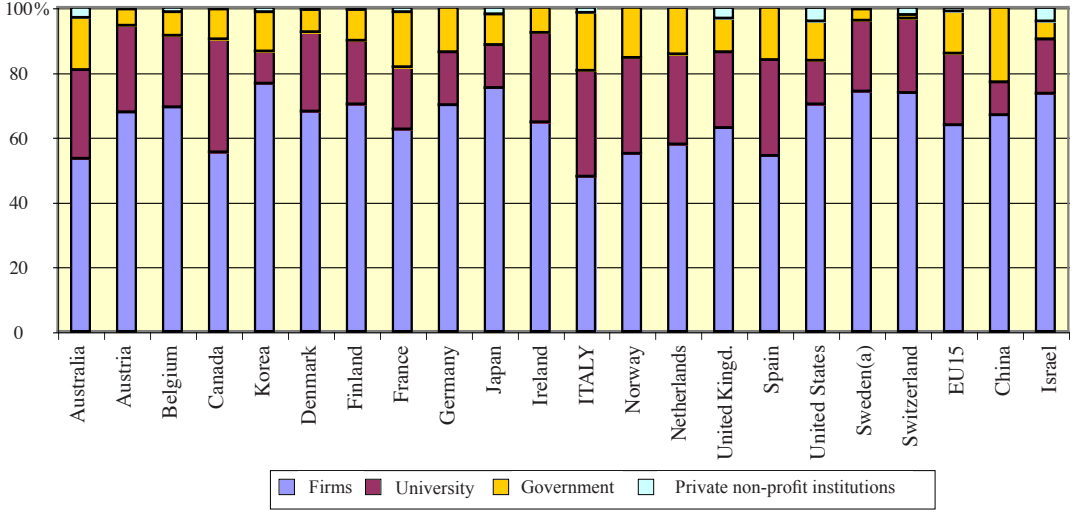
Note: (a) provisional.
Source: OECD

Figure 1.7 - R&D expenditure in several OECD countries, China and Israel, 2004



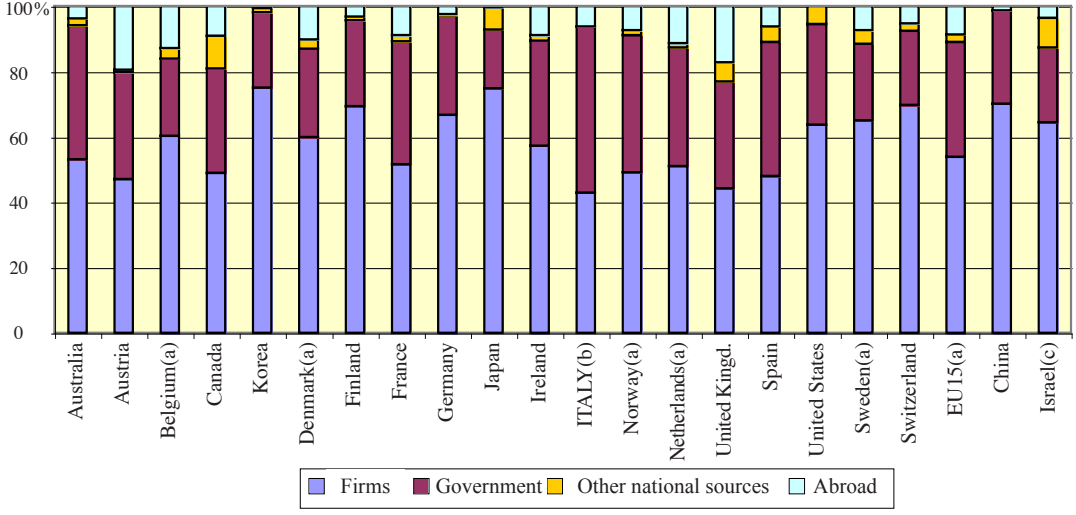
Note: (a) 2003.
Source: OECD

Figure 1.8 - Intramural R&D expenditure by institutional sector in several OECD countries, China and Israel, 2004



Note: (a) 2003.
Source: OECD

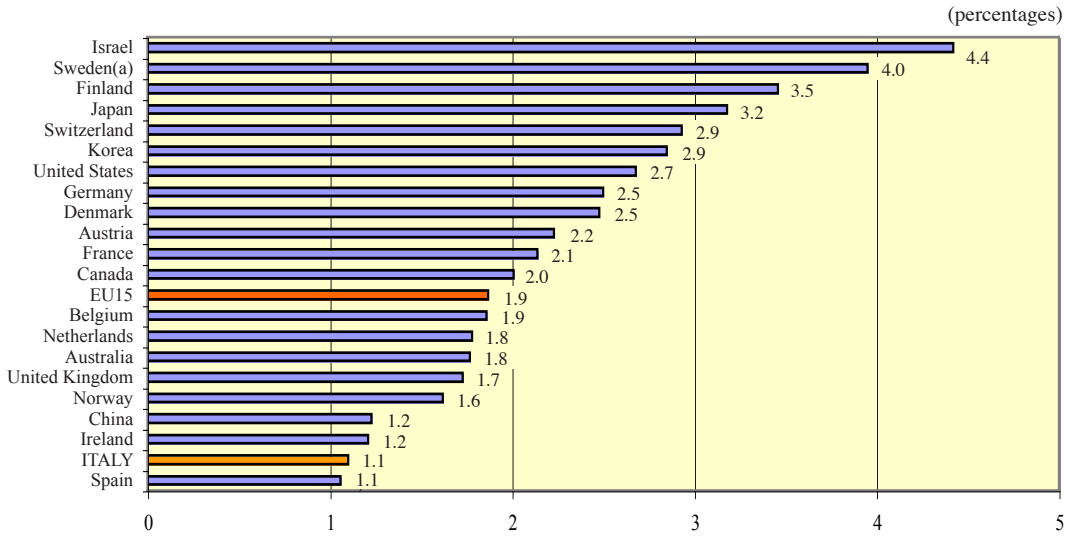
Figure 1.9 - R&D expenditure by financing sector in several OECD countries, China and Israel, 2004



Notes:(a) 2003; (b) 1996; (c) 2002.

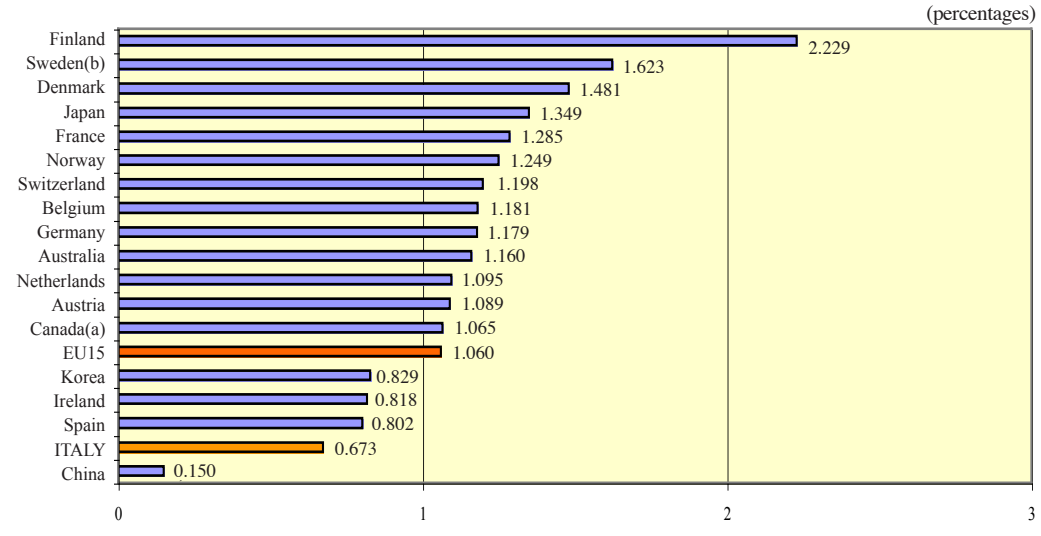
Source: OECD

Figure 1.10 - R&D expenditure over GDP in several OECD countries, China and Israel, 2004



Note: (a) 2003.
Source: OECD

Figure 1.11 - Research personnel over labour force in several OECD countries and China, 2004



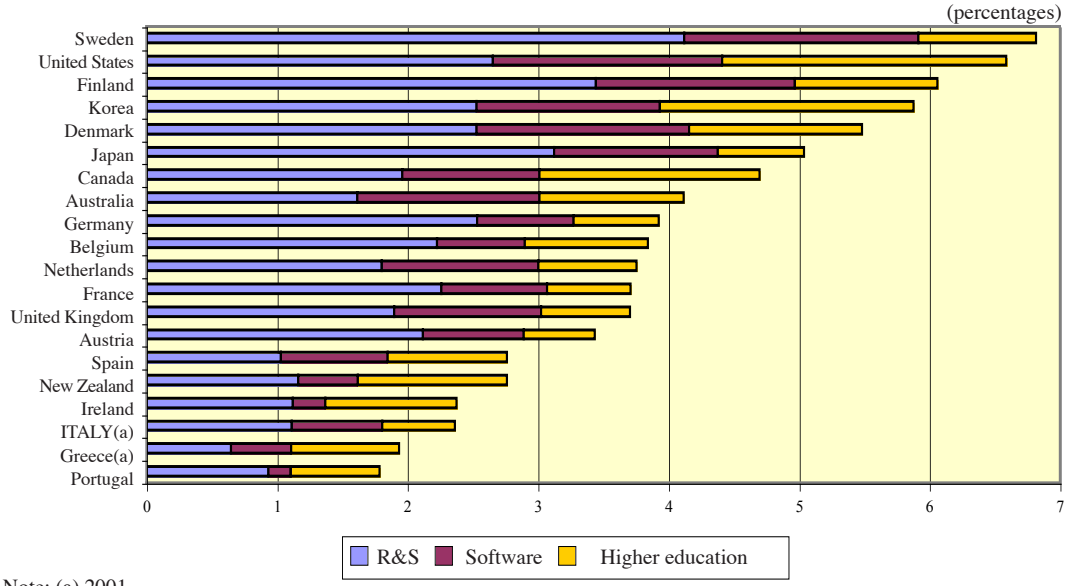
Notes: (a) 2002; (b) 2003.
Source: CERIS-CNR elaboration on OECD data

Table 1.4 - Performance indicators concerning the economy and knowledge in Italy and other European countries, 2002 and 2003

Indicators	*Years*	*ITALY*	*France*	*Germany*	*Spain*	*United Kingdom*
			Performance			
GDP per capita in pps (EU15=100)(a)	2003	98.4	103.5	99.3	87.3	108.7
Labour productivity (EU15=100)	2003	106.0	113.6	95.7	95.7	97.0
Educational attainment (20-24 years) (%)(b)	2003	69.9	81.1	73.3	63.4	78.2
R&D expenditure (% of GDP)	2002	1.1	2.2	2.5	1.0	1.8
Business investment (% of GDP)	2002	17.8	16.4	16.9	21.8	15.0
			Average annual % change			
GDP per capita (c)	1999-2003	1.2	1.3	0.8	2.1	2.5
Labour productivity (c)	1999-2003	-0.1	0.4	0.8	0.6	1.7
Educational attainment (20-24 years) (b)	1999-2003	0.9	0.3	-0.3	-0.4	0.7
R&D expenditure	1999-2002	0.03	0.01	0.02	0.04	0.00
Business investment	1999-2002	0.40	0.07	-0.90	0.33	-0.33

Notes: (a) purchasing power standard; (b) % of graduated between 20 and 24 years; (c) change rate at constant prices.
Source: EU Commission, Doc. COM (2004) 29 def/2

Figure 1.12 - Investment in the production of scientific and technological knowledge over GDP in several OECD countries, 2002



Note: (a) 2001.
Source: OECD Science, Technology and Industry Scoreboard 2005

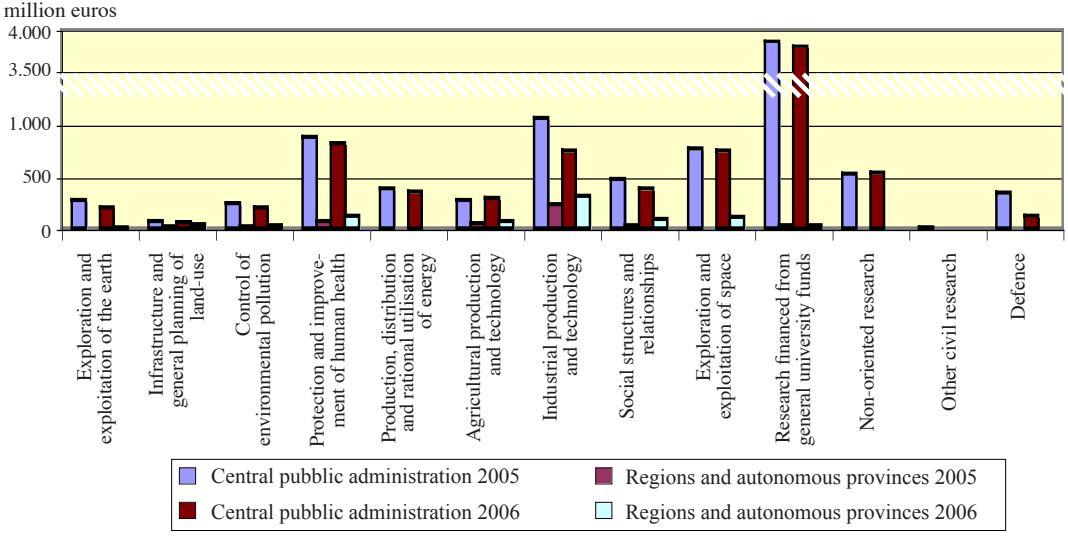
2. Government sector

This section is devoted to both government appropriations and their expenditure. The sources of data are ISTAT and OECD for the others.

Figure 2.1 breaks down Italy's public appropriations by socio-economic objectives in 2005 and 2006. The following two figures widen the perspective to include diverse industrialised countries, following a similar subdivision adopted by OECD: Figure 2.2 refers to civil appropriations and allows the reader to understand the remarkable differences in the destination of public investment in the various countries; Figure 2.3 underlines the weight of defence R&D.

Other figures describe R&D investment by public administrations: Figure 2.4 shows R&D expenditure by public administrations in industrialised countries; Figures 2.5 and 2.6 show both financial resources over GDP and research personnel as a percentage of employees.

Figure 2.1 - Government appropriations for R&D by socio-economic objectives in Italy, 2005 and 2006



Note: Data drawn from final budget. Data for previous years not available due to statistical discrepancy.
Source: ISTAT

Figure 2.2 - Government appropriations for R&D over civil budget by large socio-economic objectives in several OECD countries, 2005

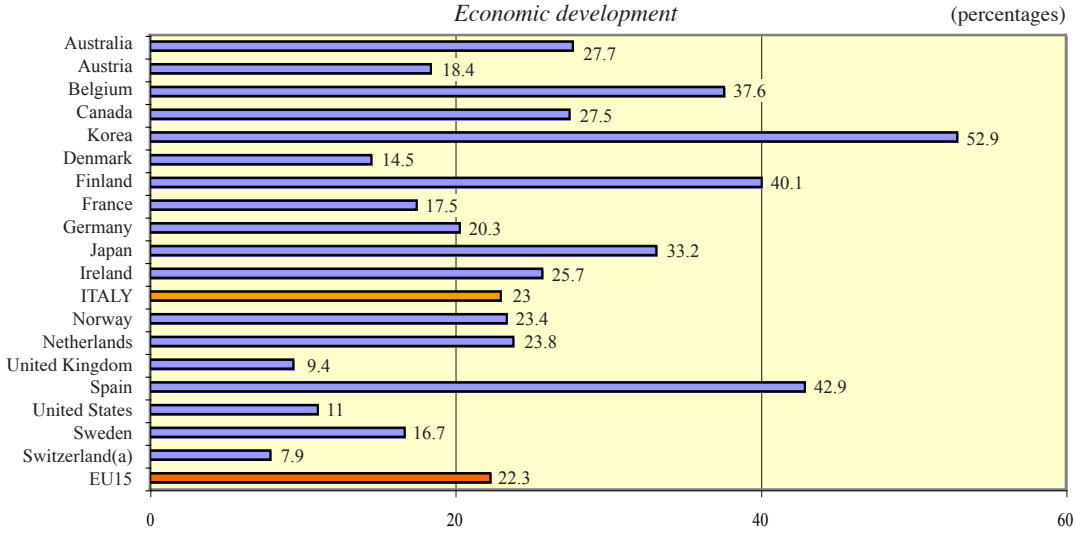


Figure 2.2 (cont.)- Government appropriations for R&D over civil budget by large socio-economic objectives in several OECD countries, 2005

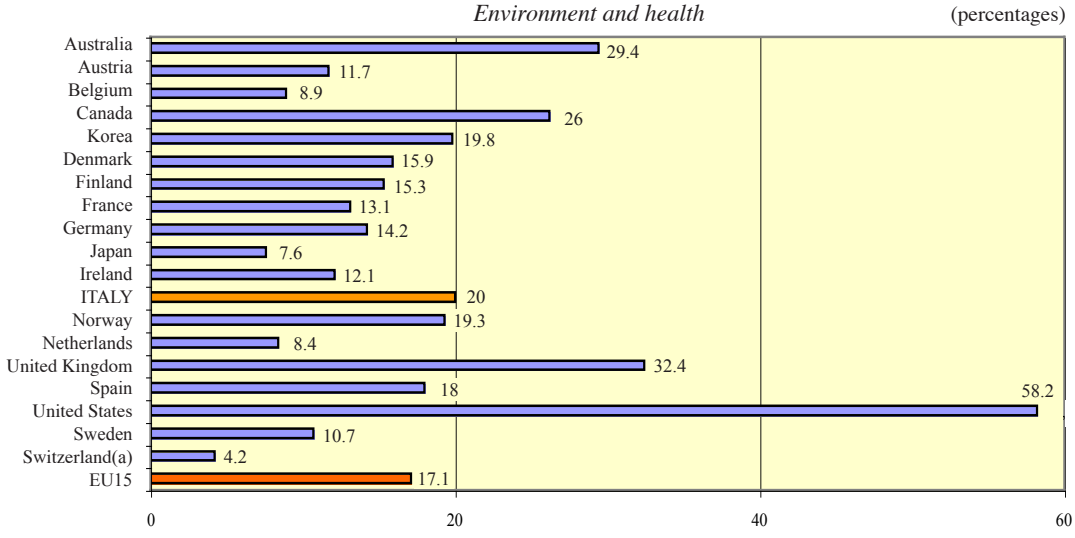


Figure 2.2 (cont.)- Government appropriations for R&D over civil budget by large socio-economic objectives in several OECD countries, 2005

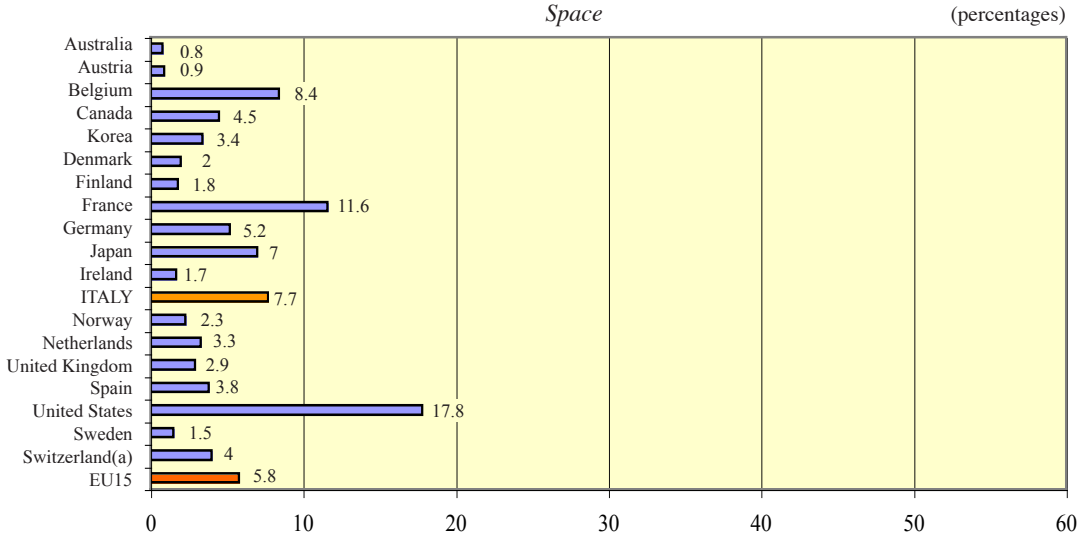


Figure 2.2 (cont.)- Government appropriations for R&D over civil budget by large socio-economic objectives in several OECD countries, 2005

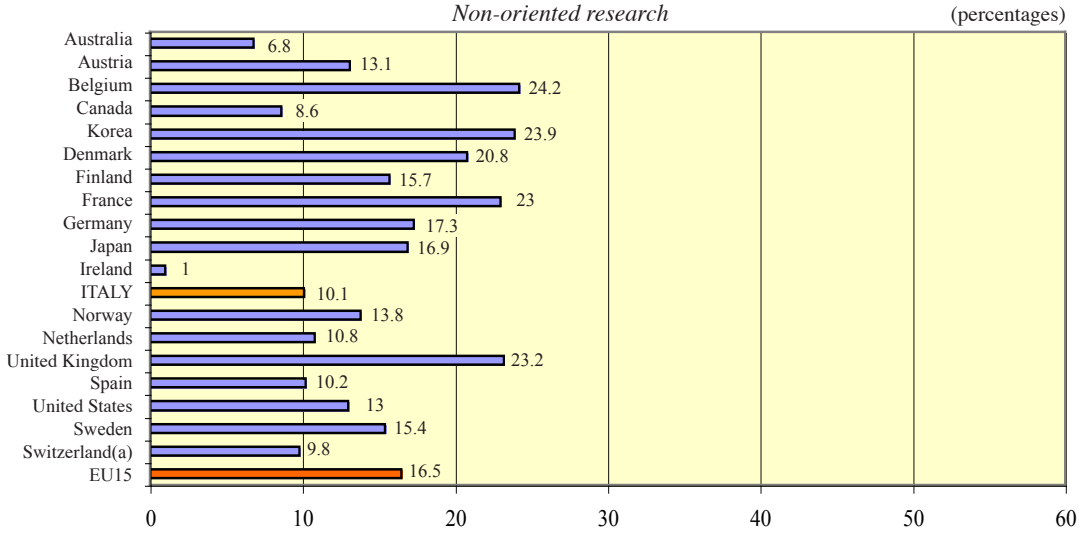
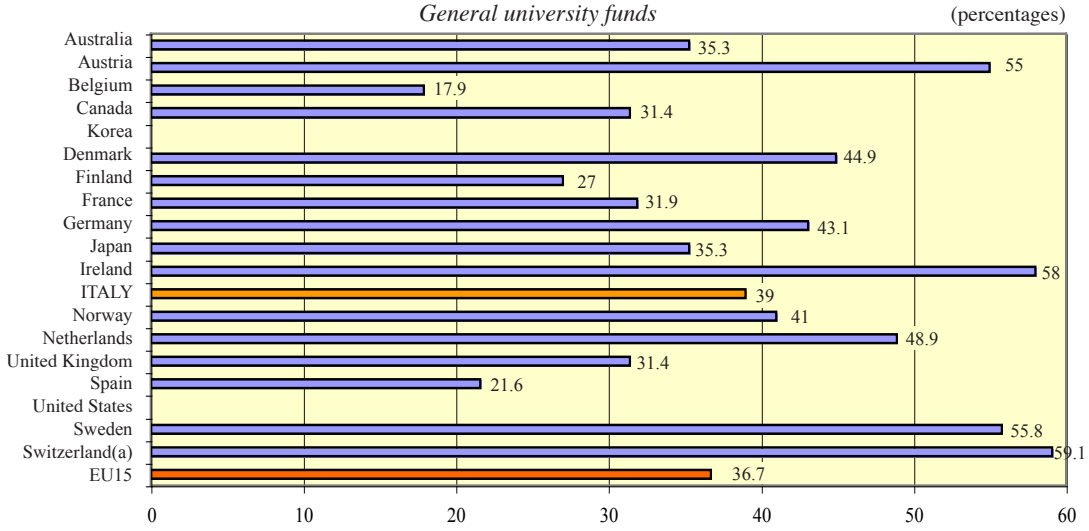
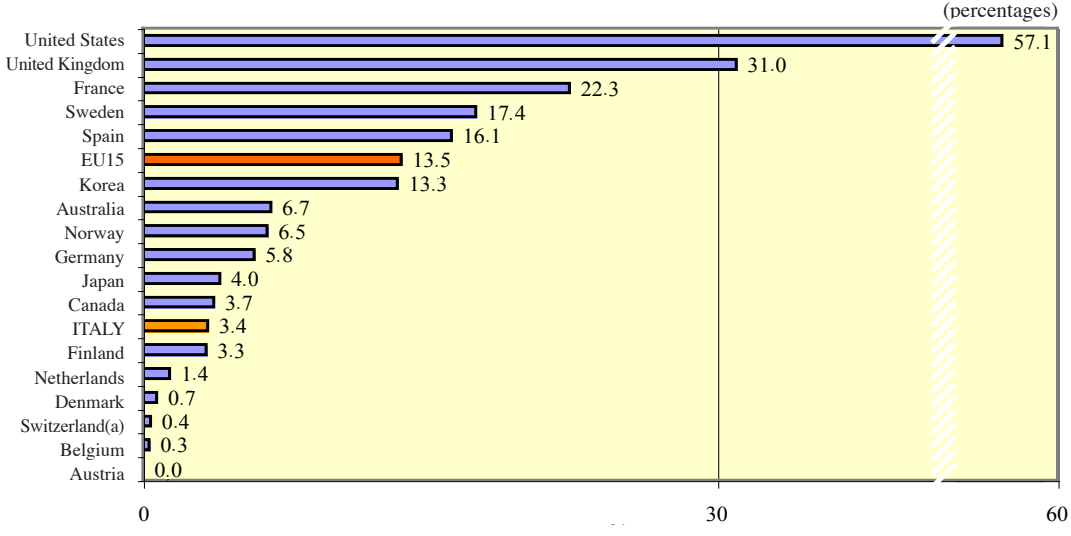


Figure 2.2 (cont.)- Government appropriations for R&D over civil budget by large socio-economic objectives in several OECD countries, 2005



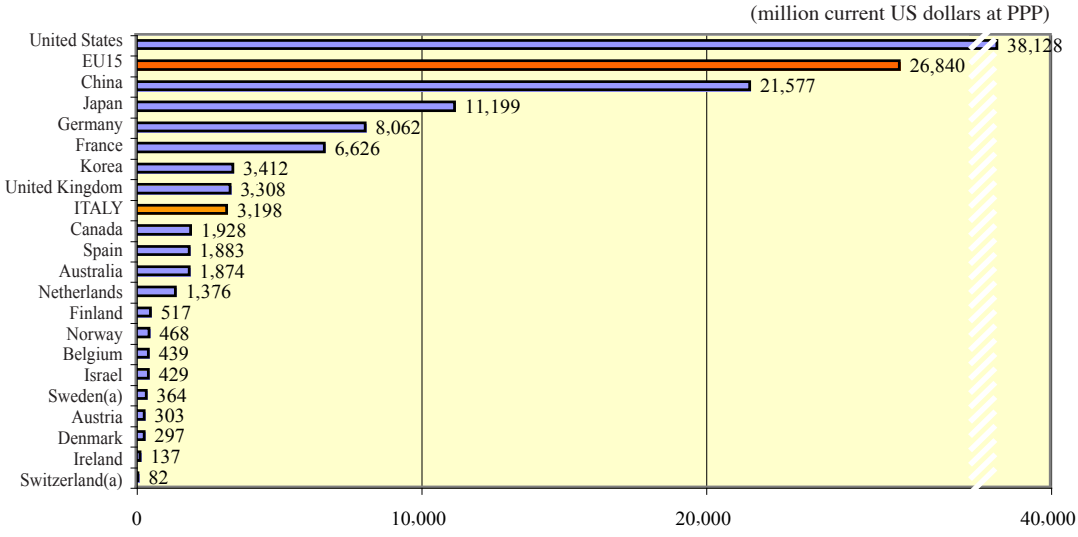
Note: (a) 2004.
Source: OECD

Figure 2.3 - Government appropriations for R&D in the sector of defence over total appropriations in several OECD countries, 2005



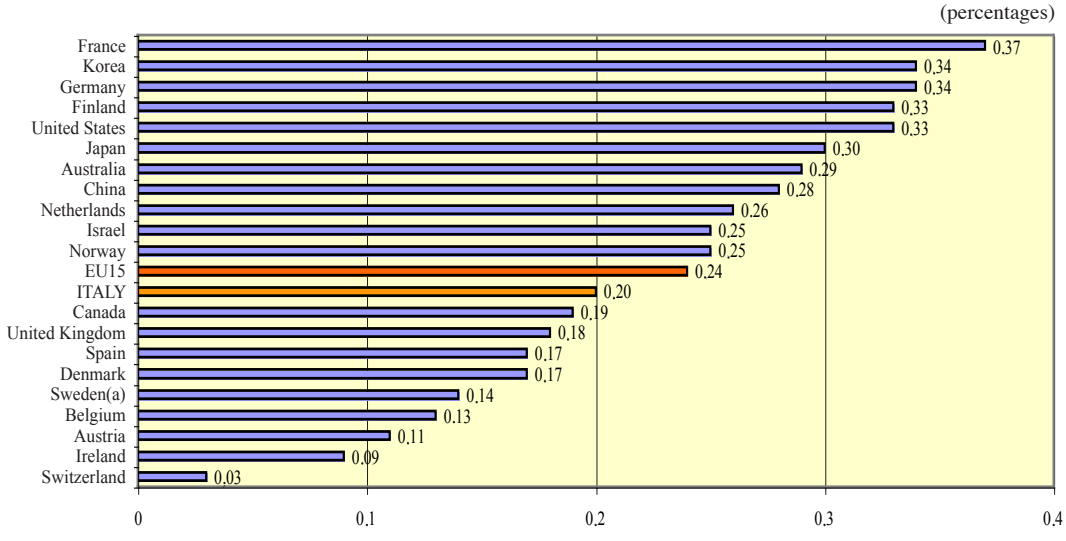
Note: (a) 2004.
Source: OECD

Figure 2.4 - Government intramural R&D expenditure in several OECD countries, China and Israel, 2004



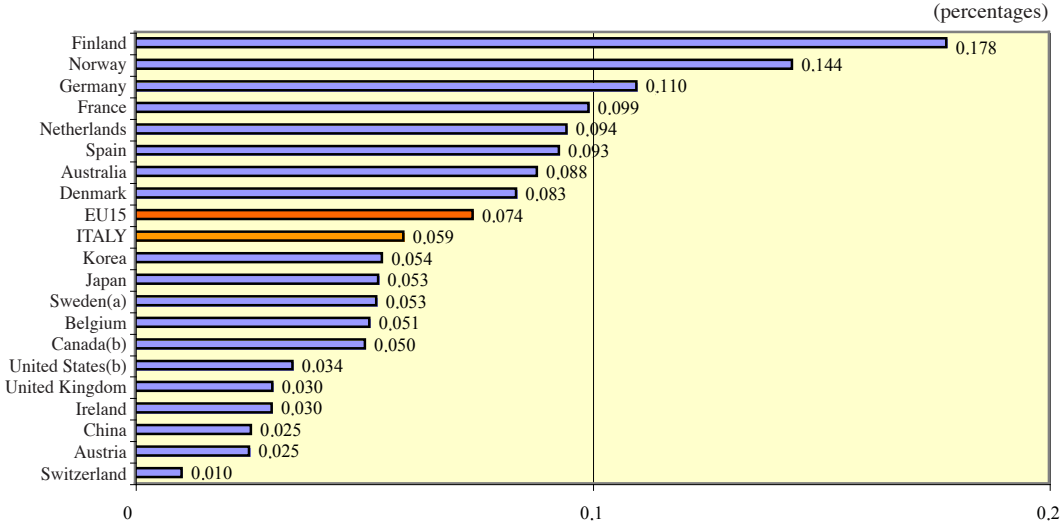
Note: (a) 2003.
Source: OECD

Figure 2.5 - Government intramural expenditure over GDP in several OECD countries, China and Israel, 2004



Note: (a) 2003.
Source: OECD

Figure 2.6 - Research personnel in public administration over total employees in several OECD countries and China, 2004



Notes: (a) 2003; (b) 2002.
Source: CERIS-CNR elaboration on OECD data

3. University

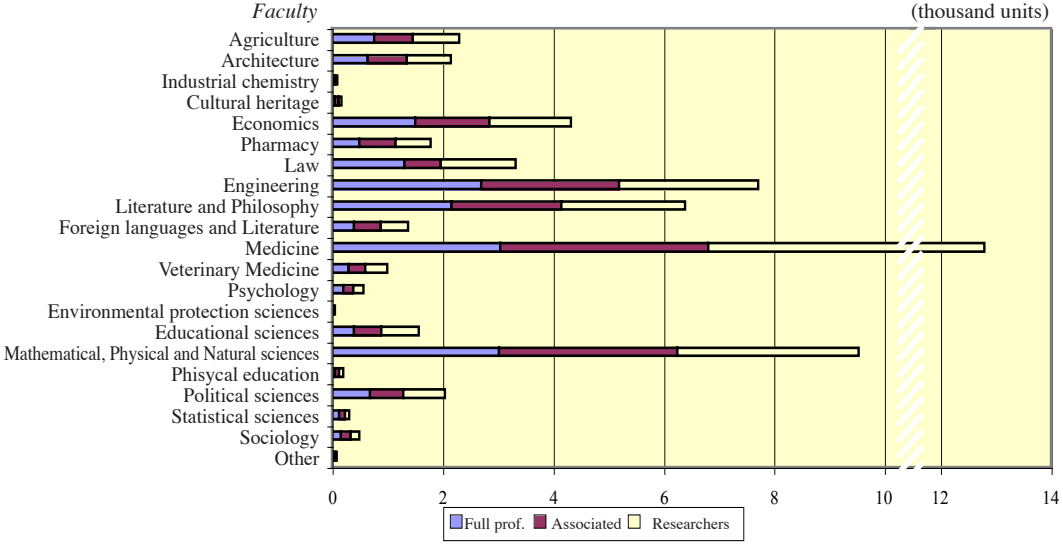
This section presents input and output data of the national university system (e.g. teachers, students, graduates, PhDs), that comprise some indicators on academic research expenditure. Data on teachers, students and graduates come from national teaching statistics (ISTAT) and from OECD and Eurostat for international comparisons, while data on the financial situation of universities are obtained from the National Committee for the Evaluation of the University System (CNVSU).

Figure 3.1 shows teaching and research personnel broken down by faculty and qualification. In Figures 3.2 and 3.4 are data concerning university students and graduates in Italy, under the new academic regulations which came into force fully in academic year 2001-2002. Numbers of students enrolled under previous course rules are then reported.

Figure 3.5 shows data on foreign university students by geographical area of origin and Figure 3.6 data on students enrolled in PhD courses. This information is useful in estimating the attractiveness of Italian universities for separate scientific disciplines. As for Italian university research expenditure, Table 3.1 shows the datum of income by financing source in years 2001-2003.

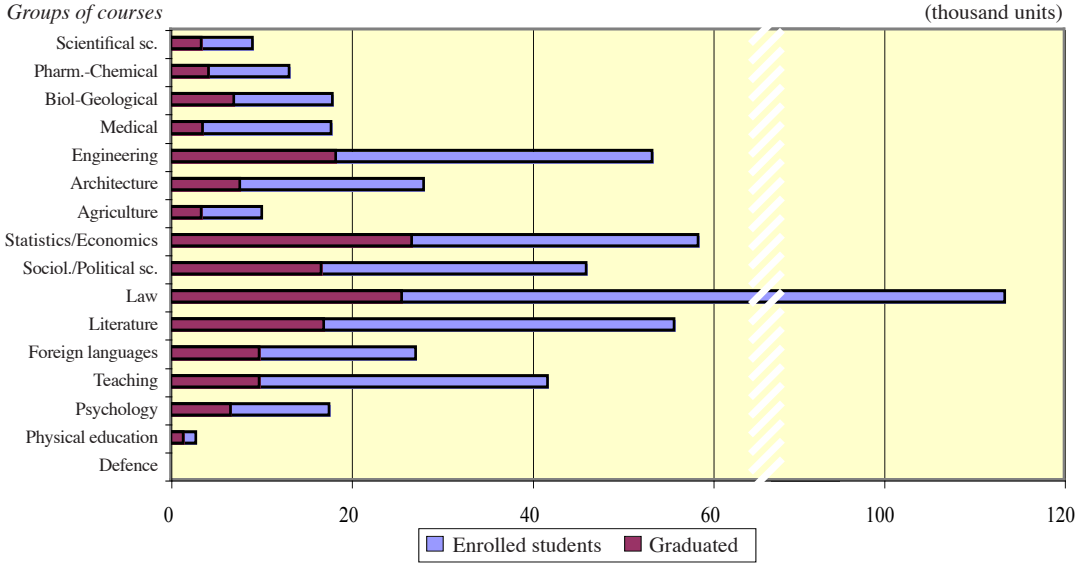
Figure 3.7 shows female enrolment in science and technology degrees in several European countries. As regards Italy and other OECD countries, Figure 3.8 presents an indicator equal to the number of PhDs over population in the corresponding age group, thus allowing for an evaluation of the absorption capacity, improvement and spread of knowledge in the country, and the supply of highly skilled personnel to the labour market. Figure 3.9 shows, as an example, the attractiveness of American universities to foreign scholars. Figures 3.10 and 3.11 permit comparison of total research investments (human and financial resources) by Italian universities with those of other countries, in respect of the production of wealth on the one side and the employees on the other.

Figure 3.1 - University teaching and research personnel by faculty in Italy, academic year 2004-2005



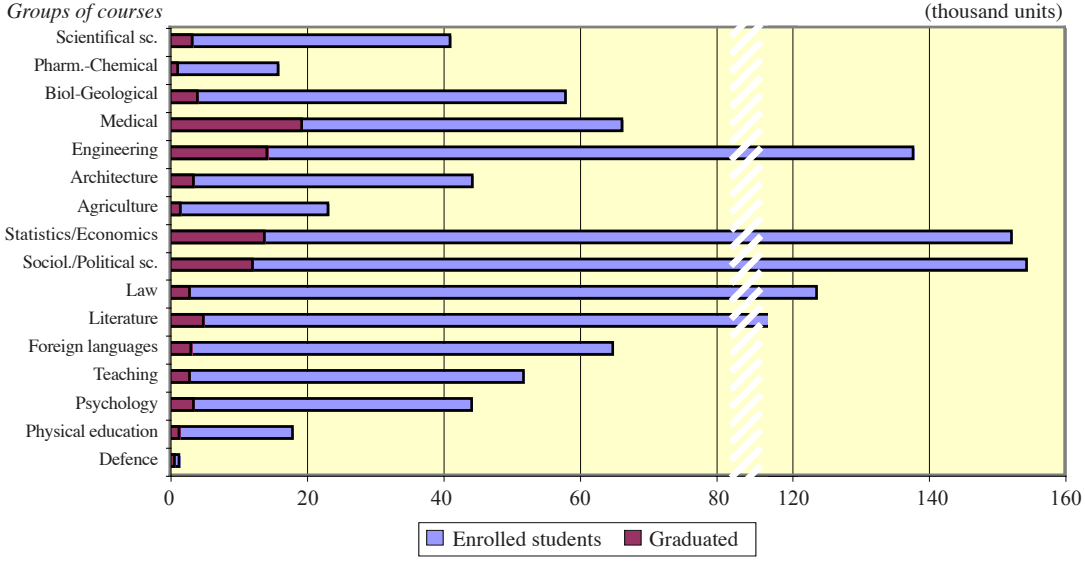
Source: ISTAT

Figure 3.2 - Enrolled and graduated university students from courses under previous regulations by groups of courses in Italy, academic year 2004-2005



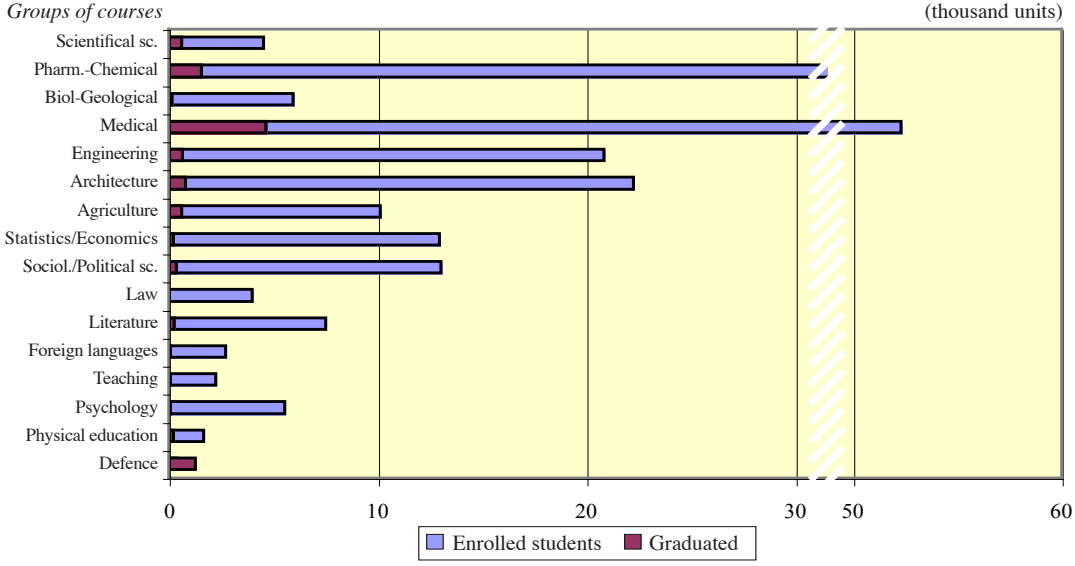
Source: ISTAT

Figure 3.3 - Enrolled and graduated university students in the new triennial degree courses by groups of courses in Italy, academic year 2004-2005



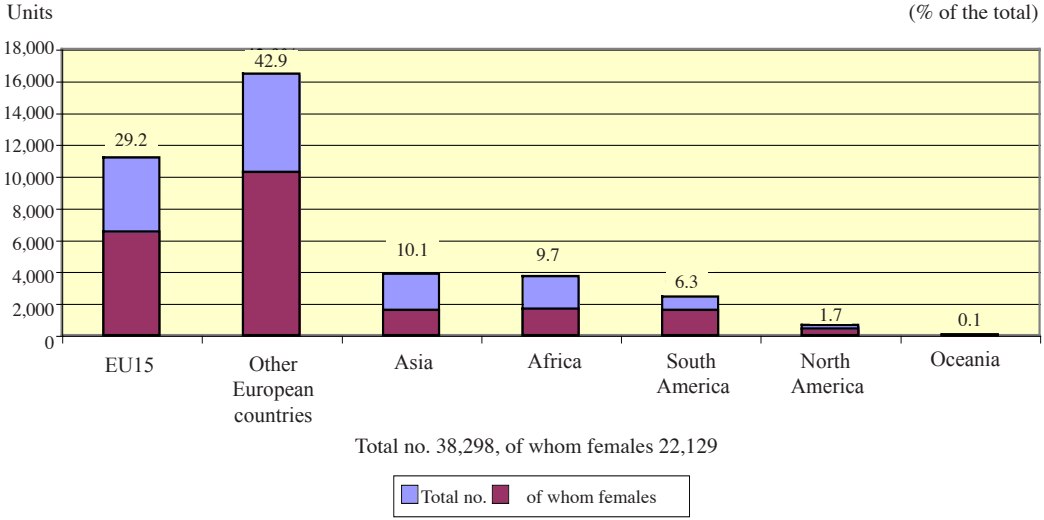
Source: ISTAT

Figure 3.4 - Enrolled and graduated university students in specialising degree courses by groups of courses in Italy, academic year 2004-2005



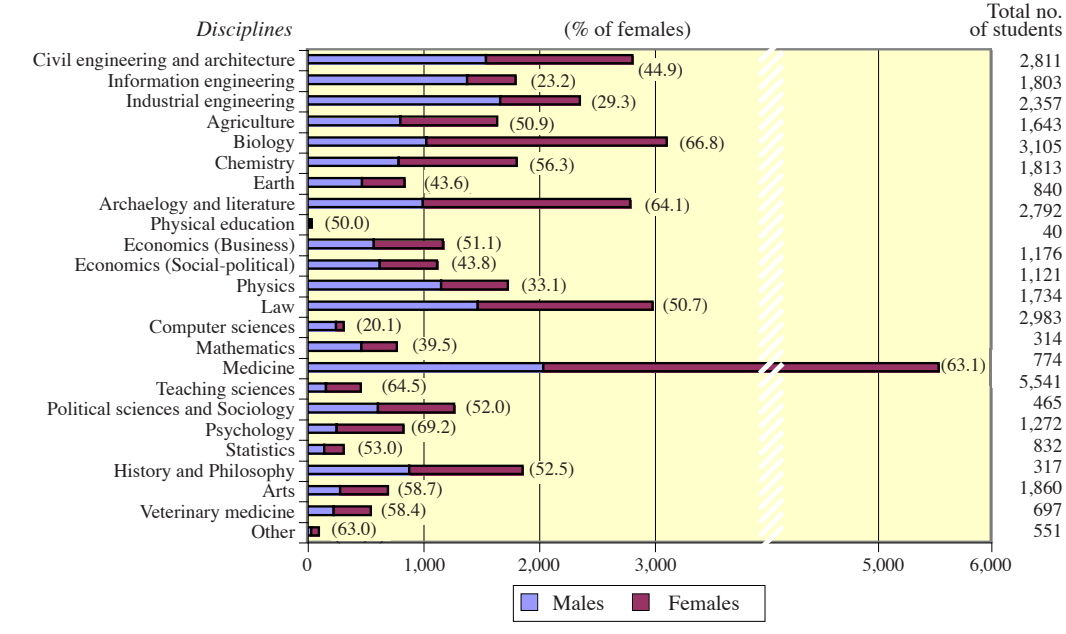
Source: ISTAT

Figure 3.5 - Enrolled foreign university students by geographical area of origin in Italy, academic year 2004-2005



Source: Statistical Office of MIUR, 2005 Survey on university teaching

Figure 3.6 - Enrolled students in PhD courses by discipline in Italy, academic year 2004-2005



Source: Statistical Office of MIUR, 2005 Survey on university teaching

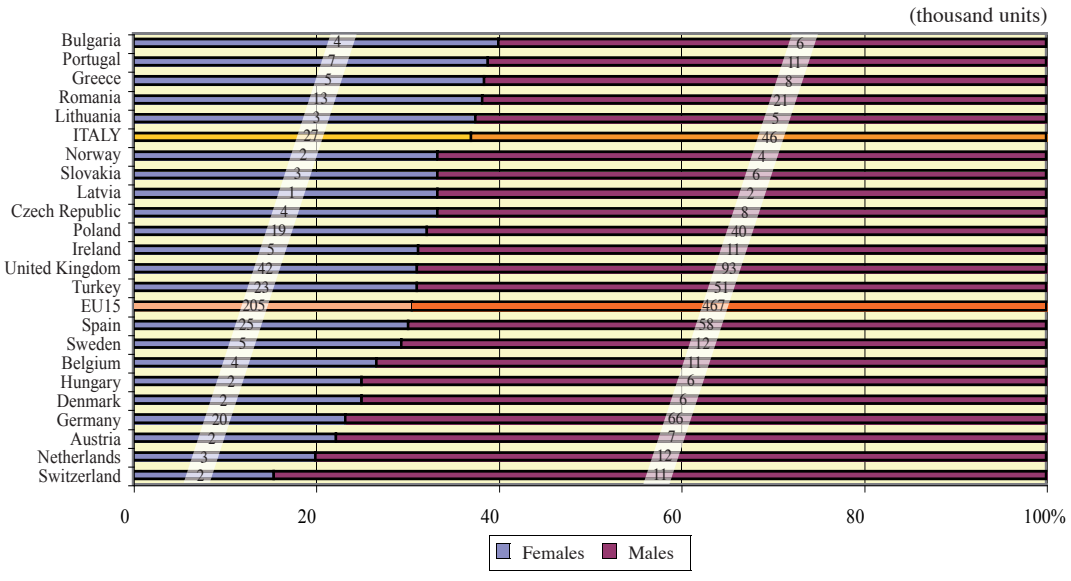
Table 3.1 - University income in Italy, 2001-2003

(million euros)

	2001	*2002*	*2003*
MIUR, ordinary fund	6,011	6,210	6,268
MIUR, funds for research projects	537	390	429
Funds coming from contracts	731	829	862
Funds coming from enrolment fees	1,044	1,143	1,269
Other funds	1,442	1,813	1,646
Total	9,765	10,386	10,474

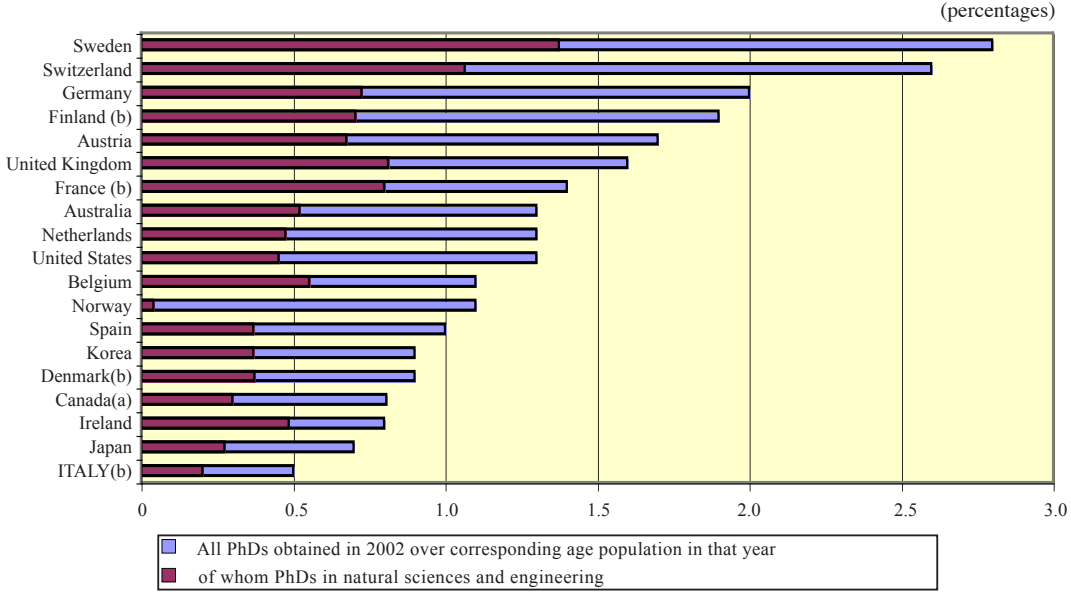
Source: CNVSU

Figure 3.7 - Graduated students in science and engineering in several European countries, 2004



Source: EUROSTAT, Science, Technology and Innovation in Europe, 2007

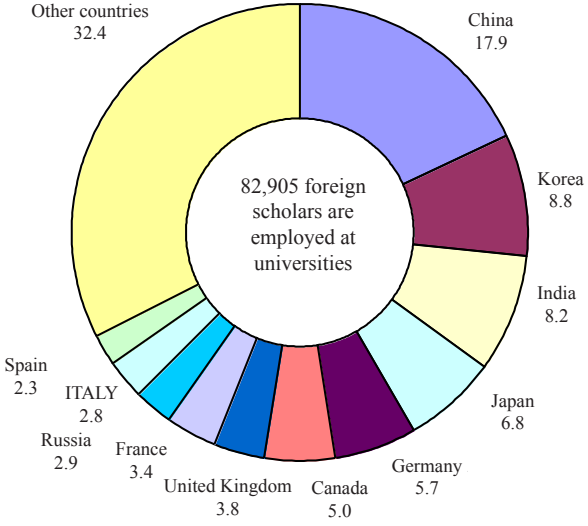
Figure 3.8 - PhD students over population of corresponding age in several OECD countries, 2002



Notes: (a) 2000; (b) 2001.
Source: OECD, Science, Technology and Industry Scoreboard 2005

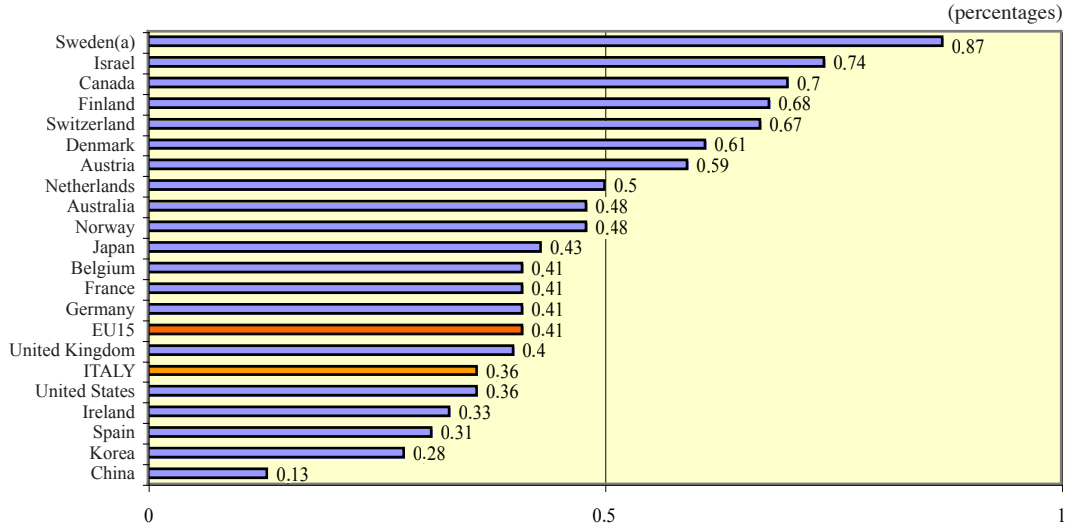
Figure 3.9 - Foreign scholars in the United States by country of origin, 2003-2004

(percentages)



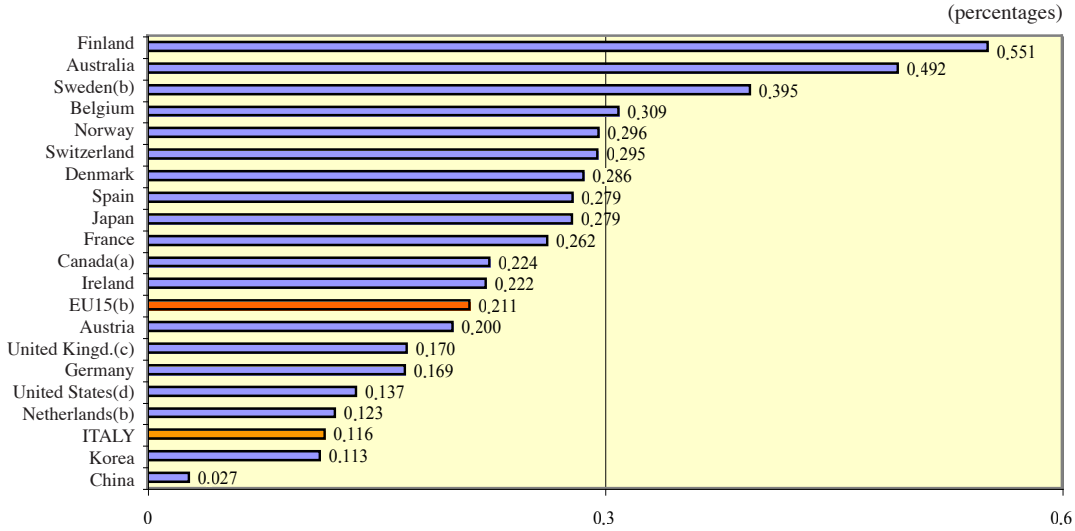
Source: OECD, Science, Technology and Industry Scoreboard 2005

Figure 3.10 - University R&D expenditure over GDP in several OECD countries, China and Israel, 2004



Note: (a) 2003.
Source: OECD

Figure 3.11 - University research personnel over total employees in several OECD countries and China, 2004



Notes: (a) 2002; (b) 2003; (c) 1998; (d) 1999.
Source: CERIS-CNR elaboration on OECD data

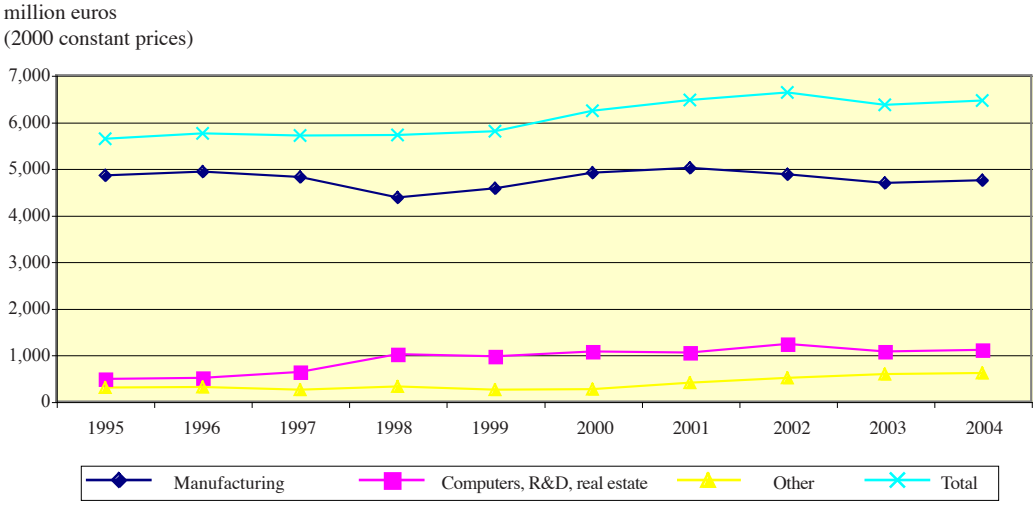
4. Business enterprise sector

ISTAT is the source of data on the Italian situation (Figures 4.1 – 4.4), while the OECD provides data for the remaining figures. Eurostat is the source of Table 4.1. Quantitative information on Italian firms concerns research carried out in diverse economic activities over a decade (Figures 4.1 and 4.2). Sources of funding (Figure 4.3) and expenditure by company size are also presented (Figure 4.4). The following figures allow comparison with other countries: financing of company R&D; the ratio between R&D expenditure and value added in a given industry (which is useful in measuring the commitment to allocating available resources in this field) shown in Figure 4.6 and scientific and technological activities carried out in research-intensive and high-technology sectors (Figure 4.7).

Figures 4.8 and 4.9 present two parallel ratios: that between research expenditure and GDP, and that between research personnel and total employees. The first ratio is a key indicator of the commitment to research of any country. Figures 4.10 and 4.11 focus on the analysis of manufacturing SMEs; these are of a special importance to Italy which is a country with a large number of SMEs.

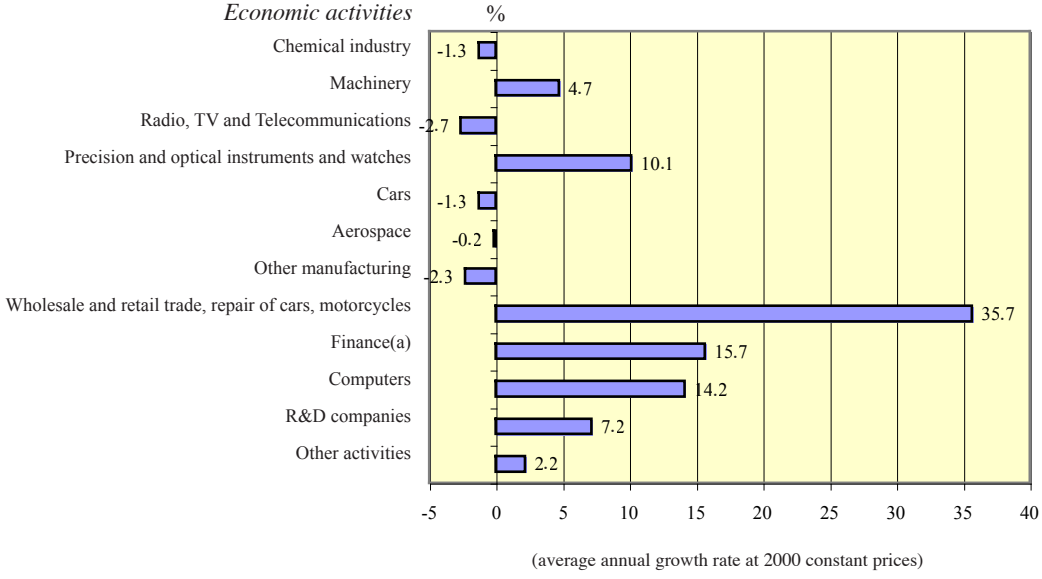
R&D expenditure in foreign affiliates of companies belonging to industrialised countries (Figure 4.12) over total research expenditure by company is an indicator of internationalisation of R&D investments. As an amplification of the previous description Figures 4.13 and 4.14 are presented. The first one indicates the trend of the R&D-to-GDP ratio in the telecommunications sector, the other shows the position of European firms with regard to web access.

Figure 4.1 - Company R&D expenditure by group of economic activities in Italy, 1995-2004



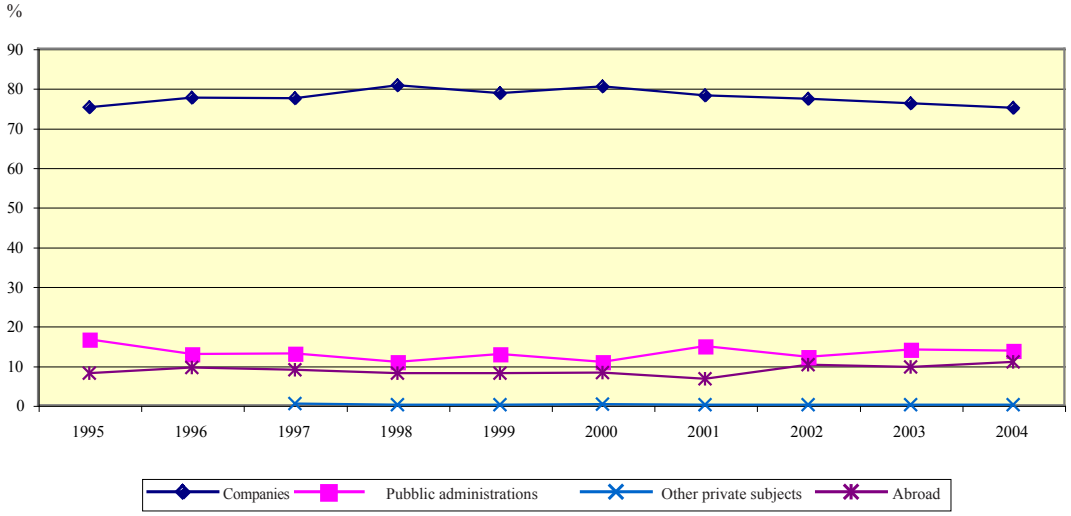
Source: ISTAT

Figure 4.2 - Trends of R&D expenditure in some economic activities in Italy, 1995-2004



Note: (a) the change ratio concerns 1997-2004.
Source: CERIS-CNR elaboration on ISTAT data

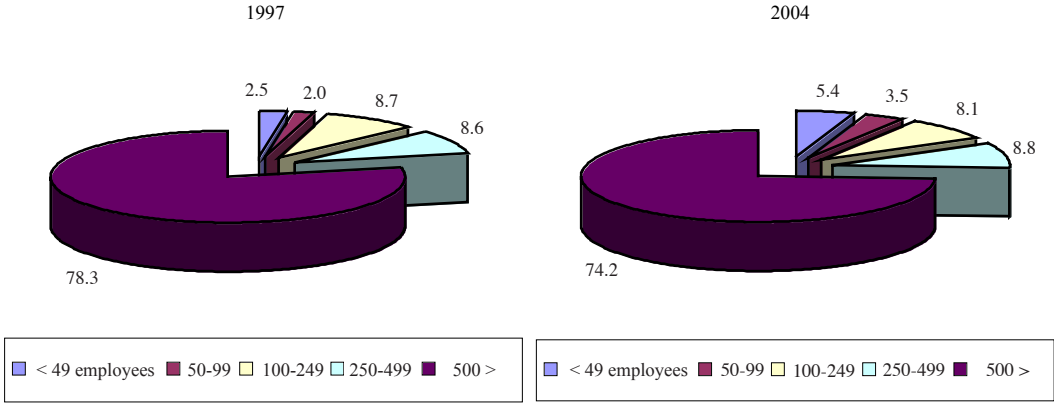
Figure 4.3 - Financing sources for company R&D in Italy, 1995-2004



Note: data concerning university not available.
Source: ISTAT

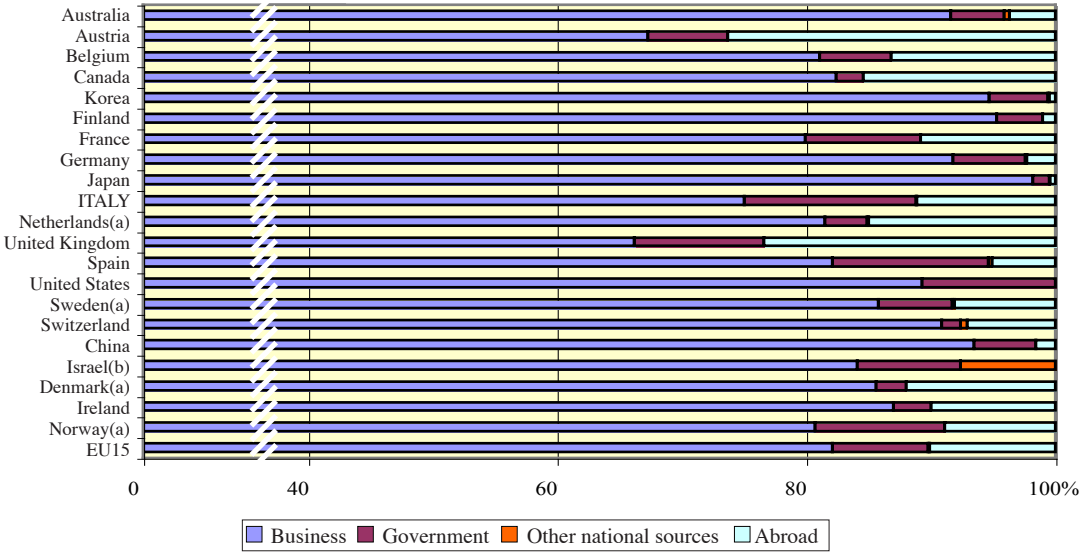
Figure 4.4 - Company intramural R&D expenditure by number of employees in Italy, 1997 and 2004

(percentages)



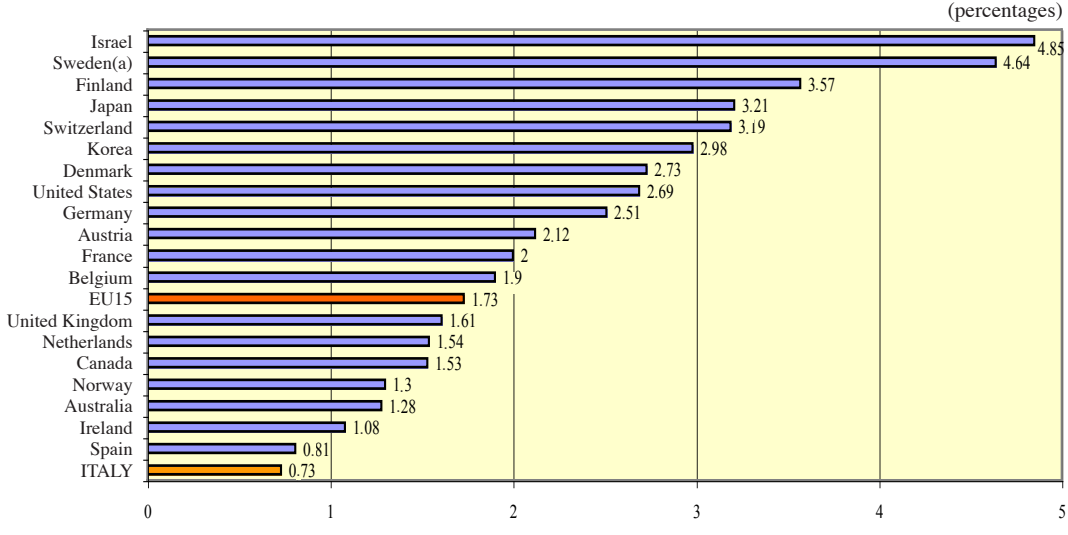
Source: ISTAT

Figure 4.5 - Funding to company R&D in several OECD countries, China and Israel, 2004



Notes: (a) 2003; (b) 2002.
Source: OECD

Figure 4.6 - Company R&D expenditure over industry's value added in several OECD countries and Israel, 2004



Note: (a) 2003.
Source: OECD

Figure 4.7 - Company R&D expenditure in research intensive sectors over company total expenses in several OECD countries, China and Israel, 2004

(percentages)

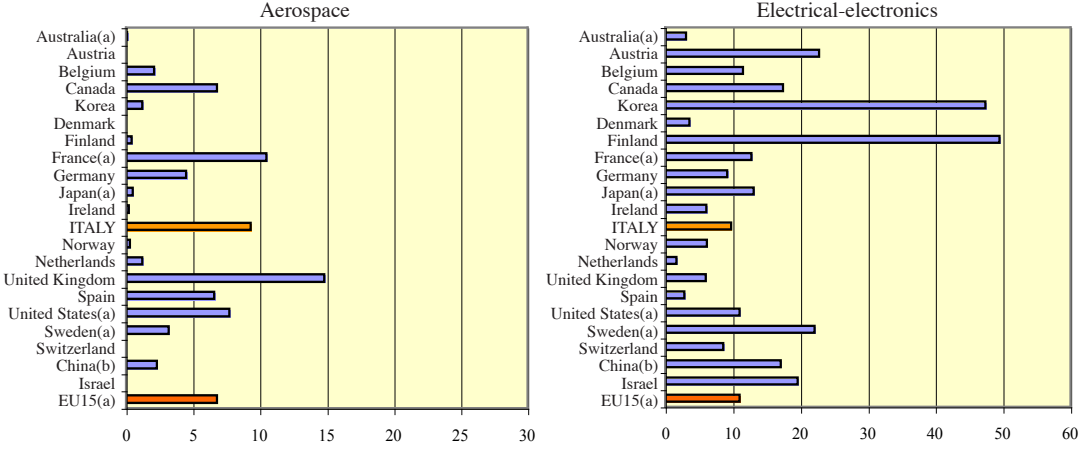


Figure 4.7 (cont.) - Company R&D expenditure in research intensive sectors over company total expenses in several OECD countries, China and Israel, 2004

(percentages)

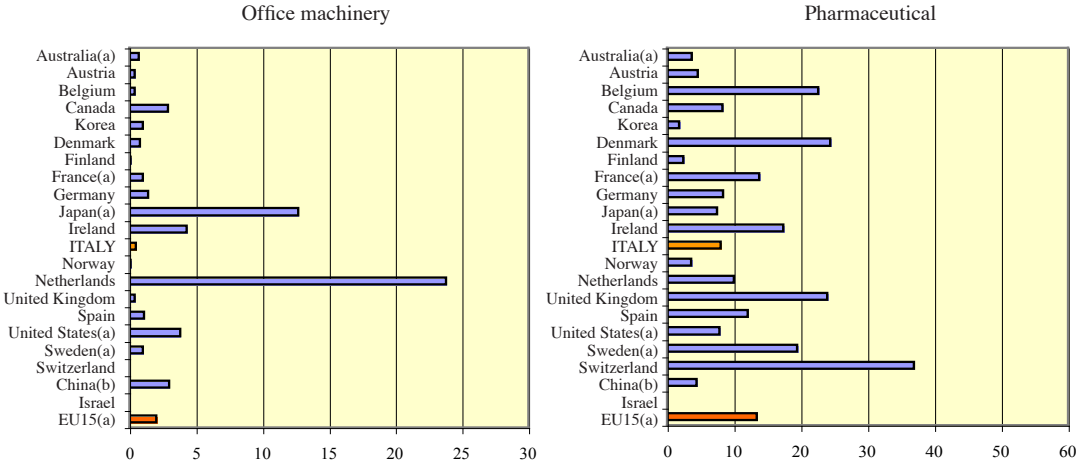
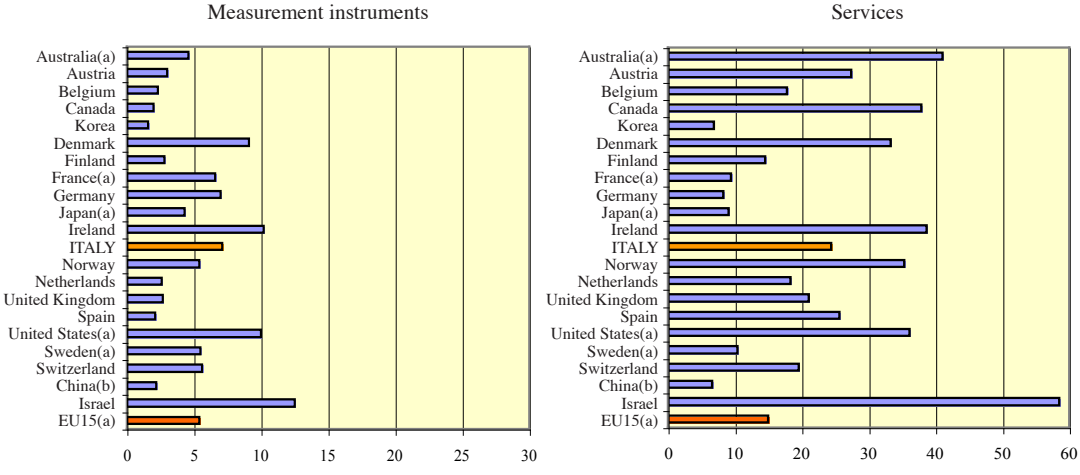


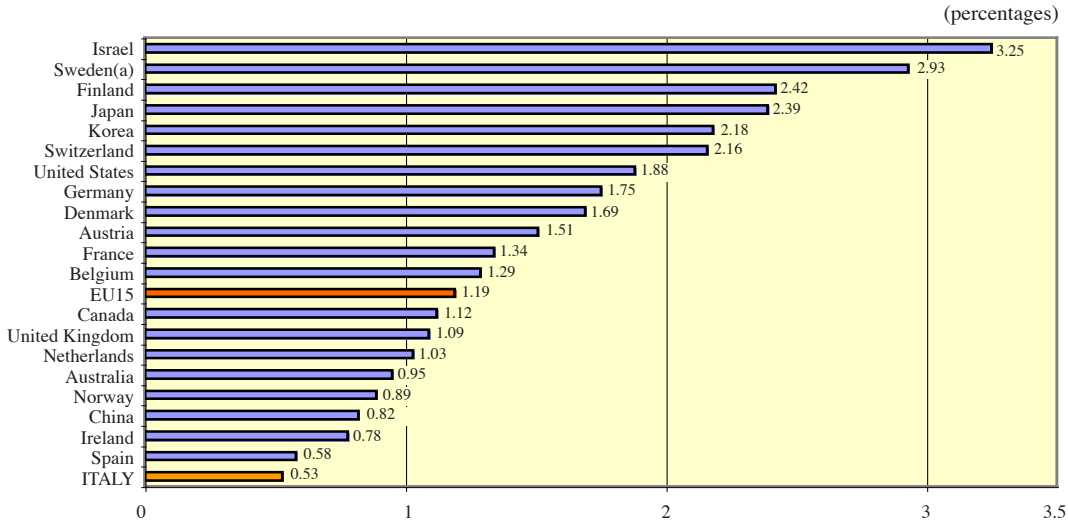
Figure 4.7 (cont.) - Company R&D expenditure in research intensive sectors over company total expenses in several OECD countries, China and Israel, 2004

(percentages)



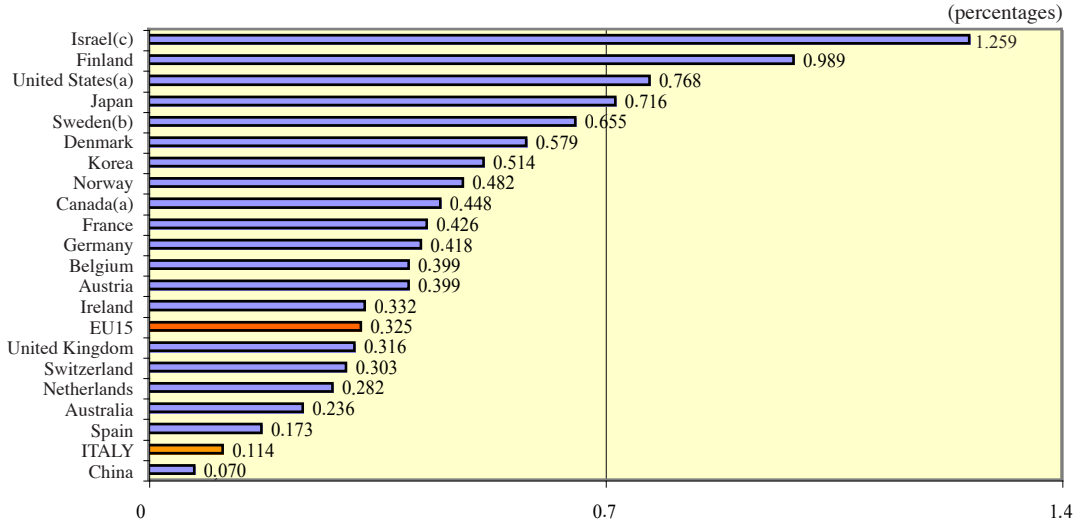
Notes: (a) 2003; (b) 2000.
Source: OECD

Figure 4.8 - Company R&D expenditure over GDP in several OECD countries, China and Israel, 2004



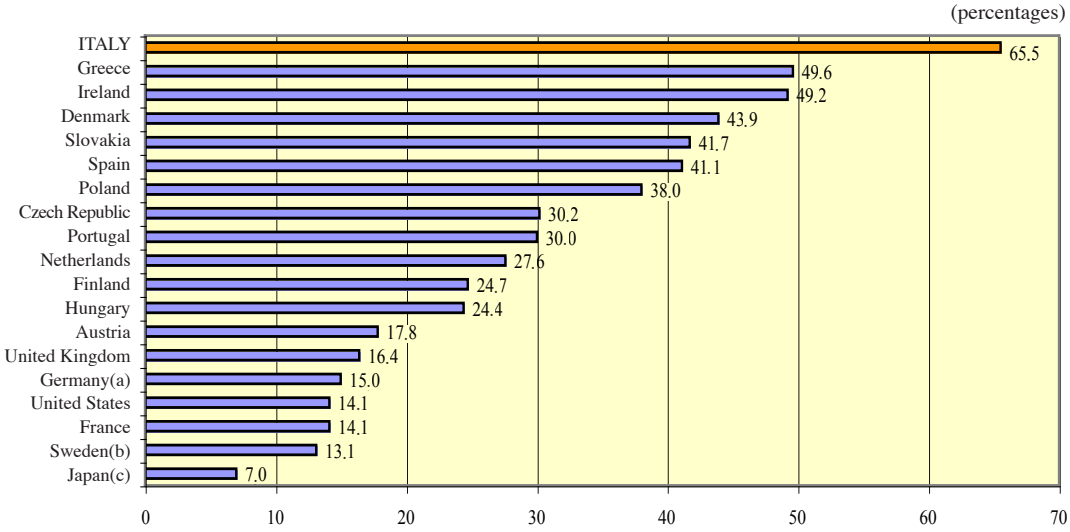
Note: (a) 2003.
Source: OECD

Figure 4.9 - Company research personnel over total employees in several OECD countries, China and Israel, 2004



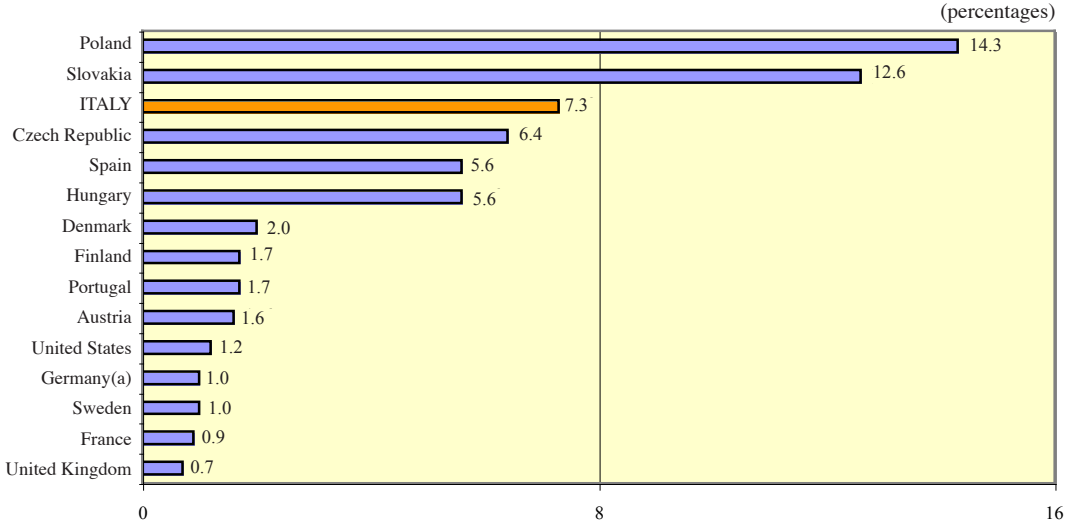
Notes:(a) 2002; (b) 2003; (c) 1999.
Source: CERIS-CNR elaboration on OECD data

Figure 4.10 - SME's R&D expenditure over total expenditure by manufacturing industries in several OECD countries, 2002



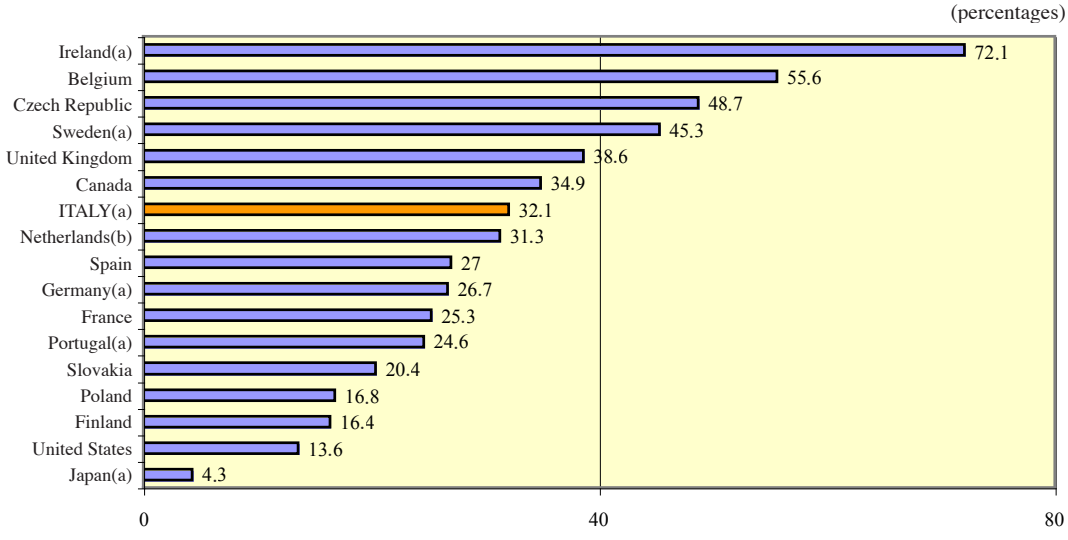
Notes: Data refer to 2002 or else to last available year. (a) Business R&D centres not included; (b) 20-249 employees; (c) less than 300 employees.
Source: EUROSTAT, Key Figures 2005

Figure 4.11 - Public financing to SMEs' R&D over total expenditure by manufacturing industries in several OECD countries, 2002



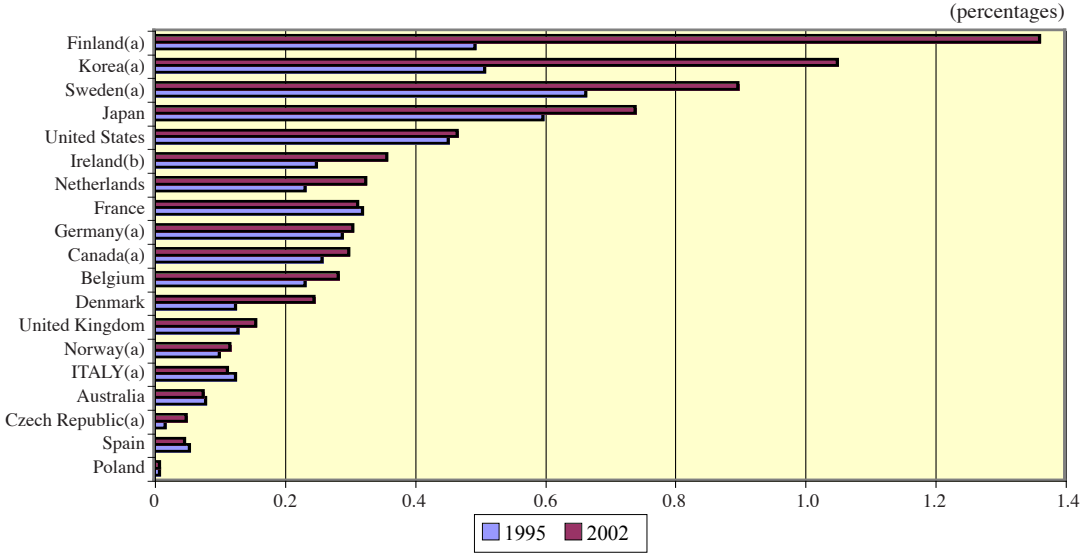
Notes: Data refer to 2002 or else to last available year. (a) Business R&D centres not included.
Source: EUROSTAT, Key Figures, 2005

Figure 4.12 - R&D expenditure by a company's foreign affiliates over total expenditure by companies in several OECD countries, 2004



Notes: (a) 2003; (b) 2002.
Source: OECD

Figure 4.13 - R&D expenditure by manufacturing firms in the telecommunication industry over GDP in several OECD countries, 1995 and 2002



Notes: As for US the Postal sector (covering 2-3% of total) is included; (a) 2003; (b) 2001.
Source: OECD, Science, Technology and Industry Scoreboard 2005

Table 4.1 - Companies that have access to the web over total number of companies in some EU countries, 2005

(percentages)

	Access to Internet	Access to Internet through a wide band connection	Firms with homepages or web-sites
Belgium	95	78	65
Czech Republic	92	52	67
Denmark	97	82	82
Germany	94	62	72
Estonia	90	67	53
Greece	92	44	56
Spain	90	76	43
France	83	49	26
Ireland	92	48	60
ITALY	92	57	54
Latvia	75	48	29
Lithuania	86	57	41
Hungary	78	48	40
Netherlands	91	71	72
Austria	95	61	70
Poland	87	43	49
Portugal	81	63	37
Slovenia	96	74	59
Slovakia	92	48	61
Finland	98	81	76
Sweden	96	83	85
United Kingdom	90	65	74
Norway	93	78	67

Note: all firms with at least 10 employees are included.
Source: Eurostat, KeyFigures on Europe: Statistical Pocketbook 2006. Data 1995-2006

5. Policy measures for science and technology in Italy

A characteristic of science and technology policy is growth and diversification of sources of financing both at national and international level.

The sources in the present section are the Italian Ministry of University and Research, the European Commission and the European Private Equity & Venture Capital Association (EVCA).
This section presents diverse data and indicators on the tools adopted by policy makers and a series of international comparisons.

Table 5.1 shows data on public funding to R&D through tenders to R&D bids directed towards public and private recipients (so called Project Funding). In the table the administration handling the funds and the principal type of funded research are specified. Three categories are singled out: policy, where the aim is to support science policy targets; academic research for curiosity-driven projects; innovation for pre-competitive research projects.

Tables 5.2 and 5.3 refer to Italian participation in the 5th and 6th Framework Programmes by type of participant and large projects, which represent a notable source of financing for Italian research.
A synopsis of R&D investment in industrialised countries, as far as data are available, indirect incentives, such as fiscal tools, are also indicated. Besides information on public funding figures on private investment in research are provided (Table 5.4).

Finally, two figures (5.1a and 5.1b) are devoted to the inflows and the outflows of venture capital in several European countries, *i.e.* the capital movement, which allows particularly risky research projects to be financed. Venture capital is without doubt an essential instrument in promoting the growth of small high-technology firms.

Table 5.1 - Financial instruments for R&D in Italy, 2002 and 2003

(million euros)

Financing subject	Financial instruments	Type of research	Budget	
			2002	2003
MIUR	FAR, Fund for the promotion of research	Innovation	72.0	-
MIUR	L. 488/92, Measures for the South	Innovation	265.0	-
MIUR	PON, Funds to R&D in the South	Finalised research	110.8	110.0
MIUR	COFIN, Co-financed research	Academic research	133.9	137.2
MIUR	PUS, Public Understanding of Science	Finalised research	10.4	8.6
MIUR	FISR, Special fund for research	Finalised research	12.5	12.5
MIUR	FIRB, Fund for basic research	Academic research	375.1	-
MIS	Finalised research	Finalised research	72.7	66.9
MAP	FIT, Fund for technological innovation	Pre-competitive research	1,324.0	635.0
MAF	Finalised research	Finalised research	308.5	-
CNR	Strategic projects	Finalised research	0.8	0.0
CNR	Finalised research	Finalised research	4.5	0.0
ASI	Contracts	Innovation	177.5	-
Abroad	EUFP, European funds	Pre-competitive research	239.2	-
Abroad	ESA, Foreign funds	Innovation	240.1	379.5
	Total		3,346.9	1,349.7

Source: “Project Funding” project, Network of Excellence PRIME - EU

Table 5.2 - Italian financial participation in research projects of the 6th EU Framework Programme (2002-2006) by type of participant

(percentages)

Sector		University	Research Centres	Big Firms	SME	Non industrial	Other
1	Life sciences, Genomics and Biotechnology for health	46.0	41.0	2.2	6.9	0.9	3.0
2	Information society technologies	34.0	19.3	28.6	8.1	3.3	6.6
3	Nano-technologies and nano-sciences	36.2	30.6	13.6	11.8	1.3	6.5
4	Aeronautics and Space	17.2	17.7	47.0	3.6	0.5	14.0
5	Food Quality and Safety	36.0	36.6	2.7	3.2	1.5	20.0
6	Sustainable develop., Global change and Ecosystems	26.6	37.1	20.9	6.5	3.2	5.7
7	Citizens and Governance in a knowledge-based society	67.6	28.7	0.0	0.1	1.2	2.4
8	RTD supporting policies and anticipating scientific and technological needs	40.1	42.0	0.9	1.7	1.5	13.7
9	Horizontal research activities involving SMEs	16.1	22.1	6.7	29.5	11.1	14.6
10	Specific measures in support of international cooperation	47.1	51.9	1.0	0.0	0.0	0.0
11	Research and Innovation	8.1	19.8	1.2	10.6	32.2	28.1
12	Support for the co-ordination of research activities	13.4	21.0	0.3	0.0	0.7	73.6
13	Euratom	17.8	57.6	6.5	6.2	2.5	9.5
	Italian average	*29.8*	*32.3*	*20.9*	*8.8*	*2.0*	*6.3*
	6th FP average	*33.5*	*29.5*	*18.1*	*8.1*	*2.5*	*8.2*

Source: MIUR, 6th R&D Framework Programme. Data on Italian participation, October 2004, quoted from Report by Lombardi L., tables 21 and 22

Table 5.3 - Italian participation in research projects of the 5th and 6th EU Framework Programme by large programmes

5th Framework Programme *Programmes*	*%*	**6th Framework Programme** *Programmes*	*%*
Environment and Energy	7.3	Sustainable development	8.2
Competitive and sustainable development	9.8	Nano-technologies and Nano-sciences	10.5
		Aeronautics and Space	7.9
Information society technologies	11.6	Information society technologies	10.0
Quality of life	7.8	Life sciences	9.3
		Security and quality of food products	7.0
Innovation and specific SME activities	11.4	Innovation	11.6
		Specific SME activities	9.3
Inco (international co-operation)	3.1	Inco (international co-operation)	3.4
Euratom (a)	11.7	Euratom	2.1
Italy over total	*9.4*	*Italy over total*	*9.2*
Italy over EU15	*10.3*	*Italy over EU15*	*10.0*

Note: (a) Fusion activities of the 5th Framework Programme (Euratom Programme) are included, in which Italy has a remarkable share; the datum from the 6th Framework Programme, therefore, does not seem significant.
Source: MIUR, 6th R&D Framework Programme. Data on Italian participation, October 2004, quoted from Report by Lombardi L., table 31

Table 5.4 - Synopsis of R&D investments envisaged by several OECD countries and Israel, 2003 and 2004

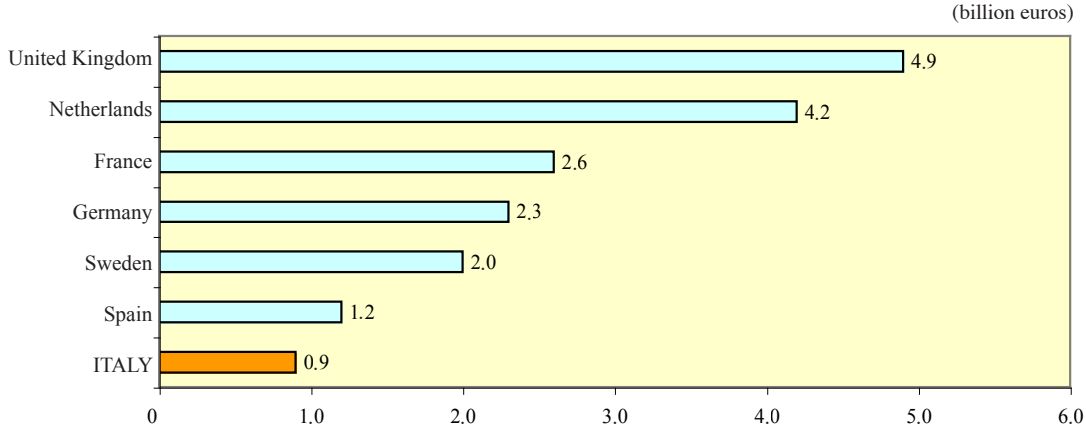
(million euros)

Countries	Pubblic Funding				Private Funding	
	Direct		Fiscal and indirect measures			
	2003	2004	2003	2004	2003	2004
Belgium	1,649.6	1,740.0	-	-	4,438.7	4,794.5
Czech Republic(a)	437.1	480.3	0.0	0.0	602.9	662,2
Denmark(a)	1,405.0	1,391.6	-	-	-	-
Germany	17,101.0	16,812.0	-	-	-	-
Greece	455.0	492.0	-	-	312.0	374.0
Spain	4,001.0	4,402.3	264.9	416.7	3,783.8	4,166.9
France(b)	12,327.0	12,668.0	520.0	985.0	19,353.8	-
Ireland	450.8	509.0	0.0	8.0	1,047.0	1,218.0
ITALY	6,925.0	7,925.0	0.0	650.0	7,102.0	7,386.0
Hungary	407.0	440.0	18.0	22.0	195.0	240.0
Netherlands	3,188,5	3,228.2	364.0	403.0	4,446.0	4,579.0
Austria	1,768.0	2,049.0	0.0	330.0	2,575.0	-
Poland(a)	628,2	647.6	-	-	428.1	449.5
Portugal	847.0	896.5	-	-	-	-
Slovenia	144.9	194.1	0.0	0.0	214.7	237.1
Slovakia	89,0	98.5	-	-	133.5	147.8
Finland	1,446.0	1,538.0	0.0	0.0	3,380.0	-
Sweden(a)	2,538.4	2,598.8	-	-	-	-
United Kingdom(a)	12,832.6	13,111.6	939.3	980.5	-	-
Norway(a)	1,548.4	1,532.4	112.5	173.7	-	-
Switzerland	1,530.0	1,643.0	-	-	-	-
United States(a, b)	103,692.5	101,421.0	-	-	155,947.7	142,153.0
Japan(a, b)	27,498.7	27,174.8	-	-	-	-
Israel	1,318.0	1,014.0	-	-	3,635.0	3,635.0

Notes: (a) worked out from data in national currency; (b) local financing is excluded.

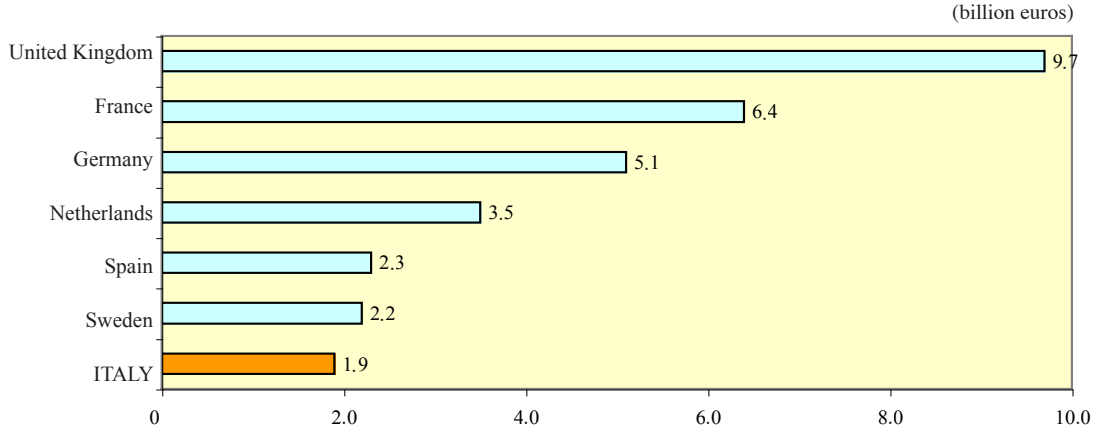
Source: EU Commission, Research Directorate General, Directorate M-Investment in research and links with other policies, 24 September 2004

Figure 5.1a - Distribution of venture capital in some European countries: funds raised, 2004



Source: CERIS-CNR elaboration on data drawn from 2004 Annual European Private Equity Survey conducted on behalf of EVCA by Thomson Venture Economics and PricewaterhouseCoopers

Figure 5.1b - Distribution of venture capital in some European countries: funds invested, 2004



Source: CERIS-CNR elaboration on data drawn from 2004 Annual European Private Equity Survey conducted on behalf of EVCA by Thomson Venture Economics and PricewaterhouseCoopers

6. R&D personnel in Italy

The data presented are selected on the basis of information on personnel: they present indicators on gender, the burden on overall population and mobility of scholars. The source for national data is ISTAT and for international comparisons the OECD and Eurostat. R&D personnel in Italy are separated by qualification (Table 6.1), by institutional sector of research (Figure 6.1) and by sector of economic activity (Figure 6.2).

The Figures (6.3-6.5) outline international comparisons, giving the numbers of researchers in some countries as an absolute value (Figure 6.3), over total employees (Figure 6.5) and female researchers in various institutional sectors (Figure 6.4).

Figure 6.6 presents Human resources for science and technology (HRST) over labour force in several European countries in 2005. In this figure data refer to the concept of HRST elaborated in the OECD's Canberra Manual: HRST identify the set of people occupied in or qualified for a job in research, for which a PhD degree is necessary. Therefore, by providing a large amount of information, such indicators estimate not only current research capacity, but also its potential and may be useful in checking the sustainability of growth in investment in R&D.

Figure 6.7 gives an idea of the complexity of international flows of highly qualified personnel.

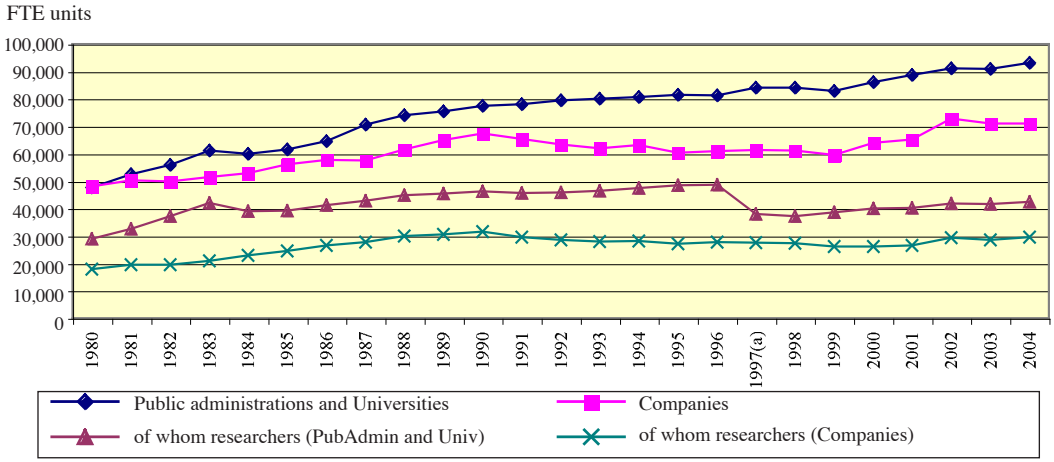
Table 6.1 - R&D personnel in Italy, 1980-2004

(FTE units)

Research sectors	1980		1990		2000		2001		2002		2003		2004	
	Researchers	Other personnel	Researchers	Other personnel	Researchers	Other personnel	Researchers	Other personnel	Researchers	Other personnel	Researchers	Other personnel	Researchers	Other personnel
Public administrations	29,046	18,636	14,502	18,611	14,315	16,916	13,006	16,759	13,565	17,357	13,976	17,487	14,237	18,164
University			31,844	12,464	25,696	29,141	27,146	31,723	28,301	31,986	27,774	31,632	28,226	32,468
Private non-profit institutions	-	-	-	-	-	-	-	-	1,357	1,229	1,716	1,285	1,955	1,457
Companies	17,953	30,168	31,530	35,966	26,099	37,899	26,550	38,721	28,019	42,209	26,866	41,092	27,594	39, 925
Total	46,999	48,804	77,876	67,041	66,110	83,956	66,702	87,203	71,242	92,781	70,332	91,496	72,012	92,014

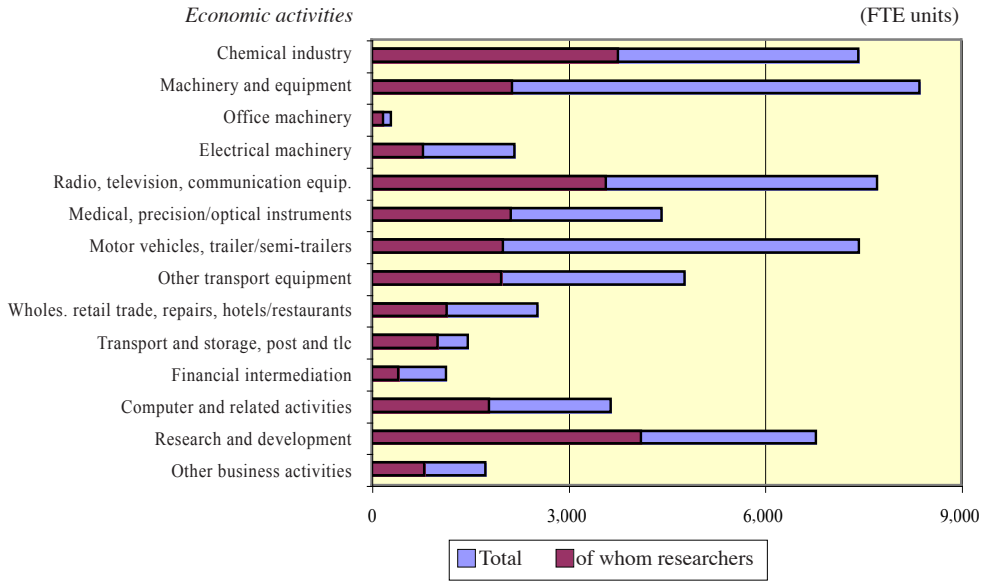
Source: ISTAT

Figure 6.1 - R&D personnel by institutional sector in Italy, 1980-2004



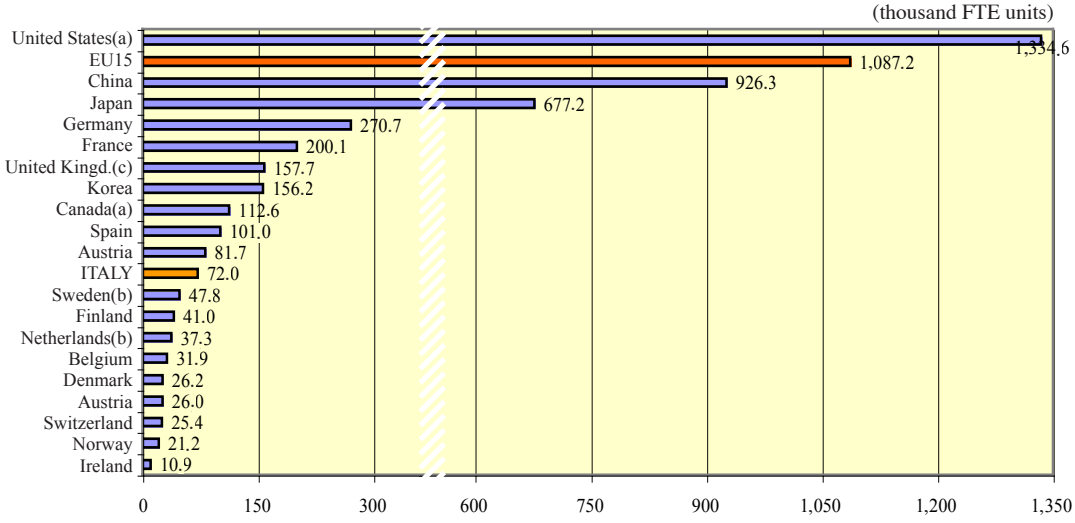
Note: (a) in 1997 the way R&D university personnel is counted was changed
Source: ISTAT

Figure 6.2 - Companies R&D personnel in some Italian economic activities, 2004



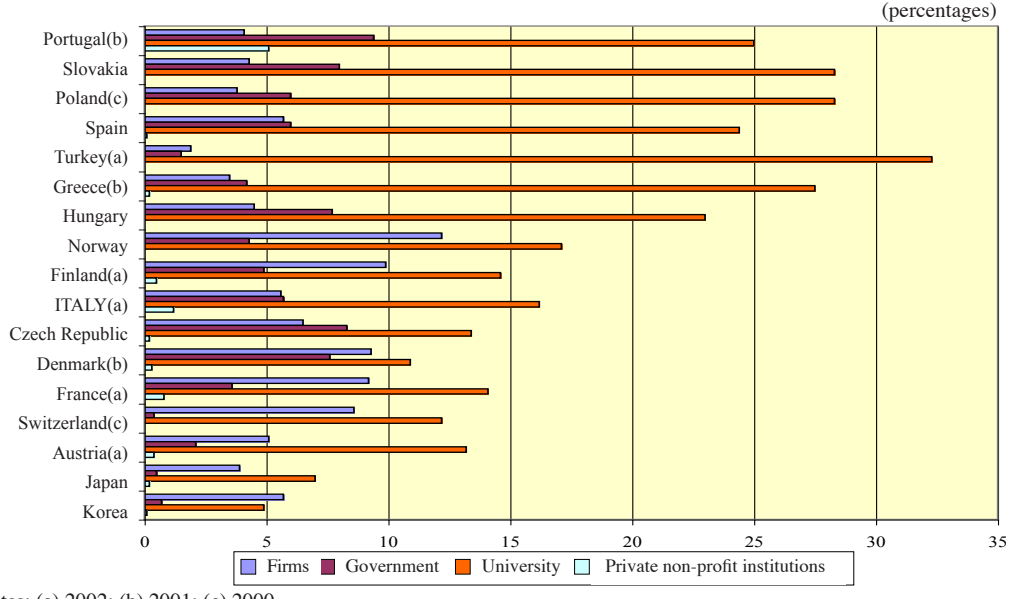
Source: ISTAT

Figure 6.3 - Researchers in several OECD countries and China, 2004



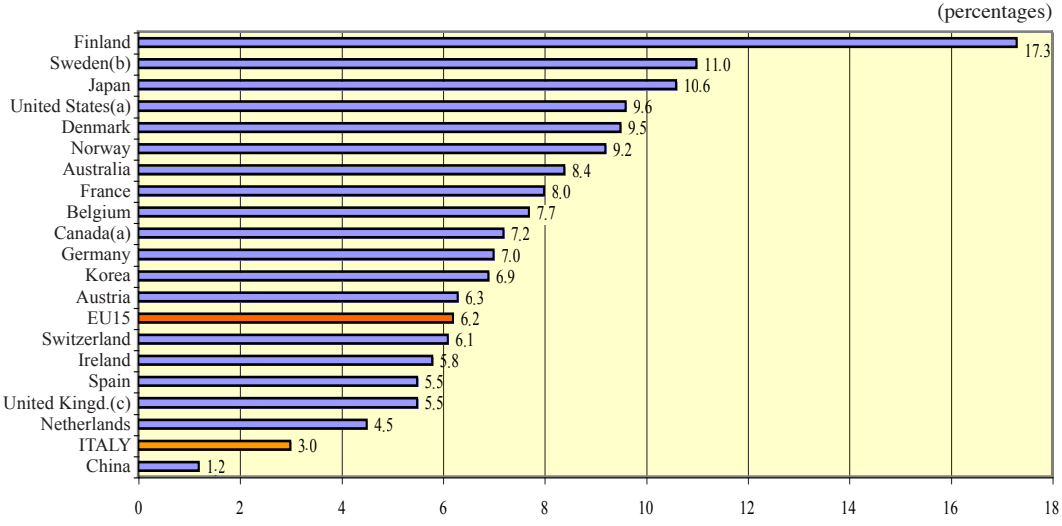
Notes: (a) 2002; (b) 2003; (c) 1998.
Source: OECD

Figure 6.4 - Female researchers by employment sectors over the total researchers in several OECD countries, 2003



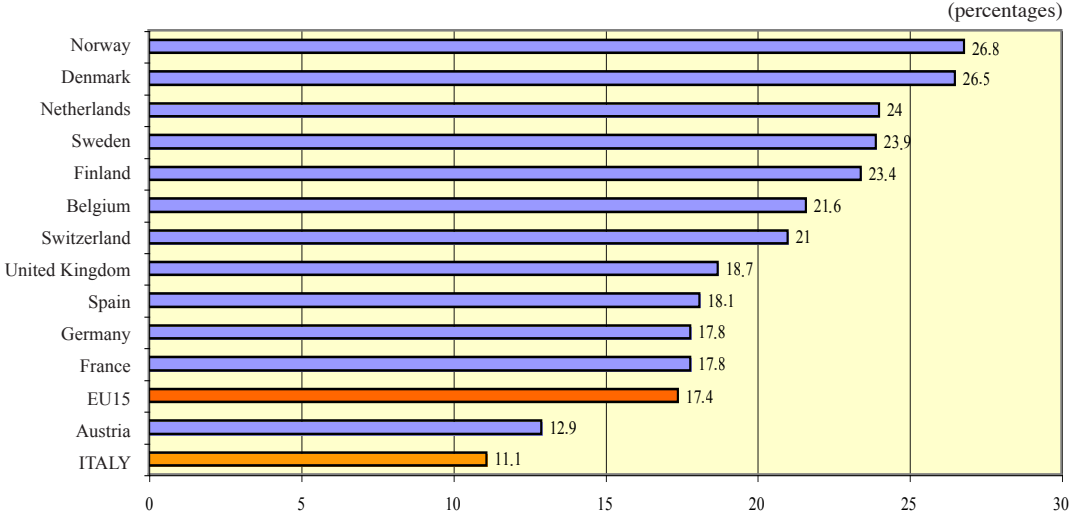
Notes: (a) 2002; (b) 2001; (c) 2000.
Source: OECD, Science, Technology and Industry Scoreboard 2005

Figure 6.5 - Researchers per 1000 employees in several OECD countries and China, 2004



Notes: (a) 2002; (b) 2003; (c) 1998.
Source: OECD

Figure 6.6 - Human resources in science and technology (25-64 years old) over labour force in some European countries, 2005



Source: EUROSTAT, Pocketbooks, Science, Technology and Innovation in Europe 2007

Figure 6.7 - International mobility of highly qualified personnel between some OECD countries, 2001

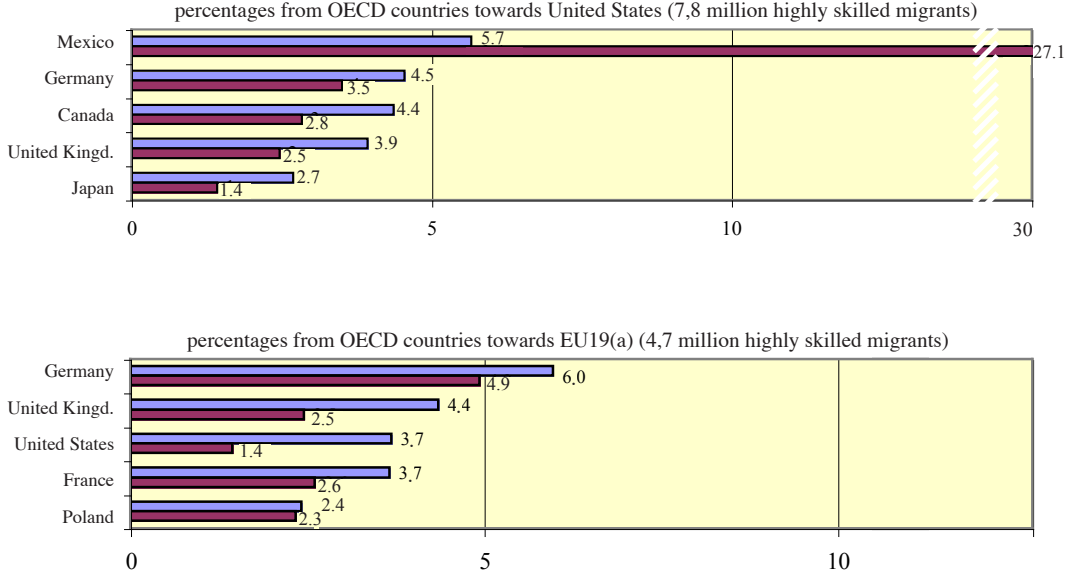
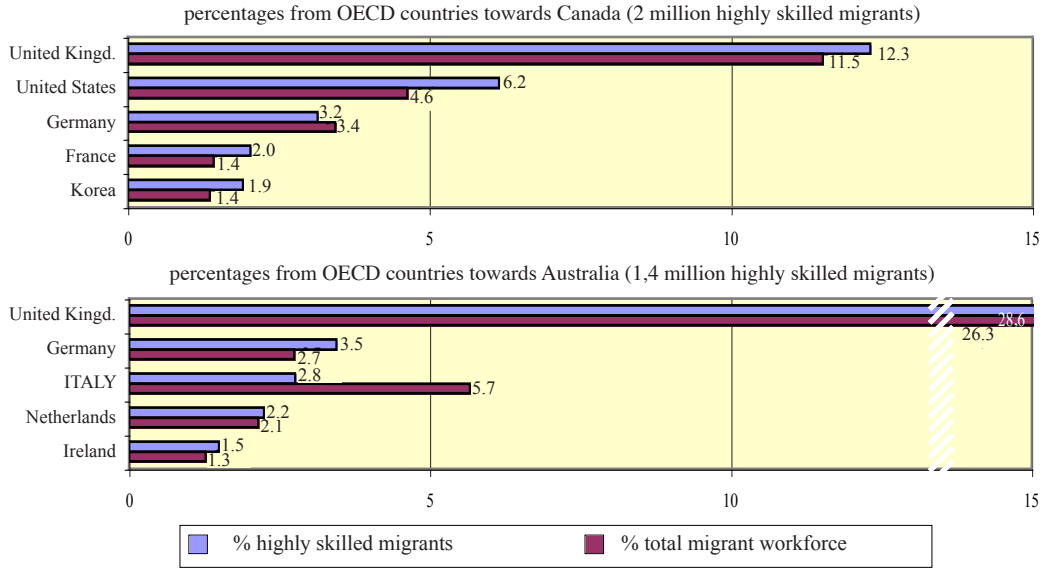


Figure 6.7(cont.) - International mobility of highly qualified personnel between some OECD countries, 2001



Note: (a) to EU15 are added: Poland, Hungary, Slovakia, Czech Republic.
Source: OECD, Science, Technology and Industry Scoreboard 2005

7. Patents

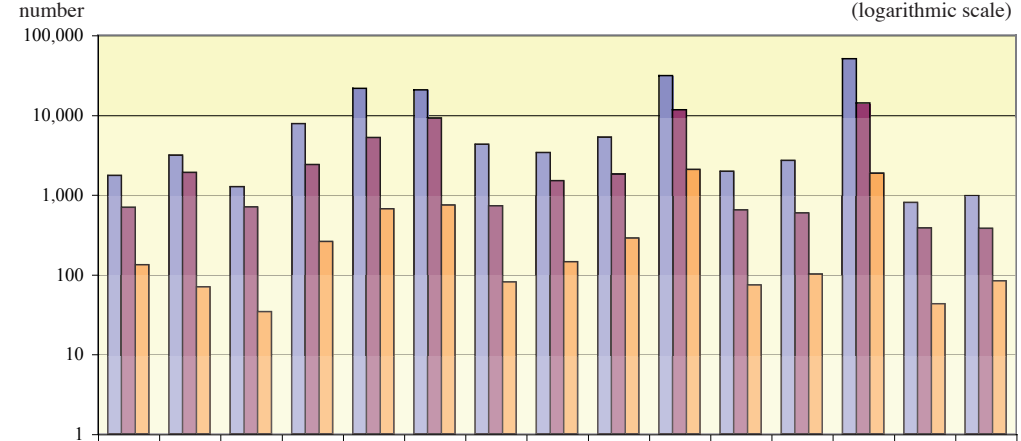
Patents on industrial inventions represent the inventor's right protected by the State to industrial and commercial exploitation of an original idea, for a limited duration in a given country. They are a useful measurement of inventive activity among researchers and laboratories located in different countries and also of technology flows.

The source of the four initial figures is OECD: Figures 7.1 and 7.2 show patent applications in two interesting sectors, information and telecommunication technology (ICT) and biotechnologies. The triad of patents refers to inventions patented at the three larger patent offices: the European Patent Office (EPO), the United States Patent and Trademark Office (USPTO) and the Japan Patent Office (JPO) with the aim of protecting a specific invention (Figure 7.3). They are weighted on the total patenting activities in OECD countries. It is commonly held that this threefold application offers better protection. Statistics on these sets of patents allow more accurate international comparison, because what the OECD defines as home advantaged is factored in.

Figure 7.4 shows joint patent activity by inventors in different countries, an indicator of the internationalisation of science and technology. The US is the principal partner in the patent activity of most countries; a consequence of both the US's commitment for R&D and their position at the technological frontier.

Figure 7.5 comes from a report on science and technology by the US National Science Foundation. Citations of technical and scientific literature in US patents are considered an indicator of the impact that science has on industrial inventions.

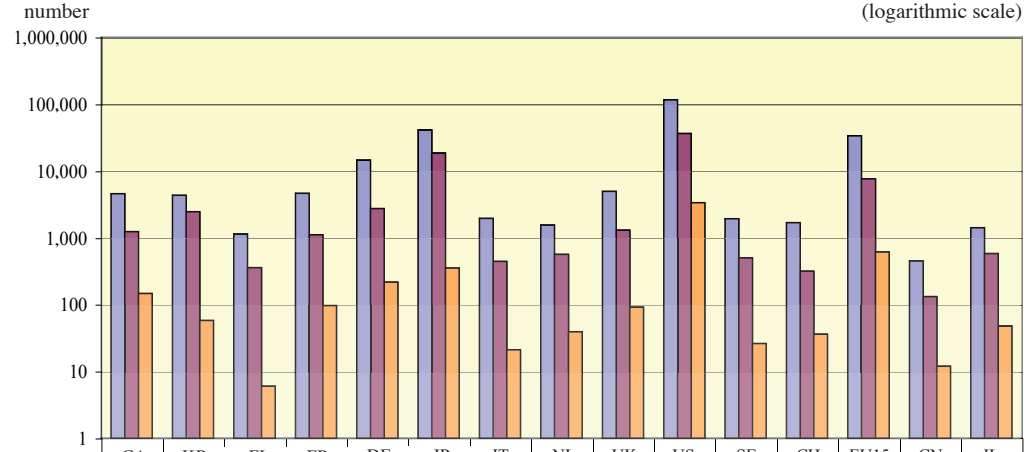
Figure 7.1 - Total patent applications to the EPO and applications in the ICT and Biotechnology sectors in several OECD countries, 2003



	CA	KR	FI	FR	DE	JP	IT	NL	UK	US	SE	CH	EU15	CN	IL
Total no.	1,737	3,113	1,254	7,779	21,442	20,625	4,279	3,376	5,255	30,942	1,969	2,678	50,285	794	975
ITC	693	1,893	700	2,382	5,204	9,157	727	1,504	1,812	11,561	646	590	14,052	382	380
Biotech.	132	70	34	260	666	737	80	144	285	2,071	74	101	1,848	43	83

Source: OECD

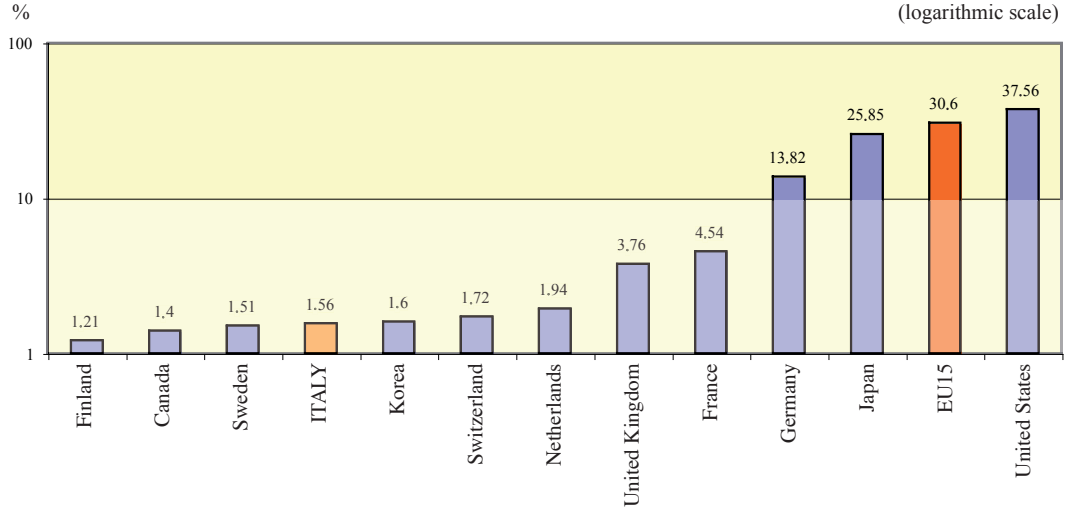
Figure 7.2 - Total patents granted by USPTO and patents granted in the ICT and Biotechnology sectors in several OECD countries, China and Israel, 2000



	CA	KR	FI	FR	DE	JP	IT	NL	UK	US	SE	CH	EU15	CN	IL
Total no.	4,578	4,333	1,137	4,644	14,513	40,828	1,938	1,559	4,909	115,215	1,923	1,676	33,269	450	1,419
ITC	1,234	2,439	358	1,112	2,748	18,432	441	566	1,305	36,553	497	317	7,580	132	577
Biotech.	146	58	6	97	218	353	21	39	92	3,355	26	36	613	12	48

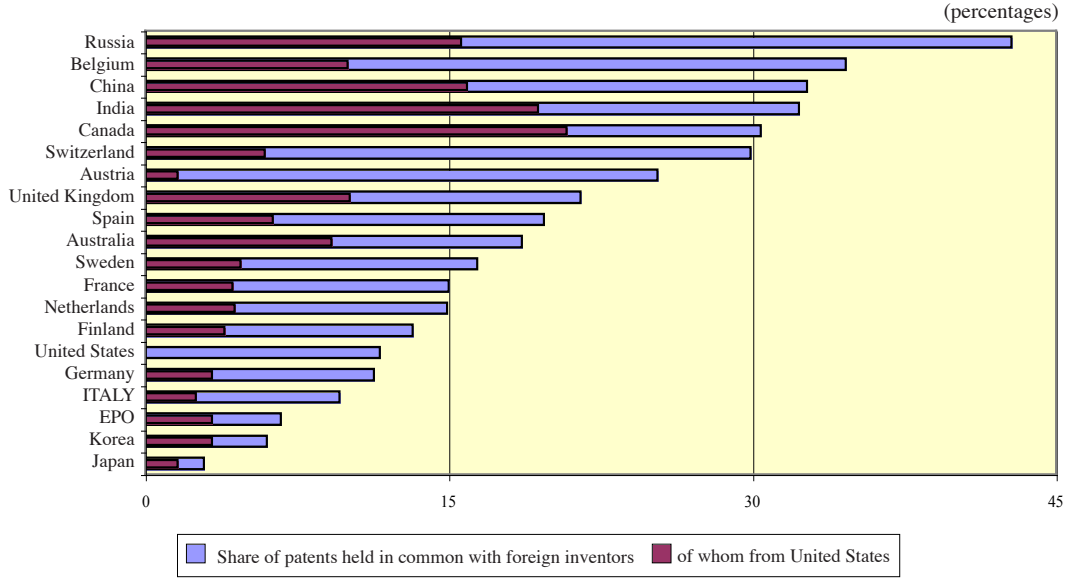
Source: OECD

Figure 7.3 - Triadic patents: applications to the EPO and the JPO, patents granted by USPTO in several OECD countries over the OECD total, 2003



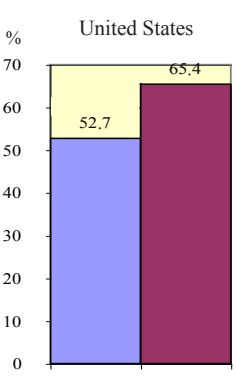
Source: OECD

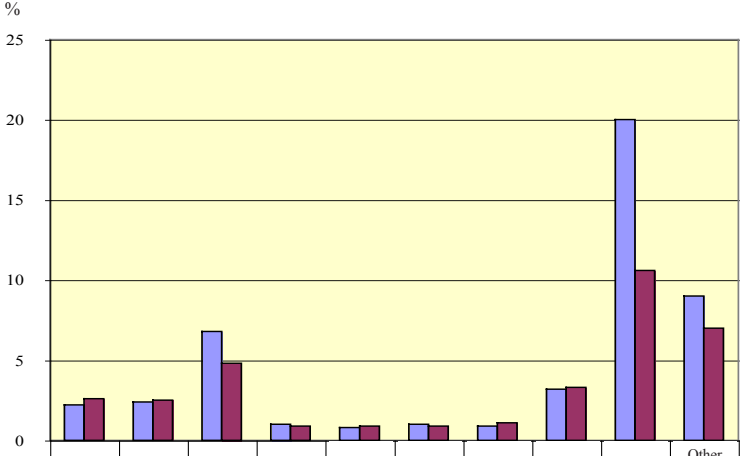
Figure 7.4 - International co-operation and co-operation with US in patent applications to the EPO, 1999-2001



Source: CERIS-CNR elaboration on data from OECD, Science, Technology and Industry Scoreboard 2005

Figure 7.5 - Patents granted by US that cite scientific literature by inventor nationality, 2001





	CA	FR	DE	IT	NL	SE	CH	UK	JP	Other countries
Total US patents 2001 (166,039)	2.2	2.4	6.8	1.0	0.8	1.0	0.9	3.2	20.0	9.0
US 2001 patents citing S&E literature (21,155)	2.6	2.5	4.8	0.9	0.9	0.9	1.1	3.3	10.6	7.0

Source: National Science Foundation, Science & Engineering Indicators, 2004

8. Articles and citations

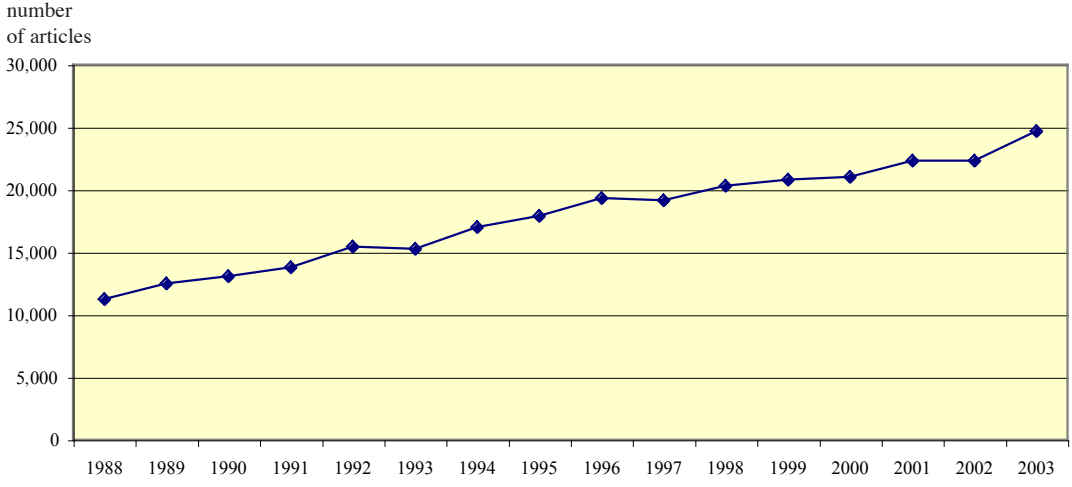
Data concerning the number of articles, collaborations and citations presented in this section concern a set of scientific publications released in a large number of scientific and technological journals selected by Thomson ISI (previously Institute for Scientific Information). It monitors publications and runs the Science Citation Index (SCI) and the Social Science Citation Index (SSCI).

The source of information (Figures 8.1, 8.2, 8.5 and 8.6) is the US National Science Foundation, using data elaborated by ipIQ, Inc. (previously CHI Research, Inc.). The number of journals has gradually increased over time from 4,458 journals in 1988 to 5,315 in 2003.

The number of articles in international journals is a proxy of the scientific productiveness of a country. Furthermore, they provide information on content and priorities of activities in a research system, on the ability to transfer R&D results into practical applications, on connections between scientific sectors. Figure 8.3 establishes a connection between scientific production in several (generally EU) countries and their populations. Figure 8.4 shows the relative weight of publications by industrialised countries over total world scientific production. The number of articles written in co-operation with scientists from other countries (Figure 8.5) provides clear indications on the interdependency on scientific activity and the links between researchers and institutions in various countries.

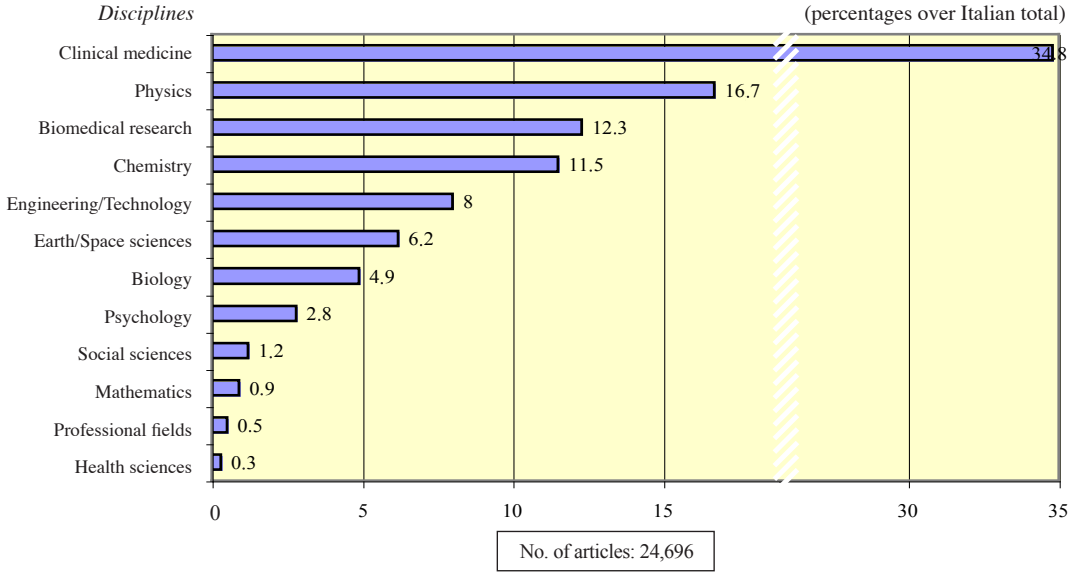
The number of citations (Figure 8.6) is an indicator of the impact that publications have on the science community both at national and international level.

Figure 8.1 - Articles by Italian scientists in the most important international journals, 1988-2003



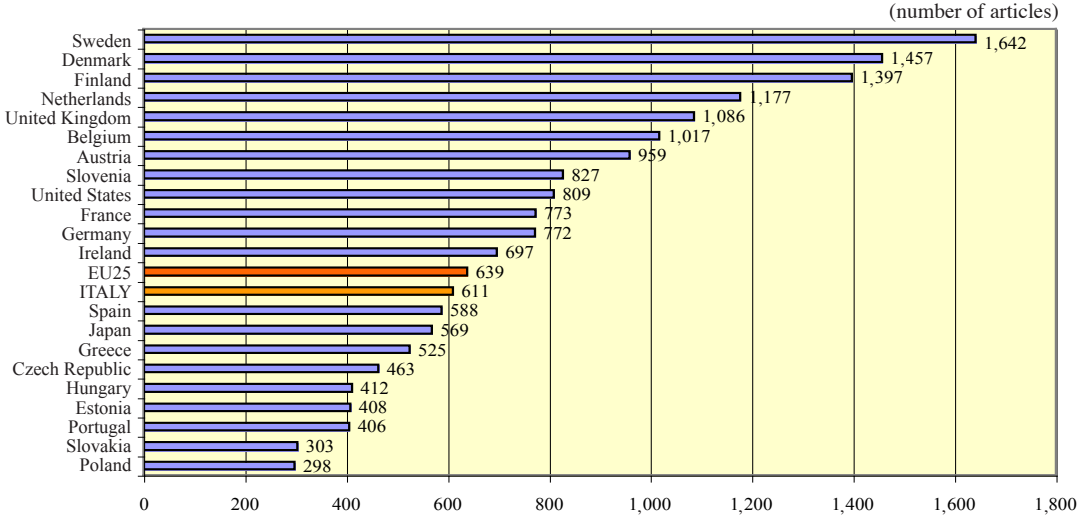
Source: National Science Foundation, Science & Engineering Indicators, 2006

Figure 8.2 - Italian authors' articles in the most important international journals sorted by discipline, 2003



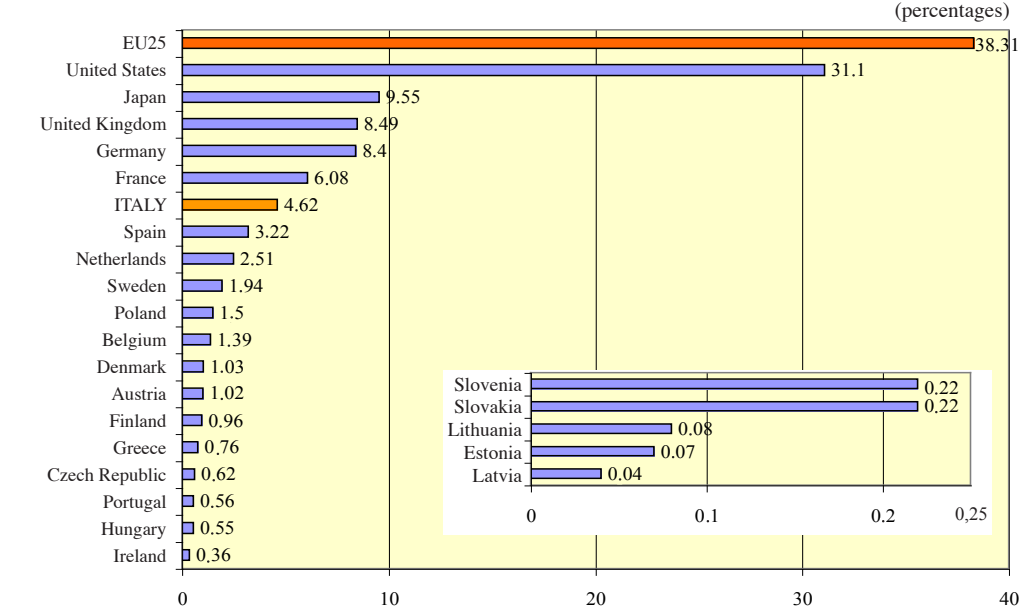
Source: National Science Foundation, Science & Engineering Indicators, 2006

Figure 8.3 - Scientific articles by authors of the EU, US and Japan per million people, 2003



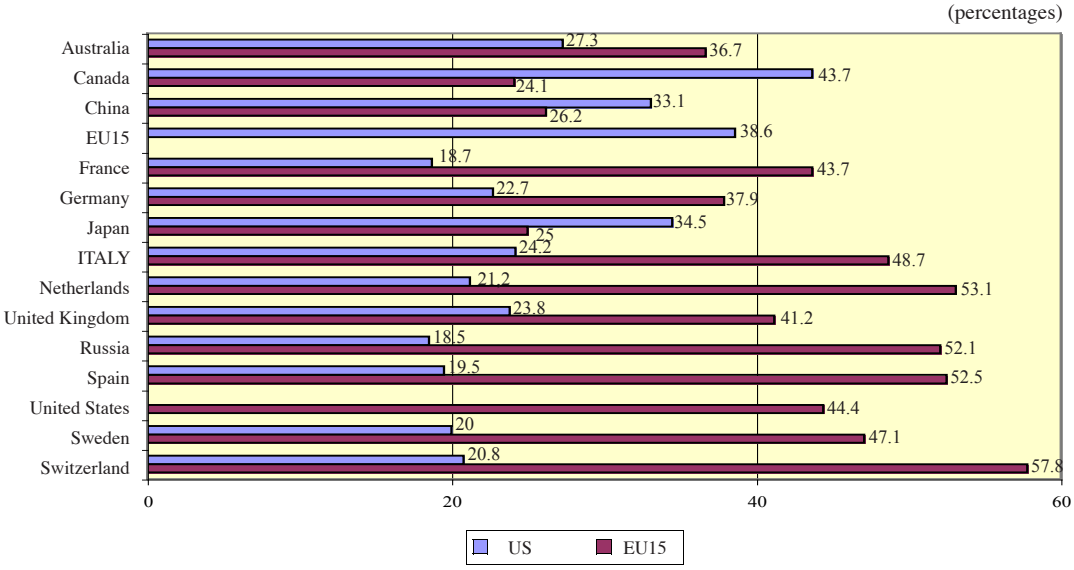
Source: EUROSTAT, Key Figures 2005

Figure 8.4 - Scientific articles by authors of the EU, US and Japan over world total, 2003



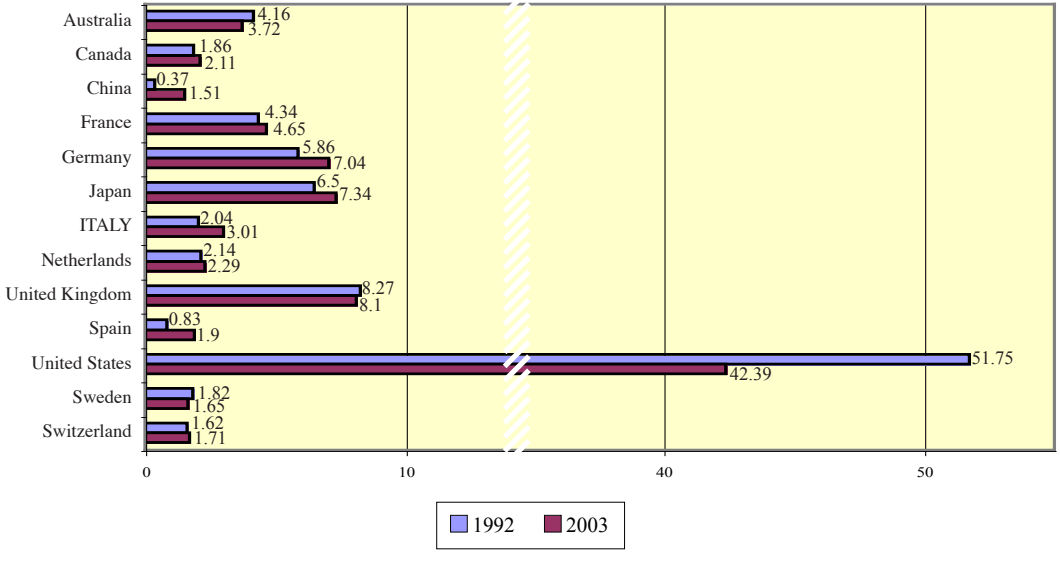
Source: EUROSTAT, Key Figures 2005

Figure 8.5 - Articles co-authored by US and EU scientists over total international collaboration, 2003



Source: National Science Foundation, Science & Engineering Indicators, 2006

Figure 8.6 - Citations of articles in the scientific publications of several OECD countries and China over world total, 1992 and 2003



Source: National Science Foundation, Science & Engineering Indicators, 2006

9. Technological Balance of Payments

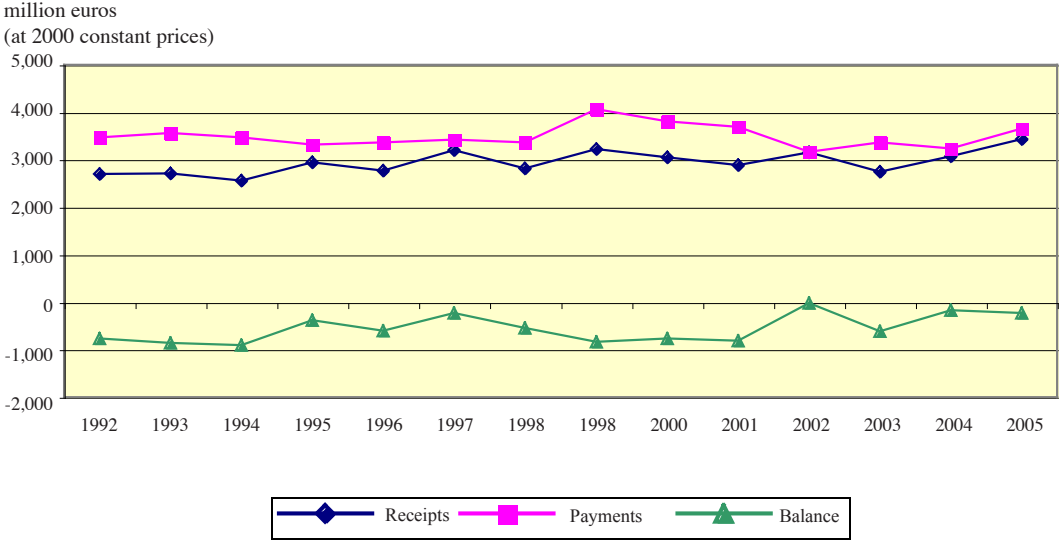
The Technological Balance of Payments (TBP) measures the invisible transactions of a country's balance of payments concerning technological trade: patents, inventions, licences, know-how, trademarks, patterns and designs, services with a technological content such as technical assistance, engineering, training of personnel, R&D services and technology exchange.

The source of data is the Italian Exchange Office (UIC). Table 9.1 and Figures 9.1, 9.2, 9.4 show the characteristics of Italy's TBP both in its trends and in its relationships with other countries.

The ratio between payments for the purchase of technology and R&D expenditures (Table 9.2) measures the flow of purchased technology over that autonomously generated. The ratio between TBP balance and R&D expenditure (Figure 9.3) shows the kind of transactions in which a country's technology is more (positive balance) or less (negative balance) competitive.

Figures 9.5 and 9.6, with international comparisons, come from an OECD source.

Figure 9.1 - The TBP in Italy, 1992-2005



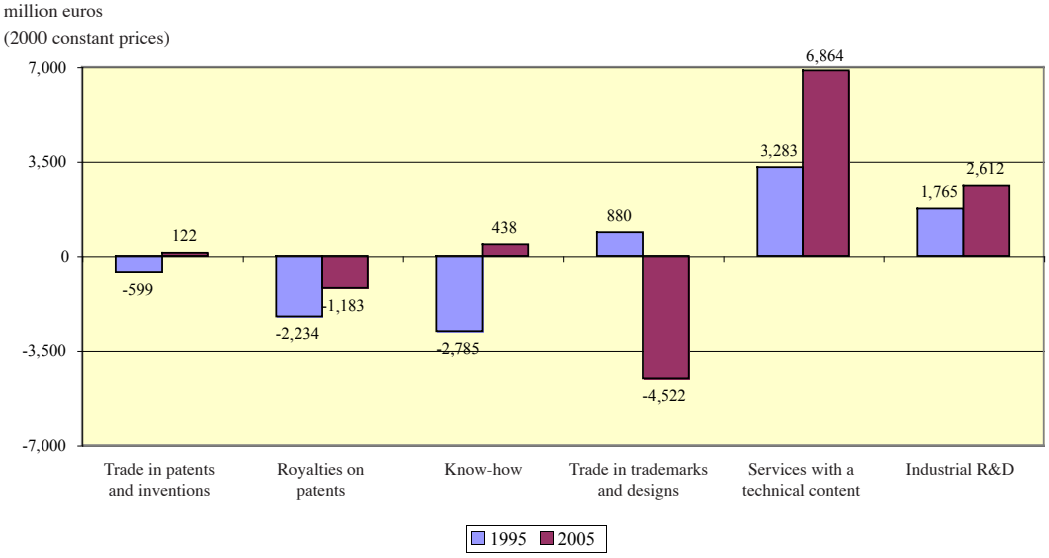
Source: UIC

Table 9.1 - The TBP sorted by diverse items in Italy, 2005

	Receipts		*Payments*		*Balance*
	million euros	*%*	*million euros*	*%*	*million euros*
Trade in technology	393.1	11.5	464.9	12.7	-71.8
Transfer of patents	*77.0*	*2.2*	*60.9*	*1.7*	*16.1*
Royalties on patents	*213.6*	*6.2*	*350.0*	*9.6*	*-136.4*
Know how	*101.4*	*3.0*	*50.9*	*1.4*	*50.5*
Transfer of inventions	*1.2*	*0.0*	*3.2*	*0.1*	*-2.0*
Transfer of trademarks, models and designs	245.4	7.2	766.6	20.9	-521.2
Royalties on trademarks, models and designs	*149.2*	*4.4*	*672.9*	*18.4*	*-523.6*
Transfer of trademarks, models and designs	*96.2*	*2.8*	*93.7*	*2.6*	*2.5*
Services with a technical content	1,914.7	55.8	1,123.5	30.7	791.1
Technical assistance linked to sales and licensing	*362.3*	*10.6*	*374.6*	*10.2*	*-12.3*
Commitment of technicians and experts	*169.8*	*4.9*	*112.3*	*3.1*	*57.5*
Training of personnel	*21.6*	*0.6*	*103.6*	*2.8*	*-82.0*
Technical and engineering studies	*1,361.0*	*39.7*	*533.1*	*14.6*	*827.9*
R&D financed abroad	805.6	23.5	504.6	13.8	301.1
R&D services	*805.6*	*23.5*	*504.6*	*13.8*	*301.1*
Total	3,358.8	97.9	2,859.6	78.1	499.2
Other	70.9	2.1	801.7	21.9	-731
Grand total	3,429.7	100.0	3,661.4	100.0	-231.6

Source: UIC

Figure 9.2 - The balance of TBP sorted by diverse items in Italy, 1995 and 2005



Source: UIC

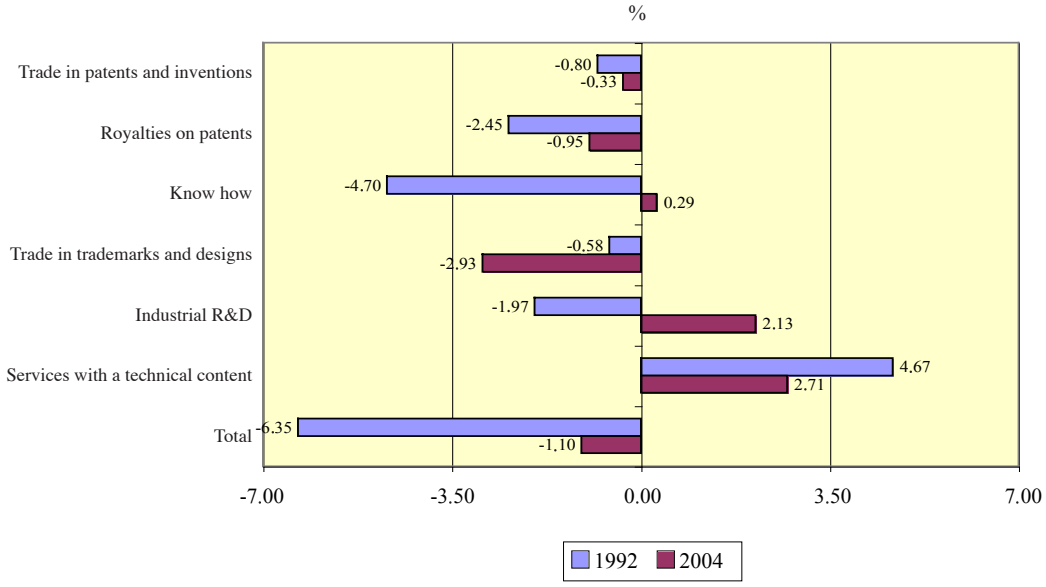
Table 9.2 - Ratio between payments for purchase of technology and R&D expenditure in Italy, 1992 and 2004

(percentages)

	1992	*2004*
Trade in patents and inventions	1.11	0.38
Royalties on patents	3.02	1.52
Know how	0.80	0.69
Trade in trademarks and designs	1.49	1.51
Industrial R&D	3.86	5.75
Services with a technical content	12.73	10.03
Total	28.82	20.39

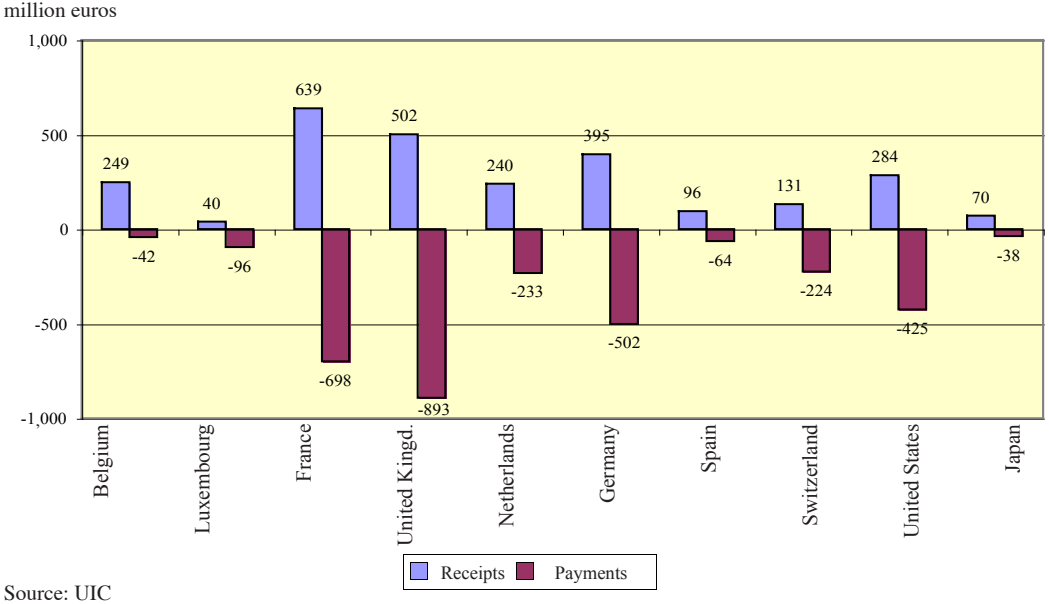
Source: CERIS-CNR elaboration on UIC and ISTAT data

Figure 9.3 - The balance of TBP over R&D expenditure in Italy, 1992 and 2004



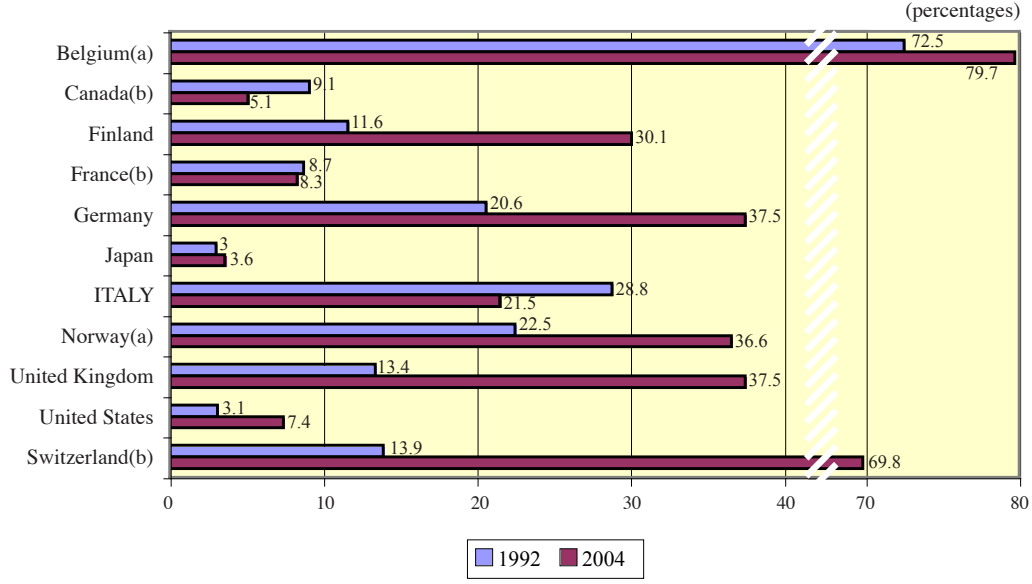
Source: CERIS-CNR elaboration on UIC and ISTAT data

Figure 9.4 - Italy's TBP with its largest partner countries, 2005



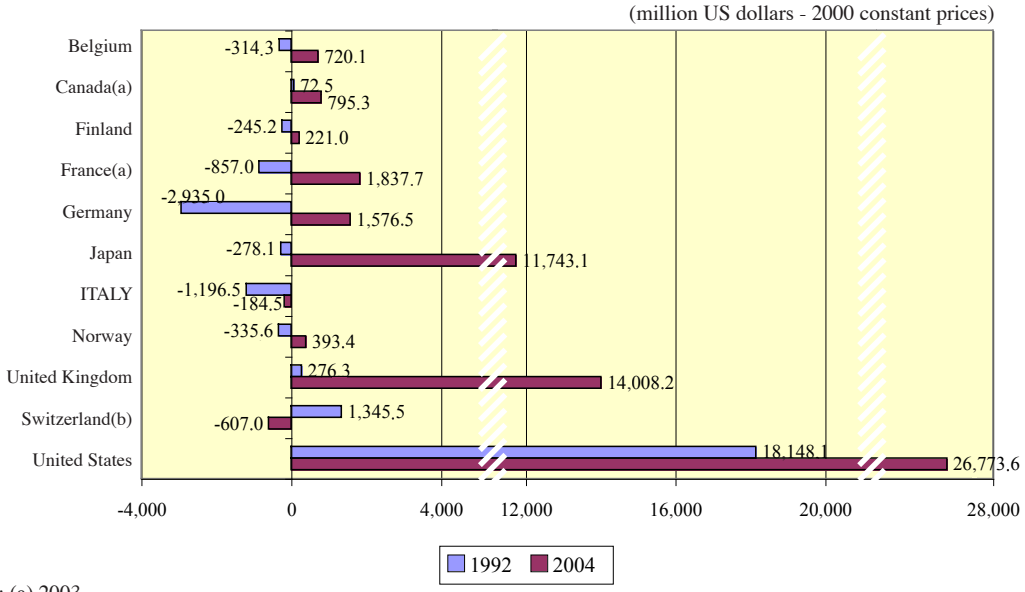
Source: UIC

Figure 9.5 - Payments of TBP over R&D expenditure in several OECD countries, 1992 and 2004



Notes: (a) 1991; (b) 2003.
Source: OECD

Figure 9.6 - The balance of TBP in several OECD countries, 1992 and 2004



Note: (a) 2003.
Source: OECD

10. Trade of high-technology products

ISTAT is the source of data for Italy (Figure 10.1), the OECD and Eurostat are the sources for international comparisons.

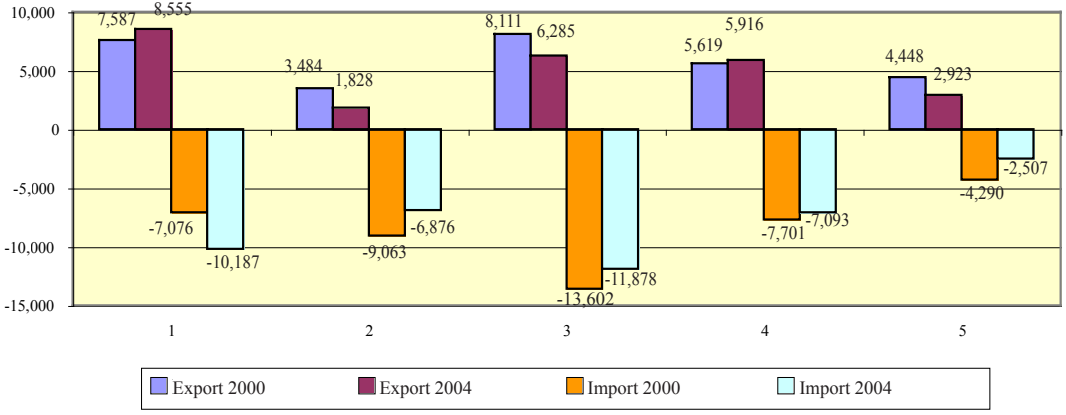
Figures 10.2, 10.3, 10.4 show some specific indicators for high-technology industries (*i.e.* R&D intensive sectors, according to the OECD definition). Industries belonging in this category are:

- the aerospace industry,
- the telecommunications industry,
- the office machinery and computer industry,
- the pharmaceutical industry,
- the medical industry, precision and optical instruments and watches.

The capability of producing goods in these sectors, whose products are highly requested in the global market, measures the strength of an industrial system to stay at the forefront of technology. As a consequence, the competitiveness of companies belonging to a country is more accurately measured by analysing the trends of its market shares in the high-technology international trade. It is expected that those countries spending more on R&D will hold the best positions.

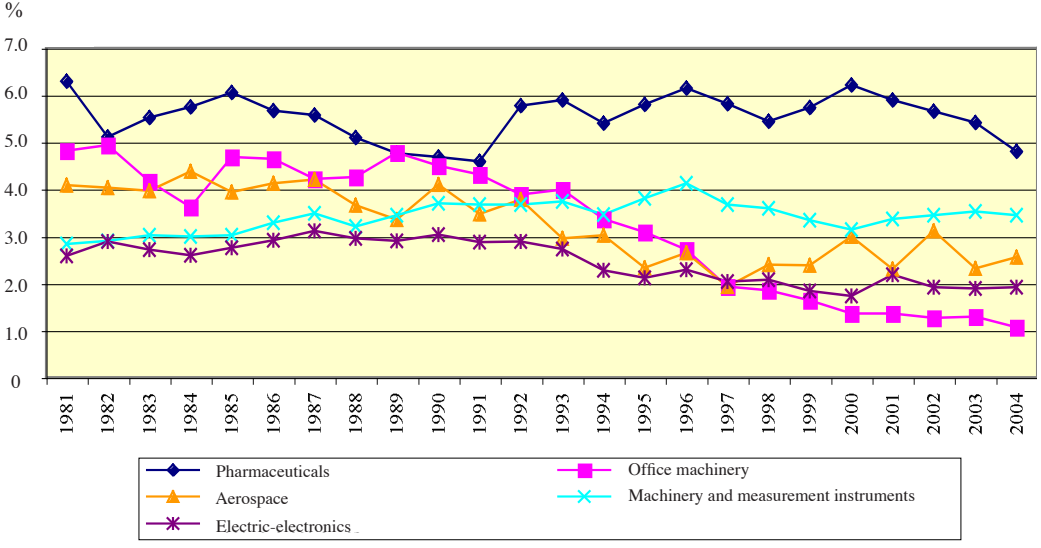
Figure 10.1 – Italian trade in certain sets of high-technology products, 2000 and 2004

million euros
(2000 constant prices)



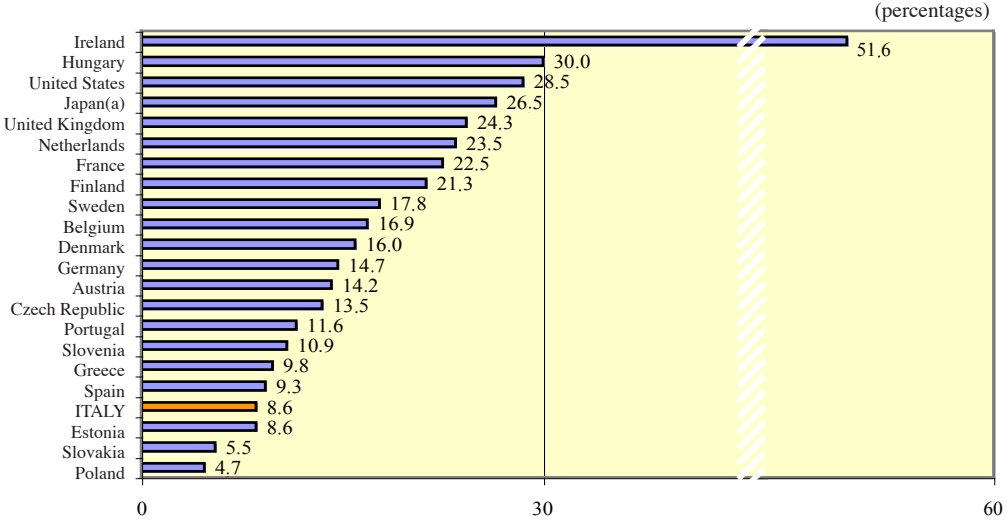
Legenda: 1) Pharmaceutical products, chemical products; 2) Office machinery and computers; 3) Radio, TV and telecommunications; 4) Medical, precision and optical instruments, watches; 5) Aerospace vehicles.
Source: ISTAT

Figure 10.2 - Share of Italian exports over total OECD exports in certain high-technology manufacturing sectors, 1981-2004



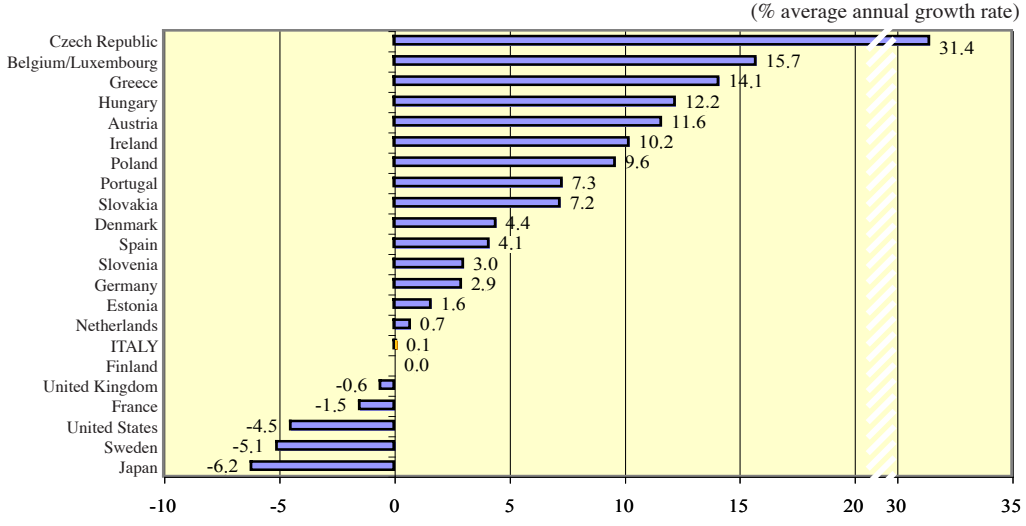
Source: OECD

Figure 10.3 - Exports of high-technology manufacturing industries over total exports in some OECD countries, 2003



Note: (a) 2002.
Source: EUROSTAT, Key Figures 2005

Figure 10.4 - Trends in world market share of exports in high-technology manufacturing industries in some OECD countries, 1997-2002



Source: EUROSTAT, Key Figures 2005

11. Innovation

Tables and figures presented here come from a specific survey carried out by ISTAT on the basis of criteria and methodologies shared by all EU countries, within the fourth European survey on innovation (*Community Innovation Survey – CIS*).

The respondents are Italian companies with at least 10 employees, operating in industries and services in the period 2002-2004. As far as Italy is concerned, the survey is limited to a sample for companies employing 10-249 units but covers all companies with 250 or more employees.

The principal indicator of innovation in Italian companies is the number and percentage of them that brought an innovation to the market during the three years under consideration. Other indicators describe distribution by type of innovation (*i.e.* process, product or both) (Table 11.1).

Table 11.2 shows data on expenditures for innovation introduced by manufacturing firms, sorted by industry. Innovation expenditure includes intramural and extramural R&D expenditure, investment in innovative machinery and equipment and in disembodied technology, design, marketing and training. In Figure 11.1 various innovative activities are shown which gather firms into four large macrosectors (in accordance with Pavitt's taxonomy which identifies industry clusters mainly on the basis of innovation sources): research-intensive science-based firms; scale-intensive firms; specialised suppliers of capital goods and suppliers-dominated firms.

The Figures 11.2, 11.3 show expenses by company size. Figure 11.3 also shows various components of total expenditure.

Table 11.1 - Principal innovation indicators in Italian companies, 2002-2004

	Number
Industrial companies	87,272
of which:	
Innovating companies	32,687
Service companies	78,838
of which:	
Innovating companies	21,771
	Approximate number
Industrial and service companies interviewed	22,000
	Percentages
Companies that introduced innovation	
of which	
industrial companies	36.4
service companies	27,1
Industrial companies that introduced	
process innovation	17.4
product innovation	6.3
both process and product innovation	12.7
Service companies that introduced	
process innovation	51.4
product innovation	16.9
both process and product innovation	31.7

Note: Survey on a sample for companies employing 10-249 units and on all companies with at least 250 employees.
Source: ISTAT, L'innovazione nelle imprese italiane. Anni 2002-2004, "Statistiche in breve", novembre 2006

Table 11.2 - Innovation expenditure in innovating manufacturing firms by industry in Italy, 2004

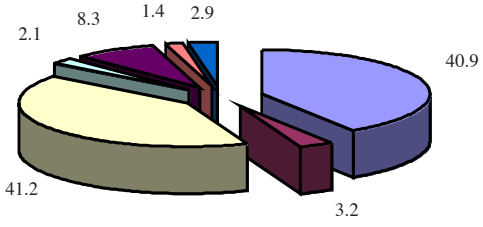
Industries	Total expenditure million euros	Expenditure by employee thousand euros
Food and tobacco	1,016.2	6.9
Textiles	548.5	5.6
Wearing apparel	127.8	3.4
Leather and footwear	232.7	5.9
Wood	222.2	6.9
Pulp, paper	363.6	9.1
Printing and publishing	705.7	12.0
Oil and coke	132.4	14.0
Chemicals	2,455.3	18.5
Rubber and plastics	890.0	8.8
Other non-metallic mineral products	617.2	5.9
Basic metals	594.5	7.2
Fabricated metal products	1,694.2	7.6
Machinery and equipment	2,882.3	9.0
Office machines	201.6	24.1
Electrical machinery	808.1	8.1
Telecommunications	1,341.7	23.3
Medical precision and optical instruments	903.1	18.4
Motor vehicles	1,125.9	9.0
Other transport equipment	993.4	13.1
Other manufacturing industries	495.6	5.0

Source: ISTAT, L'innovazione nelle imprese italiane. Anni 2002-2004. "Statistiche in breve", novembre 2006

Figure 11.1 - Innovation expenditure in innovating manufacturing firms by taxonomic macrosectors and type of innovative activity in Italy, 2004

(percentages)

Science based



Scale intensive

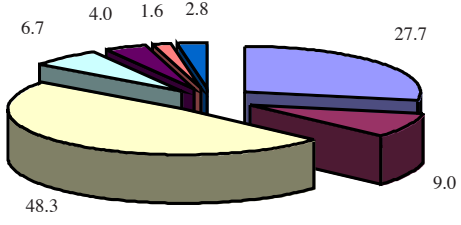
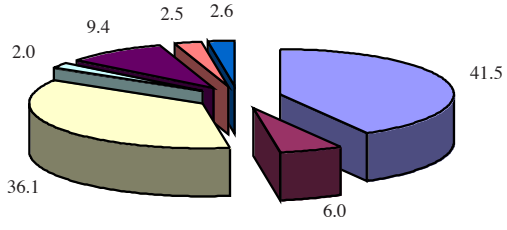
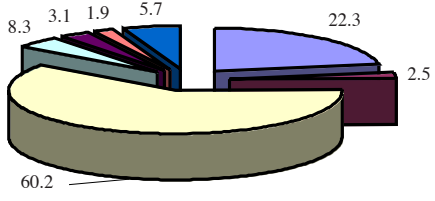


Figure 11.1 (cont.) - Innovation expenditure in innovating manufacturing firms by taxonomic macrosectors and type of innovative activity in Italy, 2004

Specialized suppliers



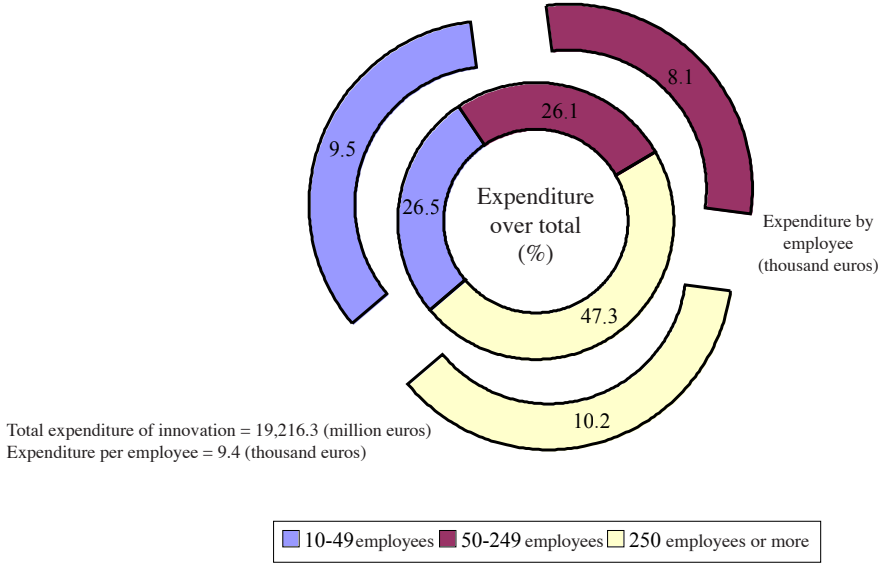
Suppliers dominated



Internal R&D
Purchase of R&D services
Purchase of innovative equipment
Purchase of technology not embodied in capital goods
Designs
Training
Marketing

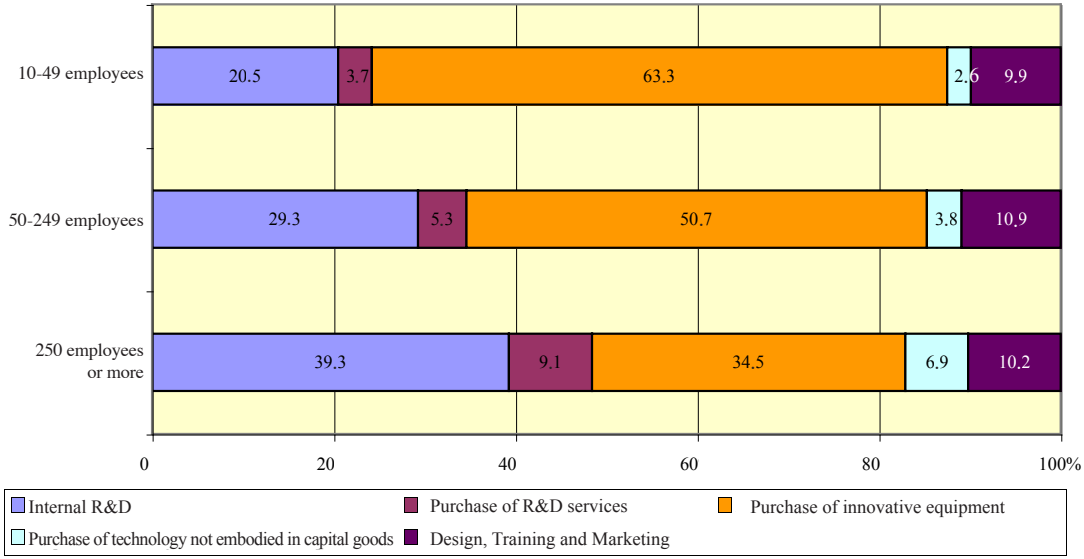
Source: ISTAT, L'innovazione nelle imprese italiane. Anni 2002-2004, "Statistiche in breve", novembre 2006

Figure 11.2 - Innovation expenditure in innovating manufacturing firms by taxonomic macrosectors sorted by number of employees in Italy, 2004



Source: ISTAT, L'innovazione nelle imprese italiane. Anni 2002-2004, "Statistiche in breve", novembre 2006

Figure 11.3 - Innovation expenditure in innovating manufacturing firms sorted by number of employees and type of innovative activity in Italy, 2004



Source: ISTAT, L'innovazione nelle imprese italiane. Anni 2002-2004, "Statistiche in breve", novembre 2006

This publication provides statistical information on Italian science and technology based on the data available in mid-2007.

Figures are provided on human and financial resources for R&D, publications, patents, the Technological Balance of Payments, R&D-intensive product exports/imports and innovation in Italy's economic system.

R&D data concerning other countries are also reported to facilitate international comparisons.

In addition, the publication provides detailed information on the public sector research activity and funding at both national and local government level.

Institute for Economic Research on Firms and Growth (CERIS) by CNR
Director: Secondo Rolfo
Research Unit: "Institutions and Policies for Science and Technology"
Head of Research Unit: Maurizio Rocchi
Via dei Taurini, 19
00185 Roma - Italy
http://www.ceris.cnr.it

Contact person: Cinzia Spaziani
Tel.: +39 06 4993 7813
E-mail: c.spaziani@ceris.cnr.it

Intese Grafiche
Brescia - Roma

ISBN 978-88-8080-076-7