

Instituto de Estudios Sociales Avanzados (CSIC)
Working Paper 98-15

The Spanish system of research **Research and innovation in Spain**

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General Characteristics of the Spanish System of Research

The Spanish System of Research, including research and innovation aspects, is characterised by a lack of tradition in recognising the political and economical relevance of science and technology and for the absence of efficient patterns of action for the management of a science and innovation system.

The efforts to reorganise the Research System were carried out, at critical opportunities, through the influence of individual actors that at given times of their careers assumed the governance of the System and attempted to reform the organisation and institutions to correct for the flaws that were hampering the effective operation of the Research System.

These "window opportunities" to introduce science and technology in the political agenda were given positive, but partial, outcomes yielding benefices to a specific area or sector of the Research System but failing to obtain a global positive outcome.

Size of the Spanish Research System: historical dependency

The evolution of the Research System in Spain has been influenced by the lack of Spanish tradition on these issues. There has not been a golden century for science and technology in Spain, the enlightenment period that occurred at the end of XIX century and first third of the XX century was cut short by the Civil War (1936-1939) that led to the autocratic regime responsible for the isolation of Spain from the world trends.

As a consequence, the size of the Spanish Research System was very small at the times were the United States and the Western European Countries were making strong efforts to develop their Systems of Research by increasing expenditures from public and private sources and the amount of skilled labour force.

The effort of 1960s

The first effort to change the relevance of the Spanish System of Research in the XX century took place in the 60s with the arrival to government of the so-called "technocrats" who attempted to put remedy to the backwardness of Spain by following the model of the French National Plans and counting on the support of the United States. Their attempts to reform were driven under the influence of international bodies and trends (the OECD played a significant role in this process). It is worth mentioning that the success in improving the economic wealth of Spain, driving the country to the tenth-eleventh position

by GDP among the industrialised countries was based on two main sectors: building and tourism together with the traditional sectors of Spanish economy like textiles, ceramics, agriculture, fisheries through their adaptation to international tides, all these areas being characterised by their reduced connections with R&D activities. The Plans for Strategic Development incorporated R&D activities as a strategic sector of activity but these activities showed scarce influence to the economic progress. The First National Plan for Development (1964-1968) was designed to meet the most urgent needs of the Spanish economy that was suffering from lack of competitive capacity as marked by autarchy. The Second Plan (1968-1971) was aimed to increase the resources devoted to science and technology, following the suggestions of OECD, but the economical crises of 1970s led to budgetary restrictions which reduced again the impulse on science and technology.

Therefore, Spain attained a wealthy economic status while spending only 0.3 per cent of her GDP in R&D and with a number of research personnel amounting to less than 10,000 full time equivalent for a population of 38 million inhabitants. In any case, it is worth noting that during the period around the sixties Spain lacked a good protocol and appropriate institutional setting for statistics on R&D.

The second effort. Science and technology in the 1980s

During the democratic transition, following Franco's death, the weak profile of R&D activities even declined, although a positive input, that lasted only for two years, was the creation of the *Ministerio de Universidades e Investigación* (geared by the socialdemocrat wing of the *Unión de Centro Democrático*, the leading party in the two first democratic elections).

The general elections of 1982 were gained by the Socialist Party (*PSOE*) that had incorporated science and technology issues in the electoral programme, allowing to some policy entrepreneurs to undertake a series of action under the general discourse of Spanish modernization. The first decision was to carry out an exercise of diagnosis of the Spanish Research System. This analysis was the subject of a publication (*Ciencia y Tecnología: una oportunidad para España*).

Among the interesting facts revealed by these analysis, it should be mentioned the following:

- lack of strategic relevance of R&D activities for technological and economical development
- reduced size of the research and innovation system, both in terms of economic expenditure and in human resources
- limited coordination within the Public System of Research with a main role played by the ministry of Education and Science but with the sectoral ministries (seven to eight) spending resources through different programmes and the Government Laboratories for which they were responsible. No specific function or envelope for R&D did exist in the General State Budget until 1986-1987
- the agencies involved in the funding of research projects and ear marked programmes through competitive mechanisms (*CAICYT*, *Comisión Asesora de Investigación Científica y Técnica*, *Fondo de Investigación de la Seguridad Social y de Investigaciones Sanitarias*) were holding around 5 per cent of the State Budget, a small percentage for performing a real strategic policy
- the business sector contributed to less than fifty per cent to the effort in research and innovation action. The lion's share of this effort being contributed by the public enterprises.
- Uneven distribution between regions. Madrid shared the 45 per cent of the Public

- System of Research, followed by Catalonia (19 per cent), while Madrid, Catalonia and Basque Country were sharing altogether the 80 per cent of the business sector
- the human resources also showed a strong concentration between Madrid and Catalonia (37.5 and 21.3 per cent, respectively) followed by Andalusia and the Valencian Community (11.2 and 6.8 per cent).

The Law for Science

The political effort of the PSOE consolidated after a series of circumstances (for a review, see L. Sanz Menéndez, *Estado, ciencia y tecnología en España: 1939-1997*) into the enactment of the *Law of Promotion and General Coordination of the Scientific and Technical Research*, colloquially referred as the Law for Science.

This legal instrument was aimed:

- to introduce science and technology into the political agenda (decision and debate)
- to foster the coordination between the Public System by establishing an Interministerial Committee chaired by a Minister, designed by the Prime Minister, and with representatives of the main sectoral ministries involved in the performance of research activities
- to promote the interaction between the social and economic actors and the Governments of the Autonomous regions with the policies on research and innovation by creating two Bodies: the Advisory Council for Science and Technology and the General Council for Science and Technology
- to drive the potential action through the establishment of a National Plan for Research and Development which will focus on priorities and will fund research through competitive mechanisms, according to appropriate assessment procedures.

Evolution of the Spanish Research System since the 1980s

There has been an increase in the size of R&D expenses, although the amount of expenditure never reached the goal of 1.2 per cent GERD that was foreseen as one of the goals of the first National Plan for R&D (1988-1991) and has been kept as objective in the following National Plans (1992-1995; 1996-2000). The relative figures have shown up and downs (see [Fig. 1](#)), although the total amounts have shown an increasing trend except for a plateau in 1992-1994 ([Fig. 2](#)). This lends support to the contention that the research activities are not exerting direct influence on the economic wealth of Spain but the opposite seems to be the truth. The government push and economic wealth are the factors which influence R&D activities in Spain.

Since 1987 there is a budgetary envelope or function for the Public Research System. The distribution for 1997 among the ministerial department is illustrated in [Fig. 3](#) which shows the relative low percentage allocated to the National Fund as compared to ministries like those of Industry and Energy, Education and Culture, Defence, Health or Agriculture, figures that cast doubts about the efficiency for coordination of the National Plan of R&D.

The business sector has been reducing its share along these years as shown for instance by the evolution of the research personnel ([Fig. 4](#)).

The reform of the late 1990s

The 1996 elections were won by the Conservative Party (Partido Popular) who has since taken the responsibilities of government. This has represented a change in several aspects of the political arena. It can be stated that R&D policy was adjourned for a time of reflection.

This stagnation or critical situation has been accompanied by a positive trend in the economic situation. Spanish economy has been growing at the fastest rate among the European countries while the R&D resources were characterised by slight increases in 1997 and 1998 as compared to economic growth. Moreover, the increase has become controversial due to the incorporation in the State Budget for R&D of the Structural Funds and some compromises in international programmes related to defence objectives and weapons.

An Office for Science and Technology, adscribed to the ministry of Presidency, has been set up in the beginning of 1998 to promote coordination and strategic planning (to prepare the new version of the National Plan and to distribute the public resources for R&D promotion). This Office is now in operation and the first outcome will be reflected in the 1999 budget.

Main Institutions

The institutions involved in the management of science and technology policies in Spain have experienced changes along this century. After the end of the Civil War, the institution that was in charge in Spain of promoting research and training for research, the *Junta de Ampliación de Estudios* (JAE) was dissolved and dismantled.

The *Consejo Superior de Investigaciones Científicas* (CSIC) was created in 1939 on the grounds of the JAE and structured to perform its functions inspired in the model of the Academies of the socialist countries. The CSIC was founded with two goals: to coordinate and foster scientific development in Spain and to launch and develop research centres. The CSIC underwent several crises in its evolutive trajectory that have been revised by several authors (see the special issue of the Spanish journal ARBOR in 1990 under the title "El CSIC: una visión retrospectiva" 1990, articles by A. Nieto in "Apuntes para una política científica" 1982, Sánchez Ron, 1992 and Santesmases and Muñoz, 1993, 1997).

In summary, it can be concluded that:

- The CSIC failed in its role as agency to coordinate and promote the scientific activity in Spain. It did not play a significant role in the design of the Spanish science policy. However,
- It was instrumental in the professionalisation of the research careers in the Public System of Research in Spain.
- It was quite successful in the launching and development of research centres and sophisticated scientific infrastructures in a wide set of scientific and technological realms going from chemistry to biology, from national resources to technological applications in some specific sectors (Automatisation and Robotics, Ceramics, Building)
- The CSIC had experienced difficulties along its history to manage the divide between science and technology, between basic and applied science, evolving along its trajectory to an academic-like institution.
- CSIC was decisive in creating and maintaining high level libraries related to science and technology.

La *Comisión Asesora de Investigación Científica y Técnica* (CAICYT) was established in 1958 to cope with the functions in the management of science and technology policies that the CSIC was unable to fulfill. It was created under the "technocratic" influence and likely inspired on a blend of models (Anglosaxon, French, German). CAICYT was established as an independent body to the CSIC but tightly linked to it at its onset. Paradoxically, the capacities of CAICYT to intervene in the scientific and technological development of Spain

were limited since CAICYT was lacking any specific budget to fill its functions until 1964 when the Fondo Nacional para el Desarrollo de la Investigación Científica (National Fund for Development of Scientific Research) was created with an endowment of 100 million Pta, an endowment that showed an increasing trend until 1971 with slight fluctuations.

The ministerial dependence of CAICYT since its origins until 1979 was the ministry of the Government Presidency. The creation of the ministry of Research and Universities implied the adscription of CAICYT to this ministry. The last critical period of UCD was accompanied by the disparition of the ministry of Research and Universities and its transformation into a Secretary of State for Universities and Research –a *second* rank at ministerial level- which was placed under the dependency of the Minister of Education and Science –CAICYT remained under this dependency until its final disparition with the enactment and put into force of the *Law for Science*.

The new agencies: promotion of technology and research on health

At the end of the seventies and beginnings of the eighties, two new agencies were established: the *Centro para el Desarrollo Tecnológico Industrial* (CDTI, Centre for Industrial Technological Development) and the *Fondo de investigaciones Sanitarias de la Seguridad Social* (FISS, Fund for Research on Health from the Social Security)

CDTI

It was established in 1978 as an organism of administrative nature inside the frame of the Spanish Administration and was transformed into a society of public nature in 1983. Its objectives were the funding of projects related to the last steps in the process of technological development according to the fostering of a favourable environment for the promotion of technology and innovation.

The new structure as a public society provided CDTI for greater flexibility to carry out its functions and to manage its resources which amounted to 779 million Pta (1978) to 1,900 million Pta (1983). In its second period, the endowment raised to 4,000 million Pta with the following breakdown: electronics and information technologies (40 per cent); mechanical processes (25 per cent); biotechnology and medicine (13.5 per cent); energy (12.4 per cent) and agrofood (8.8 per cent).

FISS

The fund for promotion of research in the health and biomedical areas was established in 1980 as a sectoral fund, adscribed to the ministry of Health and Consumption as a follow up of a previous experience of collaboration with the pharmaceutical industry which contributed with a part of the benefits of its sales to the Public Health Insurance System (Social Security System) as an endowment to fund research and training in the health and biomedical realms. The funds allocated to this sector of research have increased steadily from hundreds of millions Pta to reach figures around 6,000 million Pta in the nineties.

The research funded is performed in hospital and university related centres and the fund raising is distributed through all Spain, although the great level of funding corresponds to Madrid and Catalonia with similar positions, which represents a common trend with respect to other agencies and programmes, albeit in this agency the role of Catalonia is more prominent than in others.

La Comisión Interministerial de Ciencia y Tecnología (CICYT, Interministerial Committee for Science and Technology)

The CICYT was the deal of the Law for Science. It took from CAICYT, but with greater institutional support, the responsibility for the coordination and planning of science and technology policies and activities and relied on the General Secretariat for the R&D National Plan to manage the resources of the research programmes based on priorities and strategic objectives.

The General Secretariat has been replaced in 1998 by the previously referred Office for Science and Technology (*Oficina de Fomento y Coordinación Científica y Técnica*) resulting from the last reorganisation, but this Office appears to be more reduced in terms of human resources and infrastructure than the former Secretariat for the R&D National Plan.

National policies and priorities

The role of CAICYT

The main changes in the Spanish science and technology policies experienced since the early sixties were driven by attempts to settle and gear priorities within the science and technology realm. CAICYT was the organisation for advancing in this way but its logic of action was hampered by the lack of tradition in this field of designing strategies –the cultural influence of a dictatorial regime deepened this deficit. However, CAICYT was successful in introducing the allocation of funds to projects from the research and/or the industrial worlds through competitive mechanisms. This bottom up approach –investigator-driven or industrial manager-driven- led to the shaping of predominant areas of research from institutions devoted to basic and applied research activities and to map the most innovative areas within the business sector.

The activities in the firm-driven approach were funded through a new form of contract termed as *Planes concertados de investigación* (Concerted research projects) by which the firms developed research and development activities either in house or in collaboration with public research institutes or university departments with 50 per cent of the budget provided by public funds (*Fondo Nacional para la Investigación Científica y Técnica*, see above).

Some results to illustrate the resulting maps are shown in Tables [1](#) and [2](#). A first consideration to be drawn from the data is the apparent separation between the two set of actions. The chemical and pharmaceutical industrial activities clearly overpasses the research subsector potential, the same seems to occur with engineering-related activities.

In 1981 a short time before the general elections of 1982, CAICYT began an effort of strategic planning by launching the figures of *Programas especiales de I+D* (Special R&D Programmes) and the *Planes o programas movilizadores* (Mobilizing Programmes).

These programmes were conceived as a series of research (and development) projects linked and intertwined aimed to attain specific, wide range goals of scientific-technological and socio-economical interests. The programmes were first focused on the following domains: aquaculture, agroenergetics, biotechnology, microelectronics, transport which were considered strategic taking into account global trends and the eventual Spanish potentialities. This election, that made sense to a certain extent, was looked with apprehension by the scientific and industrial communities because the decision was taken top-down and with scarce participation of scientists and industrialists in the definition of the programmes. This negative attitude from the leading scientific and innovation actors was deepened by the weakness of the party (*Unión de Centro Democrático*) holding Spanish Government at that time.

However, after the victory of the Spanish Socialist Party in the general elections of 1982, the responsables for science and technology policies decided to keep this experience and to delve into it as a first exercise in the planning of R&D activities. The programmes and the committees involved in their management were reshuffled to launch four programmes on aquaculture, agroenergetics, biotechnology and microelectronics with an endowment of 600 million Pta (1986). The relative success of the experiment served to gain credit among the scientific community, always reluctant to "oriented" science strategies and was the scaffold to build the future National Plan of R&D.

The National Plan for R&D

The National Plan for R&D is the main instrument established by the law for Science to a mechanism for funding research put into force a based on priorities.

The first National Plan

The first National Plan corresponded to the period 1988-1991 and the priorities were determined by mixing top-down decisions with the discussion from working groups integrated by experts in the pre-selected scientific and technological areas, based on a series of experiences and criteria^[1].

The previous experience of CAICYT and the following criteria were applied for selecting the priority areas from the top-down mechanism.

1. Existence of previous national plans established by ministries or agencies, as it was the case for the Electronic and Information Technologies Plan and the Energy National Plan (both from the ministry of Industry and Energy) and the National Plan for Agriculture (ministry of Agriculture, Fisheries and Food).
2. Existence of a well developed scientific and technical community.
3. Existence of economical sectors characterised by innovation activities and links with the scientific and technical research communities.
4. Detection of flaws in any one of the scientific and productive community mentioned in points 2 and 3.
5. Priorities already existing in international programmes which may be of strategic relevance for the interests of Spain.
6. Identification of strategic areas of socio-economical relevance for Spain and her citizens that may be approached through scientific and technical developments.
7. Redirection and reshuffling of existing programmes.

The exercise resulted in the selection of 23 programmes which were grouped into 5 large areas: Horizontal Programmes, Agrofood and Natural Resources, Production and Communication Technologies, Quality of Life and Special Programmes and listed as follows:

Horizontal Programmes

Training of personnel for research
Interconnection of information resources

Agrofood and Natural Resources

Research and Antarctic Sea
Agricultural research
Research on development on livestock
Geological resources
Marine resources and aquaculture
Food technology

<i>Production and Communication Technologies</i>	Automatization and Robotics Photonics Space research Microelectronics New materials Information and communication technology
<i>Quality of Life</i>	Biotechnology Cultural and social studies on LatinAmerica Immunology Pharmaceutical research and development Research on sport Historical heritage Social issues and social welfare Toxicology
<i>Special Programmes</i>	High energy physics (relation to CERN)

Each programme was drafted by "ad-hoc" working group according to a common structure that should take into consideration the following aspects: definition and formulation of socio-economical objectives; justification of the programmes on the grounds of the demand and of the prospective issues assuming a risk analysis approach; analysis of the existing resources, interaction with other sectors –industrial, other national and international programmes; well defined objectives –scientific, technological, industrial development, social and economical income-yield capacity; lines of action; priorities and time-schedule; funding; instruments for management, coordination, monitoring and evaluation of the programme; valorisation and technology transfer of eventual results.

Each programme was assigned a Committee, intermediate body between the programme managers and CICYT and composed of representations of the funding agencies and the sectoral ministries interested in the area of competence of programme.

A first conclusions to be drawn from the first National Plan were:

- A wave of enthusiasm in the scientific and technological community and in the most innovative industrial firms.
- It was too ambitious in the number of programmes and of their goals.
- It failed to carry out internal and external evaluation and monitoring exercises as was originally foreseen. Changes in persons at different hierarchical levels in the most relevant ministries induced a loss of the original philosophy and impetus, making impossible harnessing an appropriate evolvement of the Plan.

The following National R&D Plans (II and III)

The failure of the National Plan to undertake a rolling-up mechanisms of evaluation and the changes in the political orientation converted the instrument into a funding agency for academic research activities and pursued its strategic action in a continuity of the programmes. The most evident change, after the Annual Report of Activities in 1995, was the regroupment of topics and fields in a reduced number of programmes and their concentration into areas; that listed as follows:

<i>Quality of Life and Natural Resources</i>	Agricultural sciences Food technologies Environmental and natural resources
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	Biotechnology Health and pharmaceutical research Climate R&D Marine science and technology
<i>Production and Communication Technologies</i>	Advanced technologies for production Information and communication technologies Materials Space research
<i>Socio-cultural, Horizontal and Special areas</i>	Social, economic and cultural studies Information (Network) for R&D High energy physics Research on the Antarctic Sea Fine chemistry (funds related to a programme raised and managed from Catalonia) Research training programme

In 1995, the National Plan was distributing a total of 22,425 million Pta[2] with the share between areas and actions as illustrated in Fig. 5. This year represented the end of the second National R&D Plan (1992-1995) which has permitted the funding of 9,000 research projects with amounts around 80,000 million Pta, 735 concerted and cooperative projects – in collaboration with firms- with resources from the National Plan amounting to 35,000 million Pta, a series of actions devoted to the creation of physical and equipment infrastructure (25,000 million Pta) and around 54,000 million Pta were devoted to the training of research personnel.

The third National Plan is now underway. Its main change was to focus to more applied and productive oriented research. Analysis and studies of the outcomes are still lacking.

Importance and mode of operation of priority programmes

Most of the priority programmes have been managed from the General Secretariat of the National Plan with few exceptions but the funding has been in the basic and applied research aspects, whereas the concerted projects with firms (reminiscent of the formula of *Planes concertados de investigación*) were put in charge of CDTI following the enactment of the Law for Science. This decision based on a political negotiation between the ministry of Education and Science (chair of CICYT) and the ministry of Industry and Energy (responsible for the technological and innovation policies) favoured the relation of the firms with the Administration but, at last, appeared as a hurdle for fostering the links between the academia and industry and for promoting coordination among the different actors involved in the process of research, development and innovation.

The last report available corresponding to the end of the second National Plan (year 1995) allows to establish a breakdown between the different programmes and the distinct actions within each programme as indicators of their relative importance. Table 3 illustrates such distribution expressed in percentages, vertical between programmes and horizontal for actions in each programme to facilitate for a better comparison. The data shows a division into three groups: three programmes, Environment and Natural Resources, Information and Communication Technologies and Materials with percentages higher than 10 per cent of the resources allocated, five other programmes, Agricultural Research, Food Technology, Biotechnology, Health and Pharmaceutical Research, Advanced Technologies for Production, sharing percentages between 5-10 per cent, while the remaining 9 programmes show a great diversity among them both in resources and in the internal distribution

between actions. It is worth noting that only 9 programmes had resources for the line of concerted projects (collaboration between research centres and business) and that the relative importance profile changes with respect to the total resources allocated, Advanced Technologies for Production brings up the front followed by Food Technology and Materials while Environment and National Resources bring the rear.

It can be concluded, at first glance, that the panoramic view in 1995 with regard to applied, oriented research activities does not present too much differences with that observed for 1985 (see [Table 1](#)), in spite of some difficulties to match the data because some changes in nomenclature. The comparison between tables [2](#) and [3](#) for the industry-related projects (concerted projects) holds more difficulties by the same reasons of nominalism.

Organisation of Public Sector Research: evolutive trends

The Public Sector of Research in Spain comprises the Government subsector and the Higher Education. Both together shared around 53 per cent of total R&D expenditures in 1995 and 1996 (21 per cent for the Government and 32 per cent for Higher Education).

The Government subsector

In spite of the low profile of science and technology in Spain after the Civil War, the majority of the public research centres that exist today were created or reorganised along the 1940s (see [Table 4](#)). However, the Spanish Government subsector is not homogeneous as it is integrated by sectoral centres or institutes performing research or development closely linked to the interests of the economical or industrial sector and by the *Consejo Superior de Investigaciones Científicas (CSIC)*, a multifacetic organisation devoted to the production (and to some extent) application of knowledge in a wide set of disciplines and interdisciplinary fields.

The Government laboratories were operating after their establishment on tiny annual budgets which were addressed mainly to salaries. The input gave to science and technology on the late 60s through the Plans for Development represented an important increase of income.

At the onset of the preparation of the Law of Science, the diagnostic analysis allowed to identify more than 20 centres apparently involved in public research and technical development activities (Muñoz and Ornia, 1986). The screening process that followed the preparation of the Law permitted to reduce them to nine or ten ([Table 4](#) plus the Astrophysical Institute of Canary Islands) which were qualified as Organismos Públicos de Investigación (OPIS) and were endowed by the Law with the grounds for attaining a common statute.

The path followed since 1986 has shown the difficulties to reach this statute and the author of this report is particularly sceptical about that possibility. [Fig. 6](#) illustrates in a schematic way the differences between the Spanish OPIS with regards to type of activity, relationship with the economical sectors and extent of self funding.

The Consejo Superior de Investigaciones Científicas (CSIC)

The CSIC or Spanish Research Council is the most significant public organisation involved in research. As it has been said before, the CSIC became instrumental in the establishment of well equipped research institutes and in developing a professional career for research within the Administration. Both objectives were not easy to introduce and to maintain within

the tight dress of the conventional Administration rules.

One functional problem of the CSIC that evolved with its trajectory was the fragmentation of the in-house research activities as there were a research staff of about 1,200 permanent researchers distributed at the beginnings of the eighties into almost two hundred institutes cultivating fields of activity from humanities to engineering, passing through physics, chemistry, biology, agrobiological, geology...

Another characteristic of CSIC that was becoming more problematic along the democratic transition was the high degree of geographic concentration of the research centres since forty per cent of the institutes were located in Madrid, the rest being scattered over the Spanish territory in 11 Autonomous Region out of 17. Catalonia and Andalusia share the largest number of institutes apart from Madrid with percentages slightly exceeding the 10 per cent. The Basque Country is one of the regions missing CSIC centres. After a process of evaluation taking place in mid eighties and early nineties, the number of institutes has been reduced to a figure around 90 (data of 1995). The reduction has been accompanied by a certain redistribution with regard to the regional dimension and to the collaboration with other institutions. From the 91 CSIC institutes recorded in 1995, 18 were joint centres sponsored by CSIC and the Universities and regional governments.

The evolution of CSIC personnel after a stagnation period during 1970s has showed an increasing trend along the mid eighties and the early nineties with a new period of semi-stagnation following the crisis of the nineties. In 1995, there were 6,400 permanent staff members in CSIC with the following distribution: 1,830 scientific staff or permanent researchers –all holding a doctoral degree–; 1801 research assistants which hold different educational or professional degrees; 1825 trainees, predoctoral and postdoctoral fellows; and 106 postdoctoral fellows under contract related to specific research projects.

CSIC is a public research organisation which resembles the French CNRS more than the Anglosaxon Councils, although important differences do exist between both organisations. The CSIC personnel is not committed to teaching activities although a significant number collaborate as teachers in postgraduate courses or as directions of doctoral theses –an university professor is always required as a guarantor of each thesis. This collaboration is particularly significant in the case of universities which are partners with CSIC in joint research centres or institutes. Unlike the CNRS, CSIC can not fund extramural research in those universities neither can act as guarantor of the research quality of the universities. Both institutions are required to search for funding to agencies national or regional –and/or to the productive sector. In general, a joint venture between CSIC and universities is considered as an asset for getting funds.

The CSIC holds a long tradition of collaboration with universities, not without problems because the CSIC personnel consider themselves to have lower status than the university professors, even in the periods of CSIC preeminence over universities. Since the universities became to overcome CSIC in the 1970s, the CSIC staff has been struggling to drive the organisation and their permanent research staff to the status of university.

The funding of CSIC has been very irregular and based in many cases on the political support lent by some individuals rather than on a general political strategy. The CSIC never played the role of a central public agency for funding research as was originally intended. On the other hand, after the re-emergence of research activities within the universities along the sixties, the CSIC was delved into some crises that have found expression in many aspects of its funding trajectory. The evolution of CSIC funding and the sources for it are illustrated in Figs. [7](#) and [8](#).

The funding through external sources has become essential to CSIC survival in order to cope with the restrictions imposed by the State General Budget during the last years.

Higher Education subsector

The low research profile of the Spanish universities that characterised their academic life during the first half of the XX century began to change in the nineteen-sixties when the strategic political initiatives of the Development Plans began to provide resources for infrastructure and for the promotion of research at Spanish universities. The balance between teaching and research at universities broke down, mainly due to the spectacular rise in the number of university students. From 1971-1972 to 1984-1985, the number increased from 350,000 to 750,000. Faculties more than doubled during that same period, allowing the lecturer/student ratio to remain practically constant.

During the democratic transition, the reform of the Spanish universities became a priority in the political agenda, though the fights between actors' interests and the weaknesses of the majority political party, UCD, lent to an impasse. The situation changed with the promotion to government of the Spanish Socialist Workers Party (PSOE) after their general elections victory in 1982. The University Reform Law, enacted in 1983, granted self-governance to Spanish universities (right to autonomy) and the creation of public universities continued to be promoted.

In 1985-1986 there were 31 public universities and 4 private universities. By 1994, this figure had risen to 45 public universities and 6 private universities. The number of students increased to practically double the university population by comparison with 1987. The number of lecturers also increased although not as quickly, with the lecturer-student ratio rising from 1/20 in 1987-1988 to 1/30 currently.

The evolution of universities that followed the putting into force of the University Reform Law was marked by that increasing political relevance of regional governments in their governance and funding. The Law established a Universities Council with two committees: one integrated by the Rectors, the other by representatives of those regional governments, that have to agree on the creation of new universities, establishment of curricula, number of students...Conflicts between the two committees have risen in many instances. It is, however, noteworthy that the evolvement of research within universities has followed an independent path, modulated by the science and technology policies and on that path, the National R&D Plan has exerted a highly positive influence in terms of funding.

Another important outcome of the independence granted to universities by the University Reform Law is the progressive transfer of political responsibility for public universities to regional governments. This process began in the so-called historical regions –Catalonia, the Basque Country, Galicia and Andalusia- and some fringe regions such as the Community of Valencia and the Canary Islands. This transfer of authority is in the process of expansion to all other regions, the ones known as being "in the slow lane".

It is also important to note that the transfer of responsibility to regions includes the transfer of public budgets –which refer primarily to personnel and the maintenance of the installations. On the other hand, regions have used their constitutional right (see below) to promote research by providing their own resources, which logically vary from one region to another in line with their economic characteristics and demography. These policies have had very diverse results in universities as can be seen from various indicators: proportion of permanent teaching staff, capacity to raise funds for researchs ability to link academic research and socio-economical interests. An exercise of evaluation of universities has been undertaken since mid nineties and in spite some difficulties to accept and use the results of

this exercise it can be turned out into a valuable instrument for political decision and management on the Higher Education subsector.

Innovation policies: main actors

After the "technocratic" impulse of the sixties to incorporate Spain into the modern trends, the responsibility for innovation policies has tested, and still remains, under the competence of the ministry of Industry and Energy. During the first years of the Socialist Government, the collaboration between the ministry of Industry and the ministry of Education was decisive for the preparation and launching of the Law for Science and the first National R&D Plan. The collaboration was based on personal ties between the political actors and on the illusion raised by a common project of "modernisation" for Spain. However, as the actors changed and the idea of a common project debilitated, the situation began to deteriorate and the tight coupling between research and technology was lost, although the formal agreements were kept.

The ministry of Industry and Energy was the funding agency for innovation and industrial research, either directly or through the Centre for Industrial Technological Development (CDTI) which is the carrying agency for promotion of industrial innovation in relation with the resources of the National Plan. The direct action of the ministry has been put into force by the General Directorate for Technological Policy (the name has been changing along different governments) by means of instruments linked to the Plan for Technology and Industrial Action (PATI) or the more recent ATYCA (Technology and Quality Action).

Innovation and the business sector

The R&D expenditure of the business sector, including public and private enterprises and the research groups associated to firms, amounted to 127,000 million Pta in 1987 – representing 0.35 per cent of GDP- and to 266,000 million Pta in 1993, accounting for a 0.43 per cent GDP. The expenditure has been declining during the period 1992-1996. As it was shown before, the loss of R&D effort in the enterprises was accompanied by a decrease in the personnel devoted to these activities ([Fig. 4](#)).

The firms registered in 1987 as active in R&D activities were 1,140 and 1,874 in 1993. Most of the firms are small and medium enterprises, more than 80 per cent had less than 500 workers (see [Table 5](#)) and the trend has been to increase this percentage; these SMES were spending 40 per cent of the total R&D expenditure and accounted for around 50 per cent of the R&D personnel (about 80 per cent of the firms employ less than 1 researchers in full time equivalent while only 3.5 per cent have more than 25 researchers FTE). This fact highlights that there is no big innovative business sector or high tech companies in Spain, most of the innovation effort being performed by firms of the traditional sectors –machine-tool, ceramics, textile, pharmaceutical or of the automotion sector.

[Table 6](#) illustrates the share of R&D expenditure of the firms by sector of activity.

Links between public research and industry

Creating linkages between research and industry has been one of the main policy objectives in the process of modernisation of Spanish science and technology which has taken place during the eighties. It has been also one of the goals of the regional governments.

Several mechanisms have been used to promote these links and the following should be

mentioned amongst them:

- Financial incentivisation for university staff by means of research contracts with firms. The University Reform Law allows them to increase their total remuneration by applying to it part of the income from these contracts- to a total maximum level equivalent to double the value of their salaries.
- Programmes to foster the exchange of researchers between trained staff in the universities (and other centres within the Public System of Research (PSR) as well) and companies.
- Programmes to promote the transfer of the results of research from universities (and other PSR centres) to businesses. This programme responds to the acronym PETRI from its name in Spanish (Programa de Transferencia de Resultados de Investigación).
- Creation in the universities (and other public research centres, in particular the CSIC) of Offices for Technology Transfer and for Valorisation of Research (OTRIs).

Spanish universities have responded positively in terms of using these mechanisms for collaboration with industry –OTRIs, PETRI and contract research- but the end result has been quite limited.

Innovative Spanish companies have also attempted to collaborate, and multiply contacts, with universities, although in certain cases this has been done purely for image purposes. In any case, the increase in cooperation has meant an increase in patents. Spain ranks as the 5th EU country as regards number of patents registered in the USA. Sectors in which patents have been registered include the four which are most active in R&D: chemical industry, electric equipment, electronic equipment and the automobile sector. In addition, Spanish (and European) patents have been registered in three sectors of strategic interest: bio-technology-pharmaceuticals, aeronautics and the agro-food sector.

On the other hand, industry has been involved to a very limited extent in setting priorities and in forecasting. The Spanish System of Innovation seems to be the object of pushes from the supply side rather than of pulls from the demand side. Several evaluative exercises of programmes of the National R&D Plan through surveys addressed to the project leaders point that there is a divergence of interests between the subsectors of the Public System of Research and the business sector (Espinosa de los Monteros *et al.*, 1994, 1995, a and b, 1996 a and b).

Internationalisation and relevance of EU programmes

Spain has used, during and after the period of Franco's dictatorship, science and technology cooperation as an instrument of foreign policy to overcome international isolation. This has driven the Spanish scientific community to be very active in those aspects of science policy and this path has been reinforced after the democratic transition and, particularly, after the integration of Spain into the European Communities in 1986. The Spanish actors in the R&D system have been actively involved in supporting and implementing a common European science and technology policy. The European Framework programme is seen as far more influential than its size would suggest. It punches above its weight by touching upon and influencing every national research programme in Europe.

The debate about the influence of European Framework R&D programme revolves around the question of whether it should be used for supporting research strengths –the countries who are most influential- or for compensating for the weaknesses –those who are most

influenced. There is no simple answer but perhaps it can be found in a synergy between the Framework Programme and the Structural Funds whose relevance in Objective 1 regions is obvious.

On the other hand, the trend in number of participants in the second and third research Framework programmes show that France and Spain have experienced the highest growth (Fig. 9). The distribution of funding by type of participant, Fig. 10, shows an important decrease in the share of large firms and a concomitant proportional increase for the other three main subsectors: higher education, research centres and small and medium enterprises, a situation that fits with the characteristics of the Spanish System of Research.

Importance of regional research and innovation policies and their articulation with national policy

The debate about the relationships between national and regional policies and action realms has prevailed in Spain along the process of reorganisation of the system of research and innovation and of the Higher Education subsector as well.

The Constitutional Act (1976) granted to the State and the Regions the rights to develop their own science and technology (innovation) policies while the State had the right to coordinate policies.

Therefore, the discourse of coordination was overhanging the concepts of promotion and planning in the National R&D Plan as it was diagrammatically illustrated in the original text of the first Plan (CICYT 1988 and Fig. 11).

The Interministerial Science and Technology Committee (CICYT) was established as the official body for the planning, coordination and monitoring of the National plan for Scientific Research and Development. This was considered to be the principal means of harmonising the country's scientific and technological effort through the promotion of research. It was intended to determine priorities and assign resources between the different R&D actors – company research centres and universities- and in addition to coordinate the R&D activities of the different Autonomous Regions (17 in Spain) and the State. The Spanish Constitution assigns responsibility to the National government for promotion and coordination of scientific and technological research in general terms. The 17 Autonomous Communities, through their "Estatutos de Autonomía", share the responsibilities for fostering scientific research and technological development.

Strategies of the Autonomous Regions

The strategies of the governments of the Autonomous Regions before the Law for Science and the first National R&D Plan were different depending on the historical traditions and on the party that was majority and therefore in governance of each region at that time.

Catalonia that was governed by the nationalist coalition *Convergència i Unió* appealed to the Constitutional Court against some articles of the Law for Science that were impeding the transfer of research organisations and units (specially from CSIC) from the State to the Autonomous Communities.

The Basque Country was governed by a coalition of the Basque Nationalist Party and the Spanish Socialist Workers Party who held the Department of Industry. The Basque Government gave critical support to the National Plan and continued to promote internally an industrially-driven policy.

Andalusia was governed by the Socialist Party and provided with strong support to the National Plan. It developed a Regional Plan (*Plan Andaluz de Investigación 1990-1992* in its first version that was inspired by the National Plan through essentially research-oriented objectives).

Galicia, Aragón, Valencia, Madrid all governed at that time by the Socialist Party were highly supportive of the National Plan. Progressively these Autonomous Communities changed the majority party in government and began to develop their specific own strategies, essentially research-driven and related to satisfy the research needs of the local universities.

In summary, the issue of shared responsibilities has been highly conflictive in Spain, in spite of the limited significance of R&D policies. It was finally resolved by the Constitutional Court when it stated very clearly that R&D responsibilities are shared by the State and Regional Governments. The Law for Science established a Consejo General de la Ciencia y la Tecnología (General Council for Science and Technology) to coordinate the R&D initiatives from the State and the different Autonomous Communities through exchange of information, written approval of the National Plan's priorities and incorporation of themes proposed by the regions into those national priorities as Regional Programmes (through national in scope). Some of the 17 Autonomous Region have established their own bodies or even their specific Science Laws for the planning, management and implementation of R&D activities. There is a trend towards transferring research organisations and units from the State to the Autonomous Communities, while keeping the roles of planning, coordination and international relations centralised.

Coordination of R&D activities

The coordination of all R&D activities in Spain was the aim of the National Plan of R&D (now in its third version, the first having run from 1988 to 1991 and the second from 1992 to 1995). However, ten years on, it has achieved limited success and coordination is still a very sensitive issue.

In fact, only three sectoral programmes were included in the National Plan in 1995 (see *Memoria de actividades del Plan Nacional de I+D en 1995*). These were:

- The *Programa de Promoción General del Conocimiento* (Programme for Knowledge Promotion) i.e. funding of grassroots, curiosity-driven research) which is administered by the ministry of Education and Science-the one responsible between 1986 and 1996 for chairing the CICYT.
- The *Programa Sectorial de I+D Agrario y Alimentario* (Programme for R&D in Agriculture and Agrofood) administered by the ministry of Agriculture, Fisheries and Food).
- The *Fondo de Investigación Sanitaria – FIS* (The Fund for Health Research) administered by the ministry of Health and Consumption.

The National Plan Budget amounts to a slight 9 percent of the State budget (see [Fig. 3](#)), whereas the three sectoral programmes account for 38% of the State budget (1997), but an important share of it (38 per cent) belonging to the ministry of Industry and Energy, through specific programmes (PATI until 1996 and ATYCA since 1997), remains far from this slight coordination scheme. The only activities of R&D promotion carried out by the ministry of Industry and Energy which seems to be coordinated by the National Plan are precisely those financed by the Plan itself, which are integrated under the heading of "Coordinated and Cooperative Projects", i.e projects carried out in collaboration between industries and public research centres (universities and government laboratories).

Regarding the coordination of activities between the State and the Autonomous Regions, the results do not seem any better, as can be seen from the Memoria de Actividades del Plan (Report on the Plan's Activities). Apart from a breakdown by Autonomous Communities of all activities funded by the National Plan, a practice established from 1990 onwards, there are in the 1995 Annual Report only two pages (out of a total of over 186) referring to regional programmes incorporated into the National Plan. They numbered only two, of which one, on Pure Chemistry, was proposed by Catalonia (Cataluña); it shows an uneven distribution with Catalonia receiving between 75 and 90 per cent of the funds allocated to that programme. The regional distribution of R&D expenditure is shown in Tables [7](#) and [8](#).

As for the General Council, it has been virtually inoperative, as can be deduced from the lack of reports on its activities and from the opinions expressed by some of its members. One of the main reasons for the flaw of its activities has been the heterogeneity in knowledge of science and technology issues and in political relevance of the members.

Military research: its impact

Spain is not a military power. Even during Franco regime the Armies did not control or influence the research domain except for some strategic areas of industrial relevance and of technological importance like energy/nuclear energy, and materials assays related to aeronautical or space research and shipbuilding. The ministry of Defence held the authority over two public research centres: el *Instituto de Técnica Aeroespacial* (INTA, Institute for Aerospace Technology) and the *Canal de Experiencias Hidrodinámicas del Pardo* (Canal for Hydrodynamics Experimentation, located in El Pardo, near to Madrid).

In the democratic transition, this influence even declined until the Socialist Party took the power in 1982, when an effort was made to modernise the Spanish Army with two main goals: to win the alliance of the military officers and to help to the industrial development of Spain. The ministry of Defence entered the game introduced by the Law for Science and accepted to include INTA among the Public Research Organisations (OPIs) that were reshaped by that Law, whereas the *Canal de Experiencias Hidrodinámicas* kept an ambiguous position. The CICYT was charged by the Law for Science the task to coordinate the programme of purchase of military equipment with the ministry of Defence. The ministry of Defence through programmes of development of weapons systems was increasing the share of the State General Budget, although these expenses had not been included in the R&D statistics.

The current Spanish government has decided to include spending on military projects aimed to develop weapons systems through international cooperation schemes in the overall R&D budget. This includes money for developing military technologies, including the production of aircraft, frigates and tanks for the ministry of Defence, at a cost of 1.42 billion US dollars (see report in *Nature*, vol. 395, 8 October, 1998, page 535).

A prospective view

- The new impetus for placing research and technological development among the priorities of the political agenda will be screened with great attention. It has raised new hopes among the actors of the Spanish Research System, but they are intertwined with fears and doubts about its future.
- The general discourse underlying the effort of extra spending on research and development is to promote competition between companies and stimulate innovation to correct the traditional backwardness of Spain in the development of technologies and in industrial innovation. The deficit in the technological balance is a constant in

the economic history of Spain.

- The present discourse for Spanish Research System matches well with the one pervading the global world in making R&D expenses more accountable to social and economical needs. However, this discourse may be entangled with the attitudes and position of the two main communities of actors of the Research System: on one hand; the researchers from the public sector who have been little used to think in applications of the scientific knowledge; on the other hand, the industrialists who have been mainly concerned with short time actions and are little aware of the strategic value of science and technology.
- The priorities established and geared through four-year programmes will be changed as regards to the former National R&D Plans. Energy research, biotechnology, archaeology, waste treatment, biomedicine and human health, and information technology emerge as the new priorities as a mix of scientific strengths and strategic demands as parameters. The reduction in the number of priorities is an interesting fact that should be monitored with special focus with regard to those two parameters.
- The current reorganisation at government level may foster the coordination within the State Government and the General State Budget, but the coordination between the national objectives and the regional ones will continue to experience difficulties in view of the existing heterogeneity among regional policies, their goals and the relative differences in the relevance of actors and interests.
- International programmes and activities will continue to play a significant role in the design and implementation of research and innovation of the Spanish Research System.
- It is plausible to think that a change of strategies by the Spanish scientists producing knowledge will take place in order to overcome their lack of influence –recognition of excellence-- in the Science World context. ▲

¹ A document was published as a book by the ministry of Education and Science, State Secretary for Universities and Research in 1988 containing all the theoretical and economical frame and details of the first National Plan on Scientific Research and Technological Development. ▲

² In 1998, 1 Pta = 0.0059 ECU = 0.0069 US\$ = 0.039 FF. ▲

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Table 1. Funding by CAICYT (1985) of research activities (basic and applied research)

Area of activity	Million Pta (1985)	Percentage
<i>Advance of knowledge</i>		
Molecular and cell biology	319.9	23
Biology of organisms and systems	235.4	17
Chemistry	232.6	17
Mathematics, Astronomy and Physics	231.4	17
Social sciences and Humanities	205.0	15
Earth and Space Sciences	108.9	8
Physical-chemistry	41.8	3
SUBTOTAL	1.369.0	100
<i>Applied research</i>		

Medical sciences	301.5	27
Information and Communication technologies	252.3	23
Materials science and technology	122.1	11
Agriculture	110.6	10
Chemical technology	94.8	8
Mechanical and textile technology	74.7	7
Food technology	60.0	5
Livestock	59.3	5
Environmental technology	21.0	2
Energy-technology	20.8	2
SUBTOTAL	1.117.1	100

Source: Adapted from Muñoz (1998)

Table 2. Funding by CAICYT of *Planes concertados de investigación* according to sectors of economic activity

Economic sectors	Number of projects (1969-1985)	Percentage
Farming and animal husbandry	38	8.2
Agrofood	23	5.0
Chemical	53	11.4
Pharmaceuticals	78	16.4
Plastic materials and products	25	5.4
Machine-tool	66	14.2
Electrical mechanics	21	4.5
Transport	14	3.2
Electronic systems	139	30.0
TOTAL	464	100

Source: Adapted from Muñoz (1998)

Table 3. Breakdown of resources (in percentage) allocated to the different programmes of the second National R&D Plan (year 1995)*

Programme	Training	Projects (+ Infrastructure)	Concerted Projects	Additional Expenditures	Total	
<i>Agricultural Research</i>	19	63.7	13.2	4.1	100	7.5
<i>Food Technology</i>	7.2	58.9	26.5	7.4	100	5.3

Environment and Natural Resources	11.2	78.0	8.4	2.3	100	11.4
Biotechnology	16.1	66.9	13.5	3.5	100	8.9
Health and Pharmaceutical Research	13.6	67.8	14.3	4.3	100	9.2
Climate R&D	18.4	81.6	-	-	100	0.9
Marine Science and Technology	5.2	94.8	-	-	100	1.1
Advanced Technologies and Production	8.1	43.3	46.3	2.2	100	7.4
Information and Communication Technologies	3.1	73.8	16.1	7.0	100	15.8
Materials	4.8	69.5	24.3	1.4	100	16.9
Space Research	13.0	64.1	22.9	-	100	2.8
Social, Economical and Cultural Studies	21.4	78.6	-	-	100	1.3
Information for R&D	-	100.0	-	-	100	1.4
High Energy Physics	15.9	39.5	-	44.5	100	4.6
Research on the Antarctic Sea	0.8	51.7	-	47.5	100	2.2
Fine Chemistry	-	100.0	-	-	100	0.2
Training personnel for research	100.0	-	-	-	100	2.9
TOTAL	12.4	64.6	16.6	6.4	100	99.8

* The 1995 data correlates well with the average for the whole period of the second National Plan (1992-1995).

Source: Own elaboration from *Memoria Actividades del Plan Nacional de I+D, 1995*

Table 4. List of the OPIs (Public Research Organisms) existing in Spain

OPI	Ministry of dependence (1987)	Ministry of dependence (1997)	Year of foundation
Instituto Geológico y Minero (IGME)*	Industry and Energy	Environment	1910
Instituto Español de Oceanografía (IEO)	Agriculture, Fisheries and Food	same	1914
Consejo Superior de Investigaciones Científicas (CSIC)	Education and Science	Education and Culture	1939
Instituto Nacional de Técnica Aeroespacial (INTA)	Defence	same	1942
Instituto Geográfico Nacional (IGN)	Public Works and City	eliminated 1996	1944
Instituto Nacional de Investigaciones Agrarias (INIA)**	Agriculture, Fisheries and Food	same	1933 Refunded 1971
Centro de Investigaciones Medioambientales y Tecnológicas (CIEMAT)***	Industry and Energy	same	1957
Centro de Experimentación de Obras Públicas (CEDEX)	Public Works and City Planning	Fomento (Economic Development)	1957
Instituto de Salud Carlos III	Health and Consumption	same	1986

Table 5. Evolution of R&D and innovative firms by size and resources

Type of firms (employees)	1987				1993			
	Number firms	%	% R&D expenditure	% R&D personnel	Number firms	%	% R&D expenditure	% R&D personnel
Less than 100	532	46.6	16.1	21.2	1.089	58.1	18.6	24.5
100-499	393	34.5	23.4	27.9	558	29.8	23.6	26.4
500-999	91	8.0	10.4	10.1	115	6.1	14.8	16.9
1000 and beyond	124	10.9	50.1	40.8	112	6.0	43.0	32.2

Source: Adapted from *Memoria Actividades del Plan Nacional 1995*

Table 6. Breakdown of R&D effort in the business sector by sector of activity

Sector	R&D expenses % Gross Added Value
Electric and electronics material and equipment	7.1
Other transport material (including aeronautics)	6.9
Ofimatics and computing	6.8
Automobile	4.8
Chemical (pharmaceutical)	4.3

Source: Adapted from *Memoria Actividades del Plan Nacional 1995*

Table 7. Share of R&D expenditure by Autonomous Regions

Autonomous regions	1987	1993
Andalucía	7.4	9.4
Aragón	2.4	2.6
Asturias	1.6	1.6
Baleares	0.5	0.3
Canarias	1.0	2.0
Cantabria	0.7	0.8
Castilla - La Mancha	0.6	0.8
Castilla - León	2.7	5.0
Cataluña	18.7	19.5
Comunidad Valenciana	3.7	5.8
Extremadura	0.7	0.7
Galicia	2.1	2.8
Madrid	45.3	36.6
Murcia	1.2	1.5
Navarra	1.3	1.6
País Vasco	8.5	7.9
Rioja	0.1	0.3
No regionalised	1.5	0.8

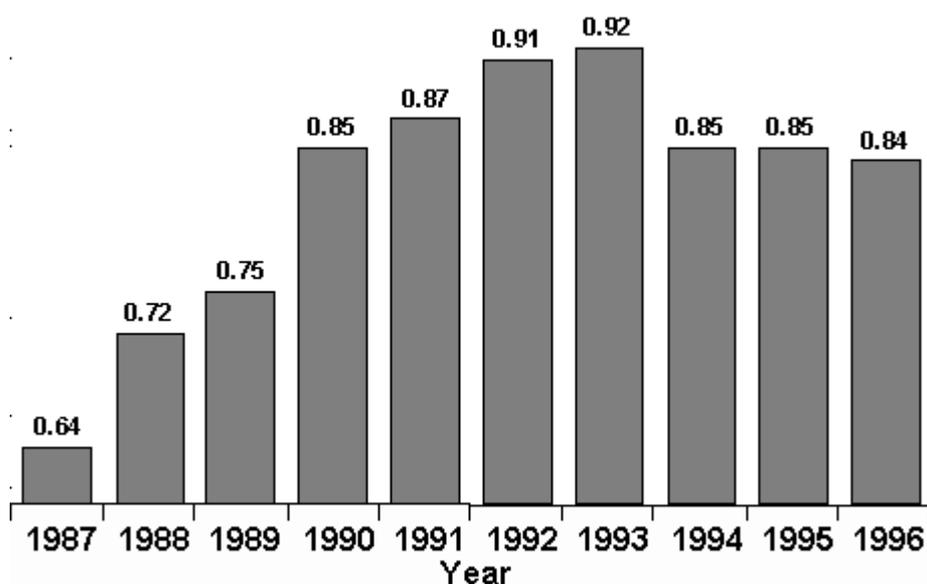
Source: INE, Memoria de actividades del Plan Nacional de I+D en 1995

Table 8. Percentage distribution of R&D expenditure by sectors of execution and Autonomous Regions (1993)

Autonomous regions	Public sector	Higher Education	Business
Andalucía	18.1	60.1	21.8
Aragón	28.0	36.4	35.6
Asturias	17.6	54.6	27.8
Baleares	29.3	60.9	9.8
Canarias	31.6	66.4	2.0
Cantabria	16.1	55.7	28.2
Castilla - La Mancha	17.1	27.9	55.0
Castilla - León	4.8	54.0	41.1
Cataluña	10.1	26.0	63.9
Comunidad Valenciana	10.7	59.6	29.7
Extremadura	35.2	57.7	7.1
Galicia	20.1	51.1	28.8
Madrid	33.4	13.1	53.5
Murcia	22.0	55.4	22.6
Navarra	2.2	47.1	50.7
País Vasco	2.5	19.9	77.6
Rioja	31.8	16.3	51.9
ESPAÑA	20.2	31.6	48.2

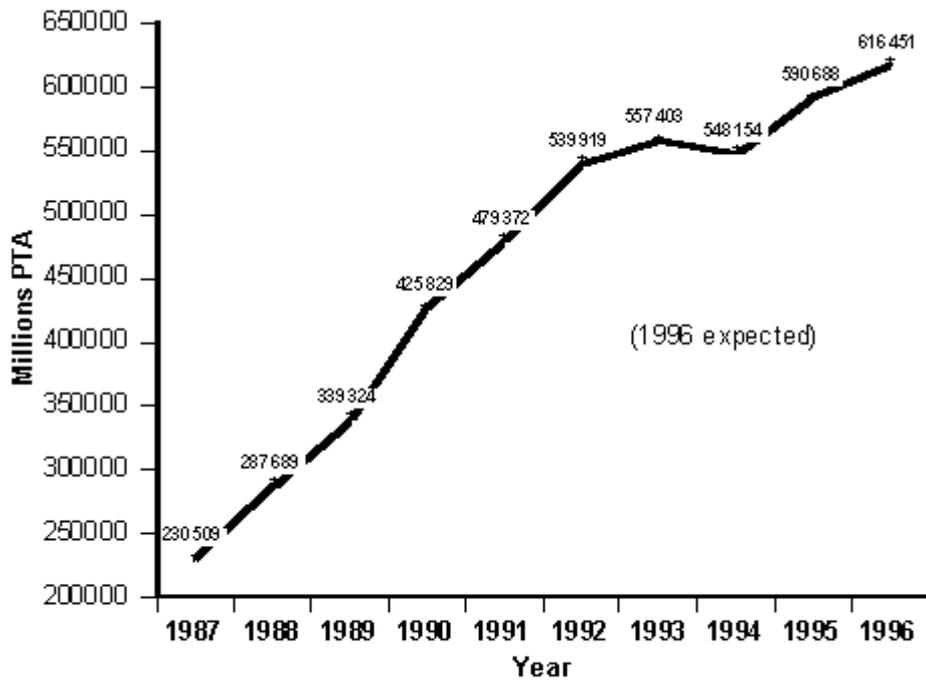
Source: INE and Memoria de actividades del Plan nacional de I+D en 1995

Figure 1. Evolution of R&D expenditure (%GERD) in Spain



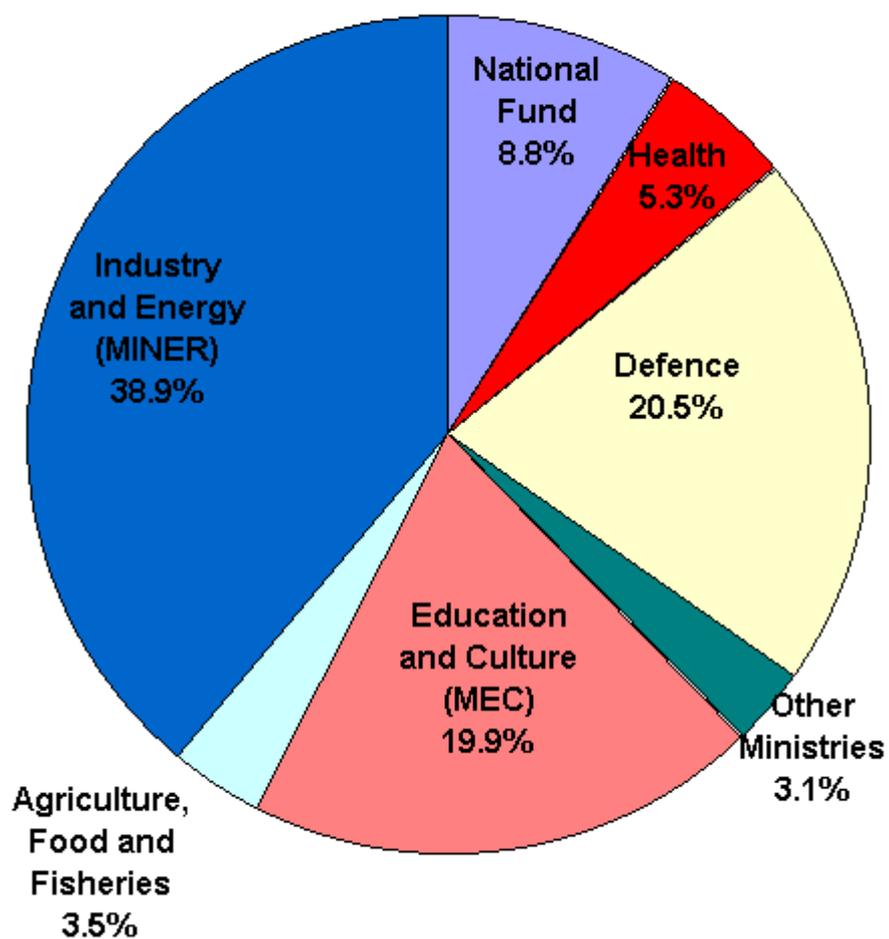
Source: INE, Oficina de Ciencia y tecnología

Figure 2. Evolution of R&D expenditure (1987-996) in Spain



Source: INE, Oficina de Ciencia y Tecnología

Figure 3. Distribution in percentage by Ministerial Departments of the R&D function of the General State Budget (1997)



Source: Presupuestos Generales del Estado.

Figure 4. Evolution of the share of personnel by sector in full time equivalents employed in R&D activities in Spain

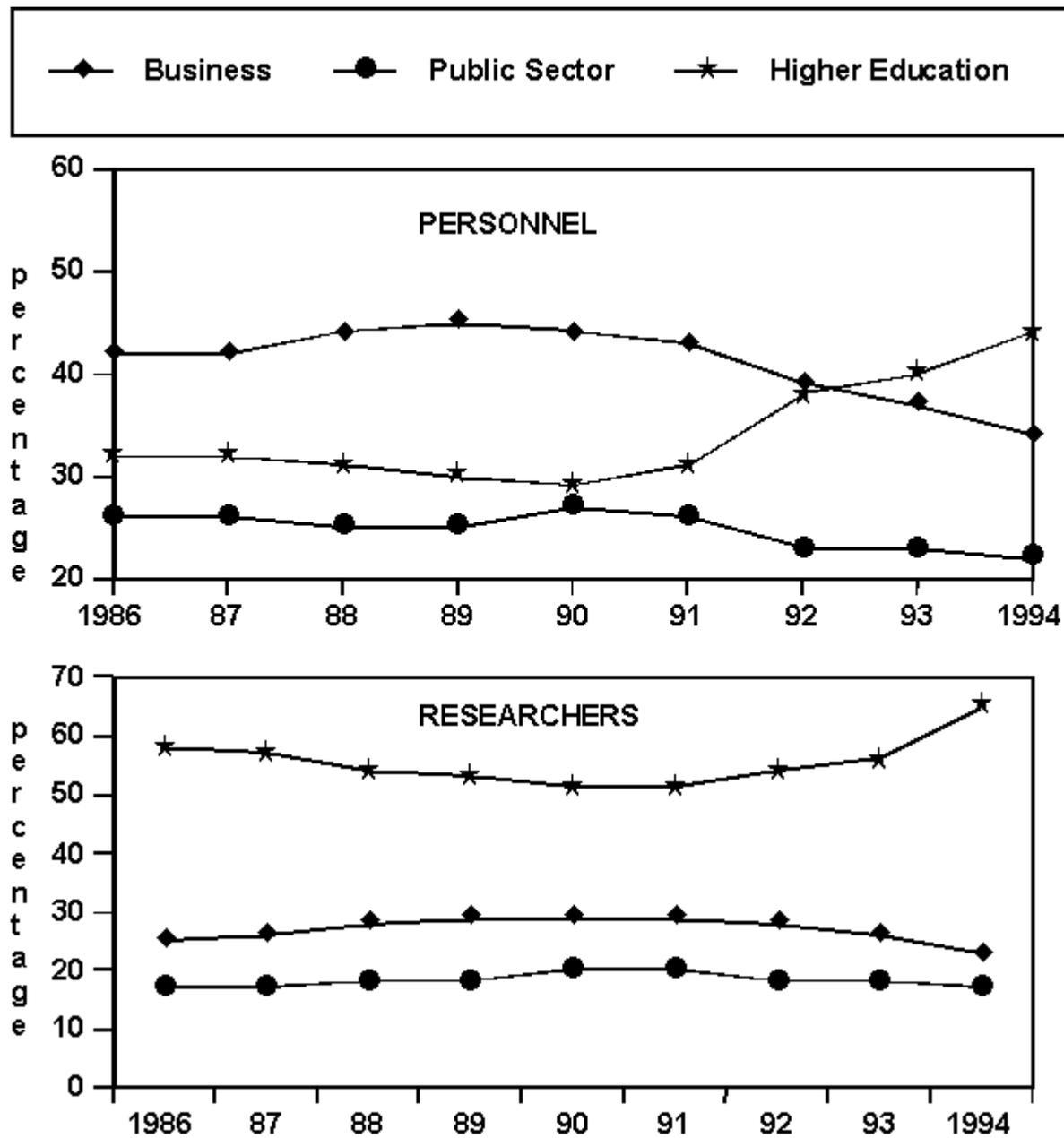
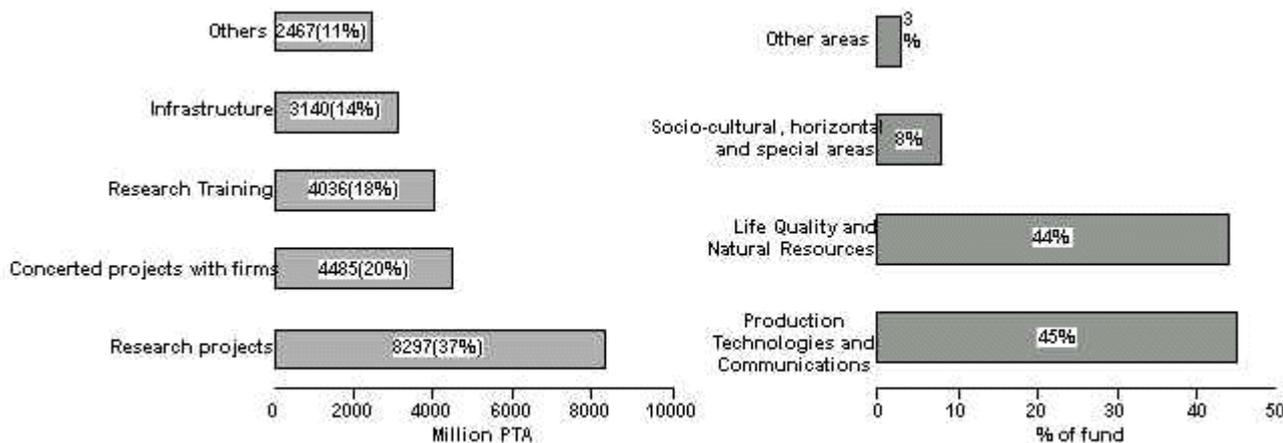


Figure 5. Fund and areas for the National Plan in 1995



Source: Memorias Plan Nacional I+D, 1995

Figure 6. Schematic characterisation of the public research organisations in Spain

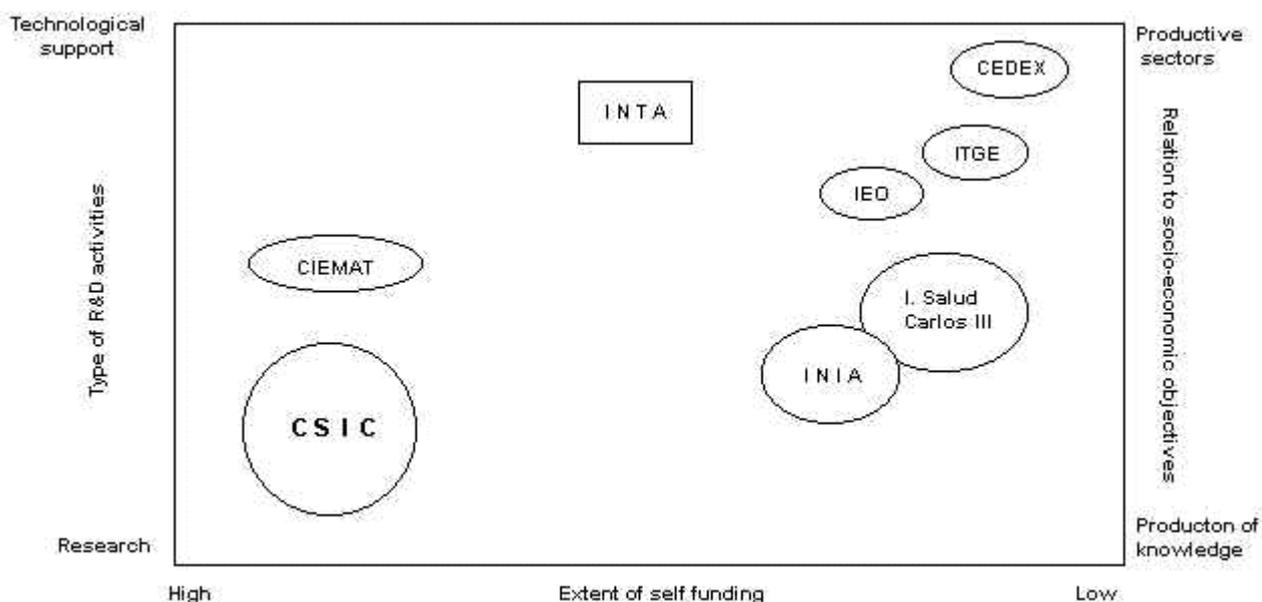


Figure 7. Breakdown of Research Funding and Evolution CSIC

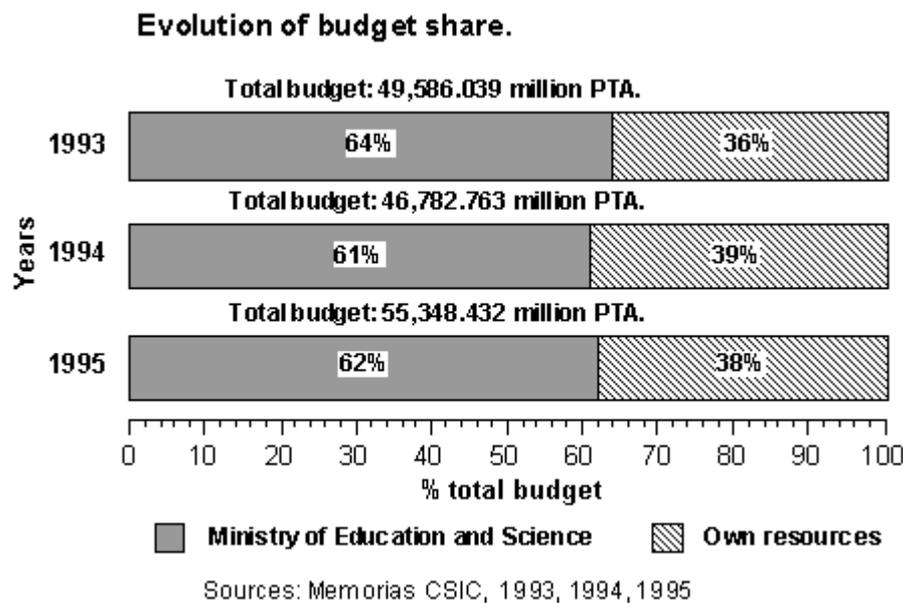


Figure 8. Breakdown of CSIC self-funding resources: evolution

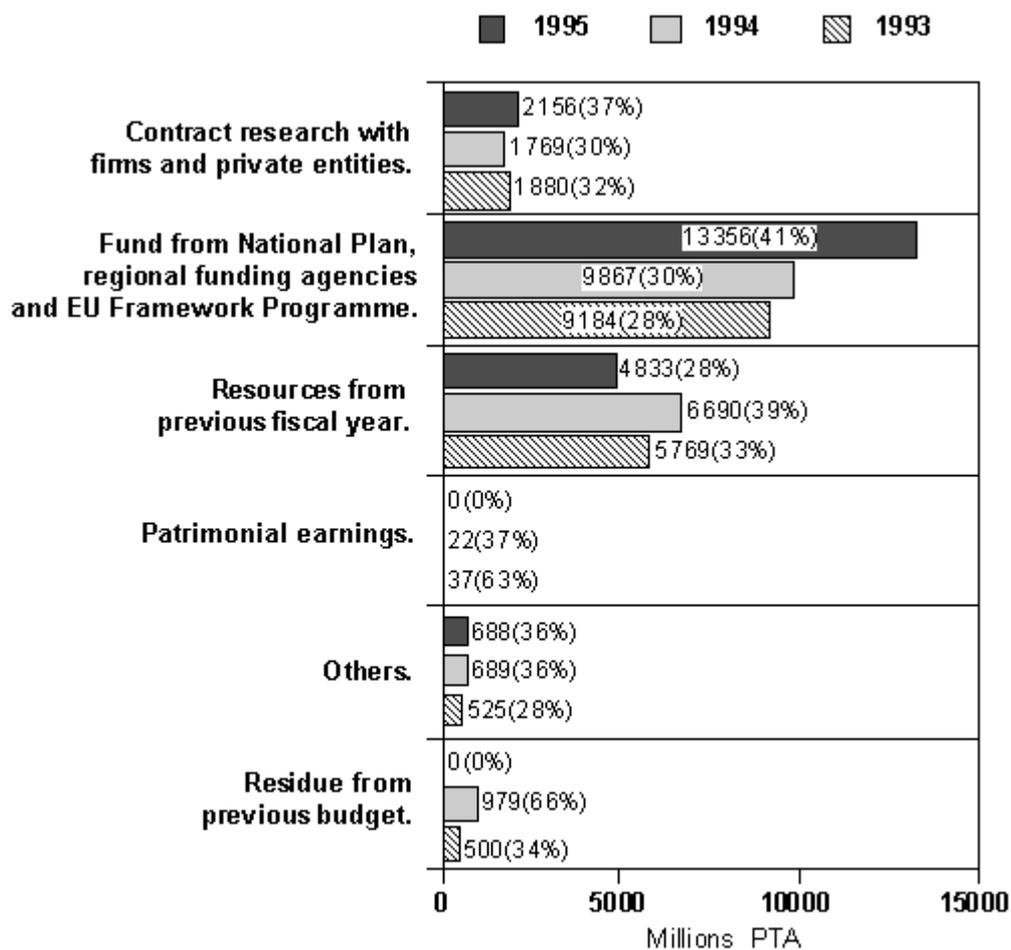
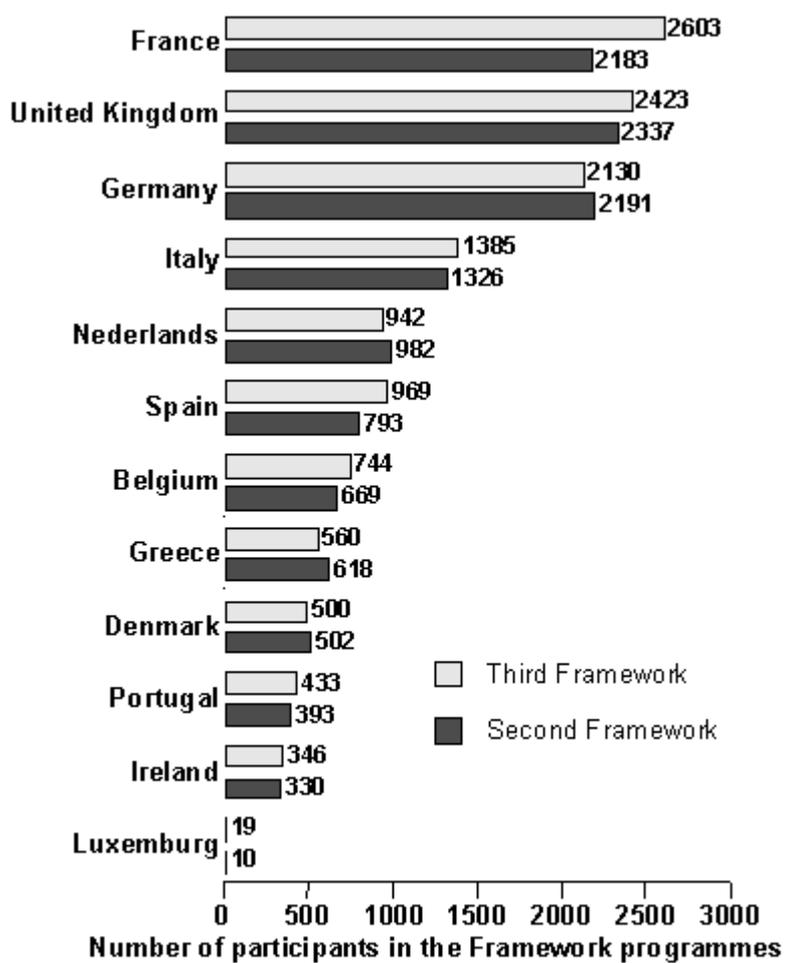


Figure 9. Number of participants in the second and third Research Framework programmes



Source: EuroTechnology, April 1997

Figure 10. Second and Third Research Framework programme funding by type of participants

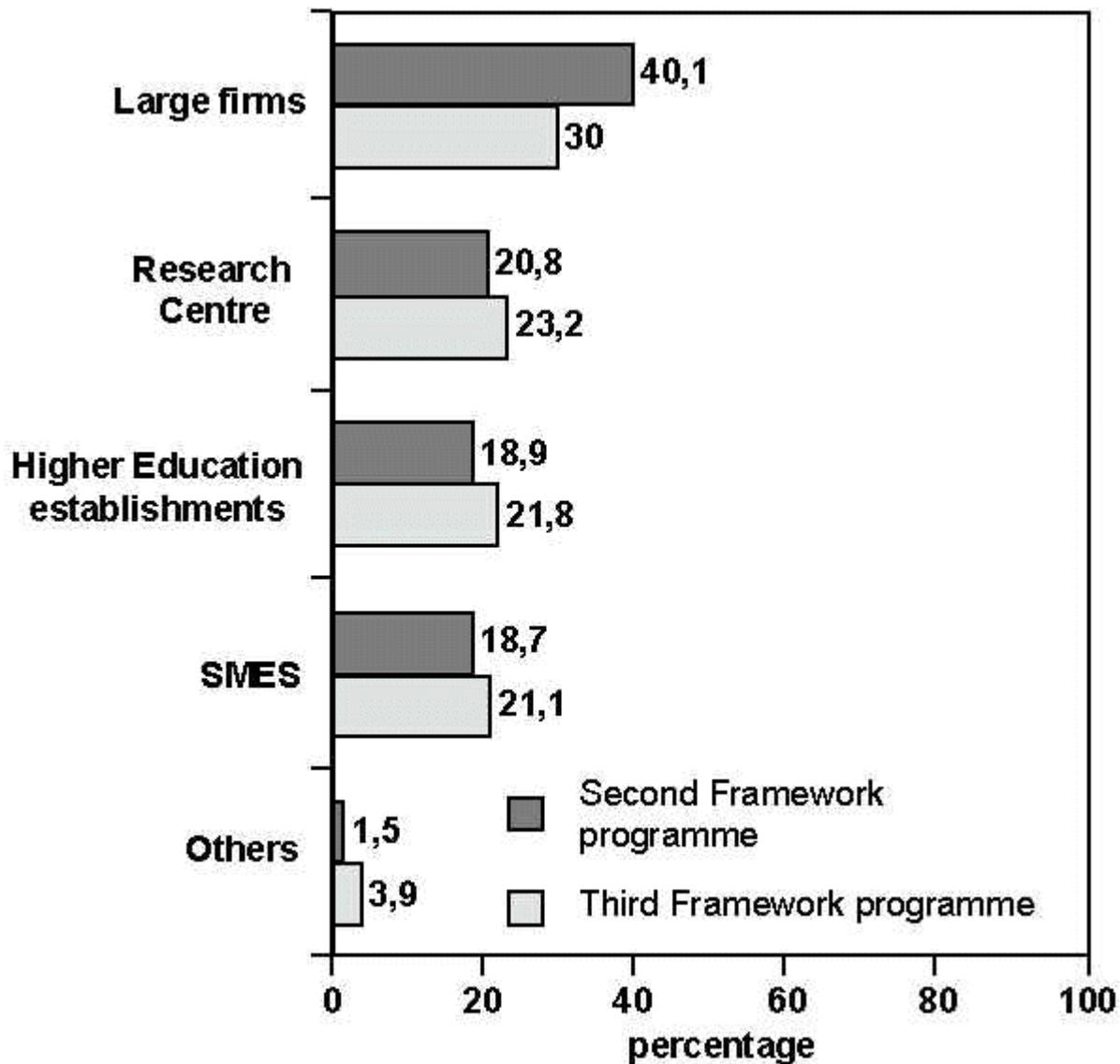
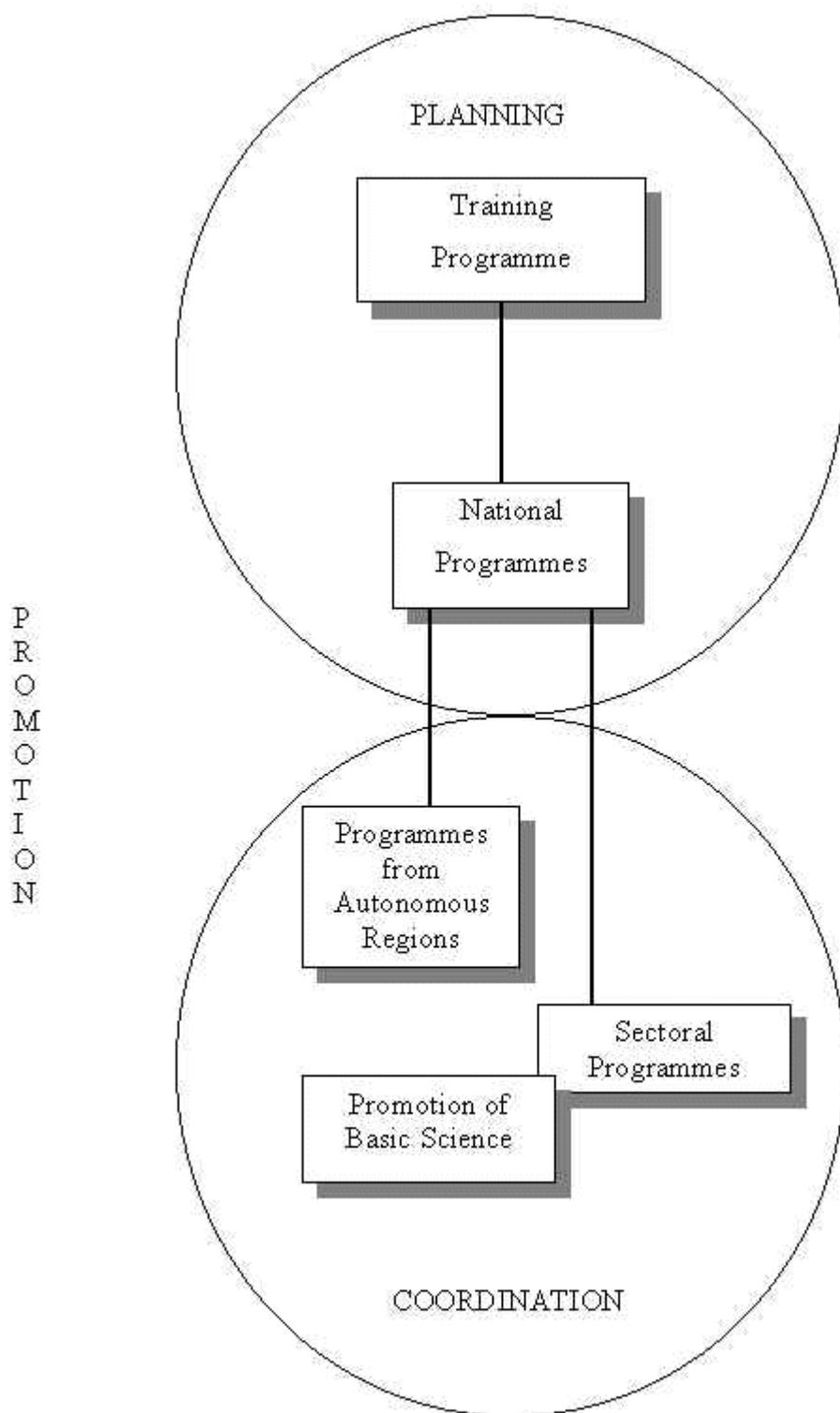


Figure 11. Coordination and Planning as Instruments for Promotion



Source: Adapted from CICYT (1988): *El Plan Nacional de Investigación Científica y Desarrollo Tecnológico. 1988-1991*. Madrid: CICYT, p. 83.

Paper presented to the seminar Evolution des Systemes de Recherche et d'Innovation des Pays Industrialisés (Paris, November 12th 1998). This report has been prepared following the frame proposed by Ph. Laredo and Ph. Mustar (CSI, Ecole des Mines). It has been possible thanks to the collaboration of various colleagues at IESA (Juan Espinosa de los Monteros, María J. Santesmases and Víctor Díaz) and to the

continuous dialogue on these issues with Luis Sanz-Menéndez (IESA-CSIC) and Fernando Aldana and Jose Luis Puerta (ministry of the Government Presidency). Author's work has been supported by grants from CICYT (SEC-93-0688) and the European Commission (TSER Project N° SOE1-CT96-1036). I am indebted to Maria Angeles Soriano for her valuable secretarial support.

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