



ERAWATCH Analytical Country Report 2007: Spain

Joaquín M. Azagra-Caro



EUR 23389 EN/4 - 2008

European Commission
Joint Research Centre - Institute for Prospective Technological Studies
Directorate General Research

Contact information

Address: Edificio Expo. c/ Inca Garcilaso, s/n. E-41092 Seville (Spain)
E-mail: jrc-ipts-secretariat@ec.europa.eu
Tel.: +34 954488318
Fax: +34 954488300

IPTS website: <http://ipts.jrc.ec.europa.eu>
JRC website: <http://www.jrc.ec.europa.eu>
DG RTD website: <http://ec.europa.eu/research/>

Legal Notice

Neither the European Commission nor any person acting on behalf of the Commission is responsible for the use which might be made of this publication.

***Europe Direct is a service to help you find answers
to your questions about the European Union***

**Freephone number (*):
00 800 6 7 8 9 10 11**

(*) Certain mobile telephone operators do not allow access to 00 800 numbers or these calls may be billed.

A great deal of additional information on the European Union is available on the Internet.
It can be accessed through the Europa server <http://europa.eu/>

JRC 44547

EUR 23389 EN/4

ISSN 1018-5593

Luxembourg: Office for Official Publications of the European Communities

© European Communities, 2008

Reproduction is authorised provided the source is acknowledged

Printed in Spain



EUROPEAN COMMISSION

ERAWATCH ANALYTICAL COUNTRY REPORT 2007: Spain

Joaquín M. Azagra-Caro

Joint Research Centre
Institute for Prospective Technological Studies (IPTS)

Joint Research Centre
Directorate-General for Research

Acknowledgements:

This analytical country report has been prepared as part of the ERAWATCH project. It makes use of information provided in the ERAWATCH Research Inventory (<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>) with support of the ERAWATCH Network (country correspondents for Spain: Eva Garcia, Joost Heijs). It has benefited from comments and suggestions of Ken Guy and Prof. Emilio Muñoz Ruiz, who reviewed an earlier version. The contributions and comments of Alexander Grablowitz and Jan Nill from JRC IPTS and Antonio Puente Rodero, Jan Larosse and Johan Stierna from DG RTD are also gratefully acknowledged.

Executive summary

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-run growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs, which aims to increase and improve investment in research and development, in particular in the private sector. One task of JRC-IPTS within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach has been tested in 2007 by applying it to a number of countries, one of which is Spain. This report is based on a synthesis of information from the ERAWATCH Research Inventory and other important publicly available information sources.

Spain has a well developed and relatively smooth functioning research system. The system has strong responses to the challenges present in most of the principal domains:

Domain	Challenge	Assessment of system strengths and weaknesses
Resource mobilisation	Securing long-term investment in research	Considerable efforts to program long-term financing for research and participate in European funding and shared infrastructure facilities
	Dealing with barriers to private R&D investment	Advanced tax incentives for R&D to reduce barriers to private R&D investment but: (i) the industrial structure, which is mainly composed of SMEs in traditional sectors and only a small number of high tech firms, is a barrier to private R&D spending; (ii) lack of venture capital is another barrier to private R&D funding
	Providing qualified human resources	Satisfactory evolution of the number of people with university degree but brain drain of young PhDs to other countries due to limited ability to absorb them; increasing participation of woman in science but under-representation of women in senior positions and in the private sector
	Justifying resource provision for research activities	Legitimacy of devoting public resources to R&D, not under debate
Knowledge demand	Identifying the drivers of knowledge demand	Existence of institutions to bring together players from the scientific, technological and entrepreneurial spheres to conduct prospective and monitoring activities
	Channelling knowledge demands	Impressive coordination of policy efforts in R&D to channel knowledge demand but scant priority setting in the support to public science, even running counter the priority setting of the European Framework Programme
	Monitoring demand fulfilment	Existence of institutions to assess progress and evaluate R&D programmes, actions, centres, teams and projects, but access to some of their data and design of some indicators are underdeveloped
Knowledge production	Ensuring quality and excellence of knowledge production	Focus on research stemming out of mono-disciplinarity, fragmentation of research groups and short-term projects, not leading to excellence

Domain	Challenge	Assessment of system strengths and weaknesses
	Ensuring exploitability of knowledge	Ineffective use of the existing tools to increase R&D activities in companies, endangering the exploitability of knowledge
Knowledge circulation	Facilitating circulation between university, public research and business sectors	Good supply of institutions and existence of long-standing programmes to promote links between the public research system and industry but governance structure of science-innovation links at early stage, due to the split in responsibilities between two ministries
	Profiting from international knowledge	Wide range of modalities for participation in international projects
	Enhancing the absorptive capacity of knowledge users	Gap for private companies between the available human resources and the technological needs in terms of human resources, hampering absorptive capacity

However, one concern relates to problems of co-ordination across domains: knowledge production does not present any particular strength whereas knowledge circulation is strong to face most challenges, given the good supply of institutions and existence of long-standing programmes to promote links between public research system and industry. Remaining problems here relate to limited absorptive capacity of firms. Therefore, a shift of emphasis of research policy from knowledge circulation to production seems justified. Knowledge production in the public sector, weakened by the lack of multi-disciplinarity and the focus on short-term projects, is coherent with a strategy of adaptation to the low-tech economic profile that may lead to practical applications and enable Spain to catch up with its neighbours, but not to achieve a position of leadership.

This coordination problem is reinforced by the division of responsibilities on science and technology between two ministries and the inexistence of an integrated ministry. Although resulting in increased resources, the current stress on separating education and science from industrial issues is ineffective at striking a balance between knowledge production and circulation.

The table below summarises the main opportunities and threats relating to recent policy dynamics.

Domain	Main policy-related opportunities	Main policy-related threats
Resource mobilisation	<ul style="list-style-type: none"> • Ambitious reform programme in line with the Lisbon objectives to increase budget allocations to R&D • Public R&D supported by increasing R&D related-EU Structural Funds • Increased credit facilities for innovative activities at SMEs 	<ul style="list-style-type: none"> • Public R&D declining down due to drop in relative level of EU Funds received from the Framework Programme
Knowledge demand	<ul style="list-style-type: none"> • Attempt to meet demand for funding of large projects through simplified procedures • Active procurement to help reduce information and communication technology gaps 	<ul style="list-style-type: none"> • Little priority setting according to the industrial structure and specialisation
Knowledge production	<ul style="list-style-type: none"> • A specific programme to raise critical mass and research excellence (CONSOLIDER) 	<ul style="list-style-type: none"> • Limited involvement of international experts in the new measures for the evaluation of projects in national programmes
Knowledge circulation	<ul style="list-style-type: none"> • Grants and tax deductions to increase human capital in companies 	<ul style="list-style-type: none"> • Possible lack of information of SMEs about their opportunities

It shows that responding to the main policy priorities of the Lisbon Strategy has created many opportunities, such as improved framework conditions, increased public R&D spending, more public-private partnerships, incentives for private R&D, management of Public Research Organisations, qualification of researchers, etc.

There is something of a lack of originality in the approach, however, as industry's structure and specialisation are scarcely taken into account in priority setting. Going through the table, one may notice that, with exceptions, the current opportunities involve indiscriminate measures for the whole spectrum of firms, more funding through grants and credits and no act on the public awareness of the importance of science and technology. A more tailored interpretation of the Lisbon Strategy would place the accent on SMEs, rely less on tax incentives, and seek to bring about broader cultural changes.

TABLE OF CONTENTS

Executive summary	3
Chapter 1. Introduction	9
1.1 Scope and methodology of the report in the context of the European Research Area and the Lisbon Strategy	9
1.2 Overview of the structure of the national research system and its governance.....	11
Chapter 2. Resource mobilisation.....	13
2.1 Analysis of system characteristics.....	13
2.1.1 Securing long-term investment in research.....	13
2.1.2 Dealing with uncertain returns and other barriers to private R&D investment.....	15
2.1.3 Providing qualified human resources	16
2.1.4 Justifying resource provision for research activities	17
2.2 Analysis of recent changes and policies.....	17
2.2.1 Relevant recent trends	17
2.2.2 Role and expected impact of recent policies.....	18
2.3 Assessment of resource mobilisation	19
Chapter 3. Knowledge demand	20
3.1 Analysis of system characteristics.....	20
3.1.1 Identifying the drivers of knowledge demand	21
3.1.2 Channelling of knowledge demand	21
3.1.3 Monitoring and evaluating demand fulfilment.....	23
3.2 Analysis of recent changes and policies.....	24
3.3 Assessment of knowledge demand.....	25
Chapter 4. Knowledge production	26
4.1 Analysis of system characteristics.....	26
4.1.1 Ensuring quality and excellence of knowledge production	26
4.1.2 Ensuring exploitability of knowledge	28
4.2 Analysis of recent changes and policies.....	29
4.2.1 Relevant recent trends	29
4.2.2 Role and expected impact of recent policies.....	29
4.3 Assessment of knowledge production	30
Chapter 5. Knowledge circulation	31
5.1 Analysis of system characteristics.....	31
5.1.1 Facilitating inter-sectoral knowledge circulation	31

5.1.2	Profiting from access to international knowledge	33
5.1.3	Enhancing the absorptive capacity of knowledge users	33
5.2	Analysis of recent changes and policies.....	34
5.3	Assessment of knowledge circulation.....	35
Chapter 6. Overall assessment and conclusion.....		36
6.1	Strengths and weaknesses of research system and governance	36
6.2	Policy dynamics, opportunities and threats from the perspective of the Lisbon agenda.....	37
References		38
Abbreviations.....		38

Chapter 1. Introduction

1.1 Scope and methodology of the report in the context of the European Research Area and the Lisbon Strategy

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key driver of long-term growth. Research-related policies aimed at increasing investment in knowledge and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. The strategy reflects this in guideline No. 7 of the Integrated Guidelines for Growth and Jobs. This aims to increase and improve investment in research and development (R&D), with a particular focus on the private sector. One task of the JRC-IPTS within ERAWATCH is to produce analytical country reports to support the mutual learning process and the monitoring of Member States' efforts. The main objective of the reports is to characterise and assess the performance of national research systems and related policies in a comparable manner.

To ensure comparability across countries, a dual level analytical framework has been developed and applied. On the first level, the analysis focuses on key processes relevant to system performance in four policy-relevant domains of the research system:

1. Resource mobilisation: the actors and institutions in the research system have to ensure and justify that adequate public and private financial and human resources are most appropriately mobilised for the operation of the system.
2. Knowledge demand: the research system has to identify knowledge needs and how they can be met, thus determining priorities for the use of resources.
3. Knowledge production: the creation and development of scientific and technological knowledge is clearly the fundamental role of any research system.
4. Knowledge circulation: ensuring appropriate flows and distribution of knowledge between actors is vital for its further use in the economy and society or as the basis for subsequent advances in knowledge production.

These four domains differ in terms of the scope they offer for governance and policy intervention. Governance issues are therefore treated not as a separate domain but as an integral part of each domain analysis.

Resource mobilisation	Knowledge demand	Knowledge production	Knowledge circulation
<ul style="list-style-type: none"> • Long-term research investment • Barriers to private R&D • Qualified human resources • Justifying resource provision 	<ul style="list-style-type: none"> • Identification of knowledge demand drivers • Channelling of demand • Monitoring and evaluation 	<ul style="list-style-type: none"> • Quality and excellence of knowledge • Exploitability of knowledge 	<ul style="list-style-type: none"> • Inter-sectoral knowledge circulation • International knowledge access • Absorptive capacity

On the second level, the analysis within each domain is guided by a set of "challenges", common to all research systems, which reflect conceptions of possible bottlenecks, system failures and market failures (see list above).

The way in which a specific research system responds to these generic challenges is an important guide for government action. The analytical focus on processes instead of structures is conducive to a dynamic perspective and eases the transition from analysis to assessment. Actors, institutions – and the interplay between them – enter the analysis in terms of how they contribute to performance in the four domains.

Based on the above framework, the analysis here proceeds in three steps. The first step is to analyse the characteristics of the current research system; the second step is to analyse recent changes in policy and governance. The third step in the analysis aims at an evidence-based assessment of the system's strengths and weaknesses and its policy-related threats and opportunities in the light of the Lisbon process ("SWOT" analysis).

The national research system is defined in functional terms as an open system comprising actors, institutions and the processes by which they interact to contribute to the production and circulation of scientific, technical and related knowledge, as well as to the mobilisation of resources and articulation of demand for R&D. Thus, the research system also includes research policy actors, together with actors and institutions at the interface with the wider innovation system. The national dimension remains important, but it has to be seen in the broader context of an increasingly open system. The report focuses here on the European context of the national research system. Many of the challenges analysed also reflect important concerns of the European Research Area (ERA). Where interactions with the EU level are relevant in addressing domain challenges they are explicitly included in the system characteristics and trend analysis – insofar as the information is readily available. In addition, the jointly agreed research-related EU Lisbon Strategy goals serve as a key reference for assessing recent trends and policy developments.

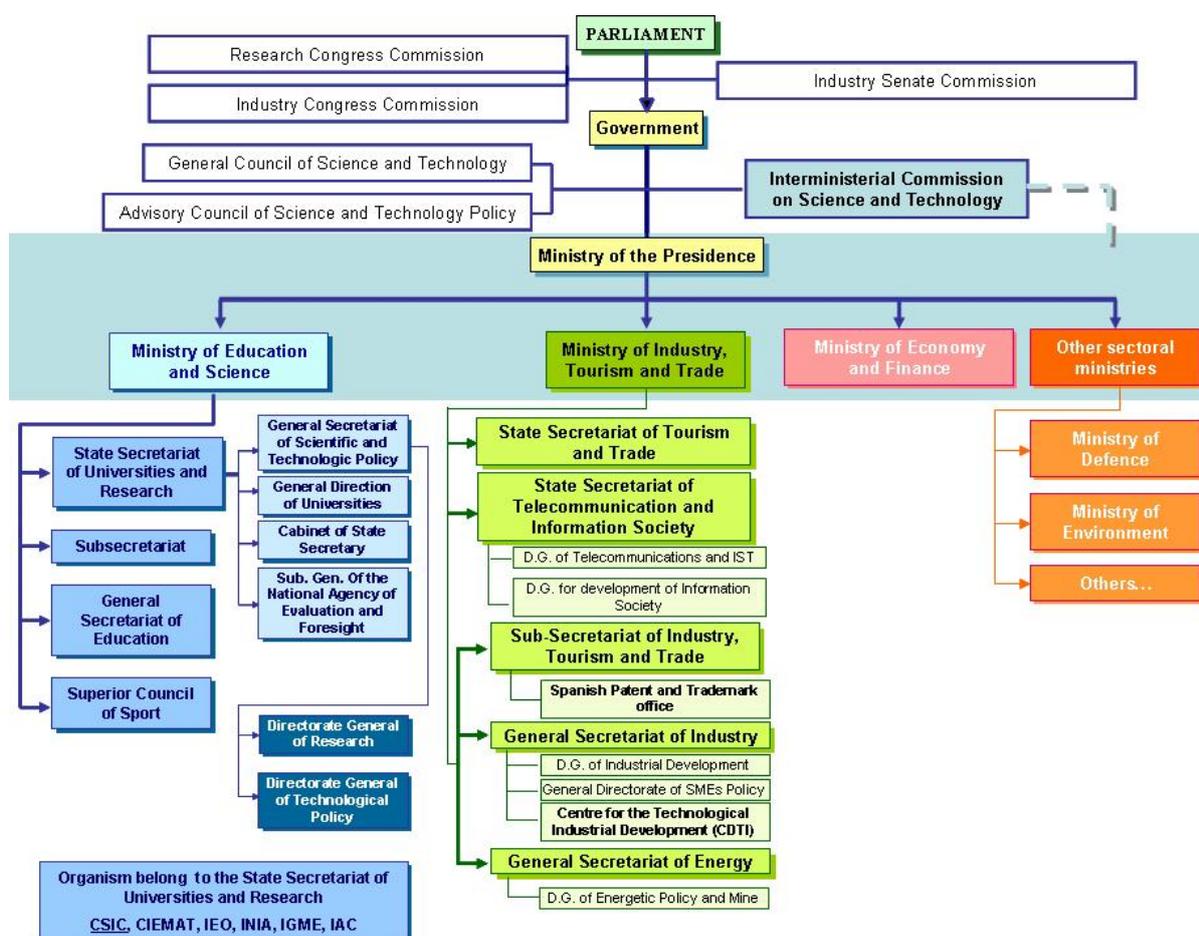
This report is based on a synthesis of information from the European Commission's ERAWATCH Research Inventory¹ and other important publicly available information sources as of autumn 2007. In order to enable a proper understanding of the research system, the approach taken is mainly qualitative. Quantitative information and indicators are used, where appropriate, to support the analysis. After an introductory overview of the structure of the national research system and its governance, chapter 2 analyses resource mobilisation for R&D. Chapter 3 looks at knowledge demand. Chapter 4 focuses on knowledge production and chapter 5 deals with knowledge circulation. Each of these four main chapters contains a subsection on relevant recent policies in the domain. The report concludes in chapter 6 with an overall assessment of the strengths and weaknesses of the research system and governance and policy dynamics, opportunities and threats across all four domains in the light of the Lisbon Strategy's goals.

¹ ERAWATCH is a cooperative undertaking between DG Research and DG Joint Research Centre and is implemented by the IPTS. The ERAWATCH Research Inventory is accessible at <http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.home>. Other sources are explicitly referenced.

1.2 Overview of the structure of the national research system and its governance

When the present government was elected in 2004, the Ministry for Science and Technology, which lasted only for four years (2000-2004), was abolished and its responsibilities divided between the Ministry of Education and Science (MEC) and the Ministry of Industry, Tourism and Trade (MITYC), a division that has been existing since the enactment of the Law for the Promotion and General Coordination of Scientific and Technological Research (“Law for Science” in short). The Inter-ministerial Commission on Science and Technology (CICYT), created in 1986 as a consequence of the “Law for Science”, is the governmental body in charge of the design, planning, coordination and monitoring of national R&D policies. It acts as a strategic working group for the different ministries involved in R&D and since the reform introduced in 1996 is chaired by the Prime Minister. The CICYT is responsible for designing and implementing the Spanish Plan for Research, Development and Innovation (Spanish R&D&I Plan) (IPTS, 2006). The current Plan covering the period 2004-2007 is arriving to its end. The Spanish R&D&I Plan 2008-2011 has been approved by the CICYT in its plenary session of July 12, 2007 and finally adopted by the Spanish Cabinet of Ministers in September of the same year, and its launching is taken place for its starting at the end of 2007 and in the first part of 2008.

Figure 1: Main governance institutions of the Spanish research system



Source: ERAWATCH Research Inventory,

<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=ri.content&topicID=35&countryCode=ES&parentID=34>

The MEC administers the funding of the public research system, which is made up of universities (administratively dependent from the Autonomous Communities) and Public Research Organisations (PROs). The incorporation of R&D activities in the university system in Spain culminated in 1983 with the Law for the Reform of Universities and the Law for the Promotion and General Coordination of Scientific and Technical Research in 1986 (ERAWATCH Research Inventory, 2007). PROs account for the bulk of the public R&D carried out in Spain, although there is an important diversity in the size and activity of individual PROs. Their role in the national R&D system is both as managers of certain programmes included in the Spanish R&D&I Plan 2004-2007 and as performers of many of the R&D activities financed by public funds, through competitive mechanisms. The Law for the Promotion and General Coordination of Scientific and Technical Research (1986) defines their activities relating to the management and performance of some Thematic Areas of the Spanish R&D&I Plan, as well as some R&D activities agreed with the Autonomous Communities; their contribution to the designing and monitoring of the objectives of that Plan; and their role as consultative bodies for the national and regional governments (ERAWATCH Research Inventory, 2007). There are six PROs in Spain under the MEC, including the largest and the only one with a multisectoral character, the Spanish National Research Council (CSIC)². Other Ministries hold single PROs (ERAWATCH Research Inventory, 2007).

The 1978 Spanish Constitution identifies 17 NUTS 2 regions, referred to as Autonomous Communities. They enjoy a high degree of decentralisation, political autonomy and financial capability. Regional Governments have had competences for innovation policies transferred to them, and they have designed their own regional strategies for R&D. Thus, the regions in Spain are playing an ever more significant role in R&D funding. According to the indicators analysed during the design of the INGENIO 2010 Programme (see section 2.2.2), in 2003 the contribution by Autonomous Communities and Municipalities was greater than that of the State (ERAWATCH Research Inventory, 2007).

The Autonomous Communities also participate in the CICYT's advisory bodies in the General Council for Science and Technology, in the working party of General Directorates drawing up the Spanish R&D&I Plan and in the Sectoral Conference of the Regional Departments with Competence for the Promotion of R&D, with the MEC (ERAWATCH Research Inventory, 2007).

The Autonomous Communities collaborate with the CICYT on the Annual Report of R&D Activities, which summarises the activities relating to the Spanish R&D&I Plan from throughout the country. The Information Exchange Working Party (Autonomous Communities-Central Administration) is an essential element in order to establish cooperation on science and technology between the regions and central government (ERAWATCH Research Inventory, 2007).

The Spanish R&D&I Plan also contains some measures aimed at increasing inter-territorial coordination, giving priority to the exchange of information on planning activities and programmes, the creation of competency centres, joint funding, support to the creation of infrastructures, participation in international programmes and the promotion of public understanding of science (IPTS, 2006).

² It is a research performer similar to CNRS in France or Max Planck Society in Germany, although with specific characteristics derived from the strong bureaucratic burdens imposed by the administrative dependence of CSIC's personnel policies as well as of its strategic planning. A reform is underway to transform the organism into an Agency in an attempt to soften those constraints and foster the autonomy but subjected to thorough evaluation procedures. In September 2007, the Council of Ministers approved this transformation (ERAWATCH Research Inventory, 2008).

Each Autonomous Community has its own agency responsible for implementing regional R&D policy, although there is no homogeneity between them. In some Autonomous Communities there are regional R&D Plans, including technological innovation or not, whereas in others there are strategic or specific programmes to complement or to correct the deficit of the all national level initiatives. Regional agencies are usually entirely public and report to the regional and even the European authorities (ERAWATCH Research Inventory, 2007).

Chapter 2. Resource mobilisation

The purpose of this chapter is to analyse and assess how challenges affecting the provision of inputs for research activities are addressed by the national research system: its actors have to ensure and justify that adequate financial and human resources are most appropriately mobilised for the operation of the system. A central issue in this domain is the long time horizon required until the effects of the mobilisation become visible. Increasing system performance in this domain is a focal point of the Lisbon Strategy, guided by the Barcelona objective of a R&D investment of 3% of GDP in the EU as a whole and an appropriate public/private split.

Four different challenges in the domain of resource mobilisation for research can be distinguished which need to be addressed appropriately by the research system and research policies:

- Securing long-term investment in research
- Dealing with uncertain returns and other barriers to private R&D investment
- Providing qualified human resources
- Justifying resource provision for research activities

2.1 Analysis of system characteristics

Spain is a large developed country and thus a large R&D performer, although still lagging behind the most advanced economies in R&D activities. According to Eurostat, the latest available data provide a provisional figure for GERD in 2005 of €10,100 million. This represents 1.12 percent of Spanish GDP, which is below the EU 27 average of 1.84 percent. The Spanish contribution to EU 27 GERD is 5 percent and GERD financed from abroad accounts for 6 percent of total GERD.

2.1.1 *Securing long-term investment in research*

Since 1988, national S&T policy has taken the form of four-year National R&D Plans, which are national government's main tool for programming long-term financing for research. The First Spanish National Plan for Scientific Research and Development (1988-1991) was launched after the Law for the Promotion and General Coordination of Scientific and Technical Research was passed in 1986. Since the fourth plan (2000-2003), following the establishment for the first time in the Spanish Government of a Ministry for Science and Technology, the name has been the Spanish National Plan for Scientific Research and Development *and Technological Innovation*. The Plan is implemented through several Research Programmes (ERAWATCH Research Inventory, 2007) and executed mainly through the MEC and the MITYC. The first supports public research, managing 28% of the budget for R&D and the second is

responsible for programmes and incentives to business research, which receive 47% of the R&D budget (IPTS, 2006).³ Function 46 is the budgetary instrument of the Spanish Budgets to finance R&D policy at the national level (European Trend Chart on Innovation, 2006).⁴

Nationally, the CSIC is the largest PRO, with an annual budget of €700 million, partly coming from the budget of the MEC (Guy and IPTS, 2006), essentially covering wages and maintenance expenses while the operating costs are obtained through competitive grants from public sources and contracts and licenses with the private sector. According to Eurostat, government-financed GERD directed at the public sector accounted for 33 percent of total government-financed GERD in 2004.

Spain also benefits from European funding and shared infrastructure facilities. The provisional figures published by the Centre for the Development of Industrial Technology (CDTI) show Spain's participation in the VI Framework Programme to have been quite significant: 817 Spanish institutions (549 of which are companies) took part in 704 projects (out of a total of 1450), of which 83 acted as leaders, receiving funding of €440.5m (IPTS, 2006). Several R&D programmes belonging to the Spanish R&D&I Plan 2004-2007 are co-financed by European Structural Funds when implemented at regional level. Furthermore, most regions in Spain have implemented their regional R&D policies within the programme of Innovative Regions in Europe, the main instrument of this being the Structural Funds (ERAWATCH Research Inventory, 2007). Regarding Large Scientific Facilities, the Spanish R&D&I Plan attempts to make effective use of the possibilities offered by the European Strategic Forum on Research Infrastructures (ESFRI, launched in 2002), as the European coordinating body for such facilities. One of the objectives of the Spanish R&D&I Plan is to optimise Spain's participation in the large-scale international infrastructures to which Spain contributes, articulating the means for enhancing the benefits from that participation. It also seeks to promote the role of the Spanish industry in building and maintaining those infrastructures. Examples of Large Scientific Facilities in which Spain participates are CERN and ESRF. Spain also takes part in the ITER project, which will have an agency in Barcelona (ERAWATCH Research Inventory, 2007) as well as the appointment of an Associate General Director. Regarding the management of these large scientific facilities, there is an advisory committee with the following functions (Tecnociencia, 2007):

- Examining possible expressions of interest from different institutions of public administration in the establishment or enlargement of national large scientific facilities or in the participation of multinational large scientific facilities.
- Evaluating the scientific and technological importance and the technical and economic viability of proposals.
- Evaluating the relevance of proposals in terms of scientific, social and industrial impact, according to the needs of the scientific community.
- Identifying facilities that might be built or enlarged in the medium to long term.
- Promoting the participation of Spanish large scientific facilities in European R&D programmes and in the industrial environment.

There is no direct information available on the evidence from existing assessments on system performance and achievements. However, the efforts so far are

³ The rest was executed by other ministries and PROs (ERAWATCH Research Inventory, 2007).

⁴ However, after the process of decentralisation to the Autonomous Communities, the regional governments have developed their own models of university funding.

considerable, since, according to Eurostat, GBAORD in 2005 was 0.85% of GDP, while the average in the EU 27 in 2005 was 0.74%.

2.1.2 Dealing with uncertain returns and other barriers to private R&D investment

Following the trend of the total R&D expenditures, BERD in Spain has been rising steadily and has also increased in weight, both in terms of GERD (from 44.5% in 1995 to 48% in 2004) and as a percentage of GDP (from 0.38% in 1995 to 0.61% in 2005). The Spanish private R&D system is largely determined by its industrial structure, which is mainly composed of SMEs in traditional sectors with a small number of high tech firms and a few large firms (some of them former public monopolies in utility sectors). Those sectors where Spanish firms have made inroads on international markets are traditionally characterised by low R&D investments (e.g. banking, tourism, building...). Nearly 70% of Spanish business employment is in micro (less than 10 employees) and small enterprises (less than 49 employees), compared to an average of 50% in the European Union and 36% in the United States. On the other hand, only 18% of business employees are employed by large firms (more than 249 employees), compared to 34% in the EU and 50% in the United States. The Spanish share of high technology products in total manufacturing exports is quite low and barely increased between 1994 and 2003 (9.9% and 10.8% respectively) in contrast with most European countries, as the EU-25 average increased from 16.3% in 1994 to 21.9% in 2003 (OECD, 2006).

Spanish venture capital instruments include "Public Venture Capital to new technology-based firms (NTBFs)", involving the participation of the Spanish National Innovation Enterprise (ENISA), and the Official Credit Institute (ICO)'s financial facilities for investments aimed at increasing and improving enterprises' technological and innovative components (European Trend Chart on Innovation, 2006). There is also the NEOTEC Programme, which is an initiative to create some NTBFs, which was launched in 2001 and is managed by the CDTI. Although the initiative is not very large in volume, it is one of the longer running Spanish venture capital programmes for technology-based enterprises (European Trend Chart on Innovation, 2006).

Tax incentives of R&D expenditures have been in place since 1995 and were modified in 2000 (to make them more attractive) and 2003 (in order to lower the bureaucratic hurdles). There are no limitations on research fields or company size/sector with access to tax deductions, which are usually around 30%, although they can reach 50% in certain cases (IPTs, 2006). All types of R&D are eligible for the tax reduction scheme (IPTs, 2006). Not counting tax incentives, the share of BERD financed by government was 12 percent of total BERD in 2004. Funding of this kind is mainly distributed by the MITYC, through the Technical Research Support Programme (PROFIT) (see also section 5.1.1) and by the CDTI, that grants financial aid to companies for the execution of both national and international research and development and innovation projects (see also section 3.1.2) (ERAWATCH Research Inventory, 2007).

On the evidence from existing assessments of the system's performance and achievements, on the one hand, an indicator of a relatively low performance so far is that national business R&D funding was 0.51% of GDP in 2004, less than the EU 27's average of 1.01%. The European Trend Chart on Innovation (2006) has highlighted the lack of venture capital as a major barrier for start-up enterprises in new technology areas that are potential engines of growth. Existing venture capital mainly funds large projects by established firms where the risk is lower than in funding start-ups. According to the European Innovation Scoreboard, Spain has a

poor showing due among, other factors, to a shortage of venture capital. The European Trend Chart on Innovation (2006) states that, with respect to the funding of new enterprises and the entrepreneurial culture, a tax incentive supporting venture capital activities funding SME start-ups and technology-based projects, as suggested by the Economic Social Council (CES), would be a desirable complementary initiative. On the other hand, IPTS (2006) describes the Spanish R&D Tax Incentive System as one of the most advanced in the world. However, the uptake by companies was lower than expected and there were difficulties in applying the law (IPTS, 2006). This may be due to some characteristics of the structure of the Spanish innovative business sector, composed predominantly of SMEs and of NTBFs in some emerging sectors, e.g. biotechnology, still in the process of maturation. These types of firms hardly can profit of tax incentives applied to their sales.

2.1.3 Providing qualified human resources

The Spanish R&D&I Plan includes the strategic objective of expanding the number and quality of human resources in both the public and private sectors (ERAWATCH Research Inventory, 2007). Spain has increased the production of human resources in science and technology over the past few years and it ranks above the OECD average in terms of the share of university graduates with degrees in science and engineering (over 20%). There are currently some 80,000 students enrolled in PhD studies and some 8,000 PhDs graduate each year. The duration of PhD studies is relatively long in Spain compared to other countries: up to six years instead of the four years common elsewhere. Spain ranks close to the EU average in terms of researchers per 1,000 employees. About one third of Spanish researchers work in the business sector while the rest work in the public sector (universities or government research institutes) (OECD, 2006).

The Spanish R&D&I Plan for R&D and Technological Innovation contains a national programme for the Promotion of Human Resources with the aim of increasing the supply of researchers in the system (IPTS, 2006). This programme includes PhD fellowships. There are also two programmes to ensure career prospects for researchers (Guy and IPTS, 2006):

- Launched in 2001, the Ramón y Cajal programme aims to support the employment of PhDs at Spanish research centres. The objective is to increase the job opportunities in the public research system and to reduce the gap between the demand for researchers and the number of researchers looking for a job.
- Implemented in 2004, the Juan de la Cierva programme supports the recruitment of postdoctoral researchers by PROs on three-year contracts. The programme, which develops the lines of action of the National Programme for the Promotion of Human Resources, aims to increase the research capabilities of R&D groups and institutions in both the public and private sector by recruiting qualified researchers.

On the attractiveness for foreign researchers, there are significant problems with the accreditation of foreign educational diplomas and in hiring non EU citizens, who cannot take up permanent positions because of public service regulations (OECD, 2006).

The European Trend Chart on Innovation (2006) provides some assessments on system performance and achievements, when it states that the evolution of the number of people with a university degree is satisfactory. The OECD (2006) recalls that the limited ability of public and business research to absorb a constant stream of

young PhDs has resulted in a brain drain to other EU countries and to North America. On the positive side, Spain has been able to increase the participation of women among its university science graduates and researcher population. Women account for 36.3% of researchers in Spain compared to 28.3% in Italy and 27.8% in France. However, most women researchers in Spain work in the public sector where they are under-represented in senior positions and only 6% of private-sector researchers in Spain are women (OECD, 2006).

2.1.4 Justifying resource provision for research activities

The legitimacy of devoting public resources to R&D and not to other activities is not under debate in Spain in the discourses both from public and private authorities. The recognition that science and technology is related to competitiveness and growth is present in the Spanish R&D&I Plan, since it maintains three general principles: to serve the general public and improve social welfare; to contribute to generating knowledge; and to contribute to improving business competitiveness. According to the INGENIO 2010 Programme (see section 2.2.2), R&D is considered a source of increased productivity and long-term growth and a means of promoting more and better employment (IPTS, 2006). The Programme also contains some measures aimed, among other things, at promoting the public understanding of science (IPTS, 2006). However, in practice there has been an underlying reluctance from the high level economic responsible actors to invest in R&D or consider this as a factor for growth and welfare.

The Spanish Foundation for Science and Technology (FECYT) is a non-profit organisation (created by the government in 2001) that works as a multidisciplinary and inter-sectoral platform bringing together stakeholders from the scientific, technological and business fields, including the Conference of Spanish Universities' Chancellors (CRUE), the CSIC, entrepreneurial associations and the main innovating companies (IPTS, 2006). They meet because one of the strategic objectives of FECYT is to promote the dissemination of scientific knowledge so as to inform society of the results of R&D and create public awareness of the role of science. It also sets out to promote activities which producers of science and technology may carry out to make their achievements known to society (FECYT, 2007).

There is no directly available information from existing assessments of system performance and achievements. As an indicator of good performance, it is worth noting that the share of GBAORD exceeded 2 percent of total government expenditure in 2004 and 2005, while it was 1.56 in 2004 in the EU 25.

2.2 Analysis of recent changes and policies

2.2.1 Relevant recent trends

Enlargement of the European Union has gradually made European funding less readily available for Spain, which is no longer considered donor rather than a recipient (ERAWATCH Research Inventory, 2007). According to the CDTI, the official representatives of the European Framework Programme for Research in Spain, the financial support received by Spain from this programme has increased continuously over time. The Framework Programme is still one of the main sources of financial support to research carried out by the public and private research sectors in Spain. Nevertheless, the ratio of participation to contribution has decreased from the fifth edition of the Framework Programme to the sixth. This ratio is calculated as the relation between the financial support received by Spain through this programme and

the Spanish contribution to the European Union's total budgets (relative to the GDP of each Member State), and is used by many countries as an indirect indicator of the success in their participation in the Framework Programme. The entrance of the New Member States and Associated Countries is highlighted as one of the possible reasons for this decrease, due to the greater competition between participants in the programme (ERAWATCH Research Inventory, 2007).

2.2.2 Role and expected impact of recent policies

Although there is no longer a ministry dedicated exclusively to Science and Technology, the budget allocations for science have been rising and in 2005 and 2006 the government has met its promise stated both in the investiture speech and in the National Reform Programme to increase the budget for R&D by 25% annually (IPTS, 2006). Most of this increase can be attributed to the INGENIO 2010 Programme.

INGENIO 2010 is Spain's response to the Lisbon Strategy. The programme was launched in 2005 and aims to align Spain with the European Union's strategy to increase R&D expenditure to 3 percent of GDP by 2010. The intermediate target is to close the gap that currently separates Spain from its main competitors (European Trend Chart on Innovation, 2006). The programme itself is part of the broad-based National Reform Plan (NRP) launched by the government in 2005 to boost Spanish competitiveness. In addition to introducing new measures, it intends to complement initiatives envisaged in the Spanish R&D&I Plan (2004-2007) approved by the previous government, the national government has almost doubled public support to R&D and innovation (in the 2007 budget more than €8 billion was allocated). Through this massive increase in public funding, the government expects that GERD will reach 2% of GDP by 2010 (OECD, 2006)⁵ and that business participation in R&D activities will reach a 55% of total R&D by 2010 (ERAWATCH Research Inventory, 2007). In general, the Spanish NRP is well structured and aims to initiate the appropriate activities to address the challenges facing the Spanish Science and Technology System. The INGENIO 2010 Programme, which represents the part of the NRP that addresses R&D and innovation issues, sets objectives for GERD, BERD and the information society. If the implementation of the various measures is carried out as planned, Spain looks set to catch up with the most advanced economies (European Trend Chart on Innovation, 2006).

The Entrepreneurship Programme complements INGENIO 2010 in the fields of start-up financing and SMEs' participation in R&D. Its initiatives include (European Trend Chart on Innovation, 2006):

- Extension of the ICO by adding a Small and Medium-Sized Enterprise Line (ICOPYME). This line has considerable potential to generate direct effects on company growth and modernisation.
- More favourable treatment of companies seeking an ICOPYME loan and which are backed by a Reciprocal Guarantee Company (SGR). This will reduce the cost of outside financing. Furthermore, the MITYC has signed an agreement with CERSA to facilitate guarantees for loans to enterprises carrying out R&D projects (within the Spanish R&D&I Plan).
- Bonuses for social security contributions for research personnel. Unlike public aid for R&D in the form of corporation tax deductions, these bonuses can be

⁵ INGENIO 2010 is managed by the same ministries that manage the Spanish R&D&I Plan (see section 1.1), mainly MITYC and MEC (37.1%), followed by far by the Ministry of Defence (5.0%) and the MSC (4.4%).

applied irrespective of whether the company makes a profit or a loss, an aspect which is particularly important in the first years of the life of a company.

- Reform of the University Teachers' Statute to enable their participation in business projects and so introduce the entrepreneurial "way-of-doing things" to the universities.
- Improvement of the technology-transfer system to companies, with particular attention on the Technological Centres.

In July 2007, there was a presentation of the draft version of the Action Plan (2007-2013) for European Structural Funds in Spain. This Action Plan shows a clear upgrading of the importance of the R&D-related activities to be financed in the backward regions of Spain. The percentage dedicated to R&D is in fact double that of the former period (ERAWATCH Research Inventory, 2008).

According to the OECD (2006), following the presentation of the Commission for Monitoring and Evaluating the Spanish R&D&I Plan (COSEP) report (see section 3.1.3), a new programme was created in July 2006: a Science and Technology Communication Plan, coinciding with Science and Technology Year, to disseminate the values of science and foster innovation in society, particularly among young people. This programme has a budget of €5 million for 2007.

2.3 Assessment of resource mobilisation

The main strengths and weaknesses of the Spanish research system in terms of resource mobilisation for R&D can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Advanced tax incentives for R&D to reduce barriers to private R&D investment 	<ul style="list-style-type: none"> • The industrial structure, which is mainly composed of SMEs in traditional sectors and only a small number of high tech firms, is a barrier to private R&D spending • Lack of venture capital is another barrier to private R&D funding

The main opportunities and threats for resource mobilisation in Spain arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Opportunities	Threats
<ul style="list-style-type: none"> • Ambitious reform programme following the Lisbon objectives to increase budget allocation of R&D • Public R&D supported by increasing R&D related-EU Structural Funds • Increased credit facilities for innovative activities at SMEs 	<ul style="list-style-type: none"> • Public R&D declining down due to drop in relative level of EU Funds received from the Framework Programme

Chapter 3. Knowledge demand

The purpose of this chapter is to analyse and assess how knowledge demand contributes to the national research system's performance. It is concerned with the mechanisms used to determine the most appropriate use of, and targets for, resource inputs. Main challenges in this domain relate to governance problems stemming from specific features of knowledge and the need for priority setting. These include:

- Identifying the drivers of knowledge demand
- Co-ordinating and channelling knowledge demands
- Monitoring and evaluating demand fulfilment

Responses to these challenges are of key importance for the more effective and efficient public expenditure on R&D aimed at in the Lisbon Strategy Integrated Guideline 7.

3.1 Analysis of system characteristics

The sectoral structure of the Spanish economy reflects the economic importance of supplier-dominated sectors based on the prominent role of traditional industries such as furniture, non metallic mineral products, textiles and the food industry, and has led to a low demand for R&D in comparison with other countries. Logically, the structure of Spanish BERD presents a relative bias according to the technological level of the manufacturing activities (compared to the EU figures): 36% (41%) in high-tech, 42% (48%) in medium-high-tech and 22% (11%) in medium-low-tech and low-tech, according to Eurostat data for 2002. Services sectors are also important, as well as BERD in those sectors, since the share of BERD performed in services was 27.3% in 2002, higher than the EU average of 15.1. This dual specialisation profile is highlighted by the analysis of the correlation between economic and R&D specialisation. In the manufacturing sector it is specialised in a number of medium- to low-tech sectors such as those mentioned above, plus transport equipment, shipbuilding and fabricated metals, in terms both of economic magnitudes (value added, employment and exports) and BERD. In the services sector, however, while it is specialised in terms of BERD in industries such as community services, other business activities, research and development and IT services, this specialisation is not translated into an economic specialisation, despite the fact that these sectors receive large shares of public funding for BERD (ERAWATCH Network, 2006).

Slightly more than a quarter of public demand as expressed in government appropriations (GBAORD) is non-oriented (27 percent in 2005), while the main bulk (73 percent in 2005) is directed towards specific socio-economic objectives. Compared to the EU 15, Spain shows a degree of relative specialisation in human health, land use, industrial research, defence and agriculture. Over the 1993-2003 period, Spain lost its specialisation in the NABS categories "exploration and exploitation of earth" and "exploration and exploitation of space", while at the same time it gained in specialisation in the socioeconomic objectives of "infrastructure and general planning of land-use" and "defence". Particularly for this gain, the trend exhibited in Spain is the opposite to that of most EU15 countries (ERAWATCH Network, 2006). This may result from the decision made by the conservative party when it took the Spanish Government in 1996. It was then decided to include spending on military international projects aimed to develop weapons systems in the overall R&D budget. Although this has been since a hot debated issue, the correction

of the situation from 2004 onwards with the new Socialist Government has taken a continuous but slow pace (Sebastián and Muñoz, 2006).

3.1.1 Identifying the drivers of knowledge demand

FECYT is a non-profit organisation, which aims to play the role of a multidisciplinary and inter-sectoral platform to bring together players from the scientific, technological and entrepreneurial spheres (see section 2.1.4.)⁶. FECYT identifies opportunities and needs and makes proposals on R&D. Its governing body includes representatives from the MEC, the Ministry of Health, PROs, universities and the CDTI. The governing body is supported by a Scientific and Technological Council, which has members from PROs, universities, scientific and technological parks, etc. (FECYT, 2007). To conduct prospective studies, FECYT uses its own strategies but also has recourse to the National Evaluation and Foresight Agency (ANEP). ANEP was created by the "Law for Science" as a basic instrument to develop the peer review system in the Spanish R&D system. ANEP was also foreseen as an instrument to carry out prospective studies. The Agency has gained general recognition in the first task, being less active and successful in the second one.

The Spanish R&D&I Plan has set up the Integrated Monitoring and Evaluation System (SISE) - a new mechanism to monitor the progress of the NRP in relation to R&D and innovation and to develop the National R&D and Innovation Programme and all its related instruments. SISE relies on the systematic collection of documents and information that is to be produced regularly by units and agencies with managerial responsibilities for programmes and actions within the R&D and innovation system or the diverse fields of science and technology. Some of the most basic SISE instruments are reports by the evaluation panels of programmes and actions; foresight studies; and technology watch activities (European Trend Chart on Innovation, 2006).

Red.es is a public enterprise under the MITYC, which, amongst other functions, is an outstanding observatory on Information and Communication Technologies supporting the public authorities through sectoral Technology Watch and Scientific Foresight studies (ERAWATCH Research Inventory, 2007).

3.1.2 Channelling of knowledge demand

The CICYT is the governmental body in charge of the design, planning, coordination and monitoring of national R&D policies, in particular the Spanish R&D&I Plans (2004-2007, 2008-2011). It is a strategic working group from the different ministries with R&D competencies, chaired by the Prime Minister (ERAWATCH Research Inventory, 2007). Two main consultative bodies support the CICYT: the "General Council for Science and Technology" and the "Advisory Council for Science and Technology Policy". The former has the main task of coordinating the Autonomous Communities (or regional governments) and the relations between them and national government. The latter was set up to promote the participation of society in the R&D policy (ERAWATCH Research Inventory, 2007), including business associations and the main innovating companies. The composition of the Permanent Commission of the CICYT is as high level as the CICYT, which leaves the effective day-to-day coordination of the Spanish R&D Plan in the hands of an informal institution: the Support and Follow-Up Unit of the CICYT (CAS-CICYT). The CAS-CICYT is chaired by the Director of the Economic Bureau of the Prime Minister and comprises two

⁶ Note that it does not appear in the structure chart in section 1.1, because FECYT is a non-profit organisation with functional autonomy.

State Secretaries (Deputy Ministers), and the Secretary Generals and Director Generals who manage most of the annual budget for R&D (OECD, 2006). The CICYT's tasks include the integration of the programmes initiated by the various sectors, proposing allocations of public funds to the various programmes under the Spanish R&D&I Plan and coordinating their implementation (OECD, 2006).⁷

The CICYT, through the Spanish R&D&I Plan 2004-2007, defines the following to be priority areas: the Life Sciences; Agro-food and Environmental Sciences; Space, Mathematics and Physics; Energy; Chemistry, Materials and Industrial Production; Safety and Defence; Information Society Technologies; Transport and Building; Humanities, Social and Economic Sciences (IPTS, 2006).

According to the General State Budgets, the national budget for R&D included the following thematic programmes in 2004 and 2005 (IPTS, 2006):

- R&D for the Information Society, around 7 to 8 percent of the total.
- Defence R&D, around 6 to 7 percent of the total.
- Health R&D, representing around 5 percent of the total.
- Other programmes, which range from 8 to 9 percent of the total.

Public procurement of innovative products and services is mainly encouraged by the CDTI. The CDTI gives financial support to R&D projects performed by enterprises, without any sectoral focus or size constraints (European Trend Chart on Innovation, 2006).

In 2005, the main socio-economic objective, receiving 25% of the Government budget allocations, was Industrial production, followed by Research financed by general university funds (18%) and Defence (16%).

Figure 2: GBAORD distribution by socio-economic objective, 2005

Nomenclature for the analysis and comparison of scientific programmes and budgets (NABS)	Percentage
01 Exploration and exploitation of the earth	1.4
02 Infrastructure and general planning of land-use	4
03 Control and care of the environment	3
04 Protection and improvement of human health	8.7
05 Production, distribution and rational utilisation of energy	1.6
06 Agricultural production and technology	5.2
07 Industrial production, and technology	25.2
08 Social structures and relationships	2.1
09 Exploration and exploitation of space	3.2
10 Research financed from general university funds (GUF)	18.1
11 Non-oriented research	8.6
12 Other civil research	2.8
13 Defence	16.1
86 Total civil research and development appropriations	83.9
99 Total appropriations	100

Source: Eurostat

The Spanish R&D&I Plan 2004-2007 is for Spain a first-line instrument for contributing, along with the other countries from the European Union, to the realisation of the European Research Area. Two of the main components for this

⁷ The CICYT also takes into account the information from FECYT (see section 3.1.1).

international scope of the Spanish R&D&I Plan are (ERAWATCH Research Inventory, 2007):

- Promoting thematic areas of the Spanish R&D&I Plan in international programmes, such as the European Framework Programme for R&D, COST, EUREKA, etc.
- Participating in multilateral European organisations, such as the European Space Agency (ESA).

On existing assessments of system performance and achievements, regarding CICYT, on the one hand, Guy and IPTS (2006) consider that the number of structures coordinating policy efforts in the R&D and innovation domain is impressive. The authors highlight that CICYT has three levels of meetings: biannual meetings of ministers headed by the Prime Minister; 3-5 meetings per year of key ministers headed by the Deputy Prime Minister; and the bi-monthly meetings of the Secretaries of State. On the other hand, the OECD (2006) views the high level and broad composition of the Commission as limiting its practical ability to act as a decision-making body. There has also been criticism of the current system of public support to basic science in Spain on the grounds that it lacks clear priorities. In fact, almost every basic research field is covered, even if, in theory, the planning procedure considers the country's strengths and weaknesses. There may even be a tendency to partially offset the effects of EU choices, which try to establish priorities through the European Framework Programme in order to enable concentration of financial efforts on fewer research fields (Guy and IPTS, 2006).

3.1.3 Monitoring and evaluating demand fulfilment

As mentioned in section 3.1.1, the Spanish R&D&I Plan created the SISE. Besides its monitoring function, this is a mechanism with which to assess the progress of the NRP in relation to R&D and innovation and the development of the Spanish R&D&I Plan, as well as all related instruments (to date, ex-post evaluations of the results of R&D and innovation have been scarce and unsystematic). The SISE relies on the systematic collection of documents and information that must be produced regularly by units and agencies with managerial responsibilities for programmes and actions within the R&D and innovation system or the diverse fields of science and technology. The most basic SISE instruments are follow-up reports, reports monitoring R&D and innovation indicators and annual reports on R&D and innovation activities (European Trend Chart on Innovation, 2006). Created in May 2005 as part of SISE, the COSEP responds to the terms of reference defined by SISE by echoing the views of a hundred experts, distributed in different sub-commissions, on the design and impact of the Spanish R&D&I Plan (OECD, 2006). In 2005, COSEP presented its first report to the CICYT, which contained a number of policy recommendations (IPTS, 2006).⁸ This instrument is the collection of documents and information that units and agencies are required to produce regularly on the progress of the programmes and actions they are responsible for running, as well as on the R&D system or the diverse fields of science and technology. CICYT uses the results for decision-making (ERAWATCH Research Inventory, 2007). Its impact is reported in section 3.2.

⁸ The COSEP report is not publicly available. However, according to OECD (2006), it praised the decisive contribution of the National Plans to the improvement of the Spanish innovation system, but criticises the fact that the Plan has become an excessively long list of thematic programmes (covering scientific-technical areas and sectors) that define scientific-technical priorities in too much detail. It also noted some deficiencies in the current implementation of the National R&D Plan.

The ANEP, also mentioned in section 3.1.1, belongs and reports to the MEC. It is in charge of evaluating research centres, teams and projects.⁹ Another organisation under the aegis of the MEC, the National Evaluation Commission of Research Activities (CNEAI), is responsible for assessing the research activities of university teaching staff (IPTS, 2006).

For the OECD (2007), the statistical infrastructure for accessing data for SISE is underdeveloped. The government has created a basic database on indicators for industry and innovation but the lack of updated data limits the possibility of evaluating many of the recent policies and discrete instruments. In addition, there is a need to define better (micro-level) indicators that can be matched to programme objectives (OECD, 2007).

3.2 Analysis of recent changes and policies

The MEC, through the General Secretariat for Scientific Policy, has launched the CONSOLIDER Programme to promote high quality research. The actions envisaged in the programme are focused on a well defined population group, and are to be implemented by well established leading research teams. These groups must have research lines beyond the state of the art, be able to show previous high quality results and have an outstanding trajectory on the international stage (ERAWATCH Research Inventory, 2007). The overall budget is €1.5 billion (ERAWATCH Research Inventory, 2007). CONSOLIDER is part of the INGENIO 2010 Programme. Through it, two traditional demands from the most prestigious researchers in Spain will be addressed. The first is to finance projects that cannot currently be fitted in to the Spanish R&D&I Plan because of their scope, relevance or size. The second demand is to simplify and increase the flexibility of the procedures by which research funding may be obtained (ERAWATCH Research Inventory, 2007).

With respect to the Lisbon guidelines on innovation, the Spanish procurement policy includes bolstering the role of public procurement and standardisation as drivers of new innovative products and services by enterprises for specific sectors, e.g. the Programme AVANZ@ (launched in 2006), to reduce the gap between Spain and its neighbours in the use of ICT, especially in terms of e-business. With a budget of €5.7 billion for 2005-2010, AVANZ@ is intended to leverage investment by other public administrations and the private sector of up to €20-€25 billion. Moreover, the AVANZ@ Programme will contain non-budgetary legislative measures for financial support (European Trend Chart on Innovation, 2006).

According to the OECD (2006), the COSEP report promoted two improvements in management (see section 3.1.3):

- A clear separation, in the National Budget, between civilian and military R&D and innovation programmes, regardless of the agency managing them.
- Drafting of a Schedule setting out all the R&D and innovation grants and aid programmes, to be published in the December prior to the year of reference, so as to provide enhanced advance information on this subject. Additionally, half-yearly reports will be issued on compliance with the schedule.

There is still room for policies to take the specific characteristics of industrial structures (many SMEs and few big companies) and the Spanish industrial specialisation into account for priority setting and the definition of objectives and means (Guy and IPTS, 2006).

⁹ There is no ex-ante interaction between SISE and ANEP but, since both report to the CICYT, ex-post interaction occurs.

During the development of the new National Plan (2008–2011) the government created the Reflection Group of the National Strategy for Science and Technology (GRECYT) whose participants – who work in small working groups – include representatives of: the General Council for Science and Technology, the ministries and regional departments involved in R&D activities; the scientific and technological community; and social agents (enterprises and labour unions). The GRECYT and its members offered information, suggestions and opinions based on their discussions and convert these into specific instruments so that all agents of the innovation system will have participated directly in the design of the new plan (ERAWATCH Research Inventory, 2008). GRECYT produced the National Strategy for Science and Technology (ENCYT), a position document on the general principles and objectives for science and technology policy from 2005 to 2015. The Spanish R&D&I Plan 2008-2011 should incorporate the results of the ENCYT in the programme distribution of the budget.

3.3 Assessment of knowledge demand

The main strengths and weaknesses of the Spanish research system in terms of knowledge demand can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Impressive coordination of policy efforts in R&D to channel knowledge demand 	<ul style="list-style-type: none"> • Scant priority setting in the support to public science, even running counter the priority setting of the European Framework Programme

The main opportunities and threats for knowledge demand in Spain arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Opportunities	Threats
<ul style="list-style-type: none"> • Attempt to meet demand for funding of large projects through simplified procedures • Active procurement to help reduce ICT gaps 	<ul style="list-style-type: none"> • Little priority setting according to the industrial structure and specialisation

Chapter 4. Knowledge production

The purpose of this chapter is to analyse and assess how the research system fulfils its fundamental role of creating and developing excellent and useful scientific and technological knowledge. Any response to knowledge demand has to balance two main challenges:

- On the one hand, ensuring knowledge quality and excellence is the basis of scientific and technological advances. It requires considerable prior knowledge accumulation and specialisation as well as openness to new scientific opportunities, which often emerge at the frontiers of scientific disciplines. Due to the expertise required, quality assurance processes are here mainly the responsibility of scientific actors, but may be subject to corresponding institutional rigidities.
- On the other hand, there is considerable interest in producing new knowledge which is useful for economic and other problem solving purposes. Spillovers which are non-appropriable by economic producers as well as the lack of possibilities and incentives for scientific actors to link to societal demands lead to an exploitability challenge.

Both challenges are addressed in the research-related Lisbon Strategy Integrated Guideline.

4.1 Analysis of system characteristics

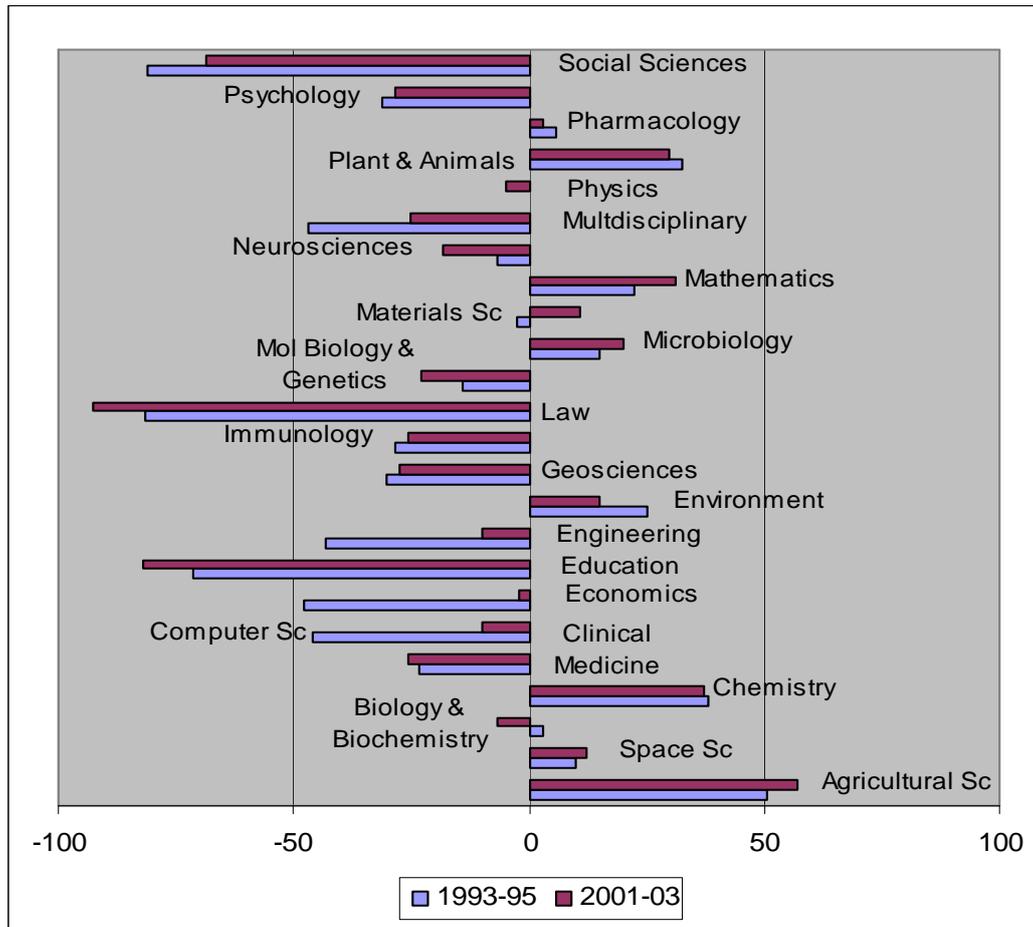
4.1.1 *Ensuring quality and excellence of knowledge production*

The Spanish R&D&I Plan includes two strategic objectives related to ensuring continuity of and specialisation in excellent research (ERAWATCH Research Inventory, 2007): to enhance the level of Spanish science and technology, both in scale and quality and to strengthen the role of the public sector in generating fundamental knowledge.

Spain's scientific specialisation, as measured by the publications and citations profiles (see figure below) is relatively stable with small changes over the period 1993-2003. Thus, Spain is specialised in scientific fields such as agricultural sciences, chemistry, plants and animals, mathematics, environment, microbiology, etc. (ERAWATCH Network, 2006). This specialisation serves to point out to the strengths of Spain in the knowledge production market and constitutes a good base for the development of strategic technologies as for instance it is the case for biotechnology (Fundación Genoma, 2007) or chemical catalysis.

The ANEP, whose broad objectives have been outlined before (see section 3.1.1), is reporting to the State Secretariat for Universities and Research and the MEC. Its specific objectives in the knowledge assessment domain are to evaluate the quality of scientific and technological proposals requesting public funding, both for the Department and for other public and private organisations; to improve the capacity of the public science and technology system; to contribute to decisions about the allocation of resources for R&D and innovation made on the basis of excellence criteria and scientific and technological quality (European Trend Chart on Innovation, 2006). Evaluations are ex-ante and take place through peer-review by external experts (ERAWATCH Research Inventory, 2007).

Figure 3: Number of publications by scientific field. 25 Scientific fields. Specialisation profile. Spain.



Notes: Specialisation index with EU15 as reference. Max specialisation: + 100. Min. specialisation: -100 based on averages 1993-1995 and 2001-2003. Source: ERAWATCH Network (2006), drawing from Thomson ISI, NSIODE 2005, own calculations.

On the evidence from existing assessments of the system's performance and achievements, there is little public promotion of large multidisciplinary projects involving companies, universities and other public research actors (European Trend Chart on Innovation, 2006). Moreover, there are no incentives for collaboration between different areas of research. As a result, most research groups are very small (European Trend Chart on Innovation, 2006). According to the National Reform Programme, the scarcity of public resources and scientific-technological infrastructures has caused Spanish public research groups to focus their activities on fields of science requiring fewer resources, to the detriment of more experimental branches. This lack of critical mass in both public and private research has turned into a level of scientific output that falls a long way short of the potential excellence of Spanish researchers. This is seen in: i) the low impact of Spanish scientific production in the productive sector; ii) an excessive fragmentation of research groups; and iii) a limited participation in the ERA (ERAWATCH Research Inventory, 2007).

Guy and IPTS (2006) note some improvements in the continued drive to raise the quality of the Spanish science base, but there is also the need to improve scientific productivity and quality if Spain is to establish itself as a leading centre of scientific excellence. They also mention recent announcements suggesting that future plans

will emphasise the importance of establishing critical masses of research excellence, with initiatives moving away from the funding of short-term projects and focusing instead on longer-term, large-scale actions involving public research groups, centres and consortia of excellence within thematic research areas. Even with projected increases in funding for R&D, such a shift is almost inevitably bound to lead to a greater concentration of effort in fewer strategic areas. It is not yet clear, however, how these areas will be chosen or how the research community will react once the implications of a greater focus on key areas are fully comprehended. The shift nevertheless represents an opportunity for Spain to orient its science base towards areas of special relevance for the future needs of Spanish industry and to enhance the predisposition of Spanish researchers to work in such areas (Guy and IPTS, 2006). All in all, this has to do with the potential situation or the quality of science in Spain, since in terms of production the number of scientific publications per million inhabitants in 2004 was 618, not far short of the EU 25 average of 662.

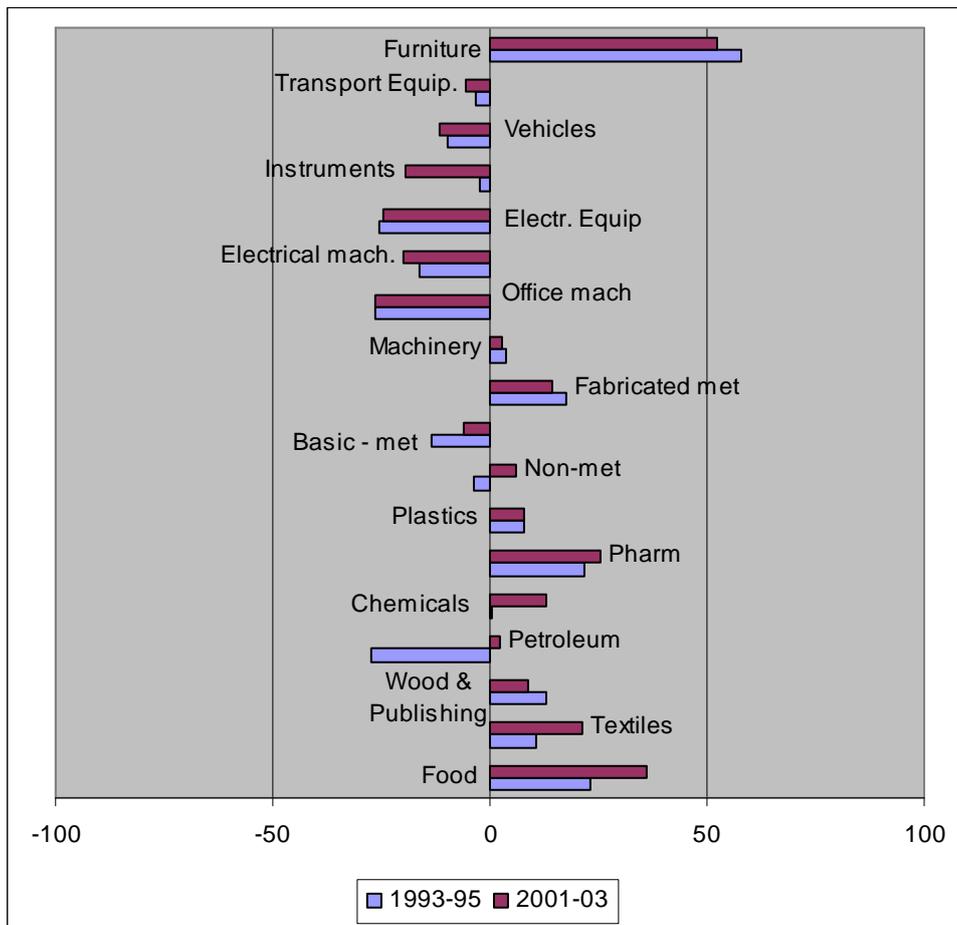
4.1.2 Ensuring exploitability of knowledge

Business R&D expenditure is limited, as is patenting activity, which constrains both innovation and technological diffusion (Guy and IPTS, 2006). Four objectives of the 5th Spanish R&D&I Plan are specifically devoted to industrial competitiveness and innovation policy. These include strengthening the links between the public sector and business and applying actions which may increase private-sector investments in R&D, including development of intellectual property rights (Guy and IPTS, 2006).

Regarding the country's technological specialisation, Spain's profile (see figure below) remained fairly similar over the period 1993-2003. Notable exceptions to this trend were the non-metallic mineral products, chemicals and petroleum industries, in which Spain went from being non-specialised to specialised within the space of a decade (ERAWATCH Network, 2006).

On the evidence from existing assessments of the system's performance and achievements, Guy and IPTS (2006) recommend that Spain should identify the best solutions to increase R&D activities in companies. The problem is not to expand the tools to support private R&D but rather to enhance the effective use of the existing tools. The specific effort to promote the different programmes devoted to supporting SMEs in their R&D projects is one thing. Moreover, the European Trend Chart on Innovation (2006) emphasises that there has been a considerable increase in the ability of the Spanish public R&D system to produce scientific knowledge, although it is not as efficient in the creation of technological knowledge and its transfer to industry. There are difficulties as a result of the rigid working schemes imposed by on civil service structures. These kinds of contracts do not encourage the search for extra funding resources from entrepreneurial sector. In any case, the number of EPO patent applications per million inhabitants also reveals some weakness, since in 2003 it was 31 as compared with 128 for the EU 27.

Figure 4: Number of patents by industrial sector. 18 sectors in manufacturing. Specialisation profile. Spain.



Notes: Based on correspondence matrix ISI-SPRU-OST. Specialisation index with EU15 as reference. Max specialisation: + 100 Min. specialisation: -100 based on averages 1993-1995 and 2001-2003. Source: ERAWATCH Network (2006), drawing from Thomson ISI, NSIODE 2005, own calculations.

4.2 Analysis of recent changes and policies

4.2.1 Relevant recent trends

There are signs that the situation of limited business R&D and patenting is improving given that sales of ‘new to market’ and ‘new to the firm’ products have recently increased (Guy and IPTS, 2006).

4.2.2 Role and expected impact of recent policies

In June 2005, as a response to the adoption of the new Lisbon Strategy, the Spanish Prime Minister announced a new R&D&I Plan (INGENIO 2010). Within the reform agenda, efforts to stimulate R&D and innovation are based on a continued need to build critical mass in research excellence and improve quality levels. One of the four key strategic areas of the action plan fits in with a policy mix framework aiming to continue enhancing human-resource and science-base capabilities (‘Raising critical mass and research excellence’). The CONSOLIDER Programme, included in INGENIO 2010, aims to accomplish excellence in research by increasing the critical mass of research teams. It gives support to centres and public consortia for large-scale and long-term research lines, and encourages participation in European

Framework Programmes (IPTS, 2006). It is managed by the MEC and includes the following actions (ERAWATCH Research Inventory, 2007):

- CONSOLIDER Projects, offering long-term (5-6 years), large-scale (€1-2 million) funding for excellent research groups and networks.
- CIBER Projects, promoting high quality research in Biomedicine and Health Sciences in the National Health Care System and the National R&D System, with the development and enhancement of Network Research Structures.
- The I3 Programme, providing incentives for the creation of stable jobs within the Spanish Science and Technology System for Spanish and foreign researchers with outstanding careers, and supporting the most relevant researchers by reducing their teaching workload.
- The "Strategic Scientific and Technological Infrastructures Fund", ensuring the availability and renewal of scientific and technological equipment and facilities, promoting scientific and technological parks linked to Universities and public research bodies, and supporting singular strategic projects.

The Public Contracts Act is also being amended in order to reduce the bureaucratic obstacles faced by public research centres to purchase R&D and Innovation products and services. Also, according to the new Agencies Act, public research centres can now acquire the status of agencies, giving them greater flexibility to manage their resources (IPTS, 2006).

Current plans to rationalise R&D funding and concentrate resources on larger programmes and projects should help counter the effects of a culture of spreading resources among as a wide a range of recipients as possible, but some improvements to overall proposal selection procedures could also be contemplated. Now, only proposals advocating budgets of more than €250,000 are subject to international peer review, and one way of aspiring to international levels of excellence is to reduce the size of this threshold. A corollary is that such proposals would also then have to be produced in English, as they are now in many EU Member States. At first sight, this might be seen to penalise Spanish researchers and to act as a disincentive, but in reality, it might be a hard but necessary step to take (Guy and IPTS, 2006).

4.3 Assessment of knowledge production

The main strengths and weaknesses of the Spanish research system in terms of knowledge production can be summarised as follows:

Strengths	Weaknesses
	<ul style="list-style-type: none"> • Focus on research stemming out of mono-disciplinarity, fragmentation of research groups and short-term projects, not leading to excellence • Ineffective use of the existing tools to increase R&D activities in companies, endangering the exploitability of knowledge

The main opportunities and threats for knowledge production in Spain arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Opportunities	Threats
<ul style="list-style-type: none"> A specific programme to raise critical mass and research excellence (CONSOLIDER) 	<ul style="list-style-type: none"> Limited involvement of international experts in the new measures for the evaluation of projects in national programmes

Chapter 5. Knowledge circulation

The purpose of this chapter is to analyse and assess how the research system ensures appropriate flows and sharing of knowledge between actors. This is vital for its further use in economy and society or as the basis for subsequent advances in knowledge production. Knowledge circulation is expected to happen naturally to some extent, due to the mobility of knowledge holders, e.g. university graduates who continue working in industry, and the comparatively low cost of the reproduction of knowledge once it is codified. However, there remain three challenges related to specific barriers to this circulation which need to be addressed by the research system in this domain:

- Facilitating knowledge circulation between university, PRO and business sectors
- Profiting from access to international knowledge
- Enhancing the absorptive capacity of knowledge users

Significant elements of Integrated Guideline 7 relate to knowledge circulation. To address them effectively requires a good knowledge of the system responses to these challenges.

5.1 Analysis of system characteristics

5.1.1 *Facilitating inter-sectoral knowledge circulation*

The support infrastructure includes several types of Technological Centres and Science and Technology Parks, although it could also be considered to include a heterogeneous group of semi-public bodies (both national and regional) that essentially offer innovation-related information and transfer, e.g. Industrial Liaison Offices and Technology Transfer Offices (OTRI/OTT), Innovation Relay Centres (IRCs), and European Business Innovation Centres (CEEIs). The nature and origins of the Technological Centres vary, but they usually arise from the needs of business groups (both sectoral and geographical) or groups of universities cooperating closely with businesses (European Trend Chart on Innovation, 2006).

Technology Centres and Science and Technology Parks have a dual role within the Spanish Science – Technology – Enterprise System: both as R&D performers, and as intermediaries between any R&D and innovation service and enterprises. Technology Centres and Science and Technology Parks make a very important contribution to the dynamics of this system, facilitating the interaction between the scientific and technological scenes and acting as a mechanism for the diffusion and generalisation of innovation processes.

From 1989 until 1996, Spanish R&D Plans gave subsidies to Public Institutions that decided to create an OTRI/OTT. This was baseline economic aid to Universities and PROs. Once these offices were created, the Spanish government launched specific measures to support OTRI/OTT activities. Financial support to the OTRI/OTT will allow these liaison organisations to launching and performance of strategic plans that

originate a better and more effective interrelationship between PROs/universities and productive environment and strengthen their work within a network (European Trend Chart on Innovation, 2006).

Among the incentives for inter-sectoral R&D collaboration and personnel circulation, the MITYC runs the PROFIT. In 2005, the budget allocated to this programme was €494 million. The general aim of PROFIT is to strengthen science-industry linkages. More specifically, its objectives are: i) to develop the use by private companies and technological centres of public and private research infrastructures; ii) to increase the participation of Spanish companies in international programmes of cooperation in scientific research and technological development; iii) to support research projects which may increase the technological capabilities of companies; iv) to increase cooperation in R&D amongst all agents within the innovation system; and, v) to stimulate R&D projects in favour of energy efficiency. PROFIT's targets are companies, entrepreneurial associations and technology centres. Projects can be proposed by individual entities or by groups of entities putting forward co-operation activities and networking (Guy and IPTS, 2006).

The MEC is running the Transfer of Research Results Support Programme (PETRI), which is designed to support the transfer of research outcomes produced in universities, PROs or technological centres to the private sector. This corresponds to a public/private partnership as defined by the OECD (2004). For the period 1989-2003, the total support provided by the Ministry came to €46 million for 1,001 projects (selected out of 1,773 proposals) (Guy and IPTS, 2006).

The shares of HERD and GOVERD financed by business in 2004 were over 7 percent, whereas the figures were 6.7% and 6.1%, respectively, for the EU 25 average, so this indicator is not in consonance with the scarcity of university-industry links mentioned in previous sections.

On the evidence from existing assessments on system performance and achievements, Guy and IPTS (2006) stress that some countries have responded to the challenge of linking science to innovation by giving industry ministries responsibility for all linkage programmes that are intended to be industry-led or focused primarily on the needs of industry, including collaborative R&D programmes and mobility initiatives designed to stimulate the flow of researchers into the private sector. The view underpinning strategies of this nature is that industrial demand rather than science push should be the primary factor affecting the shape and direction of linkage initiatives, but this perspective is only viable in situations where industry (and industry ministries) can clearly articulate industrial innovation needs and the inputs required from the science base. In Spain, the historically relatively low level of industrial innovation and the emphasis on non-technological innovation where it does occur argues against such a division of responsibilities and for a situation closer to the one currently in place. At present, responsibility for the planning and implementation of linkage schemes is divided between the MEC (which manages that part of the PROFIT programme concerned with the collaborative R&D and the generation of new knowledge) and the MITYC (which is responsible for the management of those parts of the PROFIT programme concerned with the application of knowledge and its commercial exploitation), with joint committees responsible for policy formulation and the design of implementation schemes. This governance structure is appropriate given the current state of development of Spain's innovation system, but may need to be revised in future if industrial innovation capacity increases in line with expectations (Guy and IPTS, 2006).

5.1.2 Profiting from access to international knowledge

One of the main components of the international scope of the Spanish R&D&I Plan 2004-2007 is the opening of the Spanish R&D&I Plan programmes to R&D groups from other countries. Measures will be implemented to foster progressive participation in the Spanish R&D&I Plan by R&D groups from European countries, accession candidate countries and other non-European Union countries, particularly those that have achieved greater scientific and technological development or which are a priority for Spain's foreign relations (ERAWATCH Research Inventory, 2007). The Spanish R&D&I Plan includes a national programme for international cooperation on S&T that aims to respond to the challenges of globalisation and the internationalisation of R&D. The specific objectives of this programme are to encourage the Spanish participation in international programmes and projects; to promote the mobility of researchers; to improve R&D training of researchers from developing countries; to promote the creation of multinational expert networks; to promote international networks of technological centres and scientific and technological parks; to stimulate the participation of companies in international programmes and consortia; to improve technological cooperation with other countries; to increase the dissemination of advances made by Spanish science; to coordinate R&D policies with foreign affairs policies; and to increase research in the areas of cooperation and development (IPTS, 2006). Within this programme, there are three modes of participation (European Trend Chart on Innovation, 2006):

- Complementary actions. These are an instrument intended to boost the participation of Spanish researchers in the international sphere. For this purpose, assistance is available with preparing proposals along with extra funding to run European and International projects.
- Integrated actions. These are one of the mechanisms of cooperation, in the Framework of previous agreements, trying to promote common bilateral agreements between a Spanish group and a foreign group. The funding formula consists of grants for participation in various events.
- Specialisation fellowships. These grants are oriented to the specialised training of researchers and technologist in certain high quality international organisations.

The CDTI, as already mentioned, is in charge of managing Spain's participation in international technological cooperation programmes (European Trend Chart on Innovation, 2006).

Spain also participates in IBEROEKA, EUREKA, EUROCORES (ESF Collaborative Research Programmes), COST and EMBL. It is a member of the European Science Foundation, EMBO, ESA, CERN, ESRF and ILL (IPTS, 2006). Spanish researchers can apply to government fellowships for the following international organisations and projects: ESA, EMBL, CERN, ESO, X-FEL and FAIR (IPTS, 2006).

Evidence from existing assessments on system performance and achievements is not directly available.

5.1.3 Enhancing the absorptive capacity of knowledge users

The main instrument to enhance SMEs' participation in R&D is the National Strategic Consortia for Technical Research (CENIT) Programme, created in 2005, which funds R&D projects involving cooperation between public and private entities and placements of PhDs with companies (Torres Quevedo Programme) (IPTS, 2006). CENIT Projects co-finance major public-private research activities and last for a

minimum of four years with an annual budget of at least €5 million. The private sector must provide a minimum of 50% co-financing and at least 50% of the share of public funding has to go to public research technology centres. The aim of these projects is to promote the creation of strong consortia of SMEs, big enterprises and public and private R&D centres for the development of long-term R&D strategies and projects (European Trend Chart on Innovation, 2006). The "Technological cooperation between SMEs and universities or public R&D centres" programme has been designed to give financial support to enterprises, especially SMEs, to carry out short and medium-term R&D and Innovation projects in collaboration with universities and other public R&D centres through credit-awarding entities (IPTS, 2006).

Almost a quarter of the working age population benefits from tertiary education in Spain as compared with a fifth in the EU-15 (Guy and IPTS, 2006). The percentage of science and engineering graduates in the 20-29 years age group in Spain in 2003 is equal to the number in the EU-15 (11.3% in 2003) (Guy and IPTS, 2006). Since 2001, in order to ensure the availability of a highly qualified labour force, the Torres Quevedo programme has been providing financial support for R&D personnel to join firms or technological centres to take part in R&D projects. The main objectives of this measure are to encourage demand from business for qualified personnel to launch R&D projects and to increase research capacity in companies and technology centres (Guy and IPTS, 2006). The number of R&D personnel in the private sector has doubled over the last decade, largely as a result of dedicated schemes to promote mobility from the public to the private sector (Guy and IPTS, 2006). In this way, the number of scientists and engineers as a percentage of total employment in 2006 was 5.2, close to the EU 27 average of 5.4 in the same year.

Some assessments have been conducted of system performance and achievements. According to Guy and IPTS (2006), even before many SMEs can contemplate R&D activities, one of the first tasks is to increase their absorptive capacity for technology, often via schemes designed to help them acquire in-house technical expertise (e.g. by hiring an engineer). The need for trained researchers will only arise later, when a research function has been established, but it will not arise at all if absorptive capacity remains low or non-existent. As regards the qualified labour force, for Guy and IPTS (2006), in spite of relatively highly educated human resources, there is a paradox in Spain which deserves to be highlighted. Many of the Spanish businesses with innovation activity surveyed tend to point to the 'lack of qualified personnel' as an extremely important obstacle. Only Germany has a significantly higher share of companies defining this point as crucial. For Spain, this indicator underscores the gap that exists for businesses between the available human resources and the technological needs in terms of human resources. Recent data already shows significant progress in some indicators and consequently justifies the policy. For example, the Torres Quevedo Programme helped to integrate 800 scientists and highly qualified researchers in private companies in 2005, which is three times the amount in 2003. The success of the programme led to a 40% increase in its annual budget (European Trend Chart on Innovation, 2006).

5.2 Analysis of recent changes and policies

The Human Capital Programme complements INGENIO 2010 in the area of lifelong learning and the Information Society with measures for continuing education and training such as a new system of professional training for employment, which began in January 2006. The reform is designed to encourage and extend training of employers and employees, promote the development of Company Training Plans,

create a bonus system for the training quota of companies providing training to their employees, give incentives for individual training leave and encourage the establishment of National Reference Centres specialising in different productive sectors, and running experimental and innovative training activities in the field of professional training for employment. The programme also plans to set up a network of Integrated Professional Training Centres to integrate the professional training offered, thus ensuring widespread access to continuing education (European Trend Chart on Innovation, 2006).

According to the OECD (2006), following the presentation of the COSEP report (see section 3.1.3), a new programme was created in July 2006: an Activation Plan for the 7th Framework Programme with the goal of achieving an 8% return, equivalent to Spain's economic weight within the European Union. The Plan will have four specific programmes covering public research centres, technology centres, companies, and hospitals, with a budget of approximately €16 million in 2007.

If we were to mention some blocking mechanisms, Spanish companies show a lack of R&D activities but not a structural inability or inefficiency in terms of innovative activities. Hence, the Spanish Government has put the emphasis on reinforcing the science-industry linkages. In view of the strong presence of SMEs, no such programme should neglect the possibility to involve SMEs. In this respect, some recommendations on SMEs and research should be considered within the present revision of the Spanish R&D&I Plan. Two important points to bear in mind, as far as public support to private R&D is concerned, are the following (Guy and IPTS, 2006):

- How well are SMEs informed about the public support they can receive to launch or increase their R&D activities?
- To what extent are projects evaluated and modified in order to increase their efficiency?

5.3 Assessment of knowledge circulation

The main strengths and weaknesses of the Spanish research system in terms of knowledge circulation can be summarised as follows:

Strengths	Weaknesses
<ul style="list-style-type: none"> • Good supply of institutions and existence of long-standing programmes to promote links between the public research system and industry • Wide range of modalities for participation in international projects 	<ul style="list-style-type: none"> • Governance structure of science-innovation links at early stage, due to the split in responsibilities between two ministries • Gap for private companies between the available human resources and the technological needs in terms of human resources, hampering absorptive capacity

The main opportunities and threats for knowledge circulation in Spain arising from recent policy responses and in the light of the Lisbon Strategy can be summarised as follows:

Opportunities	Threats
<ul style="list-style-type: none"> • Grants and tax deductions to increase human capital in companies 	<ul style="list-style-type: none"> • Possible lack of information of SMEs about their opportunities

Chapter 6. Overall assessment and conclusion

6.1 Strengths and weaknesses of research system and governance

The analysis has shown that Spain has a well developed and relatively smooth functioning research system. In most of the main domains the system has strong responses to the domain challenges (see also the summaries in the table below).

Domain	Challenge	Assessment of system strengths and weaknesses
Resource mobilisation	Securing long-term investment in research	Considerable efforts to program long-term financing for research and participate in European funding and shared infrastructure facilities
	Dealing with barriers to private R&D investment	Advanced tax incentives for R&D to reduce barriers to private R&D investment but: (i) the industrial structure, which is mainly composed of SMEs in traditional sectors and only a small number of high tech firms, is a barrier to private R&D spending; (ii) lack of venture capital is another barrier to private R&D funding
	Providing qualified human resources	Satisfactory evolution of the number of people with university degree but brain drain of young PhDs to other countries due to limited ability to absorb them; increasing participation of woman in science but under-representation of women in senior positions and in the private sector
	Justifying resource provision for research activities	Legitimacy of devoting public resources to R&D, not under debate
Knowledge demand	Identifying the drivers of knowledge demand	Existence of institutions to bring together players from the scientific, technological and entrepreneurial spheres to conduct prospective and monitoring activities
	Channelling knowledge demands	Impressive coordination of policy efforts in R&D to channel knowledge demand but scant priority setting in the support to public science, even running counter the priority setting of the European Framework Programme
	Monitoring demand fulfilment	Existence of institutions to assess progress and evaluate R&D programmes, actions, centres, teams and projects, but access to some of their data and design of some indicators are underdeveloped
Knowledge production	Ensuring quality and excellence of knowledge production	Focus on research stemming out of mono-disciplinarity, fragmentation of research groups and short-term projects, not leading to excellence
	Ensuring exploitability of knowledge	Ineffective use of the existing tools to increase R&D activities in companies, endangering the exploitability of knowledge
Knowledge circulation	Facilitating circulation between university, public research and business sectors	Good supply of institutions and existence of long-standing programmes to promote links between the public research system and industry but governance structure of science-innovation links at early stage, due to the split in responsibilities between two ministries
	Profiting from international knowledge	Wide range of modalities for participation in international projects
	Enhancing the absorptive capacity of knowledge users	Gap for private companies between the available human resources and the technological needs in terms of human resources, hampering absorptive capacity

However, one concern relates to problems of co-ordination across domains: knowledge production does not present any particular strength whereas knowledge circulation is strong to face most challenges, given the good supply of institutions and existence of long-standing programmes to promote links between public research

system and industry. Remaining problems here relate to limited absorptive capacity of firms. Therefore, a shift of emphasis of research policy from knowledge circulation to production seems justified. Knowledge production in the public sector, weakened by the lack of multi-disciplinarity and the focus on short-term projects, is coherent with a strategy of adaptation to the low-tech economic profile that may lead to practical applications and enable Spain to catch up with its neighbours, but not to achieve a position of leadership.

The coordination problem is reinforced by the division of responsibilities on science and technology between two ministries and the inexistence of an integrated ministry. Although resulting in increased resources, the current stress on separating education and science from industrial issues is ineffective at striking a balance between knowledge production and circulation.

6.2 Policy dynamics, opportunities and threats from the perspective of the Lisbon agenda

The table below summarises the main opportunities and threats relating to recent policy dynamics.

Domain	Main policy-related opportunities	Main policy-related threats
Resource mobilisation	<ul style="list-style-type: none"> • Ambitious reform programme in line with the Lisbon objectives to increase budget allocations to R&D • Public R&D supported by increasing R&D related-EU Structural Funds • Increased credit facilities for innovative activities at SMEs 	<ul style="list-style-type: none"> • Public R&D declining down due to drop in relative level of EU Funds received from the Framework Programme
Knowledge demand	<ul style="list-style-type: none"> • Attempt to meet demand for funding of large projects through simplified procedures • Active procurement to help reduce information and communication technology gaps 	<ul style="list-style-type: none"> • Little priority setting according to the industrial structure and specialisation
Knowledge production	<ul style="list-style-type: none"> • A specific programme to raise critical mass and research excellence (CONSOLIDER) 	<ul style="list-style-type: none"> • Limited involvement of international experts in the new measures for the evaluation of projects in national programmes
Knowledge circulation	<ul style="list-style-type: none"> • Grants and tax deductions to increase human capital in companies 	<ul style="list-style-type: none"> • Possible lack of information of SMEs about their opportunities

It shows that responding to the main policy priorities of the Lisbon Strategy has created many opportunities, such as improved framework conditions, increased public R&D spending, more public-private partnerships, incentives for private R&D, management of PROs, qualification of researchers, etc.

There is something of a lack of originality in the approach, however, as industry's structure and specialisation are scarcely taken into account in priority setting. Going through the table, one may notice that, with exceptions, the current opportunities involve indiscriminate measures for the whole spectrum of firms, more funding through grants and credits and no act on the public awareness of the importance of science and technology. A more tailored interpretation of the Lisbon Strategy would place the accent on SMEs, rely less on tax incentives, and seek to bring about broader cultural changes.

References

- ERAWATCH Network, 2006. ERAWATCH Country Specialisation Report. Seville: Institute for Prospective Technological Studies;
<http://cordis.europa.eu/erawatch/index.cfm?fuseaction=home.downloadFile&fileID=252>
- ERAWATCH Research Inventory, 2007. *Spain*. In: <http://cordis.europa.eu/erawatch/>
- ERAWATCH Research Inventory, 2008. *Spain*. In: <http://cordis.europa.eu/erawatch/>
- European Trend Chart on Innovation, 2006. *Annual Innovation Policy Trends and Appraisal Report – Spain*. Brussels: European Commission Enterprise Directorate-General.
http://trendchart.cordis.lu/reports/documents/Country_Report_Spain_2006.pdf
- FECYT, 2007. In: http://www.fecyt.es/default.cfm?id_seccion=7578&id_sec=1585&nivel=1
- Fundación GENOMA 2007. *Relevancia de la biotecnología en España 2007*. Madrid: Genoma España.
- Guy, K. and IPTS, 2006. *Policy Mix Peer Reviews - Country Report: Spain - Second Cycle of the Open Method of Coordination for the Implementation of the 3% Action Plan*. Seville: Institute for Prospective Technological Studies.
- IPTS, 2006. *ERAWATCH country related information working paper in view of the National Reform Programmes – Country: SPAIN*. Seville: Institute for Prospective Technological Studies.
- OECD, 2006. *The Policy Mix for Research, Development and Innovation in Spain – Key Issues and Policy Recommendations*. Paris: Organisation for Economic Co-operation and Development.
- Sebastián, J. and E. Muñoz, eds., 2006. *Radiografía de la Investigación Pública en España*. Madrid: Biblioteca Nueva.
- Tecnociencia, 2007. 'Grandes Instalaciones'. In: http://www.tecnociencia.es/fecyt/public/ciencia_tecno/subsecciones/tipologias/tcnciencia_tecno_ginstalaciones.html

Abbreviations

- ANEP: National Evaluation and Foresight Agency
CAS-CICYT: Support and Follow-Up Unit of the CICYT
CDTI: Centre for the Development of Industrial Technology
CEEI: European Business Innovation Centre
CENIT: National Strategic Consortia for Technical Research
CERN: European Organization for Nuclear Research
CES: Economic Social Council
CICYT: Inter-ministerial Commission on Science and Technology
CNEAI: National Evaluation Commission of Research Activities
COSEP: Commission for Monitoring and Evaluating the Spanish R&D&I Plan
COST: European Cooperation in the field of Scientific and Technical Research
CRUE: Conference of Spanish Universities' Chancellors

CSIC: Spanish National Research Council
EMBL: European Molecular Biology Laboratory
EMBO: European Molecular Biology Organization
ENCYT: National Strategy for Science and Technology
ENISA: Spanish National Innovation Enterprise
ESA: European Space Agency
ESF: European Science Foundation
ESRF: European Synchrotron Radiation Facility
ESFRI: European Strategic Forum on Research Infrastructures
ESO: European Organisation for Astronomical Research
FECYT: Spanish Foundation for Science and Technology
FAIR: Facility for Antiproton and Ion Research
GRECYT: Reflection Group of the National Strategy for Science and Technology
ICO: Official Credit Institute
ILL: Institut Laue-Langevin
IRC: Innovation Relay Centre
ITER: International Thermonuclear Experimental Reactor
MEC: Ministry of Education and Science
MITYC: Ministry of Industry, Tourism and Trade
NRP: National Reform Plan
OTRI/OTT: Industrial Liaison Offices and Technology Transfer Offices
PETRI: Transfer of Research Results Support Programme
PRO: Public Research Organisation
PROFIT: Technical Research Support Programme
SISE: Integrated Monitoring and Evaluation System

European Commission

EUR 23389 EN/4 – Joint Research Centre – Institute for Prospective Technological Studies

Directorate General Research

Title: ERAWATCH Analytical Country Report 2007: Spain

Author: Joaquín M. Azagra-Caro

Luxembourg: Office for Official Publications of the European Communities

2008

EUR – Scientific and Technical Research series – ISSN 1018-5593

Abstract

The main objective of ERAWATCH analytical country reports is to characterise and assess the performance of national research systems and related policies in a structured manner that is comparable across countries. The reports support the mutual learning process and the monitoring of Member States efforts by DG Research in the context of the Lisbon Strategy. In order to do so, the system analysis focuses on key processes relevant for system performance. Four policy-relevant domains of the research system are distinguished, namely resource mobilisation, knowledge demand, knowledge production and knowledge circulation. This analytical approach has been tested in 2007 by applying it to six countries, one of which is Spain. The report is based on a synthesis of information from the ERAWATCH Research Inventory and other important available information sources.

How to obtain EU publications

Our priced publications are available from EU Bookshop (<http://bookshop.europa.eu>), where you can place an order with the sales agent of your choice.

The Publications Office has a worldwide network of sales agents. You can obtain their contact details by sending a fax to (352) 29 29-42758.



Publications Office

Publications.eu.int