Confederación de Sociedades Científicas de España (COSCE)

Acción CRECE

Comisiones de Reflexión y Estudio de la Ciencia en España
(Proposal by the Scientific Community to boost Science in Spain)

Spain in Europe

Summary

The countries of the European Union, which Spain joined in 1986, have created a system of collective institutions and mechanisms of action that make it impossible to consider the Spanish reality without putting it into a European context. One of the areas in which the dynamics of European integration is clear is that comprising research policies, technological development, and innovation.

The European Union has recently moved various aspects of research and technological development (R+TD) and innovation further up its action agenda. For example, the idea of a European Research Area is one of the priorities of the EU political agenda. This serves the *Lisbon Competitiveness Strategy and the Barcelona Objectives for Investment in R+D+I.* Research, technological development, and space are fundamental aspects of the EU's internal policies in the *Treaty Establishing a Constitution for Europe*. To this should be added the European Commission's proposal for the *Seventh Framework Programme for Research and Technological Development (2007–2013).*

Within the framework of the European Research Area, the EU member states recently unanimously declared themselves in favour of supporting basic research. The European Commission has given this course of action visibility, budgetary treatment, and specific management in its proposal to create a *European Research Council (ERC)* within the Seventh Framework Programme. The programme itself highlights the need to pay greater attention to high-quality basic research. Around 10% of the programme's total budget will be allocated to basic research, and managed independently.

In the European context, Spain should become a key player in R+D aspects of the integration process. This would help Spain's specific characteristics to be taken into account.

Moreover, Spain's national R+D policies should also be placed into this European context. They would then be strengthened, coordinated, and integrated, instead of moving in a different direction –as often occurs. The role of companies is also crucial, but they have serious shortfalls and therefore require the most attention.

Proposals

General proposals

- Spain is no longer one of the member states with the lowest per capita salaries. As a result, the level of competitiveness needed to successfully face challenges arising in the international market should be based mainly on its capacity to *create, adapt, and apply knowledge*. Consequently, other essential factors are: a good education, excellent scientific research, innovative technological development, an enterprising industrial sector, and investment capital that is used more than revenue.

• The implementation of the Bologna process in universities will be of fundamental importance to European integration. Spain should make good use of this opportunity to readapt university structures so that they can contribute appropriately to increasing R+D development.

• Spain should endeavour to become a key player in the development of the European integration process in the R+D field. To achieve this, it should develop an active European R+D strategy. In addition, national and regional R+D policies should be put into a European context, so that they can be strengthened, coordinated, and integrated.

• The main European arena for *transnational research* has been defined by the Seventh Framework Programme. Therefore, funding agencies, Spain's research organisations, and officials and agencies responsible for scientific and technological policy need to immediately adopt measures that enable active and effective *participation in the formal decision-making processes* of *European institutions* in a way that makes use of the country's expert knowledge. Measures should also give *organisational, technical, and financial support to those research groups and innovative companies* that could participate in future European Union R+D initiatives.

• A legislative, organisational, and normative framework is needed to successfully develop a policy regarding international, cooperative scientific research, technological development, and industrial innovation. This framework would help the system's administration to become specialised, dynamic, flexible, and independent, and ensure that actions are coordinated.

Specific proposals

• A 25% increase in the average annual real investment in scientific research and civil technological development in Spain (see Chaps. 1-7) is needed over the next 4 years, if the country's R+D+I commitment is to converge with that of other European countries and approach the Barcelona objective of 3% of GDP. The proposal to double the Framework Programme's budget is an excellent opportunity for Spanish science and technology. To make effective use of it, Spanish budgets should be increased simultaneously and their management structure reformed.

• The best way to attain sufficient quality and quantity of human resources, and to counteract the negative effects of mobility, is to increase funding and researchers' social prestige. This can be achieved by raising public awareness of a career in research and improving working conditions for researchers. Spain should support the *European Charter for Researchers* and the *Code of Conduct for the recruitment of researchers*. The latter document presents a series of recommendations, including:

– Recognise the research profession at the postgraduate level.
– Establish a clear framework for the professional and personal career of scientific researchers and technologists.
– Favour the mobility of research staff' between universities and research organisations.

– Provide lifelong learning opportunities for researchers.
– Establish stable and transparent methods– in the public service or not– for recruiting trained researchers into the system, according to their merits and abilities.
– Develop training programmes for techniques that support research.

• Adopt measures, along the lines of a Commission initiative, aimed at creating a *virtual community*. This would aid in the development of mutually beneficial initiatives for transnational scientific cooperation between the community's different groups and organisations. At the same time it would keep the knowledge assets and scientific reference resources of excellent Spanish researchers, in Spain and abroad, active.

• Optimise use of large-scale research infrastructures in which Spain participates by strengthening related thematic areas.

• Business competitiveness has to be increased to strengthen Spain's role in an emerging Europe and to further its population's social well-being. The following elements, among others, are needed to achieve this. Each is complementary to transnational collaborative research:

– Design an incentive system to increase the participation in European programmes of large companies that have technological capacity and connections with SMEs.
– Promote the creation of science and technology parks and participation in scientific *euroregions* (geographic groups).
– Introduce a policy for research infrastructures that is consistent with the following economies of scale: international, European, and that of the member states.
– Establish effective and complementary European and national programmes to support SMEs.
– Create synergies with other European initiatives, such as EUREKA, COST, European Science Foundation (ESF), and other science federations and associations (EIROFORUM, FEBS, EACS, etc.).

• The EU has established a fund of 2bn per year to support basic research in all disciplines. This provides an opportunity to reduce brain drain and increase the competitiveness of a knowledge-based economy. Spain should make maximum use of this fund.

• The instruments for participation proposed in the Seventh Framework Programme are not excessively different than existing ones. However, they do aim to strengthen the major scientific networks and industrial technology platforms. Small research groups and a limited number of Spanish innovative companies will participate in this seventh programme, taking on a more significant role of scientific, technical, and organisational leadership than in the current programme. These groups and companies should be provided with appropriate administrative, legal, and financial support.

• *Technology platforms* are set up under the leadership of industry. Their aim is: to define the medium and long-term research agendas of industry, increase investment in industrial R+D, and gear the activity of publicly funded

applied-research towards business priorities. Spain should be represented on all the technology platforms, with authority and decision-making capacity. It should be able to lead some of the platforms (or some work areas) and make use of the definition process to launch national technology platforms that have appropriate funding and the participation of the public and private systems.

• Management instruments are needed to initiate actions for strengthening regional presence (in the Seventh Framework Programme proposal this is known as *regions of knowledge*).

• A *system for assessing and monitoring science* should be set up to analyse the presence of Spanish universities, research groups, and companies in European R+D programmes and actions, and to assess the results obtained and their impact on the Spanish system.

• Support the creation of scientific and technological reference and/or advisory bodies that would give Spain a more active and effective presence in the international field, particularly in Europe.

• The government's ministries, regional governments, and research funding agencies should be coordinated to improve the integration of R+D efforts. This would improve the European presence of Spanish research groups and companies and help obtain results. Such coordination is even more important in the case of technological innovation, as EU structural funds are used and the regional governments have increased their jurisdiction in this area.

• Supporting action is needed to help promote the participation of Spanish groups in international programmes, particularly in the EU's Framework Programme. This action would be aimed at training researchers in aspects of project management. It would also make some management units available to universities and research organisations, to provide them with the services they need. Other, complementary actions would be:

– Encourage the preparation of proposals by providing direct aid to groups or management units (if such units are created).
– Award additional aid to approved projects to cover expenses related to: protecting and exploiting results, OEPM (the Spanish Patent and Trademark Office) state of the art searches, costs of registering patents in Spain when they are not covered by the Framework Programme, actions fostering the creation of industrial prototypes with the collaboration of a Spanish company, drawing up business plans to create technology-based companies, etc.
– Encourage the approval of new mechanisms and procedures in the EU for administering and managing resources allocated to promoting research in all disciplines. These would avoid the excessively bureaucratic systems that are currently in use.

Introduction

During the last 15 years, an extremely significant, rapid process of political, economic, and social changes has taken place in Europe. The old Soviet Union disappeared and the majority of its members have joined the Atlantic Alliance and the European Union. The single market and single currency were established successfully and economic migration has occurred. In the last 5 years alone, the number of immigrants has risen to over 5% of the Spanish population.

At the same time, large industrial and financial groups have formed, such as: Daimler Benz-Chrysler, BMW-Rolls Royce, Sandoz-Ciba Geigy-Aventis, Rohne-Poulenc-Hoetcht, or the banks Bilbao-Vizcaya-Argentaria (BBVA) and Santander-Central-Hispano (BSCH). In addition, ambitious projects involving scientific and technological coordination, have been initiated, for example: the Large Hadron Collider, human genome sequencing, ALMA, ITER, Ariane V, the European module of the international space station, EADS, and Galileo. Finally, the treaty establishing a Constitution for Europe has been adopted, and the ratification process has started in the member states. Research, technological development, and space form part of the EU's internal policies in the Constitution.[1]

These examples show that it is essential to encourage the convergence of resources and activities from different sources to attain common objectives. The great importance of such objectives goes beyond the available resources of one political or institutional body alone. In this respect, the EU has recently moved various aspects of research and technological development (R+TD) and innovation further up its action agenda. For example, the idea of a European Research Area places science, technology, and innovation at the top of the political agenda of the EU's member countries. [2]

To this should be added the European Commission's proposal for the *Seventh Framework Programme for Research and Technological Development (2007–2013).*[3] In the next decade, this will influence programme contents, priority lines of research, and modes of action for research initiatives in member countries, scientific and technological institutions, and business. The Programme's budget is doubled in this proposal; its period of validity is extended to 7 years; and some management changes are introduced. Moreover, the proposal strengthens several *support actions for: excellent research, training and mobility of researchers, research infrastructures, and company research.*

In the past, the Spanish government considered the Framework Programme to be a supplementary mechanism for funding national R+D, in which the indicator par excellence was "financial returns". This view of European research policy traditionally relegated Spain to a secondary role in shaping and designing the Programme. In contrast, Spain has played a more decisive role on a European scale in other policies, such as those for

cohesion or structural funds. Despite Spain's involvement in the Framework Programme and other multilateral cooperation mechanisms, the inherent internationalisation and europeanisation of R+D has not been a significant factor in Spanish R+D policy. It has not guided either national policy or policy in the majority of the regional governments . In general, project funding, training, and human resources policies have lacked even the slightest perspective of internationalisation and European integration.

Therefore, it is time for Spain to become a key player in the R+D aspects of the European integration process. This would help Spain's specific characteristics to be recognised. Spain's national R+D policies should also be put into this European context– allowing them to be strengthened, coordinated, and integrated, instead of moving in a different direction, as has often occurred.

Spain needs to participate more actively in designing the EU's scientific and technological policies –and those of other R+D organisations and institutions. This participation should be on a par with the involvement of numerous Spanish research groups and companies in over 30% of the R+D projects approved by the V Framework Programme. As a result of this involvement, networks of multilateral and bilateral scientific and technological relations have been formed that have strengthened domestic efforts.

Investment in research and technological development in advanced countries in no longer merely a superficial part of the budget. However, the EU's Sixth Framework Programme[4] allocates almost €5000 million per year to R+TD. This represents only 6% of the member states' total investment in these policies. Both the authorities and the broader society are demanding –with increasing determination and urgency– to know exactly how these investments contribute to resolving economic, social, and labour-related problems.
Science and technology constantly influence the daily life of the population; hence, citizens should be informed about research advances.[5] In this respect, the Treaty on European Union calls for wide consultation on all areas of the Union's activity, in a clear, constant dialogue that is open to civil associations.[6]

Knowledge

Scientific research, technological development, industrial innovation, academic education, and professional training lead to the development of new ways of thinking, working, and living. These factors also determine the population's capacity for social participation.

Knowledge is the basis of the actions that constitute most of the new markets and public policies in strategic sectors, such as health, telecommunications, transport, the environment, and natural and technological disaster impact reduction.

Now that Spain is no longer one of the European countries with the lowest salaries, and given its lack of natural resources, the basis of its competitiveness lies mainly in its ability to create, adapt, and apply new knowledge. Therefore it also stems from a quality education, excellent scientific research, innovative technological development, an enterprising industrial sector, and capital that is geared to investment rather than to obtaining short-term profits. Efforts must thus be made to: bring national R+D+I investment closer to the Lisbon target,[7] improve the effectiveness of public spending, establish more and better incentives of business innovation. In addition, the number of young researchers and the quality of their

training must be increased, while improving their motivation and permanent recruitment into the R+D+I system, particularly in the private sector.
In this respect, the investiture speech of the Spanish President of the Government, held on 15 April 2004, was encouraging. He committed the government to centring its activity on improving economic development supported by education, research, and innovation. This is one of the government's five main focuses of action. To attain this objective, the President announced a 25% increase in the annul budget for these items, which "signifies, definitively, putting science at the centre of our priorities". In the Chamber of Deputies, on 6 April, 2005, the President reiterated that there would be an "immediate increase" of R+D in Spain and Europe.

However, to achieve these objectives, there must be an immediate increase in efforts aimed at adapting the organisational structure, size, production capacity, and application of research results, technological development, and innovation to Spain's economic, social, and cultural reality.

Scientific research and technological development are essential to improving the living and working conditions of the population, contributing to their social and economic well-being, and increasing business competitiveness. To achieve this, the following aspects need to be promoted:

- High-quality research at all levels. The Bologna process could become a blueprint for making necessary changes in higher education so that it becomes more competitive.
- Excellent basic research and a high level of creativity.
- An attractive work environment and promising career prospects for the best researchers.
- A policy for research infrastructures that is consistent with the different economies of scale: international, European, national, and regional.
- Effective and complementary European and national programmes to support innovative SMEs; synergies with other European initiatives, such as EUREKA, COST, the European Science Foundation (ESF), and with other science federations and associations (EIROFORUM, FEBS, etc.).

Cooperation

In recent decades, stable links between different organisations –the basis for building relational social capital– have been considered to form a fundamental source of strategic and operational enrichment for the parties involved. This has led to the recognition that technological and other knowledge is generated by a process of sharing. Self-sufficiency has been shown to be an inefficient strategy of action in the present globalised and extremely dynamic environment.

While this principle is applicable to all organisations, it acquires fundamental value as a guiding strategic principle in organisations associated with knowledge generation and transfer. The idea is not just to generate and transfer knowledge to another institute. Instead, organisations must be able to share information, supporting each participant's specialisation to improve the overall efficacy and efficiency of their actions.

In this context, international cooperation in research and technological development is closely related to the wider trend of internationalisation

of the science and technology systems of developed countries. Both public and private institutions understand the importance of a global strategy, and this has profoundly changed the conduct of all involved (see the box: "Types of international cooperation"). A global strategy both predates and has been accelerated by globalisation.

Types of international cooperation

The problems arising in today's' advanced societies are highly complex and of enormous importance. Similarly, undertaking scientific and technological projects requires: major economic resources, significant scientific facilities and infrastructure, combined knowledge with a high level of excellence in a wide variety of disciplines, and a dynamic, flexible, and efficient management and organisational capacity.
International cooperation is required in many cases; however, regardless of its level of development, a country cannot undertake such projects alone. The following are some examples of cooperation:

a) Large scientific projects and technological infrastructures that mainly serve what is known as "big science": ITER, CERN, Institut Laue-Langevin, ESRF, the ESO's ALMA project, X-FEL (free-electron lasers), and the European Southern Observatory.

b) Alliances between large industrial corporations– some with public participation– such as: EADS, ESA, and Galileo.

c) The chemical and pharmaceutical industries, such as ZENECA, AVENTIS, BAYER, and NOVARTIS, have undertaken cooperation in basic physical chemistry and biotechnology: . Such collaboration could take place in the near future also in the field of information and communication technology, when silicon is replaced by nano or bio-system technology.

d) Extensive networks of SMEs and networks connecting these with large companies and research organisations to generate shared knowledge.

e) The integration of economic and intellectual resources in interdisciplinary and emerging areas: nanoscience and nanotechnology, genomics, among others.

f) International collaboration between multidisciplinary research groups to advance knowledge and find solutions for problems that have a social impact: climate change, biodiversity conservation, bovine spongiform encephalopathy (BSE), genetically modified food (GMO), antenna radiation, etc.

g) *Programa Iberoamericano de Ciencia y Tecnología para el Desarrollo*, CYTED (the Ibero-American programme for the development of science and technology).

In the Spanish public system, the number of papers by Spanish researchers that were published in international journals or at conferences has increased. Specifically, international collaborations rose from 29.57% in 1988 to 33.68% in 2002.[8]

A brief analysis reveals that co-authorship rates (by scientific field) have increased significantly in recent years. Although patterns vary in the different specialities, this is a general trend.

From another perspective, a study of trends in different types of collaboration highlights the various scientific communication norms used by researchers. A high proportion of papers in the Spanish science system are still produced with no collaboration whatsoever. Collaboration would be particularly useful in the less-developed regional governments, where it could be supported by those communities with more significant development and more consolidated systems.

In terms of the *private system,* many Spanish companies have globalised their marketing networks and/or the supply of components for their products or processes. They have done this by reaching agreements with companies located in other countries and by extending their own network of offices. However, there has been considerably less participation in international networks for knowledge generation. Obviously, globalisa-

tion has affected multinational companies based in Spain, but SMEs have been affected to a much lesser extent.

From a historical perspective, public and private participation in existing European R+D programmes –those of the EU (R+D Framework Programme) and other organisations (such as ESA)– has helped catalyse international cooperation. This could be considered to be very positive for the Spanish research and technology system. In addition, some of these programmes require the joint participation of public and private institutions (the concept of a "consortium" is commonly used). This has fostered an increase in mutual R+D knowledge and better cooperation between these institutions.

Paradoxically, existing national policy instruments have not facilitated this process. The problems encountered in setting up mechanisms like the ERA-NET scheme, which was accepted and promoted by the Spanish government, demonstrate the practical difficulties. It is also very difficult to fund international industrial programmes, such as EUREKA, through national programmes (like PROFT) when there is collaboration with public institutions. This situation is seriously aggravated by inadequate distribution of the research and technological development budget between the Ministry of Education and Science and the Ministry of Industry, Trade, and Tourism.

The objective of creating a true European Research Area is still far from being fulfilled. However, it is essential to contribute fully to this goal by eliminating barriers to mobility, so that projects can be carried out with funding flows that cross borders. This would facilitate the recruitment of researchers from other countries into Spain. Germany and the United Kingdom have agreed on a specific, bilateral implementation of the "money follows people" principle for projects that are already funded in their respective countries. If Spain does not follow suit, it will lose a historic opportunity and run the risk that others will do the same, leaving the ERA highly fragmented.

Even so, the Spanish science and technology system is gradually losing the strong self-sufficient character it has maintained for too many decades. It is becoming involved in the process of opening-up, promoting cooperation with other countries, and embarking on a path of growth through knowledge. However, there is still some inflexibility in R+D administration and management that hinders internationalisation and cooperation with other countries, both of which are essential to maintaining Spain on a path of steady growth. In this respect, and notwithstanding the differences, examples provided by the EU member countries Ireland and Finland should be considered.

Likewise, by virtue of the Spanish process of political decentralisation, mechanisms also need to be established that will ensure the required degree of coordination between regional, national, and international R+D+I plans.

An international dimension has become indispensable to scientific, technological, and industrial development. At the same time, another fundamental factor for growth involves interactions between innovative companies, universities, research laboratories, and local and regional development agencies in close *geographic proximity*. These have become known as "regional innovation clusters". Regional approaches to R+D are responsible for: determining the region's capacities for research; maintaining and generating scientific, technological, and specialised infrastructures; strengthening links with industrial development areas, science and technology parks;

supporting groups and centres of excellence; and promoting training and mobility of researchers.[9]

Regional R+D and industrial innovation policies are more efficient when they are formulated and developed in coordination with interregional, state, and international policies, i.e. when the maxim *think globally, act locally* applies.

This leads to the successful coordination of R+D programmes through cooperation, occurring in the framework of federal-type planning. It also brings about the identification of "variable geometry" actions, the opening up of regional programmes, and the participation of organisations and institutions from other regions, in a search for the scientific excellence needed to resolve problems arising in each region.

Salvador Barberá's article, "El futuro del sistema nacional de ciencia y tecnología" (The future of the national science and technology system), published in *Boletín SEBBM* (2004; 142: 5-12), gave an excellent update on such important topics as: human resources, infrastructures, project funding, and funding agencies. It also discussed the relation between the state, the regional governments, and the scientific community.

The international dimension of actions in science and technology is closely linked to the programmes, priorities, ways of participating, and funding instruments for initiatives developed within the framework of national R+D+I policy. Therefore, the greater the consistency between the Spanish and international frameworks of action, the more effective the development of synergies and the integration of Spanish R+D with that of its European partners.

Individual regions tend to play increasingly important roles in research and innovation activity. They benefit from European and national resources that enable them to set up a series of alternatives and plans for interregional cooperation and to form different types of networks.

Scientific cooperation in the European Union

In a meeting on 24 November 2004, the EU's Competitiveness Council (Internal Market, Industry, and Research), with the support of the Spanish delegation, recognised the key role of national actions in achieving the Lisbon objectives. It also stressed the importance of member states' commitment to advance and carry out this process in the best way possible, with a view to attaining the Barcelona objective of raising internal investment in R+D to 3% of GDP by 2010. Two-thirds of this investment is to come from the private sector.

Five years on from the Lisbon strategy, European institutions confirmed that the entire Union, and its member states individually, have encountered difficulties in putting this strategy into practice. There have been changes in policy and in the economies of the member countries. These measures call for some changes in direction, such as creating a European institute of technology, and developing guidelines for state aid to stimulate companies, innovation, and research.[10] The main EU instrument for building a European Research Area (ERA) is the Framework Programme. Related actions involve setting in motion mechanisms to progressively open up national programmes, and processes of mutual learning associated with the "open method of coordination" (OMC). Member states are responsible for the OMC, although its impact is still very limited. In this respect, it should be taken into account that the Framework Programme accounts for only 5% of the total resources used in the different states.

An examination of the Spanish response to the ambitious Barcelona objective reveals a stark reality. Modest Spanish domestic spending on R+D has increased slightly, from 0.98% of GDP in 2001 to 1.1% in 2003. In parallel, Spain's ability to contribute to the EU budget –which funds the Framework Programmes for scientific research and technological development– has been increasing, as shown in Tables 1 and 2. This leads to the paradoxical situation that Spain is a net beneficiary of the EC budgets, but a contributor to the proportional part of the funds destined for R+D policies. That is, whilst the Spanish contribution to the EU budgets between 1999 and 2002 (a period coinciding with the duration of the Fifth Framework Programme) reached an average of 7.9%, funds returned for scientific research and technological development activities were less than 6.2%.

Of course, the Spanish balance of payments with the EU is positive, due to returns from agricultural, structural, and cohesion policies, among other factors. However, this argument should not satisfy Spain, given the greater ability of R+D to revitalise and strengthen culture, education, quality of life, working conditions, the economy, and industry. Moreover, as mentioned above, this situation will change rapidly with the entry of new

Table 1. Spanish contribution to the European Union's international budgets

	Execution 1999		Execution 2000		Execution 2001		Execution 2002	
	Amount	%	Amount	%	Amount	%	Amount	%
Germany	21,069.0	25.5	21,774.9	24.8	19,727.2	24.4	17,582.2	22.6
Spain	6,231.3	7.6	6,445.4	7.3	6,591.5	8.2	6,551.2	8.4
France	13,993.8	17.0	14,510.9	16.5	14,471.3	17.9	14,152.3	18.2
Italy	10,765.8	13.0	10,999.9	12.5	11,612.5	14.4	11,279.5	14.5
United Kingdom	11,081.5	13.4	13,857.0	15.8	7,743.4	9.6	10,152.8	13.1
...	...	...	...	...	...	...	...	...
TOTAL	82,530.8	100.0	87,959.1	100.0	80,718.1	100.0	77,698.0	100.0

Table 2. Spanish contribution to multilateral European programmes 2002*

	Percentage of participation	Contribution m Euros
European Space Agency (ESA)	4.9	117.2
European Organisation for Nuclear Research (CERN)	6.9	45.7
European Molecular Biology Laboratory (EMBL)	6.7	4.0
Institut M. V. Laue-Paul Langevin (ILL)	3.0	2.6
European Synchrotron Radiation Facility (ESRF)	4.0	2.5
European Molecular Biology Conference (EMBC)	6.5	0.7
Gran-Sasso neutrino experiment (CERN)	-	0.7
European Science Foundation (ESF)	6.1	0.4
TOTAL		173.8

Source MCYT: I+D+I activities report 2002. Different Spanish companies participate in industrial and technological developments in fields such as: civil engineering, structures, instrumentation, antennae, electronics, software, etc.

* One of the key aspects for European research policy for the period 2007-2013 will be the significant increase in funds allocated to European Union R+D, as recommended by the European Commission - from a total of €17,500m in the Sixth Framework Programme to €10,000m annually. This proposal is quite far removed from what the major countries seem willing to support.

member states and future financial redistributions.[11]

This has become increasingly obvious as the objectives and the structure of the Framework Programmes have become oriented towards concentrating available resources on a few lines of industrial research. In some cases, a policy of subsidising specific industrial sectors has emerged (e.g. aeronautics, information technology, and bio-health).

The Framework Programmes have not been directed towards stimulating the development of a European production sector, which would comprise 98% of SMEs –that is, the enterprises that are the largest generators of employment, particularly in Spain. Likewise, the public system's participation is heavily concentrated on a small number of institutions and regional governments.

Generally, the role of Spanish groups/companies is to act as suppliers of knowledge. They have

limited capacity to access most of the knowledge generated in the consortium, and even less ability to transform it into useful innovations.

Nevertheless, the Spanish research and productive system has obtained many benefits since1986, when it began participation in the EU Framework Programmes for Research and Development. Significant funds have been received –amounting to almost 10% of the total investment in national programmes during the same period– and a culture of international collaboration has been generated. In addition, Spain has been able to become involved in projects that are much more scientifically and technologically ambitious than projects that could be undertaken domestically. It has had access to the results and highly significant industrial uses of such projects, and has learned to better organise and manage its research and innovation.

Spanish participation in European R+D programmes does not end with the Framework Programmes. In fact, there are other arenas for scientific and technological collaboration, established by international agreements with some EU member states and other countries.

Of these, the following should be mentioned: EUREKA (a framework for the pre-commercial technological development of projects on any subject); COST (a framework for coordinating research actions, guided by "à la carte" participation objectives); the European Space Agency (ESA), which offers a dual programme of "obligatory" activities (mainly the scientific research programme) and "à la carte" activities in the areas of space transport and applications (Galileo); CERN (organisation for European cooperation in particle physics); the European Science Foundation (ESF) which brings together 65 organisations from 22 countries and manages programmes (mainly through coordination) and networks in a wide range of areas; the European Southern Observatory; the EADS Group; the European Molecular Biology Laboratory (EMBL); etc.

In their respective fields, the creation of these institutions represents a fundamental initiative in terms of European scientific and technological cooperation, training, mobility and exchange of researchers, dissemination of research results, and the provision of scientific advice for society.

Before these intergovernmental cooperation initiatives were established, R+D was considered to be a national activity, with the borders between the different national systems being relatively impermeable. Research involving trans-European cooperation was seldom, for researchers and for companies. In fact, European countries cooperated more actively with the United States than with each other. While this may still be the case, this tendency is slowly changing.

Spain's participation in European Union R+D programmes and programmes resulting from intergovernmental agreements can no longer be brought about only by research groups and companies acting on their own. There should be an institutional strategy, supported by governments (both regional and national), to ensure a framework of action. This strategy should also commit the national resources needed to make better use of international participation efforts. Interaction between the different regional, national, and EU levels is particularly important in the areas of infrastructure and human resources.

Regardless of the state of the international environment producing the most significant scientific and technological advances, Spain needs to:

– Participate in international R+D forums and programmes.
– Increase its active participation in international decision-making bodies.
– Participate in major global industrial technology projects.
– Foster international cooperation with competitors, suppliers, and clients, as this is a source of technological innovation.

In addition, given the limited resources, the policy of international scientific and technological cooperation should have a selective focus. Priority should be given to actions in a limited number of thematic and geographic areas.

Political and objective details of the European Commission's proposal for the Framework Programme of 2007–2013[3] are defined in the communication "Building the ERA of knowledge for growth".[12,13] In this proposal, the programme's budget is doubled and its period of validity extended to 7 years. In addition, support actions for excellent research, training and mobility of researchers, research infrastructures, and company research are strengthened. These specific aspects will be dealt with later.

Basic research

During the last 4 years, there have been European discussions on the challenges facing basic research, and the most appropriate ways to meet them within the framework of the ERA.[14,15] The EU member states have unanimously declared themselves in favour of supporting basic research, and the European Commission has given it greater visibility, budgetary consideration, and specific management in its proposal for the Seventh Framework Programme. This programme highlights the need to pay greater attention to high-quality basic research. Around 10% of the programme's total budget will be allocated this area and managed independently by the European Research Council (ERC).

According to the report on the creation of the ERC, a fund of an estimated two billion euros per year should be established within the Framework Programme to support all aspects of knowledge. This fund would be managed by the ERC, which would be autonomous, rigorous, transparent, and have administrative flexibility. It would use already-existing European scientific institutions of recognised quality.

The creation of the ERC was approved by the European Commission on 23 March 2005, in Brussels, in a meeting of heads of state and government. The ERC Identification Committee presented an interim report on 21 March 2005 that began: "Support of frontier research will form an important component of the Commission's forthcoming proposal for the Seventh Research Framework Programme". A ERC, with an executive council made up of scientists, will provide a distinctive and independent mechanism for putting this "frontier" scientific research programme into practice. The Identification Committee will assess candidates in May 2005 and present a final report in June 2005. The Committee has also presented suggestions on "working methods" for the ERC's executive council or administration. These cannot be defined precisely until the European Parliament, the Council of Ministers, and the Commission make the appropriate legislative decisions.

In the beginning of April 2005, the European Commission made its financial proposal for the period 2007–2013. The amount allocated to research was 67.8 billion (11.3 billion per year), which represents an increase of 6.6% of the total relative to the last Framework Programme (2000–2006). On 25 March, the president of the European Commission, José Manuel

Durao Barroso, published an article in which he gave the reasons why education, research and innovation are the keys to increasing productivity in the EU. The percentage of GDP allocated to R+D in Europe is 1.96% compared to 3.12% in Japan, and 400,000 Europeans who have studied science and technology currently live in the United States. Three quarters of students born in the EU who do their doctoral or postdoctoral studies in the US prefer to stay there after finishing their studies.

The *EIROforum* is made up of the seven European intergovernmental research organisations with the most modern infrastructures (CERN, EMBL, EFDA, ESA, ESO, ESRF, ILL). In a recent publication (*EIROforum report*, 2004), it identified cooperation prospects as Europe's best way to achieve the Lisbon objectives. The value of the Marie-Curie grant programme was stressed, as was the potentially enormous importance of establishing a European Fund for Research Excellence. The ERC should manage this fund with independence and flexibility in order to bring about competitive research on a global scale.

Basic research is a field of action of general interest, in which government investments yield high social, economic, and cultural returns. Support for basic research is justified, given that:

a) It has a high impact on business competitiveness, economic growth, and social well-being.

b) Its cost and complexity are growing due to the multidisciplinarity of its activities, and the private sector cannot be expected to assume this expense.

c) It guarantees that results become public property.

d) It helps to advance knowledge about the causes of certain illnesses (e.g. cancer, cardiovascular and cerebrovascular diseases, neurodegenerative conditions, AIDS, and multiple sclerosis), and seek solutions for specific problems.

e) Without it there are no high-quality teachers, without such teachers there is no high-quality education, and without education there are no high-quality teams of professionals or managers.

f) It helps to ensure sufficient empowerment, so that the most recent and complete information on the latest advances can be accessed and assimilated. Moreover, as a result, it brings about participation, however modest, in the consortiums that generate these advances.

g) If scientific culture is lost, people become both distanced from the places where decisions are made and less independent.

However, as the economic needs of basic research groups increase, those in charge of the res publica have instead chosen to reduce budget items funding actions in areas that can best withstand the pressure of different social influences. One of these areas is investment in intangible assets, such as basic research, as the results are uncertain, and quantifiable effects are most often achieved only in the long-term, beyond the duration of an electoral mandate.[16]

Spain's spending on basic research in relation to GDP is one of the lowest of OECD member countries (it is only above that of Mexico and Slovakia). It has remained at 0.15% of GDP in recent years, while the OECD average reached 0.34% in 2001. However, scientific production and research potential indicators are positive, despite the drop in the rate of productivity and the almost 30% increase in the cost per publication. In general, it could be said that productivity per

Spanish researcher is dropping because the number of researchers is increasing faster than the number of papers published. In addition, the average number of Spanish authors per paper has risen. However, the indicator of researchers per 1000 inhabitants is not as far from the European average as that of the expenditure per researcher. Thus, *"there is a need to create a more attractive basic research environment, supported by high quality education, appropriate research funding, research infrastructure, and science-innovation links, where excellent researchers are recognised and can excel, thereby strengthening Europe's performance in basic research."* (Conclusions from the Irish Presidency's Symposium: "Europe's Search for Excellence in Basic Research", Dublin, February 2004).

Mobility

The Acción CRECE paper *Human Resources in Research* provides an in-depth analysis of specific aspects of human resources. However, in this section, some brief comments will be made about the researchers' roles as a fundamental (and indispensable) resource for knowledge transfer in any activity related to scientific and technological cooperation, and their effectiveness in training young researchers.

The mobility of researchers between different scientific disciplines, research groups, and national borders is one of the most important factors in successfully developing a research policy for the EU, as has been observed over time. The resolutions and communications of European institutions have spelled out different initiatives in this field.[17] In practical terms, there has also been a steady increase in the economic resources allocated to mobility by the six Framework Programmes[18] implemented since 1985 (Single European Act).

One of the main objectives of the European Commission's proposal for the Seventh Framework Programme is to develop and strengthen human resources in research with respect to training, mobility, and development of research careers.

Publication of the Commission's recommendation concerning the European Charter for Researchers and the Code of Conduct for the recruitment of researchers represents an important step in this direction.[19] The objective of both the Charter and the Code of Conduct is to contribute to the development of a European labour market for researchers that is attractive, open, and sustainable. The market's conditions should favour high-level performance and productivity. These are Commission recommendations to the member states, who are invited to apply them voluntarily. The recommendations will be revised periodically, using the open method of coordination.

There is an urgent need for training and recruiting young researchers into the European R+D+I system. Specifically, 1.2 million research staff are needed to fulfil the Barcelona objective by the year 2010; of these, 70,000 should be researchers.[20] Additional staff would be needed to replace researchers who have reached retirement age and leave the system. Concurrently, there has been an overall population decrease and a drop in the number of students in scientific and technical disciplines essential to effectively developing business innovation.

In turn, the Bologna process presents an excellent opportunity for reforming the university system. The creation of the ERC is deemed necessary to strengthen the research mission of universities. Training and a research career are important for

European education and research. Therefore, the aim is to create more synergies between these two components, by promoting improvements in the organisation and structure of European doctoral programmes.[21] Joint programmes between European universities and the recognition of a European Doctorate are also essential.

As a result of these circumstances, initiatives need to be launched to attract excellent researchers to Europe. At the same time, changes need to be introduced to adapt the current legislative and institutional framework (entry and promotion conditions, economic and labour regime, immigration, etc.) to the new situation. Supportive services should be made available for visiting researchers, staff, and their families.

As stated in other sections of this report, knowledge-based societies are dependent on their capacity to produce, use, and transfer knowledge. These activities require the mobility of all kinds of resources and of researchers themselves within an international research framework. Likewise, the mobility of researchers between complementary disciplines and institutions (universities or research laboratories, companies, and vice versa) not only fosters knowledge transfer, but also gives impetus to cooperation among research groups, and between these groups and industry.

The scientific community is well aware of the importance of mobility, as its mobility rate is approximately 5% compared to the active population, whereas it is 2% for other professional groups. Nevertheless, this rate is not high enough to cover current scientific research and business innovation needs.

International mobility is a fundamental factor in staff promotion, although its relative importance varies greatly depending on the area. Moreover, this mobility is strongly asymmetrical. The outward flow to other countries (towards the US more than Europe) reflects the Spanish public system's lack of appeal to researchers from abroad. This is reinforced by a lack of adequate instruments and a certain inscrutability with respect to selection processes and job stability.

In the business sector, the importance and degree of international mobility of R+D staff is less than in the public sector– if we discount mobility in multinational companies that have internal staff-rotation programmes linked to promotion. The spread of other R+D centres to Spain or competition from other companies with their own staff is limited, and does not change the general opinion given here.

Spain currently has 83,000 researchers (EDP) (4.5 per 1000 of the active population, compared to a European Union average of 5.7) according to the OECD and EUROSTAT. It needs to make even greater efforts in this area. The former Ministry of Science and Technology contributed by launching the Ramón y Cajal programme in 2001. This programme's objective is to recruit 3000 young, high-level researchers (of any nationality) into Spanish public research organisations in 4 years.[22] To date, three calls for application have been made (see Table 3).

The results of this programme highlight, among other things, that many Spanish researchers living abroad (there are estimated to be about 2000 in the US alone) are interested in being reincorporated into the Spanish research system (21.4% out of a total of 1978 contracted). There are 171 researchers from other European countries in Spain (8.6% of the total number contracted).

Researcher mobility is generally advantageous, but it does entail some risks. Negative effects of

TABLE **3.** Ramón y Cajal Programme

Basic characteristics of the doctors selected for the Programa Ramón y Cajal by year				
	2001	2002	2003*	Total
Number of candidates selected	774	498	706	1978
Number of foreign candidates selected	105	99	130	334
Number of Spaniards contracted who live abroad	108	114	202	424
Average age of candidates contracted (years)	35.8	35.5	35.4	35.5
Distribution by gender of candidates contracted (%) Men	63%	66%	63%	64%
Women	37%	34%	37%	36%

Note: * provisional data
Source: Ministry of Science and Technology

***Programa Ramón y Cajal Objectives* (% of the total number of people contracted)**				
	2001	2002	2003	Total
To bring back Spanish researchers	14.0	22.9	28.6	21.4
To attract foreign researchers	13.6	19.9	18.4	16.9
To improve employment conditions and career prospects	72.4	57.2	53.0	61.7

Source: Ministry of Science and Technology

Distribution of contracts by research area		
	No.	%
Sciences (physics, chemistry, mathematics, earth and space sciences)	683	34.8
Life science and technology (plant biology, agriculture, livestock and food technology)	383	19.6
Animal and molecular biology	304	15.5
Medicine and physiology	220	11.2
Engineering, information and computer technology	190	9.7
Social sciences (economics and law)	67	3.4
Humanities (pedagogy, philosophy, art and education sciences)	113	5.8
TOTAL	1960	100

mobility can arise in countries such as Spain that have an excellent level of higher education, but no equivalent technological development. One such effect is the loss of quality human capital *(brain drain)* or inadequate use of education *(brain waste)*. To avoid this, current entry conditions for research and teaching staff need to be brought into line with those of countries that have outstanding R+D.

The brain drain could be limited if the measures established by the Lisbon Council in 2000 were adopted nationally and by the ERA, and if the European Fund (ERC) favoured the return of personnel.

Current Spanish entry conditions for research and university teaching staff should be immediately brought into line with those of countries that have outstanding R+D.

European higher education guidelines should be applied to higher education and doctoral programmes (European doctorates), and the European Charter guidelines applied to researchers.

The best way to combat the negative effects of mobility is to increase social prestige (by raising public awareness) and improve the conditions of the research career. Researchers should be recognised as professionals after the postgraduate degree. The recommendations established by the European Researcher Charter and the Code of Conduct for recruiting researchers should be adopted to achieve these goals.

Measures aimed at creating a kind of "virtual community" should be established that would keep active both shared knowledge assets and scientific resources of excellence. It would also help establish and develop effective initiatives for transnational scientific cooperation between excellent organisations, groups, and researchers both within Spain and abroad, for the mutual benefit of all.

Effective recruitment of researchers from within and outside the Spanish R+D+I system requires a legislative, organisational, information, and management framework that is efficient and readily available.

Infrastructures

Research infrastructures provide increasingly important support for the advance of basic and applied knowledge, technological development, innovation, and socio-economic competitiveness.

In the European Union, the term "research infrastructures" refers to facilities that provide essential services to the scientific community for research in different fields. Examples include: libraries, databases, biological archives, clean rooms, communication networks, and synchrotrons. They may be located in one place, distributed, or virtual.

In addition, infrastructures are:

– Focal points for technological innovation, in areas such as instrumentation and rapid data acquisition.

– Hubs for regional growth, particularly for less-developed regions, thereby improving competitiveness (research and innovation, information technology, and human capital).

– Centres for training and mobility of researchers during graduate or postdoctoral education.

All of this is particularly relevant in view of the next Framework Programme, given that the Commission Communication on the EU financial perspectives for the period 2007–2013 refers to research infrastructures as a key element to advance European scientific and technological development. Developing research infrastructures of European interest is one of the six main objectives in the Commission Communication on the future of European Union research policy[23] and the Seventh Framework Programme.

European research infrastructures' medium- to long-term requirements include devising a 10- to 20-year plan that would be drawn up in a continuous process, involving periodic updates and revisions.[24] The European Conference on research infrastructures has established that there is wide consensus, in scientific and political circles, on the need for a European focus for key research infrastructures.[25,26]

The Spanish infrastructure roadmap is in the process of being formulated and should take into account the European roadmap's tasks. It should also consider Spanish participation in existing or planned international infrastructures linked to the international scientific and technological organisations of which Spain is a member. Participation costs are considerable (see Tables 1 and 2), but essential if Spain is to be situated in the international scientific context to which it belongs. Participation also produces important industrial returns in the form of contracts and *know-how*.

In this respect, Spain should take part in new large-scale European scientific facility projects from the outset. It should establish national complementary actions to optimise subsequent use of the facilities, and also to contribute to their construction by supplying instruments, equipment, and components.

Spain already has some important scientific facilities and participates in a growing number of major international facilities (CERN, ESRF, EMBL, ILL, GBIF, etc.). Spanish groups and companies need to boost their use of these facilities both quantitatively and qualitatively. At the same time, a process of building several major scientific facilities has been initiated in just a few years. Among these are: the development of a 10-m (diameter) segmented telescope, in the Observatorio del Roque de los Muchachos on the island of La Palma, a 3.5-GeV synchrotron in Barcelona, a new 30.m oceanographic vessel, and a supercomputer with a 40-TFLOPS processing capacity in Barcelona. All of these have been created in response to a completely new policy that differs greatly from its predecessors.

This process of increasing Spain's global presence can also be seen in its 10.5% contribution to the Galileo programme, in which Spain's fixed contribution to ESA is 5%. In addition, negotiations on Spain's participation in ESO have begun. Spain's participation in the ALMA project has already been decided upon by an agreement with ESO. However, use of major international infrastructures should also be optimised and related thematic areas strengthened.

Scientific and technological infrastructures are a fundamental factor in Spain's scientific, technological, and socio-economic development. Building, improving, and maintaining them requires considerable financial investments. Therefore, in addition to the benefits drawn from the construction and scientific use of the facilities, it is important to ensure that interested communities make use of them.

The Spanish Ministry of Education and Science has begun to devise a national roadmap to promote these initiatives, providing Spanish scientists and technologists with tools to advance knowledge over a 15-year period. The roadmap's design should be coordinated with that of the European scientific infrastructures roadmap and with the plans of the regional governments in this area.

Use of the major international infrastructures in which Spain participates has to be optimised. To achieve this, lines of research and training activities in related thematic areas should be strengthened, among other measures. This would bring about optimum use of the facilities.

Business

Business plays a crucial role in the process of European integration, but it also has the most serious shortfalls and therefore requires the most attention. According to data provided by EUROSTAT, R+D spending in Spain reached 1.11% of GDP in 2003. However, companies contributed only 48.9% of the expenditure in 2002. This is a long way from the recommendations of the Lisbon Strategy stating that business should contribute two thirds of the R+D spending by the year 2010.

These data reflect the Spanish business sector's past weakness in R+D activities. This is due to several factors, for example: the industrial sector is made up of many small companies in traditional production sectors with a low technological input, and buying essential technology abroad is a common strategy. Thus, companies are not involved in creating or developing technology.[27]

Many Spanish companies, in particular financial and service companies, have a globalisation policy that involves creating marketing networks and networks for supplying components. Less effort is made to participate in international networks for generating, developing, and integrating new knowledge.

In addition, large companies with technological capacity lack clear incentives to participate in European R+D programmes. The network of stable links with other companies, European and national public centres, has an inadequate structure. In the European Union's Fifth Framework Programme, 50% of Spanish returns went to a relatively small number of companies in the business sector. The Sixth Framework Programme, which is currently being implemented, has similar figures.

Priorities have been focussed on a small number of technological areas that are far from the interests of Spanish companies. In general, programmes have long-term perspectives. Many existing programmes are ill-equipped for SMEs, which are given a marginal treatment to appease consciences; but this does not contribute to solving the problem. In addition, Spanish companies have a relative lack of interest in existing priorities, as their direct involvement in EU matters is negligible. Unlike large European business groups, very few Spanish companies are directly represented in Brussels. Consequently, they have almost no influence in devising programmes.

We should analyse the impact of the incorporation of large multinational companies into Spain, and consider how to increase the involvement in R+D of the most visible financial institutions, i.e. those with the highest turnover.

Research groups do cooperate with companies in the Framework Programme. However, Spanish companies are absent from almost 50% of the projects. Moreover, their participation in projects does not necessarily lead to their ability to make good use of the technology generated by the public system. It is difficult to estimate to what degree this is true, but in any case the carry-over effect is limited.

However, something is changing. Some Spanish companies with an international orientation and technological capacity cooperate with research centres all over the world. There is a process of improving technology access networks, as demonstrated by the acquisition (or control) of technology-based companies.

Moreover, government initiatives to boost science and technology parks, not just as urban planning projects, but as instruments for competitiveness and business development, could contribute to increasing the innovative activities of companies.

The position of Spanish companies in the major European R + D consortiums needs to be consolidated and they should participate in setting up the Seventh Framework Programme's technology platforms. Among others, the following measures should be taken to achieve these objectives:

– Link national resources to participation in European programmes.

– Strengthen collaborative activities between companies and research groups.

– Create centres that have European competence in R+D, sufficient critical mass, and technological capacities.

– Continue to support the presence of SMEs in consortiums for all European projects.

The internationalisation of SMEs should also be supported, by developing their technological access and marketing networks as well as through agreements reached with other strategic technological partners.

Comments on the Seventh Framework Programme

On 6 April 2005, the European Commission presented its proposal for the Seventh Framework Programme (2007–2013). It is too early to know the results of the European Council and Parliament's final *co-decision*. However, comments can be made about the foreseeable impact of the Programme on the Spanish science and technology system. Thus, to contribute to the formation of the Spanish government's opinion, and to prepare collectively for tackling this new initiative, key aspects of the Commission's proposal are listed below:

• There is a proposal to double the Framework Programme budget. This is good for the Spanish science and technology system, even though this budget will cover a 7-year period instead of the usual 4 years.
The higher the EU budget, the more opportunities to attain economic returns, particularly if the Spanish budget is increased and its administrative structure reformed at the same time.

• The proposal states the importance of excellent basic research in all scientific fields, and allocates it a considerable budget of 1.5 billion. In addition, the proposals of individual research teams, human resources, and researcher mobility will be independently analysed by peer review, and coordinated by the European Research Council.
The term *research team* does not necessarily imply that its members work in the same country.

• To resolve the problem of the current Framework Programme's highly bureaucratic administration, the idea of outsourcing is supported, using a model of executive agencies (one or several). This is applicable to the European Research Council, human resources and mobility programmes (Marie Curie actions), and actions geared towards SMEs.
The decentralisation of programme management and/or modes of action should not ignore or diminish decisions made by the European Commission, as the budget authority, which take precedence over decisions reached by the European Parliament, the member States, or independent expert opinions given during the evaluation of proposals, Adequate recognition must also be given to the research itself and the impact of its results.

• Proposed instruments for participation are not very different from those currently in use. Proposals can make use of the instrument best suited to the characteristics of the activity to be undertaken.
However, no less than 50% of the budget is allocated to funding research and technological innovation activities in the same fields as in previous programmes, although major scienti-

fic networks and technological-industrial platforms are strengthened. This means that small research groups and the limited number of Spanish innovative companies that could participate in this programme will find it more difficult to assume a role of scientific, technical, or organisational leadership than under the current Framework Programme. To tackle this situation, measures will have to be introduced to give the administrative, legal, and financial support required.

• *Technology platforms* are formed under the leadership of industry. Their objective is to define medium- and long-term research agendas, to increase industry's investment in R+D, and to direct the activity of the public applied research system towards business priorities. Specific legal structures could be created, like those intended for Galileo and Hidrógeno, among others.

Spain should participate in all the technology platforms, with authority and decision-making capacity. It should lead some of these platforms (or some work areas). It should also have enough critical mass to be able to use the definition process to launch national technology platforms that have appropriate funding and the participation of the public and private systems.

• The process of progressively opening up national programmes needs to be strengthened, in order to contribute to creating the ERA. Accordingly, the Commission has proposed new initiatives of interest to Spain, such as: ERA-NET PLUS (funding through joint calls for proposals), high-risk loans granted by the European Investment Bank, and a new approach to the relation between the Framework Programme and structural funds that enables actions to be taken with a strong regional presence (called *regions of knowledge* in the proposal).

Programme and project management

The effective development of a policy covering scientific research, technological development, and innovation, in the context of international (and national) cooperation, requires a legislative, organisational, and normative framework that would enable administration of the research system to become specialised, dynamic, flexible, and independent. This is particularly important in an R+D+I system like Spain's. The Spanish research system has three levels of governance (international, national, and regional). In addition, ministerial and independent competences coexist and are strongly rooted in services. All of these must be coordinated to ensure that resources are allocated effectively.

It seems likely that the Spanish government will soon pass a Law for State Agencies[28] to deal with this and other similar situations. Such agencies will be specialised administrative bodies, with organisational autonomy. Their task will be the decentralised management of public services that are independent from services provided by companies and private interests.

This organisational initiative will, in principle, require a determined political commitment. Agencies must be given a well-defined legal and public status, especially if they are to become bodies that unite public actions for promoting science. They could, for example, manage all or a considerable part of the national R+D+I plan, particularly those activities related to the public system.

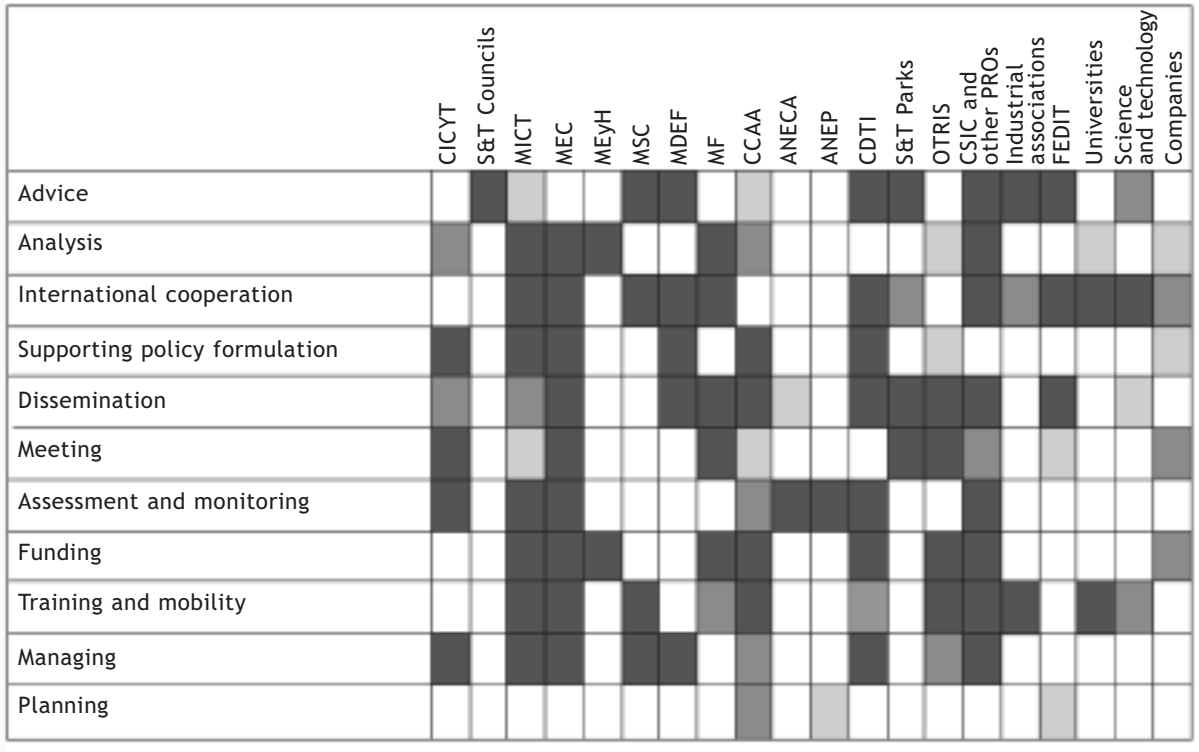
Jurisdiction as well as the budget for research are distributed between the ministries executing the national R+D+I plan. Consequently, it is important to decide whether, in this context of decentralised research management, there should be one agency or several, perhaps one for each ministry involved.

Turning now to the execution of research, the operating capacity of universities and PROs has to be increased immediately. This would enable them to manage projects from international R+D programmes, particularly those connected to the EU. The aim would be to stop Spanish groups from withdrawing from such projects. Groups avoid taking on leadership tasks due to the administrative and management responsibilities they currently involve. If the EU truly wants to encourage scientific research and lead a "dynamic knowledge-based economy", it should make its characteristically rigid, intrinsic bureaucracy more flexible.

Figure 1 lists the main authorities and institutions making up the Spanish R+D system, and their degree of involvement in different activities.

Improvements in the Spanish research and technology system must be attained in the area of effective, agile, and flexible management of its plans and programmes. The EU also needs to be given the mechanisms and procedures it needs to avoid the current administrative labyrinth.

A national agency should be created to assess proposals, programmes, and scientific and economic impacts. Such an agency would evaluate, fund, and exploit research and technological development plans to be carried out over a period of several years.



Comisión Interministerial de Ciencia y Tecnología, CICYT (Interministerial Commission of Science and Technology).

General and Advisory Councils for science and technology
Ministerio Industria, Comercio y Turismo, MICT (Ministry of Industry, Commerce and Tourism).

Ministerio de Educación y Ciencia, MEC (Ministry of Education and Science).

Ministerios de Economía y Hacienda, MEyH (Ministry of Economy and the Treasury).

Ministerio de Sanidad y Consumo
MSC (Ministry of Health and Consumption).

Ministerio de Defensa, MDEF (Ministry of Defence).

Ministerio de Fomento, MF (Ministry of Development).

Regional I+D+I Systems, CCAA.

Agencia Nacional de Evaluación de Calidad y Acreditación, ANECA (National Agency for Quality Assurance and Accreditation).

Agencia Nacional de Evaluación y Prospectiva, ANEP (National Evaluation and Long-Range Planning Agency).

Centro para el Desarrollo Tecnológico Industrial, CDTI (Centre for the Development of Industrial Technology).

Asociación de Parques Científicos y Tecnológicos de España, APTE (Spanish Association of Science and Technology Parks).

OTRIS

CSIC and other Public Research Organisations (PROs)

Asociación Española de Normalización y Certificación, AENOR (Spanish Association for Standardisation and Certification).

Federación Española de Entidades de Innovación y Tecnología, FEDIT (Spanish Federation of Innovation and Technology Organisations).University

Figure 1. The main authorities and institutions in the Spanish R+D system and their activities

Conclusions and proposals for action

As a result of the considerations and data set out above, we propose a series of measures that could contribute to improving Spain's position and effectiveness in Europe:

• Spain is no longer one of the member states with the lowest salaries. As a result, the level of competitiveness needed to successfully face challenges arising in the international market should be based mainly on its capacity to *create, adapt, and apply new knowledge*. Consequently, other essential factors are: a good education, excellent scientific research, innovative technological development, an enterprising industrial sector, and the greater use of investment capital compared to revenue.

• Implementation of the Bologna process in universities will be of fundamental importance to European integration. Spain should make good use of this opportunity to readapt university structures so that they can contribute appropriately to increasing R+D development.

• Spain should endeavour to become a key player in the development of the European integration process with respect to R+D. To achieve this, it should develop an active European R+D strategy. In addition, national and autonomous R+D policies should be put into a European context, so that they can be strengthened, coordinated, and integrated.

• The main European arena for *transnational research* is defined by the Seventh Framework Programme. Therefore, funding agencies, Spain's research organisations, and those responsible for scientific and technological policy need to immediately adopt measures that enable them to effectively participate, using their expert knowledge, *in the formal decision-making processes of European institutions.* Measures should also give *organisational, technical, and financial support to research groups and innovative companies* that could participate in future EU R+D and demonstration initiatives.

• *A legislative, organisational, and normative framework* is needed to successfully develop a policy regarding scientific research, technological development, and industrial innovation in the context of international cooperation. This framework would help the system's administration to become specialised, dynamic, flexible and independent, and ensure that actions are coordinated.

Proposals for action

• A 25% increase in the average annual real investment in scientific research and civil technological development in Spain (Chapters 1–7) is needed over the next 4 years, if R+D+I in Spain is to converge with the European goal stated in the Barcelona objective of 3% of GDP. The proposal to double the Framework Programme's budget is an excellent opportunity for Spanish science and technology. To make effective use of it, Spanish budgets

should be increased simultaneously and its management structure reformed.

• The best way to optimise the quality and quantity of human resources, and to counteract the negative effects of mobility, is to increase funding as well as the social prestige of researchers. This can be achieved by raising public awareness about a career in research and by improving working conditions for researchers. Spain should support the *European Charter for Researchers* and the *Code of Conduct for the recruitment of researchers.* The latter document presents a series of recommendations, including the following:

– Recognise the research profession beginning at the postgraduate level.
– Establish a clear framework for the professional and personal career of scientific researchers and technologists.
– Favour the mobility of research staff between universities and research organisations.
– Provide lifelong learning for researchers.
– Establish stable and transparent methods– whether in the public service or not– for incorporating trained researchers into the system, according to their merits and abilities.
– Develop training programmes for techniques that support research.

• Adopt measures, along the lines of a Commission initiative, aimed at creating a *virtual community*. This would aid in the development of initiatives for transnational scientific cooperation between the community's different groups and organisations, for the mutual benefit of all. At the same time, it would keep the knowledge assets and scientific resources of excellent Spanish researchers, in Spain and abroad, active.

• Optimise use of the large-scale research infrastructures in which Spain participates by strengthening related thematic areas.

• Business competitiveness has to be increased to strengthen Spain's role in an emerging Europe and to improve its population's social well-being. The following elements, all of which are complementary to transnational collaborative research, are among those needed to achieve this:

– Design an incentive system to increase the participation in European programmes of large companies that have technological capacity and connections with SMEs.
– Promote the creation of science and technology parks and participation in scientific *euro-regions* (geographic groups).
– Introduce a policy for research infrastructures that is consistent with the following economies of scale: international, European, and that of the member states.
– Establish effective and complementary European and national programmes to support SMEs.
– Create synergies with other European initiatives, such as EUREKA, COST, European Science Foundation (ESF), and other science federations and associations (EIROFORUM, FEBS, EACS, etc.).

• The EU has established a fund of € 2 billion per year to support basic research in all disciplines. This provides an opportunity to reduce brain drain and increase the competitiveness of a knowledge-based economy. Spain should make maximum use of this fund.

• The instruments for participation proposed in the Seventh Framework Programme do not excessively differ from existing ones. However, they do aim to strengthen the major scientific networks and industrial technology platforms.

Small research groups and a limited number of Spanish innovative companies will participate in this Seventh Programme, taking on a role of scientific, technical, and organisational leadership that is more significant than in the current programme. These groups and companies should be provided with appropriate administrative, legal, and financial support.

• *Technology platforms* are set up under the leadership of industry. The aim of these platforms is: to define industries' medium- and long-term research agendas, increase investment in industrial R+D, and gear the activity of the public applied research system towards business priorities. Spain should be represented on all the technology platforms, with authority and decision-making capacity. It should be able to lead some of the platforms (or some work areas) and make use of the definition process to launch national technology platforms that have appropriate funding and the participation of the public and private systems.

• Management instruments are needed to initiate actions for strengthening regional presence (in the Seventh Framework Programme proposal this kind of action is known as *regions of knowledge*).

• A *system for assessing and monitoring science* should be set up to analyse the presence of Spanish universities, research groups, and companies in European R+D programmes and actions, and to assess the results obtained and their impact on the Spanish system.

• Encourage the creation of scientific and technological reference and/or advisory bodies that would give Spain a more active and effective presence in the international field, particularly in Europe.

• The government's different ministries, regional governments, and research funding agencies should be coordinated to improve the integration of R+D efforts. This would enhance the European presence of Spanish research groups and companies and help obtain results. Such coordination is even more important in the case of technological innovation, as EU structural funds are used and the regional governments have increased their jurisdiction in this area.

• Support action is needed to help promote the participation of Spanish groups in international programmes, particularly in the EU's Framework Programme. This action would be aimed at training researchers in aspects of project management, and would make some management units available to universities and research organisations, to provide them with the services they need. Other complementary actions would be:

– Encourage the preparation of proposals by providing direct aid to groups or management units (if such units exist).
– Award additional aid to approved projects to cover expenses related to: protecting and exploiting results; OEPM (the Spanish Patent and Trademark Office) state of the art searches; costs of registering patents in Spain, when they are not covered by The Framework Programme; actions fostering the creation of industrial prototypes with the collaboration of a Spanish company; drawing up business plans to create technology-based companies, etc.
– Encourage the approval of new mechanisms and procedures in the EU for administering and managing resources allocated to promoting research in all disciplines. These would avoid the excessively bureaucratic systems that are currently in use.

Notes

1 Part III, Title III, Article III, Section 9ª on *Research and technological development and space* of the Treaty establishing a constitution for Europe.

2 European Councils held in Lisbon in 2000 and Barcelona in 2002.

3 Seventh Framework Programme for research, technological development and demonstration activities. COM (2005) 119, 6 of April, 2005.

4 The European Commission has proposed an annual budget of €10,000 M to finance the Seventh Framework Programme (2007-2013).

5 Science and Society Action Plan. Com (2001)714.4, Dec. 2001.

6 Treaty on European Union. Art. I-47 (democratic participation).

7 At the Lisbon European Council on the 23 and 24 March, 2000, Heads of State and Government set the following as a new EU objective for 2010: "to become the most competitive knowledge-based economy in the world, capable of sustained economic growth with more and better jobs and greater social cohesion".

8 Fundación Española para la Ciencia y la Tecnología: Bibliometric indicators of Spanish scientifc activity, (1998-2002). Madrid, 2004.

9 CDTI: "Resultados y evolución de la participación española en el Programa Marco". 27.01.2005 and 05.11.2003.

10 "Growth and jobs: a new Start for the Lisbon strategy", a speech by President Durao Barroso to the European Parliament. Strasbourg, 09.03.2005.

11 Financial perspectives 2007-2013: 1,025,000m, of which 1% of European GDP (10,000m) will be allocated to R+D (Com (2004) 101 final).

12 Building the ERA of knowledge for growth. COM (2005).

13 "El Espacio Europeo Común de Conocimiento en la Unión Europea". A Spanish approach to the problem. Emilio Muñoz et Al. Academia Europea de Ciencias y Artes, Spain, 2005.

14 A high Level Advisory Group proposal on the creation of the European Research Council (ERC). December 2003/January 2004.

15 European Commission communications on Basic Research. January and May 2004.

16 Spain's spending on basic research in relation to GDP is one of the lowest of all the OECD member countries (it is only above Mexico and Slovakia). It has remained at 0.15 % of GDP in recent years, whilst the OECD average reached 0.34 % in 2001.

17 COM (2003)436. Brussels, July 2003: "*Researchers in the European Research Area: one profession, multiple careers".*

18 The *Human Resources* budget in the 6th Framework Programme (2002-2006) is 1.58bn. It is therefore almost 10% of the budget for non-nuclear activities (€16.27bn).

19 A commission recommendation [2005/251/CE], 11 March, 2005, relating to the European Charter for Researchers and the Code of Conduct for the recruitment of researchers. DOUE L 75/67 22.3.2005.

20 "Europe needs more scientists", report by the High Level Group on Increasing Human Resources for Science and Technology in Europe. April 2004.

21 Conclusions and Recommendations from the Bologna Seminar on "Doctoral Programmes for the European Knowledge Society". Salzburg, 3-5 February 2005.

22 L. Cruz-Castro y L. Sanz Menéndez: "*Human resources. Bringing science and technology human resources back in: the Spanish Ramón y Cajal Programme",* Science and Public Policy. February 2005.

23 Science and Technology, the key to the future of Europe. (Com (2004) 353 of 16.6.04.

24 Commission services document, 29.10.04.

25 The conference presentations can be found at: http://www.cordis.lu/improving/infrastructure/events.htm.

26 European Strategy Forum on Research Infrastructures (ESFRI) created three groups in: Physical Sciences and Engineering, Biological and Medical Science, Social Science and Humanities, and a fourth group in e-Infrastructures. These have been in existence since the end of 2002 (eIRG, a group of Ministry delegations to tackle GEANT and Grid topics).

27 According to Eurostat, companies' contribution to R+D spending in Spain - out of a total of 1.11% of GDP - was only 48.9% in 2002. This percentage is a long way from the objective of two thirds by 2010 recommended by the European Council in Barcelona.

28 «ORDEN del Ministerio de Administraciones Públicas/3017/2004», of 16 September, in which a commission is formed to study and prepare the draft for the «Ley de Agencias Públicas».