SCIENCE AND GOVERNMENT. REFLECTIONS ON PUBLIC R&D POLICY

Ignasi Vendrell i Aragonès*

After a brief historical survey of changing social and cultural views of science, the first part of this article analyses the origin of science policies and their role as a tool for government action with special attention to the public service controversy and definition of research as a public service. The second part focuses on the Catalan R&D system and provides a brief outline of its historical development and policies applied in recent times. Particular attention is paid to the model towards which these policies are leading. Details are provided on approaches employed by other states, the institutions which apply science policies and the role played by government in the overall process.

Contents

* Ignasi Vendrell i Aragonès is chief advisor on fostering and procurement of the Ministry of Universities, Research and the Information Society legal department.

1. Introduction

This article aims to outline and analyse the interrelationship between science and politics, between research and government.

This interrelationship and its participants form public research systems, the Catalan version of which is the subject of this article. After a brief historical survey of changing social and cultural views of science, the first part of this paper analyses the origin of science policies and their role as a tool for government action. Special attention is paid to the controversy on what constitutes public service and definition of research as a public service.

The second part focuses on the Catalan R&D system and provides a brief outline of its historical development and policies applied in recent times. Particular attention is paid to the model towards which these policies are leading. Details are provided on approaches employed by other states, the institutions which apply science policies and the role played by the respective governments in the overall process.

2. Government and Science

2.1. Historical overview

The relationship between government and science depends to a great extent on society's conception of both phenomena at any given time, in terms of the importance and value attached to scientific and technological knowledge and the expectations from government and administrative bodies. Over the course of history and in different geographical settings the interest of government in science has ebbed and flowed, as has its willingness to provide resources and its ability to benefit from the discoveries and inventions of explorers and scientists. The relationship between the two cannot, then, be analysed without bearing in mind that present-day Catalonia is the outcome of the history of 'western society', within a philosophical tradition which has varied over time and which experienced a major transformation with the Renaissance and the work of such authors as Galileo, Descartes and Bacon.

Promotion of science has often been undertaken by government, by monarchs who summoned courts of scientists, philosophers and artists as a mark of prestige, and by loosely private organisations whose task was to administer certain social practices. This was the case of the church, especially in the more institutionalised religions.

In societies with a more highly developed state structure the public component in science and research was accordingly developed. In ancient China, under the influence of the ideas of Confucius, it was the state that promoted science with a view to improving agricultural and hydraulic infrastructure, transport and astronomy techniques, and the state bureaucracy employed scientists to serve the king or emperor.[1]

In contrast, in Europe science was a private endeavour and it therefore «lagged behind for many centuries.»[2] In the early Middle Ages the centres

[1] «[...] the state greatly helped scientific research. For example, the astronomical observatories, which housed millennium-old archives, were part of the official bureaucracy; the state paid for publication of large encyclopaedias not only of a literary nature but also medical and agricultural, and scientific expeditions were also organised, which were important for that time» (NEEDHAM, 1977, p. 215).
[2] NEEDHAM, 1977, p. 215.

of learning in western and Christian Europe were the monasteries and it was not until the development of the cities that universities or general studies created or promoted by municipal authorities or the crown became the driving force for transmission of knowledge. However, there was no real production of knowledge, since knowledge was essentially static in nature, the object of contemplative and speculative study but not experimentation. This was a science which had emerged in the Greco-Roman slave society, in which the abundance of 'living machines' rendered construction and use of machines designed to substitute human effort superfluous.[3] Of course, there were technological advances during this period, although many were imitations of other cultures (especially the Arab, Persian and Chinese); however, overall, there was little conception of the value of technical development or the 'mechanical arts'.

The break with tradition and the old conception of science was to have consequences for the political and economic system.

After the Renaissance and especially with the Enlightenment, this was to change: scientific method emerged, nature and society began to be conceived differently and experimentation was permitted. Humanistic and scientific academies gradually appeared, in an early example of what was to become a constant concern of public science policy: institutional reform. The academies were promoted or patronised by government with a view to overcoming the medieval and Aristotelian conception of science which dominated the universities.

This break with tradition and the old conception of science was to have consequences for the political and economic system. One outcome was the industrial revolution, and ideological and political ideas arising from reflection on the possibilities of technological progress. There were those who, like Tocqueville, related the existence of democratic structures in a society with a greater degree of practical application of knowledge and their absence with a greater tendency to cultivate abstract thought.[4] Others, in contrast, went further and championed the establishment of technocratic societies. In the view of relatively Utopian socialism –for example Saint-Simon– the administration of society was made possible by neutral application of science under a simple premise whereby the more science and technology, the more progress in terms of collective well-being. Later, Marxist doctrine was to accept to a great extent this view and emphasise the need for economic planning on the basis of scientific criteria.

Over the course of history, then, science has been used to justify a wide range of doctrines and ideologies, many of which, under a technocratic guise, maintained a politically driven discourse aiming

[3] ROSSI, 1990, p. 81.
[4] «The permanent inequality in social conditions leads men to confine themselves to the proud, sterile investigation of abstract truths, while the social state and democratic institutions predispose him not to cultivate science but rather its immediate and useful application» (TOCQUEVILLE, 1993, vol. II, p. 44).

to achieve objectives such as emancipation of the oppressed, establishment of new technocratic elites or the submission of peoples and cultures.

2.2. Science policies

Science policies, understood as a structured, systematic conception of public actions contributing to an increase in knowledge and its application for the material progress of society began to develop essentially after the Second World War. Many authors point to the 1945 report by Vannevar Bush for president Roosevelt, 'Science, the Endless Frontier'[5] as the starting point for this new policy area. From then on, especially given the major contribution of scientific and technological progress to the Allied victory, public policy began to focus on science, and public institutions were established to promote and even carry out research.

The early sixties marked the golden age of science policy: science was looked upon as the driving force of progress and the resources allocated to it grew without precedent.[6] The doctrinal core of science policy was initially drawn up by such international organisms as NATO, UNESCO and especially OECD (Organisation for Economic Cooperation and Development). This facilitated the entry of science and technology issues to the political agenda of the member states.

The term **science policy** is multi-faceted and liable to multiple interpretations. Following authors such as Jean-Jacques Salomon, we could conclude that it involves two mutually-sustaining dimensions: **policy for science** (i.e., providing a context which serves to strengthen research) and **policy through science** (harnessing and exploiting discoveries and innovations in various fields of government interest).[7] This dichotomy reflects the argument between those for free research, in which decisions are taken by scientists independently of political objectives («the republic of science», in the words of chemist and philosopher Michael Polanyi), and a research in which objectives are imposed by politicians.

In policy for science, an institutional research framework is established, and efforts may be directly organised through public research centres or universities, or science may be fostered by means of aids and tax incentives incorporated into planning.

In policy through science, science imposes a material limit on policy action which, to a certain extent, renders it legitimate in the public view. This exists alongside another form of science which informs policy. This is a form of science in which government may directly intervene, especially in such areas as defence and infrastructure, and in which contract-like mechanisms not only permit public policies, but allow them to play a positive role in stimulating scientific

[5] Vannevar Bush (1890-1974) was a North American engineer with an interest in science policy issues since the First World War. In November 1944, some months before the end of the Second World War, while director of the US government's Office of Scientific Research and Development, President Roosevelt commissioned him to produce what would become a famous report, in which he proposed the creation of a national research body to develop and promote a national scientific research and education policy, support basic research in non-profit organisations, develop the scientific talents of young people through study grants and support large-scale military research.
[6] Sanz Menéndez, 1997, p. 88.
[7] Sanz Menéndez, 1997, p. 61.

and technological progress. For example, companies may be encouraged to seek new technologies to meet government supply needs. A classic example is the private sector arms industry, whose sole client, at least in democratic societies, is the public sector. However, in other sectors too, public procurement serves to stimulate production, and development of new techniques and inventions in which the private sector would normally have little interest due to the excessive costs involved.

The R&D&I system has been defined[8] as the set of agents (i.e., R&D and innovation decision makers: companies, research centres, public administration bodies), values and norms (conditioning individual decisions), and institutions (legal framework, technology markets, qualified labour market, financial market, and education system) which directly or indirectly affect the collective intensity of R&D&I activities. Therefore, the links between the various agents, between government and science, are multiple, polyhedrical and defy categorisation by means of predefined doctrine.

Traditionally, it has been said that the public administration carries out three different roles regarding R&D and innovation: policing, fostering and providing a public service. In order to determine the intervention techniques being employed in research, we need to examine the concept of public service, perhaps the most hotly disputed and discussed of these three public administration roles.

2.3. Characteristics of public service

The concept of public service arose from French legal doctrine at the time of the transformation of the liberal state; when it began to assume functions above and beyond those of policing and managing international relations. Although its theoretical origins date to the 19th century, the term has never been totally free of interpretive variability depending on the authors or even legal texts in question.

This ambivalence in also present in Spanish legislation. For example, in the Spanish Constitution, which in a number of articles[9] identifies public service it with the overall body of administrative activities, whilst in others[10] it identifies it with reserved sectors which exclude the private sector.

The Constitutional Court (TC)[11] has defined public service as a form of organisation employed for the services provided or controlled by the public administration, which may only be exercised by private companies or individuals subject to a specific authorisation. Although the Constitutional Court recognises that the concept is a hotly debated one in legal doctrine, for interpretation of article 128.2, it adopts a restrictive and limited reading of public service, seeing it as an essential service provided by the public sector.

The more restrictive interpretation of public service, which several authors[12] term *'subjective' pu-*

[8] Busom, 2004, p. 11.
[9] For example, in its provisions on «patrimonial responsibility» in article 106.2 CE.
[10] For example in article 128.2 CE.
[11] STC 127/1994, of 5 May, among other rulings.
[12] Herreros López, 2003; Troncoso Reigada, 1999.

blic service, entails an obligation that government guarantee public services that are considered to be essential for the community, especially in terms of safeguarding human dignity and free development of personality. Independently of management or administrative issues[13] the concept of public service can be broadened to include other services, in what these authors speak of as *'objective public service'*, when the need for government regulation and control of a set of services becomes clear in order to maintain their quality and universality or to make them compatible with other constitutional guarantees, independently of who provides the service.

Objective public service may also collide with another concept: the public administration's entrepreneurial activity, covered by section two of article 128 of the Constitution. From the second half of the 20th century, the public administration has provided services whose regulation had not been initially foreseen or was not obligatory and in which it competed with individuals.

In practice, it is difficult to determine whether the administration is offering a service as a 'public service' or as part of its brief to act as a public entrepreneurial force in the market, especially in the light of the developments in the concept of public service in recent years.

Much of this development and reformulation of the concept of public service arose from perceptions after 1980 that public service provision was deficient. Of course, a statement such as this can be seen as ideologically biased, a discussion which is beyond the remit of this article. However, it is also true that this statement has been made from all positions of the political spectrum. Thus we find, agreement among the more neoliberal, who see the market as the essential protagonist, and more left-wing views, whose tradition is more state-centred. Among these we find such approaches as the «third way» proposed by Anthony Giddens, which argues for a reduction of the dimension of the state's role. There is a widespread wish to reduce the state's role in service provision although under certain conditions. The social democratic view tends to call for a reduction of the scale of the public sector, but not of its responsibilities, which, it is argued, may even increase. This is what Osborne and Gaebler express graphically in their idea that Government must remain at the helm so that other players, especially the NGO service sector, can row the boat.[14]

The concept of public service has never been totally free of interpretive variability depending on the authors or even legal texts in question.

The latest stage of this evolution is the new concept created by EU law of services of 'general interest', which aims to ensure provision of certain

[13] Those analysing public service from the subjective perspective also question the acceptability of private management for public services in the strict sense. What normally occurs is that individuals are permitted to participate by means of specific measures (administrative concessions, for example).
[14] Osborne and Gaebler, 1995.

services in a free competitive market. Behind this lies a desire to promote free competition in all socio-economic areas regardless of the fact that certain ideologies or economic theories hold that a single player should provide the service. Clearly, this advance was also necessary for development of a common vocabulary for the various Member State administrative traditions and conceptions of public service; we need only consider, for example, the differences between the continental and British systems.

A service of general interest must be regulated by a special or exclusive set of laws, independently of general community law, especially laws fostering a single market. To make the concept of equal services for all citizens compatible with that of a single market, European Law has set out the basic services for each sector of activity, conferring them with the characteristics of a public service, such as regularity, continuity, and a minimum quality requirement for all citizens regardless of income. Thus arose the concept of universal service with the intention of freeing these basic, essential services from market constraints, so as to enable them to reach what the European Union considers to be the common acceptable minimum for all EU citizens regardless of socio-economic status.

For services of general interest, the legislation establishes the obligations comprising the universal service and transfers these to the companies providing the service, according to criteria established for each case.

2.4. The instruments of science policy in Spain

Article 44.2 of the Spanish Constitution states that one of the overruling principles of social and economic policy is promotion by government of «science and scientific and technological research for the benefit of the general interest». Article 53.3 sets out that recognition, respect and protection of the guiding principles, including the fostering of research, must inform positive legislation, judicial practice and government action. Therefore, government must establish an appropriate framework to stimulate research activity, which it may do by means of any of the administrative action models mentioned earlier (policing, fostering or through provision of public services extended to include public entrepreneurial initiative).

Which of these three models is most suited to research? Following on from the previous section, the public service approach would be discarded, since, at least in the strict sense, it excludes the private sector. The most likely choice would be the fostering approach since it includes stimulation of activity by third parties in achieving objectives of public interest. Nevertheless, although research is not reserved to the public sector anywhere, a more comprehensive, multidisciplinary and detailed study would probably reveal some reservations concerning this approach.

Firstly, what makes higher education different to other educational levels is research, as recognised by state legislation. Organic Law 6/2001, of 21 December, on universities (LOU) establishes that «the university provides the public service of higher education through research, teaching and study» (article 1.1) and recognises research as one of the essential functions of the university (article 39). Law 1/2003, of 19 February, on universities in Catalonia (LUC) also establishes study, teaching and research as the mechanisms enabling the universities to achieve their objec-

tives (article 3.2) and promotion of scientific research and technological development and innovation as some of the informing principles of the Catalan university system (article 4). In addition, it sets out the obligation on the Catalan Government to stimulate university research through multi-year research and development plans and by means of other programmes and measures (article 21).

Furthermore, research is a basic component of many other public services which require preliminary validation and consolidation stages to determine the content of the service. Public service adaptability in the light of technical and economic development is one of the main features dealt with by all authors. Government must be able to modify service content to adapt and improve it in line with scientific and technological advances.[15] This distinctive feature may even involve total transformation of the service (it may become a universal service) or even its elimination when technological and scientific advances make it possible for the private sector to participate in providing the service in question, as occurred in the 1990s in telecommunications. Science and technology may make it possible for a natural monopoly or any other market failure which justifies government intervention from an economic point of view, to disappear.

Research as the source of public service provision is widespread in areas directly or indirectly affecting health:

Public health service

Law 15/1990, of 9 July, of the organisation of health services in Catalonia, sets out that one of the aims of the Catalan Health Service is to stimulate and sustain scientific research in the health field (article 6.1.*h*). The same law, in article 69.4, establishes that the Catalan public administration «must foster, within the Catalan health system, health research as a fundamental element for progress» and the following articles establish the Institute of Health Studies as the support organism for the Government and the Catalan Health Service with regard to training and research in health sciences. At state level, article 18 of Law 14/1986, of 25 April, (General Health Law) establishes the obligation on the public administration to «foster scientific research in the specific field of health problems.» Article 106 of the same law further develops the obligation to foster research in the area of health sciences.

Agriculture, food industry and forestry

Law 18/2001, of 31 December, on agricultural orientation, establishes that one of the objectives of the Catalan Government is to increase research and technological innovation in the agri-food industry (article 13) and that, to this end, it must promote experimental centres as instruments for transmission of R&D (article 14).

[15] Spanish positive law includes clauses on such advances, for example, article 244 of the rewrote text of Public Administration Contract Law establishes the obligation on a public works concessionaire to ensure maintenance in line with the regulations of current law according to the scientific progress.

Food safety

Law 20/2002, of 5 July, on food safety, establishes that one of the functions of the Catalan Food Safety Agency is to prepare and promote scientific studies to evaluate the extent to which the public is exposed to health risks due to foods they eat (article 13).

Public service adaptability in the light of technical and economic development is one of the main features dealt with by all authors.

In these areas of health sciences and consumer safety and protection, government regulation and control must be even greater since two constitutionally protected rights are in question: on the one hand, promotion of research, and on the other, life and physical, psychological or emotional integrity. It is therefore common, in this area for government to exercise a policing function, giving rise to government authorisations, or restriction of a certain type of research or use of the necessary material to a single public research centre.

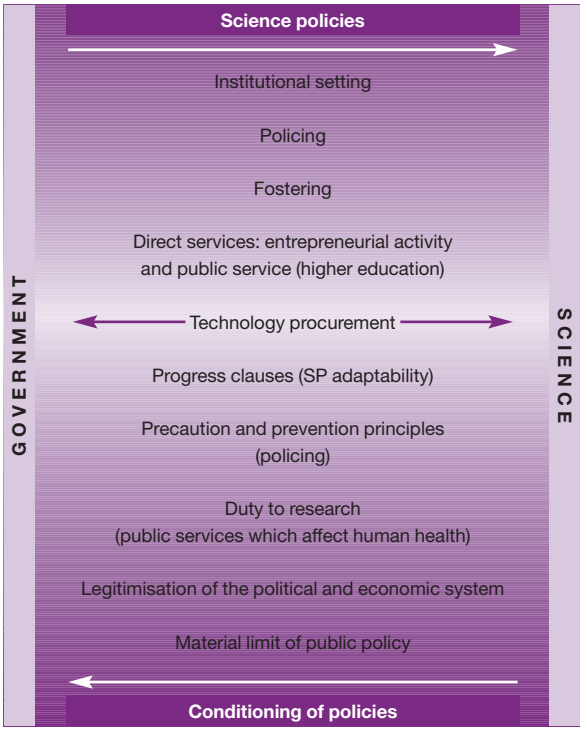
This, for example, is the case of research using cells of human origin or mother cells. The aims of the National Centre for Transplants and Regenerative Medicine, created by Law 45/2003, of 21 November, amending Law 35/1988 on Assisted Reproduction Techniques, of 22 November, include promotion and coordination of research with cells of human origin; at first, the regulation[16] made all the surplus cryoconserved pre-embryos available for research to the centre. The Centre was responsible for assigning the pre-embryos whose structures were to be used in each of the authorised research projects. Later, the regulations were amended[17] to eliminate this exclusive access to pre-embryos –the basic resource for mother cell research, although of course projects still needed to be authorised by the relevant health authority.

Research may also constrain the action of government, given that it serves as a parameter for policy decision making, as set out in recently formulated legal principles,[18] such as those of prevention and precaution. Prevention when deciding to adopt measures permitting provision of a service or authorisation of a service by third parties and precaution when there exists scientific uncertainty as to whether an already authorised technique constitutes an unacceptably high risk for society.[19]

The government's policing function not only limits the researcher, it can also and indeed usually

[16] Royal Decree 176/2004, of 30 January.
[17] Royal Decree 2132/2004, of 29 October.
[18] The European Union and other international organisations have been pioneers in this respect. For example, the European Commission's communication on the precautionary principle (COM/2000/0001 final, of 2 February). This principle has been enshrined in Catalan law in article 6 of Law 20/2002, of 5 July, on food safety.
[19] The debate between progress and safety has been a constant feature of all cultures and epochs, from the stand taken by the ulemas of Saudi Arabia regarding the introduction of cars into that country, to which they objected on the basis of the Islamic principle that possible risks to life or health should not be accepted voluntarily, to the latest controversy in Catalonia on the lack of safety of certain tunnelling techniques.

Figure 1
Inter-relations between government and science



does constitute a means of protecting the results of his or her research by limiting the actions of third parties. Such is the case of the protection provided by intellectual (and industrial) property rights regulations, especially patents, software rights, etc., which of course are a legal mechanism to ensure internal benefits from costly investments, which otherwise, would not be undertaken by individuals.

Figure 1 provides a graphical summary of the foregoing. In a word, all the forms of government action outlined may be applied to science and research depending on the material context in which they find themselves. Contextual factors together with political will lead to adoption of one or other technique, and lesser or greater levels of public intervention:

a) **Regulation** and **policing**, by means of government authorisation or licensing policies for use of certain resources, either because they are scarce or may arouse social or ethical protest, or results, in order to avoid the positive externalities arising from new knowledge or technologies.

b) **Fostering**, which entails redistribution of a country's economic resources according to government priorities, the government being responsible for management of research grants and aids to individuals and bodies. This may occur through direct transfers of funds or indirectly through tax incentives.

The protection provided by intellectual (and industrial) property rights regulations is a legal mechanism to ensure internal benefits from costly investments, which otherwise, would not be undertaken by individuals.

c) **Direct provision of services**, which, in keeping with the considerations outlined in this section, may actually be real public services. On many occasions the approaches described above are not sufficient stimulus for production of a scientific, technological or innovative product; in these cases, public structures and centres must be created to carry out the activity in question.

3. The Catalan R&D system

3.1. Origins

The institutional rift described in the first part of this paper also occurred in Catalonia in the 18th century with the creation of academies such as the Academy of Letters of Barcelona, established in 1729, the Royal Academy of Sciences and Arts, 1764, and the Royal Academy of Medicine, 1770. This was followed, during the 19th century, by a long period of recovery of Catalan identity, language and culture.

Several of the initiatives in this field, especially towards the end of the century, aimed to understand the immediate natural surroundings; therefore, it is not surprising that the first elements to be explored were those at the basis of all incipient scientific cultures, the territory and the firmament, the earth and the sky. In 1876, the *Associació Catalanista d'Excursions Científiques* (Catalanist Association for Scientific Excursions) was established, the forerunner of the *Centre Excursionista de Catalunya* (Excursion Centre of Catalonia),[20] a cultural and scientific society which was to be a model for such groups throughout the cities and towns of Catalonia. The work undertaken by these societies should not be underestimated, not only in terms of their promotion of knowledge of Catalonia but also for their studies of the territory and subsoil.

In a more institutional context, the Barcelona Provincial Council provided support in 1888 for publication of the first geological and topographical map of the province, prepared by Jaume Almera, and also supported the Meteorological Network of the Experimental Farm Agricultural School, established in 1894, the distant forerunner of the Meteorological Service of Catalonia, which was directed between 1921 and 1939 by Eduard Fontserè. Fontserè also drew up the initial design (1894) for an observatory on Collserola hill, promoted by the Royal Academy of Sciences and Arts of Barcelona, and opened in 1904 under the patronage of Camil Fabra, whom it was named after.

Coordination and consolidation of the scientific institutions was hindered by the lack of a Catalan autonomous government and also because the aim was to be independent from Official Spain and the universities, which between the late 19th and early 20th centuries were seen as alien to Catalan life and culture. One of the first public research institutions in Catalonia was the Municipal Laboratory of Barcelona, founded in 1887. However, the real need to institutionalise culture and science as conceived at that time did not become apparent until the advent of the *noucentista* movement at the close of the century.

Once initial objectives had been achieved by the *Solidaritat Catalana* movement (1906), there arose the idea of creating a research centre along the lines of other European nations. As a result, 1907 saw the foundation of the *Institut d'Estudis Catalans* (Institute of Catalan Studies), promoted by a group of intellectuals and politicians, including Enric Prat de la Riba, and supported by the Bar-

[20] From the *Associació Catalanista d'Excursions Científiques* (Catalanist Association of Scientific Excursions) broke away a group which was named *Associació d'Excursions Catalana* (Catalan Association of Excursions) in 1878. In 1890, both bodies merged again under the name of *Centre Excursionista de Catalunya* (Excursion Centre of Catalonia, the Alpine Club of Catalonia), which is still active to this day.

celona Provincial Council, of which Prat de la Riba was president. The aim was for Catalan research to become regular and more systematic by establishing a centre which would create science and organise research rather than be a merely honourable institution as the academies had turned out to be in practice.[21]

The year 1907 also saw creation of another centre, aiming to develop applied research: the *Laboratori d'Investigacions i Assaigs* (Research and Assay Laboratory), which was later to become the *Laboratori General d'Assaigs i Investigacions* (General Assay and Research Laboratory) (LGAI), under the auspices of Barcelona City Hall and the Provincial Council. After the creation of the *Mancomunitat de Catalunya*, the LGAI (1922) became one of its incorporated services and began to undertake teaching, control and appraisal work, in addition to research in association with the other institutions located in the *Escola Industrial* (School of Industry) complex.

From 1911, the *Institut d'Estudis Catalans* (IEC) operated as a confederation of autonomous academic bodies, the each of the respective presidents of its three sections (Historical and Archaeological, Philology and Science) taking it in yearly turns to occupy the overall presidency. Despite its functional autonomy, it gradually became integrated firstly into the Provincial Council and, later, the *Mancomunitat de Catalunya*, and it began to undertake advisory tasks (cataloguing and conservation of monuments) and worked on establishing the *Biblioteca de Catalunya* (Library of Catalonia), the rules of Catalan grammar and use, the Cartographic Service, the Meteorological Service, etc.).

The IEC's link to and dependence on the *Mancomunitat* was highly marked over the 1920-23 period, when institutions and powers were being transferred from the provincial councils to the *Mancomunitat*. In addition, its influence grew to include control of external research centres, such as the *Institut de Fisiologia* (Physiological Institute), established in 1921, and membership of the International Academic Union in 1923 led to international recognition for Catalan science.

The Science Section of IEC administered and managed[22] many scientific and technological services which the Mancomunitat represented as its own. Its aim was to organise Catalan research. One less than successful initiative in this regard however was the General Congress of Catalan Science.

3.2. The Second Republic

With the Second Republic, the functions and scientific centres of the provincial councils were absorbed by the new autonomous government, the Generalitat. This was the case of the General Assay and Research Laboratory and the Board of Natural Sciences. However, the IEC remained independent of government as a centre for scientific thought. Many of the services it had run during the *Mancomunitat* period were integrated into the Catalan Government (the Meteorological Service, the Institute of Physiology, etc.).

[21] BALCELLS and PUJOL, 2002, p. 40.
[22] In certain cases, such as that of the Institute of Physiology, this was on the initiative of the affiliated societies; the first case was that of the *Societat de Biologia de Barcelona* (Biology Society of Barcelona), today, the *Societat Catalana de Biologia* (Catalan Biology Society), established in 1912.

The IEC continued its scientific work, creating affiliated societies such as the *Societat Catalana de Ciències Físiques, Químiques i Matemàtiques* (Catalan Society of Physical, Chemical and Mathematical Sciences) (1931), the *Societat Catalana de Geografia* (Catalan Geographical Society) (1935), and the *Centre d'Estudis Matemàtics* (Centre for Mathematical Studies) (1933) –a non-teaching centre linked to IEC but not to the university.

During the Second Republic, a change of mentality occurred with regard to the conception of the university's functions: from a simple transmitter of knowledge it now became a generator of knowledge by means of research.

During the Second Republic, the Catalan university was transformed: it achieved the long-sought for autonomy and joined the process of restoring Catalan language and culture in the academic sphere. A change of mentality also occurred with regard to the conception of the university's functions: from a simple transmitter of knowledge it now became a generator of knowledge by means of research: «Alongside the mechanical, lecture-giving teacher, the *Patronat* [the governing body of *Universitat Autònoma de Barcelona*] introduced the concept of the teacher who worked with students in the laboratory, clinic and seminar room.»[23]

The Civil War period saw integration of various research entities –including the *Acadèmia de Ciències i Arts de Barcelona* (Barcelona Academy of Sciences and Arts)– into the formal governmental structure – the *Generalitat*. This did not occur however, with the IEC, which remained as it was, although it became less active and received a lower level of official support, some of which was allocated to the *Institució de les Lletres Catalanes* (Institution of Catalan Letters) (IEL), established in 1937 in representation of Catalan intellectuals who supported the Republican Generalitat.

3.3. The Franco dictatorship

With the reappearance of the provincial councils after the Civil War, the majority of the Catalan Government's scientific services, such as the LGAI, the Library of Catalonia and the Archaeological Museum, were once again transferred to Barcelona Provincial Council and others, including the Museum of Natural Sciences and the Botanic Institute were absorbed by the City Hall or the university, for example, the Institute of Physiology. Meantime, the IEC remained relatively inactive but was not formally disbanded. It resumed activity in 1942 and in 1947 began publishing scientific texts in Catalan again. Gradually, without any official support, it resumed its research work, though at a much less intense level than in the pre-war years. A number of provincial institutions were created with the aim of supplanting the IEC. These included the Spanish Institute for Mediter-

[23] Navarro Costabella, 1937, p. 46.

ranean Studies and the local studies institutes created in collaboration with the other three Catalan provincial councils: the *Instituto de Estudios Ilerdenses*, the *Instituto de Estudios Gerundenses* and the *Instituto de Estudios Tarraconenses* (the Institutes of Studies of Lleida, Girona and Tarragona, respectively).[24]

In 1939 the state had created the *Consejo Superior de Investigaciones Científicas* (Higher Council for Scientific Research) (CSIC) to offset to some extent the upheaval wrought by the collapse of the Second Republic and the flight into exile of numerous scientists and intellectuals. It was based on the facilities and remaining staff of the *Junta para Ampliación de Estudios e Investigaciones Científicas* and the *Fundación Nacional para Investigaciones Científicas y Ensayos de Reformas*, which the Franco regime has dissolved. In 1942, the establishment of the Barcelona branch of the CSIC was approved. This and the creation of a number of research centres based in Catalonia –for example, the Milà i Fontanals Institution and later the Institute of Applied Biology and the Institute of Fishing Research– allowed a certain decentralisation of research interests away from Madrid.

3.4. The «State of Autonomies»

With the restructuring of the Spanish state under the 1978 Constitution, powers were distributed among the autonomous regions. Delimitation of these powers is difficult, essentially for two reasons: firstly, different regional bodies exercise various functions (legislative, executive, inspection) in the same geographical area, and secondly, the ideal separation of spheres enshrined in legislation often leads to overlapping. In research, as outlined in the first section of this article, this is particularly acute, given that R&D may serve as the basis of a field of activity constituting the area of competence of a political body.

The Catalan Government was not in a position to promote research in any significant way until the two state-wide reforms were carried out: reform of the university and science policy; and until the scope of its powers was defined.

Despite these difficulties, the «Constitutional Block» (Constitution, Catalan Statute of Autonomy and other laws) define research as a specific area of competence. Article 9.7 of the Statute of Autonomy assigns exclusive competence in the realm of research to the Generalitat of Catalonia, without prejudice to the provisions of section 1.15 of article 149 of the Spanish Constitution, which assigns exclusive competence regarding promotion and coordination of scientific and technological research to the central state government.

The Constitutional Court, in its ruling on the case brought by Catalonia against Law 13/1986, of 14 April, on promotion and general coordination of

[24] BALCELLS and PUJOL, 2002, p. 323-325.

scientific and technological research,[25] interpreted the state and autonomous regions to be concurrent. The fact that the Statute employs the term *research* and the Constitution assigns exclusive powers to the state in fostering and coordinating research was deemed insignificant.

The Constitutional Court's ruling is based on an interpretation of the two areas of competence as being parallel.[26] The Court found against there being an obligation on the state to transfer competence in research to the autonomous regions, specifically in this case Catalonia, and permitted the state to maintain its Catalan research centres. A final aspect of the ruling is that it permits delimitation of competence. The Court interpreted competence in research as superior in that it can be exercised in any jurisdiction independently of which body the competence has been assigned to.

As a result of this ruling, the state has not transferred responsibility for its research centres in Catalonia to the Catalan Government and, therefore, the Generalitat, in carrying out its science policy has been forced to create its own research centres. The only exception to this approach is in the sphere of agricultural research. Even before the adoption of the Statute of Autonomy, a process of transfer of responsibility had begun in agriculture, including the agricultural research carried out by the National Institute of Agricultural Research.[27] Later, these transfers were adapted to the legal framework laid out by the Statute[28] and led to creation of the Institute of Agri-Food Industry Research and Technology (IRTA) via Law 23/1985, of 28 November.

One of the Spanish Government priorities in the 1980s was reform of the universities, as a preliminary step towards reform of the R&D system. The universities were granted autonomy, the importance of university research was explicitly recognised, and they were allowed to undertake scientific and technical projects for the private sector.[29] This was followed by institutional consolidation of the CSIC in 1986 through the Science Law,[30] which defined it as a public research organism (OPI) along with other centres such as the Centre for Energy, Environmental and Technological Research, and the Spanish Geological and Mining Institute, which maintained their statewide network of centres.

The Catalan Government soon began to apply specific policies to strengthen research, especially through the Interdepartmental Council for Research and Technological Innovation (CIRIT), established by Decree 217/1980, of 5 November, and also policies for innovation, through the Centre for Entrepreneurial Innovation and Development (CIDEM), established by Law 5/1985, of 16 April. Despite this however, the 1980s seem to have been a waiting period; the Catalan Govern-

[25] STC 90/1992, of 11 June.
[26] «*In short, art. 9.7 EAC, although it uses the expression 'research', does not expand the scope of the competence once, as has been seen, 'fostering' in this context cannot be identified with a given legal authority, nor as a specific model of administrative action excluding others which may be possible or ideal for achievement of the same aim of promoting and developing scientific and technical research.*» (FJ 2, STC 90/1992, 11 June).
[27] *Order of 17 January 1979 developing Royal Decree 1383/1978, of [23] June for the area of agricultural research, for which competence is transferred from the state government to the Catalan Government*.
[28] Royal Decrees 171/1981, of 9 January, and 1964/1982, of 30 July.
[29] Article 11 of Organic Law 11/1983, of 25 August, on university reform.
[30] Law 13/1986, of 14 April 1986, on fostering and general coordination of scientific and technical research.

ment was not in a position to promote research in any significant way until the two state-wide reforms were carried out: reform of the university and science policy; and until the scope of its powers was defined.

Decree 318/1992, of 28 December created the Universities and Research Commission with the aim of providing Catalan science policy with more internal strength[31] and 1993 saw adoption of the first Catalan Research Plan (1993-1996), drawn up by CIRIT with the objective of organising, coordinating and stimulating public incentives in the Catalan research system and following in part the methodology employed by the state in its 1988 National Scientific Research and Technological Development Plan.

Having concluded that the state's research centres were unlikely to be transferred to the regional governments and that the possible duplication arising from creating new research centres would be positive in contributing to the necessary critical mass and competition, it was decided to apply a Catalan policy for development of research infrastructure. In this second stage, publicly-funded research centres appeared which were relatively though not entirely unlinked to the universities, leading to a multi-pole system which avoided dependence on a large, multidisciplinary and bureaucracy-burdened institution. This anti-bureaucratic spirit led to a new development: structures which coordinated research groups from different centres. In this way, without establishing new legal categories, it was possible to channel public funding via these new so-called «reference centres».[32]

In addition to the decentralisation process which enabled the Catalan Government to assume responsibility in the area of research, there was also another powerful factor: the European Community, which had adopted its own science policies and issued directives which influenced that of state and sub-state bodies via its R&D framework programmes and structural funds. The European Community played a major role in subsidising research and development in southern Europe, including of course Catalonia, although only part of Catalonia was eligible for funding under objective 2 (economic and social conversion in areas with structural difficulties).

3.5. The present day. Comparison with other R&D systems

According to 2002 data, Catalonia accounts for 22.6% of state spending on R&D, compared to 31.7% for Madrid, 8.1% for the Basque Country and Andalusia.[33] In terms of Catalonia's gross domestic product, spending on R&D in 2003 at 1.38% was above the Spanish average of 1.10%, yet lower than that of certain regions, such as Madrid (1.81%), the Basque Country (1.42%) and Navarre (1.41%).[34] We see that both Spain and Catalonia are still a long way off the target set by the European Council in Barcelona in March 2002 whereby R&D spending should reach 3% of gross domestic product.

[31] The next step in the process of formal institutionalisation of science policy was the creation in 2000 of the Department of Universities, Research and the Information Society (Decree 123/2000, of 3 April) by merging the Commission and the Commission for the Information Society.
[32] Decree 26/1994, of 8 February, creating the Catalan Government's R&D reference centre network.
[33] MINISTERIO DE CIENCIA Y TECNOLOGÍA, 2004, p, 53.
[34] CIRIT, 2005, p. 79.

Table 1
R&D funding and spending in Catalonia (in percentages)

	GERMANY 2001		FRANCE 2000		UK 2000		USA 2001		SPAIN 2001		CATALONIA 1999	
	Funding	Spending	Funding	Spending	Funding	Spending	Funding	Spending	Funding	Spending	Funding	Spending
Industry	66	70.5	53	63	49.3	65.6	67.6	72.6	47	52	66.2	66.9
Public administration	31.5	13.4	39	17	28.9	12.2	27.4	11.4	40	16	14.6	8.2
Higher Education	0	16	0.8	19	0.9	20.8	2.5	12.2	4	31	15	23.4
Private non-profit institutions	0.4	0	0.9	1.4	4.6	1.5	2.5	3.9	1	1	0.9	1.5
International	2.1	-	7.2	-	16.3	-	-	-	8	-	3.3	-

Source: National Science Foundation (NSF) except Spain (INE) and Catalonia (IDESCAT).

Table 1 sets out the per sector distribution of R&D funding and spending in Catalonia, in Spain as a whole and in a set of representative states.

One feature which distinguishes Catalonia from other Spanish regions is that Catalan companies are more actively involved in R&D, in that they account for 68% of R&D spending, a figure which is equal to that of Navarre and just slightly below that of the Basque Country (75%); there are other regions, such as Extremadura, the Balearic and Canary Islands, in which companies account for no more than 25% of total R&D spending.[35] This is also set out (reflected) in Table 1, with a distribution of research spending by sector in Catalonia more similar to that in Britain than in Spain. The per-sector distribution in funding however, is similar to that of Germany, with virtually a third of R&D funding being public in origin (if we add the percentage for public administration bodies and universities).

One of the main characteristics of the Spanish R&D system, which is also applicable to Catalonia, although to a lesser extent, is the importance of university research. University researchers as a percentage of total researchers is among the highest among EU member states[36] being exceeded only by Greece. In contrast, private sector participation in the overall R&D labour force is among the lowest in the EU.[37]

Outside the universities, the central axis of Spanish public research is the CSIC, which as a multidisciplinary centre brings together all areas of research, has a prominent bureaucratic component and stable statutory staff. The number of researchers employed by the CSIC and other Spanish public institutions or their associated centres is very high, similar to the numbers working in the public research centres of France and Germany, and far in excess of the equivalent numbers in the English-speaking

[35] Data from 2001 (MINISTERIO DE CIENCIA Y TECNOLOGÍA, 2004, p. 52).
[36] In 2001, 58.6% of Spanish researchers were working in the universities, while the European average was 36% (EUROPEAN COMMISSION, 2003). In Catalonia, the percentage was 48.4% (CIRIT, 2005).
[37] In 2001, 23.7% of Spanish researchers were employed in companies, while the European average was 47.3% (EUROPEAN COMMISSION, 2003). In Catalonia, the percentage was 38.1% (CIRIT, 2005).

countries.[38] This helps to give an idea of two differing basic research models: a model entailing a higher public sector involvement, and another in which research is undertaken by the private sectors.

The research model established by the CSIC was directly inspired by the French model. Research in France has been predominated by a central institution the *Centre National de la Recherche Scientifique* (CNRS), which has led science policy in a highly centralised and interventionist system. At the conclusion of the Second World War, the Atomic Energy Commission (CEA) was founded and long-term aerospace, nuclear and defence programmes began development. That period also marked the beginning of the growth of the CNRS, which was founded in 1939 by the Popular Front Government, and was to become one of Europe's most important public research institutions, in effect incomparable with any other, and employing a staff of 26,000, 14,400 of which are researchers and engineers. The CNRS accounts for a quarter of total civil research spending in France.[39]

Obviously, the French model is not static and has undergone development and evolution. In 1960, 70% of R&D spending was state-funded and 55% of R&D was actually carried out by the state; by 1997 these figures had dropped to 48 and 40%, respectively.[40] We see then, that the role of the private sector has grown while that of the public sector has diminished.

However, the CNRS has never had exclusive rights in public R&D in France, since the French departmental administration has also led to major public bodies functioning in specific areas as government laboratories –for example, INSERM in the health field– known as *établissements publics à caractère scientifique et technique,* and similar to Spain's OPIs. Throughout the 20th century the role played by the universities and the *grandes êcoles* in research increased, and formulas were found permitting cooperation between these and the CNRS. In recent years, it has been concluded that the CNRS has become a form of research support agency which foregoes the protagonism attached to capitalising on research results in favour of higher education institutions. However, it is still clearly different from the British research councils or the USA's National Science Foundation (NSF) in that the support provided normally comprises provision of human resources and infrastructure, as opposed to funding.

In France, in 1960, 70% of R&D spending was state-funded and 55% of R&D was actually carried out by the state; by 1997 these figures had dropped to 48 and 40%, respectively. The role of the private sector has grown while that of the public sector has diminished.

In the UK, it is the universities and their associated bodies that perform most of the research and

[38] In 2001, 16.7% of Spanish researchers were employed in government research centres. The European average was 14.5%. In Germany, France, the UK and the USA, the figure was 14.4%, 15.2%, 9.1% and 3.8%, respectively (EUROPEAN COMMISSION, 2003).
[39] LARÉDO and MUSTAR, 2003, p. 459.
[40] LARÉDO and MUSTAR, 2003, p. 450-451.

they compete for funds made available in an open system by governmental bodies known as research councils. The research councils are field-specific and mainly comprise academics. They distribute the funds provided by the Department of Trade and Industry's Office of Science and Technology (OST). Despite the fact that the university's work is concentrated into relatively few centres, its contribution is mainly in basic as opposed to applied research.

The government manages and funds certain laboratories and research centres, either directly or via the councils,[41] the most important of which is the Defence Evaluation and Research Agency. However, under the New Public Management doctrine of the Thatcher Government, many of these laboratories were privatised using a number of approaches, sale to the private sector, private management or GOCO, i.e., government-owned, contractor-operated), etc.

R&D spending in the USA accounts for 44% of total OECD member spending (2001 data) and the results deriving from this are incomparable with any other world economy, whether measured in terms of publications (the USA producing almost one-third of articles in benchmark publications) or in terms of industrial property (166,000 patents registered in 2001).[42] US research also stands out for its attractiveness to foreign students and researchers (almost half of doctoral graduates in science and technology are foreign-born),[43] the applicability of research results and the importance of applied research, of development and innovation, even when produced in a university setting.

The US public sector funds practically 30% of R&D spending, although it only actually spends 12% of the total, mainly through the Department of Defense, the Department of Health and Human Services, NASA, the Department of Energy and the National Science Foundation (NSF). The NSF was created in 1950, after a five-year period of planning and discussion on the best approach. Finally, it was decided that it would concentrate on basic research and distribute the funding assigned by the federal state to the various scientific disciplines, yet would leave ample space in a public research which was fragmented by a range of agencies.[44] The agencies with responsibilities for the space race and military research were particularly important and became more so in the context of the cold war.

A model outside this dichotomy between the French and the English-speaking models, and one which is relevant to Catalonia in that it is decentralised yet adapted to a federal state, is that of Germany. Firstly, the universities and other specific higher education institutions (*Fachhochschulen*), funded mainly by the *länder*, play an important role in research. It must be remembered that at the start of the 19th century, the German universities, under the inspiration of Wilhelm von Humboldt, were the first to assign teaching and research to a single centre.

[41] In particular the Council for the Central Laboratory of the Research Councils (CCLRC), which provides a large volume of equipment for the use of science and business.
[42] NATIONAL SCIENCE BOARD, 2004, p. 0-4, 0-6 and 0-7.
[43] NATIONAL SCIENCE BOARD, 2004, p. 0-13.
[44] As proposed by Vannevar Bush in the previously mentioned report, against the argument of the Democratic senator Harley Kilgore, who favoured greater public coordination, centralisation and control in keeping with the New Deal tradition and a structure that would fund not only basic but also applied research.

In Germany, outside the university sphere, public research is organised on a highly decentralised basis both in geographical and functional terms, and comprises a range of centre networks which are mainly funded by the federal government. Chief among these are the Hermann von Helmnoltz National Association of Research Centres (HGF), the Fraunhofer Society (FhG), the Leibniz Institutes (*Blaue Liste*), the German Research Community (DFG) and, the oldest of all, the Max Planck Association (MPG), established in 1948 and specialised in specific fields of basic research and which, although formally a non-governmental organisation, is mainly government funded. Of the centres mentioned above, the HGF and DFG centres account for the highest proportions of R&D spending (35% and 25%, respectively, in 2001), while the Max Planck Association accounts for 19%.[45]

In Catalonia, apart from public research centres for which responsibility has been transferred to the Catalan Government (the Barcelona Provincial Council's LGAI, and the state's IRTA), the Catalan Government has also created its own research centres, such as the Institute for Applied Automobile Research (IDIADA), and has created a number of health care institutions which, in addition to providing health care, also carry out research (hospitals, the Catalan Oncology Institute, the Image Diagnostic Institute, etc.). The Catalan Government has also supported the creation of research centres in highly specific areas in collaboration with other bodies, especially the universities, or with private bodies both in the form of public consortiums (August Pi i Sunyer Biomedical Research Institute (IDIBAPS), the Catalan Institute of Cardiovascular Sciences (ICCC), the Consortium to Construct, Equip and Operate the Synchrotron Light Laboratory, etc.) and private foundations (Gene Regulation Centre (CRG), the Catalan Institute for Chemical Research (ICIQ), the Institute of Photonic Sciences (ICFO), etc.).[46]

Non-university public research in Catalonia has then generated a diffuse model of R&D spending which could be adopted to the German system. The choice has been to carry out research by means of groupings of centres in what were deemed to be strategically important sectors or in sectors where the previously existing conditions, whether a competitive setting or the individual excellence of particular scientists, indicated that rapid consolidation was possible. As mentioned earlier, unlike the French and Spanish model, there is no single multidisciplinary body designed to centralise all public research work. In Catalonia, the umbrella bodies such as the Inter-Departmental Research and Technological Innovation Council (CIRIT) and the Catalan Research and Innovation Foundation (FCRI), function more along the lines of the UK's research councils or the USA's NSF, by distributing research funds and coordinating research efforts, but with the difference that they are more governmental or bureaucratic than scientific organisms.

3.6. The future

European research, and this of course includes Catalonia, suffers from the so-called «European

[45] SALABURU, 2003, p. 57.
[46] DURSI, 2003a and b.

paradox», whereby good results in scientific research do not always coincide with useful applications to industry.[47] For this reason, many European policies seek to lay emphasis on innovation and on increasing private investment in research, which would by definition be more profit-oriented, and on tightening links and collaboration between public research, especially in universities, and industry.

There are well-known instruments designed to achieve this, perhaps however a more decisive effort is required: science and technology parks, technology incubators, technology transfer mechanisms, spin-offs and start-ups, etc. The Catalan Law of Universities (LUC)[48] sees the university as the engine powering the economy, which by stimulating innovation, fosters the entrepreneurial skills of researchers and students and creates innovative companies and initiatives, regulates the objectives of the science and technology parks,[49] assigns academic staff exclusively to research work and grants leave to contracted staff, not only to facilitate mobility between teaching and research institutions, but also to create companies which are directly related to the university's scientific and technological research.[50] Another step forward in this bid to link research and innovation by means of a single instrument was the Research and Innovation Plan 2005-2008 (PRI), adopted by the Catalan Government on 25 January 2005.

However, policies adopted in Catalonia cannot forget the wider context, both in state terms and internationally –the EU. The European Council meeting in Lisbon in March 2000 established the European Research Space initiative with the objective of creating a «internal market» for research and facilitating collaboration and interaction among the EU countries and moving beyond an essentially funding-focused policy. With this new initiative, the European Union seeks to address such issues as researcher mobility, networking between national research programmes, legislative harmonisation in the field of industrial property, creation of a trans-European electronic research network and fostering of science culture among Europe's citizens.

Of the possible government approaches described in the first part of this article, the Catalan Government can only essentially employ the fostering and direct service provision approaches, given that many of the institutional factors having a direct or indirect bearing on Catalan R&D are outside its competence. This is the case, for example, of industrial property and contractual legislation, the regulations governing employment of foreign researchers in Spain, or social security system coordination, recognition of academic qualifications, tax incentives for companies, basic laws governing administrative employment, and regulations concerning animal or human biological tissue which may be the object of research, etc.

In all these examples, decision-making occurs at state level, which may hinder the adoption of Catalan policies designed to strengthen research;

[47] While a third of scientific publications are from Europe, this percentage does not hold for patents registered and Europe has a trade balance deficit for high technology products.
[48] Law 1/2003, of 19 February, on universities in Catalonia.
[49] Article 24 of LUC.
[50] Martí, 2003.

for example, the impossibility of establishing tax incentives is a highly constraining factor if we accept that this measure is one of the most efficient means of stimulating private investment in R&D and innovation.[51] However, despite this, it is possible to apply innovative approaches which give rise to practical effects, as shown by a number of recent examples. For example, the private foundation entitled the Catalan Institution for Research and Advanced Studies (ICREA), established in 2001 to facilitate consolidation of the body of researchers and scientists based in Catalonia. Promoted by the Department of Universities, Research and the Information Society (DURSI) and the Catalan Research and Innovation Foundation (FCRI), the objectives of the ICREA are to stabilise Catalan's research force and increase R&D human capital by facilitating the return of highly qualified Catalan researchers and scientists from abroad in addition to attracting high quality foreign researchers.[52]

In its continued efforts to stimulate Catalan research, the PRI plans to segment public procurement as a priority action within measures to foster innovation in the government. Employing public purchasing power and opting for new technologies[53] are beyond the traditional remit of public administrative activity, increasingly however, governments in our setting are employing this approach as an additional means of fostering research. Although as yet these are only plans, present law, plus legislation yet to be adopted (the «competitive dialogue» provided for by community law) will permit such measures without difficulty; all that is needed is the political will.

The future of Catalan R&D will bring many opportunities. The progress made to date is but the beginning; there remains much to be done. The lack of large-scale public research structures apart from universities, rather than a handicap may prove to be an opportunity. Given the lack of a long history in the field, there is no need for institutional reform. All that is required is that the system be coordinated and strengthened, and decisions must be made whether to provide research more directly or establish mechanisms to foster, imitate and integrate projects applied elsewhere or whether to develop Catalan alternatives, providing subventions with open or pre-set objectives. What is needed are decisions that will enable us to establish and consolidate the Catalan R&D system.

[51] Fundación COTEC, 2004, p. 241.
[52] Barberà, 2004.
[53] Consell Interdepartamental de Recerca i Innovació Tecnològica, 2005, p.54.

References

BALCELLS, Albert and Enric PUJOL. *Història de l'Institut d'Estudis Catalans, Volum I (1907-1942).* Barcelona: IEC, 2002.

BARBERÀ, Salvador. «La Institució Catalana de Recerca i Estudis avançats». *Coneixement i Societat*, 4 (2004), p. 88-95.

BORRAS, Susana and Bengt-Ake LUNDVALL. «Repensant la racionalitat de les polítiques científiques, tecnològiques i d'innovació des de la perspectiva del coneixement». *Coneixement i societat*, 3 (2003), p. 6-25.

BUSH, Vannevar. *Science: The Endless Frontier. A Report to the President*. Washington: United States Government Printing Office, 1945. Available at: http://www1.umn.edu/scitech/assign/vb/VBush1945.html.

BUSOM, Isabel. «Recerca, desenvolupament i innovació (R+D+I): una perspectiva sobre la situació de Catalunya i Espanya». *Coneixement i societat,* 5 (2004), p. 6-35.

CIRIT (COMISSIÓ INTERDEPARTAMENTAL DE RECERCA I INNOVACIÓ TECNOLÒGICA). *Pla de recerca de Catalunya, 1993-1996*. Barcelona: Generalitat de Catalunya, Comissionat per a Universitats i Recerca, 1993.

CIRIT (COMISSIÓ INTERDEPARTAMENTAL DE RECERCA I INNOVACIÓ TECNOLÒGICA). *II Pla de recerca de Catalunya, 1997-2000.* Barcelona: Generalitat de Catalunya, Comissionat per a Universitats i Recerca, 1997.

CIRIT (COMISSIÓ INTERDEPARTAMENTAL DE RECERCA I INNOVACIÓ TECNOLÒGICA). *III Pla de recerca de Catalunya, 2001-2004.* Barcelona: Generalitat de Catalunya, Departament d'Universitats, Recerca i Societat de la Informació, 2001.

CIRIT (CONSELL INTERDEPARTAMENTAL DE RECERCA I INNOVACIÓ TECNOLÒGICA). *Pla de recerca i innovació 2005-2008.* Barcelona: Generalitat de Catalunya, Departament d'Universitats, Recerca i Societat de la Informació, 2005.

COMISIÓN EUROPEA. *El Espacio Europeo de Investigación: Un nuevo impulso*. *COM (2002) 565 final, Bruselas, 16.10.2002*. Brussels: European Commission, 2002. Available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/es/com/2002/com2002_0565es01.pdf.

COMISIÓN EUROPEA. *El papel de las universidades en la Europa del conocimiento*. *COM (2003) 58 final, Bruselas, 05.02.2003*. Brussels: European Commission, 2003a. Available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/es/com/2003/com2003_0058es01.pdf

COMISIÓN EUROPEA. *Invertir en investigación: un plan de acción para Europa*. *COM (2003) 226 final/2, Bruselas, 4.6.2002*. Brussels: European Commission, 2003b. Available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/es/com/2003/com2003_0226es02.pdf

COMISIÓN EUROPEA. *Europa y la investigación fundamental*. *COM (2004) 9 final, Bruselas, 14.1.2004*. Brussels: European Commission, 2004a. Available at: http://europa.eu.int/eur-lex/es/com/cnc/2004/com2004_0009es01.pdf

COMISIÓN EUROPEA. *La ciencia y la tecnología, claves del futuro de Europa. Orientaciones para la política de apoyo a la investigación de la Unión*. *COM (2004) 353 final, Bruselas, 16.6.2004*. Brussells: European Commission, 2004b. Available at: http://europa.eu.int/eur-lex/lex/LexUriServ/site/es/com/2004/com2004_0353es01.pdf

DURSI (Departament d'Universitats, Recerca i Societat de la Informació). *Construir recerca*. Barcelona: Generalitat de Catalunya (DURSI), 2003a.

DURSI (Departament d'Universitats, Recerca i Societat de la Informació). «Les principals inversions en R+D de la Generalitat de Catalunya (2001-2006): divuit exemples emblemàtics». *Coneixement i Societat*, 2 (2003b), p. 50-73.

EUROPEAN COMMISSION. *Key Figures 2003-2004*. *Towards a European Research Area Science, Technology and Innovation.* Luxemburg: Office for Official Publications of European Communities, 2003. Available at: ftp://ftp.cordis.lu/pub/indicators/docs/ind_kf0304.pdf

FUNDACIÓN COTEC. *Informe COTEC 2004. Tecnología e innovación en España*. Madrid: Fundación COTEC para la Innovación Tecnológica, 2004.

GARRIDO FALLA, Fernando. «¿Réquiem por el servicio público?». *Cuenta y Razón del Pensamiento Actual*, no. 116 (2000).

HERREROS LÓPEZ, Juan Manuel. «La transformaciones del servicio público». *Actualidad Administrativa*, XLIV (2003).

KLEINMANN, Daniel Lee. *Politics on the endless frontier: postwar research policy in the United States*. Durham, North Carolina, USA: Duke University Press, 1995.

LARÉDO, Philippe and Philippe MUSTAR (ed.) (2001) *Research and innovation policies in the new global economy*. Cheltenham (UK): Edward Elgar, 2001.

MARTÍ, Roser. «La Llei d'universitats de Catalunya. Un marc jurídic propi per a les universitats del sistema universitari català». *Coneixement i Societat*, 1 (2003), p. 36-79.

MARTÍNEZ LÓPEZ-MUÑIZ, José Luis. «Servicio público, servicio universal y 'obligación de servicio público'». *Administración de Andalucía. Revista Andaluza de Administración Pública*, no. 39 (2000).

MINISTERIO DE CIENCIA Y TECNOLOGÍA (MCyT). *Informe del Ministerio de Ciencia y Tecnologia 2002-2003*, Madrid: Ministerio de Ciencia y Tecnología, 2004.

NAVARRO COSTABELLA, J. *La Universitat de Catalunya*. Barcelona: Comissariat de Propaganda de la Generalitat de Catalunya, 1937.

NEEDHAM, Joseph. *The Grand Titulation. Science and Society in East and West*. London: Alien, 1972. [There is a Spanish translation: *La gran titulación. Ciencia y sociedad en Oriente y Occidente*. Madrid: Alianza Editorial, 1977].

NATIONAL SCIENCE BOARD (NSB); *Science and Engineering Indicators 2004*, Volume 1, , Arlington, Virgínia, USA: National Science Foundation, 2004. Available at: http://www.nsf.gov/sbe/srs/seind04/

OCDE. *Manual de Frascati 2002. Propuesta de norma práctica para encuestas de investigación y desarrollo experimental.* Madrid: Fundación española para la Ciencia y la Tecnologia (FECYT), 2003. Available at: http://www.ocyt.org.co/Manual%20de%20Frascati%202002.pdf

OECD. *University Research in Transition*. Paris: OECD Publications Service, 1999. Available at: http://www.oecd.org/dataoecd/9/13/2754370.pdf

OSBORNE, David and Ted GAEBLER. *Reinventing Government*. New York: Addison-Wesley,1992. [There is a Spanish translation: *La reinvención del gobierno. La influencia del espíritu empresarial en el sector público*. Barcelona: Paidós, 1995].

ROSSI, Paolo, *Francis Bacon, dalla magia alla scienza*. Bari: Laterza, 1957. [There is a Spanish translation: *Francis Bacon: de la magia a la ciencia*. Madrid: Alianza Editorial, 1990].

SALABURU, Pello (dir.). *Sistemas Universitarios en Europa y EEUU*. Madrid: Academia Europea de Ciencias y Artes, 2003. Available at: http://www.academia-europea.org/pdf/sistemas_universitarios_en_europa_eeuu.pdf

SANZ MENÉNDEZ, Luis. *Estado, ciencia y tecnologia en España, 1939-1997*. Madrid: Alianza Editorial, 1997.

TOCQUEVILLE, Alexis de. *La democracia en América*. Madrid: Alianza Editorial, 1993.

TRONCOSO REIGADA, Antonio. «Dogmàtica administrativa y el Derecho constitucional: el caso del servicio público». *Revista Española de Derecho Constitucional*, no. 57 (1999).

VALLE PASCUAL, Juan Manuel del; and José Ramón CHAVES GARCÍA. «Un enfoque jurídico sobre la investigación universitaria». *Actualidad Administrativa*, LVI (1998).