

## *Chapter 2*

# **Catalonia's S&T and Innovation Policies**

## Introduction

Since the first autonomous elections of 1980, Catalonia's government has recognised the importance of investing in R&D and innovation for the economic growth, industrial diversification and social welfare of the region. Yet the development of a comprehensive innovation system has experienced vicissitudes and been slow to emerge. Over the last three decades, Catalan approaches to S&T and innovation policies have evolved under the influence of several factors whose interdependence may continue to orient these policies and the innovation performance of the region in the future:

- **Constitutional/devolution issues:** Sharing of responsibilities and co-ordination between the State and regions over S&T policy and resources;
- **Stakeholder issues:** Relative balance of power between the academic and business communities – as well as societal concerns – for policy orientations and their consequences in terms of resource allocation;
- **Political issues:** From 1980-2003, the Coalition and Union party led the Catalan government. Since 2003, there has been more political turnover leading to frequent ministerial changes and more complex political coalitions;
- **Governance issues:** Evolution of government structure and responsibilities as regards the design, funding and implementation of S&T policy, including the growing importance of accountability of public action;
- **External sources of funding:** Catalonia's access to the European Union (EU) Framework Programme and Structural Funds following Spain's adhesion to the EU in 1986 as well as increased capabilities to benefit from Spanish support programmes;
- **Increasingly viewing innovation as a tool to address problems:** Growing recognition at all levels of the key role of innovation for sustainable development and international competitiveness across economic activities, including public and private services, as well as of the threats and opportunities brought about by globalisation; and
- **Changing approach to innovation policy:** Progressive diffusion of the innovation system conceptual framework into the policy-making process at EU, Spanish and Catalan levels.

The Catalan Agreement for Research and Innovation (CARI) signed at the end of 2008 represents a major initiative of the region. It takes stock of these evolutions to foster a socio-political consensus on the diagnosis of the Catalan innovation system, the main challenges that it faces, and the medium-term objectives that a broad-based research and innovation policy must pursue. Based on this consensus, the public and private stakeholders involved have agreed on concrete commitments whose fulfilment should contribute to meet these objectives. The CARI provides the foundation on which the next Research and Innovation Plan (PRI) for 2010-2013 is being developed.<sup>1</sup> To better understand the scope and the reach of the CARI as well as the issues to be addressed in the 2010-2013 PRI, it is necessary to review this agreement against the background of the Catalan approaches to S&T and innovation policy.

## 2.1. The evolution of Catalonia's S&T and innovation policies

### *The initial phases after the first autonomous elections (1980-1988)*

In the early 1980s, after the first autonomous elections, Catalonia was already one of the Spanish regions with the highest concentration of research and innovation activities. Although it accounted for more than 16% of the country's R&D expenditures, the intensity of that investment was much lower than that of other major European regions. The share of business in total regional R&D expenditures was already larger than the public share. Catalan enterprises outperformed those of other Spanish regions in terms of patent applications, even if the major source of technology remained embodied in imported capital goods and designs. S&T infrastructure was relatively well developed, with three public universities and a number of Spanish public research institutions operating under the aegis of the Spanish Research Council (CSIC). There were also incipient research and technological centres created by the newly formed Catalan government and operating either in collaboration with universities or under the aegis of sectoral departments.<sup>2</sup> This infrastructure contributed to a relatively good record in terms of scientific production as compared to the other Spanish regions, and in particular that of Madrid (Cruz Castro *et al.*, 2003).

In the first year of the new legislature, the Inter-ministerial Research and Innovation Commission (CIRIT) was created under the chairmanship of the region's President but could not effectively carry out its mission. It was entrusted with the allocation of Catalan public investment in, and support of, S&T-related activities. The creation of this institution at inter-ministerial

level seemed to already indicate a willingness to address in a co-ordinated fashion the demand and supply sides of R&D and technology, the strengthening of scientific capacity of public research institutions, and the technological absorptive capacities of the productive sector – mainly in industry and agriculture (Bacaria *et al.*, 2004). CIRIT immediately faced resource constraints due to the nascent conflict between the Spanish State and the *Generalitat* (Catalan government) over the transfer of responsibilities and resources in the S&T area.<sup>3</sup> These transfers, that would have contributed the largest share of the CIRIT budget, were not approved at State level.<sup>4</sup> CIRIT resources therefore remained minimal, peaking at EUR 3.18 million in 1983.

The CIRIT budget crunch had two important interrelated consequences that introduced a *de facto* bias in the governance of the system away from inter-ministerial co-ordination. To compensate for the lack of devolved Spanish government resources, there was a shift in the balance of S&T and innovation policy towards the academic side, mainly in the areas of infrastructure and human capital development through scholarships, at the expense of support to innovation and technology transfer. Second, the academic constituency gained the upper hand in the decision-making process, the selection of policy priorities and the funding of programmes (Cruz Castro *et al.*, 2003).

To compensate for this policy imbalance towards the academic side, in 1985 the Ministry of Industry created a new agency to strengthen S&T infrastructure for industry: the Centre of Entrepreneurial Information and Development (CIDEM). This agency started with actions focused on the development of sectoral technological centres, the provision of technological services such as metrology and certification, and the dissemination of information through networks. The Ministry of Agriculture secured its S&T-related resources coming from the State and its oversight on the research centres in the areas under its responsibility.

This dual or “silo” approach to S&T and innovation policy continued and was institutionalised during the second legislature (1984-1988). With the 1986 devolution of the responsibility and related resources over the public higher education sector to the regions, and the contrary decision regarding the S&T sector taken in the same year,<sup>5</sup> the pressure of the academic community to take a *de jure* control over the CIRIT became stronger. This institutional change became effective in 1988 when the CIRIT passed under the direct responsibility of the Ministry of Education. The attempt at a co-ordinated approach was unsuccessful as a narrow academic vision of a Catalan S&T policy prevailed with the institutional consolidation of a silo approach.

### *A transitory phase (1988-1992): towards consolidation of the dual approach*

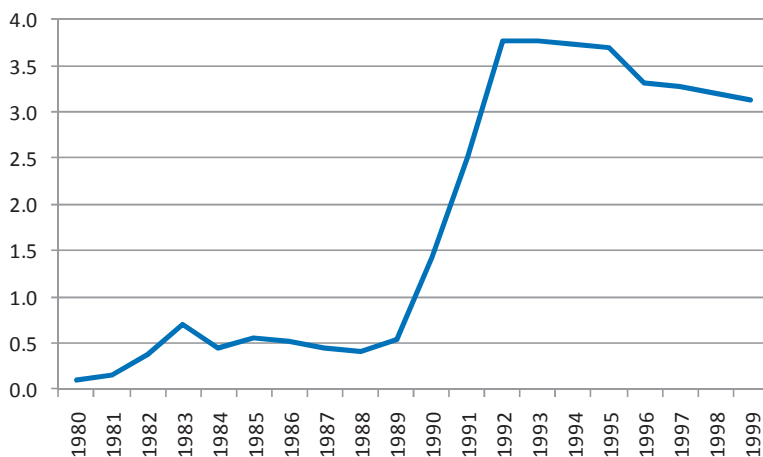
The lack of articulation between the research and innovation pillars of S&T policy deepened during this period. The academic constituency's pressure for resources to develop their research activities (mainly related to infrastructure and human capital) became more acute while awaiting resolution of the S&T devolution issue. Anticipating a negative outcome of this stalemate – after an appeal from the Catalan government was rejected by the Spanish Constitutional Court in 1992 – CIRIT managed to substantially increase the budget appropriations for research activities under its control, as well as those coming from other bodies of the Ministry of Education.<sup>6</sup> Indeed, between 1988 and 1992 the R&D budget of that Ministry (CIRIT and the Directorate General of Research) increased more than tenfold to reach EUR 33.3 million at the end of the period, with more than half allocated to CIRIT programmes (see Figure 2.1). Despite this substantial increase in absolute terms, the budget remained quite small for an economy of Catalonia's size.

Catalonia made a strategic choice to leverage outside (Spanish and EU) funding sources by strengthening research capacity, a strategy which proved successful.<sup>7</sup> This mainly involved the financing of S&T infrastructure in universities and regional research centres, support to the constitution and development of research groups, support to the creation of doctoral programmes, and a rapid increase of scholarships for advanced study. Indeed, over the last two decades Catalan research institutions, including the more recently founded universities, have been gaining a substantial share of both State research funds and of the EU Framework Programme resources awarded to Spanish research institutions (see also Chapter 3).<sup>8</sup>

However, programmes focusing on the development of universities' "third mission" remained quasi inexistent. There were few if any incentives or institutional arrangements aimed at fostering the transfer of scientific knowledge to the productive sector and the collaboration between science and industry. The only actions explicitly devoted to foster firm innovative or technological capacities were carried out through the provision of support services by CIDEM for manufacturing industries or by the Ministry of Agriculture for the agrofood sector. There were no financial instruments such as grants, loans or guarantees in support of research and innovation projects in or by enterprises.

Figure 2.1. Catalan public R&amp;D expenditure: 1980-1999

Billions of pesetas (constant prices 1986)



Notes: This includes spending under the remit of CIRIT (Inter-ministerial Commission on Research and Innovation) as well as in some years the Directorate General for Universities and/or Research. It excludes funds under the remit of IRTA, the Catalan Research Centre for Agriculture, Aquaculture and the Agrifood industry created in 1985.

Source: OECD calculations based on data from the *Gabinete Técnico de Investigación (GTR)* y *Comisionado para las Universidades y la Investigación, 2000* as cited in Cruz Castro, L. *et al.* (2003), “La importancia de los intereses académicos en la política científica y tecnológica catalana”, Papers: *Revista de Sociología*, Vol. 70, pp.11-40.

### ***The first two Research Plans (1993-2000): recognition of complementarities***

In 1992, the region developed the first Research Plan of Catalonia. Plan development was entrusted to a newly created special Commission for Universities and Research (CUR). CUR was a new government body independent from the Ministry of Education, overseeing CIRIT and the General Directorate for Research.

In principle, the Catalan government favoured an S&T strategy providing for increased synergies between the research and innovation pillars of S&T policy, but this again proved difficult. However, it maintained a linear view of the links between these two pillars. Hence the

government's original idea to strike an improved balance between supply factors (essentially support to public research infrastructure and the development of human capital), and demand factors (incentives to R&D and innovation investment as well as support to technology transfer). This view was of course inspired by the increased concerns for the competitiveness of Catalan industry and the agrofood sector in the open European market and the premium to be gained in productivity through innovation. Moreover, since the overwhelming share of the financing of the research projects was coming from outside, more resources could be invested in innovation-related activities. This vision proved difficult to obtain due to institutional inertia, as the CUR was still strongly dominated by academic interests.<sup>9</sup>

In the first Research Plan (1993-1996), the bulk of resources were devoted to strengthening research groups to capture outside competitive project funding. They sought to achieve this through support to the physical, human and organisational S&T infrastructure in universities and public research centres. Priority lines of action were only pursued through the creation of the so-called Reference Centres Network aiming to strengthen the S&T potential in areas such as biotechnology, food technology and advanced production technologies. Conceived as a means to facilitate technology transfer, these centres were financed on a contractual basis. Their performance was at best mixed as their governance lacked efficient co-ordination mechanisms between the supply and demand sides. The Plan did not include specific programmes or instruments for direct financial support to firm innovative projects. However, at the end of the period covered by the Plan, CIDEM started to provide such type of support, essentially to SMEs, with the launching of a joint CIRIT/CIDEM grant programme in 1995.

In terms of resource allocation, the *de facto* policy mix of the Plan was heavily tilted towards the scientific base. There was not much concern with either the demand side or the articulation between latent demand and the orientations of supply. Less than 7% of the 1995 budget for research in a broad sense was devoted to firms' innovation projects. The bias in the policy mix was due in part to the governance setup, with Plan development by CIRIT acting under the authority of the Commission of Universities and Research and not reflecting a true inter-ministerial approach. Another bias stemmed from a confusion of roles for CIRIT as a body involved both in policy making and policy implementation.

The period of the second Research Plan (1997-2000), whose preparation was still led by CIRIT under the authority of the CUR, marked a certain evolution towards an improved balance in the policy mix. Policies directed by the Plan as well as other developments in the region acknowledged not only public sector knowledge generation, but also private R&D as well as

technology transfer and collaboration. In addition to the Plan's focus on research infrastructure and human capital,<sup>10</sup> there were significant new initiatives that highlight this incipient evolution. While qualitatively they represent a conceptual shift to the beginnings of a systemic focus of the research/innovation nexus, quantitatively these new initiatives remained rather poorly endowed *vis-à-vis* those focusing on the strengthening of the research infrastructure (see Table 2.A1.1). Some of the new initiatives included were:

- ***The creation of a Network of Centres for Technological Innovation Support (XIT)*** in 1999. This network was co-financed by CIRIT and CIDEM with the collaboration of Catalan universities. Its purpose was to provide incentives to academic research groups to engage in knowledge transfer activities as well as to create spin-offs by individual researchers. A system of accreditation of centres was developed to provide some quality guarantees to both enterprises and research groups engaged into collaborative activities. Public resources invested in this network served as a catalyst to leverage private financing from firms engaged in collaborative activities with the centres, revealing a latent but effective demand. The number of accredited centres grew rapidly from nine in 1999 to 24 in 2000 (CIRIT, 2003). This network structure which represents the “touchstone of the Catalan technology transfer system” (Defazio and García-Quevedo, 2006), is at the origin of the creation of other similar initiatives in subsequent years.
- ***The consolidation of the programme of support to firm innovation projects*** co-financed by CIRIT and CIDEM and engaged in the last years of the previous Plan. Close to 300 enterprises, mainly but not only SMEs, were supported during the period covered by the Plan. Here again there was a leverage effect built into the programme with 1 peseta of grant inducing an investment of 9 pesetas in innovation-related activities (CIRIT, 2003).<sup>11</sup>
- ***Programmes focusing on mobility of human resources*** aiming to facilitate the insertion of R&D personnel in firms. They included scholarships to facilitate the undertaking of doctoral work in firms, or subsidies to the temporary recruitment of public research centre staff in firms.



### ***Third Plan: separate and complementary research and innovation policy areas***

In the final year of the second Research Plan, pressures mounted to devote greater attention to the promotion of innovation in the formulation of policies and the allocation of resources.<sup>12</sup> While the importance of greater co-ordination was explicitly stressed, the choice was made to elaborate separate plans for research and innovation in parallel. This approach went against pervasive influence of the systemic approaches in S&T and innovation policy fostered by the European Union and the OECD, among others. Across the two plans there was an effort to ensure some co-ordination in policy design, complementarities in support programmes and joint funding mechanisms. CIRIT was entrusted with preparing the third Research Plan (2001-2004) as it had been for the previous Plan.<sup>13</sup> The complementary Innovation Plan was entrusted to CIDEM. Both bodies had management functions for the implementation of the respective Plans.<sup>14</sup>

The third Research Plan basically pursued the same objectives of the previous one, with a primary focus on the strengthening of the Catalan research system to attract outside competitive funds. In this plan there was a greater emphasis on the support to the creation of research groups on the basis of excellence criteria (managed by the newly created Agency for Management of University and Research Grants [AGAUR]) and on the development of public research centres through either expansion or creation of new facilities. One of the major achievements of the Plan was the very rapid development of the ICREA programme, whose budget resources to hire prominent international scientists grew by over 600% during the Plan period. ICREA played a determining role in Catalonia's performance in accessing external competitive sources of funding of research projects. As was the case in earlier Plans, the only resources devoted to thematic research programmes were allocated through institutional funding of research centres overseen by DURSI, and other sectoral ministries, primarily health and agriculture. Over the four years covered by the third Plan, Catalan public resources devoted to R&D and innovation increased by over 34% (Table 2.1). Compared with the prior Plan, the share of resources devoted to the direct promotion of firm technological innovation were among those that grew the fastest, especially over the last years of the period (García-Quevedo, 2005).<sup>15</sup>

Table 2.1. **Change in levels and type of spending between second and third Research Plans**

EUR millions

	Second Plan 1997-2000		Third Plan 2001-2004		Variation
	Volume	%	Volume	%	%
Horizontal programmes <sup>1</sup>	176	16.3	270	18.5	53.0
University researchers' salaries <sup>2</sup>	560	51.9	707	48.7	26.3
Thematic areas <sup>3</sup>	342	31.8	459	31.5	33.5
Total government R&D expenditure	1 079	100.0	1 454	100.0	34.7

Notes: 1. CIRIT budget, 2. DURSI universities budget, 3. budgets from sectoral ministries.

Source: Ministry of Universities, Research and Information Society (DURSI), Catalonia.

The Innovation Plan was designed following the approach promoted by the European Commission's Regional Innovation and Technology Transfer Strategies (RITTS) initiative.<sup>16</sup> Resources for innovation promotion, including direct support to firms, increased significantly over the duration of the Innovation Plan, from EUR 11 million in 2001 to EUR 37 million in 2004 (Parellada Sebata, 2005). Applying the RITTS approach within the context of Catalonia's institutional specificities, the Innovation Plan was articulated around six main programmes. They were financed and implemented by CIDEM, some of which had already been initiated in the context of the collaboration with CIRIT in the second Research Plan (Busom, 2006):

- Development of technology markets (*Mercado tecnológico*), mainly through the support of technology transfer, collaboration activities, and human resources mobility between enterprises and public research institutions in the framework of the Network of Centres for Technological Innovation Support (XIT) initiated in 1999 in collaboration with CIRIT. This programme – which also included the provision of services in innovation supporting activities such as the management of intellectual property rights – accounted for close to 50% of the total resources of the Plan (EUR 137 million).
- Innovative entrepreneurship (*Esperit emprendedor*), mainly through support to the creation of spin-offs from academic research through the provision of specialised services and financing facilities. In 2004, this programme was consolidated through the creation of, and support to, the Network of Technological Springboards (XTT) located in all universities (and some business schools).

- Digitalisation of SMEs (*Digitalizació de la empreses*).
- Provision of financial services and support to the development of innovative projects (*Finançament*) managed jointly with the Catalan Finance Institute (ICF).
- Provision of capacity building services to SMEs for access to technological information and knowledge management (*Gestió de la innovació*); and
- Provision of support services and financing to improve access to information on, and implementation of, advanced process technologies and logistical infrastructure (*Producció i logística*).

CIDEM also introduced a programme in support of innovative projects in the form of financial incentives granted to firms on a competitive basis. Although in principle open to firms of all sectors, this programme was mainly targeted at priority sectors deemed to be strategic (e.g. pharmaceuticals or aerospace), or experiencing a rapid transformation due to increasing international competition (e.g. textile, automobiles and consumer electronics). In 2004, public support amounted to close to EUR 30 million. On the other hand, actions aiming at fostering technological transfer were further developed in 2004 through the creation of two new networks: the Technological Centres Network (XCT) and the Technology Dissemination Network (XCDDT).

The decision to develop a separate Innovation Plan apart from the Research Plan had mixed effects. On the positive side, it may be argued that an initially separate innovation policy under the Ministry of Industry and CIDEM probably facilitated a better identification of the market and systemic failures that impaired the development of firm innovative capabilities, notably in terms of access to, and costs of, technological information and financing investment. It also allowed for larger budgetary appropriation for innovation-related programmes.

On the negative side, it seems that the Innovation Plan contributed to the current multiplicity of initiatives that tend to reflect a “one problem-one instrument” syndrome. The rationale behind the definition of the different programmes and the boundary of their scope is not entirely clear. This is particularly the case for the numerous networks that now exist in Catalonia, all created to address particular aspects of the chronic technology diffusion weakness of the Catalan S&T and innovation system (see Table 2.2). Moreover, the network label may be a misnomer as it refers only to a certification credential of a private or public technological transfer institution. Since 2009, there is now an effort to better integrate these different networks under a common label of TECNIO.

Table 2.2. Catalan technology transfer networks

Technological Innovation Network (XIT)	Created in 1999, the XIT is formed by units and groups of researchers with the capacity to offer innovation services to Catalan companies. It offers the services of researchers who are most experienced in working with companies and who recognise the need to respond quickly to market opportunities. All the universities and relevant government units (it is mainly an initiative of CIDEM but includes CIRIT) are involved as providers and managers.
Network of Technological Springboards (XTT)	Launched in 2000, the objective of the XTT is to create a network of units located in universities and business schools across the region to encourage the establishment of knowledge-based companies from within universities. Network staff help identify projects that could be exploited by firms, give courses on entrepreneurship and hold competitions for the development of business plans, etc. In 2002, this took a general approach with local advisors in different organisations. In 2005, these advisors began taking a sectoral approach. In 2008, the advisors became part of CIDEM/ACC10 and began a technological approach.
Innovation Centres Network (XPIC)	The XPIC is composed of several intermediate organisms acting as strategic allies of the CIDEM, in a type of cluster approach. Their function is to design and carry out the innovation policy, and to provide SMEs with the essential information needed for their business activity. Moreover, it designs programmes according to the needs of the territory in which the network is acting, and creates synergies among the members of this industrial sector.
Technology Advisers Network (XAT)	The XAT is focused on the management of technological innovation in companies. The network is organised into 13 sectoral nodes and is delivered by chambers of commerce, specialised foundations and technology centres. They provide specialised advice to companies in project definition, information searches, and partner searches.
Business Angels Network (XIP)	The XIP is a programme designed by CIDEM to promote the growth of high potential innovative companies. It is a network of different existing investor networks which share a common code of good practice and work together to finance, advise and work with newly created companies during their early phase growth.
Technology Centres Network (XCT)	Created in 2004, XCT is the network that regroups all technology centres. The objective of this network is to map and rationalise the existing offer of technological services and fill any gaps. The participating centres focus on applied research, pre-competitive development and services. They are grouped according to their specialisation and national or international level of excellence so that depending on their size, level of knowledge and specialisation, they are able to supply continuous support to their customers' innovation activities. There are seven major technology centres in the network, including both private and public not-for-profit structures.
Technology Dissemination Centres Network (XCDT)	Also launched in 2004, XCDT was created to promote technology transfer to help overcome an infrastructure deficit and organisational problems in the Catalan innovation system. This network is based around a Registry that brings together information about the region's science and technology organisations, including their services and objectives. The XCDT centres are characterised by their geographical proximity to their client base. Services include: promotion and dissemination of technology; information and assistance with innovation; training; and advanced technology services. There are six centres in the network dedicated to local business activities and located in proximity to those firms in sectors such as wine making, textiles, furniture making.

Source: Catalan government (2008), *Catalan Agreement on Research and Innovation: Framework Document*, Barcelona with additional information from ACCIÓ.

Fostering networking among S&T institutions is a right approach as it facilitates dissemination of information and the pooling of skills in support of technology transfer activities.<sup>17</sup> But a multiplicity of specialised single-purpose networks may be counterproductive because of lack of critical mass, loss of comprehensiveness in the approach and weak complementarities in addressing technology transfer issues. In this respect, an evaluation of CIDEM's initiatives taken in the context of the Plan or continuing those previously implemented would have been useful before launching the integrated 2005-2008 Research and Innovation Plan.<sup>18</sup>

In comparison with more advanced European regions, the density and intensity of knowledge flows are weaker in Catalonia. It had been argued in the past (Riba and Leyersdorff, 2001) that Catalonia's innovation system lacked some of the essential features deemed characteristic of effective regional systems.<sup>19</sup> This is why knowledge flows, as well as the market and non-market processes that facilitate such flows, were emphasised in the third Plan. However, Spanish level regulations limit Catalan academic institutions' ability to develop their "third mission". In response to real deficiencies and to such regulations, Catalonia has taken a number of institutional initiatives aimed at overcoming the resulting systemic weaknesses and limitations suffered by universities. In the course of the third Research Plan, the number of Catalan Research Centres grew from 12 in 2000 to 20 by 2005, and the number of ICREA researchers from 60 in 2001 to 135 in 2004.

The experience of separate but complementary research and innovation plans facilitated the recognition of the systemic nature of the S&T and innovation system. The decision was made to merge research and innovation policies in the subsequent plan initiated in 2005. With hindsight, the pros and cons of separate plans may also have facilitated the ministerial restructuring that took place a few years later in 2007 with the creation of the Ministry of Innovation, Universities and Enterprise entrusted with a more comprehensive oversight over the implementation of R&D and innovation policy.

### ***The 2005-2008 Research and Innovation Plan (PRI): towards an integrated approach***

The 2005-2008 Research and Innovation Plan (PRI) reflects a shift in the balance of power among firm and academic stakeholders, laying the framework of a comprehensive and systemic approach. Its lines of actions focus in an integrated way on the factors that impinge on the performance of the Catalan S&T and innovation system as a whole and, more generally, on the competitiveness of the Catalan economy. In contrast with the preceding

plans, and in line with the findings of many analyses of the performance of innovation systems,<sup>20</sup> the PRI recognises that fostering firm capacity to invest in R&D and innovative activities enhances their ability to effectively engage in co-operation with research institutions, creating virtuous dynamics.

However, the integrated approach that underlies the conception of the Plan at the analytical level is more weakly followed at the level of policy implementation and budgetary allocation. Integration is too often sought through a juxtaposition of programmes involving complementarities, rather than through incentive structures that have built-in integration dynamics. There is a desire to increase co-ordination between government bodies that manage support programmes aimed at nurturing the linkages between the research and enterprise communities. However, this co-ordination is rarely, if at all, implemented through joint management and financing procedures between responsible departments from different ministries or agencies. It is also worth noting that the ministries concerned by the budgetary allocations for the Plan implementation were only DURSI and the Ministry of Labour and Industry (DTI) and do not include other sectoral ministries such as those of Agriculture and Health under the aegis of which are conducted important S&T activities in public research institutions.<sup>21</sup> This suggests that the integration process pursued by the Plan was not completely achieved, possibly due to inertia in governance structures and budgetary allocation procedures.

The ten objectives determined by the PRI reflect an integrated approach and a balance in policy priorities of different constituencies (Box 2.1). These objectives are supported by two sets of programmes aimed at strengthening the S&T and innovation system as a whole, as well as promoting an innovative culture across the Catalan society. There is also a set of strategic actions aimed at fostering the Catalan capacities in key technologies or sectors deemed to have large spillover effects in the regional economy (see Table 2.3). (See Table 2.A1.3 for a mapping of these programmes relative to the innovation barriers they address.)

**Box 2.1. Objectives of the Research and Innovation Plan (2005-2008)**

1. To expand the research and development base by attracting new talent and facilitating the entry of young researchers into the system.
2. To build up universities, educational centres and infrastructures to the level required of advanced and high-quality research and development activities.
3. To continue fostering improvements in the quality of research conducted in Catalonia as a prerequisite for attaining full integration in the European research area.
4. To foster the entrepreneurial spirit and the creation of technology-based enterprises by increasing the number of joint programmes between universities, research centres and businesses and by promoting the transfer of technology and knowledge.
5. To promote the entry of researchers and qualified human capital into the private enterprise sector.
6. To consolidate and unify the research, technology transfer and innovation system in Catalonia.
7. To augment the innovation capabilities of businesses established in Catalonia and to foster internationalisation projects.
8. To draw up specific sectoral and technological strategies that will drive both the development of the economy and structural modifications in productive activities.
9. To improve co-ordination between Catalan research and development policies and economic, social and cultural policies, thereby making Catalonia a reference as far as co-ordinated research and innovation support policies are concerned.
10. To promote communication and public awareness of developments in science and technology so that society as a whole becomes fully aware of the importance of research, development and innovation.

*Source:* CIRIT (2005), “*Pla de Recerca i Innovació de Catalunya 2005-2008*”, Government of Catalonia, Barcelona.

Table 2.3. **Research and Innovation Plan budget**

2005-2008

Priority actions	Ministry	Agency	2005-2008		2007	
			Budget (EUR millions)	%	Budget (EUR millions)	%
<b>Transversal actions</b>			<b>649.0</b>	<b>75.5</b>	<b>184.5</b>	<b>77.3</b>
Support to research	DURSI	AGAUR	169.0	19.6	30.0	12.6
Support to research personnel	DURSI	AGAUR/ ICREA	138.5	16.1	38.1	16.0
Research centres and infrastructure	DURSI	DGR	213.3	24.8	69.8	29.2
Technology and knowledge transfer	DTI	CIDEM	77.3	9.0	30.1	12.6
Innovation promotion	DTI	CIDEM	48.0	5.6	11.8	4.9
Financing support	DTI/DEIF	CIDEM/ICF/ Avalis	2.9	0.3	4.7	2.0
<b>Complementary actions</b>			<b>88.2</b>	<b>10.2</b>	<b>10.6</b>	<b>4.5</b>
Mobility, co-operation and internationalisation	DURSI		19	2.2	3.5	1.5
Promotion of S&T culture	DURSI		4.3	0.5	1.2	0.5
Promotion of entrepreneurship	DTI	CIDEM	23.4	2.7	2.8	1.2
Innovation in public administration	All		40.5	4.7	2.2	0.9
Co-ordination and attraction of Spanish and EU funds	All		0.9	0.1	1.0	0.4
<b>Sectoral and technology strategy</b>	DTI	CIDEM/SIE	<b>122.8</b>	<b>14.3</b>	<b>43.5</b>	<b>18.2</b>
<b>Total PRI</b>			<b>860.0</b>	<b>100.0</b>	<b>238.5</b>	<b>100.0</b>

Notes:

1. Estimated budget for the duration of the Plan. It only covers the “direct” budget to finance the actions and programmes explicitly included in the Plan. It does not cover the so-called “indirect” budget expenditures that include other government expenditures devoted to R&D and innovation such as DURSI’s contribution to the salaries of university personnel devoted to R&D activities (EUR 800 million) and sectoral ministry financing of R&D activities undertaken by institutions under their authority, mainly the Health and Agriculture ministries (EUR 400 million). Same definitions for budget executed in 2007.

2. The acronyms used in the table include: DURSI=Ministry for Universities, Research and Information Society, DTI= Ministry of Employment and Industry, DEIF=Ministry of Economy and Finance, AGAUR=Agency for Management of University and Research Grants, ICREA=Catalan Institution for Research and Advanced Studies, DGR= Directorate General of Research in DURSI, CIDEM= Centre for Innovation and Business Development, ICF=Catalan Institute of Finance, and SIE= Secretary of Industry and Energy.

Source: CIRIT (2005), *Pla de Recerca i Innovació de Catalunya 2005-2008*, Government of Catalonia, Barcelona.



The first set of programmes grouped under the label “transversal actions” focuses on the core of the innovation system. It consolidates and refines the major policy orientations of the previous Research and Innovation Plans, albeit with a more balanced approach between the support of supply and demand factors. The salient transversal actions are articulated around the following main elements:

- **Public research capacity.** Support to public research capacity building such as infrastructure, incentives for the creation of research groups, and human resources development continues to receive the largest share of budgetary appropriations (more than 60% of the total budget). This includes ICREA and, to a lesser extent, endowment of scholarship programmes.
- **Institutional but not thematic project research grants.** As in previous plans, most of the financing of public research is institutional. There are practically no budgetary resources devoted to targeted research programmes or competitive research projects. Catalonia has adopted a “subsidiarity principle”: the Catalan government finances the development of public research and academic capacities so that these institutions are better placed to attract competitive funding from Spanish and European sources.
- **Acceleration of the creation and expansion of Catalan Research Centres<sup>22</sup>** to overcome the institutional rigidities that hinder the academic research system’s ability to engage in collaboration with the private sector and invest in new scientific disciplines requiring the accreditation of new doctoral programmes. By 2008, the number of Catalan Research Centres had reached 37 with six others in development. Such an evolution goes against the trends observable in the majority of developed countries and regions where the role of specialised research centres declines *vis-à-vis* that of multi-disciplinary university research groups.
- **Substantial increase of resources devoted to support firm investment in R&D and innovative activities.** This is achieved essentially through competitive grants, and, to a lesser extent, subsidised loans and guarantees, as well as facilitated access to public venture capital. Increasing resources had already started in the last years preceding the launching of the PRI, from EUR 12.5 million in 2003 to EUR 33 million in 2004 and 36 million in 2005 (García-Quevedo, 2005). This trend was due to continue over the duration of the Plan.<sup>23</sup> The Plan is not always clear on the types or portfolio of support instruments deemed more efficient to promote private investment in R&D and innovation activities

according to the various types of market and systemic failures faced by different categories of firms.<sup>24</sup>

- **Financing.** For the first time there is an explicit recognition of the fact that the financing constraints faced by innovative enterprises deserve the development of instruments that ease such constraints beyond direct support to projects in terms of grants or loans. Hence, some timid initiatives were initiated to facilitate the development of venture capital funds by the Catalan Institute of Finance (ICF), the subsidisation of guarantee schemes (Avalis) and the provision of services to facilitate access to diversified sources of capital.
- **Increased effort devoted to technology transfer programmes.** Support is mainly supply oriented as it finances the organisation of the provision of technological services by networks of transfer institutions (see Table 2.2). Limited resources are made available directly to SMEs to undertake technological assessments of actual production processes or potential innovative projects. As noted above, while technology transfer programmes must cater for various types of need, the rationale for such a diversity of support networks may be questionable.<sup>25</sup> Moreover, it seems that a more efficient balance could be struck between instruments that focus on fostering the demand for technological services and knowledge inputs through the enhancement of absorptive capacities (e.g. subsidising the recruitment of high-skilled personnel, supporting technological diagnostics, or a cluster-type approach), and those that focus on the strengthening of supply of technological services. There are some local initiatives to support technology transfer as well.

The second set of programmes of the PRI regroups “complementary actions” that aim to generate or consolidate “an environment that sustains a culture of science, technology and innovation in all walks of society and facilitates the emergence of innovating initiatives.” In fact, this set looks like a mixed bag of actions that may be important in their own right. Therefore, the rationale for having two separate sets of programmes looks somehow artificial. This is notably the case for two programmes that could have been incorporated in the so-called “transversal actions” as they are related to issues that belong to the core of the innovation system: on the one hand, the institutional mobility of S&T personnel and, on the other, the promotion of entrepreneurship.

The third set of programmes concerns actions in support of priority areas of research related to economic or social demand and strategic sectors, the so-called “sectoral and technology strategy”.<sup>26</sup> These actions were to be financed by CIDEM and the Ministry of Industry and Employment. No indication is given as to the process that led to the selection of priority

research areas or industrial sectors. Many OECD regions go through extensive exercise to determine their priorities. For example, the Flemish Science Council recently developed the region's priorities and identified 30 priorities and 15 preconditions within six clusters of strategic importance to Flanders. Contrary to support actions pertaining to the two other sets of "transversal" and "complementary" programmes, the PRI does not define any specific policy instruments for implementation or reference indicators to monitor policy achievements or outputs in this third category.

## **2.2. Achievements and limitations of the 2005-2008 Research and Innovation Plan**

### *Indicators and evaluation*

#### *Benchmarking indicators*

To monitor and assess its achievements in quantitative terms, the PRI has defined two sets of indicators. The first set of "key indicators" relates to the Plan's global objectives in bridging the gaps with the EU average in terms of innovation performance. The second set of "reference indicators" relates to specific policies. They do not refer to measurable objectives assigned to these policies but are intended to provide statistics to monitor the fulfilment of qualitative objectives. For the first set, the PRI drew on the experience of the European Union (European Commission, 2003) and of the OECD (OECD, 2005d), to define benchmarking indicators of R&D and innovation inputs and outputs against which the fulfilment of its objectives could be measured (see Table 2.4).

Such indicators are widely used by policy makers to map and monitor the performance of innovation systems, or rather input and output variables deemed to approximate this performance. They also convey to stakeholders and the public at large useful information on achievements or failures that can be related to policy actions and feed a legitimate public debate on S&T and innovation policy such as the one developed in the framework of the CARI process. Together with more analytical programme assessment exercises, they can contribute to shaping more appropriate and efficient policies or highlight complementarity conditions among policies that may be required to meet the objectives set for a specific indicator.

Most of the Plan's quantitative targets have not been met. One of the global objectives of the PRI was to increase the ratio of R&D expenditures in Catalonia over its GDP from 1.33% in 2004 to 2.10% by 2008, with two-thirds financed by the business sector. Although this objective has not been reached, the latest available information shows that the Catalan government did indeed step up its investment in R&D&I<sup>27</sup> in the first two years of the PRI. This increase is noted both as a share of GDP and as a share of the Catalan government budget, using either the calculations of the Catalan government or those of the Spanish Ministry of the Treasury (see Table 2.5).<sup>28</sup> This trend has continued over the last two years, albeit at a slower pace than anticipated in the Plan. Similarly, innovation inputs and outputs have fallen short of set targets even if the ratio of private sector investment in R&D over GDP has experienced a robust increase at the beginning of the PRI. This ratio has since declined. Reflecting the implicit priorities of the PRI, the areas in which the achievement exceeded the Plan target is that of the number of full-time equivalent researchers (FTE) as that figure reached 24 500 in 2006, surpassing by 500 the objective set for 2008. The region also surpassed objectives in the receipt of EU Framework Programme Funds.

### *Policy monitoring indicators*

The second set of "reference indicators" intended to monitor the outcome of policy actions is extremely detailed. There are more than 100 reference indicators, between four and 12 per support programme (CIRIT, 2005). For monitoring purposes, the compilation of such indicators requires a wealth of statistical information produced at decentralised levels, in most cases by the beneficiaries of the programmes. The processing of that information by well-endowed statistical offices requires collaboration with the agencies that manage the programmes. Such a costly system has not been put in place, and at the end of the planning period the CIRIT was not in a position to come up with the indicators contemplated in the Plan, although the basic information for a number of them may be available in various institutions.

Table 2.4. **Research and Innovation Plan 2005-2008: key performance indicators**

Indicator	Latest figures available when the PRI was elaborated		Target 2008	Actual 2007
	Catalonia	EU15	Catalonia	
<b>RESEARCH, DEVELOPMENT AND INNOVATION RESOURCES</b>				
1 R&D spending as a percentage of GDP <sup>1</sup>	1.38 (2003)	1.99 <sup>7</sup> (2002)	2.10	1.48
2 Business innovation spending as a percentage of GDP <sup>1</sup>	2.42 (2000)	3.70 <sup>8</sup> (2002)	5.20	2.00
3 R&D spending by private sector enterprises as a percentage of GDP <sup>1</sup>	0.91 (2003)	1.30 <sup>7</sup> (2002)	1.26	0.93
<b>SCIENCE AND TECHNOLOGY HUMAN RESOURCES</b>				
4 Number of researchers (full time equivalent) <sup>1</sup>	18 387 (2003)	--	24 000	25 063
5 Number of researchers per 1 000 labour market participants <sup>1,2</sup>	6.42 (2003)	5.60 <sup>7</sup> (2000)	7.5	7.2
6 Private sector researchers as a percentage of the total number of researchers in Catalonia <sup>1</sup>	37.51 (2003)	50.9 <sup>7</sup> (2001)	45	41.3
7 Number of in-company researchers per 1 000 labour market participants <sup>1,2</sup>	6.29 (2003)	5.83 <sup>7</sup> (2001)	8	6.55
<b>PRODUCTIVE STRUCTURES</b>				
8 Innovative businesses (10 or more workers) as a percentage of all businesses <sup>2</sup>	25.80 (1998-2000)	44 <sup>4</sup> (1998-2000)	40	27.4
9 Industrial GVA for high-technology sectors as a percentage of total industrial GVA <sup>1</sup>	7.50 (2002)	13.7 <sup>4</sup> (2000)	10	8.15
10 Employment in high-technology industries as a percentage of labour market participation <sup>1</sup>	2.68 (2002)	3.57 <sup>4</sup> (2002)	4	3.0
<b>SCIENCE AND TECHNOLOGY RESULTS</b>				
11 Number of indexed scientific publications <sup>9</sup>	10 967 (99-00)	622 499	12 000	8 443 (avg. annual 02-06)
12 Quality of scientific publications (citations during the two years subsequent to publication as a percentage of the number of articles published in a specific period) <sup>9</sup>	5.33 (1999-2000)	6.04 (1999-2000)	6.04	Not avail.
13 Number of doctoral theses submitted <sup>3</sup>	1 200 (2003)	--	1 500	1 359 (2008)
14 Number of patents registered at the European Patent Office per million inhabitants <sup>4</sup>	62 (2002)	161 (2002)	160	Not avail.
15 High-technology industrial exports as a percentage of total industrial exports <sup>2</sup>	12.07 (2003)	--	18	15.1 (2008)
<b>SCIENCE AND TECHNOLOGY POLICIES</b>				
16 Catalan researcher success rate in Spanish State open calls <sup>5</sup>	27 (2002)	--	30	16.8
17 Value of Catalonia participation (million of Euros) in the EU Framework and other research programmes <sup>5</sup>	51 (2003)	--	75	103

Notes: 1. *Source*: INE (Spanish National Statistics Institute), for Catalonia 2007 figure the base is 2000; 2. *Source*: IDESCAT (Catalan Statistics Institute); 3. *Source*: DURSI (Catalan Ministry of Universities, Research and the Information Society), 4. *Source*: EUROSTAT, 5. *Source*: CDTI (Spanish Centre for the Development of Industrial Technology), 6. *Source*: CORDIS, 7. *Source*: OECD, 8. *Source*: Spanish Ministry of Education and Science, 9. *Source*: DURSI. From data contained in the ISI National Citation Report.

*Source*: CIRIT (2005), “*Pla de Recerca i Innovació de Catalunya 2005-2008*”, Government of Catalonia, Barcelona, except for the last column, provided in 2009 by CIRIT.

Table 2.5. Evolution of R&amp;D expenditures in Catalonia

	2004		2005		2006		2007	
<b>R&amp;D Investment in Catalonia by sector of performance (EUR millions and as % of GDP)</b>								
Enterprises	1 399	0.88%	1 460	0.87%	1 705	0.94%	1 833	0.93%
Higher education	511	0.32%	579	0.34%	598	0.32%	677	0.34%
Government	197	0.13%	263	0.15%	311	0.17%	398	0.20%
<b>TOTAL</b>	<b>2 107</b>	<b>1.19%</b>	<b>2 302</b>	<b>1.36%</b>	<b>2 614</b>	<b>1.43%</b>	<b>2 909</b>	<b>1.48%</b>
<b>Catalan government R&amp;D&amp;I expenditures<sup>1</sup></b>								
EUR million	426	550	676	760				
Growth over previous year	14.8%	29.1%	22.9%	13.9%				
% of Catalan budget <sup>2</sup> (Catalonia calculation)	2.76%	3.11%	3.18%	3.46%				
% of Catalan budget <sup>2</sup> (Spanish government calculation)	0.43%	0.53%	0.75%	0.93%				
% in Catalonia of total R&D expenditure for Spain	20.2%	23.9%	26.0%	n.a.				
% of total R&D in public expenditure in Catalonia <sup>3</sup>	60.2%	65.3%	75.1%	n.a.				

Notes: 1. Includes government expenditures on programmes in support of innovation that may not involve R&D. 2. The calculation by the Spanish Ministry of the Treasury (FECYT, 2009) is lower than that of Catalonia because it excludes: the budget of R&D university personnel, research personnel of the health system, competitive grants for R&D projects to enterprises, and thematic fields such as transport, culture, ICT, etc. The denominator used in the ratio is also different, with Catalonia including Parliament and other statutory Catalan institutions, while the Spanish government includes only spending by Catalan departments (ministries). 3. Includes expenditures from the Catalan government, Catalan public agencies, Spanish government and EU programmes.

Source: CIRIT, INE (National Statistics Institute of Spain), Ministry of the Treasury (Spain).

The organisational difficulty and the costs involved in the development of such a comprehensive monitoring information system could have been anticipated at the outset of the elaboration of the PRI. It would have probably been more useful to contemplate a less detailed but more realistic set of monitoring indicators along with the establishment of an appropriate statistical system capable of producing regular performance documents in the interim years of the Plan, or at a minimum for its last year. Such performance documents were not produced. This is a lesson that should be remembered for the elaboration of the 2010-2013 Plan.<sup>29</sup>

### *Evaluation*

The elaboration of the PRI was not underpinned by robust evidence-based evaluations of the actions undertaken in the context of the preceding Plans. This shortcoming has continued in the context of the PRI and, on the eve of the elaboration of the new PRI for 2010-2013, few assessments have been conducted either at systemic or programme levels.<sup>30</sup> As learning processes are an essential element of policy making, robust evaluation systems underpin good governance practices and need to be developed at the stages of policy design and implementation.<sup>31</sup> These systems also need to encompass evaluations of implementation agencies and institutions benefitting from government support. CIRIT (in its restructured form the Research and Innovation Co-ordination Office – OCRI) could be in charge of the development of such evaluation systems with an oversight role over actual evaluations. Assessing the PRI's achievements and limitations requires going beyond the partial and limited panorama provided by quantitative indicators and scarce evaluations.

### *Limitations in the elaboration of the Plan*

The Research and Innovation Plan was supposed to deliver a set of objectives, lines of priority action and policy instruments. The PRI sought to sustain the achievements of the previous plans and address their failures and mixed successes in the framework of a more integrated vision of the S&T and innovation system. The Plan's goals could be only partly achieved, mainly for four reasons that should be kept in mind for improving the process in future Plans.

First, as noted above, the elaboration of the PRI was not based on a thorough evaluation of the policies implemented in the previous Plans. Their impact on the performance of the S&T and innovation system was not assessed. This was partly due to the fact that innovation and research were not integrated in previous approaches, but also because there was no instituted practice of *ex ante*, in progress and *ex post* policy and programme evaluation. There are evaluations of *ex ante* individual research project quality by AGAUR and some evaluations of individual programmes by CIDEM, but this does not concern the overall PRI. And while there had been evaluations of the second and third Research Plans, these were more *ex post* exercises focused on a review of the allocation of resources among different types of programmes and an illustration of impact through benchmarking of traditional input and output indicators with a particular emphasis on the position of Catalonia *vis-à-vis* other regions of Spain.

Second, there may have been regional governance issues. Although CIRIT was entrusted with a co-ordination authority to ensure collaboration among agencies involved in the preparation of the Plan and its subsequent implementation, this co-ordination often remained superficial at least until the creation of the new Ministry of Innovation, Universities and Enterprises (DIUE) in 2007. Indeed, the University and Research Commission (CUR) oversaw public research policy and CIDEM innovation and technology transfer. The fact that these two areas are included under the same “transversal” line of action does not necessarily imply a prior reflection on policy complementarities at the level of CIRIT or implementing agencies. In a systemic view, efficient management of such complementarities is at least as important as ensuring the efficiency of individual policies because it often conditions the sustainability of the outcomes.<sup>32</sup>

Third, although the PRI recognises the importance of a systemic approach, it is limited to the interaction between research and innovation. It ignored the role of the framework conditions that impinge upon the performance of S&T and innovation systems.<sup>33</sup> The main focus of a research and innovation plan should be on policy actions, support measures and incentive structures deemed to have a direct impact on that performance in terms of inputs, outputs and socio-economic outcomes. A plan should also ensure that the policy mix and the resource allocation among institutions and programmes efficiently contribute to that performance and generate virtuous dynamic processes of interaction between research and innovation. But it is well known that the development of such processes is predicated upon enabling framework conditions in areas that the plan should at least identify, and at best encompass in its policy framework to highlight the necessary complementarity across policy areas in a whole-of-government approach to innovation.

Lastly, the important question of co-ordination between the Spanish State and the Government of Catalonia was, to a large extent, left pending. As long as Catalonia was able to benefit from a sizeable share of Spanish support programmes to R&D and innovation, the political motivation to reopen co-ordination issues may not have been sufficiently high. Funds to Catalan actors are those provided to enterprises by the Spanish Centre for Industrial Technology Development (CDTI), and to the Catalan public research system through national competitive research funds. There were, however, clear cases where a closer look at such issues would have benefitted the design and implementation of the PRI. One can mention in particular the dual role of the Spanish and Catalan governments in the development and financing of parks, the fine tuning of innovation support programmes funded by CIDEM in view of the alternative (or complementary) support provided by CDTI, and the possible Catalan



participation in the CENIT public-private R&D programmes. The fact that the new Spanish S&T policy initiative INGENIO 2010 (see Chapter 3) and the PRI were both launched in 2005, could have offered an opportunity, if not to engage in a better co-ordination process, at least to take stock of the INGENIO initiative in the elaboration of the PRI.

### *Consolidation of strong points: the public research system*

With respect to previous plans, the PRI marks a shift in the balance between S&T push and technology pull policies. In terms of policy orientations and resource allocation, this shift does not, however, question the continued importance to be given to the promotion of the quality standards of the Catalan public research system. This strengthening has been enhanced through:

- The support given to the constitution of research groups of excellence and their organisation in “reference networks,” which offsets the fragmentation of the system and facilitates the development of multidisciplinary research.
- The incipient development of performance contracts with universities which should probably be complemented by assessments having an incidence on budgetary allocations of institutional funding and the development of innovative means to broaden the management autonomy of universities.
- The rapid development of public research centres to complement the capacities of the academic sector and offset the state regulatory constraints faced by this sector.<sup>34</sup> At the end of 2008 there were 37 Catalan Research Centres (CRCs), 14 of them created since 2004, and six new ones in development.<sup>35</sup> CRCs generally have a foundation status allowing them to enjoy a high degree of management autonomy in personnel and investment matters. Public funding of CRCs is governed by contract programmes (see Box 2.2) and the share of self-financing, either through competitive contracts or the provision of services, has been regularly increasing to reach about 60% in 2006. One may, however, question whether a region like Catalonia may sustain such a rapid development of CRCs which may raise problems of too narrow specialisation and loss of critical mass.
- Resources devoted to S&T infrastructure throughout the public research system have been sustained. One caveat, however, is too little attention given to the facilities and resources provided to universities to recruit technician staff in support of research activities;<sup>36</sup> and

- Greater attention has been given to the development of a highly qualified pool of human resources in S&T (HRST). Vehicles to achieve this include a well-designed and endowed scholarship system for graduate and post-graduate studies, the fast growth of the ICREA resources and programmes aimed at fostering the insertion of HRST in enterprises that complement those offered by the Spanish government.

On the basis of available information one might argue that this consolidation has borne fruit. In the period covered by the Plan, Catalonia has increased its share of research grants received from the State and the EU relative to other Spanish regions (see Chapter 3). Its scientific production has improved quantitatively and qualitatively.<sup>37</sup> As noted above, the number of researchers (FTE) has grown at a faster pace than anticipated in the Plan.

### *Addressing structural weaknesses of the S&T and innovation system*

The PRI record is more mixed with respect to overcoming the structural weaknesses of the Catalan innovation system that were diagnosed prior to its launching.

#### *Business R&D and innovation activities*

Despite the well-articulated programmes in support of business R&D and innovation activities, the actual set of individual support instruments is quite complex. There are a variety of schemes tailored to perceived specific problems faced by various categories of firms. This may involve important management costs and hinder a more comprehensive view of the market and the systemic failures these schemes are intended to address. A rationalisation of support schemes should be pursued.

These supports have also changed orientation over the last few years. Prior to 2004, individual grants for R&D and innovation were awarded to firms, but with a limited budget. Between 2004 and 2007, grants for R&D and innovation were awarded for individual programmes, but with a sectoral approach. Grants were also available for subcontracting R&D projects to members of the Catalan technology networks or for joint R&D projects. From 2008 onwards, the grants are for joint, not individual, R&D projects for firms. Small individual grants are allowed for innovation projects, with loans available for individual R&D projects. The latest programme for joint R&D projects is known as the High-Tech Nucleus Programme (see Table 2.A1.2).

### Box 2.2. Contracts for Catalan Research Centres

In 2003, the Catalan government (through DIUE – the Ministry of Innovation, Universities and Firms) began using performance contracts with the research centres it funds, 12 in that year. All Catalan Research Centres in the CERCA programme are now subject to performance contracts. The objectives of the contracts are: *i*) to establish a new framework for the relationship between the Catalan government and the research centres; *ii*) to provide the necessary resources for the centre to achieve its goals; *iii*) to formalise participation of the DIUE in the programming and objectives of the centre; *iv*) to support strategic planning and quality improvements; and *v*) to guarantee base funding to obtain competitive project funding.

The contracts include a set of monitoring indicators. They serve to fix goals and identify any important deviations from those goals over time. The contracts are reviewed annually and thus far all centres have fulfilled their contract-programme indicators. The performance indicators are weighted by object, with 80% towards overall strategic objectives for the centre and 20% for specific objectives.

Catalan Research Centre objectives	Indicators	Weight
Strategic objectives		80%
1.1. To promote the capacity of the research centre to obtain competitive resources through the participation of the researchers of the centre in competitive calls and contracts with companies	- Income from calls for proposals - Income from contracts or agreements - Income from teaching - Income coming from patents	25%
1.2. To achieve a staff of critical mass as established in the Strategic Plan of each centre	- Senior staff - Junior staff - Post-doctoral staff - Pre-doctoral staff - R&D technical experts	5%
1.3. To encourage the excellence of the scientific production by means of the publication of articles in specialised journals of acknowledged prestige		25%
1.4. To carry out training activities in collaboration with universities connected with the research of the centre	- Doctoral theses read or supervised by a researcher from the centre	15%
1.5. To boost patent registration or the creation of spin-offs from the research performed in the centre	- Number of patent applications by the centre - Number of spin-offs	10%
Specific objectives		20%
- Each centre describes its own objectives		

With approximately two-thirds of R&D investment by firms, Catalonia is on par with European standards. However this global indicator of a satisfactory performance hides latent structural weaknesses that the PRI has started to address but that will require longer term efforts on various policy fronts to overcome them. Across practically all sectors of the economy, the R&D intensity of Catalonia's industries is lower than that of the European country average in the same sectors. This gap does not appear to have been reduced during the 2005-2008 PRI, which means that the R&D&I support programmes have only incidental effects on bringing Catalan firms closer to the technological frontier. Overall, and at the aggregate level, this reflects an adaptive behaviour of firms in their R&D&I investment, a bias towards incremental innovation, and weaker relationships with global sources of knowledge.

Notwithstanding the diversity of support schemes, the PRI has not fully succeeded in broadening the scope of firms that undertake such activities as part of their development strategy. The distribution of firms that do undertake them remains skewed. An overwhelming share of business R&D is still concentrated in larger firms and specific sectors such as chemicals, pharmaceuticals and transport equipment, with a high proportion of foreign affiliates. The more recent development of new technology-based firms in the agrofood sector, ICT and design industries is beginning to reduce the skewed distribution.

The conclusions of some studies on both the effect of CIDEM and other STI support to business R&D&I activities, as well as characteristics of beneficiary firms, deserve further investigation. It has been highlighted (Quevedo *et al.*, 2007) that the firms with the highest probability to get support are: *i*) those that have already received support; *ii*) larger firms; *iii*) firms that have an R&D laboratory; and *iv*) firms that have a high export/production ratio. With the exception of new technology-based firms, the overwhelming majority of SMEs do not share these characteristics and are therefore unlikely to benefit from these programmes. It seems that programmes aimed at fostering the absorptive capacity of SMEs do not yet act as a springboard to bring a substantial number of them to the standards to enable them to benefit from R&D&I support programmes. The same study also highlighted that although existing support programmes had globally positive effects in terms of input and output additionality,<sup>38</sup> their effects in terms of behavioural additionality<sup>39</sup> remained at best very limited. Behavioural additionality is an indication that support programmes have a positive effect on the dynamics of the innovation system, notably with regards to the interactions and knowledge flows among agents and institutions, and that they catalyse the development of virtuous circles

between generation, dissemination and application of knowledge in innovation systems.<sup>40</sup>

Beyond the positive aspects of CIDEM programmes in support of business R&D&I, stock must be taken of their limitations and strategies developed to overcome them in the next Research Plan. In this regard, several lessons should be noted for the design and financing of support programmes.

Financial support instruments need to be better articulated with other policy actions so as to increase their behavioural additionality effects. This is true for enterprises that already have a long practice of R&D&I investment, but should also be induced in other firms to broaden their innovation strategies. It is even more the case for lower technology-intensive enterprises, where behavioural additionality is predicated upon ensuring that financial support instruments reduce the costs of R&D&I investment. For such firms, the financial support instruments need to be complemented by other support measures or incentives that will foster firm absorptive capacity, such as the strengthening of human resources capacity and cluster-type policies in the case of SMEs.

Another lesson relates to the duplication or complementarity between support provided by the Catalan government and that provided by Spain (CDTI). At present, it seems that a rather important share of total Catalan support goes to projects that could be supported by CDTI. It would seem more appropriate to concentrate Catalan support either to address specific weaknesses related to the regional industrial structure (and the regional factors that account for the disparities in firm propensity to innovate) or on funding research and innovation projects in the priority areas of the region.

### *The complex system of technology transfer networks has met with mixed success*

The various technology transfer networks have reached a relatively large number of firms. However, it seems that with the exception of the XIT and XTT networks, the benefits of the services they provide have often been short-lived in the sense that they have not really succeeded in jumpstarting an innovation culture in the majority of Catalonia's firms. Technology transfer programmes have certainly helped the improvement of production processes and the introduction of new products, but they have not generated sustained knowledge relationships between the majority of beneficiary firms and knowledge production institutions. This partly reflects the supply side bias of most of the transfer programmes and the lack of complementarity with measures aimed at increasing firm knowledge absorptive capacity that

generates demand and nurtures collaboration with Research and/or Technological Centres.<sup>41</sup> Even the technological springboard network (XTT), which fosters the creation of technology advanced firms or academic spin-offs, has met with mixed success. While the number of new technology-based firms has increased quite rapidly (60 in 2007), the growth of these new firms has in general been very weak. Here again, one can suspect a policy complementarity failure as this company growth may have been constrained by shortages of available venture capital or obstacles affecting the long-term inter-institutional mobility of researchers.

### *Low level of patenting and weak intellectual property culture*

Catalonia's patenting record has not significantly improved in recent years. The low rates have persisted despite the various actions pursued by the PRI to disseminate an intellectual property rights (IPR) culture across the enterprise sector through promotion activities and financial support of patent application costs for SMEs. In this area, changes in business behaviour are slow to materialise and efforts must be pursued over the long term, using a variety of complementary approaches going from dedicated courses in science and engineering departments and business schools to training sessions in technology transfer offices and specialised services provided in the framework of cluster-type policies.

### *Risk assessment and innovation financing*

The development of capital markets able to develop risk assessment mechanisms and allocate finance to innovative ventures has not materialised at the levels anticipated.<sup>42</sup> Compared to publicly owned or controlled development banks or financing institutions in other countries, such as CORFO in Chile, the Catalan Institute of Finance (IFC) is relatively timid in its venture capital activity where it could have a catalyst role to mobilise private funds, especially when projects can benefit from subsidised guarantee schemes. This risk aversion may, to some extent, be related to the lack of evaluation expertise for technology intensive projects in this part of Catalonia's financial system, but again other country experiences show that this is not a binding constraint as it can be alleviated. Counter examples exist in Catalonia at the local level. In the case of successful technological parks developed in collaboration with universities – such as the one in Reus with the University Rovira i Virgili (URV) – local business communities have developed venture capital funds in support of the creation and development of new start ups.

### *Serving the needs of different types of SMEs*

There is a need to customise support to SMEs, a group that forms a very heterogeneous population. Such a customisation does not contradict the apparent need for policy rationalisation advocated above. In line with international best practices, Catalonia should follow the example of some OECD member countries or regions (such as Australia, Canada, Chile, or Germany's *Länder*),<sup>43</sup> that have developed a comprehensive, yet differentiated approach to the promotion of innovation in SMEs (see Box 2.3 and Figure 2.2). There are also several trends in SME support in OECD member countries that Catalonia could include among its policy instruments.

Innovation vouchers are a common tool used to support SMEs that already have an idea of a business problem for which an innovation can be a solution. In addition to helping the SME solve a problem, such programmes are also often designed to support links with nearby institutions, including universities and research centres. They are used at the national level in several countries, such as in Ireland (EUR 5 000) and the Netherlands. A study of the innovation voucher in the Netherlands showed that eight out of ten projects would not have been conducted without the use of the voucher, and that the voucher stimulated new links between firms and research institutions (Cornet *et al.*, 2006). In the United Kingdom, North West England has such a programme with two tiers, a first tier with a voucher of GBP 3 000, and a second tier, if matched with GBP 3 000 from the firm, of GBP 7 000. Within Spain, the region of Valencia has recently launched the *cheque innovación*.

There are a few challenges regarding the use of such vouchers to bear in mind. First, as SMEs may need help identifying the problem to be solved, advisory services are often required to stimulate demand. In one OECD region experience, advisory and consulting services were previously provided by the same entity, until the region found that the diagnosis was biased to fit the available tools offered by the provider. The region had to adjust the programme by separating the two functions to prevent a conflict of interest. Another challenge is for the SME to find the right service provider. Matching between SMEs and universities or research centres can be a time consuming process, and in OECD country experience a broker institution is often needed to help orient SMEs. Finally, the right service provider may not be readily found nearby with which to use the voucher.

### Box 2.3. Promoting innovation in SMEs: OECD country experiences

When placing greater emphasis on innovation in their SME policies, governments face two challenges. First, given the variety of factors that influence firm capabilities and incentives to innovate, they need to co-ordinate their actions in a variety of areas of government policy. Second, the heterogeneity of the population of small firms precludes any “one-size-fits-all” approach. In some sectors, the bulk of R&D-based innovations are due to new entrants or start-ups that challenge incumbents’ market shares. In most industries, however, SMEs contribute to the innovative process in a very different way. They operate in medium- to low-technology environments and innovate without engaging in formal R&D activities. They focus on improving production processes through the use of codified knowledge embedded in up-to-date equipment and on improving product design and marketing techniques through the use of tacit knowledge embedded in human resources.

OECD member country experience demonstrates the importance of finding the right balance between measures addressing generic problems related to firm size or newness and more targeted actions to solve problems that are specific to particular types of firms. Best practice policies have the following main components:

- **Conducive framework conditions.** The first responsibility of government is to provide a favourable climate in which entrepreneurs can easily create firms, have incentives to innovate and grow, and can access the necessary resources at a reasonable cost.
- **Measures to build innovation capacities.** Up to the early 1990s, government promotion of innovation in SMEs was largely equated with support to technology diffusion. It focused on supply-led technology transfer and was biased in favour of manufacturing. However, several factors prompted the emergence of a new generation of policies. Such factors include a mixed experience with supply-driven programmes, improved understanding of the role of new firms in increasingly interactive innovation processes, as well as growing evidence that the obstacles to innovation in most SMEs were internal to the firm and stemmed from deficiencies in labour skills and in organisational and managerial capacities. Such new policies placed more emphasis on: *i*) fostering an entrepreneurial culture; *ii*) building the “innovative and absorptive capacity” of firms through skills development and improved management; and *iii*) promoting e-business and developing other business infrastructure for small innovative firms.

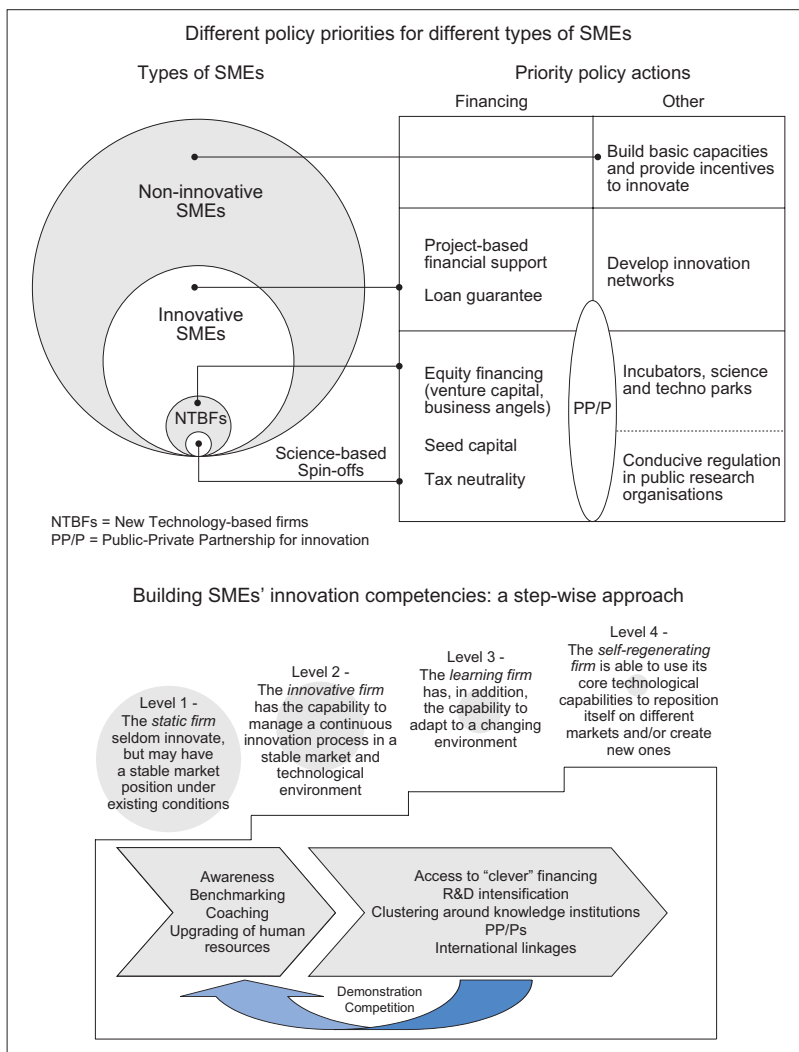


### Box 2.3. Promoting innovation in SMEs: OECD country experiences (continued)

- **Measures to facilitate financing of innovation.** Insufficient access to financing is a persistent obstacle to the creation, survival and growth of innovative SMEs. Policies to reduce financing gaps broadly fall into three categories: *i*) subsidised loans and loan guarantees; *ii*) provision of seed financing and support for the development of venture capital; and *iii*) tax incentives and/or grants to correct market failures that lead to under-investment in R&D.
- **Measures to promote networking and partnerships.** Even more than larger firms, SMEs depend on external sources of information, knowledge, know-how and technologies in order to build their own innovative capability and to reach their markets. For complementary knowledge and know-how, innovative firms increasingly rely on collaborative arrangements in addition to market-mediated relations (*e.g.* purchase of equipment and licensing of technology). Inter-firm collaboration within networks is now by far the most important channel for the sharing and exchange of knowledge. Interactions are also intensifying between firms and a number of other institutions involved in the innovation process: universities, private and public research labs, providers of consultancy and technical services, etc. In OECD member countries, public programmes and initiatives that explicitly address networking are a rather new phenomenon. They address market failures at different stages of the networking process through SME-specific or less targeted measures: *i*) raising awareness of networking opportunities and helping search for partners; *ii*) organising, financing and operating networks; *iii*) interfacing scientific and innovation networks through public-private partnerships; and *iv*) creating international linkages and building global networks.

Source: OECD (2007), *OECD Reviews of Innovation Policy: Chile*, OECD, Paris.

Figure 2.2. **Innovation in SMEs: need for comprehensive but differentiated approach**



Source: OECD (2007), *OECD Reviews of Innovation Policy: Chile*, OECD, Paris.

### *Some blind spots*

There are some important elements related to design, implementation and evaluation that are conspicuously absent from, or largely overlooked in, the PRI. The CARI has rightfully highlighted the importance of some of them for the PRI 2010-2013.

### *Thematic priority setting and public-private partnerships*

Catalonia's funding of public research institutions does not include competitive financing of projects. This is true for so-called bottom up "blank projects" or projects presented in the framework of top-down defined research programmes. Project funding has come essentially from Spain and the European Union. In the past, Catalonia has not engaged in the identification of priority scientific or thematic areas eligible for selective funding in the allocation of resources to research institutions.<sup>44</sup> Thematic funding has been provided through other means, such as scholarships and some small grants, but the region is considering a greater role for competitive research project financing in the future.

The absence of thematic research prioritisation may have been justified on two grounds in the previous Research Plans. First, it reflected the interests of the academic community provided that appropriate attention was given to the strengthening of S&T infrastructure and the formation of human capital, which has been the case. It also strengthened Catalonia's research system competitive position to benefit from outside sources of funding. The policy priority to strengthen S&T infrastructure at the expense of projects gave a premium to research institutions and the only *de facto* prioritisation was that of the creation of the Catalan Research Centres that are by essence focused on a particular sector or discipline.

As acknowledged in the CARI, Catalonia can no longer ignore trends that are observable across countries at both national and regional levels.<sup>45</sup> It is also likely that in the 2010-2013 PRI, a greater effort will be made to prioritise a range of instruments to address a list of priorities based on themes and problems (as opposed to sectors). In the policy-making process, prioritisation responds to necessities that are increasingly recognised by governments, scientific and business stakeholders, and the public at large. They include:

- Scientific excellence cannot last without a the build up of a critical mass while at the same time the costs of infrastructure are rising, therefore the dispersion of funds would lower the levels of excellence. Nurturing Catalonia's strongholds in research calls for prioritisation.

- The blurring of the frontiers between fundamental and applied research should fuel public-private research and innovation partnerships on jointly agreed scientific or thematic areas that involve explicit or *de facto* priority setting; and
- Publicly funded research activities should help respond to socio-economic concerns expressed by Catalonia's civil society, and the priorities among these concerns are local-specific. There is an accountability requirement that the government and the scientific community must comply with, and that should be reflected in the prioritisation process.

The PRI does not include any explicit programmes devoted to supporting public-private collaboration or partnerships in research and innovation, whether bottom-up projects or top-down programmes. A number of countries, including some that are comparable in size and economic development to Catalonia, have promoted this type of programme so as to strengthen industry/science relationships and facilitate technology transfer (see Box 2.4). In some instances, they are used as a means to foster synergies among public and private research capacities in the implementation of national priorities. The share of this type of programme in the total amount of public support to industry has been increasing over time in the countries that have implemented them. Spain's CENIT programme, which supports public-private partnerships, already benefits Catalonia. However, this should certainly not preclude Catalonia from envisaging the use of this support instrument in the implementation of its own strategy, relying on the specificities of its own public research system. Some of the instruments offered by ACCIÓ (such as the High-Tech Nucleus programme) have already begun to promote public-private research projects generally.

### Box 2.4. Public-private partnerships for research and innovation: a high leverage instrument

An important conclusion of recent OECD work on the role of government in fostering knowledge-based growth is that greater use of public-private partnerships (PPPs) can enhance the contribution of science, technology and innovation policy to economic performance. PPPs for research and innovation offer a framework for the public and private sectors to join forces in areas in which they have complementary interests but cannot act as efficiently alone (risk sharing and mutual leveraging effects). They can fill some gaps in innovation systems more effectively than other policy instruments.

PPPs are unique tools to promote collaborative research in areas where innovation is deeply rooted in science:

- Major programmes to promote strategic R&D co-operation among universities, public research institutes and private firms have been launched or reinforced in many OECD member countries since the late 1990s, following the pioneering examples of the Australian CRC and Swedish Competence Centre programmes (*e.g.* Kplus and Kind/Knet in Austria, the Innovation Consortiums in Denmark, the National Technological Research and Innovation Networks in France, the Technology Leading Institutes in the Netherlands, the AERIs programme in Mexico and the CENIT programme in Spain).
- PPP is the best approach to building innovative networks in new multidisciplinary research fields, either as stand-alone initiatives (*e.g.* Genomics in the Netherlands) or as part of broader PPP programmes (*e.g.* nanotechnology, Gehomme and Genoplante networks in France, and the Kplus centre on bio-molecular therapeutics in Austria).

In addition to providing effective springboards for frontier and pre-competitive R&D in areas of strategic importance, PPPs can contribute to other objectives and yield broad benefits:

- *Input, output and behavioural additionality.* Cost-sharing arrangements and industry leadership within PPPs (as in the case of Spain's CENIT programme) translate into high leverage of public support for business R&D and innovation. PPPs have also a lasting effect on the behaviour of public and private researchers, by serving to build trust and personal networks that facilitate further formal and informal co-operation.
- *New avenues for commercial spillovers from public research.* PPPs provide participating firms with easier access to public research

#### Box 2.4. Public-private partnerships for research and innovation: a high leverage instrument (*continued*)

outputs and facilitate the creation of new technology-based firms, especially spin-offs from public research, as well as the mobility of human resources between the public and private sectors (*e.g.* Israel's Magnet programme).

- *Linking SMEs with scientific research.* Most innovative SMEs find it difficult to establish direct contacts with universities and public labs. PPPs can play the role of effective bridging institutions (*e.g.* ProInno in Germany).
- *Increased synergies within and between regional innovation systems* (*e.g.* Korea's Regional Innovation Centre programme). National PPP programmes can enhance co-operation between local innovative clusters to ensure critical mass and better exploit complementarities.

Whereas PPPs can potentially achieve what other policy instruments cannot, handling them is a delicate matter since the partners must engage in sustained co-operation with partners from different managerial cultures and partly conflicting goals. OECD work points to the following critical factors for success:

- Long-term commitment from both government and industry, based on a shared vision.
- Critical mass but also depth of the national and regional innovation systems. PPPs should not create "high-technology islands" but be embedded in local and regional innovative clusters, and benefit innovative SMEs as well as large firms. Programmes to promote large PPPs can be complemented by measures to support smaller PPP research teams (*e.g.* Austria's CDL programme, Australia's ARC Linkage Grants and Fellowships programme).
- Building on existing networks without neglecting areas where potential actors are still dispersed (*e.g.* multidisciplinary research) and/or inexperienced in accessing government support.
- Efficient steering mechanisms that ensure a sustainable balance between public and private interests, especially: *i*) competitive selection of projects and participants; *ii*) optimal financing; *iii*) efficient organisation and management; and *iv*) rigorous evaluation.

*Source:* OECD (2004), *Science, Technology and Industry Outlook*, OECD, Paris.

*Innovative clusters*

Contrary to the experience over the last decade of many OECD member countries and regions, Catalonia has not explicitly integrated a cluster approach in its innovation policy as laid out in the PRI. The cluster programme promoted by CIDEM was essentially devoted to the improvement of the strategic management capabilities of firms belonging to a same sector, even if it has recently given more attention to the technological aspects of these capabilities (Pezzi, 2008). The cluster approach to innovation policy goes much further than this (OECD, 2007a; OECD, 2001). It is founded on the provision of common S&T infrastructure and intangible services to firms to enable them to increase their collective knowledge absorption and exchange capacities allowing them to put innovation at the core of their development strategies (see Box 2.5). Taking stock of the limitations of the present approach, CARI rightly emphasises the importance of a more innovation-related cluster policy. However, this emphasis too often focuses either on high-tech sectors drawing on the successful experience of BioCat (see Box 2.6) or on the somewhat restrictive notion of sectoral/territorial approach to technology transfer. Catalonia's universities and the Catalan Research Centres should be more involved in the development of innovative clusters, and some of them have already taken initiatives in that direction.

While innovative cluster approaches are relatively new, Catalonia has had a long history of cluster policy, starting with a Porter approach in the 1990s. With respect to CIDEM programmes in this decade, the first is the creation of the CIDEM Information Points Network through local bodies, chambers of commerce and other associations. In 2004, CIDEM did a mapping of local productive systems. There was also a transformation of the Innovation Points Network, with a reduced number of members and the development of local innovation plans. In 2005, CIDEM launched a new business opportunities programme. By 2008, the focus had shifted to a local innovation system and cluster development programme.

### Box 2.5. Cluster-based innovation policy: lessons from OECD member country experiences

Governments can nurture the development of innovative clusters primarily through regional and local policies and programmes to stimulate knowledge exchange, reduce information failures and strengthen co-operation among firms and between firms and knowledge institutions. More direct policy tools can be used at the national level to encourage cluster formation and development, such as public-private partnerships for R&D, public procurement and competition for government funding to provide incentives for firm networks to organise themselves on a regional basis. OECD work suggests that efficient cluster policies:

- Build a shared vision, based on a sound diagnosis of initial conditions, and ensure a vibrant dialogue between industry and government in defining and implementing the cluster development strategy.
- Catalyse rather than plan local development by bringing actors together and supplying enabling infrastructures and incentives.
- “Back and empower local leaders” instead of trying to “pick winners”.
- Improve availability and access to key resources (skilled people, R&D, physical and “intangible” infrastructure, smart money).
- Avoid “high-technology” or “manufacturing” myopia by recognising the importance of knowledge-intensive services and of the technological upgrading of traditional industries for innovation-led growth.
- Build on existing innovation networks, but keep incentive schemes open and attractive to outsiders, especially new firms.
- Customise policy approaches to fit the specific needs of different industry and technological fields. Depending on a cluster’s characteristics, government plays a variable role in addressing the following problems: lack of interaction; information imperfections; mismatch between knowledge infrastructure and business needs; lack of demanding customers.
- Leverage regional resources through interregional co-operation and participation in national and international innovation initiatives.
- Allow experimentation and learning by doing in an area with a good deal of scope for improved international diffusion of good practices.

*Source:* OECD (2001), *Innovative Clusters: Drivers of National Innovation Systems*, OECD, Paris.



### Box 2.6. BioCat: a Catalonia cluster initiative

Biocat began as the Barcelona Biomedical Alliance in 2004 and was officially founded in 2006. Since 2007, it has a staff of approximately 19 and receives financing from the Catalan government and the Barcelona City Council. Board members include high-level public officials as well as firms, research institutes, hospitals and universities. Biocat is not financed by the private sector at this stage, but it anticipates this financing source in the future. While the initiative is designed to serve firms and institutions throughout Catalonia, the vast majority working in biotech and medical technologies are located in the Barcelona area. There are some related agrofood actors in other parts of Catalonia. The cluster's strength is not reflected in its level of patenting, so Biocat started a programme on intellectual property protection.

Biocat acts at a strategic level as advisors to the government and other decision makers. They identify needs, co-ordinate big projects, and lobby on relevant issues. Other institutions affiliated with Biocat manage incubators, technology transfer and other services. Benchmarking is one of the core activities of Biocat, as it is a founding member of the EU bioregion network. This cluster is on the list of top five to ten clusters in terms of dynamism in the network. The initiative is similar to Montreal's *In vivo*.

### *Innovation in services*

Innovation in services is widespread and very important for aggregate productivity and economic growth. It is therefore vital that the needs and specificities of innovation in service sector activities are fully taken into account when innovation policy is designed and implemented. Yet, although Catalonia has a large and growing services sector (notably in the areas of tourism, design, health, ICT, financial services and logistics), the 2005-2008 PRI pays practically no attention to the promotion of innovation in services activities. This shortcoming has been perceived in the preparation of the CARI that integrates services in its broad-based vision of innovation and in a number of its recommendations.

Innovation in the services sector is not intrinsically different from innovation in manufacturing. Both involve some combination of changes in technology, design, marketing, organisation, knowledge and skills. However, in the case of most services, there is much less emphasis on the endogenous development of new technology than on the incorporation of new technologies, mainly ICT, combined with the so-called “softer” aspects of innovation, to improve the efficiency of delivery processes and expand market opportunities. Some business and consumer services, such as

information technology companies, design houses, logistics and many aspects of health provision, are extremely sophisticated in the way they absorb and exploit new technologies. In addition, services such as design and software development, which manufacturing companies formerly supplied for themselves, are becoming increasingly outsourced. Thus innovation by a manufacturing company may often require complementary innovation by its service suppliers. This means an approach to innovation policy which takes a broad view of the innovation process and does not focus narrowly on the creation and exploitation of new technology in the manufacturing and natural resources sectors. Encouraging the diffusion of technology and of promising business practices in the service sector must be seen as equally important, as should the spread of appropriate non-technological knowledge and skills (OECD, 2005a).

There are a range of policies to promote innovation in services (see Table 2.6). Such policies should recognise that success for large service firms is often based on: *i*) open markets; *ii*) innovation and ICT; and *iii*) work organisation and human resources (OECD 2005a). Furthermore, studies of innovation in knowledge-intensive service activities (KISA) show that such firms serve as sources, facilitators and carriers of innovation (OECD 2006b). Quantitative evidence of innovation by Catalan firms shows a positive spillover from knowledge-intensive services on technology diffusion in other sectors (Segarra-Blasco, 2009). In recommendations to the UK government, NESTA has highlighted several general principles that are also relevant for Catalonia: *i*) supporting innovative people and not just firms (notably advanced management); *ii*) recognising that innovative firms integrate, not just invent, technology; *iii*) stimulating innovation in existing sectors, not just emerging sectors and technologies; *iv*) widening knowledge exchange between universities and firms to include the arts and social sciences, not just science and engineering; and *v*) measure innovation in services, not just advanced manufacturing (Abreu *et al.*, 2008).

### ***Innovation driven by the public sector***

The PRI 2005-2008 suggested a need for the public administration to play a greater role in driving innovation. This concept is further emphasised in the CARI. Catalonia's CIRIT has been seeking to raise awareness about public sector innovation in all government ministries, encouraging each ministry to designate at least one person to focus on innovation. The topic is now gaining much greater attention in OECD member countries. The public sector is seeking both to provide the most efficient incentives for the private sector to innovate as well as to innovate in its own products and services.

Table 2.6. Policies for innovation in knowledge-intensive service activities

Policy-related dimension	Examples of innovation policy measures
Direct policy intervention targeting businesses/organisations	<ul style="list-style-type: none"> <li>● Securing service development-related private and public financing, grants and tax credits for businesses</li> <li>● Transfer of enabling technologies that can support the role of KISA in innovation</li> </ul>
Indirect policy intervention targeting non-business actors within the innovation system	<ul style="list-style-type: none"> <li>● Securing the skills base needed by service innovators</li> <li>● Widening the focus of RTOs towards non-technological innovations</li> </ul>
Development of framework conditions facilitating the role of KISA in innovation	<ul style="list-style-type: none"> <li>● Opening up of new markets for service providers</li> <li>● Cutting down the regulatory burden</li> <li>● Financing for the use of external KISA</li> <li>● Good practice development, standards for service quality</li> <li>● Cultivating services related to innovation culture</li> </ul>
Development of existing innovation policies, more service-friendly	<ul style="list-style-type: none"> <li>● Adopting the broad innovation concept, acknowledging the value of process innovations (technological and organisational), and product innovations (goods and services)</li> <li>● Adapting financing and assistance criteria so that services-related innovation projects get better access to existing policies</li> <li>● Training and skills development in service-related innovation for actors executing the innovation policy</li> </ul>
Development of new policy measures targeting issues that are central to the development of KISA and services-related innovation	<ul style="list-style-type: none"> <li>● Networks and customer interaction as innovation platforms</li> <li>● Developing organisations that are more capable of using internal and external KISA</li> </ul>

Source: OECD (2006), *Innovation and Knowledge-Intensive Service Activities*, OECD, Paris.

Public procurement is one of the vehicles for the Catalan government to support innovation in firms. The volume of goods and services procured by Catalonia's government is rather high in areas where technological change is rapid, and its applications can substantially improve the delivery and quality of public services. The delivery of health services, for example, is a responsibility devolved to the Catalan government. Following EU recommendations, a wide array of OECD member countries and regions are increasingly using public procurement as an integral part of their policy mix

to foster business R&D and innovation activities and promote industry/science collaboration (see Box 2.7).<sup>46</sup> Until now, this does not seem to have been the case in Catalonia and the PRI 2005-2008 does not allude to this policy instrument, whose importance is however highlighted in CARI's recommendations. In practice, implementation of innovation-related public procurement policies at the regional level may nevertheless raise some legal and/or regulatory issues with the State level.

The US federal government has well-regarded programmes to promote early stage public procurement with high-tech SMEs. The programmes include the SBIR (Small Business Innovation Research) and the STTR (Small Business Technology Transfer).<sup>47</sup> They are both competitively awarded, three-phase federal government programmes designed to stimulate technological innovation and provide opportunities for small firms. Projects funded often link small firms with the top non-profit research institutions. Six federal agencies reserve a portion of their R&D funds to be awarded via the STTR program, and 11 federal agencies run programmes under SBIR.

In terms of the public sector itself, there are different types of innovation that could be promoted. Rationales for pursuing innovation in the public sector include resource constraints, application of new technologies, demand by citizens, and a need to address global challenges like aging and climate change. The EC-funded Publin, a public service innovation programme started under the fifth Framework Programme, has outlined a series of types of public sector innovations:

- a new or improved service (such as health care at home);
- process innovation (a change in the manufacturing of a service or product);
- administrative innovation (such as the use of a new policy instrument, which may be a result of policy change);
- system innovation (a new system or a fundamental change of an existing system, for instance by the establishment of new organisations or new patterns of co-operation and interaction);
- conceptual innovation (a change in the outlook of actors; such changes are accompanied by the use of new concepts, such as integrated water management or mobility leasing); and
- radical change of rationality (meaning that the world view or the mental matrix of the employees of an organisation is shifting).

### **Box 2.7. Public procurement in innovation policy and the example of Flanders, Belgium**

#### **The rationale**

A new impetus for demand-side innovation policies was provided by the Aho Group Report “Creating an Innovative Europe” presented to European leaders at their Spring summit in 2006. The Panel, previously mandated to report on ways to accelerate the revised Lisbon Strategy, argued that an R&D-driven strategy was insufficient and advocated instead for a four-pronged approach focused on: 1) the creation of innovation-friendly markets; 2) strengthening R&D resources; 3) increasing structural mobility; and 4) fostering a culture which celebrates innovation.

Central to the group’s approach was the observation that the reason business is failing to invest enough in R&D and innovation in Europe is the lack of an innovation-friendly market in which to launch new products and services. To create such a market, they recommended actions on harmonised regulation, ambitious use of standards, a competitive intellectual property rights regime and driving demand through public procurement. Large-scale strategic actions were called for to provide an environment in which supply-side measures to raise investment in research and innovation can be combined with this process of creating demand and a market. The group identified several application areas for innovation-driven public procurement: e-Health, pharmaceuticals, energy, environment, transport and logistics, security, and digital content.

#### **The example of Flanders, Belgium**

While there had been political commitment for public technology procurement in formal plans in Flanders, there had been a lack of concrete actions. The Flemish Innovation Agency, IWT, took the lead in exploring public technology procurement as a new demand-driven tool to stimulate innovation. They started with a pilot project in the context of the region’s Innovation Platform on Environmental Issues and Energy.

First, a master plan was developed from an analysis of the actual situation with regard to a socio-economic problem or a public service that has to be improved or newly developed. Additionally, an estimate on the future socio-economic evolution in society was explored, including the citizens’ expectations on solutions for the socio-economic challenges and the public service level. Subsequently, the opportunities for innovation were explored by detecting the limits of the actual solutions.

The master plan forms the input for the innovation platform. The innovation platform brings representatives from all stakeholders together to further develop the master plan and translate it technically. Contracting authorities, research institutes, enterprises and industry sector organisations constitute the platform. The Flemish Innovation Agency (IWT) acts as a facilitator with an innovation

### Box 2.7. Public procurement in innovation policy and the example of Flanders, Belgium (*continued*)

policy interest. The innovation platform decides which mix of policy instruments is most desirable to achieve the outcome foreseen in the master plan. It also evaluates the opportunities of innovation procurement. The innovation platform in the Flemish model is headed by the contracting authority, which means that the procurement dimension is dominating. The innovation platform positions innovation procurement in the innovation cycle and defines what form of procurement should be chosen (commercial or pre-commercial). However, other stakeholders can further explore the opportunities offered by the other instruments available from the policy mix and launch complementary initiatives (e.g. launching basic research initiatives at research institutes, launch industry R&D with or without grants, propose tax measures, etc.). Although the model is primarily designed for innovation procurement purposes, it may have a wider functionality and pay-off with regard to innovation.

The pilot scheme on innovation procurement approved by the Flemish government July 2008 will be the first implementation of this model. The scheme was introduced to all interested stakeholders in September 2008, followed by a positive response from all governmental departments. At the beginning of 2009, procurement projects were defined. Thus far, EUR 10 million funding has been raised for the pilot in the innovation department and EUR 5 million will be added by procuring departments. A permanent cell “Innovation Procurement” within IWT and training of procurers in a master class will support the pilot. If the pilot proves successful, full rollout is foreseen for 2010-2014.

*Source:* Aho, E. *et al.* (2006), “Creating an Innovative Europe – Report of the Independent Expert Group on R&D and Innovation”, Mimeo, <http://europa.eu.int/invest-in-research/>; Edler, J and L. Georghiou (2007), “Public Procurement and Innovation – Resurrecting the Demand Side”, *Research Policy*, Vol. 36(7), pp. 949-963; and [www.omic-ntp.eu](http://www.omic-ntp.eu) (*Exploring Public Procurement as a Strategic Innovation Policy Mix Instrument*).

Catalonia is taking up this charge for social innovation, notably in the health and social services fields. In addition, the recent Social Services Law (12/2007 of 11 October) creates demand for new services as it clarifies the basic and specialised services that Catalans have the right to access. The law further has a component to promote social innovation (See Box 2.8). Catalonia should capitalise on this opportunity to promote its broader concept of innovation throughout government.

### Box 2.8. Social innovation and Catalonia's social services law

Chapter VII of the Social Services Law (12/2007 of 11 October) includes articles that specifically promote training and research in social services as a vehicle for institutionalising social innovation. The Department for Citizens and Social Action has therefore developed a social innovation plan, in line with the spirit of the Catalan Agreement on Research and Innovation, that seeks to promote innovation in all government sectors. Article 79 of the Law requires the relevant government departments to develop training plans for services provided, research, co-ordination with related government departments, and training to prevent work-related injuries. It also requires that the Catalan government create centres and specialised entities for training and research in social services in conjunction with universities and training centres. Article 80 emphasises the need to develop ongoing training for social services personnel. And Article 81 focuses specifically on research and technological innovation. It highlights the need for studies about current and future social needs, the causes and factors that influence the demand for services, and the evaluation of the organisation, management and economics of how social services function now and as they could in the future. It also encourages evaluation with criteria established by the government and in collaboration with universities and other specialised entities for applied research and innovation in social services.

Source: Government of Catalonia, Ministry of Social Action and Citizens, [www.gencat.cat/benestar](http://www.gencat.cat/benestar)

OECD member countries have promoted innovation in public services through different vehicles that Catalonia could also consider in its efforts to support public sector innovation. Many countries, and regions like Catalonia, have included public sector innovation in their innovation strategies. Examples include Australia, Finland, Korea and the United Kingdom. They are also using digital technology and Web 2.0 methods for information sharing and greater citizen involvement. *Gencat.net* for Barcelona is one example already used in Catalonia. Other areas of innovation pertain to user-centred and co-produced services. These examples are particularly relevant for physical and mental health services in Catalonia. Denmark's *Putting People First* works with partners to design services with users to address social problems like health and obesity. Other examples include service re-design or working with the private sector, with several health-related examples found in the United Kingdom (Leadbeater *et al.*, 2008).

The public sector may also support public service innovation organisations to provide expertise. Examples include South Africa’s Centre for Public Service Innovation and Korea’s Foundation for Innovation. The United Kingdom’s NESTA Lab for Innovating Public Services is one example of an experimentation lab and advisory service for public sector innovation (see Box 2.9). Finally, an innovation culture can be supported through incentives for public sector innovation, including awards or special funding schemes.

Approaches to measuring innovation in the public sector are in a nascent stage. One form of measurement takes a more sectoral approach that is applied to the particular public service. Many OECD member countries and regions are interested in measuring innovation in health care as it is often delivered by the public sector. Such measures may explore the creation of new products, processes, organisational and marketing methods and their impact on the cost savings or other value creation associated with the innovation specific to the sector.

Another approach is to measure the organisational culture of the entity delivering the public service to identify if it is conducive to innovation. Do actors in the public entity have the opportunity to propose or test an innovation? Are there mechanisms in place to help mainstream such an innovation? One initiative for measurement, sponsored by the Danish Ministry of Science, Technology and Innovation, is a project with Nordic countries to develop a framework for measuring public sector innovation. The approach will be similar to that taken in private sector innovation surveys.<sup>48</sup> The OECD is also examining this issue.

### **2.3. The current policy mix: imbalances and constraints**

The imbalance in Catalonia’s policy mix of programmes and instruments in support of R&D and innovation, and the limited scope to reduce its imbalances, are due to a number of factors. They include: *i*) the background of limited budgetary resources; *ii*) the “path dependency” or inertia of past policy orientations since the first Research Plans; and *iii*) the evolution of governance structures and the framework imposed by the division, or overlap, of responsibilities between Spain and Catalonia.



### Box 2.9. The NESTA (UK) Lab: Innovating public services

The National Endowment for Science, Technology and the Arts (NESTA) in the United Kingdom has created the Lab to meet a public sector need for new ideas that work. By bringing together experience and ingenuity from across the public, private and non-profit sectors, and drawing on the insights of citizens and consumers, the Lab seeks to support making public services fit for the 21<sup>st</sup> century.

The Lab provides the freedom, flexible capital and expertise to undertake radical experiments. It tests out new ways of finding and spreading the best ideas. This might be by running a challenge prize, building a social ventures incubator, or creating powerful new teams of users, front-line staff and decision makers. It is not a physical space or an institution – it's a series of practical projects, informed by research and delivered in partnership with those that run and use public services. It shares lessons about what works – and what doesn't – and creates opportunities for people to solve problems together. The Lab's success will be measured in two ways. First, has it contributed to the development of better services – and in these challenging economic times, has it found ways of delivering better for less? Second, have its methods and approaches been adopted by others to improve people's lives?

There are three parts to the Lab:

- **Challenge Lab:** explores how innovation can help services respond to critical social and economic issues, starting with ageing, climate change and health.
- **Methods Lab:** puts radical thinking into action and is where actors can test and assess the best ways of fostering public service innovation; and
- **Learning Lab:** helps innovators to apply and spread what is learned.

Source: [www.nestalab.org.uk](http://www.nestalab.org.uk)

### *Strengthening the research system remains a high priority*

The early priority given to the strengthening of Catalonia's public research system (universities and the now large number of Catalan Research Centres) has not been fundamentally modified in the budget or in the PRI. The volume of resources allocated to research and universities accounts for the largest share of the Catalan R&D&I budget (see Table 2.7). Close to 60% of the total budget goes for this purpose, and that figure reaches more than 80% if the research supported by the Departments of Health and Agriculture is added.<sup>49</sup> This priority reflects the importance of the academic

community in the policy and the deliberate choice to ensure the competitive strength of the Catalan public research in national and EU-level competitive calls. This choice has been successful in terms of its stated objectives but has probably impaired the achievement of other objectives related to the promotion of business innovation.

Table 2.7. **R&D and innovation expenditures by area (2006)**

Department/areas	EUR million	%	Without professor compensation % <sup>1</sup>
University and Research (Commission of Universities and Research)	396	58.58	35.19
Professors (% of salaries in research duties)	244	36.09	-
Universities: investments	12	1.78	2.78
Universities: research groups programmes	32	4.73	7.41
Fellowships (including ICREA)	34	5.03	7.87
Research Centres	45	6.66	10.42
Research infrastructure	10	1.48	2.31
Co-operation with other institutions <sup>2</sup>	10	1.48	2.31
Other	9	1.33	2.08
Innovation and industry (CIDEM and SIE) <sup>3</sup>	65	9.62	15.05
Technology Centres	16	2.37	3.70
R&D&I projects	36	5.33	8.33
Support to enterprise innovation	13	1.92	3.01
Health	131	19.38	30.32
Personnel (% of salaries in research duties)	120	17.75	27.78
Health Research Centres	11	1.63	2.55
Agriculture	25	3.70	5.79
Other government departments	59	8.73	13.66
Total	676	100.00	100.00

Notes: 1. This refers to the compensation of university professors for research duties. 2. In Spain and abroad. 3. CIDEM = Centre of Entrepreneurial Information and Development. SIE = Secretary of Industry and Energy.

Source: Government of Catalonia, Inter-ministerial Research and Innovation Commission (CIRIT).

One can infer that the share allocated to Catalan Research Centres is increasing relative to that allocated to universities. Beyond the autonomy enjoyed by universities, the national regulatory framework applied to Spain's public universities (personnel status, career and wage management) imposes some constraints hindering a flexible and efficient mobilisation of resources on priority research programmes or projects. It may therefore seem easier to palliate perceived weaknesses of the university system with the creation of dedicated public research centres. Such a strategy has pros and cons. It preserves the research autonomy of universities but does limit their research funding since the Catalan government does not currently offer

competitive research funding. This strategy does not promote interdisciplinary research, which can be more efficiently undertaken in a university context than in dedicated research centres.<sup>50</sup> By international and regional standards, the number of Catalan public research centres is quite large and, as noted above, this raises questions of critical mass and efficiency. While the contract programmes to which the centres are submitted can alleviate this problem, it is practically always easier to create a new centre than to close an existing one.

Another imbalance in the research system support is the way thematic research priorities and specialisations are handled. This is partially addressed through the support given to university research groups, but the relative amounts are probably insufficient. Given the size and the excellence level reached by public research in Catalonia, the quasi exclusive reliance on project funding by Spain and the EU may becoming inadequate to ensure a better contribution of the Catalan research system to the region's socio-economic needs. In this regard, the Catalan government should probably consider launching thematic research programmes focusing on regional priorities and open to competitive funding of projects presented by or in association with Catalan institutions. These programmes could encompass public-private partnerships and act as leverage for private investment in R&D activities related to meeting collective needs.

### ***Business R&D and innovation***

The relative importance of support to business R&D and innovation (including technology transfer programmes) has increased in the Catalan policy mix over the present decade. This is true particularly in the framework of the PRI 2005-2008. Resources devoted to this support amounted to 37% of the PRI budget in 2007<sup>51</sup> and over 15% of total government expenditures on RDI in 2006 (see Table 2.3). This evolution, which reflects a welcome rebalancing, calls for some remarks.

The support programmes developed by CIDEM suffer from a fragmentation into numerous support measures that may generate inefficiencies due to lack of critical mass and management costs. The financial instruments, essentially grants, may not always be the ones most suited to the needs of the enterprises, especially those SMEs that have the most difficulties to access the Spanish government CDTI support programmes.

The same is true for technology transfer programmes, whose organisation in supply-driven network layers is a source of complexity and inefficiencies. The XIT and XTT networks may be possible exceptions, in part because they began in 1999 and 2000 respectively, and therefore have

had more time to develop. The private sector needs to assume a greater role. Public support to demand should also be given greater attention. The lack of intermediary or brokerage institutions, or the insufficient complementarity between these programmes and direct financial support instruments, hinders collaboration with public research institutions and may be among the causes for the already noted weak behavioural additionality of programmes in this area.

No consideration has been given to support to public-private partnership for R&D and innovation that can leverage private R&D investment focused on regional priorities (see Box 2.4). In this area the prevailing policy has been to maximise the participation of Catalan firms in the Spanish CENIT programme.

Finally, Catalan cluster policy has up to now been isolated from the mainstream of innovation policy. Here again, fragmentation and the lack of complementarity with the provision of technological and other business services that strengthen the absorptive capacity of firms belonging to the same cluster can be seen as detrimental to efficiency of business support programmes. Innovation-related cluster policy need not be re-designed from the beginning, as it could draw on the initiatives taken by dynamic local institutions that may play a leading role in innovative clusters as well as other existing ACCIÓ (formerly CIDEM) cluster-related programmes.

### ***Human resources development***

Catalonia recognised very early that the development of human resources or “talent” is an essential pillar of its transition to a knowledge-based economy and society. On the whole, its government has skilfully played within the framework (given by the devolution of the education sector to the regions and the national regulatory environment of the universities) to promote the development of a qualified pool of human resources in S&T. The absolute and relative levels of resources devoted to this development both in the PRI and the Catalan budget reflect the region’s concern in these matters. The success and growth of the efficiently managed ICREA programme is an example of a well-designed initiative.

Despite these achievements, Catalonia continues to suffer from some of the same shortcomings as Spain as a whole, some of which relate to regulatory obstacles (OECD, 2007e). Notwithstanding the development of dedicated scholarships and the benefits drawn from the Spanish government Torres Quevedo programme, the insertion of highly qualified personnel in firms, such as PhDs, remains low. In comparison with the majority of European countries, insufficient resources are allocated to the recruitment of technicians in public research institutions.

In summary for this innovation policy area, Catalonia's policy mix is well oriented. The main problems that hinder further improvements are related to resource availability and regulatory obstacles predominantly under the purview of the Spanish government.

### *Inter-ministerial co-ordination in Catalonia*

Governance structures affect the policy mix in various ways. Their role in the definition of policy orientations and priorities is reflected in budgetary allocations within and across policy areas. Within the framework of the systemic approach to S&T and innovation policy, governance structures also play an important role of co-ordination among implementing agencies that may or may not belong to the same ministerial departments.

The creation of CIRIT as an inter-ministerial body, at times attached directly to the President of Catalonia, and its effective role in the context of the PRI, has improved the priority/budgetary and co-ordination functions. However, it seems that CIRIT was still marked by its original links with the public research community. This has affected the progressive rebalancing between push and pull policies, not only in quantitative terms, but also in the design and management of policies aimed at strengthening the relationships between research and industry. The spheres of actions and responsibilities of the Commission of Universities and Research and of CIDEM have remained quite distinct in areas where more synergy and possible joint programme financing could have been fostered. This could notably have been the case for the so-called "sectoral and technology strategy" of the PRI, which has remained rather opaque as regards the involvement of the public research system and the opportunity to develop research and innovation platforms in Catalonia's areas of priority.

Another example of limited co-ordination is the apparent lack of CIRIT oversight in research activities carried out by research institutions under the aegis of other ministries, and in particular those of Health and Agriculture. This is a delicate matter as these ministries' institutions may have their own supply and demand driven research agenda and should probably retain a margin of autonomy. On the other hand, given their weight in the Catalan R&D&I system, their research and technological transfer activities cannot be entirely left out of the purview of the main governance body and the inter-ministerial budgetary allocation process in which this body is involved.

## 2.4. The Catalan Agreement on Research and Innovation (CARI)

### *Background*

Over the last several years, Catalonia has instituted a practice of consensus-building processes leading to politically prominent agreements designed to transcend the political cycles. Such agreements among government, political and civil society stakeholders include commitments on medium- to long-term objectives and policy orientations in socio-economic areas deemed as strategic for the development of the region. The Catalan Agreement on Research and Innovation (CARI), the latest of such agreements,<sup>52</sup> was signed on 21 October 2008 by the President of the *Generalitat* and Catalonia's Minister of Innovation, University and Enterprises, as well as by numerous political and civil society stakeholders (university sector and Parliament as well as trade unions and business associations).

The final version of the formal CARI agreement drew on the conclusions of two previous exercises launched in 2007 and concluded in 2008:

- The Strategic Agreement to Promote the Internationalisation of the Catalan Economy, the Strengthening of its Competitiveness and the Quality of Employment, 2008-2011 (GC, 2008c) prepared under the aegis of the Ministry of Economy with civil society; and
- The *Catalan Agreement on Research and Innovation – Framework Document* (GC, 2008b) which is the outcome of the work of a Committee of Experts entrusted by the Minister of Innovation, University and Enterprises to present a diagnosis of the Catalan S&T and innovation system. The diagnosis covers the innovation system's performance, governance and policy implementation. The document also proposes recommendations underpinning commitments for consideration by the CARI signatories.

The Strategic Agreement encompasses the various policy areas deemed to be important for the internationalisation, competitiveness and quality of employment in the Catalan economy. It is in this framework that it addresses S&T and innovation policy.<sup>53</sup> The document does not have a systemic approach for this policy area. Rather, for the various components of the system, it highlights the salient elements of diagnosis and proposes a limited number of policy recommendations considered as the most important. For each policy area, monitoring instruments are proposed, in the form of a few performance indicators, as well as yearly target budgetary allocations.

The Strategic Agreement does not take an innovation system approach. It uses a rather fragmented approach to the innovation system, notably concerning the complementarity between policy areas. However, the Agreement has the clarity of diagnosis elements and the relevance of very concrete policy recommendations. Indeed, a number of weaknesses of the PRI emphasised above are acknowledged by the Strategic Agreement.

### *The CARI Framework Document*

In contrast with the Strategic Agreement, the CARI Framework Document and its recommendations are explicitly based on a systems approach of research and innovation. It reflects the shared vision of the Committee of Experts<sup>54</sup> and the involvement of stakeholders in the research and innovation communities.<sup>55</sup> This comprehensive approach has certainly contributed to enrich the diagnosis of the strengths and weaknesses of the Catalan system.<sup>56</sup> The CARI Framework Document and the CARI itself also introduced the importance of a stable system and policies that outlast political cycles. Many of the changes in regional governance to address the recommendations of the Framework Document would not have occurred as quickly, or at all, had it not been for the CARI.

As the CARI was designed for building consensus, not as a planning document, it has to some extent led to a blurring of the hierarchy of policy priorities. The 2010-2013 PRI will need to address this prioritisation issue.<sup>57</sup> The CARI produced a very large number of recommendations (131), too often presented without due attention to policy complementarity requirements or resource implications. While the Framework Document attempts to devise scenarios for R&D expenditures (including government expenditures) through 2017, there is hardly any evaluation or estimation of the possible costs of the proposed support programmes and expected additionality on private expenditures. It can be argued that the very process of consensus building involving a large number of stakeholders, a process that was not submitted to resource reality checks, can in fact lead to an inflation of recommendations. That inflation is due, in part, to a lack of trade-offs among participants. It is also conspicuous in this regard that the Framework Document does not address policy mix issues.<sup>58</sup>

Nevertheless, the Framework Document presents a number of very valuable recommendations whose implementation could steer the Catalan S&T and innovation system towards higher performance. Some of the most notable areas addressed in the CARI where recommendations point to a welcome change from current policies and practices include:

- Strengthen the *third mission of public research institutions* and link institutional financing to assessments that take this third mission into account;
- Foster the *inter-institutional mobility* of researchers and the insertion of human resources in S&T in the enterprise sector;
- Introduce *prioritisation criteria* in the funding of research and innovation programmes;
- Develop an *innovative clusters policy*, mixing top-down and bottom-up approaches;
- Introduce an *innovation-related procurement policy* across the Catalan administration;
- Broaden the *innovation policy scope* to private and public services;
- Rationalise the *technology transfer programmes* and give a greater role to demand side support;
- Focus on the main areas of *co-ordination with the Spanish government* in research and innovation policy; and
- Develop strong capacities for the performance *monitoring* of the Catalan innovation system and the *assessment* of research and innovation policies.

On the other hand, there are some recommendations that could be challenged or even be counterproductive. Some of these recommendations include:

- The broadening of the mission assigned to ICREA to use this facility to attract talent in other areas than scientific research. ICREA's success is to a large extent due to its specific mission and lean and efficient operating model;<sup>59</sup>
- To increase the number of research centres in strategic fields and under criteria of highest excellence.<sup>60</sup> As highlighted above, the existence of a large number of Catalan Research Centres may raise problems of critical mass and overspecialisation detrimental to interdisciplinary approaches. One of the main problems, which have only been met with *ad hoc* solutions, is that of the co-existence of, and articulation between, universities and research centres.



- Recommendations aimed at improving governance do not always address in a satisfactory way some of the issues raised by a study commissioned by the CARI Committee of Experts to outside consultants, notably with regards to the capacity to prioritise resources.

### ***Responding to the challenges ahead: CARI's objectives and commitments***

The CARI is the outcome of a high visibility and ambitious process to mobilise the main actors of the Catalan S&T and innovation system around a common vision of the challenges ahead. It served to forge a consensus not only on long-term objectives regarding the performance of this system and its contribution to the region's competitiveness and social welfare in a global environment, but also on the actual commitments that the actors have to make to reach these objectives.<sup>61</sup> Many consensus-building exercises often stop short, only providing a compass that shows agreed common goals. The ambition and merits of CARI lie in the fact that it provides the roadmap for institutions' individual or collective actions in support of the agreed objectives, including those related to ratios of total R&D and business R&D&I expenditures over GDP.<sup>62</sup>

This ambition does not go without risks. Reaching ambitious quantitative targets may prove elusive, as illustrated by the expected difficulties for a number of European countries in reaching the EU target of a 3% ratio of R&D expenditure over GDP. Actors in Catalonia may fail to comply with their own commitments and resources may be lacking. Such risks must be managed to ensure that the mobilisation of actors remains high, even in the event that Catalonia does not reach the ambitious targets. In principle, the CARI monitoring process allows for learning so as to periodically revise the course of actions that underpin the commitments. In the short term, an important effect of CARI will be the accounting of the commitments undersigned by the Catalan government in the preparation of the PRI 2010-2013, and in particular the budgetary allocation related to the Plan's implementation.

### ***General remarks on design and implementation***

The CARI did not benefit from an assessment of the outcome of the PRI 2005-2008, as one was never performed. However, CARI signatories could draw on the extensive diagnosis and the recommendations made by the Permanent Committee of Experts, as documented in the Framework Document, to forge a consensus on the so-called "strategic" and "driver" challenges to be addressed by agents of the Catalan research and innovation system (see Table 2.8).

The CARI commitments read often like a wish list or a readiness to develop a plan that should facilitate the achievements of objectives related to a specific challenge. Too often the level of specificity of the *object* of commitments, coupled with the general character of the actions to comply with them, reduces their credibility.<sup>63</sup> So does the sheer number of commitments (131) and the frequent absence of indication on the resources required to fulfil them, notably in terms of human capital and organisational capabilities. In this regard, it can be said that “the best is the enemy of the good,” as the relevance of the analytical diagnosis is diminished by the level of detail of the roadmap. In other terms, the set of commitments appear to be too detailed and over-specified.

The CARI approach raises issues of complementarity and sequencing. These issues are quite well addressed in the framework of individual objectives, as commitments of the Catalan government and other institutional agents are generally identified and agreed upon to concur and complement each other to fulfil the objective. This is not always the case across objectives when sequencing and complementarity may be a condition of success. In other terms, although the CARI refers to a systemic approach to innovation, the elements of the system remain dealt with in a rather independent manner, at least as regards the commitments corresponding to the so-called strategic challenges. These issues may not be that important for an Agreement with a long-term time horizon, but they must be addressed in the PRI 2010-2013.

What may be more problematic are the compliance costs of the CARI commitments. This is most likely to be raised in the context of the monitoring procedures considered in the Agreement.<sup>64</sup> A large majority of stakeholders' commitments, aside from those of the Catalan government, imply the undertaking of activities that will involve dedicated human and organisational resources. This is particularly the case for commitments calling for the development of programmes, strategies, information systems or the constitution of networks. These types of commitments are quite numerous throughout the CARI.

As the main “sponsor” of the CARI, the Catalan government must be exemplary in the compliance with its numerous qualitative and quantitative commitments. Chairing the Monitoring Committee, the Catalan government also plays a *primus inter pares* (first among equals) role assessing the achievement of the other institutional actors. In this regard several dangers should be avoided.

**Table 2.8. Catalan Agreement on Research and Innovation: challenges and objectives**

Strategic challenges		Objectives
1. Talent	To have the best scientific, innovative and entrepreneurial talent, with the necessary abilities and a critical mass <i>(20 commitments)</i>	<ul style="list-style-type: none"> <li>-To have an education system and a professional environment that provides, promotes and maximises scientific, innovative and entrepreneurial abilities.</li> <li>-To attain a critical mass of qualified professionals with the right profiles for innovation (creative, scientific, technical and management skills).</li> <li>-To recruit, recuperate and retain more and better scientific and innovative talent in the research and innovation system and to promote the mobility of this talent.</li> </ul>
2. Push	To develop and maintain a high capacity for generating and valuing knowledge <i>(19 commitments)</i>	<ul style="list-style-type: none"> <li>-To strengthen the public research system.</li> <li>-To attain and profit from leading scientific and technological infrastructures.</li> <li>-To reinforce the capacity of research agents to value knowledge.</li> <li>-To facilitate the development of the different types of innovation.</li> </ul>
3. Pull	To innovate systematically as a base for productive activity and public and social action <i>(23 commitments)</i>	<ul style="list-style-type: none"> <li>-To generate favourable contextual conditions for innovation.</li> <li>-To encourage the growth of an innovative and knowledge-intensive business ecosystem.</li> <li>-To have an innovative public sector as well as public administration that drive innovation.</li> </ul>
4. Internationalise	To think, be and act globally in research and innovation <i>(11 commitments)</i>	<ul style="list-style-type: none"> <li>-To direct and implement a joint co-ordinated action to internationalise research and innovation.</li> <li>-To strengthen the role of Catalonia as an international player in research and innovation.</li> <li>-To establish international strategic alliances and platforms for research and innovation.</li> </ul>
5. Socialise	To ensure that Catalan society be infused with science, technology and innovation <i>(15 commitments)</i>	<ul style="list-style-type: none"> <li>-To direct and implement a joint co-ordinated action of socialisation of science, technology and innovation.</li> <li>-To introduce science, technology and innovation into close contact with the public.</li> <li>-To place science, technology and innovation in the foreground of the political, social and economic arenas in Catalonia.</li> </ul>
6. Focus	To focus and prioritise research and innovation where there is the greatest value <i>(7 commitments)</i>	<ul style="list-style-type: none"> <li>-To define the strategy for focusing on research and innovation in Catalonia.</li> <li>-To design and develop the regional strategy for specialisation in science, technology and innovation.</li> <li>-To specify fields that are strategic priorities for research and innovation in the coming years.</li> <li>-To direct instruments and resources towards the areas focusing on and prioritising research and development.</li> <li>-To establish a solid organisation and link among agents in the Catalan research and innovation system and to strengthen their co-operation.</li> </ul>
7. Facilitate	To adopt a governance of the research and innovation system that is intelligent, efficient and effective <i>(21 commitments)</i>	<ul style="list-style-type: none"> <li>-To develop a dynamic model of governance that strengthens strategic capacity and coherence in decision making and in the design and implementation of research and innovation policies.</li> <li>-To maximise the efficiency, the effectiveness and the learning capacity of the research and innovation system.</li> </ul>

**Table 2.8. Catalan Agreement on Research and Innovation: challenges and objectives (continued)**

Strategic challenges	Objectives
8. Invest To make more and better investment into research and innovation in the public and private sectors (15 commitments)	-To increase spending on R&D to 2% of GDP and business spending on R&D&I 3.75% of GDP in 2010, with the aim of reaching 3% and 4.5%, respectively, in 2017. -To focus public spending on R&D and in supporting innovation on the objectives of the Catalan Agreement on Research and Innovation. -To improve the economic and taxation framework for R&D&I spending in Catalonia.

Source: Government of Catalonia (2008), Catalan Agreement on Research and Innovation, Barcelona.

The first danger is related to the preparation of the PRI 2010-2013 and the financing of its implementation. Notable deviations from the Catalan government commitments regarding the nature of support programmes, the outcomes of prioritisation processes or anticipated budgetary allocation to R&D and innovation activities would seriously damage the credibility of the CARI. It would also undermine the importance that the Catalan government is attaching to research and innovation as a key driver of growth and international competitiveness.

Commitments are numerous and, as noted above, they form a set that seems overly specified to the achievements of the CARI objectives. If a commitment is not complied with, the fulfilment of the objective seems in jeopardy. In monitoring exercises, micro-management or oversight of compliance requirements should be avoided. Furthermore, the transaction costs associated with this compliance should be accounted for. While the CARI envisages that over time new commitments could be “promoted to enrich the content of the Agreement in order to continually improve and update it,” the reverse situation would probably reveal an improvement in the actors’ stance *vis-à-vis* their role in the innovation system approach. Indeed a signal of such an improvement would be that perceived incentives can replace commitments.

### ***Outstanding commitments: improving the policy mix and policy effectiveness***

It is not in the purview of this report to systematically review the 131 commitments agreed in the CARI, but rather to concentrate on those that are more closely related to the Catalan government’s policy-making responsibilities in steering the S&T and innovation system. The following section highlights those commitments that address structural weaknesses of

the Catalan innovation system and blind spots of past policies. They therefore seem particularly significant for improving the policy mix and performance of the system in light of international best practices. The preparation and implementation of the upcoming PRI will be a test case for the compliance with most of these commitments. The implementation of new support measures envisaged in the CARI could raise important resources issues.

### *Policy mix*

While no explicit attention is given to policy mix issues in the CARI document, an important merit of the set of Catalan government commitments is that they implicitly lead to an improvement of this mix across and within S&T and innovation policy areas:

- Catalonia will still continue to strengthen excellence in its public research institutions in order to maximise external financing from the Spanish government and EU programmes. It will also devote budgetary resources to finance contractual and competitive research projects proposed in the framework of regional priority programmes to which universities can apply, thereby increasing the competitive funding for their research activities, notably through collaboration with research centres. This should contribute to improving the balance between universities and research centres with positive effects on multidisciplinary.
- A prioritisation ensuring that Catalonia's innovation system better responds to the region's socio-economic challenges and opportunities. This should foster the region's capacities in priority areas and strengthen public-private partnerships with leverage effects on private RDI expenditures;<sup>65</sup> and
- New or better adapted policy instruments will be developed to improve technology transfer between firms among themselves and with public research institutions, as well as public demand for innovative products and services (*e.g.* innovation clusters, demand-driven technology transfer, procurement policy).

### *Human resources in S&T (HRST)*

In this area, the portfolio of Catalan government commitments includes some that should easily be reflected in policies with a direct impact of the performance of research institutions and their collaboration with firms:

- The strengthening of policies for the *hiring of research personnel*, including technicians, with the aim of attaining per capita ratios similar to those of most advanced countries (commitment 16).
- Encouraging the *inter-institutional mobility* of HRST (through incentives and removal of regulatory constraints) and fostering their hiring by firms (commitments 18 & 21).
- The commitment related to the *broadening of ICREA's scope* of activity in the direction of highly qualified technical personnel (commitment 12) should be taken caution as the success experienced by this Institute is predicated upon criteria of scientific excellence that cannot easily be adapted to other qualifications. It seems more advisable to strengthen the capacity of ICREA without tampering with its basic mission.

### *Public research institutions*

In this area, there are important commitments that address the determinants of the performance of these institutions. They are related to the criteria for institutional funding, the broadening of the base of competitive funding, the strengthening of the collaboration between universities and research centres, and the development of public-private partnerships in research and innovation:

- *Institutional funding of universities and hospitals* will be increasingly linked to assessment of research activities in the context of multi-year programme contracts, similar to those developed with research centres (commitments 22, 24 & 26).
- *Relationship agreements between research centres and universities* will be promoted and a framework agreement will be sought with CSIC to foster co-operation and policy alignment with Catalan institutions (commitments 23 & 27). It is to be appreciated that the CARI has not explicitly endorsed the recommendation of the Framework Document to increase the number of research centres. However, the CARI could have proposed a possible consolidation of research centres.
- The *promotion of public-private partnerships (PPPs)* in research and innovation based on international best practices (see Box 2.4) is explicitly mentioned (commitment 38). The development of PPP programmes should increase the funding base of research institutions and leverage private investment; and
- In the framework of its prioritisation of research and innovation activities, the Catalan government will develop *priority programmes*

within which projects presented by public research institutions and/or private enterprises will be funded on a contractual or competitive basis (commitment 94).

### *Private sector innovation and technology transfer*

The Catalan government's present system of support to private innovation and technology transfer is suffering from inefficiencies and weak behavioural additionality effects. CARI commitments in this area should contribute to improve this situation, provided appropriate precautions are taken in the design and management of the support programmes:

- *Rationalisation of support programmes* financed and managed by ACCIÓ (former CIDEM/COPCA) will be undertaken to remedy their excessive fragmentation (commitment 55).
- Large enterprises will continue to be encouraged to apply to and participate in Spanish and EU programmes (e.g. CENIT and Eureka) and increased resources will be devoted to the *support of high-technology projects* with a premium given to those developed in co-operative arrangements (commitment 41).
- The various schemes developed to provide *support to SMEs* will also be streamlined to give rise to a fewer number of more comprehensive programmes that will cover a larger scope of innovation-related expenditures (commitment 55). However, as emphasised above (Figure 2.2 and Box 2.3), given the wide variety of SMEs, support policies should be diversified and customisation should not be a victim of the necessary streamlining efforts.
- *Rationalisation of the technology transfer networks* to reduce overlap, improve quality of services through accreditation, and give greater emphasis to demand driven actions supported by business associations (commitments 44 & 57).
- The present limited scope of industrial cluster policy will be broadened to give rise to a more comprehensive *innovation clusters policy* developed in collaboration with initiatives promoted locally by research institutions and business associations on the basis of local opportunities and specialisations (commitment 56), the innovation cluster approach should underpin SME and technology transfer support programmes.
- The CARI recognises the growing importance of *knowledge-intensive services* (KIS) in the diffusion of technology as well as the dissemination of non-technology related innovation. While no specific

measures are currently envisaged in support of this sector, the Catalan government is committed to engage in a review of international best practices in this area to eventually develop an action plan to facilitate the development of KIS and strengthen their role in innovation diffusion (commitment 45).

- In line with practices implemented at both national and regional governments in a number of EU countries, the Catalan government will develop an *innovation-related action plan for procurement*, specifically for the procurement of technology-intensive public goods and services. This plan will ensure the participation of SMEs (commitment 59). It is advisable that it also foresees the involvement of public research institutions.
- The Catalan government is committed to mobilising public resources and attracting private ones to boost the availability of venture capital funding of technology-based business projects (commitment 129), although the determining role of the Catalan Finance Institute (IFC) is not mentioned in the CARI.

### ***Catalan governance***

Efficient and transparent governance is an essential component of well-performing innovation systems. Governance issues are therefore prominent in the CARI background document's recommendations as well as in the CARI document itself. The governance principles highlighted in these documents are inspired by New Public Management best practices, followed with degrees of diversity according to institutional specificities by a number of OECD member countries.<sup>66</sup> This is particularly the case for the "principal-agent" principle which distinguishes between the functions of policy advice, policy setting and monitoring, funding, and implementation. The principle-agent issues are also relevant in the contractual arrangements between funding agencies and institutions performing research and innovation activities benefitting from public funding. The CARI also suggests a need for greater co-ordination with the Spanish government in a multi-level governance context (see Chapter 3).

The new governance structure promoted by the CARI typically improves upon existing arrangements (see Chapter 1). The creation of the new Catalan Research and Innovation Council for strategic policy guidance (commitment 102) could involve a broadening of its mission to include an advisory role over the organisation of the system of public S&T institutions. Although the CARI is not explicit on this point, it is to be stressed that the governance system should retain some margins of flexibility, at least more



than presently envisaged. For instance, the new Catalan Research Agency and ACCIÓ should be left free to join forces in supporting public-private partnerships for research and innovation.

Monitoring and assessment are essential functions of efficient governance systems. Up to now, these functions have not been adequately performed by Catalonia's government. Following the recommendations of the CARI Framework Document, the CARI has taken valuable initiatives to fill this important gap, although it can be argued that the necessary efforts to carry them out may be underestimated. The Research and Innovation Co-ordination Office should be responsible for the oversight of the monitoring and assessment function.

- Consistent and reliable information systems must rely on decentralised compilation of statistics and indicators by diversified agents according to comparable and centrally defined standards. These requirements would have to be taken into consideration for the development of information systems contemplated in the relevant CARI commitments;
- The implementation of a new system of research and innovation indicators (commitment 40) that will involve the participation of the Catalan statistical agency (IDESCAT), the funding agencies, and the public and private performers of R&D and innovation activities that have developed information systems for their own management and strategic purposes; and
- The configuration of “a system of information and analysis of information integral to research and innovation in Catalonia” (commitment 111) that can also be used for the development of an intelligence system that can be fed and accessed by public and private research and innovation agents.

There is one important aspect of the assessment function that CARI is not explicit about: that of policy and programme evaluation. As noted above there are but a few exercises, essentially conducted by academics, devoted to such evaluations which provide useful feedback on policy design and delivery.

### ***Resource implications***

The Catalan government's compliance with all of its CARI commitments will most likely add up to resource requirements that may prove difficult to satisfy. This is especially true in the context of the present global economic crisis and its implications for Catalonia's industry. The increase of total R&D investment in the region to reach a ratio of 3% of

GDP by 2010 should be regarded more as an ambitious objective than a realistic target. Nevertheless, efforts should be undertaken to get as close as possible to reaching the target.

Increasing R&D and innovation public spending is not an end in and of itself. The rationales for such expenditures must be underpinned by anticipated efficiency in terms of expected returns and spillovers. In the context of the preparation of the PRI 2010-2013, contingency planning should be undertaken to seek which of the CARI commitments ought to be prioritised and which could be postponed without jeopardising the coherence of the exercise. Finally, the compliance of their commitments by other non-governmental stakeholders may give rise to resource claims that the Catalan government should be in a position to assess.

## Notes

1. The 2010-2013 Research and Innovation Plan of the Catalan government was in progress at the time of the analysis for the review. By the time of this review publication, the Plan will have been released.
2. Such as the Agrofood Research and Technology Institute (IRTA) created in 1985 under the aegis of Catalonia's Department of Agriculture following the transfer of responsibility for the agrofood sector from the State to the *Generalitat* (Catalan government) in 1981, including the *Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria* (INIA), the State research facility in the sector.
3. The budget shortage was due in part to the Catalan government's unsuccessful attempt to press the central government for devolution of S&T resources. Other Spanish regions did not seek devolution of S&T resources at the time.
4. Contrary to what happened for public funding of agricultural research.
5. In the framework of the State Law on the Development and Co-ordination of S&T Research.
6. Such as the General Directorate for Research responsible for academic researcher salaries.
7. Thus, as highlighted by Cruz Castro *et al.* (2003), the strategic choice that was made was "to implement policy actions aiming at helping research groups to reach the best possible competitive level to access research funding from the State and the European Union".
8. During the period covered by the third EU Framework Programme (1990-1994) Catalonia received an annual average of EUR 8.8 million or about 18% of the total Programme funds granted to Spain. This share increased to more than 20% over the period covered by the fourth Framework programme (1994-1998). See Bacaria *et al.* (2004).

9. As recognised by a former Director General of Research, [while] “improving Catalan science competitiveness and optimizing interaction between public and private sectors to promote technology transfer composed the main objectives of the first Research Plan for Catalonia... the first Research Plan programmes continued the old policy of grants and fellowships set up by the CIRIT since its beginning” (Serrat, 2004).
10. With the creation of ICREA (Catalan Institute of Advanced Research and Studies), an important initiative was taken to promote the hiring of top level international scientists in Catalonia’s public research institutions with contracts not bound by university contractual regulations.
11. Note that this ratio does not measure the additional effect, but rather the relative proportions of public and private financing of the supported enterprises’ total innovation-related investment.
12. There were comparisons with other regions that contributed to this policy shift, such as the Basque Country where the promotion of innovation as the main axis of S&T policy was more responsive to industrial interests and led to stronger economic performance (Sanz-Menéndez and Cruz-Castro, 2005). This shift was underpinned by the evaluation of the Plan that explicitly recognised that the promotion of innovation, and in particular the technology transfer programmes, had been too weak in terms of scope and resources (CIRIT, 2003).
13. In 2000, the Commission for Universities and Research was converted into a ministerial department with broader competencies: the Department for Universities, Research and Information Society (DURSI). CIRIT, although technically operating within DURSI, regained its former status of an inter-ministerial commission. The minister in charge of DURSI managed, however, to hold the vice-chairmanship and, for practical purposes, effective control over CIRIT. This inter-ministerial status was to a large extent formal.
14. Although in the case of the Research Plan, apart from CIRIT, various DURSI departments were responsible for programme management.
15. From EUR 12.5 million in 2003 to EUR 33 million in 2004. It should be highlighted, however, that in 2001, the first year of the Plan, the Catalan government financed only 2.7% of business R&D expenditures whereas for the governments of the other regions in Spain, this share amounted to approximately 4% on average (García-Quevedo, 2005).
16. The region accessed EU funds to apply this approach. It highlights the importance of market and non-market processes of knowledge diffusion among public and private agents for innovation performance and puts a premium on the roles of institutions and incentives that enhance diffusion, appropriation and valorisation of knowledge.

17. This point has been highlighted in the chapter on innovation of the *OECD Economic Review of Spain* (OECD, 2007e).
18. García-Quevedo *et al.* (2007) have evaluated the effects of financial support to innovative firms. Their study concludes positive effects of the various types of financial support on R&D input and output additionality but does not find any significant impact on behavioural additionality, which is in fact the real test of lasting structural impact measures of support.
19. Riba and Leyersdorff (2001) found insufficient systemic linkages in a study on the intensity of relationships among system actors being measured by the relative share of co-publications, co-patenting or citations of regional research institutions in regional firm patent applications.
20. There is a large body of academic and policy-related literature that emphasises this point. See in particular OECD (2002a); Miotti and Sachwald (2003); and Segarra-Blasco and Arauzo-Carod (2008).
21. In hospitals and specialised research institutions for health-related research and in IRTA for agrofood research.
22. These centres are under the authority of sectoral ministries from which they receive their institutional funding. Universities may be associated to their creation. Catalan Research Centres are induced to increase their share of self-financing over time.
23. This figure includes the amount of support to investment in R&D and innovation granted to firms in priority sectors or technologies under the PRI “Sectoral and Technology Strategy” (see Table 2.3).
24. The vast literature on evaluation of R&D support programmes illustrates the fact that their outcomes highly depend on these variables rather than on the mere volume of granted support (OECD, 1997).
25. This fact has been highlighted in the evaluation of the third Research Plan that points out the inefficiencies generated by the overlaps and lack of coherence among the various networks (Ballart, 2007).
26. For economic and social demand, those sectors are health sciences and biomedicine, ICT, agrofood, socio-cultural development and environment. For strategic sectors, they include aerospace, biotechnology, pharmaceuticals, agrofood and renewable energy.

27. Budgetary figures compiled by CIRIT include government expenditures in support of innovation (CIRIT, 2008). Although CIRIT claims that it draws on the definitions of the OECD/Eurostat *Oslo Manual*, this accounting poses some problems as the *Oslo Manual* only provides definitions of innovation activities undertaken by enterprises.
28. There are differences in the methodology used to calculate this share. The Spanish calculation is lower because it excludes the budget of R&D university personnel, research personnel of the health system, competitive grants for R&D projects to enterprises, and thematic fields such as transport, culture, ICT, safety and security, environment and others. The denominators used in the ratio were also different, with Catalonia reporting a total regional budget in 2007 of EUR 26.7 billion, that includes Parliament and other statutory Catalan institutions, while the Spanish government uses a figure of approximately EUR 22 billion that includes only spending by Catalan departments (regional ministries).
29. The CARI recognises the need for an “integrated and comprehensive information system” (GC, 2008a) and the Catalan government made a commitment to that effect (GC, 2008b, commitment 111). Beyond that formal commitment, the actual implementation of such a system will raise complex and costly design and implementation issues that need to be recognised.
30. There have been general systemic assessment and some support programmes evaluations commissioned by CIDEM or independently conducted by academics (see in particular Busom [2006]; Defazio and García-Quevedo [2006]; and García-Quevedo *et al.* [2007]).
31. It may be argued that one of the implicit roles of the CARI process was to generate a consensus among stakeholders on the diagnosis of the Catalan innovation system and the outcome of the PRI precisely because there were no comprehensive evidence-based evaluations.
32. A case in point is the complementarity between measures of direct support to business R&D and innovation and policies that consolidate firm propensity to innovate, in areas such as those that foster the recruitment of human resources in S&T or strengthen relationships with outside sources of knowledge.
33. Such as those pertaining to education, training, competition, intellectual property rights, entrepreneurship, etc.
34. Notably as regards salary scales, career development criteria, internal management flexibility, and limitations of the number of project grants that can be managed by one main researcher.

35. Out of a total of 43 research centres, 23 are in science and engineering, ten in biomedicine and health sciences and ten in social sciences.
36. It has been estimated that the technician/researcher ratio in Spain is about half of the European mean. The situation is probably not much better in Catalonia.
37. According to standard scientometrics indicators provided in Moreno Amich (2008) as found in the Annex (GC, 2008a).
38. Meaning that public support had a positive multiplier effect on private R&D expenditure and led to positive outcomes in terms of market shares, patents or productivity.
39. Meaning that public support enhances a learning process through which firms improve and diversify their modes of knowledge acquisition and broaden their modes of innovation, notably through increased co-operation (OECD, 1997).
40. Innovation surveys are a key source of information to assess behavioural additionality effects. The last survey carried out in 2003 by Catalonia's Statistical Institute (IDESCAT) showed that the share of Catalan firms that developed process or product innovations in collaboration with other firms or institutions was significantly lower than the EU average. There is no indication that this gap has been significantly reduced. Countries are increasingly relying on the behavioural additionality concept to assess the efficiency of their programmes of support to business R&D (OECD, 2006a).
41. The second phase of the CIDEM cluster programme initiated in 2005 aiming at promoting new tools for the "management of strategic change" should have an incidence on the demand side.
42. Only in the last years of the PRI did the budget allocated to financing support that covers assistance to access venture capital funds increase somewhat faster than what was initially programmed (see Table 2.3).
43. Such as Australia, Canada or Germany's *Länder* (OECD, 2004), and also Chile (OECD, 2007f).
44. In the framework of the CARI, there has been a foresight exercise aimed at identifying such priorities. They may be addressed in future Plans.
45. See GC (2008a) , section II.3
46. Procurement for innovation was incorporated as an element of the European Commission's Research Investment Action Plan to raise R&D and innovation expenditures to the 3% Barcelona target.
47. For more information, please see [www.sbir.gov](http://www.sbir.gov).

48. For more information, please see [www.mepin.eu](http://www.mepin.eu).
49. If the compensation for research duties of university professors is not counted, the respective shares are still high, respectively 35% and over 70% of the total.
50. The recent development of “mixed” research groups associating researchers from Catalan Research Centres and universities is reducing, but not overcoming, this shortcoming.
51. If the resources allocated to the sectoral and strategic priority programmes funded by CIDEM/SIE are included (see Table 2.3).
52. The four previous Agreements signed since the beginning of the decade pertain to education, housing, infrastructure and immigration.
53. The *Strategic Agreement to Promote Internationalisation of the Catalan Economy, the Strengthening of its Competitiveness and the Quality of Employment, 2008-2011* is organised around seven themes: innovation and knowledge, education and qualifications, infrastructure, business competitiveness, economic activity and environment, quality of employment, and social cohesion.
54. In its introductory statement, the Committee stated that “The document presented here is of an exhaustive nature because it is based on a wide-ranging vision of what a research and innovation system is, as well as the elements which make it up and those which affect it” (GC, 2008a).
55. It has been argued that the fact that representatives of the research community were not included in the preparation of the Ministry of Economy’s Strategic Agreement was among the reasons that led to the preparation of the CARI. The Strategic Agreement does refer to the CARI process and a CARI recommendation (No. 140) calls for adapting the Strategic Agreement to the main conclusions of the CARI.
56. See the extremely detailed SWOT table and the accompanying analysis in GC (2008a), Part I.
57. The background document rightly highlights that “talent” is the overarching priority. Indeed, without adequate talent, resources invested in R&D are wasted as the efficiency of investment in R&D is predicated upon the availability of human resources to exploit it. But then the document goes into semantic variations as other areas are labelled as “key” priorities (generating and valuing knowledge) or just simple priorities (fostering innovation based on productive activity and public action).



58. This notion is only mentioned in a reference to the OECD study of Spain's innovation policy mix (OECD/FECYT, 2007).
59. See recommendation 21 in GC (2008a).
60. See recommendation 31 in GC (2008a).
61. For an overview of experiences on mobilisation of actors in the design and governance of innovation policy, see the section on mobilisation of actors and resources in OECD (2009a).
62. Respectively 2% and 3.75% in 2010, and 3% and 4.5% in 2017 (see Box 2.1).
63. Commitments by the Catalan government and/or other agents of the research and innovation system to design and implement a plan, or develop a programme or a strategy to respond to a given challenge, are frequent in the CARI document.
64. The fulfilment of the commitments will be monitored on a regular basis (at least once a year) under the aegis of a Monitoring Committee chaired by the President of the Catalan government.
65. In the framework of the CARI follow up, a priority setting exercise was launched at the end of 2008 under the oversight of the CARI Steering Committee. This exercise based on a foresight approach, developed in collaboration with an international panel of experts, has involved a large number of stakeholders. The PRI 2010-2013 will take into account strategic priorities identified by the foresight exercise.
66. See the section on governance and public policy in OECD (2009a).

## Annex 2.A1

Table 2.A1.1. **Catalonia's second Research Plan budget: 1997-2000**

millions of pesetas

Programmes	Volume	Percent
<b>1. CIRIT and DGR</b>		
<b>1.1. Research Promotion Programme</b>		
HRST (human resources for science and technology)	5 623	24.4
Research support	9 402	40.8
Research projects	617	2.7
Research Centres	4 050	17.6
International co-operation	699	3.0
Others	1 213	5.3
Total	21 604	93.8
<b>1.2 Technology Transfer Programme</b>		
HRST (human resources for science and technology)	308	1.3
Support to XIT Network	351	1.5
Support to Technology Transfer Networks	16	0.1
Support to projects	591	2.6
International co-operation	152	0.7
Total	1 418	6.2
<b>Total CIRIT/DGR</b>	<b>23 022</b>	<b>100.0</b>
<b>2. Transfer DURSI for Academic Research Personnel</b>	<b>93 136</b>	
<b>3. Total DURSI<sup>1</sup></b>	<b>122 451</b>	
<b>4. Thematic areas<sup>2</sup></b>		
Health	34 556	
Industry (including CIDEM)	6 675	
Agriculture	5 197	
Others	10 683	
<b>Grand total Research Plan</b>	<b>179 562</b>	

Notes: 1) DURSI is the Ministry that replaced the Commission for Universities and Research in 2000. 2) Funded by sectoral ministries.

Source: CIRIT (2003), "Informe d'Avaluació del II Pla de Recerca de Catalunya", Generalitat de Catalunya, Barcelona.

Table 2.A1.2. **High-tech Nucleus Programme support for business R&D&I**

<b>Objective</b>	This programme encourages technological co-operation between firms, public research organisations, private science and technology research centres, technological centres and other agents. The aim of this co-operation is to transfer scientific and technological knowledge among the participants to develop high technological impact projects related to industrial research and experimental development. This co-operation should enhance the production of new processes, products or technological improvements that would be difficult to achieve individually or by the private sector alone. Projects have to be developed in Catalonia and have to be submitted by groups of firms.
<b>Beneficiaries</b>	Companies with establishments in Catalonia grouped in technology innovation cores (minimum three firms)
<b>Subsidisable projects</b>	- Industrial research - Experimental development
<b>Duration and dimension</b>	The project should have a minimum of subsidisable expenses of EUR 1 000 000 Maximum duration: 2 years
<b>Subsidisable expenses</b>	- Own and contracted staff - External collaboration - Equipment, tools and material acquisition - Other expenses - Registration of industrial and intellectual property rights - Management - Dissemination and advertising campaigns (maximum EUR 20 000 per project)
<b>Maximum subsidy</b>	- Industrial research - Up to 70% (small firm) - Up to 60% (mid-size firm) - Up to 50% (large firm) Those quantities can be incremented up to 15%, with a maximum of 80% if: - At least one SME is involved in the project and none of the participants bears more than the 70% of the subsidisable expenses OR - the results are spread broadly through technical and scientific conferences or freely available publications, databases or open-source software. - Experimental development - Up to 45% (small firm) - Up to 35% (mid-size company) - Up to 25% (large company) Those quantities can be incremented up by 15%, with a maximum of 80%, if at least one SME is involved in the project and none of the participants bears more than the 70% of the subsidisable expenses.
<b>Result</b>	Four calls for proposals were published between 2007 and 2009: - 87 Heart R+D projects have been created. - Total invested: EUR 109.6 million - Help from ACC10: EUR 42 million - 286 participating Catalan firms

Source: Government of Catalonia, ACC10.

Table 2.A1.3. Catalan innovation programmes and innovation barriers

	Cost factors	Knowledge factors	Market factors	Orientation of intervention
Grants for R&D	Yes	No	No	Manufacturing; All firms
Credit support for R&D	Yes	No	No	Multisectoral; All firms
Grants for co-operative R&D projects	Yes	Yes	No	Manufacturing; All firms
Technological support centres	Yes	Yes	Yes	Manufacturing; SME firms
Improved university-firm relations (grants to subcontract R&D to universities)	Yes	Yes	No	Manufacturing; SME firms
Seed fund and concept capital fund	Yes	No	No	Entrepreneurs; New technology based firms
Grant for incorporating researchers and technical employees	Yes	Yes	No	Manufacturing; All firms

Source: Segarra-Blasco, A., *et al.*, (2008), "Barriers to Innovation and Public Policy in Catalonia", *International Entrepreneurship Management Journal*, Vol. 4(4) pp. 431-451, December.



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