OECD Reviews of Regional Innovation

CATALONIA, SPAIN

OECD

OECD Reviews of Regional Innovation

Catalonia, Spain

ORGANISATION FOR ECONOMIC CO-OPERATION AND DEVELOPMENT

The OECD is a unique forum where the governments of 30 democracies work together to address the economic, social and environmental challenges of globalisation. The OECD is also at the forefront of efforts to understand and to help governments respond to new developments and concerns, such as corporate governance, the information economy and the challenges of an ageing population. The Organisation provides a setting where governments can compare policy experiences, seek answers to common problems, identify good practice and work to co-ordinate domestic and international policies.

The OECD member countries are: Australia, Austria, Belgium, Canada, the Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, the Netherlands, New Zealand, Norway, Poland, Portugal, the Slovak Republic, Spain, Sweden, Switzerland, Turkey, the United Kingdom and the United States. The Commission of the European Communities takes part in the work of the OECD.

OECD Publishing disseminates widely the results of the Organisation's statistics gathering and research on economic, social and environmental issues, as well as the conventions, guidelines and standards agreed by its members.

ISBN 978-92-64-08204-5 (print)
ISBN 978-92-64-08205-2 (PDF)
DOI 10.1787/9789264082052-en

Series: OECD Reviews of Regional Innovation
ISSN 1997-6577 (print)
ISSN 1995-6585 (online)

Corrigenda to OECD publications may be found on line at: *www.oecd.org/publishing/corrigenda*.

Foreword

The importance of regional dynamics in supporting innovation is widely recognised. Strong dynamics of innovation generation in regions are crucial for achieving national innovation policy objectives. In addition, innovation performance can contribute to improving the overall economic competitiveness of individual regions. Policy recommendations are therefore being sought by national science and technology and regional policy actors, as well as by the regions themselves.

OECD countries and regions are nevertheless struggling with how to best promote regional innovation. How should national innovation policies take into account this regional dimension (*i.e.,* the importance of "place")? How can regional actors support innovation that is relevant for their specific regional context? This role-sharing in a multi-level governance for innovation is a new area for OECD countries.

In 2007, the OECD launched the series *OECD Reviews of Regional Innovation* to address this demand by national and regional governments for greater clarity on how to strengthen the innovation capacity of regions. These reviews are part of a wider project on competitive and innovative regions through the OECD Territorial Development Policy Committee. This work also supports the OECD Innovation Strategy. The series includes both thematic reports and reviews of specific regions.

Acknowledgements

Numerous national and regional stakeholders provided valuable insights during missions and in the form of comments. The OECD would like to thank in particular the lead co-ordinators and other active local counterparts for this review: Joan Comella (former Director), Albert Castellanos (current Director), Judit Castellà (Director of Programmes) and Dolors López (Chief of Information and Documentation) of the Catalan Foundation for Research and Innovation (*La Fundació Catalana per a la Recerca i la Innovació*) as well as Jordi Cartanyà, Director of the Inter-ministerial Research and Innovation Commission (*Comissió Interdepartamental de Recerca i Innovació Tecnològica)* and Joan Romero, Secretary of ACC1Ó. Additional thanks are extended to José García-Quevedo (Professor at the *Instituto de Economia de Barcelona*, *Universidad de Barcelona*).

This publication was drafted by Karen Maguire (OECD) and Daniel Malkin (Consultant to the OECD), with additional written contributions from Gernot Hutschenreiter and Daniel Sanchez-Serra of the OECD Secretariat. Beth Perry (Research Fellow, SURF – The Centre for Sustainable Urban and Regional Futures, University of Salford) also provided written inputs. Peer reviewers from Italy and Belgium participated in the review process: Mario Calderini (President, *Finpiemonte* and Professor at the *Politecnico di Torino*), Annie Renders (Senior Scientific Advisor, IWT-Flanders, the Institute for the Promotion of Innovation by Science and Technology) and Eric Sleeckx (Head of the Monitoring & Analysis Unit of IWT-Flanders). The review was co-ordinated by Karen Maguire. Erin Byrne supervised the publication process.

Table of Contents

Tables

Figures

Boxes

Acronyms and Abbreviations

AARTM	*Agència d'Avaluació de Tecnologia i Recerca Mèdiques* Catalan Agency for Health Technology Assessment
AGAUR	*Agència de Gestió d'Ajuts Universitaris i de Recerca* Agency for Management of University and Research Grants
AQU	*Agència per a la Qualitat del Sistema Universitari de Catalunya* Agency for the Quality of the Catalan University System
BERD	Business Enterprise Expenditure on R&D
CARI	Catalan Agreement on Research and Innovation *Pacte Nacional per a la Recerca i la Innovació*
CDTI	*Centro para el Desarrollo Tecnológico Industrial* Centre for the Development of Industrial Technology
CENIT	*Consorcios Estratégicos Nacionales en Investigación Técnica* National Strategic Consortium in Technical Research
CERCA	*Centres de Recerca de Catalunya (Programa)* Catalan Research Centres Programme
CICYT	*Comisión Interministerial de Ciencia y Tecnología* (Spain) Council for Science and Technology (Spain)
CIDEM	*Centre d'Innovació i Desenvolupament Empresarial* Centre for Entrepreneurial Information and Development
CIRIT	*Comissió Interdepartamental de Recerca i Innovació Tecnològica* Interministerial Research and Innovation Commission
CPER	*Contrat de Projet Etat-Région* (France) State-Region Project Contract (France)
CRC	Catalan Research Centre
CSIC	*Consejo Superior de Investigaciones Científicas* (Spain) Spanish Research Council

CUR	*Comissionat d'Universitats i Recerca*
	Commission for Universities and Research
DIUE	*Departament d'Innovació, Universitats i Empresa*
	Ministry of Innovation, Universities and Firms
DTI	*Departamentde Treball I Indústria*
	Ministry of Employment and Industry
DURSI	*Departament d'Universitats, Recerca i Societat de la Informació*
	Ministry of Universities Research and Information Society
EC	European Community
ENCYT	*Estrategia Nacional de Ciencia y Tecnología*
	National Science and Technology Strategy
ERC	European Research Council
ERDF	European Regional Development Fund
ESF	European Social Fund
EU	European Union
EUR	Euro
FCRI	*La Fundació Catalana per a la Recerca i la Innovació*
	Catalan Foundation for Research and Innovation
FDI	Foreign Direct Investment
FP	Framework Programme (EU)
FTE	Full-time Equivalent
GDP	Gross Domestic Product
GERD	Gross Domestic Expenditure on Research and Development
GVA	Gross Value Added
GWK	Joint Science Conference (Germany)
HEI	Higher Education Institution
HR	Human Resources
HRST	Human Resources in Science and Technology
ICF	*Institut Català de Finances*
	Catalan Institute of Finance
ICREA	*Institució Catalana de Recerca i Estudis Avançats*
	Catalan Institution for Research and Advanced Studies

INE	*Instituto Nacional de Estadística de España*
	National Statistics Institute of Spain
IPC	International Patent Classification
IPR	Intellectual Property Rights
IRTA	*Institut de Recerca i Tecnologia Agroalimentàries*
	Institute for Agrofood Research and Technology
KIS	Knowledge-intensive Services
LPS	Local Production System
MITYC	*Ministerio de Industria, Turismo y Comercio*
	Ministry of Industry, Tourism and Commerce
PRI	*Pla de recerca i innovació de Catalunya*
	Catalonia Research and Innovation Plan
PRO	Public Research Organisation
RDA	Regional Development Agency
R&D/ R&D&I	Research and Development/ Research and Development and Innovation
RG	Regional Government
SISE	*Sistema Integral de Seguimiento y Evaluación*
	Integrated Monitoring and Evaluation System
SME	Small and Medium-sized Enterprise
S&T/ S&T&I	Science and Technology/ Science and Technology and Innovation

Assessment and Recommendations

Review context

The crisis has highlighted that the prior growth model for Catalonia requires adjustment to focus on innovation for long-term sustainability

Similar to Spain, Catalonia's strong period of economic growth since the early 1990s has now ended. In terms of gross domestic product (GDP), Catalonia (3.2%) grew at almost the same average annual growth rate as Spain overall (3.3%) from 1995-2005, and higher than OECD regions (2.9%). For Spain generally, this slowdown is attributed in part to the reduction of the housing construction sector and the adjustment of the financial markets. Catalonia has experienced important increases in unemployment, particularly with its large population of lesser-skilled workers, many being immigrants. Between first quarter 2008 and first quarter 2009, Catalonia's unemployment jumped by 8.6 percentage points to 16.3% – above the national increase of 7.8 percentage points and the increases of other advanced Spanish regions. Recognising its need for sustainable competitiveness, Catalonia has increasingly made science, technology and innovation a focus for regional action in support of economic development.

Catalonia is seeking a broad-based approach to adapt to the crisis and the changing nature of innovation

The OECD is currently developing an Innovation Strategy that emphasises a broad, collaborative and inclusive approach to innovation. The Innovation Strategy underlines that with a mobilising vision – and the ambition to achieve it through effective policy co-ordination – governments can help consolidate or develop new comparative advantages in an environment conducive to innovation. This Strategy is equally relevant for regional as well as national policy communities. It also seeks to promote an integrated approach that combines both attention to framework conditions that support innovation and risk-taking with structural policies to strengthen education, training and entrepreneurship. Moreover, the Strategy emphasises that innovation should be a central component of policy, with strong leadership at the highest political levels. It also affirms that national policy should enable regional actors to foster innovation in their own context, building on local strengths and established frameworks, while ensuring co-ordination across regions and with national efforts. The recent Catalan Agreement on Research and Innovation (CARI) promotes such a broad-based approach to innovation addressing a number of OECD policy principles.

Diagnosing the innovation system

Catalonia: a region with a strong identity and a scale similar to several European countries

With over 7 million inhabitants and a GDP of around EUR 204 billion, Catalonia is an important region within Spain and the OECD. Located on the Mediterranean coast and bordering France, this region has a strong identity with its own language and distinct cultural heritage. Catalonia's surface area is similar to that of the Netherlands and Belgium. Its population is similar to that of Switzerland and Denmark. Finally, its economy is at the scale of Portugal and Norway. Catalonia makes a significant contribution to the Spanish economy. While Catalonia accounts for only 6% of Spain's territory, it contains 16% of its population (the second most populated region in Spain) and contributes 19% of its GDP (more than any Spanish region).

While Catalonia is not always the top-performing region in Spain on several innovation-related indicators, given its size it accounts for a large share of Spain's innovation activity and resources. Catalonia is responsible for 21% of Spanish research and development (R&D) investment and 33.7% of its patents. Catalonia contains 22.5% of Spain's innovative firms, a far greater share than other regions, the next highest shares being Madrid (15.6%) and Andalusia (15%). Given its scale and performance, Catalonia is often the largest or second largest recipient region of R&D and innovation-related programme funds from the Spanish government and the European Union (EU) Framework Programme.

Over two-thirds of Catalonia's population and economic activity is located in the Barcelona metropolitan area, with areas of dynamism in other provinces

Within Catalonia, the province of Barcelona (approximately the footprint of the Barcelona metropolitan area) accounts for 73% of the Catalan population and 74% of the economy. Catalonia has three other provinces (Tarragona, Girona, and Lleida) that contain regional cities and rural areas, with Lleida being the most rural province. All four provinces within Catalonia have a GDP per capita well above the Spanish average, supported by higher than average labour force participation rates. In terms of productivity (GDP per worker), the results are more mixed. The provinces of Lleida and Girona, with more agricultural and lower-technology industries than the other Catalan provinces, are slightly below the Spanish average. Barcelona and Tarragona are above by 4% and 13%, respectively.

Massive population increases with immigration has helped fuel GDP growth in recent years

A rapid population increase combined with a higher employment rate, related to massive immigration flows, has contributed to GDP growth. Catalonia now accounts for 21% of Spain's foreign-born population, which in 2008 totalled over 1.1 million (15% of Catalonia's population), representing a nine-fold absolute increase in ten years. Catalonia's foreign-born working population has a higher than average share of workers with little or no education, and only a slightly above average share with tertiary education (24%) relative to Spain. When looking at GDP per capita growth, the results are not as strong. Annual average growth from 1995-2005 was around 2.0%, slightly lower than the OECD regional average.

But labour productivity has declined in absolute and relative terms over the last 15 years, in part related to the changing composition of the labour force

Catalonia's labour productivity (GDP per worker) has declined in absolute and relative terms since 1995, showing weaker productivity growth than in other European regions. The extensive growth model with increases in lower-skilled labour explains in part this decline in productivity (exact rates vary by data source). The region's GDP per worker dipped in the beginning of the present decade, when the productivity of the Catalan and Spanish economies suffered a stronger shock than other European countries.

It has yet to reach prior absolute levels. In relative terms, Catalonia was at 115% of the OECD average in 1995, but dropped to only 91% by 2005. GDP per worker and per hour worked remain above the Spanish average but below some other Spanish regions (such as the Basque Country and Madrid). The average annual growth rate of GDP per worker over the ten-year period is therefore negative for Catalonia (-0.6%), like several other regions in Spain.

Diversified but declining medium-technology industrial base, large construction sector and increasing tertiary sector with below average share in knowledge-intensive services

Catalonia's economy is based on a long-standing industrial tradition, with Barcelona formerly known as the "Manchester of Southern Europe". The crisis of 1984, the entry of Spain in the EU (European Union), and the 1992 Olympic games, among other factors, facilitated a progressive transition of the Catalan economy to a new economic development model. Catalonia has been characterised by a large manufacturing base (26% of the regional gross value added (GVA) in 2000, 20% of regional GVA and 20.8% of employment in 2006). This is higher than Spain (15%) and the EU15 (17.9%). Note that different data sources report either a stable or declining absolute number of manufacturing jobs. If you add both manufacturing and market-related "production services", these sectors account for 53.7% of employment and 59.4% of GVA. Catalonia's manufacturing is more technology intensive than the rest of Spain, but about average for OECD regions generally.

The other 79.2% of employment is in the tertiary sector (66.8%), construction (10.2%) and agriculture (2.2%). While construction and services grew in absolute and relative terms through 2006, the construction sector has been subject to current crisis shocks. In terms of knowledge-intensive services (KIS), Catalonia and Spain are both below EU averages. As knowledge-intensive services firms have positive R&D investment spillovers for manufacturing firms, those sectors and their linkages are important to promote.

The dominance of SMEs in most sectors of the economy is a challenge given their lower productivity, but the region's industrial districts, specialisations and international linkages are positive factors

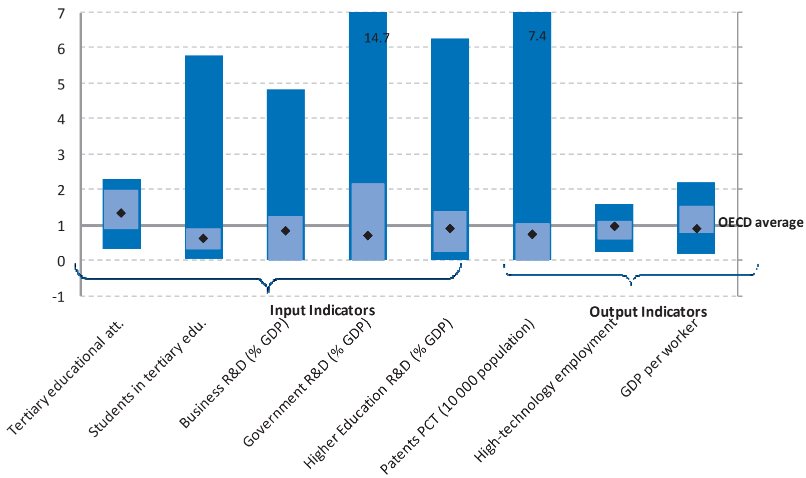
There is evidence that not only the leading metropolitan centres in Spain account for a lot of innovation activity, but also industrial districts of the kind found in Catalonia. The predominance of small and medium-sized enterprises (SMEs) in different areas of specialisation has contributed to the development of a number of such local production systems. Forty-two have been identified across the metropolitan area of Barcelona and the rest of Catalonia. SMEs represent 93.2% of GVA in the primary sector, 91.8% in construction, 66.2% in services and 56.2% in industry. Large firms continue to register a significantly higher average GVA per worker than SMEs, which are at 75% that of large firms. Yet it is small firm productivity per worker that has grown more over the last few years while that of medium and large-sized firms has decreased. Catalonia has many international linkages, being one of the main Spanish regions for foreign direct investment (FDI) inflows and outflows, along with growing exports and the presence of many foreign firms. The region's trade to GDP ratio grew from 24.7% to 32.5% between 1995 and 2005. Those levels are higher than Spain overall (from 16.7% to 25.2%) and the OECD average (from 13.3% to 19.4%) over the same period.

In terms of traditional innovation indicators, Catalonia is a leading region in a lagging OECD country…

The range of values for Spanish regions on traditional economic and innovation performance indicators is lower than that of top OECD regions, albeit within Spain, Catalonia is generally near the top (see Figure 0.1). This explains in part why Catalonia's GDP per worker is only 91.4% of the average for OECD regions. For example, Catalonia is below OECD averages for R&D intensity by all actors: business (0.86% versus 0.93%); government (including both Spanish and Catalan Research Centres [0.16% versus 0.21%]); and higher education (0.33% versus 0.37%). There is a possibility that some business R&D conducted in Barcelona is not reflected in this figure due to a headquarters bias in the statistics. International patents are also below average at 54.7 per million inhabitants, versus 72.3 for OECD regions, although patenting is not the only way that firms protect intellectual property. Catalonia does perform well above OECD averages on skill levels in terms of the share of the workforce with a tertiary education (32.4% versus 23.9%), despite the recent influx of lower-skilled immigrants.

Figure 0.1. **Catalonia's innovation performance summary**

2005



Notes: The outer band in dark blue represents the range of values for OECD regions. The inner band in light blue represents the range for TL2 regions in Spain. The diamond represents the value for Catalonia. The values of each variable were normalised to the OECD regional average for available regions. Information on all OECD regions is not available for each indicator.

Source: OECD Regional Database.

…but Catalonia has shown very strong increases on a number of innovation indicators

While Catalonia is not in the top-ranked OECD regions, the remarkable increases in innovation-related indicators should be recognised. Over the period 1996-2008, Catalonia increased R&D intensity from 0.9% to 1.61% of GDP, two-thirds of which is performed by the private sector. In absolute amounts, the expenditure by all actors on R&D increased four-fold over that period to EUR 3.3 billion, or an average annual growth rate of over 13%. From 1996 to 2006, the region's share of publications in Spain grew from 21.2% to 25.5%, in the EU15 from 1.5% to 2.5%, and in world production from 0.5% to 0.9%. In absolute terms, that is a 70% increase over the period.

Innovation variables associated with higher productivity among Catalan firms, however innovation investment remains concentrated and linkages across actors insufficient

The type of innovation and propensity to innovate among Catalan firms depends on several factors. The bulk of R&D in Catalonia is conducted by a small group of firms in only a few sectors. The majority of research staff are found in two sectors: pharmaceutical (high-tech manufacturing), and research and development (knowledge-intensive services). Firms that innovate show much higher levels of spending on innovation and R&D, by several multiples, as compared to firms that did not report an innovation (high-tech innovators 3.5 times more, low-tech innovators 5.4 times more, and KIS 11.3 times more). The probability of a Catalan firm to innovate generally has been found to increase with: *i)* firm size (but there are many examples of innovation-intensive small firms in KIS); *ii)* access to public funds (results more sensitive for KIS firms); and *iii)* firms with a higher intensity of R&D expenditure per employee. Firm perception of cost barriers (spillover failures) and knowledge barriers (co-ordination failures) appear to effect the innovation process most, over market barriers (information failures). Knowledge linkages among firms and between firms and public research institutions/universities are also relatively low in Catalonia – a problem in Spain generally – contributing to these co-ordination failures. For Catalan firms, labour productivity is positively affected by R&D intensity, the share of new products and services in sales, belonging to a group, investment in physical capital, and firm market share. In terms of firm size, the positive effect is noted for manufacturing but not services.

While "hidden" innovation does not appear to explain these often below-average results, there is innovation activity missed by traditional indicators

Given the region's poor productivity growth record, it is difficult to document the benefits of "hidden" innovation. However, there are signs of innovative activity not captured by traditional measures such as R&D investment and patents. Catalonia appears to be active in utility models (less stringent than a patent and more adapted to SME incremental innovation), and Catalonia accounts for 30% of those granted in Spain in 2007. Barcelona, the driver of Catalonia's economy, has a reputation for a growing "creative class" and strengths in design. These creative elements are likely to increasingly contribute to the innovation system in the future. Catalonia has both a higher share and a higher number of workers in the creative and culture industries than any other Spanish region. It is also a leading region in Spain for brands and trademarks.

Catalonia has a strong and continually improving knowledge generation system…

The knowledge generation sub-system includes almost 25 000 researchers. Private firms account for over 40% of Catalan researchers. The approximately 14 000 public researchers may be working in several different types of research centres. The Catalan Research Centres network, created to develop strong research centres outside of universities, accounts for over 2 500 or 18% of public researchers. There are now 37 centres in the network and six others in the process. The Spanish Research Council (CSIC) has 1 300 researchers located within Catalonia for around 9% of total public researchers. These institutions, while part of a national network, have become in several cases joint centres with a Catalan university or research entity (including six centres in the Catalan Research Centres network). Public researchers are also found in other research facilities, including those in health care (11 hospital research institutes) and other large scientific infrastructures.

Most public researchers in Catalonia are found in universities. Higher education in Spain was devolved to the regional level in 1986; therefore regions fund and administer universities but are subject to certain Spanish government regulations. Catalonia, like other Spanish regions, took the devolution opportunity to create additional universities for greater balance across its territory and to increase enrolment. Of the now 12 universities in Catalonia, most have been created since the 1990s, albeit many of these "newer" universities are based on the branch campus infrastructure of previously existing institutions. The increased number of universities has improved higher education attainment in the region as well as attracted many students (12.2% net balance of students, accounting for student inflows and outflows). Universities have also created affiliated non-profit foundations as vehicles to support more professional degrees and lifelong learning. The concept of a "third mission" of universities to support the economic development of the region has now taken root but is still new. Catalan universities are often in the top of different rankings in Spain regarding research strength and "third mission" activities.

… an insufficient technology transfer system…

Improvements in the Catalan knowledge exploitation and technology transfer sub-system have proven more difficult to achieve than in its knowledge generation sub-system. While firms are responsible for around two-thirds of R&D, Catalonia's technology transfer system can be characterised as public-driven since the "infrastructure" for technology transfer is mainly publicly funded and relatively recent. A number of institutions have developed with public support, including those with the labels of Technology Centres and Technology Dissemination Centres (launched in 2004). While centres were deemed to be part of a network, in fact they were individual centres with a shared label based on the associated public programme – like the Centres for Technological Innovation Support (XIT) created in 1999. There are also 25 science and technology parks existing or underway in Catalonia. Most are university-linked (17), while others are more broadly the initiative of a city-region (8) but may still involve universities. Given the proliferation of technology centres with successive policy instruments, and their resulting different sizes and quality of services, the Catalan government is now seeking to map and rationalise the existing offer. TECNIO (Catalan Technological Network) is the brand for this new network that will include five advanced centres, 15 technology centres and 80 innovation centres.

…and a changing regional governance system

The Catalan Ministry of Innovation, Universities and Enterprise (DIUE) accounted for over 68% of R&D and innovation-related spending by the Catalan government in 2007. Other sectoral ministries finance research and innovation, health being the largest at 19.5% of that regional spending, followed by agriculture. The inter-ministerial committee named CIRIT, created in the early 1980s with some changes over time, has been responsible for promoting and co-ordinating R&D and innovation support across the Catalan government.

Under the ministry level, there are several public agencies and publicly funded foundations that play an implementation role in R&D and innovation. They include: ACC1Ó (business development and external promotion, formerly CIDEM and COPCA); the Agency for Management of University and Research Grants (AGAUR) which manages a large portfolio of grant programmes for research and scholarships; the Agency for Quality Assurance in the University System of Catalonia (AQU) and the Catalan Agency for Health Technology Assessment (AARTM) to promote the introduction, adoption and utilisation of medical technologies as well as to co-ordinate and assess health research in conjunction with the Catalan health service. AGUAR has developed evaluation capacities (notably for *ex ante* analysis of research projects) as well as AQU (for professor performance). Foundations include ICREA, which focuses exclusively on talent (researcher) attraction, and FCRI, for science and technology, innovation and advisory services.

The organisation of Catalan public entities for research and innovation is undergoing change as a result of the CARI analysis and commitments. These changes include the creation, merger and restructuring of several agencies at the policy implementation level. They include the ACC1Ó merger, already near completion, and the creation of the Catalan Agency for Research (ACR) that merges parts of AGAUR, ICREA and FCRI. New structures to manage the research centres (CERCA) and technology centres (TECNIO, serving in a first phase as a consortium) are also in progress. Another governance change is the creation of a new Catalan Research and Innovation Council for high-level policy guidance and the reattribution of the other roles of the former CIRIT to this Council, the Inter-ministerial Research and Innovation Commission (CIRI) and a technical secretariat named the Research and Innovation Coordination Office (OCRI).

The Catalan system has a number of opportunities to overcome existing weaknesses and build on its strengths

Among the region's main strengths are its strong research infrastructure and regional attractiveness, Catalonia being one of the top regions in Spain (see Table 1). The main weaknesses concern regulatory issues and rigidities with respect to universities and long-term researcher mobility, the fragmentation of public action (within Catalonia and in co-ordination with programmes from other levels of government), and the lack of innovation culture, as manifested in the lower patenting rates and R&D intensity relative to other leading OECD regions. While there are threats to the system, including increased competition from emerging economies and a lack of productivity growth in the region, there are also opportunities. Catalonia may seize on its attractiveness and broad-based innovation approach to address emerging market opportunities raised by social challenges in the region and the world. The public sector itself can be an important driver of innovation, particularly for social challenges, through services for health, education and the aging population. The region can also better engage its SMEs in innovation strategies and global value chains.

Table 1. **Overview of the Catalan innovation system**

Strengths	Weaknesses
• High political commitment to S&T and innovation (CARI) • A number of top quality universities and public research centres (Spanish and Catalan centres) • A sizeable pool of qualified scientists • International excellence in some sectors • High level of creativity • Regional and local dynamism (including Higher Education Institutions) • Good infrastructure, including in S&T • Significant increases in R&D investment • Attractiveness (FDI, top international scientists, students, entrepreneurs) • A leading region in Spain • Strength of the regional health care system • Capacity for *ex ante* research project evaluation	• Rigidities in the HEI sector (*e.g.,* that pose problems for long-term researcher mobility, competitive salaries, accreditations, contractual arrangements for co-operation) • Relative scarcity of middle level HRST (technicians) • Low technological absorptive capacity of the vast majority of SMEs (dual industrial structure) • Spin-offs that do not grow • Weak intellectual property rights culture and low patenting level • R&D intensity across manufacturing lower than most EU counterparts • Too many public research centres and technology centres (problems of critical mass and performance) • Complex governance • Policy fragmentation; low "behavioural additionality" of support instruments; windfall benefits • Fuzzy policy mix and lack of priority focus (strategic priorities) • Financial markets ill-adapted to innovation-related investment • Low level of public-private co-operation • Bureaucratic management of support programs, and lack of *ex post* evaluation of programme effectiveness
Opportunities	**Threats**
• Growing demand for knowledge-intensive social goods, many driven by the public sector (*e.g.,* health, environment and aging) • Insertion in global knowledge networks and technological platforms (EU and beyond) • Better co-ordination and complimentarily with external S&T and innovation financing sources (State and EU) to devote larger share of Catalan resources to regional priorities • European and Mediterranean markets • Diversification of production and trade towards goods and services with higher knowledge content • Engaging SMEs in more innovation-driven strategies and clusters • Technology diffusion around multinational enterprises in line with the development of innovation-based global value chains • Knowledge-intensive services	• Recent economic growth fuelled by immigration but not productivity • Growing competition from emerging economies • Growing competition to attract EU research and innovation funds • Concerns related to alleviation of effects of current crisis (*e.g.,* priority support to labour intensive traditional sectors) • Accelerated pace of expansion of the scientific and technological frontier • Intensifying global competition to attract talent

Catalonia's innovation policy

A long history of regional S&T and innovation policy subject to several internal and external influences

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 been slow to emerge. Catalan approaches to S&T and innovation policies have evolved under the influence of several factors, including: the constitutional/devolution issues in Spain on S&T policy and resources; the importance of EU Framework Programme and Structural Funds since 1986; the relative balance of power between the academic and business communities; and the region's own political situation – which has transitioned from a period of long-term continuity (1980-2003) to one of political turnover. The Catalan Agreement for Research and Innovation (CARI) signed at the end of 2008 represents a major effort to take stock of these evolutions to foster a socio-political consensus on the diagnosis of the Catalan innovation system.

Despite initial efforts for a balanced approach in the early 1980s, the region took a more narrow academic focus, with a dual-track system for S&T and innovation

The initial phases after the first autonomous elections (1980-1988) could have led to a balanced approach to R&D and innovation but shifted to an academic focus that was reinforced through the early 1990s. The inter-ministerial committee (CIRIT) was not in a position to prove its expected effectiveness due to a budget crunch. It was not able to maintain a balanced institutional approach, with a shift in the balance of S&T and innovation policy away from inter-departmental co-ordination towards the academic side, which led to a *de facto* bias in the governance of the system. During the transitory period of 1988-1992, the lack of articulation between the research and innovation pillars of S&T policy (a dual-track approach) deepened even though the President of the Catalan government presided over CIRIT in those years. Upon resolution in 1992 of the region's case in Constitutional Court requesting the full decentralisation of R&D resources, which did not occur, CIRIT obtained a ten-fold increase in the Catalan budget appropriations for R&D. But in absolute terms this budget remained quite small for an economy the size of Catalonia. Therefore, to obtain funds from EU and Spanish sources, the region instituted a strategy of financing S&T infrastructure in universities and research centres, supporting the creation of research groups, and increasing the number of doctoral programmes and scholarships.

The first two Research Plans (1993-2000): from the primacy of the academic approach to the recognition of complementarities

While the Catalan government desired to strike a better balance between supply and demand factors in their policy tools, this did not begin to occur until the second Research Plan. New institutional bodies were put in place to achieve this balance. Nevertheless, in the first Research Plan 1993-1996, the bulk of resources were devoted to consolidation of research groups through support to the physical, human and organisational S&T infrastructure in universities and public research centres. Therefore the *de facto* policy mix was heavily tilted towards the scientific base without much concern with either the demand side or the articulation between latent demand and the orientations of supply.

The second Research Plan (1997-2000) evolved towards an improved balance. AGAUR, the region's Agency for Management of University and Research Grants, was created around this time (2001). While the main emphasis of the second Plan remained on research infrastructure and human capital, there were significant new initiatives to support private R&D and innovation activities, linkages and interface mechanisms. During that time period, albeit not through the research plan, Catalonia created the Centres for Technological Innovation Support (XIT). In terms of resources, innovation instruments remained rather poorly endowed *vis-à-vis* those focusing on the strengthening of the research infrastructure.

The Third R&D plan: institutionalisation of separate and complementary research and innovation plans, leading to greater innovation spending but a multiplicity of technology transfer initiatives

Catalonia grew to recognise the weaknesses in its supply-side driven approach, but the decision to develop a separate Innovation Plan (by CIDEM) apart from the Research Plan (managed by CIRIT) had mixed effects. On the positive side, it may be argued that an initial "autonomisation" of 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 innovative capabilities of firms. It also allowed for larger budgetary appropriation for innovation-related programmes. On the negative side, it seems that the Innovation Plan was plagued by a multiplicity of initiatives that tend to reflect a "one problem-one instrument" syndrome with a difficulty to really understand the rationale behind the definition of programmes and the boundary of their scope. This is particularly the case for the numerous networks created to address the chronic technology diffusion weakness of the Catalan S&T and innovation system.

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

The 2005-2008 Research and Innovation Plan reflects a more balanced approach between the support of supply (academic) and demand (firm) factors. 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 juxtaposition of programmes involving complementarities than through incentive structures that have built-in integration dynamics. Co-ordination is rarely, if at all, implemented through joint management and financing procedures between responsible departments from different ministries or agencies. The increased resources devoted to support firm investment in R&D and innovative activities took the form of competitive grants, and, to a lesser extent, subsidised loans and guarantees. There was increased effort devoted to technology transfer programmes tailored to the needs of diverse categories of enterprises and innovation projects. For the first time there is an explicit recognition of the fact that the financing constraints faced by innovative enterprises deserve attention through policy instruments.

Monitoring and evaluation of the PRI are not adapted to Catalonia's needs, and this should be addressed for future plans

Development of the 2005-2008 PRI and the upcoming 2010-2013 PRI have not been underpinned by robust evidence-based evaluations of the actions undertaken in the context of the preceding Plans. For the Second and Third Plans, that evaluation was more an *ex post* exercise focused on a review of the allocation of resources and Catalonia's position relative to other regions on some common indicators. Evaluations need to encompass assessments of implementation agencies and institutions benefitting from government support.

To monitor and assess its achievements in quantitative terms, the 2005-2008 PRI 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. Most of the quantitative targets were not met, namely the R&D intensity of the region. The region did surpass by far one goal, the number of researchers. The second set of "reference indicators" intended to monitor the outcome of policy actions was unrealistically detailed given the cost of such data collection. It would have been more useful to contemplate a less detailed but more realistic set of monitoring indicators along with the development of an appropriate statistical system allowing the production of regular performance documents in the interim years of the Plan, or at a minimum in its last year.

The latest plan (2005-2008 PRI) consolidated research strengths but didn't sufficiently resolve structural weaknesses

The Plan gave continued priority to strengthening the Catalan public research system, but was more mixed in terms of overcoming the already identified structural weaknesses of the Catalan innovation system. Despite the well-articulated programmes in support of business R&D and innovation activities, the actual set of individual support instruments is quite complex. This resulted in high transaction costs and a lack of a comprehensive view of the market and systemic failures being addressed. A rationalisation of support schemes is needed. 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. It seems that, with the exception of new technology-based firms, the overwhelming majority of SMEs do not share these characteristics and are therefore excluded from the benefits of these programmes. Lessons for future design include the necessary customisation (while avoiding unnecessary multiplication) of instruments to support the heterogeneous population of SMEs; financial support instruments that are better articulated with other policy actions so as to increase their behavioural additionality effects; and accounting for duplication or complementarity with the State (CDTI) (*i.e.,* concentrate Catalan support either to address specific weaknesses related to the regional industrial structure or funding research and innovation projects in the priority areas of the region). ACC1Ó has been working with CDTI in a bilateral agreement since 2007 for greater complementarity of these programmes.

The complex system of technology transfer networks has had some successes, particularly with the networks known as XIT and XTT created ten years ago. But the benefits of the services have not generated sustained knowledge relationships between the majority of beneficiary firms and knowledge production institutions. The weak intellectual property culture is slow to materialise in terms of changes in firm behaviour, as evidenced by continued low patenting rates. 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 policies. In terms of risk assessment and innovation financing, the Catalan Institute of Finance (IFC) could support to a greater extent its venture capital (VC) activity. A path that could be explored to broaden the investment portfolio and mitigate the risks is the progressive development of a fund of funds associating capital from both the IFC and other local VC funds.

Several blind spots exist in the 2005-2008 PRI, such as insufficient prioritisation, that should be addressed in the 2010-2013 PRI. A few of these problems were already recognised in the CARI

The most notable blind spot in the last PRI is the lack of prioritisation, especially given that much of the science, technology and innovation (S&T&I) funding is coming from outside the region with different priorities. In the past, there has been some minor prioritisation of a small share of the budget to certain industries, but not overall challenges for Catalonia. A series of other instruments and approaches are also missing. Public-private collaboration is common in OECD member countries (including Spain's own CENIT programme) to strengthen industry/science relationships and facilitate technology transfers. The incipient support to the development of innovative clusters is also too narrowly conceived. While the CARI rightly emphasises the importance of a more innovation-related cluster policy, it focuses too much on high-technology sectors or on the somewhat restrictive notion of sectoral/territorial approach to technology transfer. Innovation in services is widespread and very important for aggregate productivity and economic growth. While the 2005-2008 PRI pays practically no attention to the promotion of innovation in services activities, or to the role of knowledge-intensive services in technology diffusion, the CARI does in its broad-based vision of innovation. This concept needs to be operationalised in the next PRI. Public procurement does not seem to have been actively used for innovation in Catalonia and the PRI does not allude to this policy instrument whose importance is, however, highlighted in CARI's recommendations. While this may raise some legal and/or regulatory issues with the State level, it merits concrete actions as well.

Several imbalances in the policy mix also need adjustment, among which is the lock-in of resources for the ever-growing network of Catalan Research Centres…

Catalonia developed its own system of Catalan Research Centres, a unique strategy in Spain, building a strong research infrastructure in the region. However, the continued proliferation of such centres poses critical mass problems, locks in budgets and *de facto* locks in the region's research priorities. The network was created to circumvent problems with the university system and there are important strengths in many centres of the network. This separate network preserves the research autonomy of universities but does limit research funding available to them since the Catalan government does not typically finance competitive research projects. The centre-based approach is less able to promote interdisciplinary research, which can be more efficiently undertaken in a university context than in dedicated research centres. By international and regional standards, the number of Catalan public research centres is quite large (37 with 6 in process, and not including the already existing network of Spanish CSIC centres). This number raises questions of critical mass and efficiency, even if some centres may be very productive. The contract programmes to which the centres are now subject could be utilised to alleviate this problem, but it is always easier to create a new centre than to suppress an existing one, and new centres continue to be created.

… as well as the need for ensuring Catalan priorities such as through thematic research programmes…

Catalonia has few "flexible" funds available and tools to orient thematic research, as most research funds are locked into institutional funding for research centres. Furthermore, one may argue that the support given to university research groups is probably insufficient. Given the size and the excellence level reached by public research in Catalonia, quasi-exclusive reliance on project funding by the State and the EU may be insufficient to ensure a better contribution of the Catalan research system to the region's socio-economic needs. Thus far, competitive funding on thematic priorities has been through fellowships and other grants but not on a project basis. The Catalan government should consider launching thematic research programmes focusing on regional priorities and open to competitive funding of projects presented by or in association with Catalan institutions – an approach now under discussion for the 2010-2013 PRI. These programmes could encompass public-private partnerships and act as leverage for private investment in R&D activities related to the satisfaction of collective needs.

… and addressing challenges in human resources, like integrating PhDs and improving the balance between researchers and technicians

Catalonia recognised very early the development of human resources or "talent" as 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. 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 many of the same shortcomings as Spain generally, some of which relate to regulatory obstacles. The insertion of highly qualified personnel in enterprises, in particular PhDs, is still low. In comparison with the majority of European countries, insufficient resources are allocated to the recruitment of technicians in public research institutions. In this innovation policy area, Catalonia's policy mix is well oriented and the main problems that hinder further improvements are related to resource availability and regulatory obstacles to a great extent under the purview of the Spanish government.

While support to business R&D and innovation has increased over time, that support is fragmented, requires greater private sector participation, and could address some of the blind spots of prior plans

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. Resources devoted to this support amounted to 37% of the PRI budget in 2007. The support programmes developed by CIDEM (now ACC1Ó) 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 organisation of technology transfer programmes in different "networks" is a source of complexity and inefficiencies, with the possible exception of the more experienced XIT and XTT networks. The private sector needs to assume a greater role and support for technology transfer. In general, Catalonia needs to do more to respond to market demands. Insufficient funding has been allocated to support public-private partnership for R&D and innovation that can leverage private R&D investment focused on regional priorities. Finally, Catalan cluster policy could be further integrated with mainstream innovation policy.

The Catalan Agreement on Research and Innovation served to build social consensus, but with 131 commitments does not address the recurring lack of prioritisation

The ambition and merits of CARI lie in the fact that it built social consensus and set a long-term framework for the innovation system that will outlast political cycles. And it served as a platform for quickly implementing several regional governance changes to better plan and deliver research and innovation policy. But it also blurs the hierarchy of policy priorities with 131 different commitments. The document reads more like a wish list given that the consensus building process was not subject to resource estimates as CARI was not intended as a planning tool. The resulting recommendations are too often presented without due attention to policy complementarity requirements or resource implications. As a result, policy mix issues are conspicuous in their absence in both the CARI and its background documents. Too often the level of specificity of the object of commitments, coupled with the general character of the actions to comply with commitments, reduces their credibility.

The CARI background document does present a number of very valuable recommendations; however, there are some recommendations that could be challenged or even be counterproductive. Examples of questionable recommendations include: the broadening of the mission assigned to ICREA; an increase in the number of research centres in strategic fields; and an approach to resolving governance problems that does not always address in a satisfactory way weaknesses raised by a prior study, such as the capacity to prioritise resources or to co-ordinate across all implementation agencies.

Several potential pitfalls in the implementation of the CARI need to be avoided in the 2010-2013 PRI

Having so many commitments and targets in the CARI entails risks. As the main "sponsor" of the CARI, the Catalan government must be exemplary in its compliance with the numerous qualitative and quantitative commitments. It also needs to effectively monitor the commitments of other institutions. The Research and Innovation Coordination Office (former CIRIT) should be responsible for the oversight of the monitoring and assessment function. Consistent and reliable information systems will also be required that rely on decentralised compilation of statistics and indicators by diversified agents according to comparable centrally defined standards. Commitments are numerous and they form a set that seems overly specified for achievement of the CARI objectives in the sense that if a commitment is not complied with, the fulfilment of the objectives is in jeopardy. In monitoring exercises, micro-management or oversight of compliance requirements should be avoided and transaction costs associated with this compliance should be accounted for.

Especially in the context of the global economic crisis, there is a need for resource contingency planning along with prioritisation and sequencing of CARI actions

The preparation and implementation of the upcoming PRI will be a test case for the compliance with CARI commitments, including ensuring the necessary resources. 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 as well as new governance structures. In the context of the preparation of the 2010-2013 PRI, and in light of the global economic crisis, contingency planning should be undertaken to determine which of the CARI commitments ought to be prioritised and which could be postponed without jeopardising the coherence of the exercise. In this context, a sequencing exercise should be carried out that includes an analysis of the complementarity of objectives. Finally, the compliance of their commitments by other non-governmental stakeholders may give rise to resources claims that the Catalan government should be in a position to assess.

Catalonia's policy in a multi-level governance context

EU policy and funding streams have influenced Catalan policies and actors, with EU regional policy funds declining and EU research funds increasing

While Catalonia had developed its own regional science policies prior to Spain's integration in the EU in 1986, EU policy has impacted the Catalan innovation system in a number of ways. The different regulations and sectoral policy streams have an impact on the framework conditions for firms in member states. There are over-arching agendas like the Lisbon Agenda and the Bologna Process that influence public policy and actors in the innovation system. Catalonia also participates in a number of networking activities promoted by Europe, including the Four Motors Agreement (trans-national collaboration akin to the EU ERA-NET model).

The two main EU funding sources for Catalonia innovation actors are EU regional policy and EU research policy. The regional policy funds for Catalonia declined by 40.4% between the prior (2000-2006) and current (2007-2013) programme periods. One of the five axes of the current European Regional Development Fund operational programme is "knowledge economy, innovation and firm development" which will receive approximately EUR 51.4 million annually, some of which is R&D and innovation-related spending. The seventh Research Framework Programme (FP) reflects a 65% annual budget increase at EU level relative to the sixth FP. Catalonia's average annual receipt in the sixth FP was EUR 54.4 million, and in the first year of FP7 (2007), that figure jumped to EUR 86.2 million. The new European Research Council (ERC) funding streams, while not large, have been strategic for strengthening the region's research base. Catalonia accounted for more than half of Spain's receipt of the first rounds of the ERC Starting Independent Researcher Grants and ERC Advanced Investigator Grants.

Differentiated Spanish policy mix actively used by R&D and innovation performers in Catalonia

Spanish S&T and innovation policy – which in its modern form dates back to 1986 – has been evolving, generating a differentiated policy mix. The main frameworks of Spanish policy today are: the sixth National Plan for Scientific Research, Development and Technological Innovation; and the INGENIO 2010 initiative contained in the National Reform Plan developed in 2005 in the context of the re-launch the EU's Lisbon Strategy. In this framework, attempts have been made to better link national policies to both European and regional policies and initiatives. Over time, the Spanish government has substantially increased its funding for R&D and innovation. These funds are allocated through a differentiated set of direct instruments of public support (grants and loans) and via tax incentives. Spain's tax incentives are among the most generous in the OECD. In addition to European funding streams, Spanish programmes and initiatives provide important opportunities for research and innovation actors in Catalonia. In fact, Catalonia – being one of the hubs of R&D and innovation within Spain – has been able to attract considerable shares of these flows of funds. The question that remains is how to better co-ordinate such actions between the Spanish and Catalan governments to ensure the coherence of the overall policy mix across levels of government.

Attribution of roles between Spain and Catalonia for S&T, a source of inter-governmental dispute in the past, is now clearer – but attention needs to be paid to certain "gaps"

Both Spanish and Catalan levels are active in science and technology policy. There were conflicts regarding this policy domain in the late 1980s, as both levels claimed exclusive competency. In 1992, the Constitutional Court ruled that such competencies should be shared and did not respond favourably to the region's request for total decentralisation of R&D. Nevertheless there has been explicit devolution of some areas of research funding, including university funding, the public health system and its associated research, and agricultural research centres. In terms of R&D&I spending in Spain, approximately 20% of the EUR 10 billion spent in 2007 was from the regions versus 80% from the central government.

Multi-level governance of S&T and innovation must address different kinds of "gaps" to better manage duplication and enhance complementarity. In terms of "information gaps", as both Catalonia and Spain are active in this area of policy making, there are asymmetries of information in the policy development process for both levels. In terms of the "capacity gaps", Catalonia's resources and infrastructure are best suited to supporting science-based research but less so to the needs of SMEs and service sectors, for example. In terms of a "fiscal gap", while this policy field in Spain is not characterised by unfunded mandates for the regional government, there are some situations where the Catalan government becomes *de facto* responsible even if not part of the decision-making process. Some efforts have been made to address the "administrative gap", resulting from spillovers that transcend administrative borders, as Spain and Catalonia work together for the development of large infrastructure projects. However, the positive spillovers of Catalonia's innovation system for Spain in general may be insufficiently addressed, despite the region's ability to capture a large share of national resources. An incoherence of the policy mix across sectors can create a "policy gap", although both Spain and Catalonia have been making efforts at their respective levels to improve cross-sectoral collaboration through mergers of ministries and inter-ministerial committees.

Central-regional co-ordination mechanisms for S&T and innovation policy, both formal and informal, could be strengthened

Catalonia fits in a context of a relatively high degree of overlap with the central level as compared to peer countries. Co-ordination challenges are further exacerbated by the highly political and sometimes conflictual nature of relations across levels of government. A 1986 law created a General Council for Science and Technology (*Consejo General de la Ciencia y Tecnología*) for the purpose of central-regional and regional-regional co-ordination on R&D. Subsequent working groups of this body have been created. Given the degree of co-ordination needs, additional efforts within and outside of this body are warranted.

Both levels formally recognise a need for greater co-operation, but are struggling with how to improve systemic co-ordination …

The governments of both Spain and Catalonia recognise that more co-ordination is needed to guarantee greater effectiveness in co-design and implementation in this policy field. The current Spanish National Plan (2008-2011) includes a chapter on greater co-ordination between the central level and regions. Catalonia has formally recognised that improved co-ordination with the State for S&T and innovation is required. In the context of the Catalan Agreement on Research and Innovation, developing an agreement with central government is one of its commitments. Nevertheless, Catalonia has missed several opportunities to better involve the central government in its R&D and innovation efforts, such as in the development of the 2005-2008 or 2010-2013 Research and Innovation Plans as well as the 2008 CARI.

Catalonia and Spain may consider a range of mechanisms used in OECD member countries to improve systemic co-ordination. There are OECD examples of both formal and informal co-ordinating bodies for S&T policy across levels of government. Germany is an example of a formal systemic co-ordination mechanism with the GWK or Joint Conference for Science, its mission being to co-ordinate R&D policies across regions and with international policies. In the United Kingdom, an active dialogue has recently been established via an informal arrangement but to meet a central government imperative of aligning a certain share of regional funding (a transfer from central government) with central level programmes.

In addition to seeking more co-operation at the political level, a first step is to establish more working groups below the political level. In the United Kingdom, at the practitioner level, there is a group called Regional Innovation, Science and Technology (RIST) that brings together RDAs and devolved governments with central government as a very active forum for information sharing with several meetings annually. Perhaps the CICYT General Council and its Working Group could help to serve such a role in Spain. The development of comparable S&T and innovation indicators across Spain is vital for both central and regional policy makers for greater multi-level governance dialogue, and indicators such as spending calculations are not yet harmonised around the country.

Joint institutions are not easy to build but serve as an opportunity for co-ordination that could increase system efficiency. While a joint evaluation agency is one example (there are at least 12 in Spain), others could be considered with respect to R&D funding or other areas. Catalonia may also take the initiative to promote more systemic co-ordination by inviting central level authorities to participate in different Catalan committees in the strategy development process.

…with an increasing use of bilateral agreements

In Spain, the use of bilateral agreements (contracts known as *convenios*) has proliferated in recent years, with varying modalities. In the context of Spain’s INGENIO 2010 programme, a number of bilateral agreements are used to implement different S&T related programmes, such as Plan Avanza. The bilateral agreement between the State and Catalonia to support the construction of the ALBA Synchotron facility has been recognised as an example of a highly effective co-ordination tool. The structure of this agreement includes many of the characteristics of a “relational” contract that ensures an ongoing relationship across levels of government to derive the maximum benefit of the project and limit risks. Other bilateral agreements may take a very broad perspective by “agreeing to work together” and then include annual work plans. The Catalan innovation support agency, ACC1Ó, and the Spanish CDTI have such an agreement. In the first work plan, areas covered include data exchange, personnel exchange, accepting the other's evaluation assessment, joint financing of projects, and promotion of Catalan projects in EU programmes.

The lessons of best practice examples (from Spain and beyond) of comprehensive bilateral agreements could be helpful as Catalonia seeks a broad S&T framework agreement. In a light form, this may include a Memorandum of Understanding and concordats, such as in the United Kingdom between central government and Scotland. In a more comprehensive and formal form, there is the French CPER (*contrat de projet Etat-région*). It offers a framework for long-term planning and co-financing for a number of investments related to S&T and innovation between several central level ministries and the region. In the 2000-2006 round of the CPER, areas covered included: *i)* the development of existing excellence poles; *ii)* continued deployment of research capacities in regions with strong university potential; and *iii)* preserving the influence and international competiveness of large scientific centres. Support of S&T and innovation is also part of Italy's central-regional contracts know as the *Accordi di Programma Quadro*.

There is also an opportunity for greater bilateral and multilateral agreements between Catalonia and other Spanish regions. For example, Catalonia's AGAUR is already used by some other Spanish regions as an evaluation agency for the scientific merit of certain research projects. Catalonia is also seeking bilateral agreements with other regions when there is a common interest or complementarity in assets.

Catalonia seeks to create optimal conditions for bottom-up local initiatives…

Catalonia's various sub-regional levels are taking different initiatives to support innovation in a broad sense, seizing opportunities from Spanish and Catalan policy. The tools most commonly used are incubators and science or technology parks. Higher education institutions are often the leaders in these local initiatives and may take a highly proactive approach, such as Rovira i Virgili in Tarragona or the University of Girona. In several cities around Spain, including in Catalonia, there is also an accent in the city-level innovation plans on the importance of ICT infrastructure and its usage (in households, SMEs and public administrations) as well as developing an innovation culture, including through public service delivery. For example, Manresa has produced two volumes of stories about local innovators and Reus has actively promoted creative public service delivery mechanisms.

… but it could perhaps do more ex ante, including an explicit territorial approach in strategic plans, to avoid the strategy of labelling ex post when the landscape becomes too cluttered

Unlike many other OECD regions, Catalonia's formal research and innovation plans thus far do not have a territorial focus, or a sectoral focus that is *de facto* territorial. While some of the cluster-based approaches with a territorial focus are supported by ACC1Ó, this is one programme in a much broader set of policies. As a result, Catalonia has a need to rationalise physical infrastructure as well as innovation system support entities after they are developed and the landscape becomes cluttered. It is likely that Catalonia played a role in funding many of the initiatives from the beginning. The region has chosen to take the approach of labelling and financing as the primary vehicles for co-ordination with localities to help rationalise *ex post* these local and regional initiatives. Labelling systems are underway for technology centres and science parks, for example. The labelling will help prioritise for investment as well as other support that the region can offer, such as international promotion. There is a balance to be struck between top-down and bottom-up approaches, but perhaps the region could do a bit more to avoid some of the efficiency losses of a purely bottom-up strategy that nevertheless relies on Catalan funding. The upcoming 2010-2013 Research and Innovation Plan is likely to take a more territorial approach that could help better mitigate this problem in the future.

If Catalonia seeks pan-regional S&T collaboration around the Mediterranean, OECD examples show that the feasibility will depend on the types of collaboration gains expected

Catalonia is located in the Mediterranean basin whose regions and countries may confront some common or interdependent challenges. The Euro-Mediterranean Partnership, formerly known as the Barcelona Process, was re-launched in 2008 as the Union for the Mediterranean. The possible rationales for S&T collaboration in this area are many, and may include: building critical mass among common strengths, addressing shared or interdependent challenges, increasing specialisation, or better supporting functional linkages. The spatial footprint and the context (strategic versus *ad hoc*) are other important factors for the appropriate selection of instruments.

Catalonia is already involved in some transnational networks of regions that include an S&T or innovation element. They include the Four Motors Agreement, the Community of Work of the Pyrenees (CTP), the Pyrenees-Mediterranean Euroregion and a network of Creativity Districts. Other international examples of this transnational collaboration could offer additional lessons for Catalonia. They include ELAt (tri-county cross-border arrangement that builds on the S&T strengths of the bordering regions), the US-Mexico Foundation for Science (an effort at national level for both countries to use S&T to address inter-dependency issues) and the Baltic Sea Knowledge Region (experience in transnational collaboration with an ultimate goal of an inter-connected regional innovation support system across metropolitan areas in the different countries).

Introduction

Innovation is recognised as a driver of economic growth in OECD member countries

Catalonia, like many other places in the OECD, has embarked on a development path that emphasises innovation. Globalisation and rapid advances in new technologies, notably ICT, have spurred competition and opened new markets for the creation and delivery of innovative products and services. Globalisation has also increased the pressure on OECD member countries to move up the value chain and engage in a continuous process of adjustment. By strengthening innovation, countries, regions, cities and firms can become more competitive, and better prepared to face the challenges of globalisation. Innovation, a process that is generally managed by private firms, has become a concern for policy makers at all levels, from supranational to local actors.

The current economic recession has amplified the importance of innovation in economic growth. Policy responses by OECD member countries are seeking to achieve a so-called "double dividend", both restoring short-term growth and reforming economic structures. Strengthening the innovation capacity of firms is seen as one area where public investment can achieve this dual objective. Hence, increased investment in R&D and technology development is a component of economic recovery packages. Politicians around the world have emphasised that the way to recovery is via more innovation in both the private and public sectors.

The OECD is currently developing an Innovation Strategy that emphasises a broad, collaborative and inclusive approach to innovation. The Strategy underlines that with a mobilising vision – and the ambition to achieve it through effective policy co-ordination – governments can help consolidate or develop new comparative advantages in an environment conducive to innovation. This Strategy is equally relevant for regional and national policy communities. The Innovation Strategy seeks to promote an integrated approach that combines both framework conditions to support innovation and risk-taking with structural policies to strengthen education, training and entrepreneurship. Moreover, the Strategy emphasises that innovation should be a central component of policy, with strong leadership at the highest political levels. It also affirms that national policy should enable regional actors to foster innovation in their own context, building on local strengths and established frameworks, while ensuring co-ordination across regions and with national efforts.

Increased interest in the regional dimension of innovation is also spurred by recognition that some places appear to be more effective in the way they use innovation-related assets and investments than others. Many of the leading firms in "new economy" industries – those driven by rapid innovation in products, processes and commercialisation – have emerged in a limited number of regions. Such regions appear to provide more conducive environments for business innovation. Much of the effort of policy makers in other regions aims to replicate or nurture the positive environmental conditions that the best-performing regions offer.

What should regional innovation policy do?

What should regional innovation support be and what it should aim to achieve? First, it is not an end in itself. Its success should be judged on how well it performs in addressing the challenges faced by firms and by society in general. It should be more than just a buzzword and an aggregation of technical business support measures. Rather, it should be a broad vision that permeates a wide range of public and private sector activities. And it should lead to a clear investment strategy for the public sector that also encourages investment by the private sector. Finally, it should help to channel creativity towards objectives that increase wealth and well-being. These principles – broad though they are – nonetheless suggest a new type of public policy.

In the development of innovation policy, the targets and rationale for intervention should be clear. Traditionally, intervention has been justified to address market failures. However, with respect to regional innovation, there is increasing recognition that other types of "failures", beyond market failures, can impede the functioning of an innovation system and result in sub-optimal outcomes. The most commonly cited are network and systemic failures, in addition to several others (OECD, 2005b; OECD, 2006b; van Cruysen and Hollanders, 2008). Market failure arguments concern the risk and uncertainty that lead to sub-optimal investments, while systemic failure arguments focus on the issue of interactions across actors in that system. EU policies have explicitly acknowledged systemic failure in the context of their policies to support innovation through Structural Funds and other programmes, as have several OECD member countries. There is evidence in Catalonia that despite the successes in the knowledge generation sub-system, the systemic links with the knowledge exploitation sub-system are insufficient.

The ability of and incentives for firms to innovate are linked to a wide range of factors. Some of these factors are set by national policy, such as legislative and macroeconomic settings (intellectual property rights [IPR] and patent law, taxation, corporate governance, exchange rates, tariffs, competition, etc.). But innovation is also strongly influenced by region-specific factors. These endowments are both physical and human, individual and collective, and found in both public and private spheres. Innovation depends on the scientific capacity of actors and institutions (their acquired knowledge of existing knowledge and concepts, their openness to new knowledge and ability to assimilate, etc.). But the technological capacity of actors (their capacity to perceive usefulness and applicability of knowledge) is also important. And, finally, industrial capacity plays a role (the capacity of actors to transform concepts and ideas into useful, commercially viable products).

While all firms are concerned by innovation, in practice policies tend to be targeted at particular categories or types of firms. For example, among firms that are considered to be innovative, around half do not conduct any R&D. These firms tend to be far less likely to seek policy support. They are more likely to focus on process innovation and get their ideas from production managers and engineers within the firm. As such, they are less visible for policy than those that work on R&D projects with external partners (Arundel, *et al.*, 2008). A critical issue for regional innovation policy is therefore how to provide a flexible framework for policy delivery to the different types of actors.

The innovation system is increasingly useful as a policy concept as innovation has become a more open process. Firms select and acquire technology from a wide range of external sources, by outsourcing portions of R&D or engaging in partnerships to develop new technologies. The use of national and regional systems of innovation has emerged to help improve understanding of how public policy is organised to support innovation. The concept has been widely embraced across the OECD, and policy makers have seen the value of the systems of innovation literature and used it to explore regional systems of innovation (Cooke, 2004). One useful distinction, for example, has been made between a more institutionalised form of regional innovation system and an entrepreneurial system (see Table 0.1.). Catalonia is closer to the institutional model, but its aim is to develop the attributes of the entrepreneurial model as well.

Table 0.1. **Institutional versus entrepreneurial regional innovation systems**

Institutional	Entrepreneurial
R&D driven	Venture capital driven
User-producer relations	Serial start-ups
Technology focused	Market focused
Incremental innovation	Incremental and also disruptive
Bank borrowing	Initial public offerings/VC
External supply chain networks	Internal networks

Source: Cooke, P. (2004), "Introduction: Regional Innovation Systems – An Evolutionary Approach", in Cooke, P, M. Heidenreich and H. Braczyk (eds.), *Regional Innovation Systems*, Routledge, London.

New forms of innovation and innovation policy

The way firms organise their innovation is constantly evolving, which makes supporting innovation a moving target for public policy. New forms of innovation are appearing, or now being recognised, that are not always well defined or easily reached by traditional innovation support instruments. This is the case in Catalonia, which has a diverse economy that mixes both high-tech manufacturing with other non-R&D intensive sectors. The explicit aim of the Catalan Agreement on Research and Innovation (CARI) is to expand the scope of innovation policy thinking to include these harder-to-reach but nonetheless important innovators to better address social challenges.

The OECD, among others, acknowledges a need for considering innovation in a broader sense, beyond the linear, science-based approach. The OECD suggests three ways of thinking about this broader approach to innovation (OECD, 2009c):

- *The output-based approach.* This approach looks at the results of innovation. This includes the type of innovation (technological – process and product; and non technological – organisational and marketing, as defined by the Oslo Manual) and the relationship between them.
- *The behaviour-based approach (new collaborative arrangements for innovation).* This strand of thinking identifies new forms of innovation according to the new ways of organising the process of innovation. The focus is on the ways in which innovation agents interact and change behaviour to innovate.
- *The challenge-driven approach (innovation to address social challenges).* This approach considers innovation by its objectives, in particular to address specific challenges be they social, community-

based or global. It starts from the recognition that contemporary societies are undergoing a shift in production and consumption priorities pushed by issues such as climate change, the sustainability of production, persistent inequality and poverty, to name a few.

Broadening the scope of innovation policy is beyond the remit of one single ministry, at either national or regional government level. Governments are struggling to develop coherent national innovation strategies that capture the new broader definition of innovation. These policy shifts imply greater fluidity across what used to be more segmented sectoral ministry boundaries. Another key strand of government policy is the emphasis on the role of the public sector as a driver of innovation by firms (such as through "intelligent" innovation-informed procurement planning) and also as a source of innovation. Catalonia has sought to build an inter-ministerial approach to innovation support, efforts that continue so as to achieve truly effective collaboration. And Catalonia is actively supporting the idea of public sector innovation.

New governance arrangements to support regional innovation

New horizontal and vertical governance arrangements for innovation policy are required. The difficulties of co-ordinating innovation policy at the national level are exacerbated by the challenge of building functioning governance arrangements across levels of government. The policy constituencies that lead policy making in this field sometimes have little experience of collaborative policy making with other levels of government. The system by which innovation is managed across levels of government remains challenging across OECD member countries.

This distinction between national and regional roles should be based on which factors that support innovation are most susceptible to influence at the sub-national level. This is a kind of subsidiarity exercise applied to innovation policy. While this approach seems quite basic, policy experience so far is limited and is not grounded in a clear model of what regional innovation policy should look like (see Table 0.2.).

Table 0.2. **Factors that support innovation and their openness to regional influence**

Key factor	Spatial variation or strong regional characteristics?	Possibility for regional impact?
Level of development, economic performance	Strongly regional	Yes, by enhancing investment in productive factors
Regulatory framework	Usually no spatial dimension	Depends on country context
Competition regime	Usually no spatial dimension	No
Access to finance	Some regional variation (linked to market size and demand)	Yes, provision of grants and loans; problem is to stimulate local capital markets
Capacity to absorb and exploit knowledge and technology	Strong regional variation (linked to HR and sector)	Yes, needs-driven training, technology transfer and demonstration projects, etc.
Customers	Some regional variation (firms in non-core regions less exposed to demanding customers)	Limited
Sources of new technological knowledge	Some regional variation (linked to quality of HEI and bridging/ intermediation institutions)	Yes, knowledge transfer institutions, other bridging mechanisms
Networks, collaboration and social capital	Strongly regional or local	Yes, wide range of actions to support local associations and joint projects

Notes: 1) HR=human resources; 2) HEI=Higher education institution.

Source: OECD (2008), *OECD Reviews of Regional Innovation: North of England, UK*, OECD, Paris.

Is there an optimal distribution of responsibilities across levels of government with regard to innovation? There are currently different approaches to organising and managing innovation policy, largely dependent on more general institutional and constitutional frameworks. Across OECD member countries, there are examples of regions playing a passive role (as stages and implementers) or an active role (as partners and independent policy makers) (Perry and May, 2007). Catalonia is an active region, acting as an independent policy maker in this field, but increasingly recognising the need for working as a partner with central government.

Chapter 1

Innovation and the Catalan Economy

Introduction

With over 7 million inhabitants and a GDP of around EUR 204 billion, Catalonia is an important region within Spain and the OECD. It has a strong identify with its own language and distinct cultural heritage. The industrial tradition has lead to a diversified industrial base, concentrated in medium-low and medium-high technology sectors. The region has had an influx of over 1 million immigrants since 2000, many low-skilled, to feed expansion of the service and construction sectors. Like Spain generally, the Catalan economy and GDP per capita has grown due to increased labour force participation while productivity has remained stagnant. Innovation is therefore essential to ensuring sustained economic growth – especially for its SMEs. Catalonia contributes significantly to Spain's innovation system due to its size and strength, making it one of the top Spanish regions. For the OECD, however, Catalonia's innovation performance is only average. Boosting the region's innovation performance will therefore benefit both Catalonia and Spain.

1.1. What is Catalonia?

A leading region in Spain at the scale of many small European countries

Catalonia is a Spanish Autonomous Community (region) located in the Northeast of the Iberian Peninsula. It is bordered by France and Andorra to the north, the Mediterranean Sea to the east, and the Spanish regions of Valencia and Aragon to the south and west, respectively (see Figure 1.1). Catalonia is divided into four provinces (Barcelona, Tarragona, Lleida and Girona). The administrative level immediately below includes 41 counties (*comarques*) and 946 municipalities. Its capital is Barcelona City and the official languages are Catalan, Spanish and Aranese. Politically, Catalonia is one of the three "historical nationalities" in Spain (the Basque Country and Galicia being the other two). Its historic borders spanned across the current border with France. Catalonia exercises its right to self-government in accordance with the Spanish Constitution of 1978 and the Catalan Statute of Autonomy – the latest under review dating from 2006.

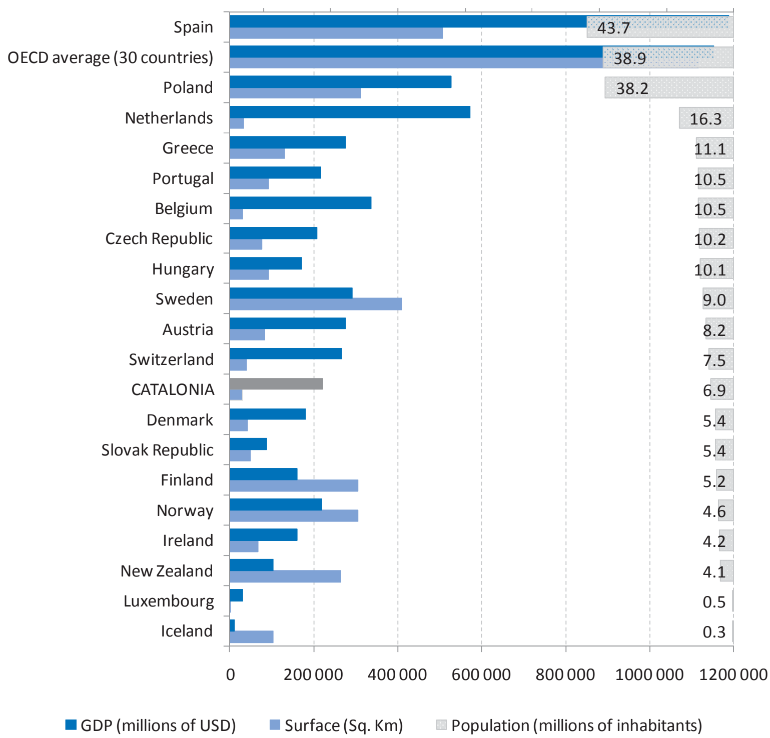
Catalonia as a region is larger than several OECD member countries in terms of population, surface and economy (see Figure 1.2). In 2005, Catalonia covered an area of over 32 000 square kilometres, had a population of approximately 7 million, and a population density of 216 inhabitants per square kilometre. Catalonia's GDP is approximately EUR 204 billion. Catalonia's surface area is similar to the Netherlands and Belgium. Its population is close to that of Switzerland and Denmark. Finally, its economy is at the scale of Portugal and Norway.

Catalonia makes a significant contribution to the Spanish economy. In 2005, Catalonia was 6% of Spain's territory, contained 16% of its population and contributed around 19% of its GDP (see Figure 1.3). Catalonia is the second most populated region in Spain, after Andalusia. In terms of surface area, Catalonia is only the sixth largest region, with Castile and Leon, Andalusia and Castile-La Mancha being the three largest. Catalonia is the leading regional contributor to the Spanish economy. Together with Madrid and Andalusia, the three regions contribute more than one half of the Spanish GDP. Spain is one of the OECD economies with a significant share of its production in a limited number of regions (approximately 50% in only 10% of its regions) (OECD, 2009c).

Figure 1.1. **Map of Catalonia**

Figure 1.2. **Catalonia in comparison with OECD member countries**

2005 GDP using current prices (in USD PPP terms, year 2000)



Note: Several larger OECD member countries were excluded from this figure for ease of graphic display.

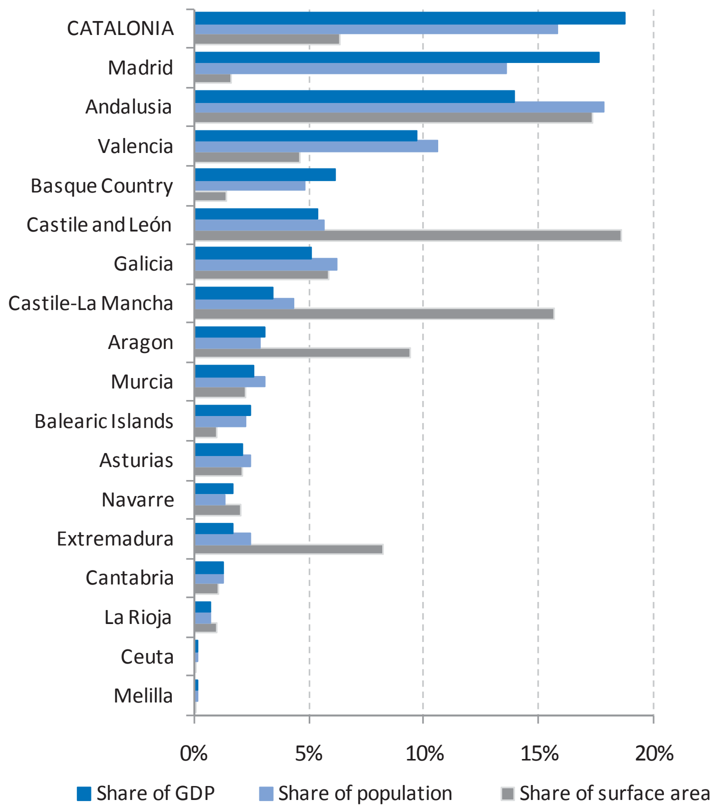
Source: OECD calculations based on the *OECD Regional Database*.

Economic activity centred around Barcelona, with dynamism in some other locations

Within Catalonia, the province of Barcelona (approximately the footprint of the Barcelona metropolitan area) accounts for 73% of the Catalan population and 74% of the economy (see Table 1.1). Indeed, in 2005 more than 5 million inhabitants were located in Barcelona province (12% of Spain's population), which included 68% of Catalonia's foreign born population. Barcelona generates 14% of Spain's GDP.

Figure 1.3. **Catalonia's contribution to Spain**

TL2 regions, 2005



Source: OECD calculations based on the *OECD Regional Database*.

Catalonia contains three other provinces that combined account for one-fourth of Catalonia's population and economy. Tarragona, Girona, and Lleida have regional cities and rural areas. They are much less densely populated than Barcelona (657 inhabitants per square kilometre), with Girona and Tarragona at 107 and 108 respectively and Lleida much more rural at 32.

Table 1.1. **Socio-economic characteristics of Catalan provinces**

	Absolute values		Share of Catalonia		Absolute variation	Annual average growth rate
	1995	2005	1995	2005		
Population						
Barcelona	4 670 353	5 078 005	76%	73%	407 652	0.8%
Girona	518 539	634 663	8%	9%	116 124	2.0%
Lleida	353 928	389 478	6%	6%	35 551	1.0%
Tarragona	560 005	683 362	9%	10%	123 358	2.0%
Total (Catalonia)	6 112 180	6 930 046	100%	100%	817 866	1.3%
GDP (millions EUR real prices 2000)			**Share of Catalonia**			
Barcelona	73 306	102 901	72%	74%	29 595	3.4%
Girona	8 610	13 301	9%	10%	4 691	4.4%
Lleida	5 530	7 899	5%	6%	2 369	3.6%
Tarragona	9 647	14 492	10%	10%	4 845	4.2%
Total (Catalonia)	101 273	138 686	100%	100%	37 413	3.2%
GDP per capita			**As a percent of Catalonia total**			
Barcelona	15 695	20 076	95%	99%	4 380	2.5%
Girona	16 570	20 602	100%	102%	4 031	2.2%
Lleida	15 629	20 039	94%	99%	4 410	2.5%
Tarragona	17 155	20 860	104%	103%	3 705	2.0%
Total (Catalonia)	16 569	20 216	100%	100%	3 647	2.0%
GDP per worker			**As a percent of Catalonia total**			
Barcelona	40 910	39 955	96%	100%	-954	-0.2%
Girona	38 336	37 552	90%	94%	-783	-0.2%
Lleida	36 502	37 903	86%	95%	1 401	0.4%
Tarragona	45 463	43 430	107%	109%	-2 033	-0.5%
Total (Catalonia)	42 548	39 948	100%	100%	-2 601	-0.6%

Source: OECD calculations based on data from the *OECD Regional Database* and the Spanish Statistics Institute (INE).

The industrial structure contributes to some differences in wealth and productivity levels across Catalonia. All four provinces within Catalonia have a GDP per capita in real prices well above the Spanish average of EUR 16 924 (ranging from EUR 20 860 in Tarragona to EUR 20 039 in Lleida) and the OECD regional average. The regions have higher participation rates relative to the Spanish average of 70% (highest of 80% in Girona, lowest of 73% in Lleida). In terms of productivity (GDP per worker in 2000 real prices), the results are more mixed. The provinces of Lleida (EUR 37 903) and Girona (EUR 37 552), with more agricultural and lower-technology industries, are slightly below the Spanish average (EUR 38 438). Barcelona (EUR 39 955) and Tarragona (EUR 43 430) are above by 4% and 13% respectively.

1.2. Demographic and economic trends

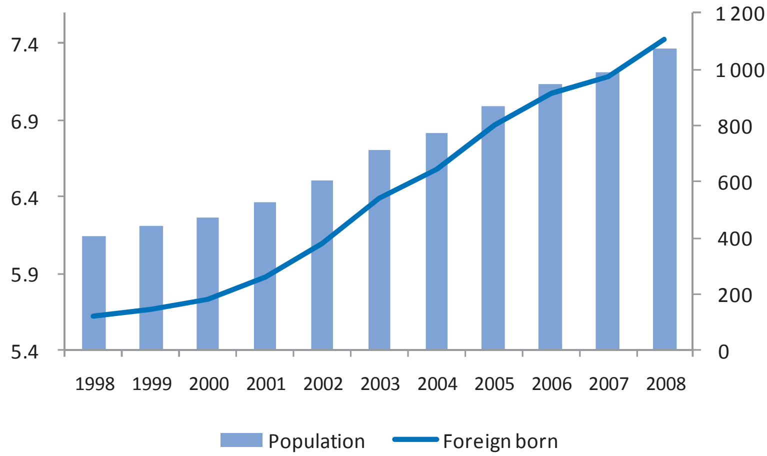
Immigrants, many low-skilled, driving population increases

Spain has been among the fastest growing OECD member countries in terms of population, and Catalonia one of the fastest growing regions in Spain. During the period 1995-2005, Spain registered higher average annual population growth rates than the OECD average (1% and 0.6% respectively). At the same time, Catalonia had an average annual population growth rate of 1.3%, above the Spanish rate of 1%. Looking at yearly trends, the population growth is concentrated in the second half of the period (2001-2005). This growth has occurred in all four of Catalonia's provinces.

Catalonia's population growth has been driven by immigration (see Figure 1.4). The Catalan fertility rate has increased in recent years but does not account for the massive population increases. The figure varied from 1.14 to 1.46 during the period 1995-2007, remaining far below the replacement level (2.1). The foreign-born population, with higher average fertility rates, has contributed to Catalan fertility growth. With recent immigration flows, Catalonia now accounts for 21% of Spain's foreign born population, totalling over 1.1 million in 2008.[1] This is a nine-fold increase in the foreign-born population from the approximately 121 000 in 1998 to become approximately 15% of Catalonia's population today. Around 745 000 or 67.5% of the foreign born are located in Barcelona province, followed by Girona (14%), Tarragona (13%) and Lleida (6%).

Figure 1.4. **Population growth and immigration in Catalonia**

Population in millions - foreign born in thousands



Source: Data from the Spanish Statistics Institute (INE).

The increase in immigration has resulted in greater ethnic diversity of the Catalan population. The top three sending regions for the current foreign-born population were Latin America (30.4%), EU-27 (25.6%) and Africa (25.2%) as of 2008. The rest of the world accounts for the remaining 19%. Since 1998, the share of foreign-born residents from Africa has declined (40% down to 25%), which has been compensated by an increasing share from South America (15% to 30%). The sending countries with the largest shares were Morocco (19% of the total Catalan foreign-born population), Romania (8%), Ecuador (7.3%) and Bolivia (5.5%). There are also increasing numbers of foreign born from Argentina, Brazil, China, Colombia, France, Italy, Pakistan and Peru. At the same time, there has been a decline in the numbers of foreign born from Serbia and Montenegro, presumably immigrants returning home after the war.

Catalonia's foreign-born working population has relatively low educational achievement. This is a challenge for Catalonia, as regions with the highest volumes of workers in occupations with low qualification requirements are going to be affected the most by the rise in unemployment with the crisis, especially immigrants (OECD, 2008a). In terms of worker's skill levels, Catalonia actually has the largest share of immigrants to Spain with little or no education (over 33.2% in 2007).[2] It is followed by Andalusia (13.7%), Madrid (11.7%) and Valencia (10.2%). Catalonia is one of the regions with the highest proportion of its immigrant labour force with very low skills (little or no education): 15% compared to the Spanish average of 9%. And while 22.3% of all immigrants in Spain with a tertiary education were located in Catalonia, a higher share (26.5%) can be found in Madrid. The share of Catalonia's foreign-born with tertiary education, 24%, is similar to the Spanish average of 23%.

Economic growth not sustainable given stagnant productivity

Catalonia's economy had strong growth over the last 15 years prior to the economic crisis. In terms of GDP, Catalonia (3.2%) grew at almost the same average annual growth rate as Spain overall (3.3%) from 1995-2005, and higher than the OECD (2.9%). Catalonia's economic growth over the period 2000-2005 was mainly due to favourable conditions in the labour market, which explains the reduction in labour productivity suffered in the majority of Spanish regions (Fernández and Montolio, 2006). The massive immigration has contributed to GDP growth in terms of population increases and a higher employment rate, given the relatively younger age structure of immigrants.

Similar to Spain, Catalonia's strong period of growth since the early 1990s has now ended, showing a weaker productivity growth than other European countries. For Spain, this slowdown is attributed in part to the reduction of the housing construction sector and the adjustment of the financial markets (OECD, 2008a). Both factors will bring deep economic changes in the economy, including a significant impact on unemployment. In fact, unemployment increased dramatically in many Spanish regions between first quarter 2008 and first quarter 2009.[3] Catalonia's unemployment jumped by 8.6 percentage points – above the national increase of 7.8 percentage points and the increases of other advanced Spanish regions such as the Basque Country (4.8) and Navarra (4.3), but below those with already high unemployment like Andalusia.

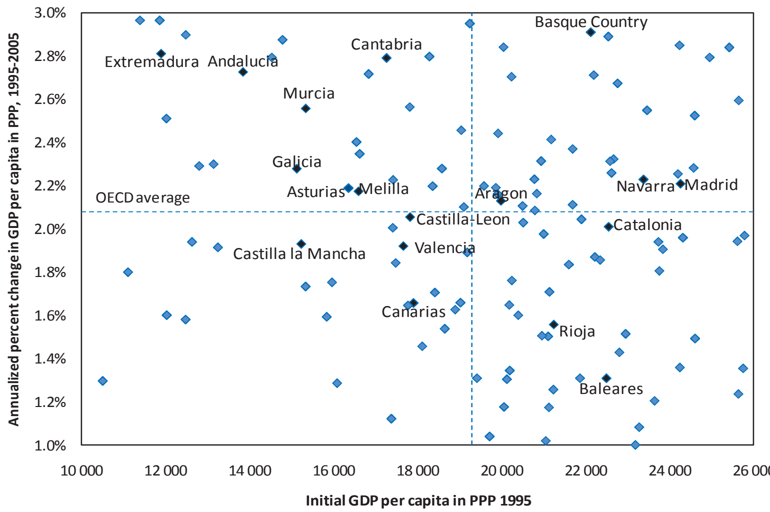
Catalonia has an above average GDP per capita level but a more average growth rate with respect to the OECD. At USD 27 504, Catalonia's per capita GDP for 2005 (in constant prices, PPP 2000) is above the OECD average of USD 26 149 and the Spanish value at USD 23 200 but behind Madrid (USD 30 171), Basque Country (USD 29 475) and Navarra (USD 29 119). Catalonia's GDP per capita growth rate at 2.0% is slightly lower than the OECD regional average (see Figure 1.5). Many other regions have a GDP per capita growing faster than that of Catalonia, including most Spanish regions.

Catalonia's GDP per capita growth occurred despite negative productivity growth in absolute and relative terms. Catalonia's employment and employment rates grew significantly faster than the OECD average, both of which are largely due to immigration (see Table 1.2). In 2005, at USD 54 349 (2000 constant prices and PPP adjusted) Catalonia's labour productivity (GDP per worker) was slightly above the Spanish value of USD 53 321, albeit several other Spanish regions are further above the average (Basque Country by 12% and Madrid by almost 9%). GDP per hour worked in Catalonia (26.7) was also lower than some other Spanish regions, notably the Basque Country (31.2), Navarra (29.4) and Madrid (28.7).[4] During the period 1995-2005, the absolute levels of the region's GDP per worker dipped in the beginning of the decade, when the productivity of the Catalan and Spanish economy suffered a stronger shock than other European countries, and has yet to reach the same absolute levels as 1995. The relative deterioration with respect to OECD member countries is notable. While in 1995 Catalonia was at 115% of the OECD average, it dropped to only 91% by 2005 (see Figure 1.6).The average annual growth rate of the ten-year period is therefore negative for Catalonia (-0.6%), like several other regions in Spain (see Figure 1.7).

The need for faster labour productivity growth is more important than ever. Spain in general is facing a productivity gap with regard to the majority of OECD member countries. Spain is specialised in medium and low-technology sectors that are characterised by poor performance and growth (OECD, 2007e). A second negative factor is the large inflows of immigrants with low skills (OECD, 2008a). And while Catalonia performs better than Spanish averages for productivity, there is a need for specialisation in sectors with higher levels of technology and skills to remain competitive globally.

Figure 1.5. **GDP per capita: level and annual average growth rate**

Select TL2 regions, 1995 and 2005



Source: OECD calculations based on data from the *OECD Regional Database*. Regions in Spain are labelled and some regions excluded for ease of display. See Figure 1.A1.1 for all OECD regions.

Table 1.2. **Factors driving GDP per capita growth**

1999-2005

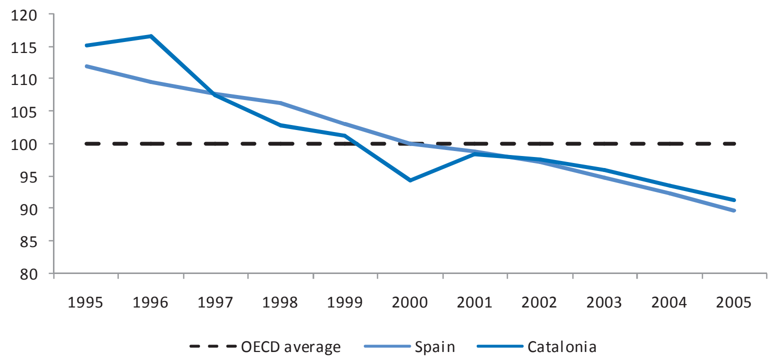
	GDP per capita average annual rate change	Productivity average annual rate change	Employment rate average annual percentage point change	Employment average annual rate change	Population average annual rate change
OECD average	1.7%	1.6%	0.1 pp	0.9%	0.7%
Spain	2.1%	-0.8%	1.6 pp	4.4%	1.4%
Catalonia	1.6%	-0.2%	1.4 pp	3.8%	1.9%

Notes: Per capita GDP = GDP in constant prices and PPP/average total population. Regional productivity = GDP at constant prices and PPP/employment at the place of work. National and OECD productivity = GDP at constant prices and PPP/civilian employment. Regional employment rate = Employment at the place of residence/population 15-64. National and OECD employment rate = Civilian employment/population 15-64.

Source: OECD calculations based on *OECD.Stat* and the *OECD Regional Database*.

Figure 1.6. **Productivity trends relative to the OECD**

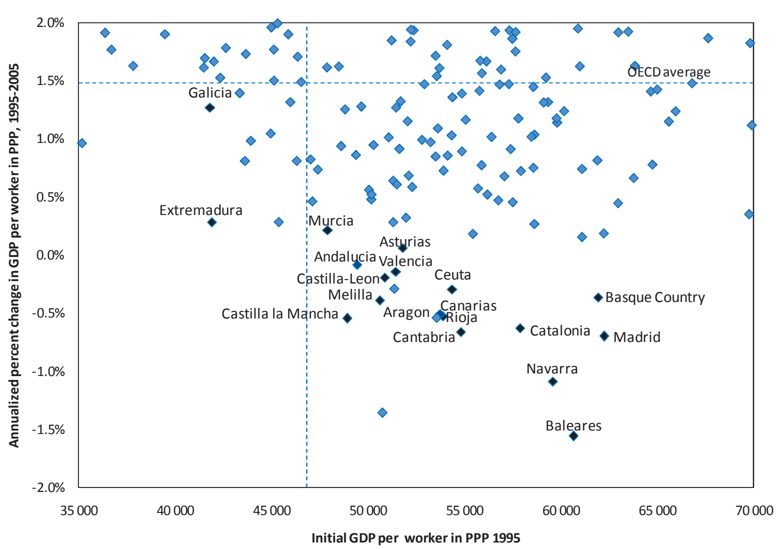
Normalised values of GDP per worker (OECD average = 100)



Source: OECD calculations based on data from *OECD.Stat* and the *OECD Regional Database.*

Figure 1.7. **GDP per worker: level and annual average growth rates**

Select TL2 regions, 1995 and 2005



Source: OECD calculations based on data from the *OECD Regional Database*. Regions in Spain are labelled and some regions excluded for ease of display. See Figure 1.A1.2 for all OECD regions.

1.3. Catalonia's industrial structure

Catalonia's economy is based on a long-standing industrial tradition as the "Manchester of Southern Europe". It also serves as a commercial trading hub in the Mediterranean. The crisis of 1984, the entry of Spain in the EU, and the 1992 Olympic games, among other factors, helped transform the Catalan economy to a new economic development model (see Box 1.1). The current structure has experienced, like other OECD regions, a continued increasing share in the tertiary sector as a result (see Figure 1.8).

Catalonia has been characterised by a large manufacturing base. In 2000, manufacturing sectors represented 26% of the regional GVA. This was a much larger share than in the Spanish economy more generally (18%) or the EU15 (19.5%). By 2006, the manufacturing share of the Catalan economy had declined to 20% of regional GVA and 21% of employment as compared with Spain (15%) and the EU15 (17.9%).[5] In absolute terms, depending on the data source, the number of manufacturing jobs has been stable or declined, albeit many jobs supporting manufacturing are now classified as services. If you add the share of manufacturing employment and production services, the total accounts for 53.7% of employment and 59.4% of GVA (see Figure 1.9).

Both the tertiary sector and construction have absorbed many of the region's immigrants and the job losses in manufacturing. By 2006 the tertiary sector accounted for 67% of the region's GVA and employment, up from 65% and 63% respectively in 2000. Construction increased notably as well over the period, from 7% to 11% of GVA, and from 9% to 10% of the region's employment. This reflects national level trends, as construction is 12.2% of Spain's employment. The share of employment in construction is high for European regions.

In terms of the productivity of different sectors (GVA per worker), it is construction showing the largest gain, with an average annual rate of 5.0% from 2000-2006 (see Figure 1.9). The primary sector remains the lowest both in terms of the GVA per worker and the decline in that figure to -3.5% over the period. The tertiary sector, a diverse category, has an overall GVA per worker slightly above the regional average with an average annual growth over the period of -0.1%. Manufacturing productivity is slightly below the average the regional GVA per worker average and also had a negative average annual growth over the period of -0.1%.

Catalonia's manufacturing is more technology-intensive than the rest of Spain, but about average for OECD regions generally.[6] Employment in the manufacturing sector is 4.5% in high-technology (1.0% of all employment), but 32.1% in medium-high technology (7.3% of all employment) – the remaining 63.5% being in medium-low or low technology industries. Catalonia is specialised in high-tech and medium high-tech manufacturing relative to Spain (1.6 and 1.3 respectively in 2006). However it is high-tech manufacturing that has shown increasing specialisation since 1994, while medium-high tech has been losing specialisation relative to the Spanish average (see Figure 1.10). The combined share of the overall economy in medium-high and high-technology manufacturing is greater in Catalonia (over 8%) than the EU15 (less than 7%). Given Catalonia's size, it is the third largest region in the EU27 in terms of absolute employment in medium-high and high-technology manufacturing, after Lombardy (Italy) and Stuttgart (Germany). As a share of employment, however, the region is ranked lower as many German and Italian regions rank higher (EU, 2008).

In terms of the knowledge-intensive services (KIS), Catalonia and Spain are below EU averages. Approximately 45% of service employment is classified as knowledge intensive (see Table 1.A1.1).[7] Of that amount, high-technology services are 5.2% of services (3.3% of total employment), 14.3% in financial services, 4.2% in market services and 21.4% in other. The latter category covers a range of services including education, health, social work and sports. Catalonia is more specialised than Spain in high technology, market and financial service sectors (1.1, 1.1, and 1.2 respectively) (see Figure 1.10). However, it is only high-technology and financial knowledge-intensive services that have been gaining specialisation since 1994.

Box 1.1. **Catalonia's industrial history**

Originally based on the industrial tradition of the textile sector of the 19th century, Catalonia became the most industrialised region in Spain. Over the last 50 years, the region experienced a profound economic transformation, characterised by an industrial take-off, partly due to the transition from an autarky (inward looking) to a more internationalised and open economy. The Catalan economic model in the 1960s was mainly based on four elements: a) the attraction of low-skilled workers from the rural regions of Spain; b) attraction of capital from Europe; c) the use of raw materials in the production process; and d) significant development of the construction sector.

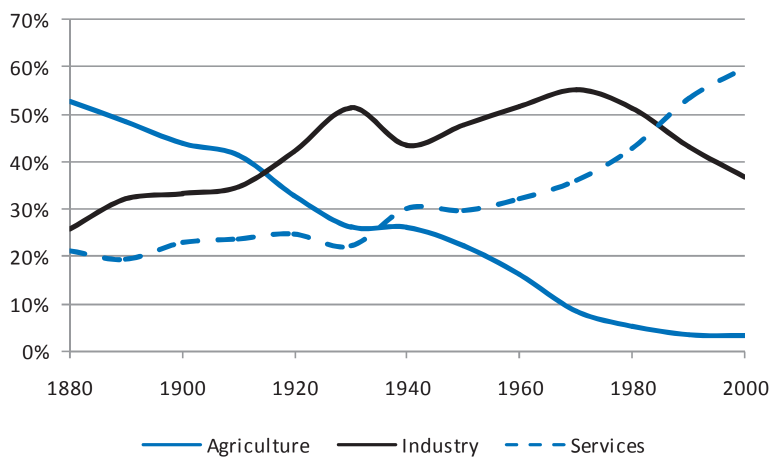
Nevertheless, the economic crisis of the 1970s created uncertainties about the region's economic competitiveness model. There was an escalating price of raw materials, wages were stagnating, migration from the rest of Spain halted, while foreign direct investment and capital coming from tourism both declined. As a result, Catalonia suffered a reduction in external demand for industrial products and services and a growth of the unemployment rate until the end of the crisis in 1984.

Box 1.1. **Catalonia's industrial history** (*continued*)

Several influences changed Catalonia's economic development model after the 1984 crisis. The incorporation of Spain to the European Community (EC) and the participation of Barcelona in the 1992 Olympic Games were positive factors. The new model became more specialised in the tertiary sector and more capital intensive than the previous model based on low-cost labour. The price of raw materials decreased and the region experienced major investments in transport and communication infrastructure. All these factors favoured the emergence of Catalonia as a new type of industrial engine in Spain and Europe.

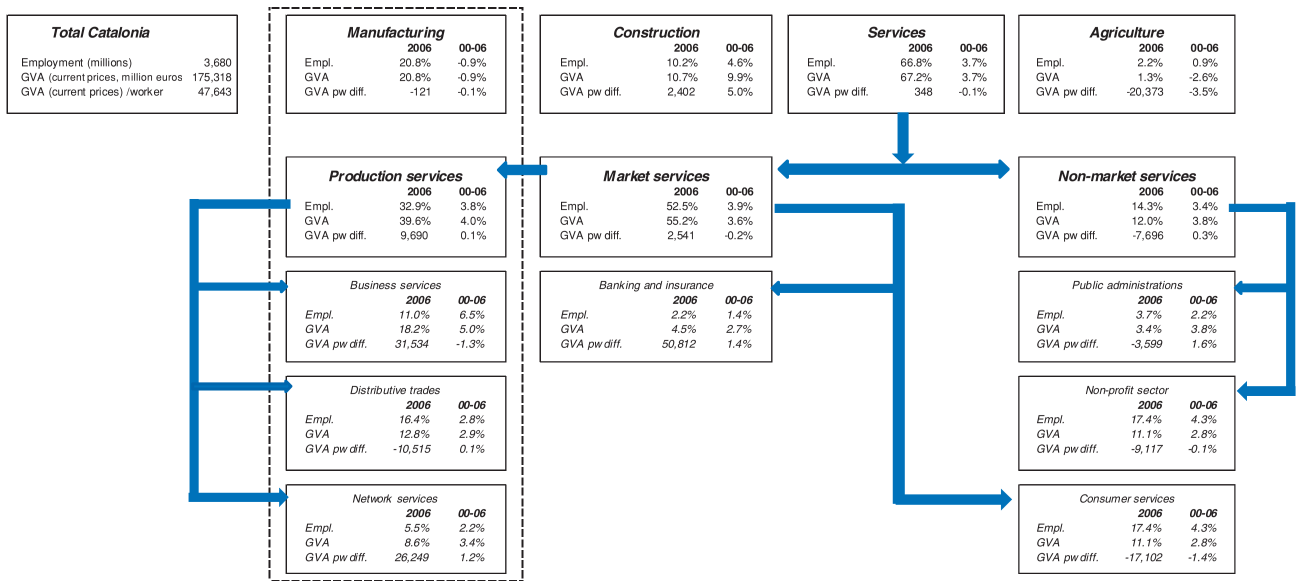
Source : Trullén, J. (1990), "Del mundo de crecimiento a partir del decenio de 1960" in Parellada, Martí (1990), *Estructura económica de Cataluña*. Ed. Espasa – Calpe, Madrid.

Figure 1.8. **Evolution of employment by sector: 1880-2000**



Source: Di Vittorio, C. Barciela López i G. L. Fontana, (eds.) (2004), *Storiografia d'industria e d'impresa in Italia e Spagna in Età moderna e contemporanea*, Padua, CLEUP, pp. 63-102 based on Census data.

Figure 1.9. **Sectoral distribution of Catalan economy**

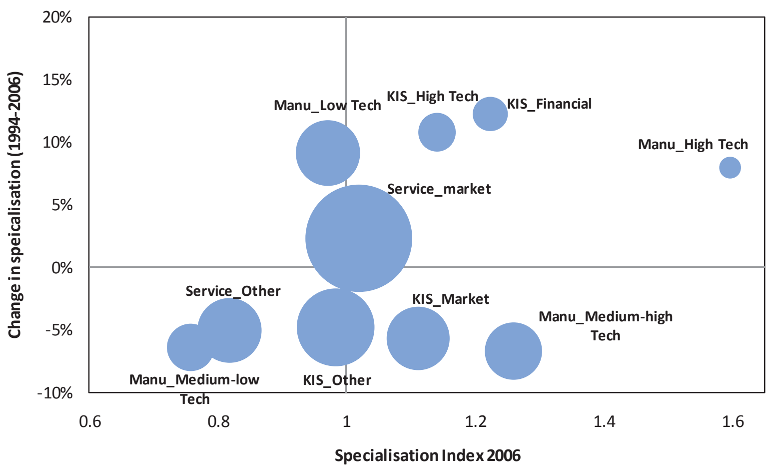


Notes: 1. GVA=Gross value added. 2. Empl.= employment. 3. GVA pw diff is the difference between the GVA per worker for the sector relative to the overall GVA per worker for Catalonia. 4. Calculations for change 2000-06 based on 2000 real prices. 5. Methodology based on Baró and Vilafaña (2009) *The New Industry: The Core Sector of the Catalan Economy,* Government of Catalonia, Ministry of Innovation, Universities and Enterprise; and EC (2003), *The Competitiveness of Business-related Services and their Contribution to the Performance of European Enterprises,* communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Brussels. 6. Manufacturing includes (NACE 10-14, 23, 15-37), Construction (NACE 45), Services (NACE 40-41, 50-95), Agriculture (NACE 01-05), Business services (NACE 70-74), Distributive trades (NACE 50-52), Network services (NACE 40-41, 60-64), Banking and insurance (NACE 65-67), Consumer services (NACE 55, 90-93, 95), Public administrations (NACE 75) and Non-profit sector (NACE 80, 85).

Source: OECD calculations based on data from Catalan Statistics Institute (IDESCAT).

Figure 1.10. **Sectoral dynamics by technology level: Catalonia relative to Spain**

Change in specialisation, 1994-2006



Note: 1. Manu=manufacturing, and KIS=Knowledge-intensive services, 2. Bubble size denotes sector size in terms of employment in 2006. 3. Specialisation is measured as the quotient of employment in the sector in Catalonia in relation to employment in the sector in Spain, corrected for total employment shares in Catalonia. A score of 1 means that a sector in Catalonia has a similar employment share as would have been expected on the basis of working population (that is: not specialised); a higher score indicates a sector in which Catalonia is specialised; a lower score indicates under specialisation.

Source: OECD calculations based on Eurostat data and classification by technology level.

Specialisation and local production systems

Catalan industry is characterised by a high degree of diversity. No category in manufacturing accounts for more than 17% of employment or gross value added (see Table 1.A1.2). Traditional industries such as metal products and food are the most important activities in terms of employment, accounting for 26%. Chemicals, vehicles and machine/equipment manufacturing also contribute an important share to the total industrial employment and gross value added.

Catalonia is specialised in a number of manufacturing sectors relative to Spain, although some lost specialisation during the period 2000-2005. Catalonia is still specialised within Spain for textiles, plastics, machinery, metals, printing and vehicles, but that specialisation has remained the same or is decreasing (see Figure 1.11, bottom right quadrant). Catalonia has shown increasing specialisation in the chemical industry (10% of manufacturing employment), clothing, electrical, paper and machinery manufacturing sectors (see Figure 1.11, upper right quadrant).

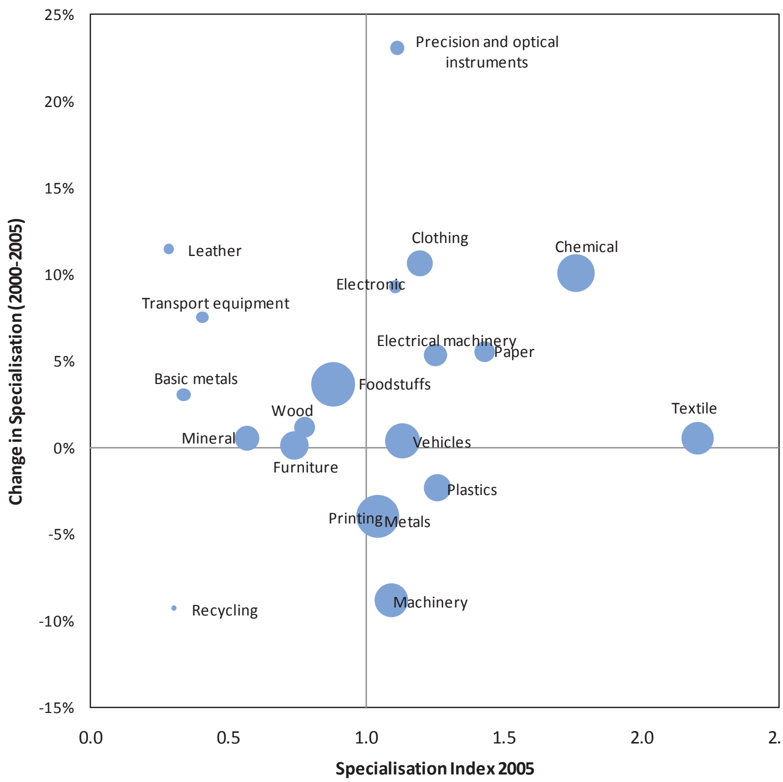
Relative to Europe, Catalonia is also more specialised in a number of sectors. According to the EU Cluster Observatory classification, Catalonia does not have any large and strong specialisations (three stars). However, four categories are considered two-star "clusters" in Europe given the combination of specialisation (relative to Europe), size (share of EU employment in sector) and focus (share of sector's employment in region's employment) (see Table 1.A1.3). They include construction, food, finance and transportation. There are also several other industry groups with a specialisation above 1 and a size of over 3% within Europe, notably chemicals, agricultural products and biopharma.

The predominance of small SMEs and different areas of specialisation have contributed to the development of a number of local production systems (LPS). Forty-two have been identified across the metropolitan area of Barcelona and the rest of Catalonia (see Figures 1.12 and 1.13) (Hernández Gascón *et al.,* 2005).[8] Among those LPS, the largest in terms of employment include metal products, automotive and plastic materials. The chemicals LPS is also one of the largest when considering sales. Many of the LPS located outside of Barcelona are related to agricultural products or textiles. One notable exception is raw chemicals in Tarragona province.

There is evidence that not only the leading metropolitan centres in Spain account for a lot of innovation activity, but also industrial districts of the kind found in Catalonia. In another analysis of Spanish local production systems (see Figure 1.A1.3), the industrial district form of LPS accounted for 20.9% of employment among the categories but 30% of Spanish patents. In terms of patents per employee, industrial districts had a rate 47% above the national average and 31% more than that of the LPS of large manufacturing firms (Boix and Galletto, 2008).

Figure 1.11. **Manufacturing specialisations in Catalonia: 2000-2005**

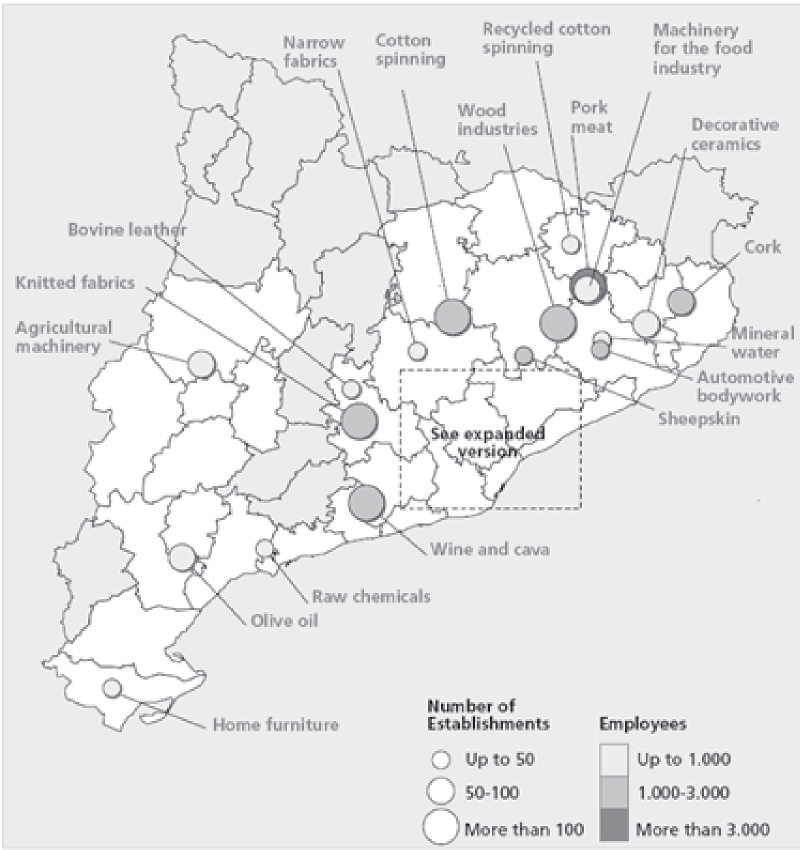
Change in specialisation by 2-digit industry code



Notes: 1. Bubble size denotes sector size in terms of employment in 2005. 2. Specialisation is measured as the quotient of employment in the sector in Catalonia in relation to employment in the sector in Spain, corrected for total employment shares in Catalonia. A score of 1 means that a sector in Catalonia has a similar employment share as would have been expected on the basis of working population (that is: not specialised); a higher score indicates a sector in which Catalonia is specialised; a lower score indicates under specialisation. 3. Computers manufacturing is not displayed given its value in the extreme bottom left quadrant, which means it is a sector that Catalonia does not specialise in and over time it is losing specialisation rapidly.

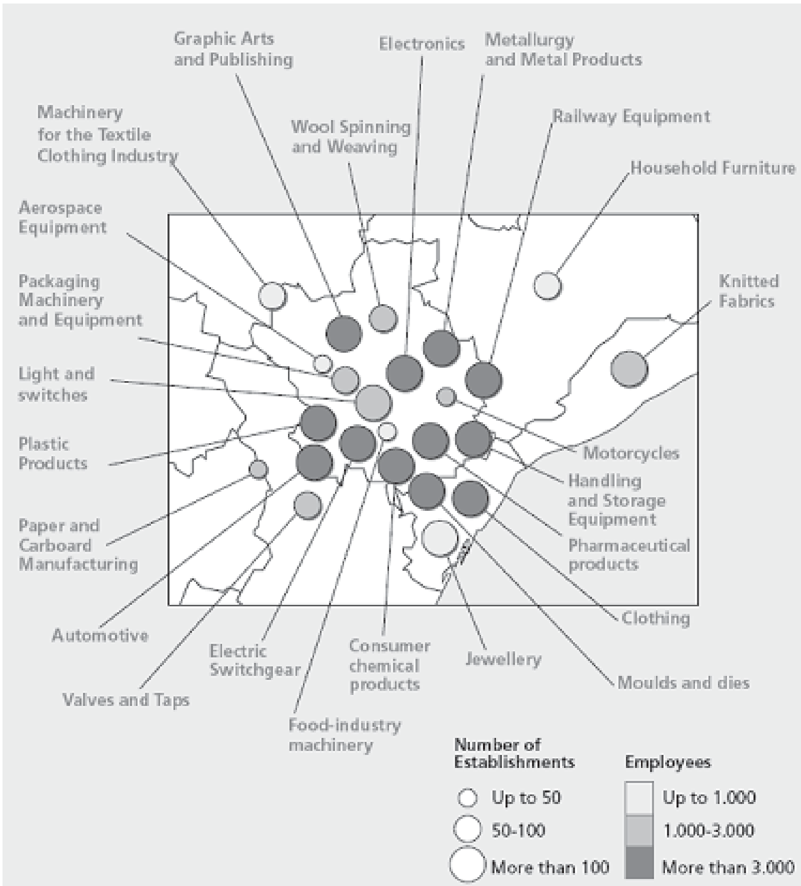
Source: OECD calculations based on data from the Catalan Statistics Institute (IDESCAT) and the Spanish Statistics Institute (INE).

Figure 1.12. **Map of Catalan local productive systems (outside Barcelona)**



Source: Hernández Gascón, J.M. *et al.* (2005), *Map of Local Industrial Production Systems in Catalonia*, Catalan government, Ministry of Labour and Industry, Secretary of Industry, Barcelona.

Figure 1.13. **Map of Barcelona area local production systems**



Source: Hernández Gascón, J.M. *et al.* (2005), *Map of Local Industrial Production Systems in Catalonia*, Catalan government, Ministry of Labour and Industry, Secretary of Industry, Barcelona.

Predominance of SMEs, many micro and family-owned

One of the main characteristics of the Catalan and Spanish economies is the small scale of firms. Of all firms in Catalonia, 99.8% are firms under 250 employees, of which 92.5% are firms with no salaried employee or fewer than 10 salaried employees (see Table 1.3). Catalonia's SMEs employ

74% of the workforce, with 31.1% in firms with fewer than ten or no salaried employees. The 0.2% of firms with at least 250 employees account for 26% of employment given the large average firm size (839 employees) (PIMEC, 2008).[9]

The share of GVA and employees generated by SMEs is significant across all sectors but with variations (see Figure 1.14). SMEs represent 93.2% of GVA in the primary sector and 91.8% in construction. In services and industry, those shares are somewhat lower at 66.2% and 56.2% respectively. In all sectors, SMEs represent an even higher share of employment: primary (92.5%), industry (71.5%), construction (94.5%) and services (74%).

What explains the growth in value added of 3% annually attributable to SMEs in Catalonia between 2002 and 2006? The answer depends on the sector (see Table 1.A1.4) (PIMEC, 2008). GVA in the primary sector has increased by 6.1% on average annually, due to increases in average firm size and productivity, while the number of firms has declined. In industry, despite increases in productivity of 1.3% annually and increasing firm size, the number of firms has declined leading to a negative GVA growth (-0.9%). The increase of 3.6% in construction is due to the increasing numbers of firms (7.8% annually), despite a decline in average firm size and more importantly productivity (-3.4% annually). Finally, services illustrate a GVA increase of 4.3%, due to the increasing number of firms, as well as minor increase in firm size and productivity.

Large firms continue to register a significantly higher average GVA per worker, albeit that of SMEs has grown more over the last few years.[10] Overall, SME productivity per worker is EUR 48 195, including SMEs without salaried employees that have a higher GVA per worker (EUR 51 624) than SMEs generally (see Table 1.3). SME average productivity per worker is only 70% that of large firms (EUR 68 383). The trend over time is positive for SMEs (0.2% average annual growth 2002-2006), but negative for large firms (-1.5% annually over the same period). Looking at a more detailed breakout of the SME population, its growth is mainly due to SMEs without employees (3.1% average annual), while that of medium-sized firms has experienced a decline in productivity per worker (-1.1%).

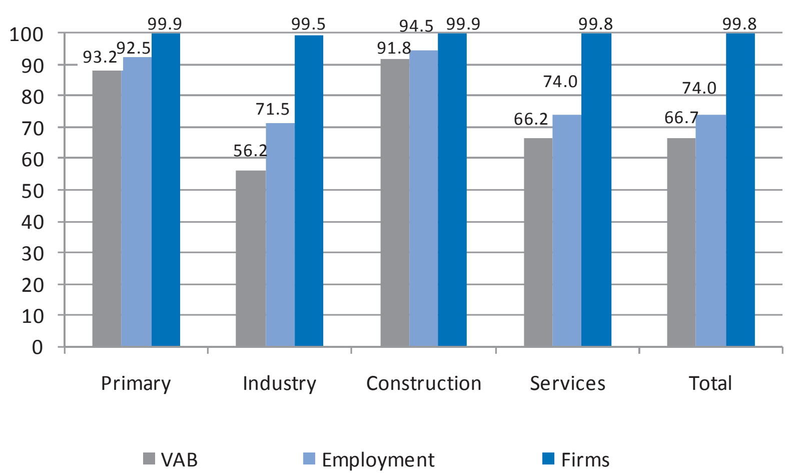
Table 1.3. **Characteristics of firms by size**

2006

	SMEs without employees	Micro-enterprises (1-9)	Small firms (10-49)	Medium-sized firms (50-249)	Total SMEs	Large firms	All firms
Firms	284 923	209 183	34 050	5 203	533 359	858	534 217
% of total	53.3%	39.2%	6.4%	1.0%	99.8%	0.2%	100.0%
Employees	284 923	576 780	676 877	508 297	2 046 877	719 936	2 766 813
% of total	10.3%	20.8%	24.5%	18.4%	74.0%	26.0%	174.0%
Productivity per worker	51 624	54 059	56 448	53 291	48 195	68 383	53 448
Average annual change in productivity 2002-2006	3.1%	0.1%	0.3%	-1.1%	0.2%	-1.5%	-0.2%

Source: PIMEC (2008), *Anuari de la pime catalan: Resultats economics in financers: 2002-2006*, PIMEC, Barcelona.

Figure 1.14. **SME shares by sector**



Source: PIMEC (2008), *Anuari de la pime catalan: Resultats economics in financers: 2002-2006*, PIMEC, Barcelona.

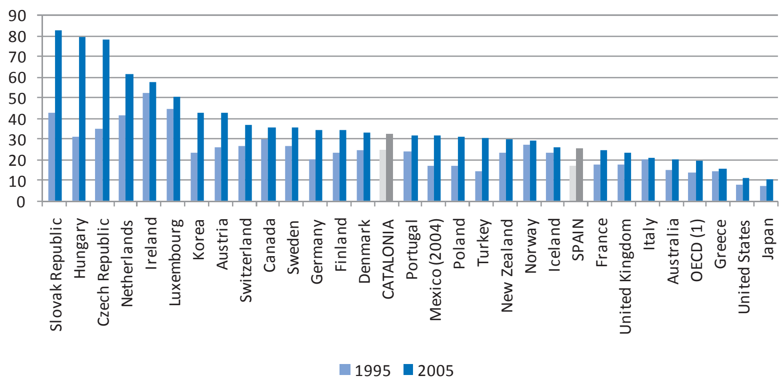
International linkages

The Catalan economy has experienced significant internationalisation since the incorporation of Spain to the European Community (EC). Exports in 2008 totalled almost EUR 50 billion. The region of Catalonia accounted for 27% of Spain's exports and 27% of imports in 2008. Exports grew by an average annual rate of 5.5% in real prices as compared to Spain overall (4.9%) from 1995 to 2005. Imports over the same period grew slightly more in Spain (6.9%) than Catalonia (6.4%). In terms of trade openness, as measured by the sum of imports plus exports over GDP, Catalonia is above OECD and Spanish standards. While in Catalonia that figure grew from 24.7% to 32.5% between 1995 and 2005, those levels are higher than Spain overall (from 16.7% to 25.2%) and the OECD average (from 13.3% to 19.4%) over the same period (see Figure 1.15). Medium-high technology industries account for the largest share of exports (see Figure 1.16). The chemicals industry is one that has experienced an increasing share of exports in recent years (see Figure 1.A1.3).

Traditionally Catalonia is one of the main Spanish regions in terms of emission and receipt of foreign direct investment (FDI), but this varies from year to year (see Figure 1.17). This investment was associated with the industrial and entrepreneurial base of Catalonia, its well-developed system of transport and communications, and the social and cultural components found in Barcelona (Bacaria *et al.*, 2004). Nevertheless, in recent years Catalonia has been losing significance within Spain in terms of FDI flows (Álvarez, 2008). The destination of FDI has been increasingly for industry rather than services, which is the opposite of the OECD member country trend of an increasing share to services (Nauwelaerts and Van Beveren, 2005). In 1997-99 the biggest proportion of FDI was concentrated in services (66%), and by 2007 the share in services was down to 44%, with industry capturing the remaining 56%.

Catalonia is also the location for many foreign firms. Among the around 3 000 foreign firms, 24% are from neighbouring France (see Table 1.A1.5). Germany, the United States and Italy are the next largest countries in terms of foreign firm presence. For these countries, and many others, more than half of these foreign firms in Spain are located in Catalonia.

Figure 1.15. **Imports and exports as a share of GDP**

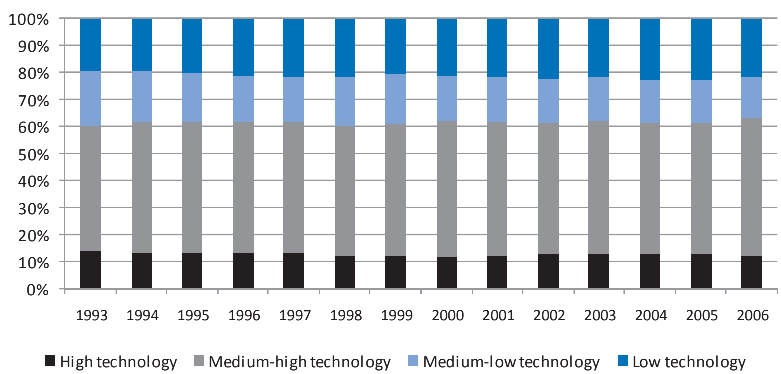


Note: 1. Belgium is not available and excluded from the OECD total. Data for Mexico refer to 2004, which also affects the OECD average.

Source: Data from the *OECD National Accounts* database, June 2007 and the Catalan Statistical Agency (IDESCAT).

Figure 1.16. **Catalan exports by technological level of products**

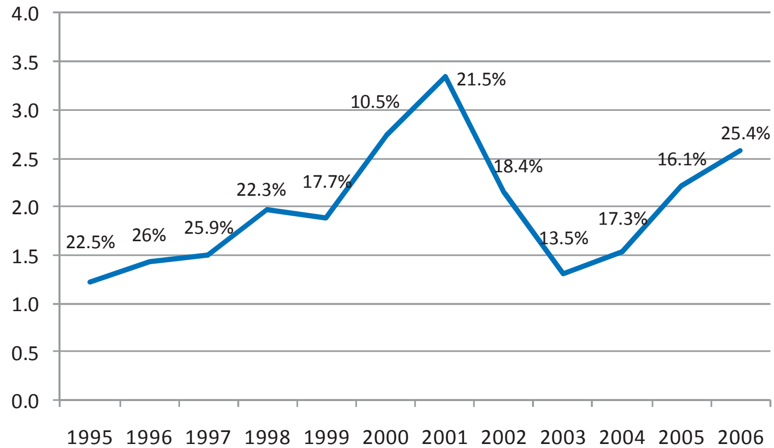
1993-2006



Source: Based on data from IDESCAT as reported in ACC1Ó (2009), *La situació de la innovaió a Catalunya,* Government of Catalonia, Barcelona.

Figure 1.17. **Foreign direct investment in Catalonia: 1995-2006**

billions of EUR and as a percent of Spanish total



Source: Based on data from IDESCAT as reported in ACC1Ó (2009), *La situació de la innovaió a Catalunya,* Government of Catalonia, Barcelona.

1.4. Innovation performance

A leading region in a lagging country for traditional innovation-related indicators

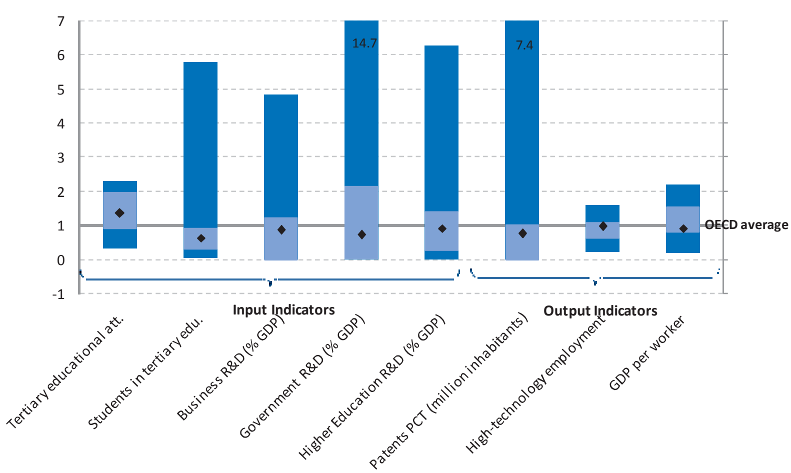
In general, Spain is a lagging country among leading OECD economies with respect to innovation performance. As illustrated in Figure 1.18, the range of values for Spanish regions is lower than that of top OECD regions. This helps explain why Catalonia's GDP per worker (2005 current GDP per capita at PPP) is only 91.4% of the average for OECD regions (57 607 versus 62 997).

While in some variables Catalonia is near the top of the range for Spain, the values for Catalonia of most variables are below the OECD average. For example, the number of students in tertiary education as a share of the population is only 3.5% versus an OECD regional average of 5.4%. The share of the economy in high-technology and knowledge-intensive services (using the broad Eurostat definition) is 36.9% versus 37.7% for OECD regions. R&D investment by different actors as a share of GDP is below average. Patents are also below average at 54.7 per million inhabitants, versus 72.3 for OECD regions, although patenting is only one way that firms may protect intellectual property. Catalonia performs relatively well on one variable: the share of the workforce with a tertiary education (32.4% versus 23.9%).

While Catalonia is not always the top performing region in Spain on several innovation-related indicators, given its size it accounts for a large share of Spain's innovation activity and resources. In terms of R&D investment, Catalonia is responsible for 21% of the total in Spain. Catalonia contains 22.5% of the innovative firms in Spain, a far greater share than other regions, followed by Madrid (15.6%) and Andalusia (15%). Catalonia accounted for 33.7% of Spain's PCT patents. This explains why Catalonia also captures a higher share of Spanish National R&D Plan resources relative to its population (see Chapter 3). However, there are questions about the efficiency with which Catalonia translates this high share of inputs into outputs relative to other Spanish regions. While Madrid and Catalonia may be leading regions in terms of these traditional indicators, analyses show that they may not be the most efficient (Zabala-Iturriagagoitia *et al.*, 2007).

Figure 1.18. **Catalonia's innovation performance summary**

2005



Notes: The outer band in dark blue represents the range of values for OECD regions. The inner band in light blue represents the range for regions in Spain. The diamond represents the value for Catalonia. The values of each variable were normalised to the OECD regional average for available regions. Information on all OECD regions is not available for each indicator.

Source: Calculations based on data from the *OECD Regional Database*.

Human capital

Human capital is one of the core inputs of an innovation system. Catalonia does have a share of the workforce with tertiary education higher than the OECD region average. However, within Spain, Catalonia is only the eighth ranked region (see Figure 1.19). For example, the Basque Country (48%), Navarra (40%) and Madrid (38%) are much higher than Catalonia at 32%. As previously mentioned, the influx of low-skilled immigrants contributes to its lower share of high-skilled workers. Catalonia's workforce includes 16% of the Spanish workforce with less than secondary education, 18% with secondary education and 17% of those with some form of tertiary education. Among leading regions in Spain, Catalonia also has a high share of low-skilled population. Among its population over 16 (regardless of labour force participation), approximately 9.6% were illiterate or without schooling in 2007. This is much higher than the Basque Country (4.3%) or Navarra (4.6%) and somewhat higher than Madrid (8.3%).[11]

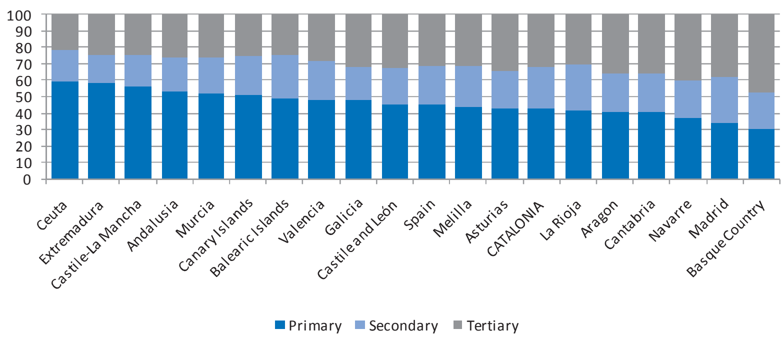
In terms of the quality of education and learning outcomes, Catalonia is lagging within the OECD and even within Spain. The region is below OECD averages in all three areas: reading, mathematics and sciences. For the ten regions in Spain with data, across which results for Catalonia are the most comparable, Catalonia does not perform well. It is ranked eighth or ninth out of these ten regions (see Figure 1.20). The skills of current students will determine the human capital of tomorrow's regional innovation system, therefore these results warrant important attention.

Doctoral students in Barcelona are more engaged in science than the general undergraduate population. Of the approximately 227 000 students in the 2005-06 academic year, 58% were in the social sciences or humanities, with only 6% in sciences (see Table 1.A1.6). There is a large share in engineering and architecture (27%). Among PhD theses in that same year, 27% were in science and 17% in engineering, and another 20% in health. Given these results, it would appear that Catalonia has a higher share of doctoral students in sciences and engineering than OECD member countries generally, where the shares are 9.8% and 11.4% respectively (OECD, 2007g).

The share of the Catalan workforce in research is an important indicator of the region's capacity to absorb R&D investment. All R&D personnel (in full-time equivalents) is 1.2% of the labour market, and that of the researchers specifically is 0.7% (Government of Catalonia, 2008a)). These rates are higher than the EU27 averages (1.0% and 5.8% respectively). OECD member countries that tend to have significantly higher rates of R&D personnel include Nordic countries (OECD, 2007g).

Figure 1.19. **Educational attainment of the labour force**

In percent, 2006



Note: Primary corresponds with ISCED codes 0 through 2, secondary with ISCED codes 3 and 4, and tertiary with ISCED codes 5 and 6.

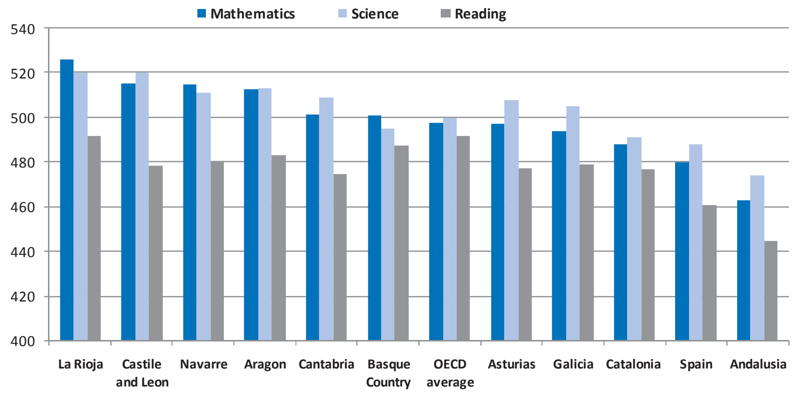
Source: OECD Regional Database.

Significant increases in R&D investment but still below OECD averages

Like the trend in Spain, Catalonia's R&D intensity (gross investment in R&D as a proportion of its GDP) has grown significantly from its initially low value. However, Catalonia is still far from the 3% of R&D expenditures as a share of GDP established in the Lisbon Agenda. This explains the lagging position of Catalonia regarding some leading European regions as Baden-Württemberg in Germany or Lombardy and Lazio in Italy (Bacaria *et al.*, 2004). As compared to the R&D intensity of OECD regions, Catalonia is below OECD averages for all actors, including business (0.86% versus 0.93%), government via both Spanish and Catalan Research Centres (0.16% versus 0.21%), and higher education (0.3 versus 0.21%).

Figure 1.20. **PISA scores: Catalonia in context**

2006 scores



Source: OECD PISA, *http://pisacountry.acer.edu.au.*

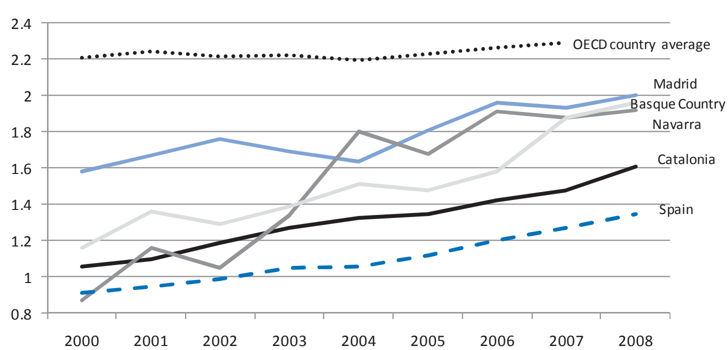
Over the period 1996-2008, Catalonia increased its R&D intensity from 0.9% to 1.61%, two-thirds of which was performed by the private sector (see Figure 1.21). In absolute amounts, the expenditure by all actors on R&D increased four-fold over that period to EUR 3.3 billion, or an average annual growth rate of over 13%. While Catalonia has been increasing its R&D intensity at a faster rate than the national average, other regions in Spain have even higher values, such as Madrid (2.0%), Navarra (1.92%) and the Basque Country (1.96%). There may be an under-reporting of R&D performed in Catalonia by firms registered in the capital, Madrid. Catalonia's R&D is mainly performed by the private sector, albeit the share has decreased slightly over time. In 2002, this proportion was around 68%, while in 2006, it was approximately 65%, just below the Basque County, Navarra and La Rioja (78%, 66% and 66% respectively using 2005 data).

Catalonia ranks the second region in Spain in terms of the overall amounts of R&D expenditure. Catalonia accounts for EUR 3.3 billion after Madrid with EUR 3.9 billion, both of which are much larger than any other Spanish region. In 2009, Madrid, Catalonia and the Basque Country were the autonomous communities that accounted for the greatest share of R&D investment in Spain (26%, 22% and 9% of the Spanish total) (INE, 2009).

There are important sectoral variations in R&D spending with the region. The highest is in pharmaceuticals at over EUR 250 million in 2005 (see Figure 1.22). The research and development category is the second highest, around EUR 200 million, but with large fluctuations over time. Other medium-high and high-tech sectors are spending between EUR 25 million and 100 million per year each (CIDEM, 2008).

In a study of the R&D investment of the 50 largest companies in Catalonia, several trends can be found, notably the dominance of automotive and pharmaceutical sectors. Of R&D investment in 2005, 43.1% was in automotive (but on a downward trend over time), 37.9% in pharmaceuticals (on an upward trend over time), 11.1% in services and distribution, 2.4% in chemicals, 2.4% in food, and 3.2% for firms in other sectors. R&D personnel are also most present in the sectors with the top investment, approximately 1 250 in pharmaceuticals and almost 2 100 in automotive. The R&D investment over sales ratio was over 8% in pharmaceuticals between 2003 and 2005, over 1.5% in automotive, and less than 1% in all other categories. External financing of R&D was used the most in volume by the pharmaceutical firms. Furthermore, 55% of the R&D investment was performed by subsidiaries, while 45% was done by non-subsidiaries. In terms of R&D personnel, subsidiaries have had slower growth in R&D personnel relative to non-subsidiaries. R&D investment over sales was almost 3% for non-subsidiaries, almost triple the figure for subsidiaries (Valls *et al.*, 2007).

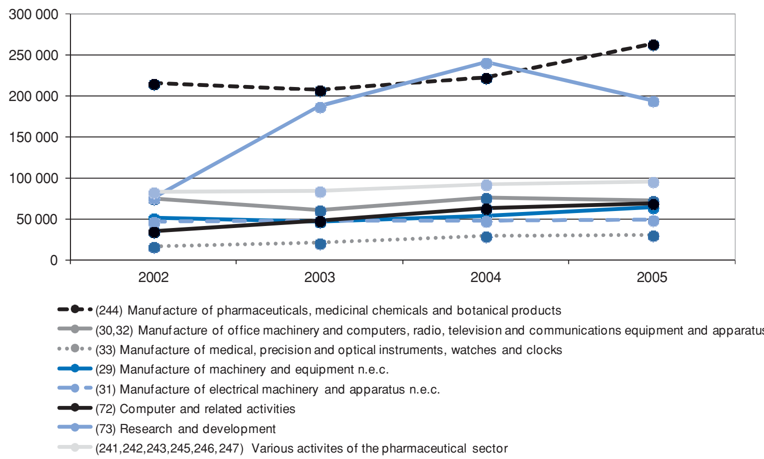
Figure 1.21. **R&D expenditures in select Spanish regions**



Source: OECD Regional Database.

Figure 1.22. **R&D expenditures in medium-high and high-tech sectors**

EUR thousands



Source: ACC1Ó (2008), *Informe Anual de l'R+D i la Innovació a Catalunya 2008*, Government of Catalonia, based on data from IDESCAT.

Catalonia a major recipient of venture capital in Spain, but is it sufficient?

Beyond human capital and R&D investment, the general availability of financing for innovation is a key input to the innovation process. Venture capital is particularly important for new firms. However in OECD member countries, the share for seed and start-up firms, as opposed to early development and expansion, is generally less than a third of the total.

Spain's venture capital market was slower to start than other countries and has gone through several phases of development. New funds raised for private equity and venture capital in Spain have grown progressively since 2001. It was initially used in the 1970s in less developed regions with public funds and later gained popularity with private funding sources (Alemany, 2006). Volume peaked in 2007, but given the crisis in 2008 has recently dipped. The main sources of financing for private equity and venture capital in Spain include financial institutions (albeit a declining share) at 31.3%, followed by contributions from individuals and funds of funds, both at 13%. The leading recipient sectors include energy (41.3% in 2008), industrial products and services (13.5%) and communications (11.5%) (ASCRI, 2009).

In 2006, Spain overall was below the OECD average in investment intensity. Venture capital as a share of GDP was 0.094%, versus an OECD average (27 countries) of 0.114% or the EU20 average of 0.145%. Spain nevertheless had similar levels to Finland, France and the Netherlands but was significantly below the leaders like Denmark, Korea, Sweden, the United Kingdom and the United States. Spain's venture capital is 29% for seed capital and start-ups versus 71% for early development and expansion. This share for start-ups is above the OECD-27 average (22%) but below the EU20 average (34%).[12]

Catalonia is typically the second leading recipient of private equity investment and venture capital in Spain after Madrid, but is often first in terms of transactions (see Figure 1.23). In 2008, Madrid accounted for 41.7% of investment (191 transactions), followed by Catalonia at 13.8% (200 transactions). The outstanding portfolio includes 475 companies in Catalonia, slightly more than the 445 in Madrid. This data is subject to annual fluctuations. In 2007, Madrid accounted for 50.9% (163 transactions) and Catalonia for 25% (192 transactions). Catalonia, with 21% of Spain's venture capital investment in 2008 (EUR 323 million), is just behind Madrid (23%). Catalonia had the most concentration of investment, with 182 investments in 160 firms (24% of operations). In terms of early stage venture capital investment, Catalonia and Madrid are the top regions for both volume and number of transactions (ASCRI, 2009).

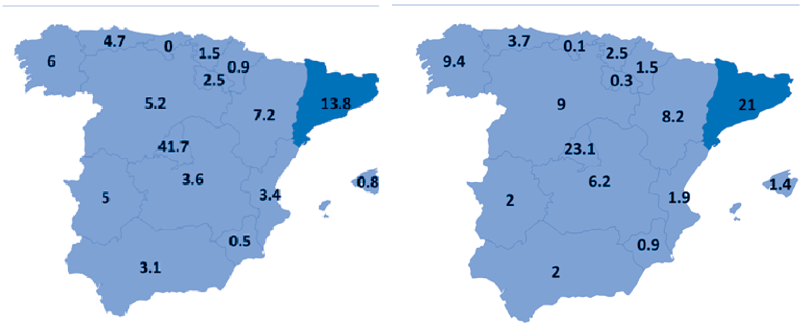
Several venture capital funds are based in Catalonia. In analysis of data from the late 1990s, it was found that regional venture capital firms were more likely to invest in their region, while firms based in Madrid were likely to invest around the country (Alemany, 2006). The Institute for Catalan Finances is the most notable public source of venture capital. It also has a financial stake in several other venture capital funds (see Table 1.4).

Linkages in the innovation system

In Spain, the information for innovation activities in firms is obtained much more from the market than knowledge-generation institutions. A rather low percentage of firms report getting their source of information from such institutions (only 1.4% for SMEs and 6.3% for large firms) (see Table 1.5). For all firms, those figures are much lower than the shares reporting information from other market-related external sources of information. Large firms (over 250) are three times more likely to have internal sources of information for innovation. But large firms are also more likely to report other external sources of information for innovation activities.

Figure 1.23. **Venture capital and private equity in Spain by region: 2008**

Percent of investment | Percent of venture capital investment



Source: Based on data from the Spanish Venture Capital & Private Equity Association (ASCRI) (2009), *Survey 2009*, ASCRI, Madrid.

Co-operation for R&D is one important linkage that is found in a vibrant regional innovation system. Several factors can drive this co-operative behaviour, including international market trends, national framework conditions, specific regional innovation systems and firm choice. While the following data is for Spain overall, many trends are likely to be found in Catalonia. High-technology firms are much more likely than low-technology firms to have an R&D agreement, in manufacturing (31.6% versus 16.5%) and in services (35.7% versus 12.4%) (see Table 1.6). The probability of engaging in R&D co-operation increases with: *i)* firms in high-technology sectors, especially services; *ii)* firm size; *iii)* intramural R&D activities; *iv*) engagement in both process and product innovation; *v)* membership in a group of firms; and *vi)* public funding. It is also noted that Spanish firms tend to engage in R&D co-operation with Spanish as opposed to foreign universities (Segarra-Blasco and Arauzo-Carod, 2008).

Table 1.4. **Venture capital funds supported by the Catalan Institute of Finance**

Name	Activity	Total Fund Capital (EUR thousands)	ICF group share (%)
Catalana d'Iniciatives SCR, SA	Venture capital	30 863	13.45
FonsInnocat FCR	Venture capital for firms with innovative projects	10 763	50.76
Spinnaker Invest SCR, SA	Venture capital for the media sector	25 000	22.00
Invercat Exterior FCR	Venture capital for internationalisation	18 881	12.50
Inernova FCR	Venture capital for firms with a technological base	5 121	5.44
Barcelona Emprèn SCR, SA	Venture capital for technology firms	8 514	22.99
Nauta Tech Invest II SCR, SA	Venture capital for technology, media and telecommunications	34 850	6.00
Mediterrània, FCR	Venture capital	7 650	24.19
Caixa Capital Pyme Innovación SCR, SA	Venture capital for firms with projects for growth	12 400	9.68
Highgrowth Innovación, FCR	Venture capital for firms with innovative projects	7 566	37.48
Ingenia Capital, SCR, SA	Venture capital for firms with projects for growth	3 358	26.94
Green Alliance I, SCR, SA	Venture capital for health sciences and biotech	41 000	7.30
Ysios BioFund I, FCR	Venture capital for renewable energies	6 072	4.47
Societat d'Ínversió Co-operativa SCR, SA	Venture capital	3 875	25.80

Note: data as of 31 December 2008.

Source: Catalan Institute of Finance (2009), *Memoria 2008*, Government of Catalonia, Barcelona.

Co-patenting is another measure of innovation relationships. Catalonia has the largest share of co-patents among Spanish regions. In 2005, of 68 patents that involved more than one patent applicant, 53 were with actors within Catalonia (78%). Of the remaining share, eight patent applications were with co-applicants from other regions in Spain and seven were with international partners, mainly the United States and Germany.[13]

Table 1.5. **Sources of information for innovation activities: Spain**

Percent of firms, 2005-2007

	Firms with <250 employees	Firms with >250 employees	All firms
All sectors			
A) % of firms that consider of great importance the following source: Internal (within the firm)	8.78	29.67	9.20
B) % of firms that consider of great importance the following sources: Market sources: Total	8.78	23.72	9.08
B.1) Market sources: Suppliers of equipment, material, components or software	5.76	13.83	5.92
B.2) Market sources: Clients	3.25	10.51	3.39
B.3) Market sources: Competitors or other firms in the same branch of activity	1.82	5.91	1.91
B.4) Market sources: Consultants, commercial laboratories or private R&D institutions	1.32	5.09	1.39
C) % of firms that consider of great importance the following sources: Institutional sources: Total	1.39	6.32	1.49
C.1) Institutional sources: Universities and other institutions of higher education	0.73	3.86	0.8
C.2) Institutional sources: Public research organisations	0.53	2.81	0.58
C.3) Institutional sources: Technological centres	0.71	3.56	0.77
D) % of firms that consider of great importance the following sources: Other sources: Total	2.83	7.72	2.93
D.1) Other sources: Conferences, trade fairs, expos	1.8	5.04	1.87
D.2) Other sources: Scientific reviews and publications	1.15	3.71	1.2
D.3) Other sources: Sectoral and professional associations	1.32	3.09	1.36

Source: Spanish Statistics Institute (INE) (2007), *Encuesta sobre innovación tecnológica en las empresas 2007*.

Table 1.6. **Co-operative R&D relationships: Spain**

Share of firms in percent, 2000

	All firms	High-tech manufacturing	Low-tech manufacturing	High-tech services	Low-tech services
Firms with R&D agreements	18.8	31.6	16.5	35.7	12.4
Co-operative partners					
Others firms of the group	8.8	15.3	8.1	15.3	5.3
Customers	8.1	15.1	6.5	22.1	3.9
Suppliers of components, equipment and software	10.6	15.8	9.1	22.3	7.6
Competitors and other firms	6.7	12.4	5.5	16.1	3.4
Experts and consultancy firms	8.7	12.9	7.3	18.8	6.5
R&D firms or laboratories	7.3	14.6	6.5	14.7	3.2
Universities or centres of higher education	11.5	22.6	9.8	27.5	5.1
Spain	10.4	21.7	8.7	24.3	4.4
EU	2.3	4.1	1.7	10.4	0.1
Other foreign	1.0	1.0	0.7	5.2	0.5
Public and non-profit research organisations	10.6	20.2	9.8	23.2	3.6
Number of firms	*4 150*	*411*	*2 426*	*367*	*946*

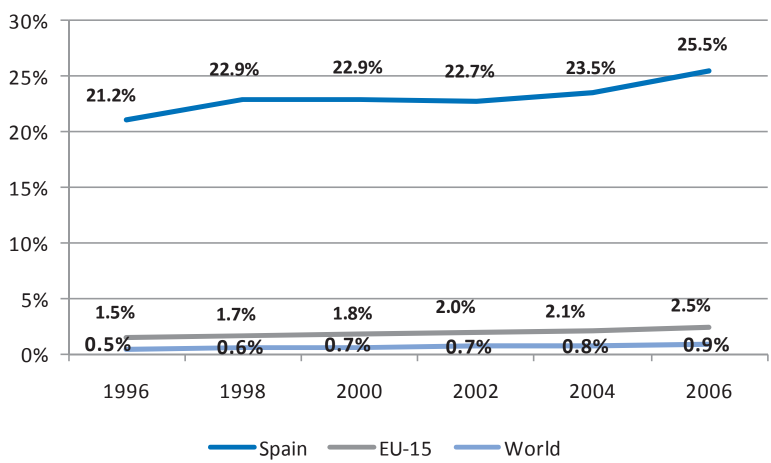
Source: Segarra-Blasco, A. and J.M. Arauzo-Carod (2008), "Sources of Innovation and Industry – University Interaction: Evidence from Spanish Firms", *Research Policy* Vol. 37, pp. 1283-1295, based on the *Survey of Technological Innovation, 2000* by the Spanish Statistics Institute (INE).

Publications and patenting

Catalonia has made notable progress in scientific publications over the last decade. From 1996 to 2006, its share of publications within Spain grew from 21.2% to 25.5%, of the EU15 from 1.5% to 2.5%, and of world production from 0.5% to 0.9% (see Figure 1.24). In absolute terms, that is a 70% increase over the period. Within Spain, Madrid is the only region that exceeds Catalonia in the absolute value of scientific publications, helped by the concentration of CSIC public research centres in the capital. The university sector accounts for 74% of publications during the period, with health sector publications having the highest visibility (over 13 citations per document). Within Catalonia, over 87% of publications are from Barcelona province (Rovira *et al.,* 2007). Barcelona itself is ranked the tenth European city (27^{th} overall) for the number of publications.

Catalonia has lower patenting levels than the OECD regional average but performs among the top within Spain. In 2006, Catalonia's patents were 33.7% of Spain's total (0.3% of the world). In terms of high-tech sectors, Catalonia's patenting accounted for 27.2% of Spain's biotechnology patents, 30.7% of ICT patents, and 37.4% of nanotechnology. Within Catalonia, 88% were patents with an inventor address in Barcelona province, 6.2% in Girona, 5.2% in Tarragona and only 0.6% in Lleida province.[14] The rate of patenting for Catalonia is the second highest in Spain at 54.7 PCT patents per million inhabitants in 2005 (versus an OECD regional average of 72.3). The OECD member country average is 108 PCT patents per million inhabitants. Within Spain, Navarra at 74.2 is higher than Catalonia, while the Basque Country (37.2) and Madrid (35.4) have lower patenting rates.

Figure 1.24. **Catalonia's scientific production**



Source: Rovira, L., R.I. Méndez-Vásquez, E. Suñén-Pinyol and J. Camí (2007), "Caracterització bibliomètrica de la producció científica a Catalunya, 1996-2006", *Informe AGAUR-PRBB,* Barcelona, *http://bibliometria.prbb.org/ncrcat06*.

Patterns of innovation activity in firms

Catalan firms in high-tech manufacturing and services are more likely to have higher values on a range of innovation-related indicators. For example, firms in high-tech industries are more likely to have innovation projects (71.5%) than those in low-tech industries (49.8%). In services, high-tech KIS are also more likely to do so (71.1%) relative to other KIS (37.8%) (see Table 1.A1.7). In terms of type of innovation for innovative firms, again the higher the technology level, the greater the share of firms engaging in different forms of innovation, with high-tech KIS being by far the most likely to have an organisational innovation. The relationship between firm size and R&D/innovation activity is not always linear and depends on sector and technology level. For example, smaller firms in both manufacturing and services at different technology levels had higher spending per employee on R&D and innovation than larger firms. However, the share of innovative firms and those with permanent R&D activities goes up with firm size in manufacturing (both high and low-tech) while in service industries (high-tech and other KIS), these variables are highest among the smallest firms (Segarra-Blasco, 2010).

Firms in Catalonia that innovate have higher values on a range of innovation-related indicators relative to those that do not. Firms that innovate show much higher levels of spending on innovation and R&D by several multiples than those that did not report an innovation (high-tech innovators 3.5 times more, low-tech innovators 5.4 times more, and KIS 11.3 times more) (see Table 1.7). Of that spending, the share devoted to R&D as opposed to other sources of innovation is also much higher among innovating firms. Firms that report an innovation are also those with higher shares of exports. The share of innovation output in sales is also notably higher, especially for KIS firms (38.7% for innovators versus only 5.6% for non-innovators). The probability of a Catalan firm to innovate generally was noted to increase with: *i)* firm size (but there are many examples of innovation-intensive small firms in KIS); *ii)* access to public funds (results more sensitive for KIS firms); and *iii)* firms with a higher intensity of R&D expenditure per employee (Segarra-Blasco *et al.*, 2008). For Catalan firms, higher labour productivity is associated positively with: *i)* R&D intensity; *ii)* share of new products and services in sales; *iii)* belonging to a group; *iv*) investment in physical capital; and *v)* firm market share. In terms of firm size, the positive effect is noted for manufacturing but not services (Segarra-Blasco, 2010).

A firm's propensity to innovate is dependent in part on real, or perceived, barriers to innovation. High-tech manufacturing firms have a higher index of innovation barriers relative to KIS or low-tech manufacturing firms (see Table 1.8). Innovative firms report greater perceived barriers to innovation than their non-innovative counterparts – perhaps because the latter under-estimate those barriers. Small firms report higher barriers than firms larger in size. Cost barriers (spillover failures) and knowledge barriers (co-ordination failures) appeared to affect the innovation process more than market barriers (information failures). Low-tech manufacturing and KIS firms are more sensitive to perceived barriers than high-tech manufacturing firms. The market share of a firm has a negative impact on innovation for low-technology manufacturing firms, where there appears to be a greater trade-off between innovation investment and economies of scale. The opposite is true for KIS, where greater firm market share has a positive impact on innovation (Segarra-Blasco *et al.*, 2008).

The bulk of R&D in Catalonia is conducted by a small group of firms in only a few sectors. The majority of research staff are found in two sectors: pharmaceutical (high tech manufacturing) and research and development (knowledge-intensive services). In Catalonia, as has been found in Spain more generally, there are R&D spillover effects on productivity among firms in the same industry. However there were no signs of inter-industry R&D spillovers except for low-technology industries (low and medium-low). There were no signs of inter-industry spillovers in KIS. However KIS firms have positive R&D investment spillovers for manufacturing firms. Therefore the linkages between the two sectors are important for the design of R&D and innovation policy in Catalonia (Segarra-Blasco, 2007).

Catalonia's overall performance relative to peers

A few existing analyses compare Catalonia with other regions using a cluster analysis or composite index, like the EU Regional Innovation Scoreboard. This composite index for EU regions uses seven indicators in the latest round to assess regional innovation performance. Spanish regions do not generally score high on this index given the often lower than average performance on many innovation indicators. The top 30 out of 208 regions in the 2006 Scoreboard are dominated by Northern Europe and Scandinavia. Catalonia ranks 82nd, preceded by Madrid (31st), Basque Country (55th), and Navarra (76th). The majority of Spanish regions fall well into the second half of the ranking list. The ranking is sensitive to the methodological approach used to develop the index, including the national weight, so the relative rankings should be interpreted in the context of general trends for peer regions.[15]

Table 1.7. **Characteristics of firms by technology intensiveness**

	High-tech manufacturing	Low-tech manufacturing	Knowledge-intensive services (KIS)
Innovative firms			
Export by sales (%)	41.7	26.3	1.3
R&D and innovation expenditure per employee (EUR)	15 553	6 019	10 671
Expenditure on R&D per employee (%)	31.1	36.4	43.0
Expenditure on other sources of innovation per employee (%)	58.9	63.6	57.0
Innovation output in sales (%)	26.1	22.5	38.7
Non-innovative firms			
Export by sales (%)	29.5	16.9	1.5
R&D and innovation expenditure per employee (EUR)	4 420	1 116	946
Expenditure on R&D per employee (%)	10.3	3.4	3.0
Expenditure on other sources of innovation per employee (%)	89.7	96.6	96.9
Innovation output in sales (%)	9.6	7.0	5.6

Note: The criteria for classification into high-technology and low-technology manufacturing was not specified.

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, based on data from the Catalan sample of the CIS4.

In another cluster analysis of regional innovation among European regions, Catalonia falls in the third out of four categories (Technopolis *et al.*, 2006). The top regions in Europe are in the Global Consolidation category, namely the Nordic countries and leading Western European capitals or hubs (see Table 1 in Annex 1.1). The "Sustaining Competitive Advantage" regions include many German, French and Italian regions. In general, Spanish regions tend to fall in the third category, "Boosting Entrepreneurial Knowledge". Madrid falls in a sub-category above the others, like Catalonia, Basque Country, Navarra and Valencia, among others. Several Spanish rural or island regions fall into the last category, "Entering Knowledge Economy". While country factors appear to play a strong role in the regional classifications, it highlights Spain's lower than average performance and the impact this has on individual regional performance.

Table 1.8. **Innovation barriers for Catalan firms: frequency and intensity**

	Innovative firms		Non-innovative firms	
	Firms with barriers (%)	Intensity of barriers	Firms with barriers (%)	Intensity of barriers
Cost barriers index				
Lack of internal funds	86.02	2.05	63.18	2.13
Lack of external funds	80.55	2.12	58.52	2.10
High cost of innovation	85.34	2.12	64.73	2.27
Knowledge barriers index				
Lack of qualified personnel	78.98	1.59	59.87	1.78
Lack of information on technology	78.89	1.45	57.38	1.64
Lack of information on markets	78.40	1.52	55.46	1.60
Barriers to finding partners	61.39	1.67	39.51	1.84
Market barriers index				
Market dominated by incumbents	80.06	1.85	55.57	1.93
Uncertain demand	83.09	1.91	58.62	1.98
Lack of demand for innovation	33.82	1.33	57.02	1.94

Note: Firms with barriers refer to the dichotomic variable of 1 if the firm found a barrier and 0 if it did not. Intensity of the barriers refers to the level of the obstacles only for the firms with barriers. This categorical variable is 1 if the intensity is Low, 2 if the intensity is Medium, and 3 if the intensity is High.

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, based on data from the Catalan sample of the CIS4.

Catalonia's performance compared to several peers is notable for the generally lower values on innovation-related variables as well as productivity and productivity growth (see Table 1.9). While the share of the population in tertiary educational attainment is an area of strength for Catalonia, this factor for OECD regions appears to be closely related to respective national values. The share in high-technology employment is also on the lower end of the spectrum of several peer regions, as is patenting. While the values for GDP per worker are in the mid-range of this group, the region stands out for its negative productivity growth in recent years.

Table 1.9. **Main innovation indicators of the selected peer regions**

2005 (annual average growth rate 1995-2005)

	Tertiary educational attainment (% share of the labour force).				Students in tertiary education (% share of population)				High technology employment (% share of employment)			
	Reg. (1995)	Reg. (2005)	Nat'l. avg. (1995)	Nat'l. avg. (2005)	Reg. (1995)	Reg. (2005)	Nat'l. avg. (1995)	Nat'l. avg. (2005)	Reg. (1995)	Reg. (2005)	Nat'l. avg. (1995)	Nat'l. avg. (2005)
Baden - Wuerttemberg (GER)	25.0	25.5	24.6	25.0	2.2	2.3	2.2	2.6	43.9	49.2	37.0	43.2
Lombardia (IT)	12.2	14.4	11.3	14.2	2.9	2.8	2.7	3.2	36.1	42.1	30.2	35.6
Rhone - Alpes (FR)	25.1	26.8	20.2	24.0	3.6	3.8	3.0	3.1	41.3	44.2	38.4	40.4
Piemonte (IT)	11.0	12.6	11.3	14.2	2.4	2.4	2.7	3.2	36.9	41.2	30.2	35.6
North West England (UK)	25.7	28.0	27.0	29.1	3.2	3.2	3.4	3.3	42.9	46.5	43.5	46.9
Vlaams Gewest (BEL)	30.0	34.7	32.7	37.9	2.7	3.0	4.8	4.8	40.6	45.3	41.7	46.1
North Carolina (USA)	17.4	23.3	20.0	24.7	5.2	5.9	5.4	5.9	40.9	46.9	44.7	47.3
Catalonia (SPA)	25.5	32.4	25.3	31.1	3.6	3.5	3.6	3.3	31.9	36.9	25.9	29.9
West midlands (UK)	23.9	26.5	27.0	29.1	3.1	3.0	3.4	3.3	44.9	48.0	43.5	46.9
Quebec (CAN)	39.2	48.1	34.8	44.8	4.4	5.7	3.4	4.2	40.0	42.4	37.6	40.7
Gyeongnam region (KOR)	26.0	34.8	22.8	30.3	5.5	6.1	6.9	7.6	7.7	10.1	7.8	10.8
OECD average	19.5	23.9			4.9	5.4			36.4	37.7		

Table 1.9. **Main innovation indicators of the selected peer regions** (*continued*)

2005 (annual average growth rate 1995-2005)

	PCT Patents (per million inhabitants)				GDP per worker (real prices at PPP)				Per worker GDP growth (1995-2005)	
	Regional (1995)	Regional (2005)	Nat'l avg (1995)	Nat'l avg (2005)	Regional (1995)	Regional (2005)	Nat'l avg (1995)	Nat'l avg (2005)	Regional	Nat'l avg
Baden - Wuerttemberg (GER)	125.2	390.4	52.7	145.5	54 139	58 935.4	51 225	56 368	0.9%	1.0%
Lombardia (IT)	27.1	87.5	9.7	41.2	55 780	70 191.1	49 796	62 257	2.3%	2.3%
Rhone - Alpes (FR)	64.8	176.3	25.0	73.3	58 641	64 982.5	60 268	66 457	1.0%	1.0%
Piemonte (IT)	13.7	69.5	9.7	41.2	53 571	62 390.5	49 796	62 257	1.5%	2.3%
North West England (UK)	51.0	76.3	48.3	82.0	46 309	50 182.7	47 586	54 190	0.8%	1.3%
Vlaams Gewest (BEL)	38.6	104.7	42.2	84.0	69 782	72 255.2	70 046	72 516	0.3%	0.3%
North Carolina (USA)	60.7	142.6	62.6	129.3	60 282	78 929.7	67 066	81 782	2.7%	2.0%
Catalonia (SPA)	16.2	54.7	4.4	20.5	57 887	54 348.9	53 881	52 296	-0.6%	-0.3%
West midlands (UK)	41.7	58.7	48.3	82.0	44 955	49 866.2	47 586	54 190	1.0%	1.3%
Quebec (CAN)	29.6	84.8	18.1	41.9	50 104	59 064.2	54 343	70 752	1.7%	2.7%
Gyeongnam region (KOR)	0.9	49.2	3.4	68.5	46 360	66 666.5	47 046	64 128	3.7%	3.1%
OECD average	31.3	72.3			48 298	55 822.1				

Source: *OECD Regional Database*.

Moving beyond traditional indicators

Commonly used innovation-related quantitative measures are missing part of the picture with respect to innovation. This has been termed "hidden" innovation in the sense that there is innovation but it is not captured in commonly used data (NESTA, 2007). Innovation-related analyses focus on R&D and science-based innovation. The latest version of the OECD-EC Oslo Manual distinguishes between technological (product and process innovations) and non-technological (organisational and marketing) innovations (see Box 1.2). However, information on types of innovation is usually obtained through firm-level surveys. Other commonly used indicators such as R&D investment, scientific publications and patenting are more easily obtainable and comparable across regions, but are more associated with technological innovations.

Box 1.2. **OECD definition of innovation: technological and non-technological**

As defined in the OECD *Frascati Manual*: "basic research is experimental or theoretical work undertaken primarily to acquire new knowledge of the underlying foundations of phenomena and observable facts ***without any particular application in view***" (emphasis added). Innovation is distinctive because of its economic and commercial imperatives. Therefore, the OECD *Oslo Manual* since 2005 identifies four types of innovation, both technological and non-technological forms:

Technological

1. *Product innovations* involve significant changes in the capabilities of goods or services. Both entirely new goods and services and significant improvements to existing products are included.
2. *Process innovations* represent significant changes in production and delivery methods.

Non-technological

3. *Organisational innovations* refer to the implementation of new organisational methods. These can be changes in business practices, in workplace organisation or in the firm's external relations. Examples include:
   - First introduction of management systems for general production or supply operations such as supply chain management, business re-engineering, lean production, or a quality management system.

Box 1.2. **OECD definition of innovation: technological and non-technological** (*continued*)

- First establishment of formal or informal work teams to improve access to and sharing of knowledge from different departments, such as marketing, research and production.
- First use of outsourcing of research or production.

4. *Marketing innovations* involve the implementation of new marketing methods. These can include changes in product design and packaging, in product promotion and placement, and in methods for pricing goods and services. Examples include:

   - The implementation of a significant change in the design of a furniture line to give it a new look and widen its appeal.
   - First introduction of direct selling or exclusive retailing.
   - First introduction of a method for varying the price of a good or service according to the demand for it.

Findings in OECD member countries: Non-technological innovation is significantly more prevalent among large firms than among small and medium-sized enterprises (SMEs), although the gap is less pronounced in countries such as Australia, Japan and New Zealand. Sectoral differences with regard to the introduction of non-technological innovations do not appear very pronounced in most countries. However, the rates of non-technological innovation are significantly higher in manufacturing in Ireland and Korea, and somewhat higher in services in Greece, Luxembourg and Portugal.

Source: OECD (2002), *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris; OECD and the European Commission (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd Edition, OECD, Paris; OECD (2007), *OECD Science, Technology and Industry Scoreboard 2007*, OECD, Paris.

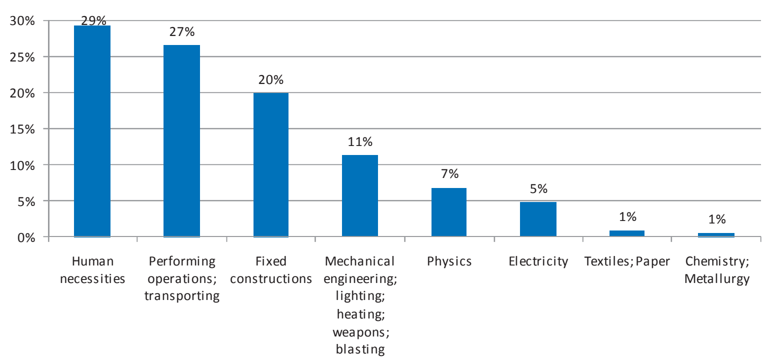
Is there evidence of more “hidden” innovation in Catalonia, a region with a relatively higher share of manufacturing employment, than elsewhere? Given the lack of productivity growth it is hard to determine if there is increased productivity that the innovation statistics don’t explain. As the trend for other innovation-related performance is positive growth greater than average growth rates in other regions, it is even more difficult to document the effects of hidden innovation in Catalonia. However, despite the lack of clear results in terms of aggregate productivity growth, there are signs that Catalonia is active in innovation-related activities not captured in traditional innovation indicators.

One area where Catalonia appears to be active is in utility models, which captures one aspect of this "hidden" innovation. A utility model has some common features with a patent in that it gives exclusive right for a limited time to an invention. However, the requirements are less stringent than that of a patent.[16] They are therefore more adapted to the needs of SMEs that often focus on incremental innovations instead of new to the world inventions. Given Catalonia's firm demographics and technology level profile, this is a very relevant indicator.

Within Spain, Catalonia accounted for 30% of all utility models (690) granted in 2007, followed by Valencia (17%), Madrid (13%) and Andalusia (8%). In terms of intensity, Catalonia ranked second (100 granted per million) in Spain, after Navarra (114). Regions following Catalonia include Valencia (87), Aragon (87), the Basque Country (65) and Madrid (50).[17] The distribution of Catalonia's utility models granted by International Patent Classification (IPC) is similar to that of Spain overall. Human necessities (29%) and performing operations/transporting (27%) are the main categories of utility models granted in Catalonia (see Figure 1.25).

Other forms of intellectual property protection include trademarks, trade names and industrial designs. Catalonia is again a leading region within Spain, but not to the same extent as with utility models (see Table 1.10). While Catalonia has 19% of the trademarks registered in Spain, it has a smaller share of trade (or brand) names (13%) as compared to Andalucia (19%) and Madrid (18%). In terms of industrial design, Catalonia has a 19% share, just after Valencia (20%) but greater than Madrid (17%).

Figure 1.25. **Catalan utility models granted by IPC: 2007**



Note: IPC is the International Patent Classification.

Source: OECD calculations based on data from the *Oficina Española de Patentes y Marcas* (OEPM), *Avance de Estadística de Propiedad Industrial 2007*.

Table 1.10. **Brands, trademarks and industrial designs**

	Trademarks (2008)		Trade (brand) name (2008)		Industrial designs (2007)	
	Number	Share	Number	Share	Number	Share
Total	47 850	100%	5 848	100%	1 497	100%
Andalucia	5 620	12%	1 073	19%	173	12%
Aragon	1 161	3%	200	4%	30	2%
Asturias	735	2%	177	2%	20	1%
Balears Islands	1 028	2%	202	3%	36	2%
Canarias	1 790	3%	294	5%	62	4%
Cantabria	434	1%	23	1%	17	1%
Castilla y León	1 869	4%	283	4%	32	2%
Castilla-La Mancha	1 166	3%	164	3%	53	4%
Catalonia	**9 658**	**19%**	**693**	**13%**	**285**	**19%**
Valencia	4 823	10%	709	12%	299	20%
Extremadura	521	1%	102	1%	5	0%
Galicia	2 238	5%	286	5%	71	5%
Madrid	12 161	24%	1 091	18%	261	17%
Murcia	1 154	3%	183	3%	57	4%
Navarra	656	1%	84	2%	11	1%
Basque Country	2 299	5%	227	4%	57	4%
Rioja	444	1%	48	1%	14	1%
Ceuta y Melilla	89	0%	9	0%	11	1%
Unknown	4	0%	0	0%	3	0%

Source: Oficina Española de Patentes y Marcas (OEPM), *Estadísticas de Propiedad Industrial*.

Entrepreneurship is an important part of the innovation system that is often neglected in traditional analyses of innovation. The rate of entrepreneurship in Catalonia was 6.8% of the population in 2005, just slightly above the OECD average of 6.7%. This rate is greater than the majority of European countries. Based on the Global Entrepreneurship Monitor, Catalonia is among the top regions when it concerns absolute numbers of entrepreneurs. However, given the region's large size, as a share of its population Catalonia is ranked more in the middle of Spanish regions (GEM, 2008).

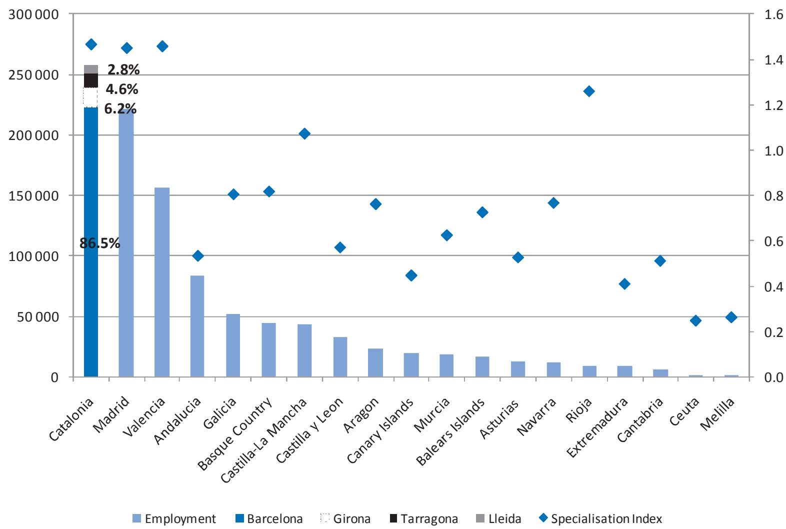
The framework conditions for entrepreneurship are also relevant for Catalonia's innovation system, and there is a notable margin for improvement. For Spain overall, the World Bank's *Doing Business* report ranks the country 49th in 2009, down from the 46th place in 2008, for ease of doing business. Relative to the OECD, the cost of launching a business is higher. It takes ten procedures to open a business (5.8 OECD), 47 days (13.4 OECD), and a cost of 14.9% of the gross national income (GNI) per capita (4.9% OECD).[18] The minimum paid in capital is lower in Spain than the OECD average (13.1% of GDP per capita, versus 19.7%). The ranking for starting a business and employing workers is more troubling, with Spain ranked 140th and 160th out of 181 respectively.

In the last couple of years, the role of creativity has received greater attention as being important for the innovation process. The European Union named 2009 the European Year of Creativity and Innovation. The OECD has classified several jobs as "creative" industries for analysis (OECD, 2007c). Catalonia is the region of Spain with the largest number of workers in culture and creative industries, over 258 000 in 2001 (see Figure 1.26). It is also the region with the highest share of its employment in such industries, just above Madrid and Valencia.

Barcelona has built up its reputation as a centre of creativity and strength in design. The province contains 86.5% of the region's culture and creative industries workers. Marketing campaigns try to build on this, such as the Barcelona City publication *Thought Up in Barcelona*. Barcelona's city attractiveness is an important element of its ability to attract qualified human capital to the region. According to the *European Cities Monitor 2009* by Cushman & Wakefield concerning the best place to locate a business, Barcelona is ranked fourth, just after London, Paris and Frankfurt. Barcelona has progressed over the last several years, up from 11th in 1990.

Figure 1.26. **Employment in culture and creative industries in Spain, 2001**

Total employment (left axis) - Sspecialisation index for Spain (right axis)



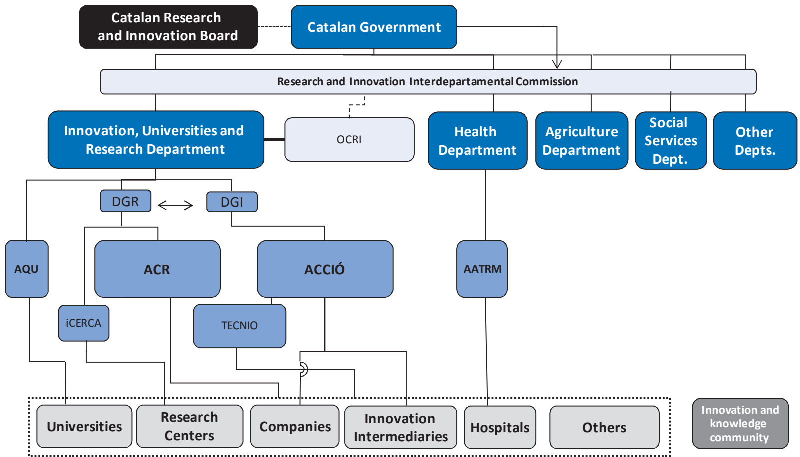
Notes: This figure includes all cultural and creative NACE 1.1 categories except: 52.12 Other retail sale in non-specialised stores, 52.48 Other retail sale in specialised stores, 52.63 Other non-store retail sale, 74.81 Photographic activities, 74.87 Other business activities n.e.c. and 92.72 Other recreational activities n.e.c. (see Cultural and Creative Classification: *www.oecd.org/dataoecd/56/54/38348526.pdf*, p. 14).

Source: OECD calculations based on data from the Spanish Statistical Institute (INE), Census 2001.

1.5. Regional innovation system actors

The Catalan innovation system has a wide range of innovation actors – many created in the last few years – leading to a cluttered landscape (see Figure 1.27). Most of these entities have been created with the support of the Catalan government, in some cases to circumvent rigidities in the university system. Other entities have been created with a range of external financing sources. The multi-level governance framework, with Spanish, Catalan and local actors – as well as the EU – is another factor contributing to the range of innovation-related actors (see Chapter 3).

Figure 1.27. **Catalan innovation system actors**



AQU: University Quality Agency
AATRM: Technology Evaluation and Medical Research Agency
iCERCA: Catalonia Research Centres Agency
Innovation Intermediaries: Technology and/or Scientific Parks
ACR: Catalan Research Agency
ACCIÓ: Innovation and Internationalization Agency
TECNIO: Catalan Technological Network
OCRI: Research and Innovation Coordination Office

Note: Includes governance changes in progress for the merger of several entities as described below.

Source: Government of Catalonia (CIRIT).

The main focus of Catalonia's science and innovation policy over the last 20 years has been improving public research (part of the knowledge generation sub-system). The strategy has been described as following an academic path given the dominance of academic and research institutions in the policy discourse and funding. This approach is contrasted with an industrial or more firm-centred approach, which was a possible alternative path given the strong industrial base in the region. In fact, the initial political will in the region was for an industrial approach but this did not materialise (Sanz-Menéndez and Cruz-Castro, 2005). In terms of public spending patterns, policies and institutional arrangements, the regional innovation system has evolved with two tracks: one for research and another for innovation (Defazio and García-Quevedo, 2006). This is not uncommon in OECD regions and member countries. The efforts are ongoing to address the "bipolarity in institutional structure of the RIS" (Bacaria *et al.*, 2004).

Regional government institutions undergoing some restructuring

The ministry that oversees most of the financing for research and innovation is the Ministry of Innovation, Universities and Enterprise (DIUE). Prior to merging two ministries at the end of 2006, the industry-related portfolio was under the Ministry of Employment and Industry. Under the DIUE Minister, there is a Secretariat for Universities and Research (with separate departments for universities and research) and another for Industry and Enterprise. DIUE accounted for over 68% of R&D and innovation-related spending in Catalonia. Other sectoral ministries finance research and innovation, health being the largest at 19.5% of the total spending (see Figure 1.28). An inter-ministerial committee, CIRIT, was created in the 1980s to promote R&D and innovation across the Catalan government.

Under the ministry level, there are several public agencies and publicly funded foundations that play an implementation role in R&D and innovation. They include:

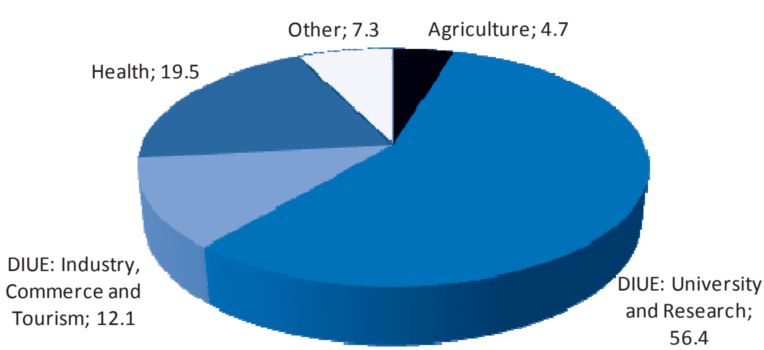
- ACC1Ó: The result of the merger of the former Centre for Innovation and Business Development (CIDEM) and Consortium for Commercial Promotion of Catalonia (COPCA).[19] These prior agencies had been created in the 1980s. ACC1Ó is the main agency for supporting business development. The agency has a staff of approximately 350 professionals across its offices, including six regional offices throughout Catalonia and a network of international representation offices.
- AGAUR: The Agency for Management of University and Research Grants, created in 2001, operates under contract with the DIUE. With a staff of 64, it manages a large portfolio (approximately EUR 90 million in some years) of grant programmes for research and scholarships. It also implements other programmes, such as the one to better co-ordinate across Catalan Research Centres. It is now the part of the merged entity ACR, the Catalan Agency for Research.
- AARTM: The Catalan Agency for Health Technology Assessment was created in 1994 and has a staff of over 40. It promotes the introduction, adoption and utilisation of medical technologies based on criteria such as safety, effectiveness and efficiency. It also provides planning, co-ordination and assessment of health research in conjunction with the Catalan health service.
- AQU: The Agency for the Quality of the Catalan University System provides assessment, accreditation and certification for higher education institutions regarding teaching, research and programmes. Initially created in 1996 for quality assurance, in 2003 powers for certification and accreditation were added.

- Foundations: ICREA and FCRI, as described further below, receive mainly public funding to support their respective missions. ICREA focuses exclusively on talent (researcher) attraction and FCRI on science & technology, innovation and advisory services, and support for researcher mobility and scientific talent. They are now the part of the merged entity ACR, the Catalan Agency for Research.

The organisation of Catalan public entities for research and innovation is undergoing change as a result of the CARI analysis and commitments (see Chapter 2). These changes include the creation, merger and restructuring of several agencies at the policy implementation level. They include the ACC1Ó merger, already near completion and the creation of the Catalan Agency for Research (ACR) that merges parts of AGAUR, ICREA and FCRI. New structures to manage the research centres (CERCA) and technology centres (TECNIO, serving in a first phase as a consortium) are also in progress. Another governance change is the creation of a new Catalan Research and Innovation Council for high-level policy guidance and the reattribution of the other roles of the former CIRIT to this Council, the Inter-ministerial Research and Innovation Commission (CIRI) and a technical secretariat named the Research and Innovation Co-ordination Office (OCRI).

Figure 1.28. **R&D and innovation spending by Catalan government ministry**

In percent, 2007



Source: Data from the Government of Catalonia (CIRIT).

Knowledge generation sub-system: main focus of efforts with successes

The approximately 25 000 researchers in Catalonia are housed in several different types of institutions. Private firms account for around 41% of Catalan researchers. Higher education institutions account for about the same share at 42%. The remaining 16% (4 100) are in public research centres. The Catalan Research Centres network accounts for over 2 500 or 10% of researchers and the Spanish national research system (CSIC) has 2 000 researchers or 8% of researchers located in Catalonia. There are also some researchers located in health-related research institutions.[20]

University system: creativity to overcome rigidity

Universities in Spain were devolved to the regional level in the mid-1980s, therefore regions now fund and administer universities but are subject to certain central level rules. To ensure quality standards, Spain authorises the degree programmes offered by a university. There is a Spanish level civil servant status that applies to public university professors hired under such contracts, which determines their salary levels. There are some other basic staff policies for public universities such as teaching load guidelines (OECD, 2007b). However regions can allow different staff contracts or provide additional compensation mechanisms for competitive academic recruitment (see below on ICREA).

Catalonia, like other Spanish regions, took the devolution opportunity to create additional universities for greater balance across its territory and to increase enrolment. Of the now 12 universities in Catalonia, eight are public or semi-public (including the Open University for distance learning) and four are private (see Table 1.11). While most of the universities have been created since the 1990s, many of these "newer" universities are based on the infrastructure of university branch campuses or other pre-existing institutions. The increased number of universities has improved higher education attainment in the region as well as attracted many students. Catalonia is second only to Madrid in the net balance of students, with a 12.2% positive balance.[21]

Table 1.11. **Catalan higher education institutions**

Name	Legal status	Year	Full-time academic staff 04-05 Number	Full-time academic staff 04-05 Catalan share	Students enrolled (non-doctoral) 04-05 Number	Students enrolled (non-doctoral) 04-05 Catalan share
University of Barcelona (UB)	Public	1450	4 230	27%	56 111	25%
Autonomous University of Barcelona (UAB)	Public	1968	2 908	19%	38 117	17%
Polytechnic University of Catalonia (UPC)	Public	1971	2 525	16%	33 242	15%
Pompeu Fabra University (UPF)	Public	1990	841	5%	10 213	5%
University of Girona (UdG)	Public	1991	959	6%	12 680	6%
University of Lleida (UdL)	Public	1297 1991	732	5%	8 425	4%
Rovira I Virgili University (URV)	Public	1991	1 098	7%	11 962	5%
Open University of Catalonia (UOC)	Public/ Private	1994	134	1%	33 996	15%
Ramon Llull University (URL)	Private	1990	1 190	8%	13 140	6%
University of Vic (UVIC)	Private	1997	474	3%	5 113	2%
International University of Catalonia (UIC)	Private	1997	331	2%	2 406	1%
Abat Oliba University (UAO)	Private	2003	67	0%	564	0%
Total			15 489	100%	225 969	100%

Source: Government of Catalonia (2008), *Catalan Agreement on Research and Innovation – Framework Document*, Barcelona and university websites.

Catalonia has several entities that represent the university sector. The public agency AQU serves as a quality assurance agency for Catalan universities as well as covering several areas of evaluation. There is an Inter-University Council of Catalonia to interface with all universities, public and private, which reports to the government and Parliament. The non-profit ACUP (Association of Catalan Public Universities) represents the eight public universities. There are other associations that represent particular interests, such as ForQ for the promotion of lifelong learning among different university foundations and private schools.

Universities have also created affiliated non-profit foundations as vehicles to support more professional degrees and lifelong learning adapted to regional innovation system needs. As in the past there were no Master's degrees offered in the Spanish system, many Catalan universities provided coursework equivalent to such a degree or other lifelong learning modules. They often involved a higher fee structure and more flexible guidelines than traditional education programmes. The Bologna Declaration of June 1999 seeks to harmonise degrees across the 46 participating countries, including the development of a Bachelor's, Master's, and PhD degree structure. Universities are assessing how to manage the change between the revised university curriculum and programmes with those offered by the foundations.

In terms of research, universities in Catalonia contain hundreds of recognised research groups. In 2005, the Catalan government received 1 091 research group submissions, and in 2009 that figure was up to 1 518, an increase of almost 40%. AGAUR classifies such research groups into three types based on evaluations: 1) emerging, 2) consolidated, and 3) singular. In 2009 there were 1 078 in the consolidated category, and 360 in the emerging category.

Several universities are pooling their resources in consortium around different disciplines to better attract top researchers. The Graduate School of Economics, for example, is a joint effort of two universities and two research centres (one national, one Catalan). The Barcelona Institute for International Studies is another joint effort across different universities and public institutions to strengthen the region's offering in politics and international relations.

The concept of a "third mission" of universities to support the economic development of the region has now begun in Catalonia. Most universities are seeking to better contribute to the region's development and have been developing institutions and strengthening research skills to do so. Individual universities have been taking actions but the university system more generally is seeking to promote this third mission, such as through a recent White Paper agreed to by the Catalan public universities (see Box 1.3). Some universities are publishing metrics to highlight their third mission engagement, including volumes of contract research and knowledge transfer contracts, scientific production, entrepreneurship and intellectual property.

In terms of performance within Spain, Catalonia universities are often in the top of different rankings that illustrate research strength and "third mission" activities. The volume of publications in Catalonia is just under that of Madrid (10 998 versus 11 276 in 2006), although in several other regions in Spain, the average number of articles per researcher is higher. In terms of patenting, the Polytechnic University of Catalonia has had the most national patent applications of any Spanish university (239 from 2000-2007). The region's Springboard programme has promoted the creation of spin-offs from universities – and 169 new technology-based companies were created between 2006-08, albeit once created the spin-offs rarely grow in employee size. Two of Catalonia's universities are in the top ten in Spain (with data available) in terms of volume of private funds for research and development (UPC, second and RiV, eighth) (Fundacíon CYD, 2008).

Box 1.3. **University of Catalonia: White Paper**

The ACUP (Association of Catalan Public Universities) issued a White Paper in 2008 to explore a new model of the Catalan University. A number of the goals actively support the engagement of universities in their third mission of regional development. The White Paper includes 64 strategies and 73 projects under ten different themes, six regarding the university model and four instrumental aspects to achieve that model. Some of these important third mission activities include: a strategy to promote more flexible and high quality life-long learning, stronger research management skills, better integrating students into the region's social, economic and employment fabric; developing a model based on a third mission; promoting this model among staff and in university funding targets, and promoting innovation through science and technology parks.

According to the White Paper, the overall new model is a university:

1. committed to society, democratic values and the Catalan culture;
2. with quality education, focusing on its students and integrated in the European Higher Education Area;
3. that is research-intensive and stands at the heart of the scientific, technological and cultural system;
4. that acts as a motor for development, innovation and welfare;
5. fully European with a global vocation;
6. at the service of people, generating equity and opportunities for progress;
7. based on flexible personnel policies aimed at promoting talent and confidence;
8. based on broad institutional autonomy and a robust system of accountability;
9. based on a good system of governance and efficient management; and
10. based on a suitable target- and project-based financing model.

Source: ACUP (2008), *White Paper on the University of Catalonia: Strategies and Projects for the Catalan University*, ACUP, Barcelona, *www.acup.cat/media/versio_final_en.pdf*.

There are a number of challenges noted by universities to improve their regional engagement. The staff policies are limiting for the recruitment of international staff. The nature of contracts also makes long-term researcher mobility a challenge. It is difficult for a researcher to work in the private sector for a couple of years. While the legal structure of universities presents some limitations for regional engagement, the foundation model previously described has been one mechanism to overcome this. The lack of base funding for university research results in some difficulties in ensuring research programmes. For example, it results in a shortage of technicians in university research labs.

Research centres and other facilities: Catalan and Spanish

Catalan Research Centres: alternative research network

The Catalan government has sponsored the creation of a series of independent research centres (see Chapter 2). The region promoted these centres as a vehicle to strengthen its research capabilities. The centres are not under the control of a university, but they typically involve one or more Catalan universities and other entities. The independence of the centres is reinforced by their own legal status, a private management model with external scientific committees, a talent-based recruitment that does not fall under civil servant status, and sufficient structural funding and investment in scientific equipment from the Catalan government.

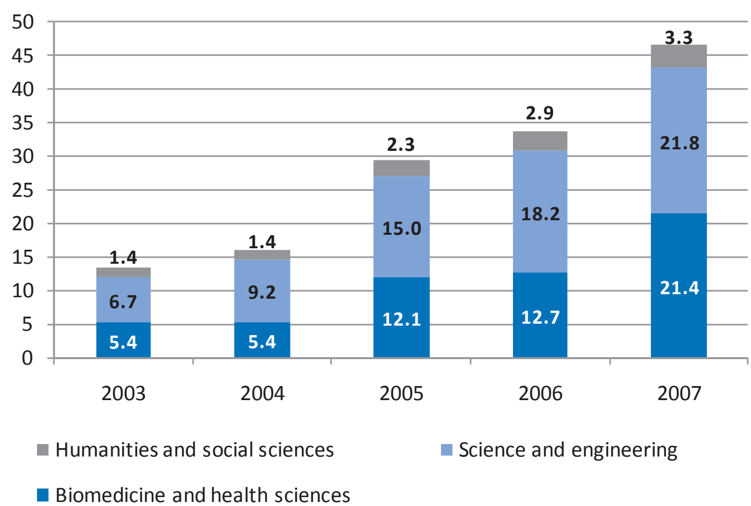
The number of centres has expanded considerably over the last several years. There are now 37 centres and six others are in the process. Of the current centres, 23 were created between 1984 and 2003 and the other 14 since 2004 (see Table 1.A1.12) One of the criteria for the centres is that it have critical mass to be internationally competitive, but one could wonder if such a large number of centres, in addition to the network of Spanish CSIC centres in the territory, all meet this criteria. Using 2006 statistics, the number of affiliated personnel to a centre ranges from 19 to over 600 for IRTA (IRTA is large because agricultural research was devolved to regions). Operating budgets generally range between EUR 1 to 5 million but with a few exceptions, including IRTA (approximately EUR 30 million). The share of the operating budget financed by the Catalan government appears to decrease over time, but not in a strict linear fashion. For example, one centre that began in 2000 receives 75% of its operating budget from the Catalan government, while another opened in 2004 receives only 32%.

The Catalan government financed on average approximately 42% of centre operating expenses in 2006. This results in an additional EUR 1.38 return for every EUR 1 of institutional funding invested by the Catalan government. The remaining sources of centre financing are from both contracts to firms and competitive research grants, mainly from the Spanish government and the EU. The region’s budget for base institutional funding of research centres more than tripled between 2003 and 2007, from EUR 13.5 million to 46.5 million annually (see Figure 1.29).

The proliferation of centres with strong independence has resulted in the need for greater co-ordination and alignment with regional priorities. One initiative outlined in the CARI is the creation of a new public agency for research centres (CERCA) to serve this co-ordination and monitoring role. As an interim step to such a centre, the region already instituted the Research Centres of Catalonia programme to co-ordinate and better capitalise on research centre activities.

Figure 1.29. **Financing of the Catalan Research Centres network**

EUR millions (current prices)



Source: Government of Catalonia (CIRIT).

The Spanish CSIC network: integrating into regional priorities

The Spanish Research Council, or *Consejo Superior de Investigaciones Científicas* (CSIC), has a network of 136 centres across Spain, including 24 in Catalonia (see Table 1.12). CSIC has been transformed into a research agency with a system of performance contracts to increase accountability. The more than 2 000 CSIC researchers working in Catalonia account for 12.7% of the overall Spanish network.

It is a challenge in OECD member countries to effectively integrate national centres into a regional innovation system, but there are some successes in Catalonia. This integration is not facilitated by the organisation structure of CSIC, as the network is one legal entity and important decisions related to centres are taken in Madrid. Nevertheless, the centres around the country all have autonomy to manage certain aspects of operations that can involve active participation in the regional system. The CSIC centres in Catalonia have had greater internationalisation and contracts with firms relative to most other Spanish regions (Bacaria *et al.*, 2004). Several CSIC research centres in Catalonia have mixed affiliations with other Catalan institutions, including six joint with Catalan Research Centres. There are also individual agreements with some of the CSIC centres and the Catalan government.

Table 1.12. **Spain's CSIC research centres in Catalonia**

Area	Institutions	Spanish and Catalan Projects 2004-07 (count)	Spanish and Catalan Projects 2004-07 (EUR)	EU Projects 2004-07 (count)	EU Projects 2004-07 (EUR)
Humanities & social sciences	2 individual centres	24	1 840 800	1	155 000
Biology & biomedicine	2 individual centres, 1 mixed centre, 1 consortium	176	24 422 700	22	4 636 500
Natural resources	3 individual centres and 1 mixed centre	204	23 400 000	33	4 264 000
Physics science & technology	3 individual centres and 1 co-ordinated centre	504	41 684 763	54	6 684 000
Chemical science & technology	1 individual centre	90	10 000 000	10	2 000 000
Materials science & technology	1 own centre, 1 mixed centre	168	20 000 000	26	5 560 000
Total		1 166	121 348 263	146	23 299 500

Note: EU projects and amounts included in total project counts. Since the brochure was published, there are now 24 CSIC centres in Catalonia, 20 full centres and four service centres.

Source : *CSIC a Catalunya*, 2004-2007 (brochure).

Other centres and scientific infrastructure

Beyond the Catalan Research Centres network there are other notable research centres and scientific facilities. Research centres for agriculture were devolved to the autonomous communities (IRTA). There are also 11 hospital research institutes supported by the Catalan government as health care is now a responsibility of regions. All other Spanish centres remained within the national CSIC network. Catalonia has several large-scale scientific facilities, most of which have been created since 2000. There are several others under construction (see Table 1.13).

Table 1.13. **Large scientific infrastructure in Catalonia**

Centre	Year	Affiliated entities
Existing		
Barcelona Supercomputing Center	2005	DIU (GC), UPC, MICINN
Supercomputing Center of Catalonia (CIEM)	1991	DIU (GC), FCRI, UB, UAB, UPC, UPF UdG, UdL, URV, UOC, CSIC
Beamline BM16 (ESRF)	2003	DIUE, MCYT, LLS
Alba Synchrotron Light Laboratory (CELLS)	2003	DIUE (GC), MICINN
Existing (no DIUE participation)		
Nuclear Magnetic Resonance Laboratory	2000	SCT (UB) - PCB
Maritime Research and Experimentation Channel	1993	UPC
Clean Room of the National Microelectronics Centre	1991	CSIC
Under Construction		
Plataforma de Biologia Estructural i Proteòmica	---	DIUE (GC), MICINN, UAB, CSIC, Consorci ALBA
Plataforma de Fenotipat Metabòlic (Mouse clinic)	---	Centre de Biotecnologia Animal i Teràpia Gènica (CBATEG); DIUE (GC), DSALUT (GC), MICINN, UAB
Plataforma d'Ultraseqüència Genòmica	---	DIUE (GC), MICINN, PCB
International Center for Numerical Methods in Engineering (CIMNE)	---	DIUE (GC), DPTOP (GC), UPC, MICINN

Source: Government of Catalonia, Ministry of Innovation, Universities and Enterprise.

Other foundations support knowledge generation

ICREA: attracting high quality researchers

The Catalan Institution for Research and Advanced Studies (ICREA) was created in 2000 as a recruitment vehicle for top quality researchers to overcome civil servant salary constraints. ICREA receives funds from the Catalan government. Researchers receive a salary from ICREA and are placed in universities or other research centres within Catalonia, including centres affiliated with the national CSIC system. In 2008, a new programme called ICREA Academia was created to provide research grants to exceptional researchers in public universities (40 recipients in 2008). ICREA as an institution has only a few administrative staff members in its form prior to the merger with the Catalan Agency for Research.

ICREA has proven successful in its mission and is well regarded in the region. Between 2000-2008, ICREA hired a total of 222 researchers (202 in position at end 2008) in a range of fields (sciences, social science and humanities). These researchers have attracted considerable amounts of research funds, including ERC Starting Independent Research Grants and ERC and Advanced Investigator Grants. They attract research funds in 2008 of EUR 19.4 million for which they were the lead, almost EUR 11 million to the groups they participated in. Given the level of funding raised by ICREA researchers, there is a clear return on the regional government's investment. Other measures of activity in 2008 for ICREA researchers include the 818 publications in the ISI database and oversight of 132 Master's and Doctoral theses presented that year. In terms of technology transfer, of the 33 patent applicants of ICREA researchers, 26 are in the filing process, one was sold, one was licensed to a private firm, three are licensed to spin-offs and two have seen no further action. ICREA has also supported three spin-offs (ICREA, 2009). The question for the future is whether any priorities established by the region will be translated into the selection criteria of future researchers.

FCRI: a gap-filling niche

The Catalan Foundation for Research and Innovation (FCRI), created in the 1980s, serves a flexible role in the regional innovation system but with a focus on supporting research and dissemination. The budget is financed mainly from the Catalan government. As a foundation, it has more flexibility for action outside of public sector constraints. Therefore it is easier for special projects to be managed through a foundation structure. Many of the initiatives include public awareness regarding science and research, such as the annual Science Week. FCRI also has a stake in many other foundations and initiatives in Catalonia (such as ICREA and i2CAT). Its activities may be reconsidered with the merger into the Catalan Agency for Research.

Other foundations

The private foundation i2CAT seeks to promote research and innovation as well as the second generation of internet. Started in 1999 as a project between the Catalan government, firms and the Polytechnic University of Catalonia, it became a foundation in 2003 adding two other universities and other public and private founders. The annual budget of approximately EUR 3 million (2005) comes from the Catalan government, firms and competitive EU project funds. The distinct focus of this foundation is on the internet/telecommunications side with priorities for clusters in audiovisual, network technologies, health and education. A number of platforms have been created through the foundation (GigaCAT, MediaCAT, GridCAT, OPtiCAT, MobiCAT).

Knowledge exploitation and technology transfer sub-system is under-performing

Catalonia's technology transfer system can be characterised as public rather than private sector-driven. While firms are responsible for around two-thirds of overall R&D investment in Catalonia, the "infrastructure" for technology transfer is mainly publicly funded even if several institutions are private entities. There are several different technology-related networks. Much of the infrastructure for technology transfer in Catalonia is also relatively recent, with a number of networks and instruments being created since 2000 (see Table 2.2 in Chapter 2). Improvements in the effective exploitation of knowledge in Catalonia have proven more difficult than that of improving the knowledge generation sub-system.

Technology Centres are also relatively new to Catalonia, as compared to other regions in Spain, such as the Basque Country. The ranges of centres include those with staff of over 100 to staff of less than five (see Table 1.A1.10). Over time, two types of technology centres were recognised by Catalonia based on different public programmes: Technology Centres and Technology Dissemination Centres. While each was named a network, in fact they were simply individual centres under different labels but there have been no synergistic aspects of being part of a network. Given the proliferation of such technology centres with successive instruments and their resulting different sizes and quality of services, the Catalan government is now seeking to map and rationalise the existing offer. The new Network of Technology Centres, TECNIO, will bring together all the different centres under one oversight entity. Criteria are being developed to grant a quality label to such centres – based mainly on scale.

There are 25 science and technology parks in Catalonia. Most are university-linked (17), while others are more broadly the initiative of a city-region (8) but may still involve universities (see Table 1.A1.11). The Catalan Network of Science and Technology Parks includes 13 of these parks, with an additional six affiliated. Several of these parks are new or in expansion through funding from sources outside of Catalonia, including Spanish government programmes.

Industry associations participate in several public actions to support the innovation system. For example, industry as well as labour and trade unions participated in and signed the Catalan Agreement on Research and

Innovation. The industry associations are also on the board of public bodies like ACC1Ó. In the current cluster policy of Catalonia, the Integral Competitiveness Plans involve firms directly as well as via firm associations. The Technological Centres are also public-private partnerships to best tailor services to firm needs. Several industry associations in health-related fields (biomedicine and medical devices) are particularly active in Catalonia.

Notes

1. In terms of Spain's share of the foreign-born population, Catalonia is followed by Madrid (19%), Valencia (16%) and Andalusia (12%).
2. While this category may also include those who do not report an educational level, presumably the rate of non-response in this data from the National Statistics Institute (INE) in Spain would be comparable across regions.
3. Data from INE, the Spanish National Statistics Institute.
4. Data on current GDP per hour worked from *OECD Regional Database*.
5. EU15 data corresponds to the year 2003 (STAN Indicators Database, 2005).
6. Notice that manufacture and services were classified as technology and knowledge intensive on the basis of the current Eurostat definition instead of the OECD definition due to data availability at the regional level. While the definitions are the same for manufacturing, the OECD adopts a stricter definition of knowledge-intensive services.
7. See note 6 for classification differences.
8. The local industrial production systems (LPS) map was created in two phases: 1) The authors identify important concentrations of companies in the same segment in a single area (normally a county); 2) they select data from the previous group to weed out the concentrations of businesses that cannot be considered traded local industrial production systems. They complement this second phase by obtaining economic data for the identified local industrial production systems.
9. The data quoted here is somewhat different from the firm counts reported by IDESCAT. For example, PIMEC reports 533 359 for 2006 while IDESCAT lists 586 729. The difference of 53 370 is approximately the same as the IDESCAT counts for the "other" category, as the counts for firms in the defined categories is almost the same, 533 355. Given the more detailed data available from PIMEC, those figures are being used for the analysis.

10. The largest employers in Catalonia include *Fomento de Construcciones y Contratas* (services, construction, cement, energy), *Sociedad General de Aguas de Barcelona* (water collection, treatment and distribution), *Foca Corporación Empresarial* (sanitary ware, ceramics), and the Catalan Health Institute, the latter with 41 000 employees.

11. Data is from INE, Spain's National Statistics Institute.

12. Data is from the *OECD Venture Capital Database,* which is based on data from Thomson Financial, PwC, EVCA, LVCA, and National Venture Capital Associations.

13. Data is from the *OECD Regional Patent Database*.

14. Data is from the *OECD Regional Patent Database*.

15. An analysis of the RIS 2006 approach but with transformation and re-scaling of the data, using a national weight of ½, produces different results, with Catalonia ranking 60th instead of 82nd. For further information, see Hollanders (2007).

16. There main differences between utility models and patents are: *i)* the requirements for acquiring a utility model are less stringent than for patents. While the requirement of "novelty" is always to be met, "inventive step" and "industrial application" may be lower than with patents; *ii)* the term of protection is shorter than for patents. This varies from seven to 15 years without the possibility of extension or renewal; *iii)* the registration process is often simpler and quicker (taking on average six months) than for patents. Normally, patent offices do not examine applications as to substance prior to registration; *iv)* the registration process is cheaper than for patents. Utility models may be granted without prior examination of some innovation requirements; *v)* in some countries, utility models protection can only be obtained for certain fields of technology and only for products but not for processes. The World Intellectual Property Organization (WIPO) has further information on utility models in their different forms in other countries.

17. Data is from the Spanish Patent and Trademark Office (OEPM), *Avance de Estadística de Propiedad Industrial 2007*. Population data from 2005.

18. The OECD average in this instance is based on 27 high income economies.

19. For organisational purposes, the merger has already taken place; however, there may be some legislative issues outstanding to finalise the process.

20. Data for 2007 on researcher by broad sector (firms, higher education, public administration) is from IDESCAT-INE. Note that the numbers reported for the Catalan Research Network (CERCA) and the Spanish

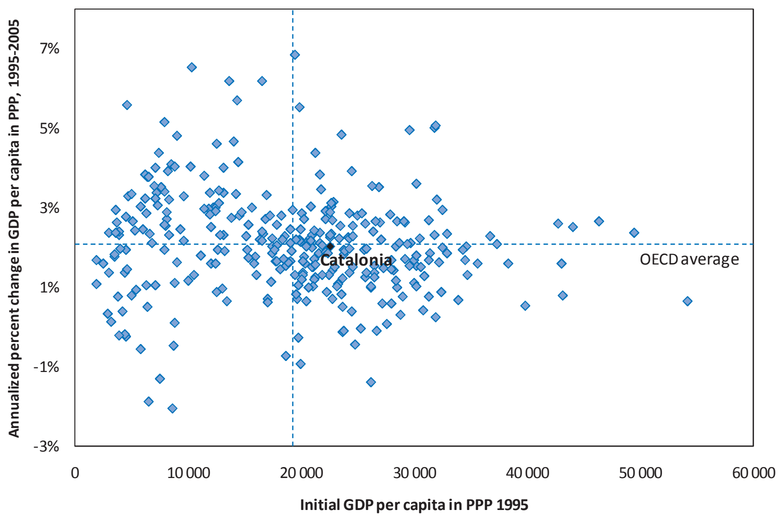
research centres (CSIC) exceed the number of researchers reported in public administrations, implying that the reported numbers for these two networks are double counting researchers.

21. Student figures per Fundacíón CYD (2008).

Annex 1.A1

Figure 1.A1.1. **GDP per capita: level and annual average growth rate (all regions)**

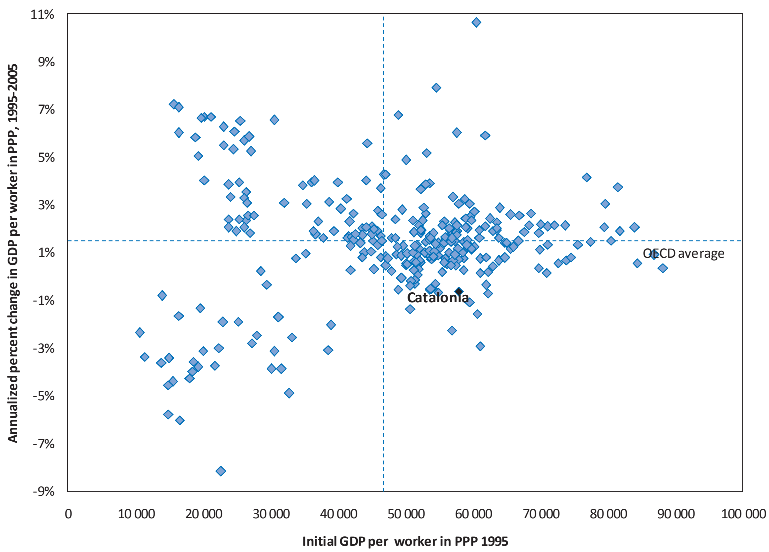
TL2 regions, 1995-2005



Source: OECD calculations based on data from the *OECD Regional Database*. Diamonds signify OECD TL2 regions.

Figure 1.A1.2. **GDP per worker: level and annual average growth rate (all regions)**

TL2 regions, 1995 and 2005



Source: OECD calculations based on data from the *OECD Regional Database*. Diamonds signify OECD TL2 regions.

Table 1.A1.1. **Employment changes by technology level**

	Spain				Catalonia			
			Change				Change	
	1994 (%)	2006 (%)	Total (000s)	Avg. ann. (%)	1994 (%)	2006 (%)	Total (000s)	Avg. ann. (%)
Manufacturing sector	19.8	15.9	713.48	2.0	28.3	22.8	177.75	2.0
High-technology manufacturing sector	0.6	0.4	12.62	1.2	1.3	1.0	7.22	1.8
Medium-high-technology manufacturing sector	4.8	4.0	212.52	2.4	9.2	7.3	53.64	1.9
Medium-low-technology manufacturing sector	4.7	4.6	334.74	3.6	5.4	5.0	55.73	3.1
Low-technology manufacturing sector	9.7	6.8	153.60	0.9	12.3	9.4	61.16	1.6
Service sector	60.3	65.7	5 630.93	4.5	58.8	63.8	929.48	4.4
Knowledge-intensive high-technology services[1]	1.7	3.0	378.87	8.3	1.7	3.3	76.01	9.0
Knowledge-intensive financial services[2]	2.7	2.2	116.60	2.4	2.8	2.6	30.45	3.2
Knowledge-intensive market services[3]	5.1	8.4	1 043.42	7.9	5.9	9.1	186.26	7.3
Other knowledge-intensive services[4]	12.3	14.3	1 324.60	5.0	12.4	13.6	202.98	4.5
Less-knowledge-intensive market services[5]	27.5	25.9	1 770.11	3.3	26.7	25.7	308.93	3.4
Other less-knowledge-intensive services[6]	11.0	11.8	997.34	4.4	9.3	9.4	124.86	3.9
Primary sector + mining and quarrying	10.0	5.2	-178.39	-1.2	3.5	2.4	7.37	0.7
Electricity, gas, water supply and construction	9.9	13.2	1 388.90	6.1	9.4	11.1	179.18	5.1
Total	100.0	100.0	7 554.92	3.8	100.0	100.0	1293.78	3.7

Note: In 2007 Eurostat provides a high-technology manufacturing sector value 47% smaller than in 2006 (16 418 and 34 747 respectively), therefore given this potentially incorrect data 2006 figures were used. 1) Includes: post and telecommunications, computer and related activities, and research and development; 2) Includes: financial intermediation, insurance and pension funding, activities auxiliary to financial intermediation; 3) Includes: water transport, air transport, real estate activities, renting of machinery and equipment without operator and of personal and households goods, other business activities; 4) Includes: education, health and social work, recreational, cultural and sporting activities; 5) Includes: sale, maintenance and repair of motor vehicles and motorcycles; retail sale of automotive fuel, wholesale trade and commission trade, retail trade (except motor vehicles and motor cycles) and repair of household and household goods, hotels and restaurant, land transport; transport via pipelines, supporting and auxiliary transport activities; activities of travel agency; 6) includes the rest of activities not contained in the other categories.

Source: OECD calculations based on data from EUROSTAT.

Table 1.A1.2. **Structure of industry in Catalonia**

2006

	Code	2006 Workers (thousand)		2006 GVA (million euros)		2006 Value-added per worker	2000-2006 Average annual employment growth rate	2000-2006 Average annual GVA growth rate
	CCAE	Number	%	Number	%			
Chemical industry	24	75.2	10%	5 589	16%	74 322	1.2%	4.0%
Food products, beverages and tobacco	15–16	101.8	13%	4 654	13%	45 717	0.9%	4.5%
Metal products	28	94.3	12%	3 432	10%	36 394	0.1%	4.4%
Vehicles	34	63.9	8%	3 281	9%	51 346	-1.5%	1.4%
Fabricated metal product manufacturing	29	61.7	8%	2 769	8%	44 878	-0.8%	2.1%
Publishing, printing and reproduction	22	51	7%	2 077	6%	40 725	0.2%	2.2%
Other non-metallic mineral products	26	32.4	4%	1 936	5%	59 753	0.6%	5.2%
Mechanic equipment	31	26.7	4%	1 798	5%	67 341	-1.6%	3.7%
Rubber and plastics products	25	39.9	5%	1 716	5%	43 008	-0.5%	0.9%
Textile industry	17	49.9	7%	1 479	4%	29 639	-5.4%	-3.1%
Office equipment and other industry	36	42.3	6%	1 233	3%	29 149	-1.5%	3.5%
Metallurgy	27	10.4	1%	1 219	3%	117 212	0.2%	8.7%
Paper	21	20.7	3%	1 187	3%	57 343	0.3%	3.5%
Clothing industry	18	33	4%	752	2%	22 788	-5.6%	-1.8%
Precision instrument	33	11.1	1%	574	2%	51 712	6.3%	8.2%
Wood	20	22	3%	538	2%	24 455	-1.0%	2.1%
Electrical and electronic equipment	32	9.5	1%	501	1%	52 737	-5.0%	3.9%
Transport equipment	35	8.7	1%	466	1%	53 563	4.4%	16.8%
Recycling	37	1.7	0%	186	1%	109 412	6.0%	13.7%
Leather	19	4.8	1%	141	0%	29 375	-3.1%	-4.8%
Computers	30	0.9	0%	29	0%	32 222	-23.5%	-32.7%
Manufacturing		761.9	100%	35 556	100%	46 668	-0.9%	3.0%

Source: OECD calculations based on data from the Catalan Statistics Institute (IDESCAT).

Table 1.A1.3. **EU Cluster Observatory: Catalonia**

Cluster category	Employees	Size	Spec.	Focus	Stars	Innovation	Exports	Notes
Construction	138 089	2.11%	1.21	4.31%	**	Medium	N/A	a
Food	103 066	2.06%	1.19	3.22%	**	Medium	Strong	a
Finance	97 597	1.37%	0.79	3.05%	**	Medium	Weak	a
Transportation	95 261	1.55%	0.89	2.97%	**	Medium	Strong	a
Hospitality	80 649	2.20%	1.26	2.52%	*	Medium	Very strong	
Automotive	74 086	2.85%	1.64	2.31%	*	Medium	Strong	
Education	60 070	1.69%	0.97	1.87%	*	Medium	N/A	
Metal	57 868	1.47%	0.85	1.81%	*	Medium	Weak	
Building fixtures	54 575	2.34%	1.34	1.70%	*	Medium	Weak	a
Textiles	52 885	2.93%	1.68	1.65%	*	Medium	Weak	
Entertainment	49 331	2.24%	1.29	1.54%	*	Medium	Weak	
Publishing	47 590	2.90%	1.67	1.49%	*	Medium	Strong	
Apparel	38 217	2.13%	1.22	1.19%	*	Medium	Weak	a
IT	38 050	1.85%	1.06	1.19%	*	Medium	Weak	
Production tech.	33 000	1.45%	0.83	1.03%	*	Medium	Weak	a
Forest	31 192	1.86%	1.07	0.97%	*	Medium	Weak	
Chemical	30 645	3.18%	1.83	0.96%	*	Medium	Weak	a
Agricultural	26 434	3.17%	1.82	0.83%	*	Medium	Strong	
Biopharma	25 485	3.10%	1.78	0.80%	*	Medium	Strong	
Distribution	23 881	1.46%	0.84	0.75%	*	Medium	N/A	a
Furniture	20 383	1.80%	1.03	0.64%	*	Medium	Weak	a
Plastics	19 354	2.37%	1.36	0.60%	*	Medium	Weak	
Communications	13 838	1.74%	1.00	0.43%	*	Medium	Weak	
Heavy machinery	13 289	1.60%	0.92	0.41%	*	Medium	Weak	a
Construction materials	11 191	1.86%	1.07	0.35%	*	Medium	Very strong	
Power	7 793	1.47%	0.84	0.24%	*	Medium	Weak	
Lighting	7 382	1.43%	0.82	0.23%	*	Medium	Weak	
Fishing	6 376	1.77%	1.02	0.20%	*	Medium	Strong	
Medical	5 913	1.32%	0.76	0.18%	*	Medium	Weak	
Jewellery	5 076	1.70%	0.98	0.16%	*	Medium	Weak	a
Oil and gas	3 952	1.05%	0.60	0.12%	*	Medium	Weak	
Sporting	2 739	1.29%	0.74	0.09%	*	Medium	Weak	a
Leather	2 463	1.45%	0.83	0.08%	*	Medium	Weak	

Notes: Innovation: data is for region, regardless of cluster category. Based on 2006 European Regional Innovation Scoreboard, MERIT. Exports: data is national export data for the cluster category, regardless of region. Based on International Cluster Competitiveness Project, ISC at HBS. (a) Cluster stars uncertain: detailed data unavailable.

Source: European Cluster Observatory, ISC/CSC cluster codes 1.0, dataset 20070613.

Table 1.A1.4. **Catalan SMEs by detailed sectors: 2006**

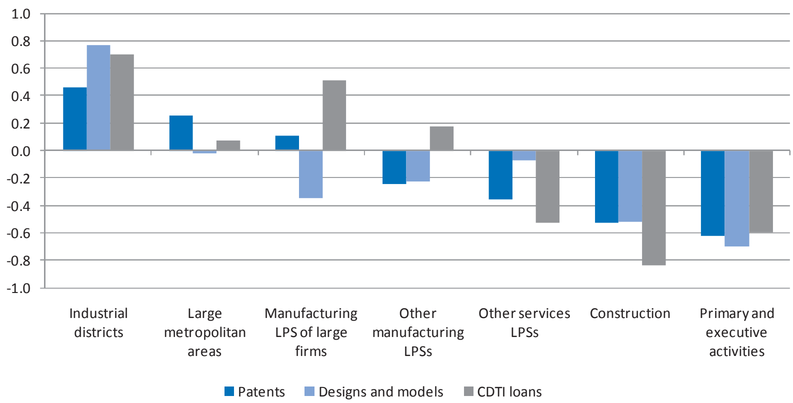
	Firms		Employees		VAB		Changes (annual variation 2002-2006)			
	Number	Share	Employees	Share	EUR millions	Share	VAB	Firms	Firm size	Productivity per worker
Primary	**29 517**	**5.5%**	**57 426**	**2.8%**	**2 132**	**2.2%**	**6.1%**	**-3.1%**	**3.8%**	**5.5%**
Industry	**44 299**	**8.3%**	**392 495**	**19.2%**	**20 482**	**20.8%**	**-0.9%**	**-3.1%**	**1.0%**	**1.3%**
Energy, gas and water	1 102	0.2%	8 551	0.4%	719	0.7%	-2.0%	6.2%	-3.0%	-4.9%
Extraction industries, excl. energy	1 770	0.3%	21 384	1.0%	1 447	1.5%	2.1%	-3.0%	2.6%	2.6%
Chemical industries	1 583	0.3%	32 453	1.6%	2 391	2.4%	-2.7%	-3.5%	2.2%	-1.4%
Metallurgy, machinery and material electric	14 824	2.8%	124 344	6.1%	6 538	6.6%	0.7%	-1.8%	0.3%	2.2%
Transport materials	912	0.2%	15 365	0.8%	808	0.8%	-1.7%	-1.5%	-1.3%	1.1%
Agro-food industry	3 878	0.7%	45 620	2.2%	2 035	2.1%	0.5%	-1.7%	2.1%	0.1%
Textile, leather and clothing assembly	6 685	1.3%	46 913	2.3%	1 723	1.7%	-7.3%	-7.6%	-1.3%	1.7%
Paper, graphic arts and editing	5 627	1.1%	42 352	2.1%	2 163	2.2%	-1.0%	-1.1%	0.0%	0.1%
Rubber, wood and other industries	7 917	1.5%	55 512	2.7%	2 657	2.7%	0.1%	-4.4%	3.3%	1.5%
Construction	**78 106**	**14.6%**	**292 182**	**14.3%**	**13 722**	**13.9%**	**3.6%**	**7.8%**	**-0.6%**	**-3.4%**
Services	**381 437**	**71.5%**	**1 304 774**	**63.7%**	**62 322**	**63.2%**	**4.3%**	**3.5%**	**0.1%**	**0.5%**
Trade and motor vehicle repair	122 913	23.0%	424 084	20.7%	19 534	19.8%	2.7%	0.7%	1.3%	0.7%
Hotels and restaurants	35 315	6.6%	130 548	6.4%	4 570	4.6%	2.3%	2.6%	1.6%	-1.8%
Transport and communications	39 754	7.5%	116 303	5.7%	5 732	5.8%	2.9%	2.1%	0.9%	-0.2%
Financial services, insurance and real estate	45 665	8.6%	95 830	4.7%	7 660	7.8%	6.1%	14.3%	-5.2%	-2.1%
Other services to firms	74 661	14.0%	267 335	13.1%	12 429	12.6%	5.0%	5.1%	0.1%	-0.2%
Other services to people	63,130	11.8%	270 674	13.2%	12 397	12.6%	6.6%	3.2%	0.4%	2.9%
Total	**533 359**	**100.0%**	**2 046 877**	**100%**	**98 649**	**100.0%**	**3.0%**	**3.0%**	**-0.2%**	**0.2%**

Note: Variation in VAB based on 2006 constant EUR.

Source: PIMEC (2008), *Anuari de la pime catalan: Resultats economics in financers: 2002-2006*, PIMEC, Barcelona.

Figure 1.A1.3. **Innovative performance by typology of local production system**

Difference from the mean



Source: Boix, R. and V. Galletto (2008), "Innovation and Industrial Districts: A First Approach to the Measurement and Determinants of the I-District Effect", *Regional Studies*, Vol. 43(9), pp. 1117-1133.

Table 1.A1.5. **Foreign firms in Catalonia**

	Catalonia	Share of Catalan foreign firms	Spain	Share of Spain by country of origin
France	705	23.9%	1 142	61.7%
Germany	519	17.6%	853	60.8%
United States	399	13.5%	664	60.1%
Italy	356	12.1%	650	54.8%
Netherlands	198	6.7%	390	50.8%
Japan	148	5.0%	210	70.5%
United Kingdom	140	4.8%	300	46.7%
Switzerland	111	3.8%	163	68.1%
Belgium and Luxembourg	87	3.0%	160	54.4%
Denmark	67	2.3%	144	46.5%
Sweden	62	2.1%	280	22.1%
Portugal	46	1.6%	250	18.4%
Austria	44	1.5%	88	50.0%
Canada	28	1.0%	38	73.7%
Finland	20	0.7%	60	33.3%
Norway	15	0.5%	67	22.4%
Total for selected countries	2 945	100.0%	5 459	53.9%

Note*:* Year of data not available.

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

Table 1.A1.6. **Students in Catalonia by field of study**

2005-2006 academic year

	University students		Doctoral theses	
	Total	Share	Total	Share
Total	227	100%	1 433	100%
Humanities	22	10%	198	14%
Social sciences	109	48%	316	22%
Science	13	6%	385	27%
Health	20	9%	284	20%
Engineering and architecture	61	27%	250	17%

Source: government of Catalonia (2008), *Catalan Agreement on Research and Innovation – Framework Document*, Barcelona.

Table 1.A1.7. **Innovation trends of firms in Catalonia**

	High-tech industries	Low-tech industries	High-tech KIS	Other KIS
R&D and innovation activities in 2004 (share of firms %)				
Innovation projects	71.50	49.75	71.11	37.78
Permanent R&D	66.28	39.63	67.14	26.84
Sporadic R&D	12.47	10.94	7.22	7.24
Public support in R&D	26.99	19.26	43.32	16.61
Co-operative agreements in R&D	25.66	12.19	28.88	13.21
Patents	23.00	11.85	21.66	4.54
Innovative firms by type of innovation in 2002-2004 (share of firms %)				
Innovative firms	60.00	34.58	53.42	20.88
Product innovation	58.84	36.93	54.87	25.42
Process innovation	51.32	44.76	41.15	32.38
Organisational innovation	48.14	38.39	58.84	42.32
Market innovation	26.28	19.81	24.18	13.06
Product or process innovation	70.97	52.94	62.81	38.35
Product and process innovation	39.20	28.75	33.21	19.46
Process product (1)	66.61	77.86	60.52	76.53
Product process (1)	76.37	64.24	80.70	60.08
Product permanent R&D (1)	78.23	69.75	72.04	57.14
Process permanent R&D (1)	65.55	73.60	51.61	65.07
Output product innovation				
New for the firm (% sales)	11.73	7.98	11.11	6.40
New for the market (% sales)	6.33	3.22	14.07	3.19
Average size (workers)	160.14	114.18	161.32	320.15
Average size (sales, millions EUR)	51.23	27.59	31.65	39.28
Export over sales (%)	26.06	16.49	9.05	3.03
Number of firms	1 130	1 443	277	704
R&D and innovation expenditures by firm				
Research personnel (% total workers)	7.62	2.19	24.53	4.39
Innovation expenditure per worker (EUR)	6 764	3 748	19 118	4 719
Intramural R&D	4 559 (67.40)	1 470 (39.22)	15 590 (81.55)	3 463 (73.38)
External R&D	1 346 (19.89)	173 (4.62)	2 571 (13.45)	406 (8.60)
Machinery and software	462 (6.83)	1 159 (30.92)	233 (1.22)	586 (12.42)
Other sources	396 (5.85)	943 (25.16)	721 (3.77)	262 (5.55)

Note: (1) Conditional frequencies. KIS=Knowledge-intensive services, R&D=research and development.

Source: Segarra-Blasco, A. (2010), "Innovation and Productivity in Manufacturing and Service Firms in Catalonia: A Regional Approach", *Economics of Innovation and New Technology*, DOI: 10.1080/10438590802469594 based on data from CIS4 data for Catalonia.

Table 1.A1.8. **Innovation performance by industry sector: 2004**

Industries	Firms	Sales	Export	Invest-ment	R&D investment	Innovation investment	Employees	Research employees
High-tech manufacturing	**294**	**15 633**	**3 404**	**400**	**473**	**710**	**44 698**	**2 252**
Aircraft and spacecraft	2	6.2	1.9	0.4	0.3	0.8	84	2
Pharmaceuticals	106	9 568.3	1 783.6	281.1	345.5	533.8	27 021	1 201
Office, accounting and computing machinery	7	1 364.9	17.9	30.7	45.4	59.9	2 581	314
Radio, TV and communications equipment	71	3 665.6	1 361.3	34.6	51.9	75.5	8 989	484
Medical, precision and optical instruments	108	1 028.1	239	53.1	29.8	40	6 023	251
Medium-high-tech manufacturing	**836**	**42 267**	**15 843**	**1 567**	**324**	**974**	**136 271**	**1883**
Electrical machinery and apparatus, n.e.c.	122	6 283.3	1 687.7	196.9	58.8	99.9	25 546	470
Motor vehicles, trailers and semi-trailers	106	17 900	8 413.4	800.5	90.9	616.7	50 087	385
Chemical products	285	13 500	3 977.8	470.3	113.2	175.1	37 774	675
Railroad equipment and transport equipment	31	1 515.9	601.1	25	15.5	22.2	5 098	37
Machinery and equipment n.e.c.	292	3 068.2	1 163.3	74.4	45.5	59.6	17 766	316
Medium-low-tech manufacturing	**357**	**11 161**	**2 521**	**617**	**58**	**108**	**49 523**	**307**
Rubber and plastic products	17	3 231.1	1 005.7	146.5	14.4	33.2	17 009	76
Other non-metallic mineral products	88	3 172	412.4	132.6	16.1	20.1	11 581	68
Metallurgy	58	2 210.4	444.9	134.4	9.2	15.5	5 600	32
Metal products	194	2 547.7	658	203.3	18.6	38.7	15 333	132
Low-tech manufacturing	**933**	**28 665**	**5 479**	**1156**	**131**	**268**	**115 248**	**538**
Furniture and other manufactures	137	1 547	353.1	36.7	13.4	17.5	9 506	42
Wood and cork	28	182.5	54.2	3.7	0.1	0.9	1 449	8
Paper industries	86	3 599.3	970.5	262.1	6.2	17.8	13 563	36

Table 1.A1.8. **Innovation performance by industry sector: 2004** (*continued*)

Industries	Firms	Sales	Export	Invest-ment	R&D investment	Innovation investment	Employees	Research employees
Printing industries	120	1 983.3	340.4	105.4	6.1	17.7	11 419	37
Food products, beverages and tobacco	242	17 073.9	2 047.8	630.9	54.1	105.6	50 448	238
Textile industry	233	2 331.6	868.2	79.5	27.5	81.1	17 964	117
Clothing and furrier's	59	1 633.4	672	27.8	20	23	8 272	41
Leather articles and footwear	28	313.8	173.1	9.6	4.1	4.6	2 627	20
Knowledge-intensive services (KIS)	**765**	**19 154**	**1 740**	**1 184**	**606**	**838**	**181 771**	**3 427**
Post and tele-communications	40	4894.6	38.4	453.2	20.5	38.4	8 191	26
Financial intermediation	127	6 841.8	883.4	490.7	44.6	66	19 090	88
Computer and related activities	187	3 384.1	520.4	50.6	110.4	161.6	31 066	982
Research and development	50	489.7	85.3	31	367.8	484.3	5 430	1 931
Other business activities	361	3 543.3	213	158.3	62.9	87.7	117 994	399
Total	3 185	116 880	28 988	4 923	1 593	2 897	527 511	8 407

Source: Segarra-Blasco, A. (2007), "Innovation, R&D Spillovers and Productivity: The Role of Knowledge-intensive Services", Document de Treball XREAP2007-12, Xarxa de Referència en Economia Aplicada based on data from the Catalan Innovation Survey CIS-4.

Table 1.A1.9. **Categorisation of EU regions for innovation**

Broad category	Sub-categories	Description and regions
Global consolidation	Nordic high-tech learning Science and service centre	These regions are on the top rung of the ladder of European innovative regions and include: Copenhagen, Ile-de-France, London, Prague, Stockholm and Vienna, etc. These regions are clearly well above the average for all four factors as well as GDP/capita with the exception of the private technology factor where they are close to the EU average.
Sustaining competitive advantage	Learning Centro techno High techno	Sustaining competitive advantage regions (strong industrial and learning Regions, *e.g.* Baden-Württemberg, Flanders, Ireland, Piemonte, Rhône-Alpes, Salzburg and Scotland, etc.) are relatively strong on private technology (reflecting the industrial tissue and heritage of these regions) and on learning families but much weaker in public knowledge and urban services (suggesting a difficulty to restructure towards more knowledge-based services).
Boosting entrepreneurial knowledge	Local science and services Aging academia	This category includes second-tier capitals and regions with strong public research *e.g.* Athens, Berlin, Bratislava, Catalonia, Lisbon, Midi-Pyrénées, Warsaw, and Wallonia, etc. that are strong on public knowledge and relatively competitive in terms of urban services but need to boost private technology and in particular learning family drivers of their knowledge economies.
Entering knowledge economy	Southern cohesion Rural industries Eastern cohesion Low-tech government	The entering knowledge economy regions (broadly similar to the Structural Fund convergence regions) lie on the southern and eastern rims of the EU. This group includes most of Greece, southern Spain, Poland except Warsaw, Estonia, Lithuania, Portugal except Lisbon, the Mezzogiorno, etc.). These regions are broadly speaking users rather than producers of technology.

Source: Adapted from Technopolis *et al.* (2006), "Strategic Evaluation on Innovation and the Knowledge based Economy in Relation to the Structural and Cohesion Funds, for the Programming Period 2007-2013: Synthesis Report", a report to the European Commission, Directorate General Regional Policy, Evaluation and Additionality, 23 October 2006.

Table 1.A1.10. **Technological centres in Catalonia: scale and type**

2008

Technology Centres	Staff	Total revenues in EUR millions (0 to 1.5, 1.5-3, >3)	Share of revenues from R&D (<50%, >50%)
Advanced Technology Centres			
ASCAMM (The Foundation of the Catalan Moulds and Matrices Companies Association)	89	>3	<50%
CTM (Cerdanyola del Vallès, Vallés Technology Parko Manresa Technology Centre)	73	>3	>50%
LEITAT (Terrassa Textile Conditioning Research and Test Laboratory)	123	>3	>50%
CETEMMSA (the Mataró-Maresme Business Technology Centre Foundation)	63	>3	<50%
BM-CI (Barcelona Media Innovation Centre)	148	>3	>50%
Technology Centres			
AIICA (Association for Research in the Fertiliser and Related Industries, Igualada)	27	1.5-3	<50%
CTAE (Aerospace Technology Centre*)*	25	0-1.5	>50%
IMAT (Construction Technology Centre)	23	1.5-3	>50%
CENTA (Agroalimentary Industries Technology Centre, Girona/Monells)	8	ND	ND
BDCT (Barcelona Digital Technology Center)	30	>3	<50%
CTNS (Health and Nutrition Technology Centre)	ND	ND	ND
CTQC (Chemical Technology Centre of Catalonia)	ND	ND	ND
Technology Dissemination Centres			
Eduard Soler Technology Centre, Ripoll	51	>3	<50%
INCAVI (Catalan Vine and Wine Institute Centre, Vilafranca del Penedès)	44	>3	<50%
Fund CECOT	15	1.5-3	<50%
FITEX (Igualada Foundation for Textile Innovation)	7	1.5-3	<50%
Fund ITL (Lleida Technological Institute)	19	0-1.5	<50%
CENFIM (Wood and Furniture Technology Dissemination Centre)	5	0-1.5	<50%
INNOPAN (Bakery Sector Technology Dissemination Centre)	2	0-1.5	<50%
Cam. Grafica	7	0-1.5	<50%
TCM Audiovisual (TecnoCampusMataró Audiovisual)	6	0-1.5	<50%
CATIC (ICT applications Centre)	3	ND	ND

Note: ND=no data available.

Source: Based on data provided by the Government of Catalonia (ACC1Ó).

Table 1.A1.11. **Science and technology parks in Catalonia**

	University-linked	City/region-linked
UB	Parc Cientific de Barcelona	Parc Tecnològic des Vallès, S.A.
UAB	Parc de Recerca UAB	
	Parc Salut Sabadell	TecnoCampusMataró (TCM)
UPC	Parc Tecnològic de Barcelona	Parc Tecnològic de la Catalunya Central (Manresa)
	Parc Cientific iTecnològic de Vilanova I la Geltrú	Biopol (Bio cluster)
	Parc Cientific iTecnològic de Terrassa	22@Barcelona
	Parc Mediterrani de la Tecnologia	B_TEC Barcelona Innovació Tecnològica
UPF	Parc de Recerca Biomèdica de Barcelona	Ciutat Aeroespacial I de la Mobilitat (Viladecans)
	Parc Barcelona Media	
	Parc Ciències socials (in progress)	
UdG	Parc Cientific iTecnològic de Girona	
	Parc Cientific iTecnològic Agroalimentari de Lleida	
URV	Parc Cientific iTecnològic de Tarragona	
	Parc del Turisme I Oci de la Costa Daurada	
	Parc Cientific iTecnològic de la Indústria Enològica	
	TecnoParc- Parc Tecnològic del Camp (Reus)	
URL	Parc d'Innovació La Salle	

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

Table 1.A1.12. **Catalan Research Centres network**

2006 data for centre created prior to 2006

Centre	Year established	Associated personnel to centre	Total operating budget (EUR millions)	Share of budget from Catalan govt.
Engineering				
International Centre for Numerical Methods in Engineering (CIMNE)	1987	120	5.9	3%
International Centre for Coastal Resources Research (CIIRC)	1993	33	0.5	26%
Computer Vision Centre (CVC)	1994	66	1.8	22%
Telecommunications Technological Centre of Catalonia (CTTC)	2001	66	2.8	76%
Center for Visualisation, Virtual Reality and Graphic Interaction	planned	n.a.	n.a.	n.a.
Health and life sciences				
August Pi i Sunyer Institute for Biomedical Investigations (IDIBAPS)	1996	196	12.5	27%
Centre for Genomic Regulation (CRG)	2000	236	18.2	42%
Catalan Institute of Cardiovascular Sciences (ICCC)	2000	55	2.8	61%
Centre of Regenerative Medicine in Barcelona (CMRB)	2004	37	4.0	32%
Institute for Bioengineering of Catalonia (IBEC)	2005	193	1.1	100%
Centre for Research in Environmental Epidemiology (CREAL)	2005	50	1	100%
Institute for Research in Biomedicine (IRB)	2005	380	6.8	95%
Centre for International Health Research in Barcelona (CRESIB)	2006	n.a.	n.a.	n.a.
Girona Biomedical Research Institute (IdIBGi)	2004	n.a.	n.a.	n.a.
Institute of Predictive and Personalised Medicine of Cancer (IMPPC)	2006	n.a.	n.a.	n.a.
Vall d'Hebron Institute of Oncology (VHIO)	2006	n.a.	n.a.	n.a.
Sciences				
Centre for Mathematics Research (CRM)	1984	25	1.1	40%
Institute for Food and Agricultural Research and Technology (IRTA)	1985	634	28.8	31%
Centre for Ecological Research and Forestry Applications (CREAF)	1987	101	3.1	31%
Institute of High Energy Physics (IFAE)	1991	110	4.1	24%

Table 1.A1.12. **Catalan Research Centres network** (*continued*)

Centre	Year established	Associated personnel to centre	Total operating budget (EUR millions)	Share of budget from Catalan govt.
Forestry Technology Centre of Catalonia (CTFC)	1996	125	5.4	14%
Institute for Space Studies of Catalonia (IEEC)	1996	72	2.3	23%
Institute of Geomatics (IG)	1997	24	1.3	34%
Centre for Research in Animal Health (CReSA)	1999	97	4.9	17%
Institute of Chemical Research of Catalonia (ICIQ)	2000	175	7.1	75%
Institute of Photonic Sciences (ICFO)	2002	153	5.25	59%
Catalan Institute of Nanotechnology (ICN)	2003	48	1.6	60%
Centre for Research in Agricultural Genomics (CRAG)	2004	102	2.3	39%
Centre UdL-IRTA	2005	n.a.	n.a.	n.a.
Catalan Institute of Paleontology (ICP)	2006	n.a.	n.a.	n.a.
Catalan Institute for Climate Sciences (IC3)	2008	n.a.	n.a.	n.a.
Catalan Institute for Water Research (ICRA)	2006	n.a.	n.a.	n.a.
Catalonia Institute for Energy Research (IREC)	2008	n.a.	n.a.	n.a.
Social sciences and humanities				
Centre for Demographic Studies (CED)	1985	49	1.1	35%
Centre for Research in International Economy (CREI)	1994	19	1.2	68%
Catalan Institute of Classical Archaeology (ICAC)	2000	47	1.6	79%
Catalan Institute of Human Paleoecology and Social Evolution (IPHES)	2004	50	2.1	35%
Catalan Institute of Research into Cultural Heritage (ICRPC)	2006	n.a.	n.a.	n.a.
Markets, Organizations and Votes in Economics (MOVE)	planned	n.a.	n.a.	n.a.
Research Centre of the History of Catalonia (CRHisCat)	planned	n.a.	n.a.	n.a.
Research Institute for Tourism of Catalonia (IRTUCA)	planned	n.a.	n.a.	n.a.
Research Institute in Social Plurilingualism (IRPluS)	planned	n.a.	n.a.	n.a.
Centre for Technological Logistics (LinTec)	planned	n.a.	n.a.	n.a.

Source: Government of Catalonia (2007), "Centres de Recerca a Catalunya", *Temes de Recerca i Innovatió,* N° 4, Ministry of Innovation, Universities and Enterprise, Commission for Universities and Research, Barcelona.

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.[1] 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.[2] 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.[3] These transfers, that would have contributed the largest share of the CIRIT budget, were not approved at State level.[4] 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,[5] 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

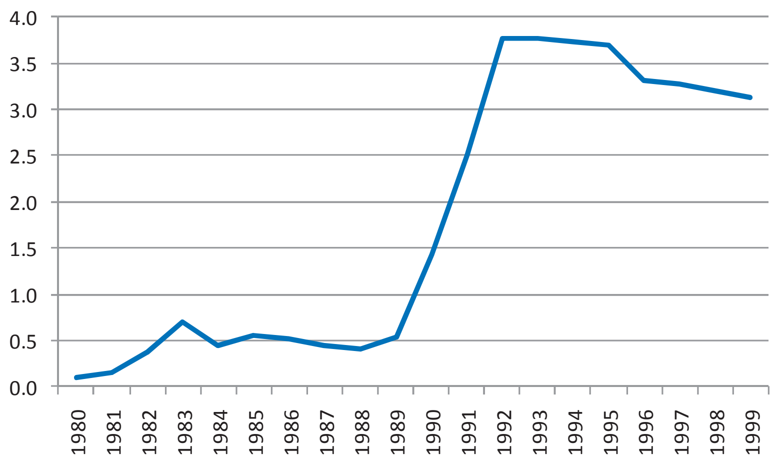
The lack of articulation between the research and innovation pillars of S&T policy deepened during this period. The academic constituency's pressure for resources to develop their research activities (mainly related to infrastructure and human capital) became more acute while awaiting resolution of the 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.[6] 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.[7] 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).[8]

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&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.[9]

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,[10] 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).[11]

- ***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.[12] 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.[13] The complementary Innovation Plan was entrusted to CIDEM. Both bodies had management functions for the implementation of the respective Plans.[14]

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).[15]

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[1]	176	16.3	270	18.5	53.0
University researchers’ salaries[2]	560	51.9	707	48.7	26.3
Thematic areas[3]	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.[16] 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).

- Digititalisation of SMEs (*Digitalizació de la empresas*).
- 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 (XCDT).

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/ACC1Ó 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 ACC1Ó.

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.[17] 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.[18]

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.[19] 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,[20] 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.[21] 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 Budget (EUR millions)	2005-2008 %	2007 Budget (EUR millions)	2007 %
Transversal actions			**649.0**	**75.5**	**184.5**	**77.3**
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
Complementary actions			**88.2**	**10.2**	**10.6**	**4.5**
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
Sectoral and technology strategy	DTI	CIDEM/SIE	**122.8**	**14.3**	**43.5**	**18.2**
Total PRI			**860.0**	**100.0**	**238.5**	**100.0**

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***[22] 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.[23] 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.[24]

- ***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.[25] 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".[26] 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[27] 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).[28] 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	
RESEARCH, DEVELOPMENT AND INNOVATION RESOURCES					
1	R&D spending as a percentage of GDP[1]	1.38 (2003)	1.99[7] (2002)	2.10	1.48
2	Business innovation spending as a percentage of GDP[1]	2.42 (2000)	3.70[6] (2002)	5.20	2.00
3	R&D spending by private sector enterprises as a percentage of GDP[1]	0.91 (2003)	1.30[7] (2002)	1.26	0.93
SCIENCE AND TECHNOLOGY HUMAN RESOURCES					
4	Number of researchers (full time equivalent)[1]	18 387 (2003)	--	24 000	25 063
5	Number of researchers per 1 000 labour market participants[1,2]	6.42 (2003)	5.60[7] (2000)	7.5	7.2
6	Private sector researchers as a percentage of the total number of researchers in Catalonia[1]	37.51 (2003)	50.97[7] (2001)	45	41.3
7	Number of in-company researchers per 1 000 labour market participants[1,2]	6.29 (2003)	5.83[7] (2001)	8	6.55
PRODUCTIVE STRUCTURES					
8	Innovative businesses (10 or more workers) as a percentage of all businesses[2]	25.80 (1998-2000)	44[4] (1998-2000)	40	27.4
9	Industrial GVA for high-technology sectors as a percentage of total industrial GVA[1]	7.50 (2002)	13.7[4] (2000)	10	8.15
10	Employment in high-technology industries as a percentage of labour market participation[1]	2.68 (2002)	3.57[4] (2002)	4	3.0
SCIENCE AND TECHNOLOGY RESULTS					
11	Number of indexed scientific publications[9]	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)[9]	5.33 (1999-2000)	6.04 (1999-2000)	6.04	Not avail.
13	Number of doctoral theses submitted[3]	1 200 (2003)	--	1 500	1 359 (2008)
14	Number of patents registered at the European Patent Office per million inhabitants[4]	62 (2002)	161 (2002)	160	Not avail.
15	High-technology industrial exports as a percentage of total industrial exports[2]	12.07 (2003)	--	18	15.1 (2008)
SCIENCE AND TECHNOLOGY POLICIES					
16	Catalan researcher success rate in Spanish State open calls[8]	27 (2002)	--	30	16.8
17	Value of Catalonia participation (million of Euros) in the EU Framework and other research programmes[5]	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&D expenditures in Catalonia**

	2004		2005		2006		2007	
R&D Investment in Catalonia by sector of performance (EUR millions and as % of GDP)								
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%
TOTAL	2 107	1.19%	2 302	1.36%	2 614	1.43%	2 909	1.48%
Catalan government R&D&I expenditures[1]								
EUR million	426	550	676	760				
Growth over previous year	14.8%	29.1%	22.9%	13.9%				
% of Catalan budget[2] (Catalonia calculation)	2.76%	3.11%	3.18%	3.46%				
% of Catalan budget[2] (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[3]	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 difficultly 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.[29]

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.[30] 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.[31] 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.[32]

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.[33] 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 re-open 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.[34] At the end of 2008 there were 37 Catalan Research Centres (CRCs), 14 of them created since 2004, and six new ones in development.[35] 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;[36] 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.[37] 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,[38] their effects in terms of behavioural additionality[39] 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.[40]

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.[41] 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.[42] 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*),[43] 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.

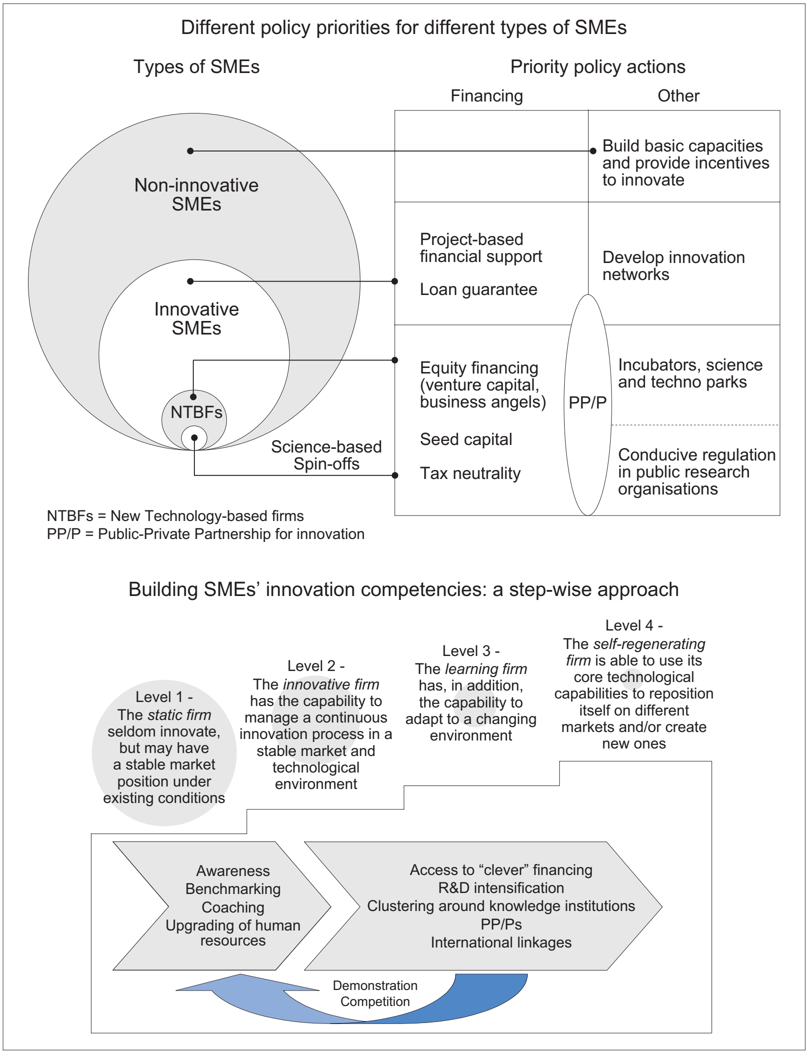
Box 2.3. **Promoting innovation in SMEs: OECD country experiences** (*continued*)

- ***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.[44] 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.[45] 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 ACC1Ó (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	• Securing service development-related private and public financing, grants and tax credits for businesses • Transfer of enabling technologies that can support the role of KISA in innovation
Indirect policy intervention targeting non-business actors within the innovation system	• Securing the skills base needed by service innovators • Widening the focus of RTOs towards non-technological innovations
Development of framework conditions facilitating the role of KISA in innovation	• Opening up of new markets for service providers • Cutting down the regulatory burden • Financing for the use of external KISA • Good practice development, standards for service quality • Cultivating services related to innovation culture
Development of existing innovation policies, more service-friendly	• Adopting the broad innovation concept, acknowledging the value of process innovations (technological and organisational), and product innovations (goods and services) • Adapting financing and assistance criteria so that services-related innovation projects get better access to existing policies • Training and skills development in service-related innovation for actors executing the innovation policy
Development of new policy measures targeting issues that are central to the development of KISA and services-related innovation	• Networks and customer interaction as innovation platforms • Developing organisations that are more capable of using internal and external KISA

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).[46] 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).[47] 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 pursing 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.omc-ptp.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*

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.[48] 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 21st 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

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.[49] 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 %[1]
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[2]	10	1.48	2.31
Other	9	1.33	2.08
Innovation and industry (CIDEM and SIE)[3]	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.[50] 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[51] 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 ACC1Ó (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,[52] 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.[53] 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[54] and the involvement of stakeholders in the research and innovation communities.[55] This comprehensive approach has certainly contributed to enrich the diagnosis of the strengths and weaknesses of the Catalan system.[56] 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.[57] 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.[58]

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;[59]
- To increase the number of research centres in strategic fields and under criteria of highest excellence.[60] 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.[61] 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.[62]

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.[63] 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.[64] 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 *(20 commitments)*	-To have an education system and a professional environment that provides, promotes and maximises scientific, innovative and entrepreneurial abilities. -To attain a critical mass of qualified professionals with the right profiles for innovation (creative, scientific, technical and management skills). -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.
2. Push	To develop and maintain a high capacity for generating and valuing knowledge *(19 commitments)*	-To strengthen the public research system. -To attain and profit from leading scientific and technological infrastructures. -To reinforce the capacity of research agents to value knowledge.
3. Pull	To innovate systematically as a base for productive activity and public and social action *(23 commitments)*	-To facilitate the development of the different types of innovation. -To generate favourable contextual conditions for innovation. -To encourage the growth of an innovative and knowledge-intensive business ecosystem. -To have an innovative public sector as well as public administration that drive innovation.
4. Internationalise	To think, be and act globally in research and innovation *(11 commitments)*	-To direct and implement a joint co-ordinated action to internationalise research and innovation. -To strengthen the role of Catalonia as an international player in research and innovation. -To establish international strategic alliances and platforms for research and innovation.
5. Socialise	To ensure that Catalan society be infused with science, technology and innovation *(15 commitments)*	-To direct and implement a joint co-ordinated action of socialisation of science, technology and innovation. -To introduce science, technology and innovation into close contact with the public. -To place science, technology and innovation in the foreground of the political, social and economic arenas in Catalonia.
6. Focus	To focus and prioritise research and innovation where there is the greatest value *(7 commitments)*	-To define the strategy for focusing on research and innovation in Catalonia. -To design and develop the regional strategy for specialisation in science, technology and innovation. -To specify fields that are strategic priorities for research and innovation in the coming years. -To direct instruments and resources towards the areas focusing on and prioritising research and development.
7. Facilitate	To adopt a governance of the research and innovation system that is intelligent, efficient and effective *(21 commitments)*	-To establish a solid organisation and link among agents in the Catalan research and innovation system and to strengthen their co-operation. -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. -To maximise the efficiency, the effectiveness and the learning capacity of the research and innovation system.

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 multidisciplinarity.
- 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;[65] 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 ACC1Ó (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.[66] 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 ACC1Ó 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 ambitions 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 additionality 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 of 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 trough 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 asses 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*.

48. For more information, please see *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
1. CIRIT and DGR		
1.1. Research Promotion Programme		
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
1.2 Technology Transfer Programme		
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
Total CIRT/DGR	**23 022**	**100.0**
2. Transfer DURSI for Academic Research Personnel	**93 136**	
3. Total DURSI[1]	**122 451**	
4. Thematic areas[2]		
Health	34 556	
Industry (including CIDEM)	6 675	
Agriculture	5 197	
Others	10 683	
Grand total Research Plan	**179 562**	

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 Ricerca de Catalunya", Generalitat de Catalunya, Barcelona.

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

Objective	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.	
Beneficiaries	Companies with establishments in Catalonia grouped in technology innovation cores (minimum three firms)	
Subsidisable projects	- Industrial research - Experimental development	
Duration and dimension	The project should have a minimum of subsidisable expenses of EUR 1 000 000 Maximum duration: 2 years	
Subsidisable expenses	- 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)	
Maximum subsidy	- 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.
Result	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 ACC1Ó: 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.

Chapter 3

Multi-level Governance of Catalonia's S&T&I policy

Introduction

Catalonia’s S&T and innovation policies are embedded in a multi-level governance context. In this policy field, both EU and Spanish policy streams are significant. Catalonia must also co-ordinate across its different local governments. Local actors are increasingly making efforts to support innovation in terms of both soft and hard infrastructure. As discussed in Chapter 2, Catalonia has developed its own policies in part as a function of the objectives, policy content, resources and evaluations set by policy makers elsewhere. Given this mutual dependence, Catalonia needs opportunities to co-design, when possible, the policies originating at other levels of government. Secondly, it needs instruments to help effectively share and co-ordinate these S&T and innovation competencies. The governments of both Spain and Catalonia recognise that more co-ordination is needed to guarantee greater effectiveness in co-design and implementation in this policy field.

This chapter first highlights the importance of funding streams coming from outside of the region for Catalonia’s innovation system. It then explores the influence of EU policy and instruments on Catalonia’s policy approach and its innovation system actors. The Spanish policy context, and the mix of instruments that can be accessed by Catalonia’s actors, is discussed. The formal roles of both Spanish and Catalan governments in terms of S&T and innovation policy is reviewed, a role sharing that has been challenged in the past but has stabilised. The different “gaps” resulting from this role sharing are highlighted, as well as the effectiveness of mechanisms for co-ordination to bridge these gaps. Finally, Catalonia’s opportunities to co-ordinate in this policy field with its own local communities, as well as regions beyond Spain, are highlighted. Horizontal co-ordination among Catalan government actors is addressed in Chapter 2.

3.1. EU and Spanish S&T and innovation policy context

Catalonia’s explicit strategy with respect to public financing of R&D has been to use its own resources to build research excellence so as to maximise funding receipt from EU and Spanish sources. For 1994, one calculation of publicly financed R&D accessed by Catalan actors showed a split of: 7.5% Catalan funding, 11.4% Spanish funding and 81.1% EU funding, the latter including EU Structural Funds.[1] There has been considerable growth in the levels of different sources of funding for R&D, with the exception of EU Structural Funds, and Catalonia has grown increasingly successful in attracting EU competitive research funds. The net result is that in the mid-2000s the flow of S&T and innovation funds was approximately 4% from the EU Framework Programmes, 5% from relevant EU Structural Funds, 50% from Spanish government programmes and 41% from the Catalan government (see Table 3.1). The Catalan government figure includes funding of the share of university professor salaries associated with research duties. If those amounts were excluded, the Catalan share of spending would decline. In 2006, for example, 36% of Catalan government spending on R&D&I was for university professor salaries associated with research duties (see Table 2.7).

Table 3.1. **Public funding for S&T and innovation**

mid 2000s

Organisation or programme	Funding trend over time	Period of data	Public funding total (EUR million)	Public funding avg. annual (EUR million)	Share (%)
Catalan government[1]	Up	2004-2007	2 407	602	41%
Spain (National R&D Plan – includes CDTI)[2]	Up	2004-2007	2 917	729	50%
EU Framework Programme	Up	2002-2006	217.5	54.4	4%
EU-Regional Policy (ERDF)[3]	Down	2000-2006	445.2	63.6	4%
EU-Social Policy (ESF)[3]	Down	2000-2006	51.1	7.3	1%
Total			6 038	1 456	100%

Notes: 1. Includes all funds reported by the Catalan government across ministries for R&D&I in the annual CIRIT reports, which includes university funding. 2. Includes grants, loans and approved funds for human resources. 3. The figures, in current prices, refer to Community contributions and projects effectively executed until 31/12/2008 inside the 2000-2006 programming period. The ESF during the 2000-2006 period shares the same operational programme with the ERDF. The ESF figures introduced in the table refer to actions related to the strengthening of labour capacity in research, science and technology.

Source: OECD calculations based on various data sources (EU, Spanish government (*Memoria* of National R&D Plan), and the Catalan government (CIRIT).

An analysis of Catalan firm use of public programmes at EU, Spanish and Catalan levels of government reveals interesting findings to understand the respective roles in a multi-level governance context. Firms that receive public support from domestic sources (national and to a slightly lesser extent regional) increase the likelihood that firms co-operate with national or international partners. National and regional programmes also increase the probability that firms develop product innovations. Regional programmes further support changes in process innovation. Firms that participate in national and international pre-competitive programmes are more likely to have patented, while firms that use other forms of intellectual property protection apart from patenting were more likely to participate in national (as opposed to international) programmes (Fernández-Ribas, 2009).[2]

EU influence on Catalonia's regional efforts

With Spain's integration in the EU in 1986, EU policy has influenced the Catalan innovation system in a number of ways. It should be noted that Catalonia had already begun to develop its own regional science and technology policies prior to 1986. The different EU regulations and sectoral policy streams have an impact on the framework conditions for firms in Catalonia. There are also over-arching agendas like the Lisbon Agenda and the Bologna Process that have an important influence on public policy and actors in the innovation system. Catalonia participates in a number of networking activities promoted by Europe. The two main EU funding sources for Catalonia's S&T and innovation actors are EU regional policy and, to an increasing extent, EU research policy.

EU agendas and networks

The EU Lisbon Agenda aims to modernise Europe to become "the most dynamic and competitive knowledge-based economy in the world". One of the two main quantitative targets is an R&D intensity of 3% by 2010.[3] Member states commit to this agenda and Spain has considerably increased public funding for R&D and innovation, which Catalonia benefits from as a leading recipient of many Spanish programmes. Regions also have an incentive to promote greater R&D investment to meet this target. The Lisbon Agenda is also serving to direct EU spending in different policy areas, such as research and regional policy.

The Bologna Process seeks to harmonise higher education systems across member states for one European higher education system.[4] In Catalonia, some universities had created foundations to offer professional training in the form of non-degree programmes and lifelong learning to overcome the rigidities in the Spanish higher education system that did not include professional Masters degrees. Implementation of the Bologna Process will therefore facilitate the development of degree programmes in Spain and Catalonia that are easier for students to have recognised in the labour market. It will also support Catalonia's efforts in attracting foreign students.

A number of different EU-related networks provide a forum for information sharing and potentially joint action with Catalonia. The Four Motors Agreement promotes joint projects on a range of themes among four leading industrial regions in their respective countries, including Catalonia.[5] A current focus is on "further strengthening of their economic, scientific and technological competitiveness in an interconnected global context" and to better access EU funds in regional and research policy streams. Catalonia participates in other trans-national networks as well (see later section). Catalonia is a member of numerous groups for sharing best practices, such as ERRIN, the European Regions Research and Innovation Network, which includes approximately 70 EU regions.

EU regional policy

For Spain, EU regional policy funds have played a key role in supporting regional innovation systems, particularly in lesser developed regions. While the overall EU regional policy budgets are going up, the share and absolute amounts to Spain are going down. Only 15.9% of the total EU funds in the 2007-2013 programming period are going to regions that are *not* in the convergence or phasing out categories. This decline in EU regional policy funding to Spain has been identified as a threat to the national innovation system given its role in S&T and innovation-related infrastructure funding in many regions (EC, 2008). The core regional policy funds to Spain (ERDF, ESF, and the new Technology Fund) declined by 31.4% between the 2000-2006 and 2007-2013 programming periods (from EUR 40.4 billion down to EUR 27.7 billion in 2004 prices).

For Catalonia, as a leading region in Spain and above average in the EU25, the decline in Structural Funds is even greater. In the latest period (2007-2013), Catalonia will receive a total of EUR 1.2 billion in 2004 prices, down 40.4% from the prior period. The 2007-2013 Plan for using ERDF funds totals EUR 679 million, on average EUR 97 million annually. One of the five axes of the plan is "knowledge economy, innovation and firm development" which will receive 53% of the funds or approximately EUR 51.4 million annually from the EU with matching Spanish funds. While not all of these funds may be considered pure R&D and innovation-related investments, this amount gives a rough benchmark of the scale of funds from this EU policy stream. The European Social Fund, approximately EUR 284 million in the latest period (EUR 40.6 million annually on average), includes some portions for entrepreneurial development. There are EU Cohesion Funds that may be used in Catalonia, but they have only an indirect impact on the regional innovation system.

Several specific initiatives targeted at regional innovation system development have been used by Catalonia. One is the RIS (Regional Innovation Strategies). The RITTS (Regional Innovation and Technology Transfer Strategies) approach was the basis for Catalonia's first Innovation Plan 2001-2004 (see Chapter 2). The process was valuable in helping shift Catalonia's approach from the "academic" research orientation to one that increasingly recognises firm demand for innovation support. The process included firm interviews to identify different innovation processes. Programmes were developed based on an innovation-project logic for firm support. International benchmarking was also part of the plan development.

EU research policy

The EU Research Framework Programmes are the guiding plans for EU research policy funding. The Seventh Framework Programme (FP), *Building the Europe of Knowledge*, runs from 2007-2013.[6] It reflects a 65% budget increase from the Sixth FP, from an annual average spending of EUR 4.375 billion to EUR 7.217 billion. Catalonia has been able to capture a growing share of Spain's total FP receipt over time, from 14.7% in the Third FP to 23% in the Sixth FP (see Table 3.2). Furthermore, Catalonia is capturing an increasing share of European spending, as the region's growth rates in receipt between the Third and Sixth FP are significantly higher than the EU as a whole.

Within the Seventh FP is the new European Research Council (ERC), and Catalonia's researchers have successfully accessed its funding streams (see Table 3.3). The programmes include ERC Starting Independent Researcher Grants and ERC Advanced Investigator Grants.[7] While the funding amounts are not at the same scale as the other EU research funding sources, they are strategic for Catalonia's goal of attracting and building its science research base. The overall EU budget in 2007 for the ERC Starting Grant was EUR 335 million and in 2008 for the ERC Advanced Investigator Grant EUR 553 million. The benefits of Catalonia's researcher attraction policies, as supported by the ICREA Foundation, are evidenced here.

Table 3.2. **EU Research Framework Programme: Catalonia**

Programme period	Years	Total budget EU (EUR billions)	Increase from prior period annual average (%)	Share of Spanish total (%)	Catalonia Total received (EUR millions)	Catalonia Avg annual (EUR millions)	Increase from prior period (%)
Third	1990-1994	6.60	23%	14.7%	34.4	8.6	--
Fourth	1994-1998	13.12	99%	17.7%	75.5	18.9	119%
Fifth	1998-2002	14.96	14%	20.4%	127.9	32.0	69%
Sixth	2002-2006	17.50	17%	23.2%	217.5	54.4	70%
Seventh[1]	2007-2013	50.52	65%	25.3%	86.2	86.2	59%

Note: 1. Figure for the year 2007 only.

Source: OECD calculations and data from EU, Spanish and Catalan government sources.

Table 3.3. **European Research Council grants: Catalonia**

	Starting independent research grants	Advanced investigator grants
Spain grants	33	12
% EU total	4.2%	2.7%
Catalonia grants	18	7
% Spain total	55%	58%
Recipients	-10 Catalan Research Centres -8 ICREA researchers	-3 Catalan Research Centres -6 ICREA researchers

Source: Catalan government, Ministry of Innovation, Universities and Enterprise.

Spanish strategy, programmes and funding

Evolution and current status of Spanish science, technology and innovation policy

While Spain's economic growth was strong until the onset of the current financial and economic crisis, labour productivity growth has been modest. GDP per hour worked expanded by just 0.8% per year between 2001 and 2007 – one of the lowest growth rates among OECD member countries, significantly below the OECD average of 1.7%, and far below the productivity growth realised by the best performing countries within and outside the OECD. There are several factors behind this low productivity growth (OECD, 2008a). The lower than average investments in R&D is one factor. Spain spent 1.27% of GDP on research and development in 2007, significantly below the EU27 (1.77%) and OECD (2.29%) averages.

Furthermore, the composition of R&D and innovation funding in Spain reveals some structural features that are typical of less mature national innovation systems, notably a lower than average share of R&D investment by firms', due in part to industrial structure (see Box 3.1).

Box 3.1. **Spain: R&D investment trends**

Spain spent 1.27% of GDP on research and development in 2007, significantly below the EU27 (1.77%) and OECD (2.29%) averages. While the current level of R&D and innovation represents a substantial increase from the levels of the mid-1990s (around 0.8% of GDP), and innovative capacity has increased by the strong growth in R&D personnel (which expanded by 7.8% per year on average between 2000 and 2006), Spain's overall investment in R&D and innovation is still comparatively low. In a longer-term perspective, this dampens productivity growth and reduces the potential for sustainable gains in income per capita. In addition, R&D efforts are concentrated in two regions: Madrid and Catalonia account for half of total R&D.

The composition of R&D and innovation funding in Spain reveals some structural features that are typical of less mature national innovation systems. The share of total expenditures on R&D (GERD) financed by the business sector is 47% while that financed by government at 42.5% is nearly as high; 5.9% is financed from abroad – reflecting a need for increasing participation of industry in European R&D programmes – and 4.5% from other national sources (2006). The business sector performs just 55.9% of total Spanish R&D (2007), as compared to 63.4% in the EU27 and 69.5% in the OECD – a share of industry which is much more representative of the best performing countries. While Spain has succeeded to increase the share of industry in total R&D performed, further boosting R&D and innovation in the business sector is a challenge given Spain's industrial structure. Most industries are relatively low-tech and most firms are small or medium-sized. The share of government in financing business enterprise expenditure for R&D (BERD) was 14.4% in 2006, twice the EU27 (7.2%) and OECD (6.8%) averages (not including tax incentives for R&D).

Boosting productivity growth is therefore one of the main challenges for achieving strong, sustainable growth performance in the Spanish economy. Science, technology and innovation is a key pillar in any strategy to meet this goal. Recent initiatives, including the National Reform Programme 2005, aim to boost productivity and sustainable growth through reforms in product and labour markets, higher education and human capital, investment in infrastructure and by fostering research and innovation.

The system of science, technology and innovation policy has evolved, notably after 1986[8] – the year of Spain's accession to the European Union. Over time, the portfolio of instruments of Spanish science, technology and innovation policy has developed into a differentiated set of measures providing generic support, addressing specific shortcomings, or fostering emerging strengths in the Spanish innovation system. The European TrendChart lists about 50 such instruments. This evolution at the national level has taken place against the background of regional governments' emergence as increasingly important players in innovation, developing their own R&D and innovation policies. This co-evolution can potentially complement and magnify the impact of policies delivered at the national level but may also lead to some degree of inefficiency in the case of an inadequate interplay of, and between, different levels of government.

Spanish R&D and innovation policy continues to evolve. Successive governments have been active in approving new science and technology plans, and proposing new policy schemes, sometimes accompanied by reorganisation and redistribution of competences among ministries. Currently, the main foundations of Spain's research policy are laid out in the sixth National Plan for Scientific Research, Development and Technological Innovation (2008-2011) – complemented by the INGENIO 2010 initiative which is part of the wider National Reform Plan.

The National Reform Plan

The National Reform Plan (*Ministerio de la Presidencia*, 2005 and 2008) is a broad-based initiative launched by the Spanish government in 2005 to boost Spain's competitiveness. The National Reform Plan contains the INGENIO 2010 initiative which is designed to contribute to closing the gap in science and technology with Europe's most advanced countries. INGENIO 2010 can be seen as the main policy instrument to shift the overall policy mix towards higher quality research and innovation in the business sector. It complements the measures taken under the National Plan for Scientific Research, Development and Technological Innovation (see below). Under INGENIO, the Spanish government has strongly increased public support to R&D and innovation (allocating more than EUR 8 billion in the 2007 budget), with a view to achieving a research intensity (ratio of GERD to GDP) of 2% by 2010.

The INGENIO 2010 initiative encompasses a number of instruments. They are designed to: increase the focus and the level of funding of public research; stimulate technology transfer by encouraging public-private partnerships; and enhance the incentives for business-sector research and the diffusion of new technologies. The policy package of INGENIO 2010 includes the promotion of public-private partnerships (CENIT) for innovation, venture funds and programmes to increase research capacity (CONSOLIDER and CIBER).

The overarching goal of the differentiated set of policy instruments proposed by INGENIO 2010 is to build critical mass in research, foster networking and increase the contribution of public research to innovation throughout the Spanish economy. The funding is targeted at long-term, large-sized and broad-ranging projects, to stimulate higher-risk and more ambitious research. Regional investment is encouraged, therefore regional governments are encouraged to collaborate in the start-up of the programmes as well as to co-finance the subsequent activity in their areas (OECD/FECYT, 2007).

The National Plan for Scientific Research, Development and Technological Innovation

The National Plan for Scientific Research, Development and Technological Innovation ("National Plan") is the basic programming instrument of the Spanish system of R&D and innovation, as defined in the Science Law of 1986. It is the mechanism to establish medium-term research and innovation policy objectives and priorities, and to design the tools to achieve them.

The sixth National Plan for 2008-2011, approved in 2007, relates to the National Strategy for Science and Technology (*Estrategia Nacional de Ciencia y Tecnología*, ENCYT). This National Strategy was adopted in early 2007 as the guide for S&T policies until 2015, at the third Conference of Presidents (with regional governments) chaired by the Prime Minister. It aims to provide a general framework of principles and broadly shared objectives upon which the future national and regional plans for R&D and innovation will be elaborated.

The sixth National Plan presents the following four areas related to its general objectives and linked to instrumental programmes aiming at specific objectives: *i)* knowledge and capacity generation; *ii)* promotion of co-operation in R&D; *iii)* sectoral development and technological innovation; and *iv)* strategic actions (see Box 3.2 for a summary of National Plan objectives).

Box 3.2. National Plan for Scientific Research, Development and Technological Innovation

The National Plan (2008-2011) encompasses six objectives:

- ***Put Spain in the vanguard of knowledge:*** Raising the profile of knowledge generation; funding based on criteria of excellence and demand; increasing the number of researchers and their qualification.

- ***Promote a highly competitive firm structure:*** (1) Increasing the capacity of the science and technology (S&T) infrastructure organisations and (2) its interdisciplinary use by all agents, especially small- and medium-sized enterprises (SMEs), fostering (3) co-operation and (4) technology transfer; (5) matching R&D with demand in the markets.

- ***Integrate the regional level into the national S&T system:*** (1) Encouraging co-ordination between national and regional policies (2) including joint tenders and (3) the evaluation of policies.

- ***Strengthen the international dimension of the S&T system:*** Promoting the international (1) co-operation of Spanish R&D agents; (2) participation in and use of large European research facilities and (3) participating in the seventh Framework Programme, (4) providing access for foreign R&D actors to national public tenders; (5) co-ordination of R&D performing actors of different countries through ERA-NET.

- ***Provide a favourable climate for R&D investment:*** Improving (1) co-operation, (2) transparency, (3) the policy management and (4) organisation (evaluation criteria, access, etc.) to assure the achievement of goals related to investment in R&D and innovation.

- ***Provide favourable conditions to promote scientific culture and the diffusion of S&T advances in society:*** (1) Using new communication forms to show the scientific and technological innovations to the society; (2) design stable structures to promote scientific culture; (3) create networks for the social communication on science and technology.

The National Plan contains quantitative objectives relating to 16 S&T indicators. The specific goals of the INGENIO 2010 initiative – which is part of the National Reform Plan aimed at achieving the objectives of the Lisbon Strategy – include an increase in the ratio of R&D investment to GDP to 2% by 2010, with a private participation of 55%, and convergence to the EU15 average in the percentage of GDP devoted to ICT.

Source: European Commission (2009), *ERAWATCH Country Report 2008: An Assessment of Research System and Policies (Spain)*, European Communities, Luxembourg.

The sixth National Plan was prepared in a participatory process to which the key stakeholders of the Spanish innovation system have contributed. The National Plan attempts to involve the regional governments, not only in designing the National Plan, but also in taking part in and financing the actions it defines. In contrast to previous National Plans, the sixth National Plan relies on a new model that is based on the definition of instruments designed as policy responses to the strategic and operational objectives set out in the National Strategy for Science and Technology. The sixth National Plan includes a set of "strategic actions" or initiatives in areas of special interest, among them climate change and energy. It also led to some changes in the Spanish innovation policy mix, some of which respond to OECD recommendations (OECD-FECYT, 2007). Among these new initiatives (EC, 2008) are:

- The establishment of *technology platforms and networks* to enhance co-operation between firms and actors in research. The EuroIngenio Programme was presented in 2007. It was designed to enhance the participation of Spanish researchers in European projects and enhance the internationalisation of the Spanish research community. It had a budget of EUR 15.6 million in 2007 for its four sub-programmes (Euroscience, InnoEurope, Eurohealth and TecnoEurope).
- The *PROFIT Programme*, which had the overall aim to encourage R&D and innovation activities in organisations, was discontinued. However, its specific objectives have been integrated in other programmes.

As other countries, Spanish S&T and innovation policy is undergoing some longer-term change. Among these trends one can observe (EC, 2009):

- a shift from institutional (block-grant) funding to competitive project funding;
- a shift from grants to soft loans and fiscal incentives in the period 1998-2004 and a re-emergence of subsidies in recent years;
- an increasing role of the universities in scientific research as well as a diversification of their tasks;
- an increasing emphasis on excellence and critical mass in research;
- a degree of re-orientation of the research system towards the needs of the economy and society as a whole;
- notably, growing attention to the varied and changing needs and requirements of business sector R&D and innovation, inducing a diversification of policy instruments; and

- a growing emphasis on policies to foster human resources, including at the post-doctoral level.

These trends are complemented by corresponding developments in the governance system. They include the growing role of regional governments on the one hand and the European Union on the other, leading to the emergence of a multi-level governance structure. Another is the concentration of R&D and innovation-related competencies among actors in the Spanish government within the Ministry of Science and Innovation. And finally, Spain has implemented the Integrated Monitoring and Evaluation System (SISE) for *ex post* assessments of the impact of R&D and innovation programmes.

Some characteristics of the Spanish policy mix

According to ERAWATCH, for the National Plan and INGENIO 2010, the greater part of funding (57%) takes the form of subsidies, versus 43% through loans (EC, 2009). Over 41% of the grants and 81% of the loans are devoted to generic public competitive tenders for projects, a further 11% to infrastructural support and 16% to human resources. The Working Programme for 2007 (covering the National Plan and INGENIO 2010) foresaw that 34% of the funds are allocated to the public R&D sector, 27% to the private sector and 39% to public-private initiatives.[9] The main instrument of Spanish R&D policy directed towards public R&D is subsidies (84% of the funds received), while for private R&D and public-private initiatives, funding takes mainly the form of loans (63% and 53%, respectively).

It appears that priority setting has not been among the strengths of Spanish S&T and innovation policy. The main beneficiaries are firms in the following sectors: transport (construction of components, vehicles and others [18%]), IST services (11%), aeronautics and space (12%), machinery and equipment (4%), chemical products (5%) and pharmaceuticals (3%). The intensity of support (support as a percentage of own R&D expenditures) varies across industries, the average being 14%.[10]

Spain has a number of direct measures in its policy mix that are complemented by initiatives to reduce red tape and provide more innovation-friendly framework conditions through legal reforms. The European Commission (2008) identifies the following main areas of actions within the Spanish policy mix:

- creation of innovative enterprises, with a special focus on technology-based enterprises, by providing direct support and indirect incentives (*e.g.* fiscal measures);

- consolidation of enterprises (Neotec Programme, InnoEmpresa and the Statute of the Young Innovation Enterprise of the sixth National Plan);
- support to R&D and innovation projects in enterprises (CENIT, InnoEmpresa and the sixth National Plan);
- improvement of researcher employment conditions and human capital (I3 Programme), Torres Quevedo Programme, Organic Universities Act and the ratification of the Bologna Process;
- fostering innovation capacity and knowledge transfer (Strategic Fund, CREA Programme, CIBER Projects and PROFARMA);
- policy assessment through the establishment of a monitoring and assessment instrument (SISE) to evaluate the performance of the measures implemented so far; and
- expansion of the information society (Avanza Plan).

In addition to direct support through grants and soft loans, Spain also applies indirect support via fiscal incentives to stimulate R&D and innovation. Although these measures do not involve a flow of money, they do increase the total amount of government support to R&D and innovation (see Figure 3.1). The Spanish system of tax incentives for R&D and innovation is one of the most generous among OECD member countries. It allows a deduction from corporate taxes to firms investing in R&D and innovation activities, offering a mixed system of "volume-based" and "incremental" tax credits. Deductions can reach as much as 30% of the level and 50% of the increment in R&D expenditure on a broad range of operations, including staff costs, acquisition of technology and purchase of material.

In 2003, the government enabled the Ministry of Industry, Tourism and Commerce (MITYC) to issue certificates for R&D and innovation activities for firms willing to benefit from the corresponding tax incentives. This policy was developed with the aim to increase legal security for firms confronting the internal revenue service and encourage them to use R&D and innovation benefits more broadly. Between 40% and 50% of Spanish innovative firms were estimated to benefit from these incentives (around 4 000 in 2004)[11] which represented EUR 262 million in the annual budget for the year 2006 (21% more than in 2005). Of the overall estimated allowances in the 2006 MITYC report for R&D and IT, roughly EUR 36 million were registered for Catalonia, 35% of the Spanish total of EUR 130.5 million (Sanchez Granada, 2008).

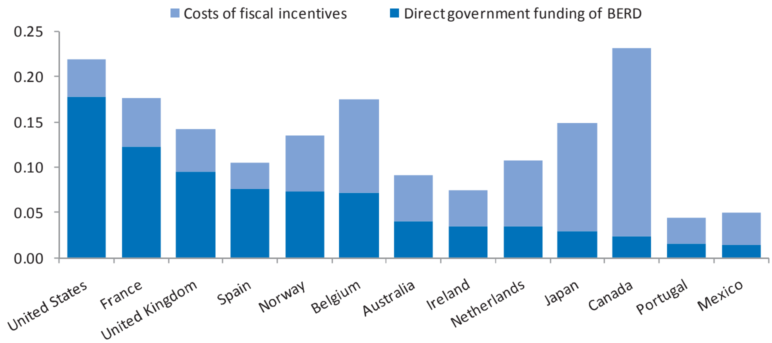
The tax reform approved in November 2006 has brought about important changes.[12] First of all, a new instrument has been introduced in the form of a reduction of 40% in the social charges to be paid by the firm corresponding to R&D staff (not compatible with the use of R&D and innovation corporate tax benefits). Second, corporate tax rates have been reduced 15% for all companies, in one year for SMEs (from 30% to 25% by 2007) and in two years for the rest of firms (from 35% to 32.5% by 2007 and to 30% by 2008). Third, to compensate for the general decrease in corporate taxes, R&D and innovation corporate tax credits have also been reduced (8% by 2007 and 15% by 2008). Fourth, the tax reform also states that the current system of tax incentives for R&D and innovation will not be available as of 1 January 2012.[13] Finally, the government envisages to evaluate the relative effectiveness of the two alternative R&D and innovation support measures (reduction in social charges for R&D staff versus R&D and innovation corporate tax credits) before the end of 2011 and decide which one is better adapted to the needs of the Spanish economy.

Taken together, all these provisions make Spain's fiscal incentives for R&D and innovation the second-most generous in the OECD, as measured in terms of the subsidy rate per USD spent on R&D (see Figure 3.2). Only France has a more generous scheme of incentives in place.

Catalonia is one of the top two recipients of Spanish programme funds, albeit in some categories its share declined between 2004 and 2007 (see Table 3.4). The region is the top recipient in terms of "competitiveness support" at 24.1% of the Spanish total, mainly funds from CDTI. It follows Madrid in terms of "RDI projects" (22.8% in 2007), "complementary actions" (18.4%) and "human resource development" (18.9%) categories. The region has gained in its share of "S&T equipment and infrastructure" receipt. In 2008, Catalonia continued to lead Spanish regions in terms of CDTI funds, 22% of the Spanish total.

Figure 3.1. **Direct and indirect government funding of business R&D and tax incentives**

2005 or latest year available

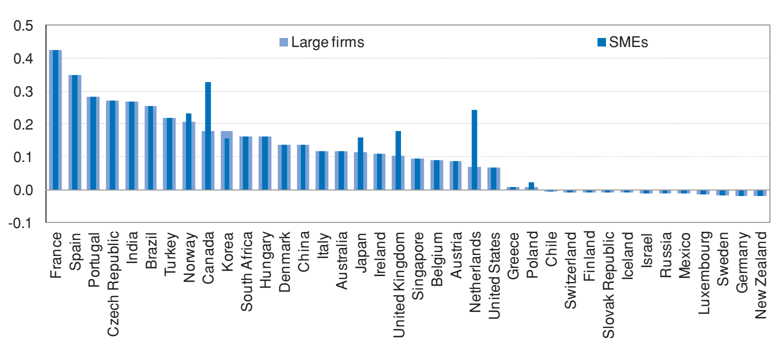


Notes: The estimates cover the federal research tax credit for the United States; the SR&ED tax credit for Canada; the mixed volume and incremental incentive for France; the refundable research premium for Austria; the tax credit consisting of a reduction of taxes on R&D wages as well as the allowance on profits of R&D self-employed for the Netherlands; the volume measure for Mexico, Norway and the United Kingdom; the mixed volume and incremental measure for Spain (now being phased out); both the tax offset and incentive depreciation for Australia; the incremental tax credit for Ireland; the tax incentives for experimental research plus the special tax depreciation of equipment for developmental research for Japan.

Source: OECD, based on national estimates (NESTI R&D tax incentives questionnaire), some of which may be preliminary.

Figure 3.2. **Tax subsidy rate for USD 1 of R&D**

Large firms and SMEs, 2008



Source: *OECD Science, Technology and Industry Scoreboard 2009*.

Table 3.4. **Use of Spanish National Plan funds by category**

In percent

Share of Spanish total	RDI projects		Complementary actions		Human resources development		Competitiveness support		S&T equipment & infrastructure	
	2004	2007	2004	2007	2004	2007	2004	2007	2004	2007
Catalonia	28.1	22.8	14.2	18.4	19.5	18.9	29.2	24.1	14.7	21.1
Madrid	26.2	33.6	45.9	35.1	24.9	30.8	7.5	15.8	10.4	11.2
Basque Country	9.2	10.7	8.4	8.5	2.7	2.3	14.3	13.3	5.5	15.1
Total of three regions	63.5	67.1	68.5	62	47.1	52	51	53.2	30.6	47.4

Source: OECD calculations based on the *Memoria de Actividades*, 2007 and 2004, Spanish Ministry of Science and Innovation.

3.2. Central-regional competency sharing on S&T&I

Formal attribution of roles

The increasing regional role in S&T and innovation policy is part of a number of trends that change the terms of mutual dependence across levels of government (OECD, 2009b). Economic, scientific and socio-cultural factors in relation to the role of science in society are interacting with dynamic changes in political governance to give rise to this increasing regional role among OECD member countries (Perry and May, 2007).

The Spanish Constitution of 1978 lays out the framework for competency sharing between the central government and the regions, known in Spanish as *Comunidades Autónomas* (see Table 3.A1.2). There are currently 17 of these regions with similar devolved powers, albeit the process for creation of the regions (1978-1983) and the decentralisation of responsibilities took place at different speeds. Spain is one of the OECD member countries with a relatively higher share of sub-national fiscal activity, with sub-national governments responsible for over a third of public revenues and almost half of expenditures in 2006.

Control over science and technology policy has been a source of inter-governmental disagreement, particularly with respect to Catalonia. Per Article 149.1.15 of the 1978 Spanish Constitution, among the functions considered to be of exclusive competence of the central government is the "promotion and co-ordination of scientific and technical research."

However, Article 9.7 of Catalonia's 1979 Autonomy Charter stated that it too had exclusive jurisdiction in the field of research. Subsequently, the 1986 Science Law of Spain noted that the central government should have exclusive competencies for the promotion and formulation of science and technology policy, albeit the central government's R&D plans could take into account regional activities. In 1987, the Catalan government filed a case in the Constitutional Court regarding this law, requesting that the central government transfer funds for such policies and give the region control over the central government's research labs (CSIC network) located in its boundaries. The Court ruled in 1992 not to decentralise this R&D funding. Nevertheless there has been explicit devolution of some areas of research funding, including university funding, the public health system and its associated research, and agricultural research.[14]

The 2006 Charter for Catalonia, currently being reviewed by Spain's Constitutional Court, clarifies its S&T and innovation focus and linkages with the Spanish State. Per Article 158 on research, development and technological innovation, the *Generalitat* has "exclusive power in matters concerning its own research centres and structures, and the projects it finances" and "shared power over the co-ordination of the research centres and structures in Catalonia." It further acknowledges that "collaboration criteria between the State and the *Generalitat* in research policy, development and innovation shall be established within the framework of the provisions of Title V. Likewise, systems shall be established for the participation of the *Generalitat* in determining policies affecting these matters at European Union level, and in other international bodies and institutions." These Title V framework conditions give the rationale for co-operation to "provide mutual assistance to each other and collaborate when necessary so as to effectively exercise their respective powers and defend their respective interests." The instruments for collaboration may include conventions (agreements) as well as multilateral bodies and procedures, in addition to other collaboration instruments as appropriate.

In practice, science and technology policy is therefore a shared responsibility between central and regional levels in Spain. Regions may seek to take on greater S&T policy responsibilities based on their own budgets, capacities and strategies as well as agreements with central government. The Basque Country is unique in Spain in that it has recently negotiated additional competencies in research.[15] While a few regions began their S&T policies in the early 1980s, prior to Spain's integration into the EU, today all regions have their own S&T policies that are funded with regional budgets. Of public R&D&I spending by Spain and its regions in 2007, approximately 20% of the EUR 10 billion comes from the regional governments (CICYT, 2007).

The overlapping roles between central and regional governments in the field of S&T and innovation are common, particularly in regionalised or federal OECD member countries. In such countries, there are often concurrent responsibilities, meaning that both levels are active in the policy fields (see Table 3.5). For example, recent legal changes in Italy allow each region to set its own research and innovation policies beyond what is set at national level, with a wide variation in regional responses to this new opportunity. In Germany, the *Länder* have substantial S&T&I powers, however in some cases there is required consultation across levels of government. In France, the regions have no formally devolved powers for S&T, but rather regions are increasing their activities in S&T&I given competencies for economic development. Consequently, regional actions in France are more focused on innovation, technology transfer and knowledge exchange.

Managing S&T and innovation between central and regional levels

The challenge in Spain

There are inevitable inefficiencies and transaction costs associated with duplication across levels of government. There is of course a trade-off between such potential losses and the gains from regional experimentation. In general, the lesser developed regions in Spain tend to follow the actions of central government, while the advanced regions are more likely to experiment. Nevertheless, the duplication of programmes and agencies which results in actors "forum shopping" or accumulating benefits unknown by the other level warrants attention.

As a result of this overlap, different "gaps" may emerge which require action at specific government levels given the particular role-sharing arrangement (see Table 3.6). These gaps may be related to information asymmetries, as one level of government has the information needed for the other to develop or implement its policies. There may be capacity barriers to effective implementation of the policy. There is a fiscal gap if one level of government has the policy competence but lacks the funds to implement the policies. An administrative gap occurs when the spillovers from the policy action go beyond its administrative boundaries. Finally, a policy gap may occur when a particular policy is not sufficiently integrated with relevant related policies managed by other ministries or agencies (OECD, 2009b).

Table 3.5. **Division of S&T&I responsibilities: select OECD member countries**

Country	National role	Regional role
France	Formally the State has the primary and largely exclusive responsibility for STI policy across domains, including higher education, with the exception of areas relating to regional economic development which are joint.	While there are no formally devolved powers for STI policy, the regions have exploited competences for economic development to develop increasing activities in these areas. The General Code of Territorial Authorities states that regions can design and develop regional technological poles, can design regional interest pluri-annual programmes and are associated to the design and implementation of national research policy. Each region must have a regional consultative committee of technological research and development, though many are not active. Many regions now have regional research or higher education schemes, but these remain small by national standards. Regional involvement is generally limited to issues associated with innovation, technology transfer and knowledge exchange, though some national programmes, such as U3M or Plan Campus, have increased the involvement of regions in infrastructure and university-related expenditures.
Germany	The German Constitution clearly states that some STI policy tasks are for the *Bund* (federal government), while others for the *Länder.* Federal competences include grants in aid-based thematic R&D funding; institutional funding for large research organisations; foresight; horizontal R&D; international dimension of R&D policy; and innovation-oriented programmes and policies. There are also a range of joint tasks, such as the funding of non-university research institutes. The *Bund* can be involved in the construction of R&D facilities and there is a support scheme to allow involvement in university funding to take account of increasing costs.	The *Länder* are responsible for financing research and teaching at public universities – each state independently enacts its own legislative framework. The *Länder* also contribute to the funding of non-university research institutes and have substantial powers in STI leading to a range of regional research programmes and interventions.
Italy	The State retains primary responsibilities but the 2004-2006 National Research Plan clarifies that the regional legislative authorities can regulate aspects that have not been regulated by the State in relation to	Regions have acquired more responsibility through a change in the Italian Republic’s Basic Law which enables them, along with the State, to adopt autonomous STI policies. All regions are allowed to have local regulation and establish specific regional STI policy. Each

Table 3.5. **Division of S&T&I responsibilities: select OECD member countries** (*continued*)

Country	National role	Regional role
	STI policy. State responsibilities include support of academic research and public research institutions; mission R&D programmes realised through the FIRB fund; the creation of large public-private labs; the co-ordination of a national scientific system; and support of the research infrastructure. There is a strong regional approach to STI policy based on the concept of the "technological district".	region has its own research policy and innovation policy that runs concurrently with the State. Regional research councils do not exist yet and there are few governance structures. Important areas of regional research policies have been covered by the National Operating Programmes (PON) conceived as a means to implement EU Structural Funds.
Spain	The central State has power to co-ordinate and promote scientific and technical research, as well as set the basis for and co-ordinate the general planning of economic activity. The Constitution states that the State has exclusive competence on the encouragement and co-ordination of scientific and technological research.	The Constitution allows for Autonomous Communities to assume competences on the promotion of research. The Constitution includes ambiguities subject to interpretative flexibility. Most bilateral contracts between the State and the ACs include a role for the regional government in R&D policy. Most regions have R&D plans and there are a large number of overlapping instruments, programmes and agencies. The decentralisation of hospitals has also led to more regional funding for research on drugs and healthcare, for example.
United Kingdom – Scotland	The United Kingdom operates a dual support system in which institutional funding for universities is administered through the Funding Councils and direct research funds through the UK Research Councils. The UK government has overall responsibility for STI policy.	In Scotland, science and research are concurrent powers. Institutional funding for higher education and quality elements (through the Research Excellence Grant, Horizon Grants and the General Fund) are administered through the Scottish Funding Council (SFC). All universities and eligible research performers can apply for UK research council funding. Scotland has its own science and innovation policy to ensure collaboration between public, private sectors and key stakeholders. Scottish ministers are responsible for policy on the SFC, for powers relating to knowledge transfer from higher and further education into business and society.

Source: ERAWATCH (2009), *http://cordis.europa.eu/erawatch/*; OECD (2007), *Linking Regions and Central Governments: Contracts for Regional Development,* OECD, Paris; and Charles, D. (2007), *Case Study Regional Report Scotland (UK). RIP-Watch. Analysis of the Regional Dimensions of Investment in Research,* available at *http://cordis.europa.eu/erawatch/*.

Table 3.6. **Minding and bridging multi-level governance gaps**

Mind the co-ordination gaps	Bridge the co-ordination gaps
Information gap	Performance measurement
Capacity gap	Grants, co-funding agreements and multi-annual budget
Funding gap	Quasi-integration mechanisms (*e.g.* mergers and inter-municipal co-operation)
Administrative gap	Inter-sectorial collaboration (*i.e. ad hoc* and informal meetings)
Policy gap	Co-ordinating bodies, agencies
	Contracts
	Legal mechanisms and standard setting

Source: OECD (2009), "Mind the Gaps: Managing Mutual Dependence in Relationships among Levels of Government", *OECD Working Paper on Public Governance No. 14*, OECD, Paris.

In the case of Catalonia, there are some gaps that both Spain and Catalonia could address:

- *Information gap:* In this case, there is an information gap for both levels of government. There is a higher degree of uncertainty associated with the returns to S&T investment as opposed to many other investments, with actions at both levels of government to support it. Another information gap concerns the greater proximity of Catalonia to regional innovation actors than the Spanish government, information which is important for the effectiveness of Spanish policy given the considerable flow of Spanish programme funds to the region.

- *Capacity gap:* Catalonia's ability to implement its policy initiatives requires, most of all, greater capacity (knowledge, services and providers) to reach SMEs. Both levels of government share a capacity gap in terms of working effectively across levels of government on this topic. With respect to Catalonia, there is less of a general S&T capacity gap than may be found in other Spanish or OECD regions.

- *Fiscal gap:* There are no specific mandates by central government with respect to S&T or innovation programmes managed by the regional level that are explicitly unfunded.[16] However, there are some situations where the Catalan government becomes *de facto* responsible through loans between a locality in the region with the Spanish government or in future salaries and operating costs of facilities after an upfront Spanish subsidy.

- *Administrative gap:* Given the economic geography of Catalonia, there is less of an administrative gap than in other regions where functional economic areas are less contained within administrative borders. For specific projects with clear spillovers, like large infrastructure projects, Spain and Catalonia have been more effective at working together to bridge the administrative gap through contracts and joint funding and management. The general importance of Catalonia's spillovers in the overall Spanish innovation system is perhaps not sufficiently recognised in policy development, although the region is nevertheless able to capture significant shares of Spanish funds.
- *Policy gap:* Catalonia and Spain have respectively combined research and innovation policy through quasi-integration mechanisms and both have inter-ministerial committees seeking to reduce this cross-sectoral policy gap. While there is always progress to be made in terms of collaboration with different sectoral ministries, the gap is not as high as in many other OECD examples.

In a comparative context, Spain stands out among several peer countries for having a somewhat higher unmet need for co-ordination to address gaps. The problem is not the overlap per se, which as stated above is common in many regionalised or federal countries. Rather, the particular challenge is a high degree of overlap of S&T responsibilities in a field where there is a considerable need for increased spending at both levels. Furthermore, the co-ordination with respect to S&T and innovation occurs within a context of politicised, and at times, confrontational inter-governmental relations more generally. Both general central-regional conflicts as well as political party conflicts are an impediment to central-regional co-ordination. In many other regionalised countries, the degree of co-ordination may be low, but this is less of a challenge given the more complementary or clearly assigned roles of the different levels of government in theory or practice.

Co-ordination tools in place

Begun in 2004, the highest level political co-ordination vehicle between the governments of Spain and the regions is the Conference of Presidents. The Presidents meet to discuss important themes and arrive at a common agreement among members on actions to be taken, similar to initiatives in some federal countries. Thus far, the Conference has met three times. The First Conference (2004) discussed the institutionalisation of the Conference, improving Spanish regions' participation in European Community programmes, and an analysis of the financing of public health. The Second Conference (2005) focused on an agreement regarding health financing. The Third Conference (2007) involved the adoption of the National Plan for

Research, Technological Development and Innovation, an agreement to create Sectoral Conferences for Water and Immigration, and the creation of a Working Group to establish guidelines for the Body (MPT, 2009).

The general and permanent framework for inter-governmental relations with Catalonia is the *Generalitat*-State Bilateral Commission.[17] Its purpose is to work with the State on matters affecting Catalonia's autonomy and to exchange information and collaborate in areas of common interest. The Commission's functions are to "deliberate, make proposals and, if appropriate, reach agreements…" The *Generalitat* is also supposed to co-operate with the State in the consultation and implementation of EU policy. The Commission has an equal number of State and *Generalitat* representatives with rotating annual chairmanships. Meetings are plenary sessions twice per year plus additional meetings as needed.[18]

With respect to science and technology, there is a specific body to promote central-regional co-ordination. A 1986 Law (13/1986) created the General Council for Science and Technology (*Consejo General de la Ciencia y Tecnología*) as the consultation body within the Inter-ministerial Commission for Science and Technology (CICYT). This body is charged with promoting co-ordination for science and technology among the regions and between the regions and the State (see Table 3.A1.3 for a listing of formal functions). The Council members include representatives of several central level ministries as well as each region. In 2006, the Council created a Working Group associated with the General Council to further develop some themes. The Working Group also has an associated Group for Information Exchange State-Autonomous Communities. The main role of the Councils has been to facilitate information sharing.

The development of comparable S&T and innovation indicators across Spain is vital to both central and regional policy makers for improving multi-level governance dialogue. The Group for Information Exchange State-Autonomous Communities, part of the formal co-ordination body, has begun this work. But there are still differences in definition, for example, on what areas of public spending constitute R&D and innovation. Such standards are required to better track resources across levels of government and potentially develop joint programmes.

The need for improved co-operation across levels of government to address gaps has been recognised in Spain by both central and Catalan levels as well as external evaluations.[19] The current Spanish National Plan (2008-2011) includes a chapter on greater co-ordination between the central level and regions (see Box 3.3). As mentioned above, in the third Conference of Presidents, the special theme in 2007 was S&T, thus leading to an agreement in the National Plan to work more together and to develop a mapping of large infrastructure through 2015. The National Plan also proposes different models for central-regional relations for R&D&I in Spain, including: *i)* co-information; *ii)* co-decision; *iii)* co-responsibility and co-management; and *iv)* co-funding. However, the tools to do so are not yet in place.

Catalonia has formally recognised that improved co-ordination with the State for S&T and innovation is required. In the context of the Catalan Agreement on Research and Innovation (CARI), a number of co-ordination issues are raised. The most important co-ordination areas highlighted in the CARI are:

- planning and funding of large scale S&T infrastructure;
- revision of the university funding system;
- implementation of CSIC centres;
- regulatory and framework conditions (*e.g.* intellectual property management; competition conditions; taxation of R&D investment; financial markets);
- accreditation of technological parks; and
- alignment and complementarity of priority research and innovation support programmes.

Another important element of co-ordination, overlooked by the CARI, relates to the development of the information system on research and innovation activities including those funded by the respective governments.

Opportunities for supporting systematic co-ordination

There are OECD examples of both formal and informal co-ordinating bodies for S&T policy across levels of government that Spain could consider in its co-ordination efforts (see Table 3.7). Germany is an example of a formal systemic co-ordination mechanism with the Joint Conference for Science, its mission being to co-ordinate R&D policies across regions and with international policies. Another example of a formal structure is the National Conference of Science and Technology in Mexico. The biannual meetings are a forum for the National Council of Science and Technology and the corresponding state councils to share information and discuss possible initiatives.

Box 3.3. Measures in Spain's National Plan to promote central-regional co-ordination

A) ***Co-ordination in the planning, monitoring and assessment of R&D&I activities through the Science and Technology Council.*** The agreements regarding the SISE (Integrated Monitoring and Evaluation System) adopted at the Third Conference of Presidents of the Regional Governments (RG) will be analysed in greater depth in order to:

- Jointly draw up the annual National Plan work programmes (the activities of the General State Administration [GSA] and of the RGs), identifying areas of mutual interest that may be the target of co-funded activities and bilateral or multilateral negotiations, and reducing any overlap in order to optimise budget resources;
- Jointly analyse the economic resources allocated to promoting research and innovation activities, according to distribution among beneficiaries, funding instruments and modes of action; and
- Co-operate in drawing up the respective annual reports and follow-up reports on R&D&I activities.

B) ***Funding to complement GSA calls for proposals. Joint GSA-RG calls for proposals.*** A mechanism will be put in place for the RGs to use their resources to complement the funding of the GSA calls for proposals in their respective regions. In other words, the Plans calls for proposals are open to "*à la carte*" participation by interested RGs in the programmes and calls they consider appropriate, through respective specific agreements with the GSA. For example, in a call for proposals on HR mobility, an RG could allocate resources for funding the mobility of the five top-evaluated researchers in their region who have not been funded by the GSA or, alternatively, complement GSA funding for regional researchers that have been awarded grants. This co-funding activity might eventually rule out the need for a specific call for proposals on HR mobility by the RG itself, thus further simplifying the R&D&I system instruments established in the new National Plan and increasing the quality of the results. The co-funding system put forward is, in principle, better suited to the instrumental strands of HR, projects, institutional strengthening and infrastructures, as these activities are associated with a specific regional locations.

C) ***New instrumental strand for institutional strengthening.*** This is a funding mechanism linked with R&D excellence objectives, which will be developed in collaboration with the RGs. As part of this instrumental strand, programmes will be started up directed towards different stakeholders in the system. This programme should become one of the fundamental instruments for GSA-RG collaboration.

Source: CICYT (2007), *The Spanish National Plan for Scientific Research, Development and Technological Innovation: 2008-2011.*

Table 3.7. **Examples of multi-level S&T&I collaboration arrangements**

Country	Definition of co-ordination problem	Collaborative arrangements
France	Regions have increasing and creeping competences in research and innovation, but the relationship between national and regional instruments could be more efficient. The need to increase coherence is particularly acute given the territorialised nature of many national policies and the responsibility of the national State for balanced growth and the attractiveness of regions.	The primary mechanism for co-ordination is through individual contracts with each region (CPER). Under the 2000-2006 generation of CPER there were three main objectives: to develop existing excellence poles, especially in rural areas; to continue the deployment of research capacities in regions with strong university potential; and to preserve the influence and international competiveness of large scientific centres. There are also representatives of the State in each region specifically for this policy area (*la délégation régionale à la recherche et à la technologie* [DRRT] and *Directions Régionales de l'Industrie, de la Recherche et de l'Environnement* [DRIRE]) through the emphasis on decentralisation. However, relations with regions are on a one-by-one basis, rather than co-ordinated through a single point.
Germany	While the scope of federal and regional competences are laid out in the Constitution, the implications for different policy domains remain subject to continuous negotiations. As economic development is a shared responsibility, the potential need for co-ordination is greater. A particular issue is also seen to be horizontal co-ordination between ministries for research and economic affairs, at national and regional levels.	Germany has an elected second chamber of Parliament, the *Bundesrat*, composed of representatives of the regions. This is therefore a general co-ordination mechanism between the *Bund* and the *Länder* across all policy areas. In STI, rather than unilateral contracts, there are a series of more institutionalised forums for co-ordination. The *Kultusminsterkonferenz* is a co-ordination body for university legislation but has no binding decision-making powers. The *Bund-Länder* Commission for Education Planning and Research Promotion (BLK) was a semi-permanent forum for the discussion of all questions of education and research promotion of common interest to federal and state governments. This has now been replaced by the GWK – the Joint Conference of Science. The mission of the GWK is the co-ordination of national European and international R&D policies with the aim of enabling Germany's performance and competitiveness. In addition, the new joint commissions may develop important co-ordination roles (the Council for Innovation and Growth and the Research Union Science-Industry).
Italy	The Constitution in Italy makes it easier to define areas in which the regions do not have competences than those that do. Accordingly, there is potential for multiple actions, instruments and conflicts between national and regional actors in STI.	There is a permanent state-regions committee in the Italian context. In addition, two other general mechanisms for co-ordination include the use of contracts and the National Operating Programmes (PONs). The *Accordi di Programma Quadro* operationalises the *Intesa Istituzionale di Programma* - a broad agreement reached by the central government and the regions or autonomous provinces on the definition of objectives, sectors and areas

Table 3.7. **Examples of multi-level S&T&I collaboration arrangements** (*continued*)

Country	Definition of co-ordination problem	Collaborative arrangements
		where infrastructure essential to territorial development should be built, which may include scientific infrastructure. The PON is a national multi-regional programme aimed at regional development, which stresses STI in underdeveloped regions. Each region has a regional programme (POR). EU Structural Funds are important sources of finance and some degree of co-ordination is necessary.
Spain	Spain has a complex research policy landscape with shared and overlapping responsibilities. There is a clearly defined and documented co-ordination problem both vertically and horizontally, linked in part to political struggles which limit long-term stability in policy directions.	The National Strategy for Science and Technology was endorsed by the State, ACs and other actors. ACs participate in the CICYT's advisory bodies in the General Council for Science and Technology, in the working party of General Directorates drawing on the Spanish RDTI plan and in the sectoral conference of the regional departments with competence for the promotion of R&D. Information exchange is also an essential element to establish co-operation on S&T between regions and central government. Contracts are also used as a mechanism to address overlaps.
United Kingdom – Scotland	Although the division of responsibility in relation to research and higher education funding are clearly defined, the Scottish Executive has a broadly defined science and technology policy with overlapping competences with the UK government. However, it has been noted that it is horizontal and not vertical co-ordination that is the dominating problem in the Scottish case, requiring greater joint thinking between actors at the sub-national level to create strong policy networks for action.	There is a Memorandum of Understanding with the UK government, a range of concordats with UK government departments and the Research Councils, and committees like the Chief Scientific Advisory Committee and the Science and Engineering Base Co-ordinating Committee.

Source: ERAWATCH (2009), *http://cordis.europa.eu/erawatch*; OECD (2007), *Linking Regions and Central Governments: Contracts for Regional Development,* OECD, Paris; and Charles, D. (2007) *Case Study Regional Report Scotland (UK). RIP-Watch. Analysis of the Regional Dimensions of Investment in Research,* available at *http://cordis.europa.eu/erawatch*; Crespy, C. *et al.* (2007), "Multi-level Governance, Regions and Science in France. Between Competition and Equality", *Regional Studies,* Vol. 41(8), pp. 1069-1084; and Lyall, C. (2007), "Changing Boundaries: The Role of Policy Networks in the Multi-level Governance of Science and Innovation in Scotland", *Science and Public Policy*, Vol. 34(1), pp. 3-14.

In the United Kingdom, an active dialogue has recently been established for an informal arrangement that must meet a central government funding requirement. The parties involved are the regional S&T Councils (business and research leaders in the region helping with regional strategies) and the central level Technology Strategy Board. The incentive for this close co-operation was a requirement by central government for alignment of resources between the Board and regional development agency (RDA) spending. As RDAs receive their budgets from central government, compliance with the alignment request was required. One positive result of the resulting series of group and bilateral meetings has been a greater understanding by the central level and other regions of the regional assets and vocations across England, serving as well to increase trust. Another result has been greater alignment of spending to reduce transaction costs and programme clutter and to increase critical mass – albeit limiting somewhat the regional scope for experimentation.

In addition to pursuing agreements at the political level, working groups below the political level can be used to promote co-ordination. In the United Kingdom, at the practitioner level, there is a group called Regional Innovation, Science and Technology (RIST) that brings together RDAs and devolved administrations with central government as a very active forum for information sharing, with several meetings annually. Increasing relationships among professional staff has served to build trust and develop useful information sharing that informs policy development at both levels. The Working Groups associated with the *Consejo General de la Ciencia y Tecnología* might be able to play such a role.

Joint institutions are not easy to build but serve as an opportunity for co-ordination that could increase system efficiency. When regions have scope for independent policy making, there are opportunities for experimentation at low cost but a risk of inflation in the number of bureaucratic institutions. For example, in Spain there are now at least 12 agencies for evaluation research quality between the central government and regions. A joint evaluation agency would reduce the evaluation burden on recipients as well as increase the quality of evaluations in the regions by pulling from a wider pool of objective evaluators and preventing "forum-shopping" (OECD/FECYT 2007). While a joint evaluation agency is one example, others could be considered with respect to R&D funding or related areas.

Catalonia may take the initiative to promote more systemic co-ordination by inviting central level authorities to participate in different Catalan committees. Participation does not imply that a central government representative would have authority over Catalan decision making. However, it offers a form of one-to-one co-ordination with a continual feedback mechanism during strategy development rather than for one specific programme after a strategy is already in place. Catalonia missed an important opportunity to better involve the central government in the Catalan Agreement on Research and Innovation (CARI) during the extensive consultation process. Furthermore, prior research plans have not explicitly taken into account national level plans in their development. Increased inter-governmental interaction in different committees could increase awareness at central level of Catalan needs and provide additional expertise to Catalonia. It would also support general trust building between levels of government. Ultimately, it could serve to better align common interests and inform national policy development. Given the prominence of Catalonia within the Spanish system, the central government also has clear incentives to support more effective collaboration.

Bilateral agreements (contracts)

While bilateral agreements do not have the same possibility of promoting systemic co-ordination as other mechanisms, they offer many benefits for managing multi-level governance when well designed. Such contracts reorganise the rights and duties of government other than by way of the Constitution (OECD, 2007d). They serve to align resources, build trust, give a longer-term perspective for projects, and reveal useful information from both regional and central government sides. They also should include a clear enforcement mechanism for when the parties do not follow the agreements.

In Spain, the use of bilateral agreements (commonly in the form of *convenios*) has proliferated in recent years. The number of *convenios* signed has grown from 14 in 1980 to 800 in 2004. Such agreements are being used for a range of different programmes. However, the funds that are accorded to regions as part of *convenios* is a small share of overall revenues for a Spanish region (in 2001 2% of overall revenue, 7% of conditional revenues).[20] The format of *convenios* is very flexible, therefore there can be a wide range of examples from very complete contracts to those that are more "relational" and involve a greater element of working together and relationship building for a common goal (OECD, 2007d). One of the negative side effects of the proliferation of agreements is that it is difficult to develop a systematic vision of the kind of co-operation that has been established across the different agreements.

In the context of Spain's INGENIO 2010 programme, a number of bilateral agreements are used to implement different S&T-related programmes (see Figure 3.3). Plan Avanza, for example, is a programme to develop the knowledge and information society in Spain, targeting firms, the public sector and citizens. In its first phase from 2005-2008, the Plan had a budget of more than EUR 5 billion. Budget sources include the EU Structural Funds, the national budget and multiple ministries. Additionally, regional and local governments co-finance initiatives. For instance in the region of Catalonia, between 2006-2008, the Plan invested a total of just over EUR 1 billion, of which EUR 334 million were dedicated to fostering innovation. Indeed, Catalonia is the second-largest recipient of funds, after Madrid. The second phase of Plan Avanza is now underway, with a greater emphasis on innovation and development of the ICT sector.

The bilateral agreement between the Spanish government and Catalonia to support the construction of the ALBA Synchotron facility has been recognised as an example of a highly effective co-ordination tool. The nature of the agreement is likely similar for other large installations in Spain (but the example of Catalonia is examined in detail). As an important investment for both Spain and the region, that neither has engaged in before, there is a need for contracting that ensures an ongoing relationship to derive the maximum benefit of the project and limit risks. The structure of this agreement includes many of the characteristics of a "relational" contract, one where all the conditions cannot be specified upfront (*ex ante*) so the parties agree to follow the instructions of a common decision mechanism after signing the agreement (*ex post*) (see Box 3.4).[21] The joint financing, execution and management of the facility are important for relationship building across levels of government.

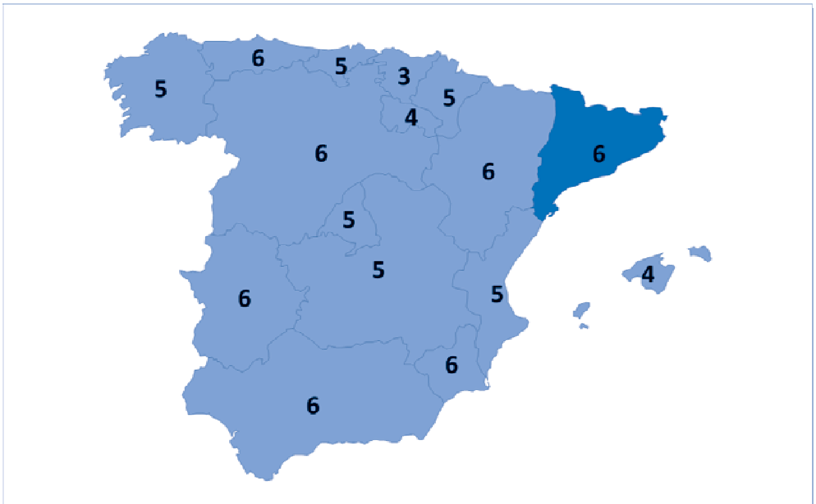
Other bilateral agreements may take a very broad perspective of "agreeing to work together" and then include annual work plans. The Catalan Innovation Support Agency, ACC1Ó, and the Spanish CDTI (Centre for the Development of Industrial Technology) share common objectives for promoting innovation, spinoffs and knowledge transfer. Catalonia is the leading region in terms of CDTI funding receipt, therefore there are clear mutual interests in better collaboration. A 2005 *convenio* serves as a framework to agree to work together through a commission composed of actors on both sides to develop annual plans. In the first work plan, areas such as data exchange, personnel exchange, accepting the other's evaluation assessment, joint financing of projects, and promotion of Catalan projects in EU programmes were raised. These are important first steps but there remain separate and duplicated action lines and administrative processes resulting in a continued burden to firms and system inefficiencies.

The lessons of good practices (from within Spain or other countries) could be helpful for Catalonia as it seeks to develop a framework agreement for S&T with the central government (see Table 3.7). Such an agreement is a stated commitment of the CARI. There is concern in Catalonia that the current bilateral agreements are not enough for effective central-regional co-operation. However, the scope and contents of what such a framework agreement might look like have not been decided at Catalan level nor discussed with the central level.

In a light form, such an agreement may include a Memorandum of Understanding and concordats, such as in the United Kingdom between central government and Scotland. In a more comprehensive and formal form, there is the French CPER (*contrat de projet Etat-région*). It offers a framework for long-term planning and co-financing for a number of investments related to S&T and innovation between several central level ministries and the region. In the 2000-2006 round of the CPER, areas covered included: *i)* the development of existing excellence poles; *ii)* continued deployment of research capacities in regions with strong university potential; and *iii)* preserving the influence and international competiveness of large scientific centres. Support of S&T and innovation is also part of Italy's central-regional contracts know as the *Accordi di Programma Quadro*.

There is also an opportunity for greater bilateral and multilateral agreements between Catalonia and other Spanish regions. For example, Catalonia's AGAUR is already used by some other Spanish regions as an evaluation agency for the scientific merit of certain research projects. Catalonia is also seeking bilateral agreements with other regions when there is a common interest or complementarity in assets.

Figure 3.3. **Bilateral S&T related agreements between central and regional governments**



Notes: The agreements included in the counts refer to: the Avanza Plan, Online Health, Internet in the Classroom, SARA, and the Programme of Incentives for Employment and Intensification of Scientific Activity. It also includes whether the region has a R&D&IP network point. Updated to January 2007.

Source: Based on information from CICYT (2007), *The Spanish National Plan for Scientific Research, Development and Technological Innovation, 2008-2011*, using information from the general State administration.

Box 3.4. **Contracting across levels of government: the ALBA Synchotron**

The ALBA Synchrotron is a particle accelerator, a very large and expensive research facility, now located in Cerdanyola, a site near Barcelona that also hosts a university and many technological firms. This project has important spillovers (benefits) to local, regional and Spanish level actors. The type of contract needed for this co-ordination context is co-decision with arbitrage, and that is how the contract is designed. The contracting is relational, based on a permanent partnership between layers of government.

A 2002 *convenio* between the Ministry of Science and Technology and Catalonia splits construction costs 50% between the two levels of government. The amount of payments per year are specified, but the agreement does not specify the obligation to contribute to operating expenses, since these costs are expected to be fully covered by user charges paid by the research teams that use the particle accelerator. However, the agreement says that if an operating deficit appears, the Monitoring Commission (*Comisión de Seguimiento*) could solve the problem by writing a new agreement (*Addenda*) which specifies the distribution of the burden.

In addition to cost and risk-sharing-related construction and operations, the agreement creates the partnership (*consorcio*) that is responsible for managing the facility. The governance structure of the *consorcio* includes a political decision-making body (*Consejo Rector*) and a management body (*Comisión Ejecutiva*). The *Consejo Rector* is formed by a president, which will rotate yearly from one layer of government to the other and have a qualified vote, and by eight representatives (four for each layer of government). Its responsibilities include providing general guidelines of activity, approving the annual budget and the plans of activity and projects, and specifying the rules of the relationship with the users of the facility. The *Comision Ejecutiva* is formed by a manager and four members (two from each layer of government). Among its responsibilities are organising the services offered by the facility and setting the user charges.

The co-ordination context is also characterised by a high level of interdependencies. There are horizontal inter-dependencies derived from the fact that the facility would benefit all the Spanish scientific community, and vertical inter-dependencies derived from the fact that both layers of government have responsibilities on this matter. Moreover, the project's success could have an impact on future R&D programmes that could be carried out by the central government and by the other regions since future programmes will depend on access to the equipment and since all the partners will have to pay for maintenance in the future. Also, the clustering of researchers around the Synchrotron will help the national scientific community in general by fostering the development of scientific programmes in related fields of knowledge.

Box 3.4. **Contracting across levels of government: the ALBA Synchotron** (*continued*)

Both layers of government have a low level of knowledge (relative to other types of agreements). Neither has previously built or managed such a facility. Moreover, the project entails significant risks: the construction risk (*i.e.* exact localisation, detailed design of the building, budgetary deviations), the scientific risk (*i.e.* failures in identifying the most appropriate research policy for the facility, related to the number of light lines defined and to its assignment to research groups and firms), and the management risk (*i.e.* optimisation of the financial returns and possible appearance of operating deficits in the future). Although a great part of these risks can (and should) be dealt with in advance, it is clear that a number of very complex decisions are required.

Source: OECD (2007), *Linking Regions and National Governments: Contracts for Regional Development*, OECD, Paris.

3.3. Other areas of co-ordination

Local communities in Catalonia

Under the level of a Spanish region (autonomous community) are several layers of local government. In 1985, the Basic Law on Local Government (*Ley Reguladora de las Bases de Regimen Local – LRBRL*) formalises the institutions and competencies for the local and provincial levels.[22] In addition, there are historic territories known as *comarques* (counties) that are considered a form of local government and in Catalonia have a representative council. Catalonia contains four provinces, 41 counties (*comarques*) and 946 municipalities.

Through their competencies for economic promotion, local authorities are beginning to support innovation. The tools most commonly used are the land and infrastructure for science or technology parks, usually including incubators. In several cities around Spain, there is also an accent in the city-level innovation plans on the importance of ICT infrastructure and its usage (in households, SMEs and public administrations) as well as developing an innovation culture (Cotec, 2008). The support of local innovation systems is seen as a way to reorient the region, given the job losses in many traditional sectors, and to attract investments from the Spanish or Catalan governments as well as develop knowledge-economy conditions.

In general, the roles of the region and localities are complementary, given differences in competencies. There are numerous examples in Catalonia of local initiatives to support innovation systems. Higher education institutions are often the leaders in these local initiatives and may take a highly proactive approach, such as the University Rovira i Virgili in Tarragona (see Box 3.5) or the University of Girona (see Box 3.A1.1). Other local initiatives may seek to promote a culture of innovation among the general population. For example, the town of Manresa has produced two volumes of stories about local innovators and their work. The town of Reus has promoted, along with neighbouring towns, instruments such as a venture capital fund for private firms. They have also been promoting public sector innovation with creative public service delivery mechanisms (a comprehensive school for immigrants) or in making a holding company for more efficient management of public health service delivery.

The largest possible synergies and duplication occur between the region of Catalonia and Barcelona City. Not only is Barcelona a driver of the regional system, the local government has resources and capacity for significant programmes (see Box 3.6). The city may have some duplication with programmes at the Catalan level, specifically with respect to innovation, such as those promoted by Barcelona Activa. Given geographic and relational proximity, there are already informal ties with Catalan level institutions like ACC1Ó to minimise duplication or to find complementarities.

Unlike many other OECD regions, Catalonia's formal research and innovation plans do not have a territorial focus, but could do more to make this explicit. There are recognised sub-regional specialisations (see Chapter 1) and attempts by the Catalan government to link research and technology transfer infrastructure when possible to those specialisations. The reticence for making sectoral choices in the different research and innovation plans and agreements helps explain in part the lack of a territorial distinction in formal documents. The region does not want to stifle bottom-up initiatives and in some cases seeks to provide soft support in terms of increasing local capacity. However, the region is perhaps too cautious in its willingness to be more explicit on a territorial strategy. The PRI 2010-2013 may seek to address this.

The region has chosen to take the approach of labelling and financing as the primary vehicles for co-ordination with localities to help rationalise *ex post* certain local and regional initiatives. The need for rationalisation has been raised with respect to technology centres and science parks, for example, given the development of a number of institutions but of varying quality (see Chapter 2). By labelling those institutions judged of sufficient quality, the hope is that the most successful will be supported. That support could take the form of financing or other backing, such as international promotion. The tradeoff is between stifling local initiative and efficiency of investing in an oversupply or inefficient linkages across institutions within the regional innovation system. It would appear that since many of the initiatives are co-financed from the beginning by the region, that the region could take action in some cases a bit earlier instead of allowing the proliferation to reach the point of needing additional labelling systems.

Another co-ordination challenge between the region and localities occurs when the central government contracts directly with the localities. This has been the case with soft loans, such as was done for technology parks, which bypassed the regional level and thus priorities. The central government had launched a programme and evaluated different proposals for localities based on technical criteria. However, that approach did not take into account the regional implications of these technology parks in terms of links with the other local actors or regional priorities (spatial or thematic). Furthermore, given the debt financing approach, the Catalan government is ultimately involved in repaying the loans that localities have contracted. In addition, grant financing for projects that imply an upfront central government contribution and a sub-national contribution for future years can also lead to longer-term sustainability problems for salaries or on-going maintenance in terms of physical infrastructure. To avoid such co-ordination failures in the future for important investments in the regional innovation system, the central government could ensure that local government applicants have received regional support. This is a common solution used in OECD member countries of co-selection and, often, co-financing.

Catalonia in trans-national S&T&I co-operation

Catalonia is located in the Mediterranean basin whose regions and countries may confront some common or interdependent challenges. European regions closer to the Mediterranean in general lag behind many Northern European counterparts. There are several EU-promoted inter-regional initiatives. The previously mentioned Four-Motors Agreement includes co-operation among several leading industrial regions, albeit not all Mediterranean. The Euro-Mediterranean Partnership, formerly known as the Barcelona Process, was re-launched in 2008 as the Union for the Mediterranean.

Box 3.5. **Rovira i Virgili University: building a region of knowledge in Tarragona**

Rovira i Virgili University (URV) is a public university founded in 1992 from already existing university faculties and schools. It offers 52 programmes of study across the different disciplines to over 12 000 students. In terms of its research strengths, URV had EUR 17 million in research grants from different sources in each of the last several years (approximately 10% of URV revenues), including grants from leading EU, Spanish and Catalan programmes. URV also stands out for its high level of citations in Spain, particularly in its centres for Chemistry (fifth), Clinical Medicine (second) and Engineering (fourth).

URV has taken great strides to support its "third mission" of regional engagement by promoting social and economic projects at regional level like the knowledge antennas (*i.e.* URV offices) set up in towns throughout the region or the 19 classrooms for elder people in municipalities and extra-mural activities. Also on the economic side, the URV Foundation was created as a specific structure to support knowledge transfer; some evidence of the URV Foundation activities include:

- EUR 6 million in knowledge transfer revenues, more than half of which comes from private companies.
- 18 entrepreneurs presented to the Catalonia Springboard Network in 2007 to create spin-off firms.
- The number of lifelong learning students has more than doubled from 2003-2007 to over 4 000, including in-company training.

URV is also active in supporting knowledge clusters in the Tarragona province through its teaching, research centres, science and technology parks, and other institutions. Those clusters include: chemistry and energy (Tarragona has one of the biggest petrochemical sites in Southern Europe); nutrition and health; heritage and culture; tourism and leisure; and oenology. Investment in the related science and technology parks has totalled EUR 39 million.

The University has also taken the lead in a strategic initiative to support innovation through its Tarragona Region of Knowledge Office, which has within its main objectives to support fundraising for innovation and R&D projects in companies and to promote territorial strategic projects for companies and for institutions. A Socioeconomic Committee led by URV and including many other regional stakeholders (employers, unions, chambers of commerce, and the Port of Tarragona) has put together a strategic plan for the area that takes into account the latest approaches to the importance of a territory for effectively supporting an innovation system.

Box 3.6. **Barcelona's innovation strategy, including Barcelona Activa and 22@**

Barcelona has a four-pronged innovation plan:

- Infrastructure for innovation (including 22@);
- Innovation in the public administration;
- ICT and technology development; and
- Promoting an innovation culture.

Barcelona Activa is the local development agency of the City of Barcelona and one of the leading implementation agencies for Barcelona’s innovation plan. It was created in 1986 to promote quality employment and innovative businesses and started modestly as a business incubator coaching 14 business projects. Some 20 years later, its role and reputation has grown and it is the primary instigator of employment and innovation in the city. To give a sense of scale of firm support activities, in 2008 there were 19 387 participants in activities for business creation, 1 379 business projects coached, 116 innovative start-ups based in the Incubator and Tech Park, 711 companies members of the Xarxactiva network and 350 companies coached in business growth programmes. Other performance indicators include: 84% business survival rate in the business incubator at fourth year, EUR 900 000 average turnover of incubated companies at fourth year, 9.8 average workers per incubated company at fourth year, and 26% foreign entrepreneurs in the business incubator. Business growth and creation are only 21% of the agency’s annual budget, but they work with other Catalan programmes and funding sources to increase the impact of their work.

The 22@ Barcelona is an urban renewal project which is developing an urban model that offers modern, technologically advanced, and singular flexible spaces for the top economic activities. The 22@ Barcelona project is also an economic development project which aims at stimulating the creation of a scientific, technological and cultural pole to become one of the main platforms for innovation and knowledge economy in Spain and Europe. The project involves the transformation of 200 hectares of land nearby the waterfront at the heart of Barcelona. The 22@ district will permit the creation of up to 3.2 million m^2 of commercial space for firms (with a focus on certain technology-intensive sectors), in addition to the 400 000 m^2 of new GFS for facilities, social housing and green spaces to guarantee urban and environmental quality. The 22@ district has a good level of connectivity within the city and the metropolitan area, mainly through a well-developed network of public transport. It also hosts a state-of-the-art infrastructure for telecommunications, waste collection, heating/cooling system and power supply. The presence of top level institutions such as the Pompeu Fabra University, the Barcelona Media Innovation Centre and the Parc Barcelona Media makes this district an attractive place to establish a business and work.

Source: OECD (2009), *Promoting Entrepreneurship, Employment and Business Competitiveness: The Experience of Barcelona*, OECD, Paris; Cotec (2008), *Innovaciones tecnológicas con aplicación en el ámbito local*, Cotec, Madrid; and information provided by Barcelona Activa.

The possible rationales for collaboration are many, and the modality for and possible success for the S&T co-operation depends on a number of factors (see Table 3.A1.4). Often the collaboration is used for building critical mass, addressing a common challenge, building on common strengths, increasing specialisation, or recognising functional linkages. The footprint and its scale (whether the regions are contiguous in a functional region or spread out) determine the nature of possible collaboration instruments. While projects in a more strategic framework for co-operation have greater potential to bring longer-term positive spillovers, the transaction costs for such co-operation may be high, which is why many arrangements are either with specific institutions or even more *ad hoc* project-based collaboration. The type of driver, including governments, firms, or other knowledge-generation institutions (universities, research centres, etc.) will also determine the agenda for collaboration.

Catalonia is already involved in some transnational networks of regions that include an S&T or innovation element. They include the Four Motors Agreement, the Community of Work of the Pyrenées (CTP), the Pyrenées-Mediterranean Euroregion and a network of Creativity Districts. Other international examples of this transnational collaboration offer lessons for Catalonia (see Table 3.8). There are many regional networks or neighbouring region collaborations in Europe. ELAt is just one example. It is a tri-county cross-border arrangement that builds on the S&T strengths of the bordering regions for the knowledge-economy links in terms of critical mass and regional marketing. The US-Mexico Foundation for Science is an effort at national level for both countries to use S&T to address inter-dependency issues for the border region and beyond. While the Southern Technology Council is for regions only in the United States, it is an example of co-operation across a large geographic area focused on marketing, investment promotion and culture change in an area that had traditionally been lagging relative to national averages. Finally, the Baltic Sea Knowledge Region seeks to promote experience in transnational collaboration with an ultimate goal of an inter-connected innovation support system across metropolitan areas in the different countries.

Table 3.8. **Examples of trans-national S&T co-operation**

Criteria	ELAt	Baltic Sea Knowledge Region	Southern Technology Council	US-Mexico Foundation for Science
Footprint	Cross-border (international)	Transnational (some cross-border)	Cross-border (national, but large scale)	Cross-border (international)
Scale	3 metropolitan areas (Eindhoven, Netherlands; Leuven, Belgium; and Aachen, Germany)	Initial phase with Hamburg, Oresund and Helsinki with a goal to include entire region of 11 countries and 103 million people	13 US states	Mexico and United States (including but not restricted to multiple border states)
Nature	Strategic and institutional (with 2 formal bilateral agreements)	Institutional with goal to generate more strategic approaches among governments	Strategic	Strategic
Driver	Government/ key research institutions	Universities, research institutions	Government	Foundation (with endowment from two national governments)
Benefits	-Critical mass -complementarity in knowledge areas	-Critical mass -build on common/ complementary strengths	-Common challenges, strengths	-Common or inter-dependent challenges, strengths -economic development of border region -administrative management of projects
Examples	-Mapping and supporting clusters -talent attraction -"lobbying" for public resources/over-coming administrative barriers -transport infrastructure -regional marketing	-information sharing to support clusters (web portal) -build relationships for financing -promote broader regional agenda to other entities	-information sharing -investment promotion -image/culture change	-projects to develop technology-based sectors -S&T human resources development -health and environment research area focus

Notes

1. From the Institut d'Estudis Catalans (1997), *Reports de la recerca a Catalunya: Technologies de la informació I de les communications*, IEC, Barcelona as quoted in Riba Villanova and Leydesdorff (2001). Note that a later study finds that in the late 1990s, the Catalan government accounted for 55% of related spending, while 35% came from the Spanish government and 9% from the EU (see Table 3.A1.1). It is not clear if in this analysis EU Structural Funds are included under the Catalan government expenditures or simply excluded entirely.

2. The data used for this analysis is the Fourth wave of the Spanish Community Innovation Survey.

3. Initially set out by the European Council in 2000, it was simplified in 2005 to be more focused on jobs and growth. One of the two main indicator targets for this strategy is an R&D intensity of 3% by 2010 (total public and private investment in research and development over GDP). The other is an employment rate of 70% by 2010.

4. The Bologna Declaration of June 1999 has helped launch over time a series of reforms regarding higher education to enable greater standardisation across countries and institutions that are more attractive for European and non-European scholars. The three priorities of the Bologna process are: introduction of the three cycle system (bachelor/master/doctorate), quality assurance and recognition of qualifications, and periods of study.

5. In 1988, the Four Motors Regions signed a co-operation agreement in view of the expected Single European Market. The regions include: Catalonia (Spain), Rhône-Alpes (France), Lombardy (Italy) and Baden-Württemberg (Germany). The objective of this group was: to contribute to the internationalisation of the regions and their citizens, as well as to promote the role of its regions in Europe in the process of European construction. A co-ordinating committee meets regularly (approximately three times a year) under the supervision of the presiding region. For more information see *www.4motors.eu*.

6. The four main programmes include: the Co-operation Programme for research-industry links in a transnational framework, the Ideas Programme to support exploratory research, the People Programme to support existing and attract new young researchers and the Capacities Programme to support excellence in research such as research infrastructure, research-driven clusters and SME-relevant research. For more information see *http://cordis.europa.eu/fp7*.

7. Based on the model of the US National Science Foundation, the ERC was launched in 2007 to support leading researchers in Europe with blue sky or "frontier knowledge". The ERC Starting Grants finance promising research leaders to establish or strengthen research teams. The ERC Advanced Grants are for leading researchers to conduct frontier research of their choice – including risk-taking and inter-disciplinary research. For more information see *http://erc.europa.eu/index.cfm*.

8. Law 13/1986 on the Promotion and General Co-ordination of Scientific Research provided the basis for future policy development.

9. According to the same source, the corresponding distribution was 50%, 32% and 18% for subsidies. Loans, in contrast, are mainly allocated to organisations representing public-private co-operation (48%) and the private sector (40%).

10. Data is from INE, the Spanish National Institute of Statistics.

11. Data is from the Ministry of Economy.

12. Law 35/2006, of 28 November (published in BOE 285, of 29 November 2006).

13. Law 35/2006, *Disposición Derogatoria Segunda*.

14. For discussions of this competence sharing, see for example, Bacaria *et al.* (2004); Defazio, D. and J. García-Quevedo (2006); and Sanz-Menéndez, L. and L. Cruz-Castro (2005).

15. The 1979 Statute of Autonomy of the Basque Country included the competence for research and development. However, the region has recently negotiated the transfer of exclusive R&D competency from 2009 onwards, but it must be exercised in co-ordination with the Spanish government.

16. The context of the current fiscal equalisation scheme in Spain that includes Catalonia is beyond the scope of this review, which focuses on S&T and innovation.

17. In terms of financing in Spain, there are 15 regions under the "common regime" that includes both taxes and tax-sharing with unconditional transfers in the context of an equalisation scheme. Catalonia falls under

this regime. Two regions (Basque Country and Navarra) belong to the "foral regime" whereby the region collects taxes directly and pays a negotiated amount to central government for services central government has provided to the region's inhabitants. The relations are therefore in part conditioned by the type of regime within which the region falls.

18. Per Organic Law 6/2006 of 19 July on the Reform of the Statute of Autonomy of Catalonia, Articles 183-192.

19. See, for example, OECD/FECYT (2007), *R&D and Innovation in Spain: Improving the Policy Mix*, *Fundación Española para la Ciencia y la Tecnología*, Madrid and OECD, Paris.

20. For more information, see the *Ministerio de Economía y Hacienda* (2001), "*Informe sobre la financiacion de las CCAA*".

21. On the one hand ***"transactional" contracting*** corresponds to a logic by which the respective duties of both parties can be stated in advance. All co-ordination problems can be stated *ex ante* (before the signature of the agreement) and the arrangement between the parties states the reciprocal duties of each of them. The resulting contracts are "contingent" and "complete" in the sense that they set the obligations of each of the parties as a function of external events (*e.g.* the economic climate) and of the actions of the other party. This guarantees *ex ante* an effective co-ordination and the only challenge is to encourage the parties to enforce their obligations. As a result, such types of contracts implement "incentive schemes" and are supervised by external third parties (such as the judiciary). On the other hand, ***"relational" contracting*** corresponds to a logic by which the parties commit to co-operate *ex post* (after the signing of the contract) and design a "governance mechanism" for that purpose. The parties agree to follow *ex post* the instructions of a common decision mechanism and to implement a specific bilateral mechanism to manage their potential conflicts. Co-ordination problems are solved *ex post* and supervision of the enforcement of the agreement tend to be bilateral and to rely on co-operative spirit. For more information on this contracting approach, see OECD (2007), *Linking Regions and Central Governments: Contracts for Regional Development*, OECD, Paris.

22. There are exceptions for provincial governments in regions with only one province (provincial power merged with those of the region), in the Balearic Islands and Canary Islands, and the three-province Basque Country region. The North African enclaves are municipalities associated with provinces elsewhere.

Annex 3.A1

Table 3.A1.1. **Public funding for S&T and innovation: late 1990s**

Organism or programme	Period	Public funding (EUR million)	Share (%)
Generalitat (Catalan government)	1996-1999	123.20	55.12
Spanish administration (universities)	1996-1999		12.59
Spanish administration — CDTI (firms)	1998-1999	49.96	22.35
EU-IV Framework Programme	1995-1998	21.04	9.40
Local administration (universities)	1996-1999	1.14	0.51
Total annual (average)		223.50	100.00

Note: It is not clear whether any EU Regional Policy funds, such as a portion of ERDF receipts in Catalonia, are included in this table under the Catalan government total, or simply excluded from the calculation.

Source: Bacaria, J. *et al.* (2004), "The Changing Institutional Structure and Performance of the Catalan Innovation System", in *Regional Innovation Systems – the Role of Governance in a Globalized World*, (ed.) P. Cooke, M. Heidenreich and H.-J. Braczyk, 2nd edition. Routledge, London and New York.

Table 3.A1.2. **Responsibilities of central and regional governments in Spain**

State	Autonomous Community (AC)
S1) Exclusive legislative and executive competencies	AC1) Exclusive legislative and executive competencies
• Immigration and emigration • International affairs • Defence • Justice • Commercial, penal, labour, industrial and intellectual property and civil law (except matters regulated by traditional regional law) • Foreign trade • Monetary system, exchange regime, and State treasury and debt • Infrastructure of national scope, (*i.e.* inter-regional roads, railroads and water transportation, and commercial ports and airports) • Sea fishing	• General organisation of self-government • Changes in municipal boundaries and creation of supra-municipal bodies • Land use planning and housing • Infrastructure of a regional scope (i.e. intra-regional roads, railroads and water transportation, and non-commercial ports and airports) • Agriculture, forestry and river fishing • Domestic trade and fairs • Tourism • Culture (i.e. museums, libraries, historical heritage, cultural promotion, etc.) and sports (i.e. facilities and promotion) • Social services • Environmental policy • Other listed in the "Statute of Autonomy" and not included in S1
S2) Power to set basic legislation	AC2) Competencies subject to basic state legislation
• Banking and insurance activities • Health care • Social security • Education • Local self-government	• "Economic development within the national economic framework" • Other listed in the "Statute of Autonomy" but included in S.2 or S.3
S3) The central State also has the power for:	AC3) In addition, the ACs have competencies
• Co-ordinating and promoting scientific and technical research • "Setting the basis for and co-ordinating the general planning of economic activity" • "Guaranteeing the equality of all Spaniards in the exercise of their constitutional rights and duties"	• Any competence delegated by the state

Source: Spanish Constitution with elaboration as appeared in OECD (2007), *Linking Regions and Central Governments: Contracts for Regional Development*, OECD, Paris.

Table 3.A1.3. **Functions of the General Council for Science and Technology**

1. Inform preparations for the National Plan, especially with respect to the best use of resources and means of research available
2. Propose objectives for the National Plan
3. Propose, based on interest, programmes and projects of research by the autonomous communities, with the corresponding presentation by the governors
4. Promote the exchange of information between the State and the autonomous communities regarding their respective research programmes so as to facilitate the general co-ordination of scientific and technical research
5. Promote actions in conjunction with or among them and the State, to develop and execute research programmes
6. Disseminate information and reports, referring to the co-ordination of research developed by public administrations, requested by the inter-ministerial Communion on Science and Technology or the Advisory Cabinet for Science and Technology
7. Constitute a basis of documentation about the different research plans and programmes promoted by public authorities

Source: www.ingenio2010.es.

Table 3.A1.4. **Modalities of international S&T co-operation**

Footprint	Nature of collaboration	Drivers of collaboration	Rationale for collaboration
Cross-border (contiguous)	Strategic (part of broader joint planning process for development)	Government (supra-national, national, regional, or local)	• Functional area or other inter-dependency • Common challenges or strengths
Transnational (non-contiguous)	Institutional (key institutional alliances)	S&T related institutions (universities, research centres, foundations)	• Increase critical mass • Increase specialisation and complementarity
	Project-based (*ad hoc* joint projects)	Private sector (Firms, could be a cluster or value chain relationship)	• Economies of scale to joint action • Overcome regulatory or institutional barriers • Opportunities for knowledge sharing
		Combination	

Box 3.A1.1. **Girona: building local advantage**

Girona is a province of Catalonia with 635 000 inhabitants, located between the French border and Barcelona. Until now, the services sector employs in Girona 62% of the population, within which tourism plays a major role. Within industry, agro-food has about 800 companies, 200 of them devoted to the meat industry. The second most important industrial sector is machinery production. Some other sectors of industrial importance are mineral waters, fiber and regenerated cotton textiles, corks for sparkling wines and bus bodyworks. All of them are traditional sectors. Factors have emerged to change the competitive mode including: *i)* the creation of the University of Girona and the presence in the area of other actors related to R&D; and *ii)* the science, technology and innovation policies implemented by the Spanish government and the *Generalitat* of Catalonia, policies that have helped local initiatives grow.

In execution of the third mission, the University of Girona (created in 1991) promoted, with other actors of the region, a Science and Technology Park inaugurated in 2007. While the university is the lead actor in the region for the knowledge generation and transfer system, several other centres exist and are the consequence of the initiative of local individual and institutional actors. In this respect, Girona has a characteristic that might constitute a competitive strength: the closeness of the agents in the territory. But those local agents have taken advantage of the different programs that develop science, technology and innovation policies, so much of the Spanish government as principally of the *Generalitat*. As regards the influence of these policies in the development of the region, the most notable milestones include:

- The decision of the *Generalitat* of Catalonia, adopted at the beginning of the 1990s, of diversifying the Catalan university map allowing the creation of the University of Girona;
- Previously, the *Generalitat*, with the support of the local food industry, created and distributed in the territory diverse centres of the Institute of Research and Food and Agriculture Technology;
- At the end of the 1980s and beginning of the 1990s, the technology transfer offices were encouraged in Spanish universities by means of programs of the Spanish and Catalan governments. These programs gave form to the current Technology Transfer Office (OITT) of the University of Girona;
- The promotion, on the part of *Generalitat* of Catalonia, of a network of non-university research centres (CERCA programme) has facilitated the appearance in Girona of centres like the Catalan Institute of Water Research (ICRA), the Catalan Institute of Investigation in Cultural heritage and the Institute of Biomedical Research of Girona;

Box 3.A1.1. **Girona: building local advantage** (*continued*)

- Girona develops clusters based on traditional sectors (production technologies cluster and the pork meat sector cluster) and emergent clusters, based on the knowledge actors of the area (biotechnology, IT and water). This promotion of clusters has been strongly influenced by the Spanish programme of Associations of Innovative Companies (AEI);
- The Network of Technological Springboards promoted by Acció of the *Generalitat* has allowed the creation in the region of new companies based on knowledge;
- The IT Network of the *Generalitat* of Catalonia has promoted technology transfer between the University of Girona and the companies of the region. The University of Girona has ten research groups in this Network, a very high number compared with the rest of Catalan universities;
- The programme of the Spanish government directed to promote R&D in Science Parks, a programme initiated in the year 2000, has supported the creation of the Science and Technology Park of the University of Girona, a project that captures the will of change of the competitive model in the area; and
- The presence of the University Hospital, which depends on the *Generalitat*, and the creation of the new School of Medicine will allow the consolidation in the north of the city of the Health University Campus.

Source: Information provided by the Science and Technology Park, University of Girona.

Bibliography

Abreau, M., V. Grinevich, M. Kitson and M. Savona (2008), *Taking Services Seriously: How Policy Can Stimulate the 'Hidden Innovation' in the UK's Services Economy*, NESTA Research Report, National Endowment for Science, Technology and the Arts, London, *www.nesta.org.uk/assets/Uploads/pdf/Research-Report/taking_services_seriously_report_NESTA.pdf.*

ACC1Ó (2008), *Informe Anual de l'R+D i la Innovació a Catalunya 2008*, [2008 Annual Report on R&D and Innovation in Catalonia], Government of Catalonia (ACC1Ó: CIDEM/COPCA), Barcelona.

ACC1Ó (2009), *La situació de la innovaió a Catalunya*, Government of Catalonia, Barcelona.

Acosta, M. and D. Coronado (2003), "Science–technology Flows in Spanish Regions: An Analysis of Scientific Citations in Patents", *Research Policy*, Vol. 32(2003), pp. 1783–1803.

AEVAL (National Agency for the Evaluation of Public Policies and the Quality of Services) (2007a), *Evaluation of the National Reform Programme of Spain. Main Conclusions and Recommendations*, Ministry of Public Administrations, Madrid.

AEVAL (2007b), *Programmes to Foster Research, Development and Innovation – INGENIO 2010*, Ministry of Public Administrations, Madrid.

Aho, E., Cornu, J., L. Georghiou (Rapporteur) and A. Subira, (2006), *"Creating an Innovative Europe - Report of the Independent Expert Group on R&D and Innovation",* Mimeo, *http://europa.eu.int/invest-in-research/.*

Alemany, L. (2006), "Venture Capital in Spain: Evolution, Characterisation and Economic Impact Analysis", *International Journal of Entrepreneurship and Innovation Management,* Vol. 6, N° 4/5, pp. 412-428.

Alvarez Calzada, O. (2008), "Inversión estranjera directa en Cataluna". *Boletín económico de ICE, Información Comercial Española*, Nº 2952, pp. 31-45.

Arundel, A. *et al.* (2008), "Neglected Innovators: How do Innovative Firms that Do Not Perform R&D Innovate?", *INNOMetrics*, March.

Asociación Española de Entidades de Capital-Riesgo (ASCRI) (2009), *Survey 2009*, ASCRI, Madrid.

Bacaria, J., S. Borràs Alomar, and A. Fernández-Ribas (2004), "The Changing Institutional Structure and Performance of the Catalan Innovation System", in *Regional Innovation Systems – the Role of Governance in a Globalized World*, (ed.) P. Cooke, M. Heidenreich and H.-J. Braczyk, 2nd edition. Routledge, London and New York.

Bacaria, J., A. Fernandez-Ribas, and S. Borràs (2002), "Public Action and Innovation-support Institutions in New Technological Agglomerations: the Case of the Vallès Occidental County", *European Urban and Regional Studies*, Vol. 9(4), pp. 283-296.

Ballart, X. (2007), *"Informe d'Avaluació del III Plan de Ricerca de Catalunya – Resum Executiu",* Government of Catalonia (CIRIT), Barcelona.

Benneworth, P. (2007), *Leading Innovation Building Effective Regional Coalitions for Innovation*, National Endowment for Science, Technology & the Arts (NESTA) Research Report, UK, December.

Boix, R. and V. Galletto (2008), "Innovation and Industrial Districts: A First Approach to the Measurement and Determinants of the I-District Effect", *Regional Studies,* Vol. 43(9), pp. 1117-1133.

Busom, I. *coord.* (2006), *La situació de la innovació a Catalunya,* Government of Catalonia (CIDEM), Barcelona.

Charles, D. (2007), "Case Study Regional Report Scotland (UK)", *RIP-Watch. Analysis of the Regional Dimensions of Investment in Research*, available at *http://cordis.europa.eu/erawatch/.*

CICYT (*Comisión Interministerial de Ciencia y Technología*) (2007), *The Spanish National Plan for Scientific Research, Development and Techological Innovation, 2008-2011*.

CIDEM (Centre d'Innovació i Desenvolupament Empresarial) (2006), *La Situació de la innovació a catalunya*, government of Catalona, Barcelona.

CIDEM (2007), *Catàleg d'ajuts R+D+i 2007,* Government of Catalonia, Barcelona.

CIRIT (*Comissió Interdepartamental de Recerca i Innovació Tecnològica*) (2001), *III Pla de Recerca de Catalunya 2001-2004,* Government of Catalonia, Barcelona.

CIRIT (2003), *Informe d'Avaluació del II Pla de Ricerca de Catalunya,* Government of Catalonia, Barcelona.

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

CIRIT (2008), *Accions finançades per la Generalitat de Catalunya en materia de recerca, desenvolupament i innovació,* Government of Catalonia, Barcelona.

Cooke, P. (2004), "Introduction: Regional Innovation Systems – An Evolutionary Approach", in Cooke, P, M. Heidenreich and H. Braczyk (eds.), *Regional Innovation Systems*, Routledge, London.

Cornet, M., B. Vroomen, and M. van der Steeg (2006), "Do Innovation Vouchers Help SMEs to Cross the Bridge Towards Science?", CPB Discussion Paper No. 58, CPB Netherlands Bureau for Economic Policy Analysis, the Hague, February.

Cotec (2008), *Innovaciones tecnológicas con aplicación en el ámbito local*, Cotec, Madrid.

Crespy, C., J. Heraud, B. and Perry, (2007), "Multi-level Governance, Regions and Science in France. Between Competition and Equality", *Regional Studies*, Vol. 41(8), pp. 1069-1084.

Cruz-Castro, L., M. Fernandez Mellizo and L. Sanz-Menéndez, (2003), "La importancia de los intereses académicos en la política científica y tecnológica catalana", *Papers: Revista de Sociología*, Vol. 70, pp. 11-40.

Defazio, D. and J. García-Quevedo (2006), "The Government-Academia-Industry Relationship in Catalonia", *Int. J. Foresight and Innovation Policy*, Vol. 2(3-4), pp. 327 – 344.

Di Vittorio, C. Barciela López i G. L. Fontana (eds.) (2004), *Storiografia d'industria e d'impresa in Italia e Spagna in Età moderna e contemporanea*, Padua, CLEUP, pp. 63-102.

Edler, J and L. Georghiou (2007), "Public Procurement and Innovation – Resurrecting the Demand Side", *Research Policy*, Vol. 36(7), pp. 949-963.

ERAWATCH, accessed 5-12 August 2009. ERAWATCH is jointly carried out by the EC's Directorates-General for Research and Joint Research Centre/IPTS in collaboration with CORDIS. *http://cordis.europa.eu/erawatch/*

EC (European Commission) (2003a), *The Competitiveness of Business-related Services and Their Contribution to the Performance of European Enterprises,* communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions, Brussels.

EC (2003b), *European Trendchart on Innovation – European Innovation Scoreboard (EIS)*, Brussels.

EC (2007), *INNO-Policy TrendChart – Policy Trends and Appraisal Report: Spain 2008*, Enterprise Directorate-General, Brussels.

EC (2008), *INNO-Policy TrendChart – Policy Trends and Appraisal Report: Spain 2008*, Enterprise Directorate-General, Brussels.

EC (2009), *ERAWATCH Country Report 2008: An Assessment of Research System and Policies (Spain),* European Communities, Luxembourg.

European Union Cluster Observatory (2008), *www.clusterobservatory.eu/*, accessed 10 August 2009.

FECYT (*Fundación Española para la Ciencia y la Tecnología*) (2009), *Informe sobre la política de gasto en actividades de investigación científica, desarrollo e innovación tecnológica en los Presupuestos Generales del Estado, 2008,* Ministry of Science and Innovation, Madrid.

Fernández, T. and D. Montolio (2006), *R+D+i, creixement i productivitat de Catalunya en el context europeu*, Papers de treball, Generalitat de Catalunya. Departament d'Economia i Finances, Direcció General de Programació Econòmica, Nº 8.

Fernández-Ribas, A. (2009), "Public Support to Private Innovation in Multi-level Governance Systems: An Empirical Investigation", *Science and Public Policy*, Vol. 36(6), pp. 457-467.

Funcas (2007), "Perspectivas de la industria Espanola: evolución y futuro", *Papeles de Economia Espanola*, No. 112, June.

Fundación Conocimiento y Desarrollo (2008), *Informe CYD 2008*, Fundación CYD, Barcelona.

García-Quevedo, J. (2005), *L'evolució recent de la política d'innovació tecnológica i la seva aplicación a Catalunya,* Nota d'Economia 82, pp. 103-119, Departament d'Economia i Finances, Generalitat de Catalunya, Barcelona

García-Quevedo, J., N. Duch Brown, D. Montolio Estivili, and J. Polo Otero (2007), *Avaluació dels ajusts atorgats per el foment de'R+D i la Innovació empresarial per la Secretaria d'Indústria i el CIDEM en el periode 2004-2006,* Government of Catalonia, CIDEM, Barcelona.

Global Entrepreneurship Monitor (2008), *Informe Ejecutivo GEM España*.

Government of Catalonia (*Generalitat de Catalunya*) (2008a), *Catalan Agreement on Research and Innovation – Framework Document,* Barcelona.

Government of Catalonia (*Generalitat de Catalunya*) (2008b), *Catalan Agreement on Research and Innovation,* Barcelona.

Government of Catalonia (*Generalitat de Catalunya*) (2008c), "*Strategic Agreement to Promote Internationalisation of the Catalan Economy, the Strengthening of its Competitiveness and the Quality of Employment, 2008-2011",* Ministry of the Economy, Barcelona.

Hernández Gascón, J.M., J. Fontrodona Francolí, and A. Pezzi (2005), *Map of Local Industrial Production Systems in Catalonia*, Government of Catalonia, Ministry of Labour and Industry, Barcelona.

Hollanders, Hugo (2007), *2006 European Regional Innovation Scoreboard (2006 RIS)*, Trendchart: Innovation Policy in Europe, revised version 4 January.

ICF (Catalan Institute of Finance) (2009), *Memoria 2008*, Government of Catalonia, Barcelona.

ICREA (*Institució Catalana de Recerca i Estudis Avançats*) (2009), *Memoir *08*, ICREA, Barcelona.

INE (Spanish Statistical Agency) (2009), *Technological Innovation in Companies Survey 2008.*

Leadbeater, C., J. Bartlett, and N. Gallagher (2008), *Making it Personal*, Demos, London.

Lyall, C. (2007), "Changing Boundaries: The Role of Policy Networks in the Multi-level Governance of Science and Innovation in Scotland", *Science and Public Policy*, Vol. 34 (1), pp. 3-14.

Ministeria de la Politica Territorial (2009), *www.mpt.es/documentacion/politica_autonomica/Co-operacion_Autonomica/Coop_Multilateral/Conf_Presidentes.html* accessed 17 September 2009.

Ministerio de la Presidencia (2005), *Convergence and Employment: The Spanish National Reform Program*, Madrid.

Ministerio de la Presidencia (2008), *Spain – National Reform Program. 2008 Progress Report*, Madrid.

Miotti, L. and F. Sachwald (2003), "Co-operative R&D: Why and With Whom – An Integrated Framework of Analysis", *Research Policy*, N°. 32, pp. 1481–1499.

Moreno, L. (2002), "Decentralisation in Spain", *Regional Studies*, Vol. 360(4), pp. 399–408.

Moreno Amich, R. (2008), *La Recerca a Catalunya: Oportunitats i Reptes de Futur,* mimeo, Government of Catalonia, Ministry of Innovation, Universities and Enterprise, Barcelona.

Nauwelaerts, Y and I. Van Beveren (2005), *Sectoral Concentration of FDI in OECD Countries*, paper presented at the International Conference on International Trade and Logistics, Corporate Strategies and the Global Economy, Le Havre, France, 28-29 September 2005.

NESTA (National Endowment for Science Technology and the Arts) (2007), *Hidden Innovation: How Innovation Happens in Six 'Low Innovation' Sectors*, NESTA, London, June.

OECD (1997), *Policy Evaluation in Innovation and Technology: Towards Best Practices*, OECD, Paris.

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

OECD (2002a), *Benchmarking Industry-Science Relationships,* OECD, Paris.

OECD (2002b), *Frascati Manual: Proposed Standard Practice for Surveys on Research and Experimental Development*, OECD, Paris.

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

OECD (2005a), *Enhancing the Performance of the Services Sector*, OECD, Paris.

OECD (2005b), *Governance of Innovation Systems, Volume 1: Synthesis Report*, OECD, Paris.

OECD (2005c), *OECD Economic Surveys: Spain*, Volume 2005/6 – April, OECD, Paris.

OECD (2005d), *OECD Science, Technology and Industry Scoreboard 2005,* OECD, Paris

OECD (2006a), *Governement R&D Funding and Company Behaviour: Measuring Behavioural Additionality*, OECD, Paris.

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

OECD (2007a), *Competitive Regional Clusters –National Policy Approaches,* OECD, Paris

OECD (2007b), *Higher Education and Regions: Globally Competitive, Locally Engaged*, OECD, Paris.

OECD (2007c), "International Measurement of the Economic and Social Importance of Culture", OECD STD/NAFS(2007)1, unpublished.

OECD (2007d), *Linking Regions and Central Governments: Contracts for Regional Development*, OECD, Paris.

OECD (2007e), *OECD Economic Surveys: Spain,* Volume 2007/1, January, OECD, Paris.

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

OECD (2007g), *OECD Science, Technology and Industry Scoreboard 2007*, OECD, Paris.

OECD (2007h), *OECD Territorial Reviews: Madrid, Spain*, OECD, Paris.

OECD (2008a), *OECD Economic Surveys: Spain*, Volume 2008/19, November, Supplement No. 1, OECD, Paris.

OECD (2008b), *OECD Reviews of Regional Innovation: North of England, UK*, OECD, Paris.

OECD (2008c), *OECD Reviews of Regional Innovation: Piedmont, Italy*, OECD, Paris.

OECD (2009a), "Country Reviews of Innovation Policy", DSTI/STP (2009)4REV1, OECD, Paris, unpublished.

OECD (2009b), "Mind the Gaps: Managing Mutual Dependence in Relationships among Levels of Government", *OECD Working Paper on Public Governance No. 14*, OECD, Paris.

OECD (2009c), "New Forms of Innovation: Challenges for Policy Making", DSTI/STP/TIP(2009)6, OECD, Paris, unpublished.

OECD (2009d), *OECD Regions at a Glance 2009*, OECD, Paris.

OECD (2009e), *Promoting Entrepreneurship, Employment and Business Competitiveness: The Experience of Barcelona,* OECD, Paris.

OECD/European Commission (2005), *Oslo Manual: Guidelines for Collecting and Interpreting Innovation Data*, 3rd Edition, OECD, Paris.

OECD/FECYT (2007), *R&D and Innovation in Spain: Improving the Policy Mix*, Fundación Española para la Ciencia y la Tecnología, Madrid and OECD, Paris.

Parellada Sabata, M. *coord.* (2005), *Evaluación de la políticas públicas de apoyo a la industria en Cataluña,* Government of Catalonia, CIDEM, Barcelona.

Perry, B. and May, T. (2007), "Governance, Science Policy and Regions: An Introduction", *Regional Studies*, Vol. 41(8), pp. 1039-1050.

Pezzi, A. (2008), "Cluster Policy in Catalonia" , mimeo , Government of Catalonia, Secretariat for Industry and Enterprise, Barcelona.

PIMEC (2008), *Anuari de la pime catalan: Resultats economics in financers: 2002-2006*, PIMEC, Barcelona.

Revilla Diez, J. (2000), "Innovative Networks in Manufacturing: Some Empirical Evidence from the Metropolitan Area of Barcelona", *Technovation*, Vol. 20, pp. 139–150.

Riba Villanova, M. and L. Leyesdorff (2001), "Why Catalonia Cannot Be Considered as a Regional Innovation System", *Scientometrics*, Vol. 50(2), pp. 215-240.

Rovira, L., R.I. Méndez-Vásquez, E. Suñén-Pinyol and J. Camí (2007), "Caracterització bibliomètrica de la producció científica a Catalunya, 1996-2006". *Informe AGAUR-PRBB.* Barcelona.

Sánchez Granados, A. (2008), "Taxation in Fostering Innovation: A Direct or Indirect Impact?", *Paradigmes No. 0: Strategies for Innovation*, May.

Santiago, P. *et al.* (2009), *OECD Reviews of Tertiary Education: Spain*, OECD, Paris.

Santisteban, M. A. (2006), "Business Systems and Cluster Policies in the Basque Country and Catalonia (1990–2004)", *European Urban and Regional Studies*, Vol. 13(1), pp. 25–39.

Sanz-Menéndez, L. and Cruz-Castro, L. (2005), "Explaining the Science and Technology Policies of Regional Governments", *Regional Studies* 39 (7), pp. 939–954.

Segarra-Blasco, A. (2007), *Innovation, R&D Spillovers and Productivity: The Role of Knowledge-intensive Services*, document de Treball XREAP2007-12, Xarxa de Referència en Economia Aplicada.

Segarra-Blasco, A. (2010), "Innovation and Productivity in Manufacturing and Service Firms in Catalonia: A Regional Approach", *Economics of Innovation and New Technology*, DOI: 10.1080/10438590802469594.

Segarra-Blasco, A. and J.M. Arauzo-Carod (2008), "Sources of Innovation and Industry–university Interaction: Evidence from Spanish Firms", *Research Policy* Vol. 37, pp. 1283–1295.

Segarra-Blasco, A., J. García-Quevedo, and M. Teruel-Carrizosa (2008), "Barriers to Innovation and Public Policy in Catalonia", *International Entrepreneurship Management Journal*, Vol. 4(4), pp. 431-451, December.

Serrat, D. (2004), "Historical Views and Challenges for the Research Plans for Catalonia", mimeo, Barcelona.

Technopolis *et al.* (2006), *Strategic Evaluation on Innovation and the Knowledge-based Economy in Relation to the Structural and Cohesion Funds, for the Programming Period 2007-2013: Synthesis Report*, a report to the European Commission, Directorate General Regional Policy, Evaluation and Additionality, 23 October.

Trullén, J. (1990), "Del modelo de crecimiento a partir del decenio de 1960" in Parellada, Martí (1990), *Estructura económica de Cataluña*, (ed.) Espasa – Calpe, Madrid.

Valls *et al.* (2007), *R&D Investment by the 50 Largest Companies in Catalonia, Collection of Studies* (10), Government of Catalonia, Barcelona.

van Cruysen, A. and H. Hollanders (2008), *Are Specific Policies Needed to Stimulate Innovation in Services?*, final version for the workshop "Towards a European Strategy in Support of Innovation in Services", Workshop of DG Enterprise and Industry, 4 February 2008.

Zabala-Iturriagoagoitia, J., P. Voigt, A. Gutiérrez-Garcia, and F. Jiménez-Sáez (2007), "Regional Innovation Systems: How to Assess Performance", *Regional Studies*, Vol. 41(5), pp. 661-672.

OECD PUBLISHING, 2, rue André-Pascal, 75775 PARIS CEDEX 16
PRINTED IN FRANCE
(04 2010 02 1 P) ISBN 978-92-64-08204-5 – No. 57277 2010

OECD Reviews of Regional Innovation

CATALONIA, SPAIN

With over seven million inhabitants and a GDP of around EUR 204 billion, Catalonia is not only an important region within Spain, but within the OECD as well. Indeed, its economic output is similar to countries like Portugal and Norway. The region experienced massive population growth over the past decade, due to immigration, which in part drove GDP growth. However, Catalonia's productivity is slipping, relative to other OECD regions, necessitating the transition to a productivity-driven growth model through a stronger regional innovation system. The region has successfully strengthened its research base, with investments in R&D having increased four-fold over the past decade. Catalonia is now mobilising actors across the innovation system in regional centres, such as Barcelona, to improve productivity and address social challenges.

This report assesses how to improve Catalonia's current strategy and actions in order to boost its innovation system through both its own programmes and those of Spain and the European Union. It will be of interest to policy makers, firms and others active in promoting innovation and regional economic development.

OECD*publishing*
www.oecd.org/publishing

ISBN 978-92-64-08204-5
04 2010 02 1 P

9 789264 082045