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Abstract
The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

This report provides an analysis of the research and innovation (R&I) system in Spain for 2015, including relevant policies and funding, with a particular focus on topics critical for EU policies. The report identifies the main challenges for the Spanish R&I system and assesses the policy response. It was prepared in accordance with a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports and websites. The quantitative data are, if possible, comparable across all EU Member State reports. Unless specifically referenced, all data used in this report are based on Eurostat statistics available in February 2016. The report contents are partly based on the *RIO Country Report Spain 2014* (Zubieta, 2015).

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Executive summary

This report provides an analysis of the research and innovation (R&I) system in Spain for 2015, including relevant policies and funding, taking into account the priorities of the European Research Area and the Innovation Union. The report was prepared in accordance with a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports and websites. The quantitative and qualitative data are, if possible, comparable across all EU Member State reports.

Context

Spain is one of the EU Member States that has been hardest hit by the financial and economic crisis that started in 2008. Before the crisis, during the 2002–2008 periods, gross expenditure on research and development (GERD) had doubled in absolute terms and the increase in relative terms was also remarkable: GERD, as a percentage of gross domestic products (GDP), reached an intensity of 1.35 % in 2009. Since 2009, overall R&D intensity has decreased: in 2014, it had decreased to 1.20 %. Today, research and development (R&D) funding indicators suggest a decreasing trend. Government budget appropriations or outlays on R&D (GBAORD) were €5 776 million in 2014, lower than in 2006 (EUR 6 737.4 million).

Direct government expenditure on R&D (i.e. GERD by the government) has declined monotonically since the start of the crisis in 2009. Public budgets for R&D from the State have also been greatly reduced: from EUR 9 673 million in 2009 to EUR 6 406.5 million in 2015 (i.e. from 2.52 % to 1.46 % of the total central budget). This 2015 share of the total central budget is similar to the R&D budget of 2001 (i.e. 1.49 %) (ICONO-Ministry of Finance -MINHAP, 2015). Although they have increased in recent years, the contributions to R&D from the European Commission and from indirect public support remain too marginal to compensate for the decline in direct public funding.

Key developments in the R&I system in 2015 are presented below.

- In November 2015, Royal Decree 1067/2015 approved the creation of the Spanish Research Agency. This Agency should formally be created in 2016. It aims to be an autonomous entity that assigns R&D funding, monitors and evaluates research projects. The Agency will follow principles of transparency and efficiency to simplify administrative procedures related to project funding.
- The replacement rate of retirees for public research organisations was increased in 2015 from 10% to 50%. A new maximum of 100% was set for 2016. In 2011, regulatory measures to correct the public deficit (e.g. Royal Decree-Law 20/2011) had limited staff recruitment and the filling of positions left vacant by retirees in the public research sector to 10%.
- The 2015, the release of a new roadmap of research infrastructure was announced as part of the National Reform Programme.

The main national public programmes to stimulate research and innovation in the private sector are included in the "Business leadership programme" and in the "Promotion of R&I towards societal challenges programme". Both programs are part of the State Plan of Scientific and Technical Research and Innovation (2013-2016).

The identified challenges for Spain's R&I system consist of:

(1) improving the public labour market for researchers;

(2) improving funding and governance of the public research system;

(3) promoting a culture for innovation and stimulating performance in business R&D and innovation;

(4) stimulating regional R&I potential and performance;

(5) promoting effective policy evaluation mechanisms.

Research and innovation challenges

Challenge 1: **Improving the public labour market for researchers**

Description

Human resource constraint is considered the most pressing challenge of the Spanish research and innovation (R&I) system (ERAC, 2014). Three main reasons have been proposed to be the principal causes of this challenge.

The first one is directly linked to the economic crisis. Since 2008, the main consequence of research and development (R&D) budget reductions has been the non-renewal of temporary researchers' contracts. This has resulted in a drastic reduction in the possibilities for young researchers to obtain a stable position of employment. Since 2010, the employment rate for those with a PhD qualification has been constantly decreasing, while the number of students graduating with a PhD has increased every year, from 7 150 in 2007 to 9 483 in 2012 (Eurostat).

The second factor has a more systemic nature and is linked to the structure of the research system. The Spanish labour market for researchers is characterised by a singular duality. On one hand, civil servants form the core permanent staff at universities and public research organisations (PROs). On the other hand, non-civil servants, most often young researchers, are generally contracted temporarily.[1] This duality is accompanied by a change, over time, in the possibility of obtaining a civil servant position (which can be obtained only through public competition); this means that the career of a researcher in Spain is highly dependent on the availability of permanent positions. Since the beginning of the economic crisis, the availability of such positions has been very limited because of budget restrictions. Furthermore, while formally the recruitment process for permanent research positions at university is open,[2] in reality tacit mechanisms favour insiders (i.e. researchers from the same university) rather than external candidates. Of the EU Member States, Spain has one of the highest rates of endogamy in its university system (measured by the proportion of staff that obtained their PhD in the university at which they work) (ERAC, 2014: 26).

Finally, the third factor that explains the increasing unemployment rate among recently graduated PhD researchers is the limited access to research project funds for researchers with temporary contracts. Generally, application processes for project funding favour researchers with permanent positions. This requirement drastically reduces the options for young researchers with regard to applying for funding.

Policy response

In the last few years, Spain has deployed a number of formal policy responses to improve, among other things, the public labour market for researchers. Law 14/2011 on Science, Technology and Innovation, and, subsequently, two strategic documents, namely the Spanish Strategy for Science, Technology and Innovation (2013–2020) and the National/State Plan for Scientific, Technical Research and Innovation (2013–2016), have established or reinforced several instruments for strengthening human resources for science, technology and innovation (STI), including additional resources for doctoral

[1] Although most non-civil servant contracts are temporary, some of them are permanent (*contrato indefinido*).

[2] The formal openness of the recruitment system has mainly involved, since 2001, the need for candidates to be first evaluated by the National Agency for Quality Assessment and Accreditation (ANECA) in order to be able to apply for a position. The transparency of this process is, however, counter-balanced by the capacity of universities to decide the timescale between publication of a vacancy and the deadline for application, thereby allowing universities to influence the composition of the members of the selection panels and establish ad hoc selection criteria that favour internal candidates.

and postdoctoral training grants and the introduction of mobility schemes (OECD, 2014). Among these, the 'Ramón y Cajal' contracts facilitate the recruitment of national and foreign researchers. They include an initial grant to start a research project in Spain and an additional EUR 100 000 for institutions that award researchers permanent contracts after five years of activity (OECD, 2014). In addition, Law 14/2011 on Science, Technology and Innovation confirmed the 'Profesor Contratado Doctor' contract, created in 2001, and included the 'Investigador distinguido' contract, in order to offer stable contracts to non-civil servant researchers. To complement these measures, the government increased the replacement rate for retirees from 10% to a maximum of 50% for 2015 and to a maximum of 100% for 20163.

Assessment

At the same time as the adoption of these strategic policy documents meant to improve the human resource situation in the public research system, drastic budget cuts often hindered the implementation of these policies. As a result, the demography of the research system remains a pressing problem for Spanish R&I.

Throughout the research system (i.e. institutes and universities), an alternative path is needed to move research careers away from the standard civil service model (ERAC, 2014). This could include the further strengthening of positions such as the 'Professor Contratado Doctor' or the further implementation of the 'Contrato de investigador distinguido' envisaged by Law 14/2011. So far, the number of such positions is very low and they have not been translated into stable contracts.[4]

Challenge 2: **Improving funding and governance of the public research system**

Description

Since the beginning of the crisis, the considerable reduction of GBAORD between 2009 and 2013 (by 39 %) has limited Spain's growth potential. The central government's budget for public expenditure on R&I in 2014 and 2015 indicates that the decreasing trend has been halted; however, budget levels remain at the 2005–2006 level. In this context, it is still essential that new sources of funding are identified and that the effective and efficient use of resources is ensured (Council Recommendation, 2015). In addition to the lack of flexibility of the public research system (see Challenge 1), two main factors are considered to inhibit national research performance (ERAC, 2014).

The first one is directly linked to the drastic reduction of public funding for research. Between 2008 and 2013, the amount of competitive funding financed from the state budget decreased by 62 % (ERAC, 2014: 19). The second factor that influences national research outputs is the weakness of the incentives for research performance. Decisions on whether or not to award funding to universities are generally based on criteria related to the number of students and teachers without capturing research performance. Spain's performance, as based on scientific publications, is at the Organisation for Economic Co-operation and Development (OECD) median, although the ratio of public R&D expenditure to GDP is slightly below (OECD, 2014).

Policy response

Law 14/2011 on Science, Technology and Innovation and, subsequently, the Spanish Strategy for Science, Technology and Innovation (2013–2020) and the National/State

[3] See Ley de Presupuestos Generales del Estado 2016 (art. 20, 2, I, p.68): http://www.congreso.es/docu/pge2016/pge2016/PGE-ROM/doc/L_16_A_1.PDF

[4] In December 2014, the government opened 25 positions of 'contrato de investigador distinguido'. The work plan for 2015 (i.e. the Annual Work Plan) considered the opening of 15 positions of 'contrato de investigador distinguido'.

Plan for Scientific, Technical Research and Innovation (2013–2016) present a set of comprehensive policies and reforms aimed at improving the research system.

One of the most emblematic measures aimed at increasing the national research performance was the creation of the National Research Agency. This organisation, already foreseen in the Law on Science (2011), is tasked with the efficient management of R&D investment through the elaboration and implementation of Spanish research funding policy. The Agency is expected to foster independent peer reviews of projects by international experts and evaluations based on the innovative capacity of projects. Since 2011, the creation of the National Research Agency has been suggested in each country-specific recommendation. The Agency was created in November 2015.

In addition to the creation of the National Research Agency, the Spanish policy framework aims to improve researchers' productivity through an individual-level incentive system: the *sexenio*. In this scheme, a bonus is provided on the basis of a favourable assessment of research outputs. These bonuses can consist of pay supplements, the ability to participate in academic decision-making bodies at universities, a reduction in teaching activities, an increase in research activities, etc.

Complementary to the elaboration of policy measures, the evolution of the central government's budget for public expenditure on R&D over the last two years indicates that the decreasing trend has been halted. In 2015, the national budget for public spending on R&I increased by 4.8 %. However, this is partly because of a large increase in military-related R&I spending. Moreover, the 2015 budget included funds to reimburse multiannual R&I project grants committed in previous exercises. Therefore, in practice, only a small proportion of the increase in the public R&I budget will be available to support the national strategy for STI (EC, 2015: 76).

Assessment

Despite the progress made and the implementation of important reforms (such as the creation of the National Research Agency), insufficient funding and structural weaknesses in the research system continue to limit Spain's growth potential (EC, 2015: 61). Generally, a change in the government's perception, that public research funding is an expenditure that should be delayed until sufficient economic growth has been achieved, is needed (ERAC, 2014). Rather, such funding should be considered a core part of the economic strategy for recovery. Therefore, the European Research Area and Innovation Committee (ERAC) peer review panel recommends progressively increasing public funding for research in order to reach a target of 0.7 % of GDP by 2017.

Challenge 3: **Promoting a culture for innovation, and stimulating performance in business research and development and innovation**

Description

The Spanish industrial structure is characterised by a significant proportion of small and medium-sized firms in low-tech traditional sectors (RIO Country Report, 2014). It lacks large private investors with a leading role in creating R&D-related networks. Furthermore, since the beginning of the crisis in 2008, Spain has faced a dramatic reduction in the number of companies active in R&D, which has decreased from 12 997 in 2008 to 7 628 in 2014 (ERAC, 2014)

While the economic crisis remains the direct determinant of the low level of R&D activities, longer-term structural challenges need to be highlighted. Over the decade 2000–2009, the considerable increase in public and private R&D expenditure did not significantly boost innovation in Spain. During this period, the country made little progress in accumulating intellectual assets (e.g. patent applications, community trademarks and designs), improving public–private and private–private partnerships or introducing new innovative products, processes and services (EC, 2012: 25). These

characteristics suggest that the low engagement of business with R&I can partly be ascribed to a lack of innovation-friendly framework conditions and to a limited innovation culture (ERAC, 2014; COTEC, 2015).

Policy response

Spain has designed a large number of support schemes to foster R&D activities, to increase knowledge transfer between public and private sectors and, more generally, to increase innovation culture. In 2011, the Law on Science, Technology and Innovation introduced several changes in order to improve knowledge transfer mechanisms. It encourages, for example, the creation of technological spin-off companies by allowing researchers to work part-time in private companies that were created by the organisations for which they originally worked. The Spanish Strategy for Science, Technology and Innovation (2013–2020), established in 2013, explicitly mentions, as one of its four goals, the promotion of business leadership in research and development. The National/State Plan for Scientific, Technical Research and Innovation (2013–2016) also encourages the creation of university spin-offs and public–private research cooperation (RIO Country Report, 2014). To complement this, several programmes have been launched to promote innovation clusters and knowledge transfer mechanisms.[5]

Assessment

There has been no systematic evaluation of the policy measures that aim to encourage knowledge transfer and improvements in the innovation culture; however, the development of an institutional framework shows that there is a definite will to improve the amount and scope of R&I activities. Still, there is a need for nationwide public–private partnerships geared towards innovation that gather the best resources from both private and public sectors. To do this, the implementation of the agenda set by the Spanish Strategy for Science, Technology and Innovation (2013–2020) should be accelerated, both at the national and regional levels (ERAC, 2014). The absence of a sufficient number of small and medium-size companies that perform R&I activities is still a major structural weakness of the innovation system.

Challenge 4: **Stimulating regional research and innovation potential and performance**

Description

Out of the 17 Spanish autonomous communities, only two – the Basque Country and Navarra – display a R&D intensity above the EU average and are considered, by the Innovation Union Scoreboard, to be 'Innovation Followers'. The other 15 regions fall into the category of 'Moderate Innovators', for which R&D intensity is below the EU average. In addition, R&D activities are highly concentrated in four regions, which accounted for 70.4 % of all R&D expenditure in 2013: Madrid (25.8 %), Catalonia (22.9 %), Andalusia (11.4 %) and the Basque Country (10.2 %) (ICONO-INE, 2015). This fragmentation creates important challenges for the Spanish R&I system with regard to stimulating R&I potential and performance (ERAC, 2014: 18).

Policy response

Law 14/2011, namely the Spanish Strategy for Science, Technology and Innovation (2013–2020), was jointly elaborated by the state and the autonomous communities and

[5] Some relevant sub-programmes that aim to promote knowledge transfer are the RETOS Colaboración, Torres Quevedo; EMPLEA; EQUIPA (technology parks); INNCIDE (Knowledge Transfer Offices); NEOTEC (New Technology Based firms); Innovative Companies Associations and Clusters (AEI); Technology Platforms; and 'CIEN' Strategic private consortia for innovation.

is presented as a 'RDI political agenda which includes coordination between the actions of the General State Administration, the Autonomous Regions and the European Union'.

This document has been complemented by the adoption, in 2014, of Smart Specialisation Strategies in each autonomous community. These strategies aim to identify comparative advantages for each region and take into account the diversity of regional potential. In the case of Spain, many of the autonomous communities focus on similar priorities (ERAC, 2014): sustainable agriculture and natural resources (14 regions); intelligent and sustainable transport (13 regions); sustainable energy (9 regions); and digital society (9 regions). Except in the cases of La Rioja, Navarra, Cantabria, Castilla-La Mancha and Castilla y León, the Spanish regions have not yet adopted any action plan to implement their smart specialization strategy.

Assessment

While the adoption of a national strategy for science, technology and innovation and the complementary regional Smart Specialisation Strategies offer a policy framework that grasps the diversity of territories and the priorities in Spain, there is still substantial room for improvement.

In particular, for some autonomous communities, the elaboration of Smart Specialisation Strategies might have consisted of a replication of Spanish priorities, with little strategic work being carried out to identify genuine regional strength. In addition, most regional strategies do not include any mechanism for cooperation with other Spanish regions (ERAC, 2014: 59).

Challenge 5: **Promoting an effective policy evaluation mechanism**

Description

Despite an intention to establish a culture of policy monitoring and evaluation across the whole R&I system, effective instruments to achieve this goal are still limited (ERAC, 2014; RIO country report, 2014). To achieve efficiency and accountability in all public administration actions linked to the promotion of research, development and innovation (RDI), the Spanish Strategy for Science, Technology and Innovation (2013–2020) foresees 'the setting up of an integrated information system and the improvement of the quality of indicators for monitoring the actions funded by the Public Administrations and their impact'. While the integrated information system has been developed through a Platform for research and innovation (PAID), further steps are expected to improve the monitoring system. In addition to the creation of a national research agency, the elaboration of two policy intelligence tools is recommended (ERAC, 2014: 73).

The first one is a policy-oriented monitoring system. This system would gather detailed and regular information on the policies that have been implemented (including ex post data on project results), and link these in a coherent framework structured according to the Strategy's goals.

The second tool is a common evaluation system based on international evaluation standards at different levels (i.e. programmes, institutions and laboratories). This would probably involve the combination of different existing evaluation systems under a national umbrella with independent governance. This could take the form of a think tank with operational capabilities (e.g. foresight, econometrics of the research system).

Policy response

The need to improve the policy evaluation culture is recognised by the Spanish Strategy for Science, Technology and Innovation (2013–2020), which sets out the intention to reinforce a culture of policy monitoring, accountability and evaluation of the system.

Today, the Secretary of State for R&I, with the support of the Spanish Foundation for Science and Technology (FECYT) and the Centre for Industrial and Technological

Development (CDTI), carries out the monitoring of the national plan policies and most of the business-oriented R&I policies. However, the reports produced mainly relate to how funding is distributed and generally lack a proper assessment of the quality and efficiency of the funding mechanisms (RIO Country Report 2014). Strategies and plans are increasingly based on some of the evaluation analyses, but these are not always publicly available. Nonetheless, a range of studies has been carried out by different stakeholders (e.g. the Spanish Confederation of Scientific Societies (COSCE) and the COTEC Foundation) and academics which could help to improve the policy-making process (RIO Country Report 2014).

Assessment

In general terms, the evaluation system would benefit from better integration into the policy system, and from the generalisation and standardisation of a common evaluation system with international evaluation standards that work at different levels (programmes, institutions, etc.). Information on R&I indicators and policies is increasingly collected systematically by different stakeholders, indicating that the implementation of this monitoring system is currently feasible. It is worth mentioning that the evaluation culture of the Spanish R&I system is dominated by an auditing function because of strict requirements with regard to public accountability from the Ministry of Finance over a learning function, which diminishes the opportunities to implement an integrated monitoring policy system. Also, the establishment of the National Research Agency has provided a good opportunity to reinforce evaluation practices (ERAC, 2014).

1. Overview of the R&I system

1.1 Introduction

Spain is the second largest country in the European Union (EU), with an area of 498 511 km^2.[6] In 2015, its population was 46.4 million[7] (i.e. 9.1 % of the total population of the 28 Member States (EU-28)). Gross domestic product (GDP) per capita in 2014 was EUR 22 400 (see Table 1). This value has increased by EUR 300 over the last year, but it is far from the EU-28 average of EUR 27 400. After several years of negative GDP growth rate values, Spanish GDP growth rate was positive in 2014 (1.4 %); this value is slightly higher than the EU-28 average of 1.3 %. (–2.6 % in 2012 and –1.7 % in 2013). Importantly, the budget deficit as a percentage of the public budget has been decreasing over the last three years, with figures of –10.4 % in 2012, –6.9 % in 2013 and –5.9 % in 2014, and it is now approaching the –3 % of the euro zone. Despite the efforts to reduce the budget deficit, government debt as a percentage of GDP increased yearly over the same period, reaching a figure of 99.3 % in 2014 (85.4 % in 2012 and 93.7 % in 2013), which is more than 10 % higher than the EU-28 average (which was 86.8 % in 2014). The unemployment rate as a percentage of labour has decreased over the last year by 1.6 % (to 24.5 %), but is more than double the European average of 10.2 %.

The economic structure of Spain is dominated by the service sector, which accounts for 74.4 % of its GDP. The industry sector contributed 17.5 % to the nation's GDP, followed by the construction sector (5.6%) and the agriculture sector (2.5 %). The weight of the construction sector, in terms of Spain's economy, declined from 11.5 % in 2011 to 5.6 % in 2014 (INE-2015). The Spanish economy appears to be moving towards a higher knowledge intensity economy. The knowledge intensity indicator was 38 in 2012, following a 2.7 % growth rate between 2007 and 2012, which is higher than the European average growth rate of 1 % (which had a knowledge intensity indicator of 51.2 in 2012) (EC, 2014d). The country also appears to have increased competitiveness through technology acquisition. The Spanish contribution of high- and medium-technology goods to the EU trade balance was 3.3 % in 2012 and increased by 15.9 % between 2007 and 2012; this is much higher than the European average of 4.8 % (4.25 % in 2012) (EC, 2014d).

Research and Development (R&D) funding indicators still show a decreasing trend. Government budget appropriations or outlays on R&D (GBAORD) were EUR 5 360 million in 2014, which is lower than they were in 2006 (EUR 6 737.4 million), and negative GBAORD growth rates of 5.7 % were seen in 2014, 8.1 % in 2013 and 14.7 % in 2012. Total gross expenditure on research and development (GERD) was EUR 12 820.8 million in 2014, which is lower than GERD in 2007 (EUR 13 342.4 million). GERD as a percentage of GDP declined from 1.24 % in 2013 to 1.2 % in 2014 (i.e. GERD returned to the 2006 levels of 1.2 %). R&D intensity (i.e. GERD/GDP) is also far below the European average of 2.03 % in 2014. GERD per capita was EUR 273.6 in 2014, which is only half of the EU-28 average (of EUR 558.4). Employment in high- and medium-high-technology manufacturing sectors, as a percentage of total employment, increased from 3.8 % in 2013 to 4 % in 2014, which is quite far below the EU-28 average of 5.7 %. Employment in knowledge-intensive service sectors, as a percentage of total employment, decreased slightly from 36.3 % in 2013 to 36.1 % in 2014 (the EU-28 average was 39.8 % in 2014). The turnover from innovation and the value added of non-high-tech manufacturing suggest a more positive situation for the country. Turnover from innovation as a percentage of total turnover was 14.3 % in 2012, which is well above the European average for the same year (of 11.9 %). The value added of manufacturing as a percentage of total value added was 22.3 % in 2013, which is below

[6] Unless otherwise indicated, all data are from Eurostat (extracted in December 2015).
[7] Provisional data.

the 2012 European average (of 26.2 %). The value added of high-tech manufacturing as a percentage of total value added was 1.3 % in 2013.

Table 1. Main R&I indicators, 2012–2014

Indicator	2012	2013	2014	EU average
GDP per capita	22 300 (p)	22 100 (p)	22 400 (p)	27 400
GDP growth rate	–2.6 (p)	–1.7 (p)	1.4 (p)	1.4
Budget deficit as a percentage of public budget (%)	85.4	93.7	99.3	86.8
Government debt as a percentage of GDP (%)	–10.4	–6.9	–5.9	–3
Unemployment rate as a percentage of the labour force (%)	24.8	26.1	24.5	10.2
GBAORD (million EUR)	6 185.179	5 682.178	5 360.378	92 828.145
GERD (million EUR)	13 391.6	13 011.8	12 820.8	
GERD as a percentage of GDP (%)	1.27	1.24	1.2	2.03
GERD (EUR per capita)	286	278.5	273.6	558.4
Employment in high- and medium-high-technology manufacturing sectors as a percentage of total employment (%)	3.9	3.8	4	5.7
Employment in knowledge-intensive service sectors as a percentage of total employment (%)	36.3	36.3	36.1	39.8
Turnover from innovation as a percentage of total turnover (%)	14.3			11.9
Value added of manufacturing as a percentage of total value added (%)	22.0	22.3		26.2
Value added of high-tech manufacturing as a percentage of total value added (%)	1.2	1.3		0.0

Source: Eurostat.

Spanish R&D investment targets were set by a national strategy (the Spanish Strategy for Science, Technology and Innovation (EECTI), 2013–2020) and a national plan (the State Plan of Scientific and Technical Research and Innovation (PECTI), 2013–2016). EECTI downgraded the R&D investment target for 2020 to 2 % GERD per GDP from the previously set 3 % target. EECTI and PECTI include a target of 0.73 % for business R&D

expenditures (BERD) per GDP for 2016, and EECTI also includes a target of 1.2 % for 2020. The progress towards reaching these targets has been negative because of decreasing public and private investments in R&D.

The decreasing trend in public R&I funding indicates that R&D has not been used as a counter-cyclical engine to overcome the financial crisis. Total and relative R&I funding has decreased to 2006–2007 levels. The central government budget for R&D (PGE-46) as a percentage of the total budget (PGE) has decreased to 2000 levels (1.46 % in 2015 versus 1.4 % in 2000). Importantly, the fiscal consolidation measures adopted in 2012 have affected the Spanish R&I system. These have delayed the implementation of Spanish research initiatives and have limited young researchers' access to permanent positions. In addition, the lack of alternative measures to compensate for the significant reductions in public funding have given rise to concerns about the sustainability of the Spanish R&I system (ERAC, 2014).

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

Spain has a decentralised R&I system. Regions (*comunidades autónomas*) have political and administrative responsibilities for R&I, and are in charge of university funding. They play an important role in R&I, as regional budgets represent 60 % of total GBAORD (ERAC, 2014). Regions tend to implement innovation policies more frequently because of the distribution of competences between national and regional levels of governance.[8] The need for a more effective coordination mechanism is considered one of the main governance challenges of the Spanish decentralised R&I system (OECD, 2006; ERAC, 2014). Differences in R&D efforts among regions are important. In 2014, four regions accounted for 70.4 % of all R&D expenditure: Madrid (25.8 %), Catalonia (22.9%), Andalusia (11.4 %) and the Basque Country (10.2 %). In relative terms, the leading regions are the Basque Country, Navarre, Madrid and Catalonia, with a GERD per GDP of 2.0 %, 1.8 %, 1.6 % and 1.5 %, respectively (ICONO-INE: 2015).[9]

In 2014, the distribution of GERD by the source of funds suggests that the business enterprise sector (BES) and government sector are the main R&D funders, providing 46.4 % and 45.5 % of total funding, respectively, followed by small percentages from other sectors: 7.4 % from abroad and 0.7 % from the private non-profit (PNP) sector (ICONO: INE-2015). The Spanish GERD distribution suggests that in Spain the R&I system relies more on public funds than the EU-28 average.[10] Total funding from the government sector decreased by 1.9 % between 2013 and 2014. Disinvestment in the public budgets for R&D has been significant: GBAORD decreased by 14.7 % in 2012, by 8.4 % in 2013 and by 5.7 % in 2014, reaching a figure of €5 360 million. This public disinvestment in a R&I system that relies on public funds has threatened the sustainability of the Spanish R&I system.

The business enterprise sector is the main funder of R&D, contributing 52.6 % of GERD in 2014 (0.63 % of GDP), followed by the higher education sector (HES) (which

[8] The Spanish Constitution grants powers to both the national and regional administration for promoting scientific and technical research. National authorities are in charge of the coordination in this area (Art. 149.1.15 and 148.1.17). However, allocation of competences relating to innovation is not mentioned in the Constitution. See Gómez (2007) and Díez-Bueso (2013) for more details on the R&I national and regional allocation of competences.

[9] Data were updated on 25 November 2015.

[10] In 2012, the private sector accounted for 45.6 % of R&D investment in the EU-28 as a whole, compared with 54.9 % in Spain. The corresponding figures for government were 32.8 % and 43.1 %, for investment from abroad were 9.8 % and 6.6 % (Eurostat, 2015). Data by sectors were not available at European level for 2013.

contributed 28.3 % of GERD and 0.34 % of GDP), the government sector (18.9 % of GERD and 0.23 % of GDP) and the PNP sector (0.2 % of GERD) (Eurostat, 2015). A total of 48 public universities contributed 28 % of GERD in 2014 (EUR 3 277.7 million; 91 % of HES GERD), while eight public research bodies (OPIs) contributed 7.8 % of GERD (EUR 994.1 million; 41 % of government sector GERD).11 A total of 9 370 small and medium-sized enterprises (SMEs) (90.6 % of the total number of SMEs) contributed 24.5 % of GERD in 2014 (EUR 3 139 million; 46.1 % of BERD) (INE-2015). The number of people employed in R&D activities in 2014 was 199 583 full-time equivalents (FTEs) (Eurostat, 2015). Across sectors in 2014, the business enterprise sector contributed 43.6 % of total R&D FTEs, followed by HES (36.8 %), the government sector (19.4 %) and the PNP sector (0.2 %) (Eurostat, 2015). With regard to research performance, universities showed the highest performance based on the total number of international articles published in 2012 (ICONO-Scimago: 2014). In 2012, around 70.3 % of the total number of articles were published by universities, followed by the health sector (which published 24.6 % of articles), OPIs (23.9 %), others (2.5 %) and the private sector (1.8 %). However, taking into account the quality of the publications (i.e. the 'normalised impact'), OPI publications had the highest impact (with an average impact factor of 1.6), followed by the health sector (average impact factor of 1.5) and universities (average impact factor of 1.4).

SMEs constitute 90.6 % of the total number of firms that perform R&D (9 370 in 2014) and these enterprises contributed 24.5 % of GERD in 2014 (EUR 3 139 million; 46.1 % of BERD) (INE-2015). Large firms (which represent 9.4 % of the total number of firms that perform R&D) perform 53.7 % of private sector R&D. The service sector and industry represent 49.2 % and 48.2 % of business sector expenditure, respectively, and the agricultural sector represents a minor percentage. 'Professional R&D activities' account for 60 % of service sector expenditure, followed by 'R&D services' (43.5 %). 'Pharma' and 'Chemistry' are important sectors, representing 17.7 % and 7.2 %, respectively, of the industry sector in 2014 (INE-2015).

1.2.2 Governance

Spain has a relatively well-developed R&I structure in place, but its effectiveness and stability has been challenged by budgetary cuts during the financial crisis period (see sections 1.1 and 3.1), and by difficulties in coordinating national and regional authorities, which prevent the improvement of the R&D policy-making process (ERAC, 2014). The central government provides an R&I policy framework, which leads the definition of broad policy orientation on a multiannual basis through national strategies and PECTI (2013–2016). This structure also includes mechanisms for the coordination and involvement of stakeholders (e.g. regional and local authorities, industry, parliaments and citizens) through the Council of Science, Technology and Innovation (CPCTI), which is responsible for the national strategy and the coordination with regional governments and other actors of the R&I system. The advisory council CACTI, which gathers representatives of relevant research communities, enterprises and trade unions, is complementary to this. The substantial effects of the financial crisis on the Spanish R&I system indicate that the current R&I structure does not guarantee the provision of a stable policy and budgetary framework.

The key players of the R&I policy-making process of the Spanish R&I system across policy roles (i.e. policy-making, implementation and policy advice) are:

- the policy-making bodies (see organigram below);
- the implementation bodies;
- the bodies that provide science policy advice and support.

[11] See section 1.2.3.

Policy-making bodies

The Ministry of Economics and Competitiveness (MINECO) is the main body responsible for R&I policy design and operational management; in 2015, MINECO distributed 71 % of the Spanish State Budget[12] among R&I activities (ICONO-MINHAP: 2015). Other ministries that are relevant to the management of R&I are the Ministry of Industry, Energy and Tourism (MINETUR) (responsible for 24.3 % of the budget in 2015), the Ministry of Defence (MDEF) (2.5 %) and the Ministry of Education, Culture and Sports (MEDU) (1.5 %) (ICONO-MINHAP: 2015) (see section 3.3.1 for more details).

MINECO implements, through the State Secretary for Research, Development and Innovation (SEIDI), the responsibility of drafting and managing the main R&I instruments, namely the multiannual 'strategies' and 'plans'. EECTI (2013–2020) sets the rationale, objectives and indicators of the Spanish R&I policy. PECTI (2013–2016) is a multiannual plan that implements EECTI by setting its priorities, programmes, coordination mechanisms, costs and sources of funding. EECTI and PECTI were approved on 1 February 2013.[13] The proposals have merged the two strategies and plans originally envisaged by the 2011 Law of Science, Technology and Innovation (LCTI 2011).

R&I policies at state level are supported by the Executive Committee for Science, Technology and Innovation Policy (CDCTI). CDCTI is an inter-ministerial body responsible for the planning, evaluation and coordination of the main Spanish instruments for R&D and innovation.

Implementation bodies

SEIDI is a body of the National State Administration (AGE) that implements and carries out MINECO's R&I responsibilities. These include the design and execution of the central government policies on R&I; the supervision of OPIs (see section 3.3.1 and Annex 4); the coordination with other regional R&I bodies; and the international representation of the Spanish government on R&I issues.

The main funding bodies involved in the implementation of R&I policies are the Spanish Research Agency (AEI) and the Centre for Industrial Technological Development (CDTI).

The AEI was envisaged by the LCTI 2011. However, because of measures to reduce the government deficit (Royal Decree 8/2010), the creation of the AEI was delayed until 27 November 2015 (Royal Decree 1067/2015). The AEI aims to be an autonomous entity that will assign R&D funds on the grounds of scientific merit.

The CDTI is a public corporate entity mainly involved in the funding and promotion of innovation and technological development by companies (see section 3.5.1 for more details).

In fact, SEIDI shares responsibilities for funding and implementing PECTI with the abovementioned CDTI, the Carlos III Health Institute (ISCIII), the National Institute for Agricultural and Food Research and Technology (INIA), the State Secretary of Technology and Information Society and the State Secretary of Education, Professional Education and Universities (MEDU) and FECYT. In 2015, SEIDI (for MINECO) managed about 50 % of the central government budget,[14] CDTI managed about 30 %, while other bodies managed less than 10 % of this budget (see section 3.3.1, for more details on the 2015 funding distribution, and Annex 4).

12 In contrast to GBAORD data, this budget includes not only subsidies and direct or indirect R&D and innovation expenditures, but also loans and credits.

13 PECTI replaced the National Plan for R&D and Innovation (2008–2011), which was extended to the end of 2012.

14 The percentages referred to in this sentence were calculated considering the distribution of the provisional budgets of the working plan of PECTI distributed by AGE in 2015. MINECO distributed 71 % of the public budget for R&D (PGE) for 2015.

The Information System of Science, Technology and Innovation (SICTI) will be responsible for the data collection, ex post analysis and impact assessment of all policy programmes and instruments of the R&I policy.[15]

Bodies providing science policy advice and support

The two main advisory and supporting bodies of MINECO are the CPCTI and CACTI.

The CPCTI is a body for the general coordination of R&I with the representatives of national and regional governments. It supports the drafting of the national strategies, informs with regard to national and regional R&I plans, approves information exchange methods between national and regional administrations, promotes joint actions and knowledge transfer activities, and advises national and regional governments. Its members are the ministries or secretaries of state of the ministries with R&D and innovation responsibilities, and representatives of each of the regional governments (*comunidades autónomas*). The CPCTI was established on 18 September 2012.

CACTI gathers representatives of the research community, enterprises and trade unions. It provides policy advice to the CPCTI. Its responsibilities are to review national R&I strategies and plans, to advise the national government and the CPCTI on R&I issues, and to promote evaluation mechanism. It gathers 14 experts on R&I, representatives from business associations and trade unions. At least two-thirds of its members come from the R&I community. It adheres to the principles of excellence, independence and transparency. It was established on 16 November 2012.

The R&I policy evaluation system in Spain is considered moderately developed (Eparvier, 2009; Heijs and Martinez, 2011; Heijs et al., 2011; Molas-Gallart, 2012; ERAC, 2014). SICTI will be responsible for the data collection and impact assessment of all policy programmes and instruments of the R&I policy.[16] However, the most recent peer-review exercise of the Spanish R&D system made by ERAC states that there is 'a lack of an effective system of evaluation at policy, institutional or research quality levels and only a partial existence of a policy intelligence system' (ERAC, 2014, p. 4). This report considers the need to reinforce a monitoring and evaluation system to be the second-most cross-cutting challenge necessary to improve policy impact (ERAC, 2014: 73). The need to extend the evaluation culture is recognised by EECTI (2013–2020), which sets out the intention to reinforce a culture of policy monitoring, accountability and evaluation of the system. The evaluation culture in Spain is dominated by its control functions, which diminish the learning and distributive evaluation functions (Molas-Gallart, 2012).

Under the mandate of MINECO, the FECYT carried out yearly reviews of the R&D public calls for proposals from 2006 until 2010 as SISE and later as annual reports for R&I. Currently, MINECO has decided to perform these reviews over a longer time frame. The last annual report refers to 2012. However, the annual reports mainly describe how funding was distributed across instruments, and they usually lack any assessment of the quality and efficiency of the funding mechanisms. The CDTI reports and evaluates most of the business-oriented instruments. They are more up to date as they are yearly reports (e.g. CDTI, 2014a) and include some impact indicators (e.g. *cuadernos*; see CDTI, 2014b) (see section 3.5). Strategies and plans are increasingly based on some of the evaluation analyses, but these are not always publicly available.[17] Therefore, despite the improvements, there is not an effective monitoring and review system in place, as

15 The current monitoring system for EECTI coordinated by SEIDI is supported by the Automated Data Platform for I+D+I (PAID); the Network of Public Policies for R&I (REDIDI), as an informal coordination network; and the Spanish Observatory for R&D (ICONO) technology platform.

16 The current monitoring system for EECTI coordinated by SEIDI includes PAID; REDIDI, as an informal coordination network; and the ICONO technology platform.

17 PECTI mentions the weaknesses of the previous National Plan (p. 6), but it does not refer to the analysis from which these weaknesses were identified. It may be based on the SISE reports that evaluate the implementation of the national plans. These reports were carried out on a yearly basis from 2006 to 2010.

full use is not made of output indicators, international benchmarking, ex ante or ex post evaluation tools, or impact analysis. Data on funding through R&D programmes are made publicly available, but with significant delays, and therefore it is difficult to assess whether or not this information is used as input for designing subsequent funding cycles.[18] In general terms, the policy evaluation system would benefit from a better integration into the policy system, and from a generalisation and standardisation of a common evaluation system with international evaluation standards working at different levels (programmes, institutions, etc.) (ERAC 2014: 74).

1.2.3 Research performers

In 2013, HES (which, as a whole, contributed 28.3 % of GERD) included 48 public universities, 29 private universities and 86 other centres, which contributed 90.9 %, 6.3 % and 2.8 % of HES GERD, respectively (Eurostat and INE-2015). Public universities registered 87.7 % of the total student population for the academic year 2013–2014 (1 412 673 students), while private universities, which are basically teaching universities with little research activity, registered 12.3 % of total students (CRUE, 2015). The student population of private universities increased by 18.2 % between the academic years 2008–2009 and 2013–2014, while the student population of public universities decreased by 0.4 % (CRUE, 2015). Polytechnic universities have a higher degree of specialisation than general-oriented universities (CRUE, 2015). The number of university personnel decreased between 2010 and 2013 to 4 943 full-time permanent academics (CRUE, 2015). The number and quality of publications from universities is increasing. In 2012, Spanish universities produced 56 657 documents, 52 % of which were in the first quartile with regard to impact, whereas, in 2008, Spanish universities produced only 40 445 articles, 46 % of which were in the first quartile (CRUE, 2015).

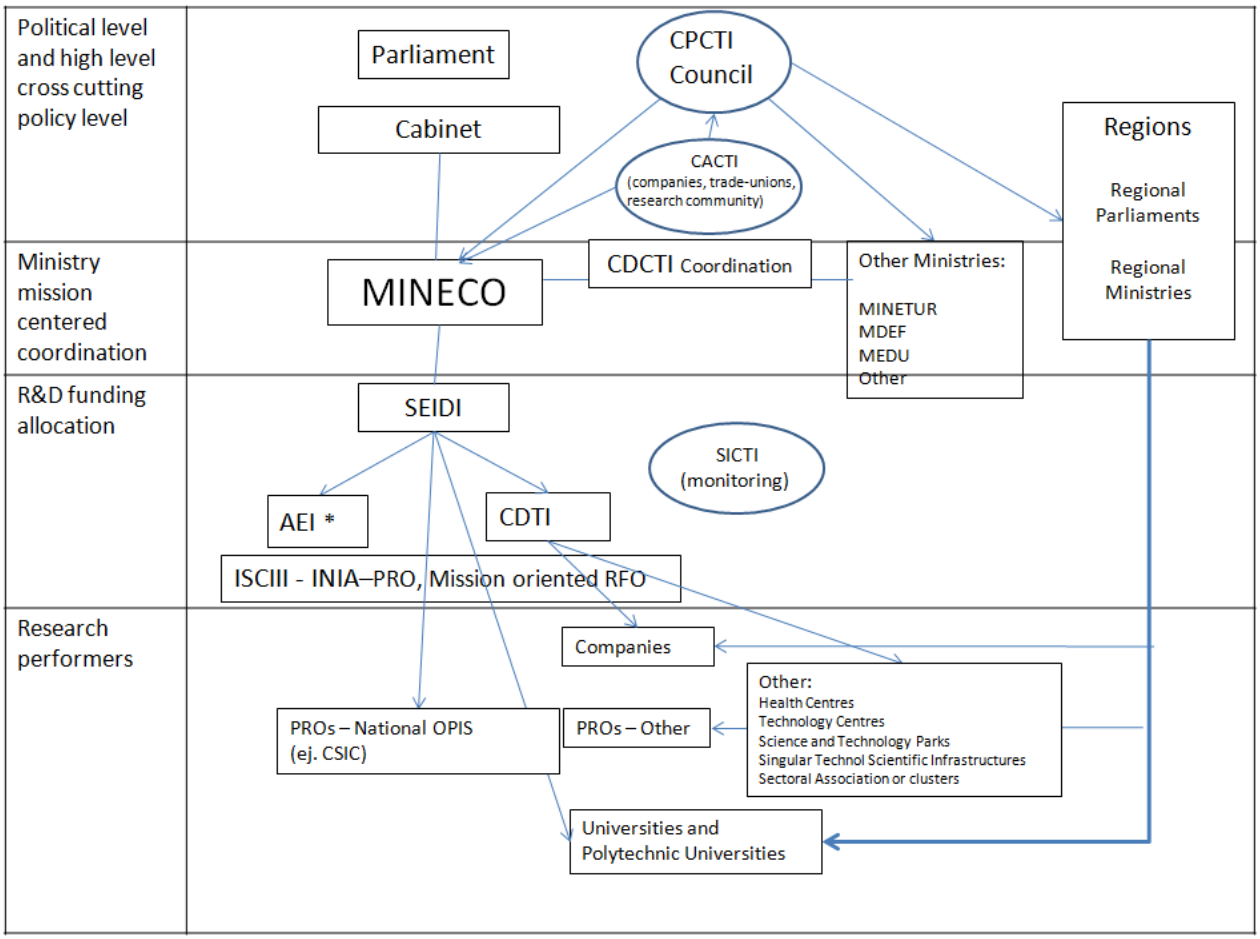
In 2014, the government sector (which, as a whole, contributed 18.9 % of GERD) included 8 OPIs, 56 other public national centres, 356 regional and local public centres, and 69 other centres, which contributed 42 %, 10.6 %, 36.2 % and 11.3 % of government sector GERD, respectively (Eurostat and INE-2015). The main OPIs regulated by LCTI 2011 and under the umbrella of MINECO are the CSIC; the Research Centre for Energy, Environment and Technology (CIEMAT); the Geological and Mining Institute of Spain (IGME); the Spanish Institute of Oceanography (IEO); the National Institute for Agricultural and Food Research and Technology (INIA); and the ISCIII. In addition, the National Institute for Aerospace Technology (INTA) is under the umbrella of the MDEF. According to the central government budget for R&I in 2014, the main OPIs are the CSIC, which represents 47.7 % of the total OPI budget (EUR 1 258 million), followed by the ISCIII (22.8 %) and INTA (8 %) (Molero and de Nó, 2014c). Within the OPIs, there are bodies that fund research – Research Funding Organisations (RFO) – such as the ISCIII and INIA. Some of these are more generally oriented (e.g. CSIC), while others are more mission oriented (e.g. INIA). The institutional mission of OPIs is to carry out scientific and technical research; to transfer knowledge to other sectors; and to train R&I personnel.

The business sector (which contributed 52.6 % of GERD in 2015) included 9 307 SMEs (90.6 % of the total) and 968 non-SMEs (9.4 %), which contributed 46.3 % and 53.7 % of BERD, respectively (Eurostat and INE- 2015). In 2014, a total of 83.1 % of R&I-performing companies did not have any foreign participation, 8.7 % had high levels of foreign participation (≥ 50 %), 4.5 % had some foreign participation (< 50 %), 2.2 % were economic consortia (AEIs) and other research centres, and 1.5 % were public-private companies (INE- 2015). The service sector contributed approximately 49.2 % of

[18] For example, at the time of writing this report, data on public R&D expenditures through national public programmes were only publicly available for 2012; the work programme that established how the funds of PECTI were going to be distributed for 2014 was published in December 2014.

BERD, followed closely by the industry sector, which contributed nearly 48.2 % of BERD in 2014. The service sector has a higher proportion of SMEs and a lower proportion of companies with foreign participation than the industry sector (92.9 % versus 88.3 % with regard to the proportion of SMEs, and 6.1 % versus 11.9 % with regard to companies with high levels of foreign participation). Other relevant private research entities are technology centres that carry out industrial research and knowledge transfer activities.

In addition, other research-related actors could be considered, such as technology centres,[19] public health bodies[20] or university institutes.[21]



AEI	Spanish Research Agency
CACTI	Advisory Council of Science, Technology and Innovation

[19] Technology centres are not-for-profit entities with the institutional mission of improving society and company competitiveness through R&I activities and technology applications. According to the map of R&I entities of the FECYT, there are 139 technology centres in Spain (accessed on 13 October 2015).

[20] According the FECYT map, there are 93 public health bodies (including hospitals) in Spain. These include public health centres and the private foundations that manage them.

[21] According to the FECYT map, there are 520 university institutes in Spain. This group includes public and private centres owned by universities or 'mixed' centres, that is, those created in collaboration with other public and private entities. Other research-related actors included on the map are singular scientific and technical infrastructures (40); technology parks (81); OPIs (16); research centres (339); private universities (28); public universities (217); and technology transference offices (101).

CDCTI	Executive Committee for Science, Technology and Innovation policy
CDTI	Centre for Industrial Development
CPCTI	Council of Science, Technology and Innovation
CSIC	Spanish National Research Council
INIA	National Institute for Agricultural and Food Research and Technology
ISCIII	Carlos III Health Institute
MDEF	Ministry of Defence
MEDU	Ministry of Education, Culture and Sports
MINECO	Ministry of Economy and Competitiveness
MINETUR	Ministry of Industry, Energy and Tourism
SEIDI	State Secretary of Research, Development and Innovation
SICTI	Information System of Science, Technology and Innovation
*	Not yet implemented

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

Spain approved its R&I strategy, that is, **EECTI (2013–2020),** on 1 February 2013. The strategy establishes the rationale, objectives and indicators of the Spanish R&I policy for the period 2013–2020.

EECTI is based on the following: five basic principles; four general objectives disaggregated into 18 specific objectives; six priority axes; and six articulation mechanisms. It also sets out indicators to measure the impact of the R&I policy.

The five EECTI principles are (1) the coordination of R&I policies; (2) a stable framework; (3) quality and social impact; (4) efficiency and accountability; and (5) gender issues. Box 1 shows the general and specific objectives set by the strategy.

Box 1. General and specific objectives of the Spanish R&I policies according to EECTI 2013–2020

Recognition and promotion of talent and employability (which has three specific objectives)

(1) Education and training in R&I; (2) mobility and development of research career; and (3) human resources employability.

Promotion of excellence (which has four specific objectives)

(1) Institutional strengthening; (2) sustainability and use of scientific and technological infrastructures; (3) promotion of frontier knowledge; and (4) promotion and development of emergent technologies.

Business leadership (which has three specific objectives)

(1) Encouragement of business R&I; (2) market-oriented R&I activities; and (3) promotion of enabling technologies.

Promotion of R&I towards societal challenges (which has eight specific objectives)

(1) Health, demographic change and welfare; (2) bio-economy, security and food quality, sustainable agriculture production and natural resources sustainability; (3) energy, security and green energy efficiency; (4) smart, sustainable and integrated transport; (5) climate change, efficiency in the use of resources and raw materials; (6) innovation and social change; (7) digital economy and society; and (8) security, liberty and rights protection.

The EECTI identifies 14 challenges that are quite similar to the ones identified by the 2006 OECD report (OECD, 2006). According to EECTI, the identification of these challenges was based on an analysis, but this analysis does not appear to be publicly available. Two public consultation processes on the strategy were carried out in October 2012 and December 2012 (see ERAWATCH, 2014a). EECTI includes the concept of smart specialisation in one of its six priority axes (Priority 5) as a tool for increasing the competitiveness of the regional systems of innovation.

EECTI covers R&I in an integrated manner. It merges the two strategies envisaged by LCTI 2011 – the Spanish Strategy for Science and Technology (EEST) and Spanish Strategy for Innovation (EEI) –which focused on research and innovation, respectively.

The most important changes that have occurred over the last three years, which might have affected the implementation of EECTI, are the financial crisis (see section 3.1) and the design of the Smart Specialisation Strategies (RIS3) (see section 2.4). The strategy identified the financial crisis as a threat (EECTI, p. 15), but it did not envisage any specific measures to address its possible negative consequences on the R&I system. Similarly, the concept of smart specialisation is mentioned in the strategy, but synergies between regional Smart Specialisation Strategies and the national strategy are not clearly identified. Therefore, it appears that emerging opportunities were not clearly specified. EECTI is implemented through PECTI (2013–2016), which sets its priorities, programmes, coordination mechanisms, costs and sources of funding. This policy framework suffered from inefficiencies during the crisis, including delays in the launch of instruments (e.g. the AEI), R&D programmes (e.g. the call for R&I projects) and research institutions (e.g. CSIC budget cuts) (see section 6 and the RIO Country Report 2014).

EECTI reflects the EU Europe 2020 Strategy, because its objectives are aligned with those set by the European strategy. However, the strategy has set a new lower target of 2 % GERD per GDP for 2020, instead of the previous target of 3 %; this 2 % target departs from the European R&I investment objective (see section 2.4 for more details). Joint programming and cross-border cooperation mechanisms are included in EECTI's priority axis 5.4, which focuses on internationalisation and international leadership (p. 35–36). Joint programming is also considered to be one articulation mechanism (p. 38) (see section 4.2.1).

2.2 R&I policy initiatives

In addition to the adoption of the strategy (EECTI (2013–2020)) and plan (PECTI (2013–2016)) in 2013, other relevant R&I policy initiatives that define the Spanish policy agenda are the LCTI, adopted in 2011, and the Entrepreneurship and Internationalisation Support Act published in 2013 (Law 14/2013). In addition, improvements with regard to tax deductions and social security benefits for R&I (see section 3.5.2), the creation of the AEI on the 27 November 2015 (envisaged by the LCTI) and the implementation of new programmes, such as the 'CIEN strategic private consortia for innovation'(see section 3.5.1), should also be mentioned.

The **LCTI** (adopted 1 June 2011) replaced the so-called Law of Science 1986. The LCTI aims to improve coordination with regional and European authorities, take into account the growth of the Spanish R&I system, improve research careers and help the transition to an economy based on knowledge and innovation. It also mentions gender issues and ethics. The emphasis on innovation, which was missing from the Law of Science 1986, the design of several mechanisms aimed at improving national and regional coordination (e.g. the CPCTI and SICTI), and the AEI project are the main relevant aspects of the new law. It modifies governance and human resources related to R&D (e.g. new labour contracts and a unified professional career in order to facilitate mobility between public research centres and universities) and improves the mechanisms for the transfer of

knowledge (e.g. by improving the granting of property rights to researchers and reducing the incompatibility for researchers employed by public institutions who wish to work in private firms) (See Annex i for more details on the changes brought by the LCTI).

The **Entrepreneurship and Internationalisation Support Act** (Law 14/2013) was published on 27 September 2013 and includes the following measures:

- In order to boost entrepreneurship, its aims to provide training; to implement the legal statuses of 'Limited Liability Entrepreneur' (*Emprendedor de Responsabilidad Limitada*) and 'Progressively Formed Limited Liability Company' (*Sociedad Limitada de Formación Sucesiva*); to reduce the time required to create a limited liability company to 24 hours; to create Entrepreneur Service Points; and to provide a second chance for entrepreneurs through an extra-judicial payment mechanism.
- Fiscal measures will involve changing the timing of VAT obligation to actual cash payments; introducing tax allowances for the reinvestment of profits; R&D allowances; and tax incentives for investments in entrepreneurs.
- In order to boost finance for entrepreneurs, it will eliminate charges so as to create incentives for issuing securities on the alternative fixed-income market; make the regulations for refinancing agreements more flexible; and boost new instruments to finance projects for internationalisation.
- To promote business growth, it will extend the list of activities not subject to municipal licences and reduce obstacles to entrepreneurs who wish to access public contracts.
- To boost the internationalisation of the Spanish economy, a new system of visas and residence permits is planned to attract talent and investment from abroad; and a Spanish strategy for internationalisation is envisaged.

Strategies and policies are increasingly attempting to encompass research, innovation and education aspects. LCTI 2011 emphasises the role of innovation and the need to exploit potential synergies between research and innovation. The law envisages separate strategies and plans for research and for innovation, but these were finally merged into a single strategy and plan in order to improve the synergies between research and innovation. In addition, the new strategy clearly indicates that all of these aspects should be addressed simultaneously: 'This strategy approaches innovation on all its levels, including all the agents that share the responsibility for innovation, for promoting education, for encouraging technological change, scientific research, industrial development, infrastructures, etc.' (EECTI: 9). The new strategy also aims to promote 'Industrial PhD programmes' that involve universities and companies, with the view to attaining a better match between education and training supply and employment needs, and to encourage inter-sectoral job mobility. However, despite the progress and the spirit of the strategy, the structure of the Spanish R&D system presents some difficulties in relation to increasing the synergies among these three areas. The different allocation of competences at national and regional levels (i.e. the horizontal level of governance) will probably need to be more clearly defined in order to implement the agenda set by the LCTI and EECTI (ERAC, 2014). MEDU is in charge of designing education policies at the national level, while the regions are responsible for universities. Because of this fragmentation, efforts must be made to encompass research, innovation and education in the policy-making process. MINECO is the main body responsible for coordinating and designing R&I policies at the national level, but at state level these are implemented through different funding bodies: the AEI for research-related policies (Real Decreto 1067/2015 dated 27 November 2015) and the CDTI for innovation-oriented policies. In addition, the regions have an exclusive role in the definition of their innovation-oriented policies according to their policy competencies. In order to improve synergies, therefore, ERAC has suggested that the AEI should be operationalized and that attention should be

given to both its funding and its strategic roles (ERAC, 2014).[22] Investment in research infrastructures is also considered in policies and strategies.

New policy programmes, such as the 'CIEN Strategic private consortia for innovation' which offers funding for private consortia with SME and OPI participation in order to address big technological projects, indicate that new efforts are being made to increase public–private cooperation and knowledge transfer. Similarly, the 'Industrial PhD programme', which allows PhDs to be carried out in the private sector, indicates that efforts are being made to encompass research, innovation and education. Both programmes were introduced in the 2014 PECTI working plan. In addition, the new 'PYME Horizon programme', which targets SMEs that have applied for European funding for a high-quality R&I project but were unsuccessful, was introduced in the 2015 PECTI working plan. This indicates that increasing attention is being paid to SMEs in the policy mix (see sections 2.3 and 3.4.3 for more specific measures).

2.2.1 Evaluations, consultations and foresight exercises

In 2014, ERAC carried out the most recent peer-review evaluation of the Spanish R&D system. After a request by the Spanish authorities in November 2013, ERAC established a group of international peers. This group worked in collaboration with experts from the European Commission and MINECO during the first semester of 2014 and published the ERAC peer review of Spanish Research and innovation system: Final *report* in August 2014 (ERAC, 2014). The report highlights that the Spanish research system is unequal with regard to the distribution of its levels of excellence; that it is limited by a fragmented system of governance; that it has significant institutional rigidities, which prevent an effective flow of people and knowledge; and that it lacks an effective system of evaluation at policy and institutional levels. The report recognises that the objectives of LCTI 2011 and EECTI (2013–2020) are good, but they do not outline any effective paths for the implementation of these objectives. Such paths are needed, particularly with regard to addressing the dual character of the research system (i.e. the high-quality peak performances but low average performance); its integration with the business sector (with a small number per capita of businesses with R&D innovation capabilities); and its fragmented system of governance (with national and regional capabilities).

- The report includes the following 10 key recommendations (ERAC, 2014: 4–9):
- 'It is clear that Spain's R&I system needs increased resources but these must go hand in hand with structural reform for a more efficient and effective use of public investment. This will ensure a faster and more sustainable recovery for the Spanish economy. The additional resources should be used exclusively to incentivise reform'.
- 'Human resources are the most pressing problem and rapid action is needed'
- 'Institutional reform is critical'.
- 'Research institutes and universities need to be subject to an assessment system that influences resource allocation both directly and indirectly. There is also a need to increase the proportion of competitive funding'.
- 'A new level of coordination between actors is required for effective innovation. We propose national consortia, termed Strategic Innovation Arenas'.
- 'Bringing more business actors into the innovation system is critical'.
- 'A market and a culture for innovation'.
- 'The need for an autonomous agency to implement the reform programme'.
- 'Incentivising regional synergies in support of business and business creation'.
- 'Effective monitoring and evaluation to support evidence-based policy'.

[22] 'A Research Agency that has the classical function of a research funding organisation receiving grant proposals, as well as the newer strategic and networking functions that such organisations are taking up in many countries, is a necessary part of the Spanish research system. It is not sufficient, of course, to address the issues (which were outlined above) but can contribute by being pro-active' (ERAC, 2014: 35–36).

The arguments and recommendations of the ERAC report are accompanied by interesting national and international examples of how to address the challenges. The Spanish National Reform Programmes (NRPs) (for 2014 and 2015) refer to the results of the ERAC report. However, the R&I measures envisaged in the NRPs could be considered limited with regard to addressing the challenges that were highlighted by the peer-review exercise (see section 2.3). The ERAC report is also cited in the EC–Spain Partnership Agreement, which sets down the strategy for the optimal use of European structural and investment funds for growth and jobs in Spain for the period 2014–2020, as one of the evaluations that has been carried out on the Spanish system and that could provide some opportunities for the country (pp. 41 and 70).

The FECYT and the CDTI, both of which are under the responsibility of MINECO, produce reports on R&I national policies and the main R&I input and output indicators, and they commission external evaluations on the R&I system. The most recent reports of the FECYT and ICONO focus on R&I indicators (FECYT, 2015a) and bibliometric indicators (FECYT, 2014a). These types of reports have examined R&I activity since 1990. Previously, the FECYT conducted yearly reports on national plans; however, since 2012, these have not been available (FECYT, 2013c).

The FECYT also reports on the results of the Panel on Innovation and Technology (PITEC) (FECYT, 2014b). PITEC has provided statistical data on the innovation activities of Spanish companies since 2005. PITEC publications report on company behaviour, sources of funding and R&I funding. The FECYT also publishes reports on the international analysis of the Spanish R&I system (FECYT, 2015a, b). These reports are mainly descriptive. In addition, the FECTY commissions impact analysis studies (e.g. Sánchez Muñoz et al., 2014). These indicate that the intangible assets (intellectual capital) of companies are more important than company size with regard to explaining innovation activity. They also indicate that innovative businesses apply flexible management models.

Similarly, the CDTI reports its yearly activities related to the management of R&I programmes for companies (e.g. CDTI, 2014a), including information on funding and impact. It also publishes *cuadernos* that review some specific policy programmes in detail and include some impact indicators (e.g. CDTI, 2014b). In addition, it commissions some impact analyses that point to positive additionalities of public R&I support to company R&I investments (Huergo et al., 2009) (see section 3.5).

The National Agency for Quality Assessment and Accreditation (ANECA) evaluates research and teaching activities and reports its results (e.g. ANECA, 2014a, b) (see section 4.4.2).[23] It also evaluates policy programmes. However, these are mainly the programmes undertaken by MEDU and the results are not usually publicly available.

Different R&I stakeholders conduct or commission R&I reports, such as the Spanish Confederation of Scientific Societies (COSCE), the COTEC Foundation, the Spanish Conference of University Rectors (CRUE) and the foundation of the CCOO trade union ('Fundación 1º mayo'). COSCE commissions yearly reports on the central government's public budget for R&I (Molero and de Nó, 2014a, b, c, 2015a, b). These reports provide general trends and breakdowns of the R&I budget. During the financial crisis, they provided empirical evidence and highlighted concerns about the consequences of decreasing public funds on the sustainability of the R&I system. The COTEC Foundation conducts yearly reports on the main R&I input and output indicators (with international comparisons), central government public funding and the results of its annual survey to experts on the problems and evolution of the Spanish innovation system (COTEC 2014, 2015). In addition, CRUE commissions detailed yearly reports on the R&I activity of universities (Hernández Armenteros and Pérez García, 2014) and other evaluations of

[23] ANECA also evaluates PhD programmes *ex ante* (VERIFICA) and ex post (ACREDITA), and monitors their implementation (MONITOR) and recognises outstanding PhD programmes (ACREDITA Plus).

the education activities of universities. The 'Fundatión 1º de Mayo' provides data on human resources of the main R&I OPIs (e.g. Fundación 1º de mayo, 2014).

No significant R&I foresight exercises were carried out at national level between 2014 and 2015, or are not publicly available. R&I foresight exercises are the responsibilities of the Observatory for Industrial Technology Foresight (OPTI) and ANEP. OPTI was created in 1997 by the Ministry of Industry, Tourism and Trade in order to provide insights into the policy-related decision-making process regarding technology at both public and private levels. Its most recent report was about the anticipated impact of biotechnology on agriculture and farming in 2025 (Ruiz Galán and Rodríguez, 2013). ANEP does not carry out foresight activities directly. In 2012, OPTI was merged with the School of Industrial Organisation (EOI), after the resolution of the Council of Ministers on the rationalisation of the public sector (B.O.E. 24.03.2012). According to the report *Global Foresight Outlook 2007: Mapping foresight in Europe and the rest of the world* (EFMN, 2007), a total of 47 exercises have been mapped in Spain.[24]

Other significant review exercises carried out in 2012 and 2013 were the peer-review exercise on the Spanish university system requested by MEDU, namely the 'Proposal for the reform and improvement of the efficiency and quality of the Spanish University System' (MEDU, 2013a), and the public consultations on EECTI and PECTI (see country reports for 2013 and 2014 (ERAWATCH, 2014b; ERAWATCH, 2015). The draft of the 'Spanish Strategy for Bio-economy: Horizon 2030' underwent a public consultation process in September 2015.

2.3 European Semester 2014 and 2015

NRP 2015 and NRP 2014 follow the agenda of reforms stated in the previous NRP, which aimed to tackle the restriction of growth and employment creation. NRP 2015 and 2014 reinforce the need to ground the national reforms on their fiscal consolidation and to restructure the financial sector, and to implement other structural reforms. The NRPs recognise the importance of R&I with regard to boosting economic growth and social development (NRP 2014: 50; NRP 2015: 32). NRP 2015 states that, despite the fiscal consolidation measures, the Spanish government has made important efforts to increase public and private R&I funding through direct and indirect mechanisms. In addition, it states that the creation of the AEI is envisaged for 2015. Among the direct funding mechanisms, NRP 2015 states the 4.8 % annual increase in the government's public budget for R&I in 2015. Indirect mechanisms include the implementation of the tax incentives envisaged by Law 27/2014 of 27 November 2014 (see later in this section for more detailed measures regarding country-specific recommendations (CSRs), section 3.2 for smart fiscal consolidation measures and section 3.5.2 for fiscal measures).

NRP 2014, as did NRP 2013, highlights the approval of EECTI (2013–2020) and PECTI (2013–2016) as important R&I measures. These documents and measures are referred to in Axis 4 'Innovation and new technologies', and are included in the third priority area 'Promoting growth and competitiveness for today and tomorrow'. NRP 2014 mentions the intention to increase private investment in R&D through the improvement of the conditions of private loans and fiscal incentives; the creation of the AEI; the boosting of European partnerships through joint programming; and the need to improve the situation with regard to human resources for R&I. R&I-related topics are also mentioned in Axis 3, as part of the consideration of the measures proposed by the expert group on the Spanish university sector, namely the 'Proposal for the reform and improvement of the efficiency and quality of the Spanish University System' (MEDU, 2013a). This might

[24] Most of these exercises use panels of experts, literature reviews and Delphi exercises as methodologies. They tend to be nationally oriented, with a small number of participants (fewer than 50 members), and they tend to produce policy recommendations, analyses of trends and key technologies.

affect the situation of researchers working at universities and the internationalisation of universities. New technologies are mentioned as part of the Digital Agenda for Spain (ADE), which sets the strategy for the area for the period 2013–2015. New plans are envisaged to improve e-administration procedures. This also includes the Plan for Digital Public Services. In addition, the document mentions that the Structural Funds tool will devote a significant budget to research and new technologies in the 2014–2020 financial framework: EUR 4 330 million of the European Regional Development Fund (ERDF) will be devoted to research and new technologies as part of thematic objective 1, namely 'Boost research, technological development and innovation'.

NRP 2015 is structured across CSRs adopted by the Council of the European Union on 2 June 2014 (COM(2014) 410 final). NRP 2015 includes six specific R&I measures that address the CSRs (CSR 6.4.27–31). These measures are presented across five main R&I objectives as follows (NRP 2015: 32–34):

- To provide more financial and human resources for R&I by:
- increasing the PGE for R&I by 4.8 %[25] in 2015, increasing financial and non-financial instruments, and increasing the budget for PROs and OPIs by EUR 12.8 million (CSR 6.4.29);
- considering the R&I sector as a 'priority' sector, which allows a 100 % replacement rate of retirees from permanent positions, and launching calls for PhD positions in PROs and OPIs (CSR 6.4.30).
- To promote private sector participation in R&I (CSR) by:
- implementing measures included in the Plan for Growth, Competitiveness and Efficiency (CRECES) published on 14 June 2014 (CSR 6.4.29 and CSR 6.4.33);
- promoting the social security benefits for companies that hire researchers (CSR 4.2.6 and 6.4.34) and the fiscal benefits included in the Support Act to promote entrepreneurship and its internationalisation, published in 2013, and the fiscal reform of 2014 (CSR 1.4.52).
- To increase participation in joint programming initiatives within the European Research Area (ERA) by the dissemination; funding, through the 'Europe Excellence', 'Europe Networks' and 'Cofund' instruments; and alignment of national priorities with the ones set by Horizon 2020 (CSR 6.4.31).
- To improve the implementation and coordination of R&I policies through the creation of the AEI (CSR 6.4.35) and the creation of a new roadmap for research infrastructure (CSR 6.4.28).
- To review the Spanish R&I system through the peer-review exercise published in 2014 (CSR 6.4.32).

The CSR indicated that the Spanish R&D system 'needs to increase the quality of its scientific outputs, foster public–private co-operation and facilitate the conversion of research and innovation into commercial products' (p. 6). It indicated that the adoption of EECTI (2013–2020) must be properly supported with public funding. It also pointed out that the creation of the AEI was still pending. Therefore, the main recommendations were to identify sources of finance for EECTI (2013–2020) and to put in place the AEI. NRP 2015 includes more details on the progresses made over the last 12 years than NRP 2014. However, the increments of government public R&I budgets (4.2 % in 2015 and 0.4 % in the foreseen budget for 2016) (Molero and de Nó, 2015a, b) mean that total public expenditure on R&I is far below its pre-financial crisis level,[26] and represent only a small contribution to the 2 % GERD per GDP national objective for R&I. Similarly, the creation of the AEI was delayed until 27 November 2015. Generally, the R&I measures indicated in NRPs 2014 and 2015 lack substantial impact because of the breadth of the policy measures aimed at addressing the problems highlighted by the CSR (e.g. a relatively low budget for a country as large as Spain).

[25] This increment was finally set at 4.2 % (ICONO-MINHAP: 2015).

[26] The government public budget for R&I for 2016 is EUR 6 429.6 million (Molero and de Nó, 2015b), which is lower than the 2006 budget (EUR 6 545.7 million) (ICONO-MINHAP: 2015).

2.4 National and Regional R&I Strategies on Smart specialisation

Smart specialisation entails the need to prioritise specific areas of R&I based on the requirements and resources of regions. EECTI (2013–2020) includes this concept in one of its six priority axes (Priority 5) as a tool for increasing the competitiveness of the regional systems of innovation. PECTI (2013–2016) also mentions this concept. However, these documents do not foresee specific mechanisms to ensure synergies between regional Smart Specialisation Strategies and the national strategy.

All Spanish regions have developed and made public their RIS3 strategies: Andalusia, Aragón, Asturias, Cantabria, Castilla-la Mancha, Castille and León, Catalonia, Comunity of Madrid, Valencian Community, Extremadura, Galicia, Balearic Islands, Canary Islands, La Rioja, Navarre, the Basque Country and the Region of Murcia. Strategies appear to have been developed using a similar structure, which includes financial requirements, measures to stimulate private investment, and monitoring and evaluation mechanisms. A more accurate statement about how these aspects have been envisaged in the RIS3 strategies would require a detailed content analysis of these documents.27 It appears that many autonomous communities have focused on similar priorities (ERAC, 2014): sustainable agriculture and natural resources (14 regions), intelligent and sustainable transport (13 regions), sustainable energy (9 regions) and digital society (9 regions). An action plan at national level has been adopted through the EC–Spain Partnership Agreement 2014–2020. Action plans are difficult to monitor at regional level as these are not publicly available. Four autonomous communities (Aragon, Castile and Leon, the Basque Country and Galicia) have been peer reviewed in this context (registered countries and regions in the S3 Platform).[28] In addition, Navarre and the Balearic Islands have been the subjects of case studies on smart specialisation (Ortega-Argilés, 2012).

REDIDI plays a supporting role by ensuring synergies between national and regional RIS3 strategies. This network has a specific section devoted to RIS3 dissemination, and organises working groups on RIS3 to improve coordination at the national, regional and European levels. REDIDI has created a document with examples of RIS3 indicators and data sources.

The information system SICTI introduced by LCTI 2011 was aimed at improving national and regional coordination with regard to gathering data. This system could offer a mechanism for adequately monitoring and evaluating RIS3 strategies. The Spanish Foundation for Science and Technology has implemented ICONO, a web platform of indicators. Increasing numbers of indicators are becoming available at the international, national and regional levels. ICONO provides objective data on more than 120 R&I indicators, and analyses science, technology and innovation policies and strategies. ICONO contributes to a better understanding of the Spanish R&I system, thus improving its accountability and transparency. This represents a positive trend and could help to improve the number of indicators available at regional level. Under the mandate of MINECO, the FECYT have been collecting data from regional and national programmes since 2009, in order to foster a better coordination of R&D policy among the different administrations. Heijs and di Anselmo (2013) pointed out that some indicators were not available at regional level, which has complicated the designing, monitoring and evaluation process for RIS3 strategies. RIS monitoring mechanisms could face problems

[27] The structure of Navarre and the Basque Country appears to have developed more independently of this common structure. However, this does not indicate that the previous aspects have not been considered. Navarre had developed its strategy in advance (see Ortega-Argilés, 2012) and the Basque Country had implemented this rationale a long time ago[27] (see Aranguren-Querejeta et al., 2012), being the region with the highest R&D investment per GDP in Spain (2.1 % in 2013) (INE-2015).

[28] In addition, the case of Navarre and the Balearic Islands has been subject of case studies on smart specialisation (Ortega-Argilés, 2012).

with regard to implementation in Spain because of the low evaluation culture of the country, which is dominated by a control function (Molas-Gallart, 2012). If this evaluation culture is not properly addressed, monitoring systems could be an administrative burden instead of a learning tool. Strategies appear to shape the policy initiatives. However, it is difficult to assess if they are actively implemented, as data do not appear to be publicly available yet.

2.5 Main policy changes in the last five years

The Spanish R&I system has undergone important changes over the last five years. Considering the sustainability of the R&I system, the most important changes are probably related to the severe public budget cuts that were made over the last four years, especially the cuts of 2012 and 2013 (see section 3.1), and the unreliable implementation of the policy framework because of budget constraints. In 2015, total public R&I investment levels returned to 2005–2006 levels; in relative terms (i.e. R&I budget per total budget), this is equivalent to 2000–2001 levels (in 2005, the total public R&I budget was EUR 6 406.5 million and in 2015, it was EUR 6 545.7 million; in 2015, the R&I budget was 1.46 % of the total budget and in 2001, it was 1.49 %). These budget cuts have threatened to hinder the progress made by important R&I efforts over the pre-crisis period.

In addition, the Spanish governance system has changed considerably in this period because of the approval of the new law (LCTI) in 2011, as well as the approval of EECTI (2013–2020) and PECTI (2016–2020) in 2013. These documents have set the agenda for changing the Spanish R&I system (see section 2.2). However, the implementation has been difficult for several reasons: the already-mentioned public R&I budget cuts; the fiscal consolidation measures adopted in 2012 that have delayed the implementation of the AEI and delayed young researchers' access to permanent positions; and the lack of flexibility with regard to adapting the objectives and pathway to a new environment (see section 6). In addition, in 2013 the Entrepreneurship and Internationalisation Support Act (Law 14/2013) was published (see section 2.2).

In 2014, the elaboration of the RIS3 strategies (see section 2.4), the publication of the ERAC peer review exercise (2.2.1) and the adoption of the EC–Spain Partnership Agreement 2014–2020 must be highlighted, as they could bring new opportunities for the Spanish R&I system.

In 2015, the decreasing trend with regard to public R&I investments appears to have halted. The announcement of the loosening of fiscal consolidation measures has offered the opportunity to launch the AEI envisaged by the LCTI in 2011 and to increase the replacement rate of retirees which could alleviate the brain-drain problem (see the summary in Table 2).

Table 2. Main policy changes in the last five years

Main changes in 2011
The Law of Science, Technology and Innovation (LCTI 2011) (1 June 2011) replaced the so-called Law of Science of 1986
The New Spanish President in office since December 22 and the Ministry of Science and Innovation (MICINN) created in the previous legislative term (2008–2011) was closed down. Their competences were transferred to the Ministry of Economy and Competitiveness (MINECO)
Main changes in 2012
Important budget cuts in public funding for R&D
The R&D system of governance was reorganised because of the change in government, the elaboration of the new strategy and plan, and the implementation of some measures envisaged in the LCTI
The previous plan (National Plan for R&I 2008–2011) and strategies were extended for one year
Fiscal consolidation measures that affect R&D freezing, the creation of the Spanish Research Agency (AEI) and the fixing of the replacement rate of retirees from permanent positions to 10 %
Significant public budget cuts give rise to concerns among research-related organisations, leading to the launch of a grass-roots movement in support for science
Main changes in 2013
Significant budget cuts in public funds for R&D
Significant delays in launching important R&D calls and programmes
The Spanish Strategy for Science, Technology and Innovation (EECTI) (2013–2020) was approved on 1 February 2013
The Spanish State Plan for Scientific and Technical Research and Innovation (PECTI) (2013–2016) was approved on 1 February 2013
The Entrepreneurship and Internationalisation Support Act (Law 14/2013) was published on 27 September 2013
The Spanish National Research Council (CSIC) underwent a major budget crisis
Grass-roots initiatives in support of science continued over the year
Main changes in 2014
Autonomous regions developed their Smart Specialisation Strategies (RIS3) as a Structural Funds prerequisite
The European Research and Innovation Area Committee (ERAC) carried out a peer-review evaluation of the Spanish R&D System (ERAC, 2014)
The EC–Spain Partnership Agreement 2014–2020 was adopted
Main changes in 2015
The decreasing trend with regard to public investments for R&I levels appeared to halt
The loosening of the fiscal consolidation measures adopted in 2012 that affected R&D was announced
The AEI was approved on the 27 November 2015
The replacement rate of retirees was increased by up to 50 % from the 10 % target set previously and a 100 % replacement rate was announced for 2016[29]

[29] The law of the PGE for 2015 (Law 36/2014) sets the replacement rate at 50 % and the law of the PGE for 2016 (Law 48/2015) at 100 %. In March 2015, the Council of Ministries approved a 100 % replacement rate for OPIs (MINECO news 20.05.2015).

3. Public and private funding of R&I and expenditure

3.1 Introduction

Spain's R&D intensity (GERD as a percentage of GDP) has been decreasing since 2009, and has decreased even further below the EU average. Spanish R&D intensity was 1.2 % in 2014 (1.32 % in 2011), which is below the EU-28 average of 2.03 % (see Table 3 below for the latest Eurostat data for 2011–2015). Spanish R&D intensity has returned to 2007 levels (1.23 %). On a per-capita basis, GERD in Spain amounted to EUR 273.6 in 2014 (EUR 303.9 in 2011), which is less than half of the European average (EUR 558.4). The GBAORD in Spain and its regions has been decreasing significantly over the last four years. In 2014, GBAORD decreased again by 5.7 %, to EUR 5 360 million. The amount of funding for R&D provided by the enterprise sector as a percentage of GDP declined slightly from 0.58 % in 2011 to 0.57 % in 2013, which is far less than the European average of 1.12 %.

The funding for research provided by different sectors (i.e. HES, PNP and abroad), as a percentage of GDP, remained quite stable between 2011 and 2013 (with changes of only 0.05 %, 0.01 % and 0.09 % for each sector, respectively). The Spanish R&D funding system relies more on funds from the HES sector than the European R&D funding system does (0.05 % for Spain versus an EU-28 average of 0.02 %).

The proportions of funding for research performed by the three sectors HES, government and business, as a percentage of GDP, all decreased during the period 2011–2014: the HES sector decreased from 0.37 % in 2011 to 0.34 % in 2014; the government sector decreased from 0.26 % to 0.23 %; and the business sector decreased from 0.69 % in 2011 to 0.63 % in 2014; All of these percentages are below the European averages for the same period (0.47 %, 0.25 % and 1.3 %, respectively, in 2014).

Table 3. Basic indicators of R&D investments

Indicator	2011	2012	2013	2014	2015	EU average (2015)*
GERD (as a percentage of GDP)	1.32	1.27	1.24	1.2	n.a.	2.03
GERD (EUR per capita)	303.9	286	278.5	273.6	n.a.	558.4
GBAORD (million EUR)	7252	6185	5682	5360	n.a.	92828
R&D funded by HES (% of GDP)	0.05	0.05	0.05	NA	n.a.	0.02
R&D funded by PNP (% of GDP)	0.01	0.01	0.01	NA	n.a.	0.03
R&D funded by BES (% of GDP)	0.58	0.58	0.57	NA	n.a.	1.12
R&D funded from abroad	0.09	0.08	0.09	NA	n.a.	0.2
R&D performed by HEIs (% of GERD)	0.37	0.35	0.35	0.34	n.a.	0.47
R&D performed by government sector (% of GERD)	0.26	0.24	0.23	0.23	n.a.	0.25
R&D performed by business sector (% of GERD)	0.69	0.67	0.66	0.63	n.a.	1.3

**Refers to the last year available. NA: Not Available*

After 2013, data on only the central government's budget for public expenditures (PGE) on R&I are available.[30] The PGEs for 2014 and 2015 increased by 3.6 % and 4.2 %, giving a budget of EUR 6 406 million in 2015. Despite these increases, the 2015 PGE was lower than the 2006 PGE (EUR 6 546 million) (ICONO-MINECO: 2015). In relative terms, the R&I budget represented 1.46 % of PGE (PGE-46/PGE) in 2015, and therefore the R&I budget has returned to 2000–2001 levels (1.4 % in 2000 and 1.49 % in 2001). The foreseen budget for 2016 envisages a slight increase of EUR 23.1 million (0.4 %) (Molero and de Nó, 2015b). These data indicate that, despite the slight increase in the central government's budget for R&I since 2014, the impact of the R&I investment crisis might have been exacerbated by reductions in government public budgets for R&I.

The percentage of Structural Funds devoted to R&I is increasing (Heijs and di Anselmo, 2013; ERAC, 2014). In the 2007–2013 period, a total of EUR 7.8 billion was allocated to research, innovation and entrepreneurship in Spain,[31] which represents 22.6 % of the total FEDER fund for Spain (EC, 2014a). Spain increasingly participates in Horizon 2020, the EU Framework Programme for Research and Innovation. The Spanish share of this EU programme increased from 6.1 %, under the Sixth Framework Programme (FP6) to 8.8 %, under Horizon 2020 (it was 8.1 % under FP7). Spain participated in 1 322 projects as part of Horizon 2020 and coordinated 653 projects.[32] Spain has also increased the percentage of projects it coordinates, from 25.1 % under FP6 to 49.4 % under Horizon 2020 (37.9 % in FP7). This percentage of coordinated projects is well above the EU average (37.6 % under Horizon 2020).

EECTI and PECTI aim to increase the following: the Spanish participation in the EU Framework Programme from the current 8.3 % to 9 %; the returns from OPIs by up to 20 %; and the percentage of projects headed by Spanish entities up to 10 %. There was an increase in the total budget allocated to Spain from FP7 (from EUR 6 866 million in 2012 to EUR 8910 million in 2013), but the return levels for Spain from FP7 decreased from 8.3 % in 2012 to 7.8 % in 2013 (ICONO-CDTI: 2015). Most of the FP7 funds received are concentrated in Madrid, Catalonia and the Basque Country, which receive 33.2%, 27.3 % and 12 % of the funds, respectively.

3.2 Smart fiscal consolidation

3.2.1 Economic growth, fiscal context[33] and public R&D

After an extended deep recession in 2008–2013, **economic growth** resumed in 2014 (1.4 % in real terms). Driven by private consumption growth, due mainly to job creation, negative inflation and a pick-up in business activity, the economy is estimated to have expanded by 3.2 % in 2015. It is expected to grow further in 2016–2017, but at a slower pace (by 2.8 % in 2016 and by 2.5 % in 2017).

Spain has been severely hit by the economic crisis and there has been a significant worsening of public finances as an immediate consequence, that is, **budget deficits** have widened and **public debt** has increased (Figure 1). However, as a result of consolidation measures, the deficit decreased from 11 % of GDP in 2009 to 5.9 % of GDP in 2014. It is expected to narrow further, although gradually, to 4.8 % in 2015, 3.6 % in 2016 and 2.6 % in 2017. Public debt increased rapidly during and after the financial crisis, and it is expected to reach around 100.1 % of GDP by 2016–2017.

[30] Data from FECYT (2015a) and COSCE reports (expenditure heading 46).
[31] Core RTD allocated to Spain from 2007–2013 was EUR 4.2 billion with a total of EUR 3 billion of certified expenditure.
[32] Data provided in October 2015 by RIO.
[33] Sources: DG ECFIN, http://ec.europa.eu/europe2020/pdf/csr2016/cr2016_germany_en.pdf

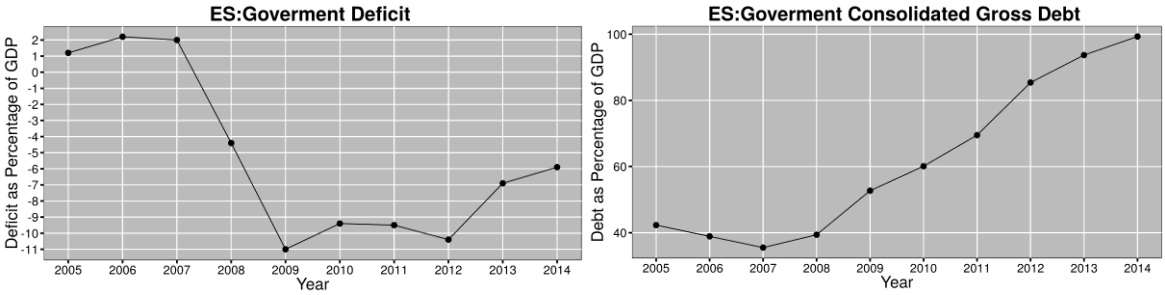


Figure 1. Government deficit and public debt

Data source: Eurostat.

Total GERD in Spain was EUR 13 011.8 million in 2013. There are three main sources of R&D funding in Spain: the business sector (EUR 6 025.1 million in 2013), the government sector (EUR 5 416.4 million) and foreign funding (EUR 957.9 million).[34] The bulk of domestic direct public funding goes to public research-performing organisations (EUR 2 026.84 million) and HES (EUR 2 645.8 million). Business enterprises received a considerably smaller amount of public funding (EUR 740.2 million).

Table 4. Key Spanish public R&D indicators

Indicator	2007	2009	2013
GBAORD, as a percentage of government expenditure	1.90	1.76	1.22
GERD, as a percentage of GDP	1.23	1.35	1.24
out of which GERD to public, as a percentage of GDP	0.55	0.65	0.58
Funding from GOV to:			
Business, as a percentage of GDP	0.11	0.12	0.07
Public (GOV+HES), as a percentage of GDP	0.43	0.52	0.44
Total, as a percentage of GDP	0.54	0.64	0.52
EU funding, percentage of GDP (%)	0.09	0.07	0.05

Source: Eurostat.

[34] EU funding in 2012 was EUR 567.1 million. Data for 2013 is not yet available. Total foreign funding for 2012 was EUR 890.2 million.

3.2.2 Direct funding of R&D activities

Figure 2 shows the historical evolution of GERD financing in Spain in current prices.

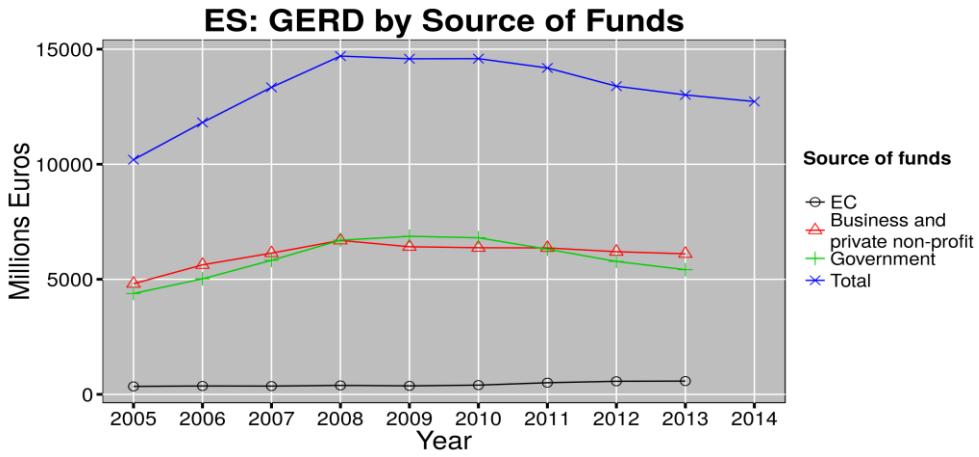


Figure 2. Funding of GERD

Data source: Eurostat

The governments' and private sector's (i.e. the aggregated funding from business and private non-profit) contributions to the total GERD are the most relevant and are of a comparable nominal level, although the private sector slightly outperformed the government sector as a source of funds for Spanish R&I in 2012 and 2013. The effect of the crisis is apparent because of the negative growth of the overall GERD in Spain from 2009 onwards, and the 2014 levels are comparable to the 2007 levels.

Funding from the European Commission (EC) for Spanish R&D plays a very marginal role, despite the visible increase after 2010.

Direct public funding from the government

Direct public funding is usually the main component of the total governmental support to R&D. Figure 3 shows the evolution over time of total R&D appropriations (GBAORD) and the GERD directly funded by the government in millions of euros. The EC contribution, aggregated with the funding provided by the government, is also shown in Figure 3.

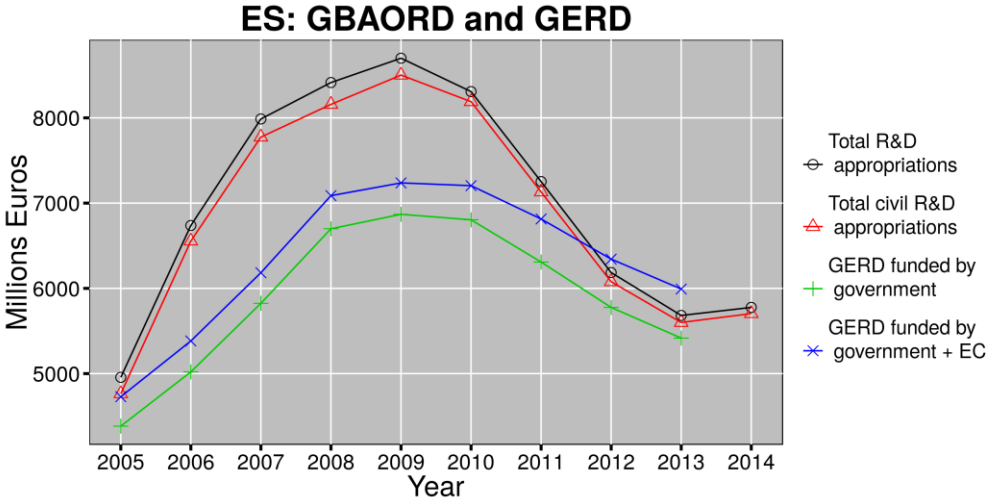


Figure 3. R&D appropriations and government-funded GERD in millions of Euros

Data source: Eurostat

Both GERD funded by the government and the total (civil) appropriations (GBAORD) exhibit negative growth from 2009 to 2013. Although the total (civil) appropriations show a small increase in 2014, they are still below the levels of 2006. The military R&D allocations play a marginal role in Spain, as can be seen from the small difference between the total and civil allocations. The gap between the appropriations and funding from the government started to close in 2009. Despite its marginality, the contribution from the EC increased monotonically from 2009.

Finally, if the allocations are expressed as a percentage of the government expenditure, then the decline in GBAORD predates the crisis, since it dates back to 2007. A similar argument applies to the government GERD as a percentage of government expenditure, the decline of which also started before 2009.

As a consequence, the negative trend of GERD and government GBAORD, particularly visible in nominal terms after the crisis, began before the onset of the 2008–2009 financial crisis.

Direct public funding from abroad

The EC is the most important external public source of R&D funding for Spain. External public funding from other governments and higher education entities, as well as from international organisations, has been marginal, as shown in Table 5.

Table 5. Public funding from abroad for Spanish R&D

Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013
Total (million EUR)	585.74	701.43	935.52	838.10	795.97	836.64	947.49	890.19	957.89
BES (million EUR)	213.36	273.18	486.09	379.18	340.87	321.88	276.41	222.54	279.99
EC (million EUR)	345.05	362.91	358.87	388.12	368.45	400.34	505.23	567.11	575.76
GOV (million EUR)	15.74	44.22	45.92	39.02	69.15	87.67	138.31	61.07	75.37
HES (million EUR)	4.76	3.66	3.45	4.69	6.28	4.22	7.54	8.52	9.26
International organisations (million EUR)	5.40	12.82	38.08	22.84	7.07	13.16	13.92	21.55	8.51
Total as a percentage of GERD (%)	5.74	5.94	7.01	5.7	5.46	5.73	6.68	6.65	7.36
EC as a percentage of GOVERD (%)	7.87	7.23	6.16	5.79	5.36	5.88	8.01	9.82	10.63

Table 5 clearly shows that the percentage of EC funding has monotonically increased since the 2009 minimum. In 2013, it represented almost 11 % of the total GERD funded by the government. As a long-lasting effect of the crisis, we observe that funding from abroad decreased during the 2009–2012 period and only started recovering in 2013.

Distribution of public funding

Figure 4 shows how the distribution of public funding among the various sectors has evolved over time.

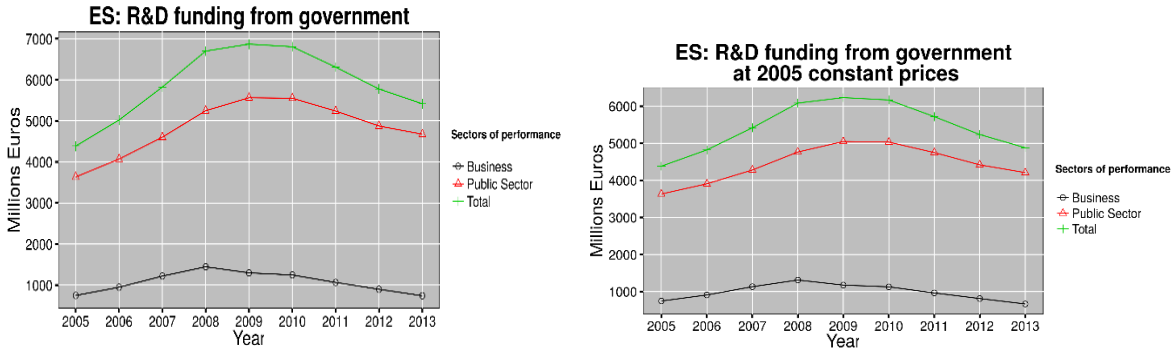


Figure 4. Government intramural expenditure by sectors

Data source: Eurostat

The public sector (GOV and HES) is the main recipient of government-funded GERD, but it is not the only sector affected by the cuts. The private sector was also affected and in 2013 the direct support received by the government was at a level comparable to the level in 2005.

3.2.3 Indirect funding – tax incentives and foregone tax revenues

The Spanish system of R&D tax incentives is one of the most generous among OECD countries. It is based on a combination of three different elements (Ministry of Science and Innovation, 2011: 12): (1) tax deductions for R&D and innovation activities (ex ante and ex post); (2) income reductions for transferring intangible assets ('Patent Box'); and (3) social security benefits for full-time R&D personnel. This system was first introduced by Royal Decree-Law 4/2004 and was further developed (recently through Royal Decree 475/2014) and provides a tax incentive to employers for personnel exclusively involved in research-, development- and innovation-related activities. The tax relief consists of a 40 % reduction of social security contributions made by employers to researchers.

Despite its formal generosity, the impact of these R&D tax incentives on funding for the Spanish R&D system remains limited. The evolution of forgone tax revenue (revenue loss) resulting from the R&D tax incentive scheme, as it appears in the Spanish budget, is presented in Table 6.

Table 6. Foregone revenue resulting from R&D fiscal incentives

Amount (million EUR)	Year	Source
382.74	2008	MINHAP (budget office)
253.14	2009	MINHAP (budget office)
175.50	2010	MINHAP (budget office)
221.68	2011	MINHAP (budget office)
271.64	2012	MINHAP (budget office)
281.09	2013	MINHAP (budget office)
243.27	2014	MINHAP (budget office)
639.91	2015	MINHAP (budget office)
693.65	2016	MINHAP (budget office)

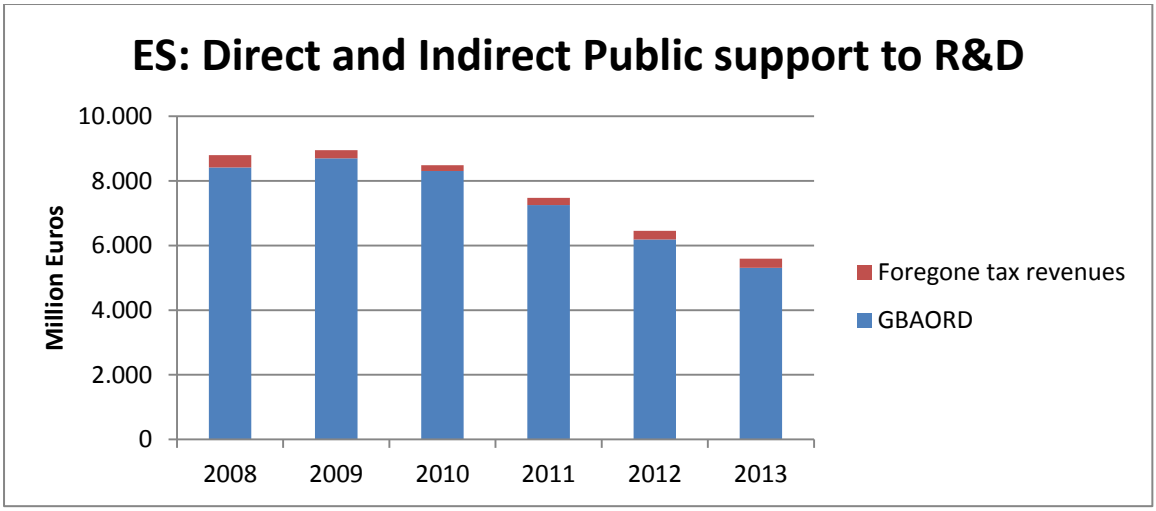


Figure 5. GBAORD and forgone revenue resulting from R&D tax incentives

The evolution of the R&D tax incentives, from EUR 243.27 in 2014 to EUR 639.91 million in 2015 and EUR 693.65 million in 2016, can be explained by an 'improvement' of the tax relief regime that involves the possibility for companies to retroactively claim some tax relief that was not implemented in 2014 or 2015.

Tax incentives have increased in recent years, but they are still not sufficiently high to compensate for the cuts in the direct support to R&D before 2013 2013 (see **figure 5.**). This conclusion may need to be partially revised if new data (i.e. after 2013) on the Spanish GBAORD become available, especially given the increase of forgone tax revenues in 2014–2015.

3.2.4 Fiscal consolidation and R&D

Based on the above discussion, it seems that the Spanish post-crisis fiscal consolidation process has come at the massive expense of public R&D expenditures. Figure 6 shows a scatterplot of the structural balance and a relevant measure of R&D (GBAORD as a percentage of GDP is shown in the left panel and GERD as a percentage of GDP is shown in the right panel).[35]

[35] Structural balance data are from the AMECO database; the other indicators are from Eurostat.

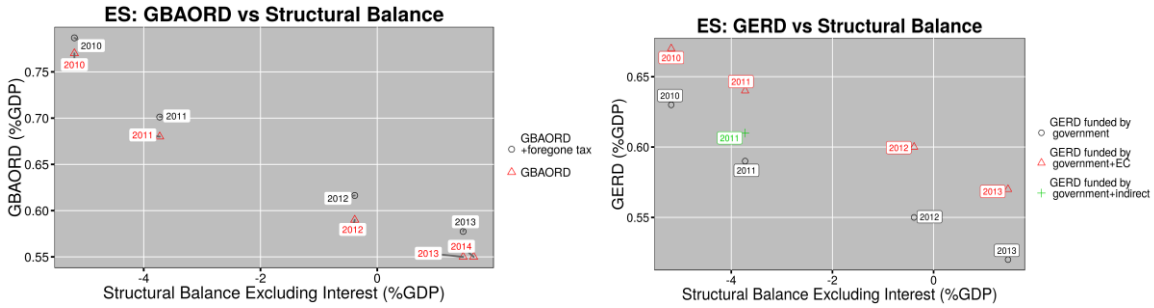


Figure 6. Fiscal consolidation and R&D

Data source: AMECO, Eurostat

The key message from Figure 6 is that post-crisis fiscal consolidation had a significant negative impact on both GBAORD and GERD funded domestically by the government, as they both correlate negatively with the structural balance. Indeed, while the structural balance has progressively shifted to a minor surplus from a large deficit, GBAORD decreased by approximately 0.2 % and government-funded GERD decreased by approximately 0.1 %, both in terms of GDP. This may stem from the severe budget cuts for new projects and temporary contracts, 36 which are primarily reflected in the GBAORD. If EU funding for government-financed GERD is included (GERD and structural balance; see Figure 6), the picture improves only marginally, and there is still a negative correlation with the structural balance consolidation.

Despite the severity of the crisis that hit Spain in 2009, the Spanish economy has shown signs of recovery, particularly since 2012 (i.e. the deficit has decreased and government debt has built up at a slower rate).

On the other hand, direct government expenditure on R&D (i.e. government-funded GERD) has declined monotonically since the onset of the crisis in 2009. The contribution from the EC and indirect public support to R&D, despite having increased in recent years, is still too marginal to compensate for the decline in direct public funding.

During the 2010–2014 period, Spain significantly improved its structural balance, while reducing the proportion of GDP devoted to R&I appropriations and direct funding. For these reasons, notwithstanding the significant progress that has been made with regard to the Spanish economy since 2012, Spain cannot be said to have deployed a policy of smart fiscal consolidation with regard to R&I.

[36] The budget of the Spanish National Research Council decreased by 30 % between 2008 and 2013. It faced severe problems in meeting its financial obligations, which necessitated a financial rescue by the central government in 2012–2013. The recruitment of permanent researchers was reduced to very low levels. At the same time, several grants for temporary researchers were delayed, cut or reduced in scope, which provoked a loss of young researchers. This adds to the problem of the ageing profile of staff at universities and research organisations. A recent report that provided a peer review of the Spanish research and innovation system highlights that the age imbalance may have a significant long-term impact on scientific production. This could in turn affect the overall capacity of the economy to produce knowledge and reverse its downward trend (Source: ERAC, 2014. Available online: http://www.mineco.gob.es/stfls/mineco/comun/pdf/140801_Final_report_public_version.pdf)

3.3 Funding flows

3.3.1 Research funders

MINECO, assisted by SEIDI, is responsible for the design and management of the main R&I funding instruments and the supervision of OPIs (see section 2.1). MINECO allocates 71 % of the public budget for R&D (PGE) for 2015 (EUR 6 406.5 million), MINETUR allocates 24.3 %, the MDEF allocates 2.5 % and MEDU allocates 1.5 %. Other ministries, such as MINHAP (which allocates 0.3 %), allocate percentages that are lower than 1 % (ICONO – MINHAP: 2015).

SEIDI is responsible for allocating research funds and implementing PECTI with the CDTI, but other bodies, such as the ISCIII, also allocate funds. The main managing with regard to the distribution of the provisional budgets of the PECTI working plan, distributed by AGE for 2015 project funding (see Table 1 and Annex 4), are MINECO (53 %), the CDTI (31.7 %), SETSI (7.1 %), the ISCIII (3.7 %), the MECD (2.9 %), INIA (0.5 %) and the FECYT (0.1 %).

The legal framework of the Spanish R&I system is set mainly by the LCTI [4/2011][37] (see section 2.2). The institutions of AGE (e.g. MINECO) are also bound by the Law on Central Government Budgets (PGE) [22/2013], which sets the regulation for PGE R&I funding; and the General Law on Subsidies [38/2003], which establishes the procedures to grant financial help on a direct and competitive basis, and the rights and obligations of beneficiaries. In addition, the Entrepreneurship and Internationalisation Support Act [14/2013] (see section 2.2) and other legal frameworks for tax incentives complement the Spanish R&I legal framework (see section 3.5.2).

PECTI (2013–2016) clearly states that most of the funds will be distributed through competitive funding mechanisms: 'Public funds will be allocated on competitive bases. The selection of grants will take into account scientific and technical criteria. Additional technological feasibility and commercial value will be also considered supported by international standards. Criteria will follow transparent evaluation processes based on international peer review standards' (PECTI: 4). National programmes will be mainly allocated through competitive processes (PECTI: 14).

The specific call text mandates for granting funds from PECTI across programmes are

The 'Recognition and promotion of talent and employability' programme:

ECC/1402/2013, 22 July 2014;

ECC/1820/2014, 26 September 2014;

ECC/2483/2014, 23 December 2014.

The 'Promotion of excellence' programme:

ECC/1779/2013, 30 September 2013.

The 'Business leadership' programme:

ECC/1333/2015, 2 July 2015.

The 'Promotion of R&D and innovation towards societal challenges':

ECC/1780/2013, 30 September 2013. Amended by ECC/2483/2014, 23 December 2014.

Private not-for-profit funding for R&I was 0.2 % of total R&I funding in 2014 (EUR 21.5 million) (Eurostat, 2015). The health discipline accounts for the highest

[37] The LCTI replaces the previous Law of Science (Law for the encouragement and general coordination of scientific and technical research [13/1986]).

proportion of the R&D funds executed by the PNP sector, with 57.4 % in 2014 (INE-2015). However, it is difficult to identify the main sources of PNP funding for public research performers in Spain. According to some studies on the not-for-profit sector, 36.6 % of the Spanish foundations have the promotion of research among their objectives (INAEF, 2011). Some important foundations that promote R&I activities should be mentioned, such as the BBVA, ONCE, Telefónica and the Ramón Areces foundation. However, it is not possible to identify the proportion of total R&D funding that these institutions represent because of the anonymous character of R&I surveys and the lack of more systematic studies of the sector.

3.3.2 Funding sources and funding flows

The distribution of GERD by funding sources and sectors of performance indicates that the BES and HES rely mainly on their own sources of funding (see Table 7). 'Own funds' represents the main funding source of GERD in Spain, and was 64.3 % in 2014. Public government funding provided 21.3 % of total GERD in 2014. Funds from abroad represented 7.7 % of GERD in 2014, while private sources funded a similar percentage (7 %) of GERD in 2013. PNP and universities provided a small proportion of funding for research, with percentages lower than 1 % in the same year.

The distribution of public funding across administrative levels showed that the national government provided 58.2 % of public funding in 2014 (excluding 'own funds'), followed by regional governments (30.8 %) (see Table 7). Local authorities represented a small source of funds (1 %). Public funding allocated to the private sector represented the remaining 10 %.

Funding from abroad came mainly from EU programmes: 56.6 % of funding from abroad in 2014 was from EU programmes.

National funding decreased by 5.5 % between 2013 and 2014. Similarly, funding from abroad decreased by 0.8 % over the same period. Funding from EU programmes decreased over the last year by 6.6 %, while other funding from abroad from other sources increased by 7.9 %.

Because of the lack of regional breakdowns in national aggregates, the data in Table 7 might not provide an accurate picture with regard to the role of regions in public R&I investments. Regions represent an important part of Spanish public R&I investments. It is estimated that regions represent 60 % of GBAORD (ERAC, 2014).[38]

The distribution of the Spanish GBAORD by thematic social economic objectives[39] shows that, in 2013, more than 50.7 % of funds could be considered generic, while 47.8 % could be directly assigned to specific technological or scientific areas. With regard to thematic R&D priorities in 2013, the most important ones are 'Health', with 32.4 % of the funds being assigned to specific technological or scientific areas, and 'Industrial production and technology' (IPT) with 14.2 % of funds being assigned to this area, followed by 'Agriculture' (13.8 % of funds). If the last two years are compared with regard to funding distribution, an increase in Spain's participation in 'Health' and 'Agriculture' is apparent. According to the provisional budget for R&I distributed by the State Secretary of Research Development and Innovation for 2015, the state programme 'Promotion of R&I towards societal challenges' will distribute EUR 1 479.2 million of funds (19.7 % lower than the budget distributed by this programme in 2014) (MINECO, 2015).

[38] The public budget for R&D (PGE) for 2014 (EUR 6 146.1 million) indicates that regions received 31.2 % of this budget (ICONO-MINHAP: 2015). R&I PGE for 2015 do not disclose information across regions.

[39] Information provided to the ERAC Panel for 2012. GBAORD is probably the most comprehensive approach for analysing the thematic priority setting of the Spanish policies for R&D and innovation. See ERAWATCH (2011) for different alternatives for analysing the thematic focus and the advantages and disadvantages.

Table 7. GERD by funding sources and sectors of performance, 2013–2014

	2013	2014						
FUNDING SOURCES	**Total**	**BES**	**GOV**	**HES**	**PNP**	**Total**	**%**	**Average growth change**
Non-abroad funding	**12 007.20**	**5 729.5**	**2 184.2**	**3 408.6**	**20.9**	**11 343.2**	**92.3 %**	**–5.5 %**
Own funds (including GUF for HES)	**7 845.20**	**5 091.5**	**333.8**	**2 474.0**	**5.5**	**7 904.7**	**64.3 %**	**0.8 %**
Own funds				514.8				
General university funding (GUF)				1 959.2				
Public funding (GOV)	**3 158.20**	**262.6**	**1 668.9**	**677.8**	**3.8**	**2 613.1**	**21.3 %**	**–17.3 %**
National	1 551.00		**1 145.8**	373.8	1.1	1 520.8	58.2 %	–1.9 %
Regional	845.5		**511.5**	290.3	2.0	803.8	30.8 %	–4.9 %
Local	21.5		**11.6**	13.7	0.6	25.9	1.0 %	20.6 %
Private funding (BES)	**944.9**	**494.5**	**139.8**	**214.4**	**9.7**	**858.4**	**7.0 %**	**–9.2 %**
University funding (HES)	**20**	**2.4**	**8.4**	**6.3**	**0.1**	**17.2**	**0.1 %**	**–14.1 %**
PNP	**38.8**	**9.7**	**33.3**	**36.1**	**1.9**	**81.0**	**0.7 %**	**108.6 %**
Funding from abroad	**957.9**	**527.4**	**224.5**	**197.6**	**0.6**	**950.2**	**7.7 %**	**–0.8 %**
EU programmes	575.8	227.9	148.1	161.6	0.3	537.9	56.6 %	–6.6 %
Other funds from abroad	382.1	299.5	76.4	35.9	0.4	412.3	43.4 %	7.9 %
Total R&D funding	**13 011.80**	**6 256.9**	**2 408.7**	**3 606.2**	**21.6**	**12 293.4**	**100.0 %**	**–5.5 %**
%	**100.00 %**	**50.9 %**	**19.6 %**	**29.3 %**	**0.2 %**			

Source: Own calculations based on data from INE (2015).

Data for the period 2007–2012 indicate that European funds (Structural Funds and FP research funds) represent 19.6 % of public funding, with Structural Funds representing 12 % (ERAC, 2014: 21). The same sources indicate that the proportion of Structural Funds in Spain is very low (20 %, which is higher than only the proportion of Structural Funds allocated to Greece) and that the Structural Funds for R&D are heavily concentrated in less well-developed regions: Andalucía has the highest proportion of these funds (39 %), followed by Galicia (19 %) (ERAC, 2014: 59).

Funding for the private sector relies heavily on the 'own sources' of this sector. In 2014, the main sources of BERD were 'own funds' (EUR 5 091 million, which represents 81 % of the total) (see Table 7), government funding (4.2 %), other funds from other companies (7.8 %) and funds from abroad (8.4 %). Private funding from universities and PNP play a minor role in funding private R&D, with percentages lower than 1 %. Funds from abroad for private R&D (EUR 527.4 million) were not mainly from EU programmes; with regard to funds from abroad for private R&D in 2014, 56.8 % of funding was from 'other' foreign funds, while 43.2 % of funding was from European programmes. Spain was the second largest recipient of foreign direct investment (FDI) in 2014 (UNCTAD, 2015), but no information on R&I FDI appears to be available (see section 5.5).

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

The allocation of project funding through competitive funding mechanisms has been encouraged in Spain in previous years through the LCTI and PECTI. LCTI 2011 simplifies the allocation of competitive funding for R&I by giving the responsibility for the allocation of funds to two main bodies, the new research agency (to be created) and the existing CDTI. PECTI (2013–2016) clearly states that most of the funds will be distributed through competitive funding mechanisms. The legal framework for the allocation of institutional funding has remained quite stable over recent years and it is generally allocated through the form of non-competitively allocated block funding

The distribution of institutional funding is different between universities and PROs. Regions became responsible for university funding in 1995 and applied different mechanisms of distribution of institutional funding that are mainly based on the number of students and teachers, and other related criteria (see section 2.4.2). It is assumed that university academic personnel devote 66 % of their time to teaching and 33 % to research activities. Therefore, one-third of their salaries can be considered as institutional R&D funding. The state and regions provide little or no institutional funding for research (block funding), so the rest of the research funds come mainly from regional, national and international programmes based on project funding. This project funding is generally distributed through public tendering that is oriented to broad thematic fields. The proportion of GUF over all higher education institutions (HEIs) increased during the period 2011–2013, from 49.8 % in 2011 to 54.3 % in 2014. The institutional funding for PROs is mainly channelled through the state budget (PGE) by MINECO, although other ministries also distribute R&D funds for PROs (e.g. the MDEF channels funds for INTA).

Funding in 2014 for PROs was EUR 1 258 million (1.8 % higher than in 2013), which is 20.5 % of the total government public budget (PGE) (Molero and de Nó, 2014c). A substantial part of PRO funding is used for salaries (53.9 %), operational costs (19.2 %) and investments (24.1 %), while 'operational transfers' – which are mainly used for research – accounted for only 1.2 % of the received institutional funding in 2014 (Molero and de Nó, 2014c).[40] Although R&I funding for OPIs increased last year (by 1.9 %), total R&I funding for OPIs declined by 6 % between 2012 and 2014 (and has decreased by 15.9 % since 2010) (Molero and de Nó, 2014c). The percentage of funds used for each budget item (i.e. salaries, operational costs, investments and operational transfers) changed during the period 2012–2014: the proportion of funds used for salaries increased (from 50 % in 2012 to 53.9 % in 2014) at the expense of the other budget lines (the proportion of funds used decreased from 19.9 % in 2012 to 19.2 % in 2014 for operational costs; from 26.4 % in 2012 to 24.1 % in 2014 for investments; and from 2.2 % in 2012 to 1.2 % in 2014 for operational transfer) (Molero and de Nó, 2014c).41

Project funding has gained importance within the Spanish R&I system,[42] but the financial crisis and the reduction of the public budget for R&D has severely affected this

[40] Based on PGE data allocated to the CSIS, which represented 47.7 % of total budget for PROs (OPIs) in 2014. Own calculations. For 'Operational transfers' (or *transferencias corrientes*), refer to Chapter 4.

[41] The proportion of operational costs fell from 19.9 % in 2012 to 19.2 % in 2014; investments fell from 26.4 % in 2012 to 24.1 %; and operational transfers fell from 2.2 % in 2014 to 1.2 % in 2014 (Molero and de Nó, 2014c).

[42] In 1989, this form of support accounted for 30 % of the R&D-related state budget, while at the beginning of this century, this percentage was approximately 23 % of all funds (Sanz, 2005). A more recent study on public research centres (OPIs and technology centres) from 2002 to 2007 (Castro et al., 2012) indicates that institutional funding represents about 71 % of their funding, while competitive funding represents a percentage of between 24 % and 34 %, although there is a high diversity in their funding portfolio. Competitive funding appears to have slightly increased,

funding scheme. Figures on the proportion of competitive versus institutional public funding for R&D are not usually publicly available. However, data provided to the ERAC panel show that competitive funding (grants and fellowships) from the state budget for R&D decreased by 62 % between 2008 and 2013 (ERAC, 2014: 20). Because of the more fixed character of institutional funding, state R&D cuts appear to have particularly affected funds allocated in a competitive funding mode. The approximate proportion of competitive funding decreased from 52.1 % in 2011 to 36.9 % in 2013.[43] In addition, several policy measures have tried to increase the competitiveness of the R&D system, for example the 'Severo Ochoa and María de Maeztu centres and units of excellence',[44] which promotes excellence in scientific research by recognising and granting performance-based funding to outstanding research institutions (see below section 3.4.3).

The AEI might play an important role in the future allocation of project funding because it will be in charge of the funding and evaluation of R&D funding. With approximately 300 personnel, the AEI aims to manage the calls in a more flexible and autonomous way. It aims to provide a more reliable implementation time frame on R&D calls, as its budget and objectives will be set on a multiannual basis (MINECO press release 27.11.2015). However, the AEI was created without increasing public budgets, which might undermine the effectiveness of its objectives.

3.4.2 Institutional funding

As mentioned in section 3.4.1, the allocation of institutional funding in Spain is generally in the form of block funding. Research institutions do not received a variable/competitively allocated institutional funding. The allocation of institutional funding is different between universities and PROs. Since regions (*comunidades autónomas*) became responsible for university funding in 1995, they have applied different variations of mechanisms for the distribution of institutional funding, which are mainly based on the number of students, personnel and other related criteria. From 1987 to 1993, allocation of university funding followed an 'incremental' criterion, based on previous year expenditures and changes in teaching and administrative personnel (*Personal Docente Investigador* (PDI) and *Personal de Administración y Servicios* (PAS)). From 1994, the *Modelo 92* based on the unitary cost of personnel in relation to the number of students was applied (Puerto Cela, 1994). Since 1995, regions have applied different versions of these mechanisms (Pérez Esparrells and Utrilla de la Hoz, 2008). The allocation of institutional funding to PROs does not seem to be based on an efficient and transparent mechanism. For example, despite the continuous improvement of its research performance, the CSIC suffered a budgetary crisis in 2013.45

Evaluation mechanisms for the allocation of institutional funding do not generally consider criteria related to research performance. Therefore, it is possible that these are not applied in an efficiently, transparent and regulated manner (see section 2.2.1).

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although the great diversity in funding makes it difficult to estimate whether this variation is significant (Castro et al., 2012).

[43] Own calculations from ERAC (2014) report figures. The proportion of competitive funding was calculated using the figures for competitive funding (grants and fellowships) against a total (EUR 1 333 million in 2013) that includes 'Current transfers (OPIS)', 'Fees and current transfers (international infrastructures)', and 'Scientific and Technological Infrastructures (ICTs)'. This total does not include the least important in budget lines 'Non competitive funding and awards' and 'others' as they were not available in the ERAC (2014) report. Therefore, the proportion shown is approximated.

[44] Named 'Severo Ochoa centres and units of excellence' in the previous working plan.

[45] Since 2010, the CSIC has suffered large budget cuts from the government, resulting in a total reduction of approximately EUR 500 million. The yearly reductions ended up in a budget crisis in 2013. The CSIC is Spain's largest scientific organisation with about 15,000 employees and one of the most important research performers in the country, with about 20 % of the national scientific production (see country report for 2013 EW, 2014b).

Among other factors, this might be because of the limited strategic policy planning and evaluation culture (EECTI, 2013; ERAC, 2014), dominated by its accountability functions, instead of the learning and distributive ones (Molas-Gallart, 2012).

3.4.3 Project funding

The main programmes for allocation of project funding at national level are included in the national plan (PECTI 2013–2016) and distributed across programmes and sub-programmes. Table 8 shows the distribution of total funds and percentages for 2014 and 2015 across the main instruments (programmes and sub-programmes) of the current national policy framework set out by the current PECTI (2013–2016) and distributed by AGE. Data for 2014 and 2015 should be treated with caution as they have been taken from the PECTI (2013–2016) working plan; they are, therefore, estimates based on provisional budgets.

Table 8 indicates that total funds decreased by 8.8 % between 2015 and 2014. Funding for the 'Promotion of excellence' programme increased by 76.6 % over the same period. However, funding for the other programmes decreased: by 19.7 % for the 'Promotion of R&I towards societal challenges'; by 12.1 % for the 'Recognition and promotion of talent and employability' programme, and by 0.8 % for the 'Business and leadership' programme. Within programmes, the instruments that decreased most significantly between 2014 and 2015 were the 'Strategic action digital economy and society', by 63.8 %, and the 'Sub-programme of employability', by 24.3 %. By contrast, the 'Sub-programme of collaborative R&D and innovation' showed the highest increment over the same period (20 %).

Table 8. Distribution of total budget and percentages across instruments of PECTI (2013–2016) in 2014 and 2015 by AGE

Instruments	2014 total (million EUR)	%	2015 total (million EUR)	%	Average change 2014–2015
Recognition and promotion of talent and employability programme	442.5	14.4 %	389.0	13.9 %	–12.1 %
Sub-programme of 'Education and training'	172.0	5.6 %	180.3	6.4 %	4.8 %
Sub-programme of 'Employability'	255.2	8.3 %	193.2	6.9 %	–24.3 %
Sub-programme of 'Mobility'	15.3	0.5 %	15.5	0.6 %	1.1 %
Promotion of excellence programme	**197.0**	**6.4 %**	**347.8**	**12.4 %**	**76.6 %**
Sub-programme for knowledge generation	133.8	4.3 %	139.1	5.0 %	3.9 %
Sub-programme of Institutionalstrengthening	63.3	2.1 %	58.8	2.1 %	–7.2 %
Sub-programme for 'Scientific and technological infrastructures'	0.0	0.0 %	150.0	5.3 %	
Business leadership programme	**596.0**	**19.4 %**	**591.0**	**21.1 %**	**–0.8 %**
Sub-programme for 'Business R&D and Innovation'	345.1	11.2 %	331.0	11.8 %	–4.1 %
Sub-programme of 'Enabling technologies'	126.0	4.1 %	110.0	3.9 %	–12.7 %
Sub-programme of 'Collaborative business R&D and innovation'	125.0	4.1 %	150.0	5.3 %	20.0 %
Promotion of R&D and innovation towards societal challenges	**1 842.5**	**59.9 %**	**1 479.2**	**52.7 %**	**–19.7 %**
Challenges and actions	1 194.6	38.8 %	1174.5	41.8 %	–1.7 %

Strategic action in health	96.0	3.1 %	104.6	3.7 %	9.0 %
Strategic action digital economy and society	552.0	17.9 %	200.0	7.1 %	–63.8 %
TOTAL	**3 078.1**	**100.0 %**	**2 807.0**	**100.0 %**	**–8.8 %**

Source: own calculations based on MINECO working plan 2014 and 2015.

The main instruments (i.e. those that received more than 1 % of the total budget) and the budget distribution percentages across programmes and sub-programmes for 2015 are outlined below (also see Annex 4 for more details):

(1) Recognition and promotion of talent and employability programme (13.9 %):

(1.1) Sub-programme of 'Education and training' (6.4 %):

- The 'Doctoral training programme' received EUR 94.4 million of funding (for 1 022 grants), which represents 3.4 % of the total budget. It provides university students four years of financial support so they can obtain a PhD degree. It is managed by MINECO.
- University doctoral training (FPU) received EUR 65.8 million of funding (for 800 grants), which represents 2.3 % of the total budget. It provides university students four years of financial support so they can obtain a PhD Degree. It is managed by the MECD.

(1.2) Sub-programme of 'Employability' (6.9 %):

- The 'Ramón y Cajal' programme received EUR 54 million of funding (for 175 grants), which represents 1.9 % of the total budget. It provides outstanding researchers with less than 10 years of career experience five years of financial support so they can start a tenure-track research position in a Spanish Institution.
- Emplea loans and grants for hiring R&D managers in companies received EUR 101.5 million of funding, which represents 3.6 % of total budget. It offers financial support to companies and other R&I-related institutions so they can hire R&I technicians for a period of between one and three years. It is managed by MINECO.

(1.3) Sub-programme of 'Mobility' (0.6 %).

(2) Promotion of excellence programme (12.4 %):

(2.1) Sub-programme of 'Knowledge generation' (5%):

- R&D projects received EUR 125.5 million of funding, which represents 4.5 % of the total budget. It provides research groups financial support to carry out R&D projects of three to four years. It is managed by MINECO.

(2.2) Sub-programme of 'Institutional strengthening' (2.1%):

- The 'Severo Ochoa centres of excellence' and the 'María de Maeztu units of excellence' received EUR 52 million of funding, which represents 1.9 % of the total budget. These funds provide grants based on research performance to outstanding research institutions and research groups so they can implement research strategic plans. This funding is managed by MINECO.

(2.3) Sub-programme for 'Scientific and technological infrastructures' (5.3%):

- Grants for the acquisition of R&D equipment amounted to EUR 150 million, which represents 5.3 % of the total budget. This provides public universities and public research centres funding to acquire and maintain scientific infrastructures. It is managed by MINECO.

(3) Business leadership programme (21.1 %) (see section 3.5.1 on public funding for private R&I for more details):

(3.1) Sub-programme for 'Business R&I' (11.8 %);

(3.2) Sub-programme of 'Enabling technologies' (3.9 %);

(3.3) Sub-programme of 'Collaborative business R&I' (5.3 %).

(4) Promotion of R&I towards societal challenges (52.7 %):

(4.1) Challenges and actions (41.8 %):

- 'Collaboration Challenges' R&I projects received EUR 573.9 million of funding, which represents 20.4 % of the total budget. This offers companies, universities, research centres, and other research and technology centres grants and loans for experimental development projects that are performed in collaboration in order to address societal challenges. It is managed by MINECO.
- Research Challenges' R&I projects are led by public sector research groups and received EUR 243.9 million of funding, which represents 8.7 % of the total budget. This funding provides public research centres and PNP research organisations financial support so they can develop research projects, of three to four years, that aim to address societal challenges. This funding is managed by MINECO.
- 'Firm Challenges' (see section 3.5.1 for R&I more details).
- 'FEDER interconnection' (See next section 3.5.1 for R&I more details).
- 'CDTI innovation direct line' (See next section 3.5.1 for R&I more details).

(4.2) Strategic action in health (3.7 %).

(4.3) Strategic action digital economy and society (7.1%).

The allocation of competitive funds usually follows a peer-evaluation process, but they normally involve domestic experts. International peer evaluation is less frequent. EECTI (2013–2020) includes the international evaluation of competitive funding as one of its five basic principles (principle number 3). In addition, one of its six articulation mechanisms (number 5) considers the 'harmonisation of criteria and practices of evaluation – ex ante and ex post', including international peer-review standards. PECTI (2013–2016), as it implements EECTI, also aims to increase the role of competitive funding and 'international peer review'. It states that most of the funds will be allocated through competitive mechanisms. The role of 'international peer review' is specifically mentioned in several programmes (e.g. 'Basic R&D', 'Human Resources for R&D' and 'Research Infrastructures'). For some important programmes (e.g. 'Promotion of R&I towards societal challenges'), researchers have to submit a summary in English and can choose to submit the proposal either in Spanish or in English. Some more internationally oriented specific sub-calls have to be submitted in English (e.g. within the previous working programme, the sub-call 'International Joint Programming Actions' had to be submitted in English). Success rates are not generally publicly available for most of these funding instruments. However, the CDTI reviews some of its funding programmes, including their success rates (see next section 3.5). Individual grants represented about 13.9 % of the total PECTI budget in 2015, as most of the calls included in the 'Recognition and promotion of talent and employability' programme are granted to individuals.

Considering the peer-review system, the 'Severo Ochoa' and 'María de Maeztu' sub-programme is also worth mentioning, as it supports excellent research centres and groups. This sub-programme was launched in 2011 within the framework of the Spanish National Plan for R&D and Innovation (NP) 2008–2011. It is aimed at existing centres and units that perform cutting-edge basic research and are among the world's best in their particular areas. The impact and international scientific leadership of these centres and units is essential for their recognition. Accreditation as a 'Severo Ochoa Centre of Excellence' or a 'María de Maeztu Unit of Excellence' is valid for four years and includes a grant of EUR 1 million per year during this period. This programme involves international peers and international evaluation panels.

3.4.4 Other allocation mechanisms

Contract research for governmental organisations is managed independently by each organisation according to a common regulation (Law of Public Administration Tendering RD 1098/2001 modified by RC 773/2015). The Platform of Public Tendering does not disclose information across R&D types of contract research. The Observatory of Public Tendering estimates that public tendering represents 18.5 % of GDP. However, it does not offer information on public tendering for R&I.

3.5 Public funding for private R&I

3.5.1 Direct funding for private R&I

The main programmes for the allocation of funding for private R&I at the national level are included in the national plan (PECTI 2013–2016) and are managed by CDTI. In addition, regional authorities implement regional strategies for innovation and direct funding for innovation.

The CDTI mission is to increase the competitiveness of Spanish companies by increasing its technological capacity. Its activities focus on (1) managing and financing research and technology development projects for companies; (2) managing and encouraging the participation of Spanish institutions in programmes of international cooperation; (3) encouraging technology transfer and public–private collaboration at national and international levels; and (4) supporting the creation and consolidation of technology-based enterprises (TBEs) (CDTI, 2014a).

The programmes managed by the CDTI function well from a policy-making perspective. CDTI programmes set priorities; respond to societal challenges (see below for details on the specific instruments that address societal challenges); include selection criteria; report results regularly including their impact on target groups (e.g. CDTI, 2014a); carry out evaluations (e.g. 'Cuadernos'; CDTI, 2014b); and publish other relevant private R&D studies that show financial additionalities of CDTI loans (e.g. Huergo et al., 2009; CDTI, 2014b).

The main national public programmes aimed at stimulating R&I in the private sector are included in the 'Business leadership' programme (21.1 % of the total provisional budget in 2015) and in the 'Promotion of R&I towards societal challenges' programme (11 % of the total budget managed by the CDTI or 52.7 % of the total budget for this programme). The distribution of percentages across programmes, sub-programmes and instruments (that are higher than 1 % of total provisional budget) for private R&I according to the provisional budget to be distributed by AGE in 2015 are outlined below (see Annex 4 for more detail):

1) Business leadership programme (21.1 %):

(1.1) Sub-programme for 'Business R&I' (11.8%):

- R&I projects received EUR 183 million of funding (for 375 projects), which represents 6.5 % of the total budget. This funding offers companies and consortia loans for industrial R&D projects of three years. It is managed by CDTI.
- 'CDTI innovation direct line' technology innovation projects received EUR 104 million of funding (for 210 projects), which represents 3.7 % of the total budget. This funding can provide loans to companies for development technology projects of 1.5 years. It is managed by CDTI.

(1.2) Sub-programme of 'Enabling technologies' (3.9 %):

- CDTI R&I projects received EUR 81 million (for 160 projects), which represents 2.9 % of the total budget. This funding provides loans to companies and consortia for applied technology projects of one to three years. It is managed by CDTI.

- CDTI innovation direct line funds innovation technology projects with EUR 29 million (for 60 projects), which represents 1 % of the total budget. This funding provides loans to companies for technology development projects of 1.5 years. It is managed by CDTI.

(1.3) Sub-programme of 'Collaborative business R&I' (5.3 %):

- 'CIEN' strategic private consortia for innovation received EUR 150 million of funding (for 21 projects), which represents 5.3 % of the total budget. This funding provides loans to companies and consortia for large-scale industrial research and technology development projects lasting three to four years. It is managed by CDTI.

(2) Promotion of R&I towards societal challenges (52.7 %):

(2.1) Societal challenges and actions (instruments) (41.8 %):

- 'Firm Challenges' are R&I projects that received EUR 141 million of funding (for 284 projects), which represents 5 % of the total budget. This funding provides loans to companies and private consortia (AIE) for applied projects of one to three years that aim to address societal challenges. It is managed by CDTI.
- 'FEDER interconnection' received EUR 110 million of funding (for 58 projects), represents 3.9 % of the total budget. This funding provides financial support to private consortia (of two to six companies) in FEDER regions to develop experimental projects that aim to address societal challenges. It is managed by CDTI.
- 'CDTI innovation direct line' Firm Challenges received EUR 57 million of funding (for 100 projects), which represents 2 % of the total budget. This funding offers companies loans for technology development projects of 1.5 years so they can gain competitive advantages. It is managed by CDTI.

CDTI funding instruments, excluding FEDER Interconecta projects, NEOTEC and innovation line, provide loans at a fix interest rate (Euribor + 0.1 %) that are partially refundable up to a maximum of 20 % of CDTI support depending on the characteristics of the project and the company.[46]

Funding streams cover the entire value creation chain from fundamental research to market innovation, but these are distributed by different programmes (e.g. R&I projects and CDTI projects, respectively).

Different programmes require and stimulate public–private cooperation. These are:

- 'CIEN' strategic private consortia for innovation which requires the participation of between three and eight companies and at least one SME, and the collaboration with research centres for at least 15 % of the project;
- 'Collaboration Challenges. R&I projects' which require consortia of research centres and companies (at least 60 % of private participation);
- 'Firm Challenges. R&I projects' for businesses that contract research collaboration with public research centres. Therefore, innovative financing solutions, such as public–private partnerships, are implemented. Other innovative financing solutions include funding for projects that have been positively reviewed in EC programmes but not granted (e.g. PYME horizon), indicating that Spain complements EU R&I programmes with a focus on SMEs.

Measures to reduce the uncertainty of participation by private entities were taken, but these might have been at the cost of increasing the administrative burden to participation of private entities. In 2003, the national government introduced the 'Informes Motivados', which aims to reduce the uncertainty of private entities with regard to applying for national R&I support (Royal Decree 1432/2003). Through these reports, private entities get ex ante recognition from the national administration of the tax deductions that they are entitled to for carrying out nationally funded R&I projects.

[46] This criterion is periodically adapted to provide better access to companies.

In 2007, Royal Decree 2/2007 modified this regulation, granting the CDTI the right to provide these documents. Since 2015, an 'Informe Motivado' can be obtained through an online procedure. The 'Informes Motivados' are a safe guard for companies, ensuring that they will received a tax deduction for R&I projects, but they also imply an administrative burden to participation (see section 5.4). Funding support increasingly aims to tailor to the needs of companies, including SMEs. For example, the 'PYME Horizon programme' was launched in 2015 to target SMEs (see section 3.6).

Funding schemes for companies are regularly reviewed (e.g. 'Cuadernos'; CDTI, 2014b). Benchmarking exercises might exist, but there are no publicly available programmes that are recognised to have been benchmarked against comparable schemes in other countries.

3.5.2 Public Procurement of Innovative solutions

According to the Spanish Observatory of Public Procurement, public procurement represents about 18.5 % of Spanish GDP[47] – or, in other words, EUR 194 billion a year.[48]

Legal public procurement framework

Existing regulation in Spain in the area of public procurement stems from Directive 2004/18/EC and Directive 2004/17/EC. In particular, and after the transposition of both directives, the fundamental rules in the area of public procurement in Spain at present are the Spanish 'Law on Public Sector Contracts'[49], a consolidated text adopted by Royal Legislative Decree 3/2011 of 14 November (referred to as 'TRLCSP'), and, in the water, energy, transport and postal service sectors, Law 31/2007 of 30 October, regulating the procurement procedures in these sectors, which are referred to by this law as 'special sectors'. Finally, Law 24/2011 of 1 August 2011 regulates the public sector contracts in the fields of defence and security.

A number of laws emanating from some of the autonomous communities also need to be taken into account, for example Law 3/2011, of 24 February, on measures regarding 'Public Sector Contracts of Aragon, and Navarra' Law 6/2006, of 9 June, on Navarra public contracts.[50]

The PCP/PPI landscape in Spain

Public demand-driven innovation is one of the key pillars of Spain's renewed National Plan for R&D and Innovation.[51] This encompasses both an R&D procurement phase based on PCP and a phase of procuring innovative solutions ready for market deployment based on 'forward commitment procurement'. It also foresees the development of a financial support mechanism governed by a central government body, namely the CDTI, that encourages public procurers to undertake such procurements.

Public procurement of innovative goods and services has been increasingly encouraged in Spain. The Spanish legal framework differentiates two complementary mechanisms for

[47] http://www.obcp.es

[48] Comisión Nacional de los Mercados y Competencia, *Pro/cnmc/001/15: analysis of public procurement in Spain: opportunities for improvement from the perspective of competition*, p. 3. The same document states that the evaluation of public procurement as 18.5 % of GDP may be an underestimate mainly because it does not include public procurement other than by contracting, such as in-house providing and agreements.

[49] http://europa.eu/rapid/press-release_IP-11-430_en.htm?locale=en

[50] http://www.iclg.co.uk/practice-areas/public-procurement/public-procurement-2014/spain

[51] http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.7eeac5cd345b4f34f09dfd1001432ea0/?vgnextoid=83b192b9036c2210VgnVCM1000001d04140aRCRD

'Pre-commercial Procurement' and 'Public Procurement for Innovation',[52] as described below:

- Pre-commercial Procurement (*Compra Pública Precomercial*): this modality aims to provide the conditions for procurement of R&D to tackle issues defined by a public actor;
- Innovative Public Technology Procurement (*Compra Pública de Tecnología Innovadora*): the procurement of commercial end-solutions without procuring R&D; For CPTI, FCP using, in particular, the competitive dialogue is applied.[53]

In 2010, the Council of Ministries agreed to promote innovative public procurement through the elaboration of a Spanish *Guide on Innovative Public Procurement (Compra Pública Innovadora, CPI)*, published in 2011.[54] The document describes administrative action to foster the development of new innovative markets from the demand side, through public procurement. This guide was updated and a second version was released in December 2015.[55]

The 'Law 2/2011 on Sustainable Economy'[56] (2011) introduced the public procurement of innovative goods and service as a policy instrument to promote innovation, especially in some specific fields such as environmental protection and digitalisation of public services. Articles 37 and 38 of this law define, in particular, the conditions of public–private collaboration contracts and services that deal with R&I.

PECTI (2013–2016)[57] covers the public procurement of innovative goods and services within the 'Strategic Action of Economy and Digital Society', the programme of 'Business leadership', and the sub-programme of 'Business R&D and innovation'. A working group of the Spanish Ministry of Science and Innovation (MICINN) and the CDTI is developing the Spanish strategy for PPI in more detail.[58]

PCP/PPI Initiatives

Spain introduced a **3 % target** for the public procurement of innovative products and services in its procurement law of 8 July 2011.[59] Seven tenders have been listed on the CDTI website since 2013. The current state of progress towards the 3 % target remains unclear.

Of the seven tender procedures, two were still open at the beginning of 2016:

- The first of these deals with the identification of innovative solutions regarding the design and implementation of anti-fog highway protection systems.[60]
- The second is managed by the Port of Huelva and deals with the paving of the infrastructure.[61]

The other five tenders launched in 2013, 2014 and 2015 relate to:

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[52] http://ec.europa.eu/information_society/newsroom/image/document/2015-50/spain_12540.pdf

[53] http://www.idi.mineco.gob.es/stfls/MICINN/Innovacion/FICHEROS/Politicas_Fomento_Innv./Guia.CPI.pdf

[54] http://www.idi.mineco.gob.es/stfls/MICINN/Innovacion/FICHEROS/Politicas_Fomento_Innv./Guia.CPI.pdf

[55] http://www.idi.mineco.gob.es/portal/site/MICINN/menuitem.7eeac5cd345b4f34f09dfd1001432ea0/?vgnextoid=281c12c94d364410VgnVCM1000001d04140aRCRD

[56] https://www.boe.es/boe/dias/2011/03/05/pdfs/BOE-A-2011-4117.pdf

[57] http://www.idi.mineco.gob.es/stfls/MICINN/Investigacion/FICHEROS/Politicas_I+D+i/Plan_Estatal_Inves_cientifica_tecnica_innovacion.pdf

[58] http://cordis.europa.eu/fp7/ict/pcp/docs/spain_pcp_v3.pdf

[59] http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2011:0849:FIN:EN:PDF

[60] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=2397&r=1366*768

[61] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=2335&r=1366*768

- the identification of innovative solutions for the design, construction, equipment and management of the ultrashort pulse ultra-intense laser centre;[62]
- the development of a high repetition rate target system for proton production by a laser plasma acceleration; this project is managed by the University of Santiago de Compostela;[63]
- the design, construction, testing and delivery of infrastructure for a liquefied natural gas (LNG) carrier; this project is managed by the public company Navantia;[64]
- the design and implementation of a project on personalised medicine in psychiatry; this project is managed by the Catalan Health Service;[65]
- the design of an education project for the public company red.es.[66]

3.5.3 Indirect financial support for private R&I

The central government's budget (PGE) for R&D in 2015 was EUR 6 406.5 million, of which 62.4 % was for financial operations (loans) and 37.6 % for non-financial operations (subsidies) (ICONO-MINHAP, 2015). Considering the budget that had been planned for 2015 in the national plan for R&D (EUR 2 807 million), a total of 63.6 % was distributed through loans and 41.9 % through subsidies and repayable advances from the ERDF (MINECO, 2015).

In addition, the Spanish system of tax incentives (indirect government funding) for R&I has been one of the most generous among OECD countries for the past few years (MINECO, 2011; OECD, 2015). Spain ranks second, after Portugal, according to the tax subsidy rate[67] on R&D expenditures among 36 OECD countries for 2013 (OECD, 2015). However, despite the fact that tax incentives are formally generous, tax incentives for R&I represent a small and decreasing proportion of government funding for private R&I. Direct government funding of business R&D was 0.10 % of GDP in 2011, while tax incentives for R&D represented 0.02 % of GDP in the same year (OECD, 2015).[68] This percentage of tax incentives decreased from 0.03 % in 2006 to 0.02 % in 2011 (OECD, 2015). Spain ranks 22nd with regard to the percentage of indirect government support through tax incentives.

Spanish tax incentives include fiscal incentives for R&I projects and social security bonuses for full-time R&I personnel. These incentives target companies regardless of their size and economic activity area. There are three main types of R&D tax incentives for companies (MINECO, 2015): (1) tax deduction for R&D and innovation activities (ex ante and ex post); (2) income reduction for transferring intangible assets ('Patent Box'); and (3) social security benefits for full-time R&D personnel.

Since 2015, Law 27/2014, of 27 November, on corporate taxes (Art. 35 and 39) has set the legal framework for deductions. This law includes the changes included in Law 14/2013, of 27 December, that is, the Entrepreneurship and Internationalisation Support Act (e.g. fiscal measures for R&I and 'Patent Box' changes). These could reach up to 42 % of direct costs. They have a yearly limit, but benefits can be claimed in successive

[62] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=2334&r=1366*768
[63] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=2264&r=1366*768
[64] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=2156&r=1366*768
[65] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=1908&r=1366*768
[66] http://www.cdti.es/index.asp?MP=4&MS=0&MN=1&TR=C&IDR=1860&r=1366*768
[67] The tax subsidy rate is defined as '1 minus the B-index', a measure of the before-tax income needed by a 'representative' company to break even on USD 1 of R&D outlays (Warda, 2011).
[68] 'Estimates refer to the R&D and innovation tax credit, based on the R&D and innovation tax credit, based on the tax authorities data on claims, published by the Ministry of Economy and Competitiveness. Estimates include support for technological innovation. According to data from an no-random subset of firms (informes Motivados), this accounts for more than 45% of all qualifying expenditures and nearly 20% of all deductions. Estimates do not include the cost of allowances for employers' social security contributions, which was less than 1 million euros in 2007' (OECD, 2015).

fiscal exercises ('fiscal check').[69] Income reduction for transferring intangible assets (Patent Box) is set a limit of 40 %. Law 17/2012 and Royal Decree 475/2014 regulate social security benefits for full-time R&D personnel. They enable up to a 40 % reduction in social security taxes of R&D staff working for companies, make compatible certain deductions for 'innovative SMEs', and allow personnel to benefit from R&D deductions retrospectively.

Therefore, tax incentives are explored and adopted in Spain, but they have a limited impact (MINECO, 2011, 2012, 2014b; OECD, 2015). The lack of information, the complexity and the uncertainty about the tax deduction procedure might limit the effect of R&I tax incentives. Large companies appear to be more able to benefit from tax deductions (MINECO, 2011). 'Motivated reports' managed by the SEIDI and CDTI aim to reduce uncertainty and are increasingly used. A total of 1 318 companies applied for 2 567 motivated reports in 2009 and this increased to 1 857 companies and 3 900 reports in 2013 (51 % of which were SMEs) (MINECO, 2014b). Data for 2010 indicate that qualified reports accounted for EUR 1 599 million(52 % of R&D costs and 48 % of innovation costs), representing deductions of 21 % (MINECO, 2014b). Patent Box deductions represented EUR 250 million in 2013 (fiscal exercise of 2012) (see section 5.8 for more details on the impact of regulation).

3.6 Business R&D

3.6.1 The development in business R&D intensity

The intensity of the Spanish BERD is relatively modest (slightly more than 0.6 % of the GDP in 2014). An increasing trend during the 2005–2008 period is apparent, which was almost entirely reversed over the following years (in 2014, the intensity of the total BERD was close to the 2006 level). The economic crisis that affected all aspects of the Spanish economy had particularly negative effects on the overall business intensity.

No sign of recovery is observable, since BERD is still decreasing, that is, from 0.67 % of GDP in 2012 to 0.66 % in 2013 and 0.63 % in 2014.

A number of policy measures have been adopted in recent years to encourage private investments in R&D. However, their impact has not been translated into any modification of the abovementioned downwards BERD trend.

Among them, several policies and funding schemes (such as the NEOTEC programme) target young innovative companies to help them commercialise ideas rapidly and promote their internationalisation. Other support measures for SMEs target industries with a growing market. Policies and instruments to encourage cooperation and knowledge sharing, and to create a more favourable business environment for SMEs, also exist. For example, the 'CIEN Strategic private consortia for innovation' requires that consortia include, at least, one SME and collaboration with public research centres, in order to increase cooperation and knowledge sharing.

Spain has also developed fiscal incentives to increase business R&D expenditure (EVCA, 2013). The Entrepreneurship and Internationalisation Support Act (Law 14/2013) has thus developed tax incentives for private companies. Similarly, Law 5/2015 on private funding includes regulations for investment lending and equity crowdfunding.

[69] Law 3/2009 and Law 2/2011 and Royal Decree 475/2014 on the tax reform approved in November 2006 brought important changes. First, this legislation enabled up to a 40 % reduction in social security taxes of R&D staff working for companies. Second, following a trend of reducing corporate taxes, R&D and innovation corporate tax credits were also reduced. In 2009, the deduction procedure was simplified: the time limit of two years to deduce taxes for R&D investments was cancelled. Moreover, in 2011, the deduction for innovation was increased from 8 % to 12 %, but this increase has been cancelled for 2012 and 2013. Royal Decree 475/2014, which entered into force on September 2014, allows retrospective benefits from R&D deductions for 2013.

The economic sectors of services and manufacturing have remained at a low and relatively stable level since the beginning of the crisis in 2008. Manufacturing changed from 0.31 % of GDP in 2008 to 0.3 % in 2014, while services changed from 0.36 % to 0.32 % (see Figure 7). The sectors of construction; electricity, gas, steam and air conditioning supply; and sewerage, waste management and remediation activities remained at a negligible level, of between 0.1 % and 0.2 % of GDP, over the whole period.

Most business R&D funding comes from business itself. It has been very stable over the crisis and post-crisis period (0.55 % of GDP in 2008; 0.54 % in 2013). The funding from government is much lower and, after an increase between 2005 and 2008, followed a downwards trend until 2013 (0.07 %). Its 2013 level was below the level observed in 2005 (0.08 %). It should be noted that despite the severe economic crisis, the private part of business R&D has remained very stable over recent (albeit at a low level).

Figure 7 does not show the development in forgone tax revenues due to fiscal incentives (see section 3.2). This also declined between 2008 and 2010, although it increased again in the years after 2010. In 2015, the expected amount of forgone tax revenues suddenly more than doubled, but it is still unclear whether the actual forgone revenues in 2015 reached this projected amount (MINHAP budget office 2015 in RIO smart fiscal consolidation report Spain 2015). Nevertheless, it is clear that the government's contribution to BERD would appear considerably higher if these forgone revenues had been taken into account.

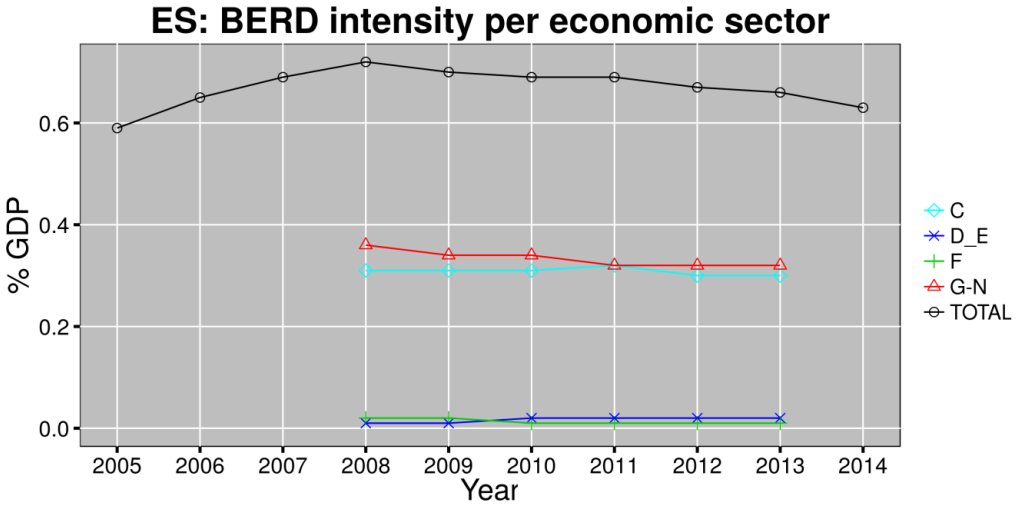

Figure 7. BERD intensity broken down by most important macro sectors (C, manufacture; G_N, services; F, construction; D_E, electricity, gas, steam and air conditioning supply, and sewerage, waste management and remediation activities)

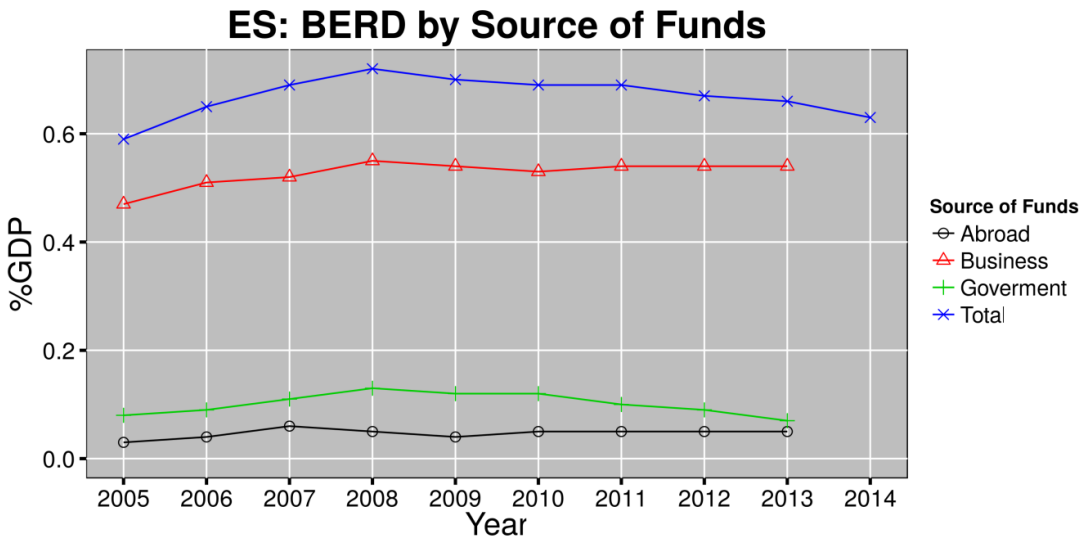

Figure 8. BERD by source of funds

3.6.2 The development in business R&D intensity by sector

In 2013, within manufacturing, the 'manufacture of other transport equipment' and the 'manufacture of basic pharmaceutical products and pharmaceutical preparations' sectors reached a similar level of R&D expenditure (around EUR 568 million; see Figure 9). However, while the former showed a continuous downwards evolution from 2010, the latter showed a remarkable increase between 2008 and 2011, before decreasing until 2013. The manufacture of motor vehicles followed a similar trend, with an increase between 2008 and 2010, and a decrease until 2013, at which point it reached EUR 328 million.

The manufacturing sector with the highest number of companies ranked in the top 1 000 R&D companies in the EU is the pharmaceutical sector, with Almirall (188th position), Grifols (189th position), Zeltia (352nd position) and Laboratorios Farmaceúticos ROVI (765th position).

With regard to services sector, all of the top services, in terms of R&D investments, showed a similar modest downwards trend, The 'professional, scientific and technical activities' is the top sector, with EUR 2085 million of R&D spending in 2013. It is followed by 'information and communication' (EUR 845 million of R&D spending in 2013) and 'wholesale and retail trade; repair of motor vehicles and motorcycles' (EUR 203 million of R&D spending in 2013) (see Figure 10).

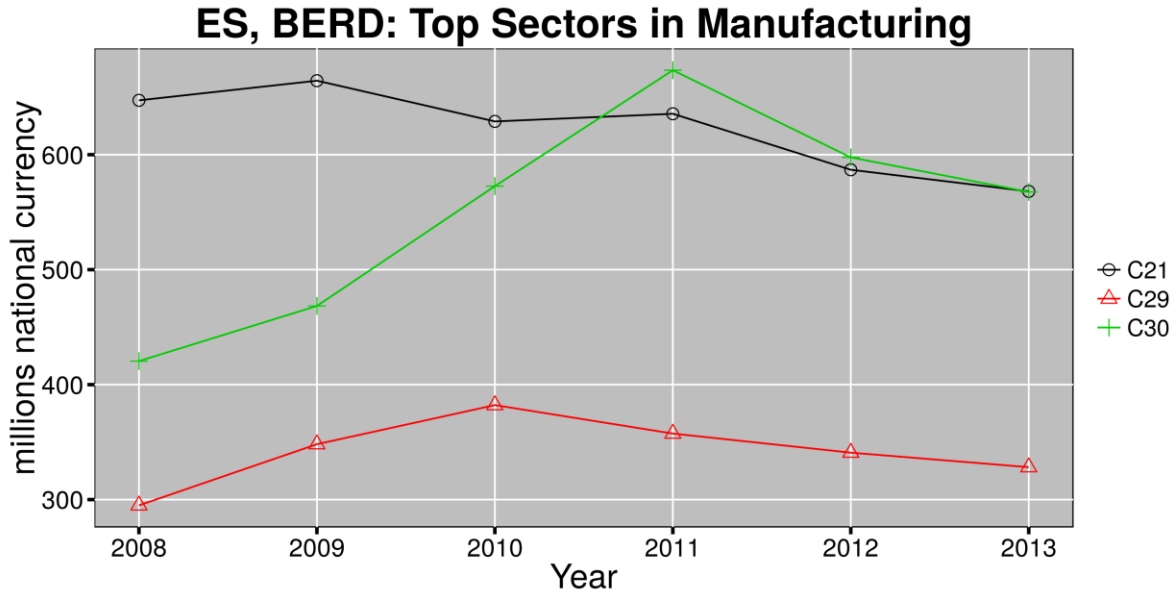

Figure 9. Top manufacturing sectors (C21, manufacture of basic pharmaceutical products and pharmaceutical preparations; C29, manufacture of motor vehicles, trailers and semi-trailers; C30, manufacture of other transport equipment)

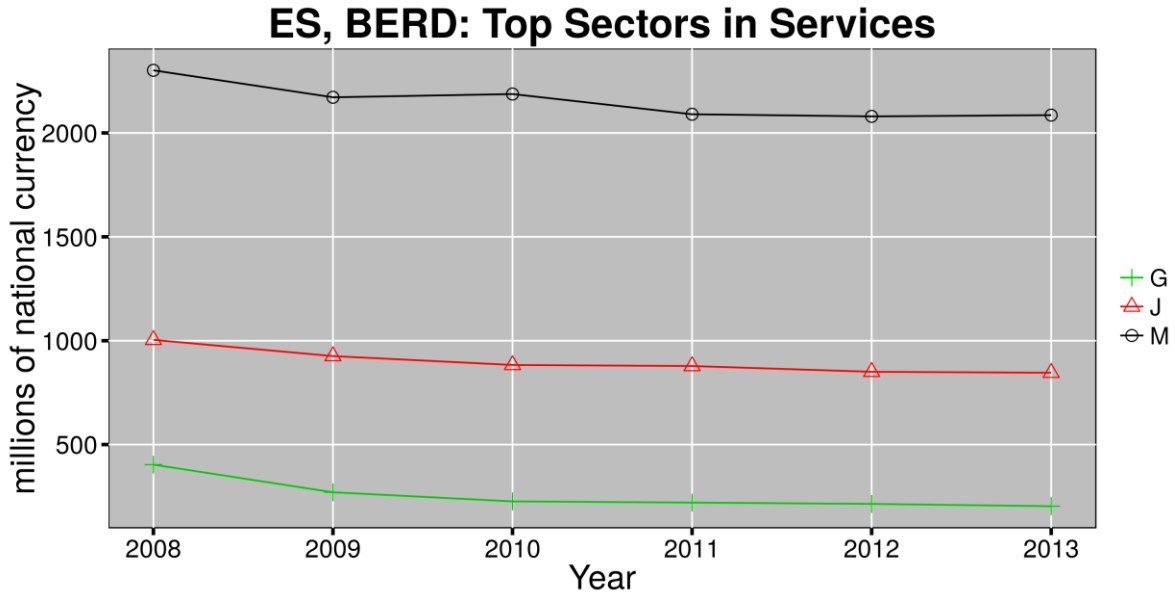

Figure 10. Top service sectors (J, information and communication; G, wholesale and retail trade; repair of motor vehicles and motorcycles; M, professional, scientific and technical activities)

3.6.3 The development in business R&D intensity and value added

Manufacturing is the biggest contributor to gross value added (GVA) in Spain (13.3 % of GVA). Its value is, however less than the EU-28 average (of 15.2 %). A top service sector in terms of BERD, namely the 'wholesale or retail trade; repair of motor vehicles and motorcycles', is also one of the most important sectors in terms of GVA (contributing 12.6 % of GVA). Its value in Spain is higher than the EU-28 average (of 11.2 %). Construction is the third most significant economic sector (8.6 % of GVA) and its contribution to GVA in Spain is much higher than the EU-28 average (of 5.9 %).

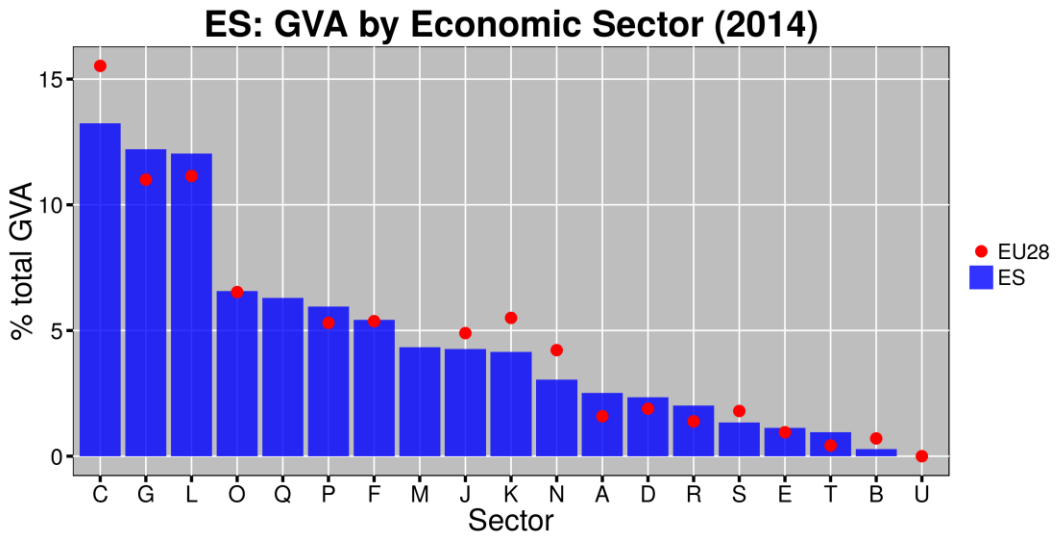

Figure 11. Economic sectors as a percentage of total GVA. The top six sectors in decreasing order: (1) manufacture (C); (2) wholesale and retail trade, repair of motor vehicles and motorcycles (G); (3) construction (F); (4) real estate activities (L); (5) accommodation and food service activities (I); and (6) public administration and defence, and compulsory social security (O)

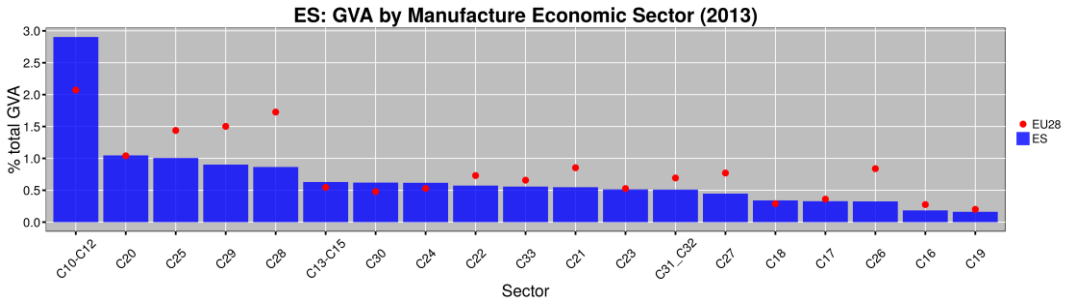

Figure 12. GVA by manufacturing sector. The top six manufacturing sectors: (1) manufacture of food products, beverages and tobacco products (C10–C12); (2) manufacture of chemicals and chemical products (C20); (3) manufacture of machinery and equipment n.e.c. (C28); (4) manufacture of textiles, wearing apparel, leather and related products (C13–C15); (5) manufacture of coke and refined petroleum products (C19); and (6) manufacture of basic pharmaceutical products and pharmaceutical preparations (C21)

The breakdown of manufacturing activities shows that, as a percentage of GVA, most sectors are below or equal to the EU average. The most noticeable exception is the leading sector 'Manufacture of food products; beverages and tobacco products' (2.9 % of GVA, compared with 2 % for the EU-28).

The importance of SMEs for value added in Spain should also be noted. According to the Small Business Act 2015 (DG GROW, EC),[70] SMEs are more important in Spain than in other European countries because they account for a higher proportion of value added and employment than their European counterparts. SMEs provide almost three-quarters of all jobs and more than 60 % of value added. The proportion of SME employment in the manufacturing sector exceeds that of other EU countries by 11 percentage points, accounting for more than 70 % of all jobs in this sector. The situation is similar for value added, which is 14 percentage points higher than the EU average. Spanish SMEs have still not recovered from the crisis. In 2014, value added and employment were estimated

[70] http://ec.europa.eu/growth/smes/business-friendly-environment/performance-review/files/countries-sheets/2015/spain_en.pdf

at 29 % and 23 %, respectively, below their 2008 pre-crisis levels. This pattern is also founded in the total number of active businesses registered, which has decreased by 11 % since 2008.

Value added in the retail sector increased considerably between 2005 and 2008. After a small dip in 2009, it continued to grow, although at a much lower rate. The modest pre-crisis growth in value added of the information and communication sector and the professional, scientific and technological activities sector (sector M) has also stalled since 2008. In sector M there was a modest growth again in 2011. A decrease in value added in the automotive and motorcycle manufacturing sector was visible after 2007. Unfortunately, there are no data after 2009. Value added in the pharmaceutical sector decreased by almost 15 % between 2008 and 2013.

While employment in the manufacturing sectors studied decreased, the number of scientists and engineers employed in the manufacturing sector increased, suggesting a process of 'upskilling'. A similar process is visible for all the top service sectors analysed.

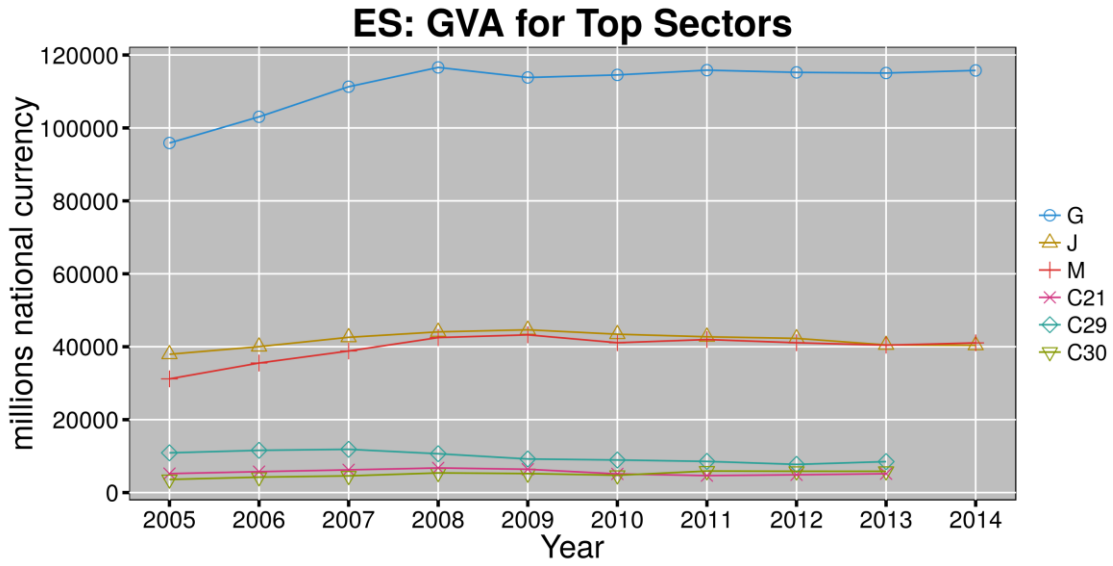

Figure 13. Value added at factor cost for the leading manufacture and service sectors in Figures 9 and 10

3.7 Assessment

Public R&I investment levels are worrisome (1.46 % PGE-46/PGE in 2015, compared with 2.7 % in 2008) (ICONO-MINHAP: 2015) and threaten to set back all the progress made in the previous period, 2002–2008. The system lacks reasonable alternative sources of funding, as research input from the private sector is nearly half of that of the European average and is also decreasing. In addition, the decrease in the execution of public R&I budgets (from 91.3 % in 2007 to 54.5 % in 2013 (FECYT, 2015a)) indicates that further efforts could be made to review programmes that appear not to be attractive enough.[71]

Despite the policy efforts to increase the proportion of project funding (e.g. EECTI and PECTI), the budget cuts for R&I have particularly affected project funding. The more fixed character of institutional funding has probably affected this negative trend. Institutional block funding includes salaries for researchers with permanent contracts (public officials) and other fixed operational costs such as infrastructure. Temporary researchers are usually hired through project funding programmes. Institutional funding is mainly allocated through block funding, and performance-based mechanisms are not

[71] Molero et al. (2016) show that the low level of execution is mainly attributable to programmes based on loans and targeted at companies.

usually taken into account to allocate these funds. This has increased competition for project funding among already research-active researchers. In addition, excluding the human resources calls, the access of researchers under temporary contracts (non-permanent staff) to project funding is very limited (see section 4.4.2). Measures to distribute institutional funding in a competitive mode could incentivise behaviour towards increased research quality and the achievement of critical mass. Recent trends indicate that the Spanish share of project and institutional funding is likely to be more affected by budget availability than by the need to incentivise behaviour towards increased research quality.

Spain implements a large set of direct and indirect instruments for funding R&I for business organisations. There is some evidence that suggests that direct financial support to business R&I leads to additional company R&I investments (e.g. Huergo et al., 2009). However, the low level of execution of R&I budgets indicates that R&I programmes for business organisations, mainly based on loans, might not be attractive enough to encourage companies to apply.[72] The limited use of tax incentives, despite its formal generosity, might indicate that indirect mechanisms for R&I funding could not be properly designed or that they are not effective at boosting innovation in the private sector.

New efforts to increase public–private cooperation, knowledge transfer and the involvement of SMEs in R&I activities are apparent in the evolution of the policy mix. New policy programmes, such as the 'CIEN Strategic private consortia for innovation', that offer funding for private consortia that include SMEs and OPIs and that aim to undertake large-scale technological projects, indicate that new efforts are being made to increase public–private cooperation and knowledge transfer. The 'Industrial PhD programme', which allows students to carry out PhDs in the private sector, indicate the efforts to encompass research, innovation and education. Both programmes were introduced in the 2014 working plan of PECTI. In 2015, the 'PYME Horizon programme' which targets SMEs was launched. These new programmes indicate an increasing attention to knowledge transfer and SME involvement in the policy mix (see section 2.3 and 3.4.3 for more specific measures). However, the low level of execution of public R&I funding indicates that the policy mix could be substantially improved.[73]

[72] Internal comments from the national contact points (NCPs) indicate that the extensive deleveraging of Spanish companies might be the main reason behind the low level of execution.
[73] Internal comments from the NCPs suggest that the low level of execution reflects a policy mix driven by macroeconomic conditions, such as the fact that loans do not account for public deficit whereas grants do.

4. Quality of science base and priorities of the European Research Area

4.1 Quality of the science base

As shown in Table 9, the latest data on research output indicators show that Spain produced 1.60 publications per 1 000 inhabitants in 2013, which is above the EU-28 average of 1.43. Of these publications, 43.03 % were internationally co-published the same year, which is also above the European average of 36.4 %. The number of international publications per 1 000 inhabitants in Spain was 0.70 in 2013, which is above the European average of 0.52 and below the number in France (0.78). In the period 2000–2013, 11.08 % of Spanish scientific publications were in the top 10 % most cited publications worldwide, a figure very similar to the 11.29 % of top scientific publications produced in the EU-28. During this period, the quality rate of the Spanish publications changed from below the European average to above the average rate (12.18 % of the Spanish scientific publications were in the top 10 % versus 11.68 % for the EU-28). The proportion of public–private co-publications in Spain was 1.3 % in the period 2000–2013, compared with 1.8 % for the EU-28.

These data indicate that research performance levels are increasing in Spain. Spanish researchers show research performance levels above the European average. Spanish researchers publish with international peers much more frequently than their European peers. The quality of Spanish research production is also increasing. This indicates that the efforts made with regard to input, in the period 2002–2008, might have had a positive effect on output. However, there might be a decline in the coming years because of the significant decline in public R&I investments (see section 3.4). It appears that Spanish researchers are more active in searching for European funding (see section 3.1), but these funds do not compensate for the decline in public R&I investments.

The production levels of Spanish researchers could be further improved through structural changes, as highlighted by OECD (2006) and ERAC (2014) reports (e.g. considering the research performance on the distribution of direct funding; increasing institutional autonomy; reducing fragmentation and rewarding research performance at individual level). Among the policy measures that have been taken over the last three years that could help to improve the performance of the research system, the elaboration of the Smart Specialisation Strategies is notable. These strategies might help to reduce fragmentation, as they require regions to identify their strengths in research (see section 2.4).

Table 9. Research performance indicators

Indicator	Year (2013)	EU average
Number of publications per 1 000 of population	1.60	1.43
Proportion of international co-publications	43.7 %	36.4 %
Number of international publications per 1 000 of population	0.70	0.52
Percentage of publications in the top 10 % most cited publications	11.08 %	11.29 %
Proportion of public–private co-publications	1.3 %	1.8 %

Source: JRC IPTS RIO elaboration on Scopus data collected by Science-metrix in a study for the EC DG RTD (Campbell, 2013). The proportion of public–private co-publications is derived from the Scival platform and is also based on Scopus data.[74] The data on public–private co-

[74] Scival © 2016 Elsevier B.V. All rights reserved. SciVal® is a registered trademark of Reed Elsevier Properties S.A., used under license.

publications are not fully compatible with the data included in the IUS because of differences in the methodology and the publication database adopted.

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

Policy actions to support joint activities are encompassed within the policy efforts for increasing the internationalisation and orientation towards societal challenges of the Spanish R&I system. EECTI and PECTI note the need for the Spanish R&I system to better align R&I agendas with grand challenges through optimal transnational cooperation. Joint activities are especially encouraged through the PECTI programme 'Promotion of R&I towards societal challenges'. This programme includes among its objectives the 'articulation of R&I activities and funding mechanisms with other regional and international actors (especially European ones) to properly develop joint programming actions' (MINECO, 2015: 53) (see section 3.4 for funding). Within this programme, PECTI includes a specific mechanism to fund 'Joint programming actions', included in the sub-programme 'Challenges and actions'. This action is aimed at supporting joint research projects that have been positively evaluated and selected in joint international calls in which MINECO is involved (ERA-NETs, Joint Programming Initiatives (JPI), Joint technology Initiatives (JTI), etc.). The 2015 budget for this was EUR 10 million, which represented 0.4 % of the total provisional budget for 2015. In addition, the 'Strategic action on health' includes a specific funding mechanism to fund joint programming actions. It had a budget of EUR 2.9 million for 2015, which represented 0.2 % of the total provisional budget for 2015 (PAA). The call is managed by the ISCIII and offers funding to R&I centres in the biomedical field that are involved in ERA-NETs and other joint programming actions.

Reported joint actions at national level include initiatives carried out through: Article 185, [75] ERA-NETs, INCO-NET, COST, ERA initiatives (i.e. JTIs, JPIs, public–private partnerships (PPPs), European Innovation Partnerships (EIPs)) and SET-Plan. Spain participated in four programmes based on Article 185: Ambient Assisted Living (AAL); the European Development Clinical Trials Partnership (EDCTP); the European Joint Programme dedicated to the research and development in small and medium-sized enterprises (EUROSTARS); and the European Metrology Research Programme (EMRP). MINECO reported participation on 30 ERA-NETS initiatives and 7 INCO-NET projects, Spain chaired 46 COST actions and is involved in 1 081 other actions (COST webpage; 2015). ERA initiatives include six JTIs, JPIs, PPPs, five EIPS, SET-Plan and IIEs.[76] A study on Joint and Open Research Programmes (JOREP) shows that Spain devotes more than 4 % of its GBAORD to joint programmes excluding the ESA (JOREP, 2012). ESA initiatives represent the highest volume, followed by other European initiatives and bilateral agreements.[77] Public funding for R&I projects developed through the ERA-NET scheme was about EUR 2 000 million between 2004–2014. A total of EUR 1 200 million of public investment is estimated for 2013–2015. ERA-NETs are coordinated in several administrative units (e.g. the R&I 'Subdirección General de Proyectos' coordinates FORESTERRA and SEAS-ERA, and the 'Subdireción General de Proyectos Internacionales' coordinates the remaining ERANETS).

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[75] 'Article 185 of the Treaty on the Functioning of the European Union (TFEU) [ex Article 169 of the Treaty establishing the European Community (TEC)] enables the EU to participate in research programmes undertaken jointly by several Member States, including participation in the structures created for the execution of national programmes' (Cordis).Therefore, initiatives based on Article 185 are Public-Public Partnerships between Member States (and associated states) and the EU.

76 Information extracted on October 2015. This might not be up to date, and includes initiatives from the FP6.

77 Access to CIRCAB was not possible.

Ex post evaluation is not frequently undertaken in Spain, making it difficult to know whether an ex post evaluation has been carried out on these programmes (Molas-Gallart, 2012) (see section 2.2.1). The CDTI offers some evidence that shows that the participation of Spanish firms in international programmes of technological collaboration increased between 2012 and 2013, particularly with European partners (CDTI, 2014b: 4). Companies that receive CDTI funds report that this funding has helped them to address R&I projects with a wider scope (80 %) (CDTI, 2014b). Based on a sample of 2 556 innovative companies in 2011, CDTI (2014b) indicates that companies that received funds from CDTI show a higher innovation activity (62 % versus 55 %) and a higher level of technology cooperation (89 % versus 38 %) than firms that do not receive CDTI funds.[78]

Different administrative units manage jointly funded research (e.g. MINECO, ISCIII) which might make it difficult to define common priorities, selection decision, reporting requirements, eligibility criteria, definitions of eligible cost, intellectual property rights, standards for proposal evaluation, funding rates, etc.). Because of the Spanish system of governance, information on joint activities is spread among national and regional authorities, thus making it difficult to determine the degree of Spain's involvement in these activities. The LCTI includes some elements for a partial solution to the legal barriers for joint programming and access to research infrastructures, granting national government the ability to design rules that facilitate international cooperation (Art. 44 and additional provision 17).

Policies for transnational cooperation and competition have been defined and implemented in Spain to a great extent. They have probably contributed to increasing the quality of the national research system, but it is difficult to state exactly by how much. Spain's participation in European programmes (e.g. FPs, Horizon 2020) and its research performance is increasing, which might suggest that R&I policies for cooperation and competition have helped to improve the quality of the national research system.

4.2.2 RI roadmaps and ESFRI

The Spanish National Research Infrastructures (RIs) roadmap was released in 2010. It was designed considering the European Strategic Forum for Research Infrastructures (ESFRI) roadmap. It includes a definition of large RI, considers the Spanish participation in RIs and evaluates Spanish priorities on RIs in a European context. It was established by evaluation committee with researchers from different fields that designed a proposal of RI that was sent to a committee on the prioritisation of RI composed by those responsible for R&I policy. It included criteria for evaluation and prioritisation, and published its results. Areas of specialisation were designed following ESFRI areas and considering Spanish strengths on these. From a total of 44 ESFRI projects envisaged in Europe, Spain ranks within the top 12 in the areas of social sciences and humanities (the Share project), biological and health science (the Elixir, Infrafrontier and Instruct projects), environment (Euro-Agro and COPAL), energy (IFMIF), materials (ILL and ESRF), physics and engineering (E-ELT and FAIR) and e-infrastructures. The NRP (2015) envisages the design of a new roadmap of infrastructures.

According to the ESFRI 2010 roadmap, two pan-European RIs will be located in Spain: Life watch in environmental sciences and the solar infrastructure EU-SOLARIS in environmental sciences and energy. A total of 53 RIs located in Spain received funds from the EC to provide transnational access to researchers.

Spain contributes significantly to a broad range of RI facilities. According to MINECO, Spain participates in 14 international RIs. Budget cuts for R&I have caused some delays

[78] A recently published report of the CDTI (2015) indicates that CDTI funds have helped to change the behaviour of companies during the crisis. Companies with CDTI financial help have seen R&D investments as a counter cycle engine to overcome the economic crisis.

in the payment of the country's financial contribution to some international research infrastructures (e.g. CERN and the European Science Foundation (ESF)). For example, 2014 PGE includes a budget line to cover unpaid financial contributions to CERN (Molero and de Nó, 2014c). Similarly, contributions to ESA were subject to significant reductions and extra budget commitments (ERAWATCH, 2014a).

Measures to remove barriers to access of research infrastructures have been taken. For example, Law LCTI (2011) includes several elements for a partial solution to the legal barriers to access to research infrastructures (provision 17). EECTI (2013–2020) considers the 'sustainability and use of scientific and technological infrastructures' as one of its specific objectives (sub-objective 2). And the PECTI (2013–2016) follows the strategy and devotes one of its sub-programmes (number 4) to RIs. Spain contributes significantly to a broad range of pan-European RIs. It is estimated that this sub-programme will distribute EUR 150 million (i.e. 5.3 % of the total PECTI budget for 2015).

In summary, the national roadmap was aligned with the ESFRI 2010 roadmap, the areas of specialisation of RIs are envisaged to be complementary by national roadmaps, and national participation in ESFRI was considered. Large national scientific and technological platforms appear to be generally open to foreign access, as the roadmap follows ERIC principles on mobility.

4.3 International cooperation with third countries

EECTI aims to reinforce the long-lasting cooperation with countries in Latin America and other Mediterranean countries. It also aims to support international actions with third countries in R&I matters and support economic development (EECTI, 2013: 36).

CDTI has a 'Foreign Network' that helps innovative Spanish firms to reach international markets through cooperation agreements with other countries; it also helps to identify technological market opportunities in third countries. It includes offices in 28 countries: Japan, South Korea, China, India, USA, Morocco, Chile, Brazil, Mexico, South Africa, Egypt, Algeria, Canada, Argentina, Colombia, Peru, Taiwan, Malaysia, Australia, Singapore, Indonesia, Thailand, Emirates, Turkey, Israel, Russia, Switzerland and Belgium. The CDTI foreign network has increased the number of delegations (from 9 in 2013 to 28 in 2015) through an agreement with the State Secretary of Commerce.

Most of the PECTI calls that target individual researchers ('Recognition and promotion of talent and employability programme) are open to third countries (see Section 4.4.2). This openness might be considered to help increase the attractiveness of ERA to talented minds.

Because of its traditional relationship with Latin America, Spain has several cooperation agreements with this region. These agreements include the 'Ibero-American Programme of Science and Technology for Development' (CYTED) agreement for multilateral cooperation with 19 Latin American countries and Portugal in the following areas: 'Agro-Alimentation', 'Health', 'Promoting Industrial Development', 'Sustainable Development', 'Global Change and Ecosystems', 'ICT', 'Science and Society', and 'Energy'. Within this framework, the Iberoeka programme promotes technological cooperation with Latin America. It is managed by the CDTI. In 2014, there were 38 Iberoeka projects with a Spanish budget of EUR 17 million, involving partners from Argentina (20), Peru (3), Colombia (1) and Chile (1) (COTEC, 2015).

In addition, Spain has several bilateral cooperation agreements with innovation agencies in China (Chineka), Canada (Canadeka), India (ISIP), Korea (KSI), Japan (JSIP) and South Africa (SASE). In 2014, four technological projects within this framework were approved with Spanish funding of EUR 1.4 million (COTEC, 2015).

In 2014, MINECO signed a collaboration agreement – NSF-Pire – with the National Science Foundation (NSF) for R&I collaboration projects within the PECTI framework.

Spain appears to be involved in improving the coordination of the objectives and activities of the EU, Member States and associated countries with regard to third countries and international organisations. For example, it has participated in some events included in the Strategic Forum for International S&T Cooperation (SFIC) for improving coordination with China.

Spain participates in the further development of the multiannual roadmaps for international cooperation. The national roadmap and national strategy aim to improve excellence, attractiveness and industrial competitiveness. They also aim to tackle global societal challenges. Finally, they also support external policies of the EU.

Then, it appears that national initiatives promote coherent and sustainable EU level cooperation with third countries.

4.4 An open labour market for researchers

4.4.1 Introduction

Spain is characterised by a highly regulated market for researchers, with low levels of institutional autonomy with regard to management and a dual labour market for researchers (civil servants versus non-civil servants). Permanent staff at universities and public research institutions generally have a civil servant status (Mora, 2001) (see section 4.4.2 on permanent contracts with no civil servant status, such as 'profesor contratado doctor'). There is no room for salary negotiations. Salaries follow fixed scales with small variations based on productivity. Low departmental autonomy in the management of human resources means that 'internal labour markets' are predominant (Cruz-Castro and Sanz-Menéndez, 2010). About 73 % of Spanish public university personnel were recruited by the university at which they obtained their PhD in the academic year 2013–2014 (MEDU, 2015). The existence of a dual labour market has caused non-permanent researchers in particular to suffer the consequences of the budget reductions in R&D and fiscal consolidation measures, thus making human resource management the most urgent problem of the Spanish research system (ERAC, 2014).

The number of people employed in R&D activities in 2014 was 199 583 (FTE) (333 134 head count in 2013) (Eurostat, 2015).[79] The impact of the crisis in R&D personnel has been significant. After increasing by more than 65 % from 2002 to 2010, this number decreased in 2011 by 3.1 %, in 2012 by 2.9 %, in 2013 by 2.6 % and in 2014 by 1.8 %, thereby returning to levels similar to those of 2007 (Eurostat, 2015). A total of 43.6 % employees were working in the private sector, 36.8 % in HEIs, 19.4 % in government and 0.2 % in the PNP sector, based on FTE data for 2014 (Eurostat, 2015). The number of personnel working in human resources in science and technology (HRST) as a proportion of the labour force in 2014 was 41.5 %,[80] which is below the EU-28 average of 42.5 % (Eurostat, 2015). The number of PhD holders in Spain is increasing, having risen from 7 830 in 2008 to 10 889 in 2013 (MEDU, 2015).

The unemployment rate among PhD holders increased from 2 % in 2008 to 5 % in 2013 (MEDU, 2015), which indicates an imbalance between the supply and demand for researchers. In addition to increasing unemployment levels, more and more evidence indicates that the economic crisis and decreasing public investments in R&I are making the labour market situation for researchers in Spain very difficult, especially for young researchers. The number of university personnel decreased by 2.1 % between the academic years 2011–12 and 2013–14, reaching a figure of 115 071 academics in 2014 (MEDU, 2015). The number of researchers working at OPIs is also decreasing. For example, the CSIC reduced its PhD training contracts (*Junta de Ampliación de Estudios*

[79] FTE data are provisional. No data more recent than these were available for head count at the time of this report from Eurostat.
[80] Includes breaks in time.

(JAE)) from 2 045 in 2008 to 300 in 2013. The number of employees decreased from 12 928 in 2011 to 11 582 in 2013, and that of grant holders from 618 to 435.[81]

4.4.2 Open, transparent and merit-based recruitment of researchers

Spain has a dual labour market for researchers (civil servants and non-civil servants) with different regulations and rights. The University Law (LOU), the regulations of PROs and all the legislation governing access to 'civil servant' status, including Art. 103.3 of the Spanish Constitution, regulate access to the different research positions in the Spanish R&I system.[82]

At university level, civil servant research and teaching personnel include two main categories: (1) *Catedráticos de Universidad* (CU), the highest-ranking category, which is equivalent to 'Professor'; and (2) *Titulares de Universidad* (TU).[83] In the academic year 2013–14, there were 10 562 CU and 29 690 TU (MEDU, 2015). Non-civil servants at university level include: (1) *Profesorado contratado doctor* (Art. 52), who have permanent contracts but not 'civil servant' status. In 2013, this category included 8 692 researchers and represented 17.8 % of the permanent research workers at universities (MEDU, 2015). Finally, there are about 46 642 academics with temporary contracts (mainly *asociados* (Art. 54)) (this number was 19 707 in the academic year 2013–14).[84] This dual market also exists in OPIs. 'Civil servants' at PROs include, from the highest to lowest rank: (1) *Profesor de investigación* (a research professor); (2) *Investigador científico*; and (3) *Científico titular*. Non-civil servants include *personal laboral*.

The LCTI (of 1 June 2011) replaced the so-called Law of Science of 1986 and modified governance and human resources for R&I. The LCTI includes four types of private (non-civil servant) labour contracts: (1) to carry out a PhD degree (four years maximum with minimum wages) (Art. 21); (2) 'to grant access (five years and a maximum of 80 hours of teaching) (Art. 22); (3) for researchers working on research projects (D.a 23a); and (4) for distinguished researchers or scientists, 'of great prestige' who will be able to occupy key positions in management or in 'important' programmes (which can be permanent) (Art. 23). The implementation of the pre-PhD contract was delayed until 2014 and the implementation of the others were conditioned by the public budget constraints and public employment supply.

The LCTI has created a unified professional career, but there is no regulation on the career progression of a researcher (see Annex i). The different official professional scales for scientists with a civil servant status in PROs are merged into three scales, comparable to those of the CSIC: (1) research professor; (2) scientific researcher; and (3) permanent scientist. This merging facilitates staff mobility between the PROs. The LCTI also improves several aspects of researchers' careers. The replacement of the '2 + 2' system (a two-year scholarship and then a two-year contract) by a four-year employment contract implies the full recognition of certain rights such as unemployment

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[81] According to the institution declarations to the press (18 October 2013): http://sociedad.elpais.com/sociedad/2013/10/18/actualidad/1382111759_201200.html

[82] Law 4/2007 modified Law 6/2001 (LOU) on the access of university personnel, changing the 'habilitation' system to a national 'accreditation' system, which is necessary to participate in the recruitment process 'concur', which provides access to university personnel. Universities are responsible for launching the call according to their own regulations. In addition, Royal Decree 1312/2007 and Royal Decree 1313/2007 are important in this regard. The role of the universities is regulated by Law 30/1992, Royal Decree 774/2002 and Law 7/2007, which regulates the *Public functionaries* staff regulations.

[83] Two other categories could be included: *catedráticos de escuela universitatia* (CEU) and *Titulares de escuela universitaria* (TEU). In 2013, there were 1 069 CEU and 5 610 TEU, and, in addition, about 144 'other public functionnaires'.

[84] Other temporary university personnel are *Ayudante*, *Ayudante Doctor*, *Asociado de Ciencias de la Salud*, *Colaborador* and *Visitante*.

benefits and maternity leave. In addition, the LCTI improves mobility between private and public organisations by allowing extended leave for a maximum of five years and by partly reducing the incompatibility with working in private firms.[85]

Formally, the recruitment process for researchers in the Spanish R&D system is open, transparent and merit based, but tacit mechanisms favour 'insiders' (students or researchers from the same university, faculty or even the same department). Despite this informality, officially, candidates from the EU have full access to research and teaching positions. Vacancy announcements usually include job profile, skills and competences information on the selection process, and criteria are also usually available to candidates. However, tacit mechanisms behind the formal process (or 'internal labour markets') make it difficult for outsiders to access research positions (Fernandez Esquinas et al., 2006: 167; Cruz-Castro and Sanz-Menéndez, 2010). Frequently, the timescale established between vacancy publication and the deadline for applications makes it difficult for outsiders to apply. Institutes or departments can influence the composition of the members of the selection panels and establish ad hoc selection criteria. Selection panels for permanent positions include national external members, whereas international external members are rare. Applicants have the right to receive feedback on the results of the requirement, as well as having the right to appeal against the decision. Information on the rules for the composition of selection panels is available for candidates. The composition of the selection panel is also published. However, the vagueness of some criteria (e.g. 'suitability for the job') allows tacit mechanisms to be exercised. Therefore, the degree of openness of the selection process depends on the interests of the department and research organisations to exercise it. However, the increasing competition of the research system and the implementation of some measures (e.g. accreditation) appear to have formally and informally opened up the system.[86]

It is difficult to assess to what extent the LCTI has changed the labour market for researchers as no evaluations on the level of implementation of the new mechanism included in the law have been carried out. Similarly, the limited implementation of the contract for 'distinguished researchers' has reduced the effectiveness of the LCTI to change the labour market for researchers making it more competitive and flexible (ERAWATCH, 2014a).[87]

Since 2001, there has been a requirement to have official recognition or accreditation in order to access an academic position (some temporary and all permanent positions).[88] ANECA evaluates research and teaching activities and provides accreditation at national level for universities through

the Evaluation of the Academic Personnel Programme (PEP) and the ACADEMIA programme. Similar evaluations are implemented at the regional level.[89] University

[85] It allows researchers to work part-time in private firms created by the organisations in which they are working and by eliminating restrictions on the maximum share ownership of a private company (to 10 %) and the restrictions on being a board member in private companies. It modifies the previous Law of Sustainable Economy (Law 2/2011) to allow researchers to profit from their patent earnings.

[86] The National Commission for Evaluation (CNAE) has recently slightly changed its criteria for the evaluation of university and CSIC personnel (BOE 01.12.2014).

[87] For example, it is envisaged that the CSIC will hire next year, for the first time under this contract, 17 researchers. A very small figure considering the size of the institution and the number of researchers that are currently under a Ramón y Cajal contract and need to be renewed with a permanent contract.

[88] According to Law 4/2007, which modified Law 6/2001, Royal Decree 1052/2002 and the Resolution of 18.02.2005 for temporary positions. Permanent positions are regulated by Royal Decree 1312/2007.

[89] The regional evaluation agencies are: DEVA-ACC (Andalusia); Madrid+d (Madrid); ACCUEE (Canary Island); ACSUCYL (Castille and Leon); ACSUG (Galicia); ACUCM (Casltille-La Mancha); AQU Catalunya (Catalonia); AQUID (Balearic Islands); AVAP (Valencia); Univasq (Basque

non-civil servant contracts are evaluated by PEP of ANECA. These contracts include the positions of Profesor Contratado Doctor, Profesor Ayudante Doctor and 'Professor for Private Universities'. In 2014, PEP carried out 5 754 accreditations, of which 62 % were positive. Humanities had a lower success rate, with 56 % of positive answers (ANECA, 2014b).[90] The ACADEMIA programme grants accreditations for *Titulares de Universidad* and *Catedráticos de Universidad*. The ACADEMIA programme carried out 2 529 accreditations, of which 63 % were positive (ANECA, 2014b). The high number of Teaching and Research Personnel (PDI) (*Ayudante doctor* and *Contratado doctor*) with positive evaluations, compared with the offer of positions, also indicates the mismatch between supply and demand in the labour market for researchers (18 908 as opposed to 2 936 for PAD and 16 342 as opposed to 7 882) (ANECA, 2014a).

Compared with the European average, Spain shows low levels of researcher mobility whether the sector of reference is citizenship (2012: Spain, 4 %; EU-28, 15 %) or higher education (Spain, 7 %; EU-28, 15 %) (MORE, 2013). However, mobility among more junior staff is higher than the European average: in 2012, among PhD students, it was 40 % in Spain compared with 18 % in the EU-28, and among postdoctoral staff it is was 31 % compared with the EU average of 30 %. Employment mobility is also below the European average (8 % compared with 12 % in 2012) (MORE, 2013). The same report finds some evidence of a recent brain drain problem in the country, pointing to the economic crisis and the lack of attractive conditions and career prospects as main drivers (MORE, 2013). Izquierdo et al. (2015) find similar evidence of a brain drain problem.[91]

In addition to the decreasing number of researchers at universities and public research centres, there is some indication of an increasing temporariness and ageing of R&D personnel. For example, the ratio of temporary to permanent personnel at the CSIC changed from 1:10 in 1986 to 12:10 in 2011 (Fundación 1 de mayo, 2014). Public functionaries (civil servants) decreased by 2.5 % from 2012 to 2013, while temporary contracts decreased by 16.7 % (Fundación 1 de mayo, 2014).[92] A total of 58 % of the researchers in the CSIC are over 49 years old (Fundación 1 de mayo, 2014). A total of 47.3 % of university personnel were over 50 years old (MEDU, 2015).

The low levels of inward researcher mobility in Spain indicate the lack of attractiveness of the country for foreign researchers.[93] In addition to other quality- and economic-related factors, several potential barriers for foreign researchers should be mentioned. The ANECA accreditation process is very bureaucratic, making access by foreign researchers more difficult. For example, it is necessary to provide certificates for all the CV (curriculum vitae) merits in advance. Universities do not use the positive evaluation from ANECA as a guarantee of CV merits. Therefore, this bureaucratic process has to be carried out again and probably makes the labour market for researchers less fluid and acts as a barrier to foreign researchers. In addition, some language barriers exist. Sometimes positions require an advanced knowledge of Spanish or other regional languages (such as Catalan, Galician or the Basque language). The importance of these regional languages in the evaluation criteria for selecting researchers or for obtaining promotion affects the chances of foreign researchers and also makes the internal mobility of Spanish researchers more difficult.

Country).

[90] The results of other fields were: 'Experimental Committee' (68 %); 'Health' (59 %); 'Social Sciences' (60 %); and 'Technology' (68 %).

[91] According to the MORE (2013) report, the outflow of Spanish researchers is greater than the outflow the Spanish citizens (6 % versus 4 % in the sample). Izquierdo et al. (2015) found that recent emigrants (since 2008) from Spain are younger and more highly educated than Spaniards who stay.

[92] In 2013, a total of 5 664 were public functionaries, 4 800 temporary contract and 1 171 *laboral personnel* (they have a civil servant status, but they are not public functionaries).

[93] A total of 2.4 % of university personnel in the academic course 2013–2014 was foreign (MEDU, 2015)

All R&I human resources programmes are open to foreign researchers (see section 3 and Annex 4). Therefore, it could be argued that measures to attract foreign researchers do exist. Similarly, measures that support the attraction and reintegration of foreign-based nationals exist (e.g. the Ramón y Cajal programme). However, the low number grants and the difficulties faced by Ramón y Cajal researchers with regard to finding a permanent position[94] reduce the effectiveness of these policy measures.

In summary, Spain has a dual market for researchers with increasing unemployment rates, high temporariness and a low level of access to research project funds for researchers with temporary contracts. Currently, the career path for young researchers is nearly non-existent, making human resource management the area that probably requires the most urgent action in the Spanish R&I system (ERAC, 2014).

4.4.3 Access to and portability of grants

Publicly funded R&I grants and fellowships provided via public funding are generally linked to Spanish R&I centres. R&I grants and fellowships are open to non-residents but research must generally be carried out in a Spanish R&I institution. Non-national researchers (EU and non-EU nationals) can apply to the human resources programme calls (e.g. 'Pre-doc', 'Juan de la Cierva' and 'Ramón y Cajal' within the 'education and training' and 'employability' programmes) which usually require researchers to develop their projects in a Spanish research institution. Tenders for R&D projects generally require principal researchers to have a Spanish institutional affiliation for the whole duration of the project, which favours Spanish-based researchers with permanent positions.[95] Members of the research team are generally also required to have this type of institutional affiliation. In addition, tenders for R&D projects are accessible to foreign companies operating in Spain.

The portability of grants is limited. Most of the grants targeted at researchers require an agreement/contract between the researcher and the host institution. If the researcher wishes to undertake the research in a different foreign or national institution, the host institution has to allow it. Committees can, however, mediate if there is a disagreement between the researcher and the host institution. Institutions are reluctant to facilitate portability, as it implies a loss of resources, making the portability of grants to a foreign or national institution difficult.

4.4.4 Doctoral training

Spain has developed a legislative framework to set up the 'doctoral schools' model of organising doctoral training.[96] Doctoral training is regulated by Royal Decree 99/2011, in accordance with the Salzburg principles [97] developed under the framework of the European Higher Education Area (EHEA) and the European Research Area (ERA). Universities enjoy high levels of autonomy in the organisation of their doctoral training

[94] A new call has been created to grant Ramón y Cajal researchers with permanent positions, 'Grants for the employability of PhDs', because of the problems that research centres face when attempting to comply with the obligation required to award researchers a permanent position.

[95] This information is based on some programmes included in PECTI, and regional calls apply similar criteria. Some exceptions are made for researchers granted Ramón y Cajal fellowships. In 2014–2015, the call for R&D projects ('Promotion of R&D and innovation towards societal challenges') included a specific sub-call for young researchers with temporary institutional description (*Proyectos de I+D+I para investigadores sin vinculación o vinculación temporal 2014*). However, excludability criteria have considerably reduced the opportunities for applying to these calls (e.g. excluding members of a research team in a previous R&D project call). In addition, the programme has a small budget considering the number of researchers with temporary contracts.

[96] In contrast to the classic model of master and apprentice.

[97] The 10 Salzburg principles were defined in 2005. They were supplemented in 2010 by a series of Salzburg recommendations on ways to implement the principles. These principles are the base of the seven principles of Innovative Doctoral Training jointly with good Member State practices and Marie Curie experiences.

programmes, the university departments being the basic unit for research and doctoral training. 98 Within the general framework set by the national regulations, they can organise doctoral training according to their internal regulations.

A significant number of Spanish universities have adapted their doctoral programmes to the new regulation (RD 99/2011) across several or all of their departments. According to the 'Registro de Universidades, Centros y Títulos' (RUCT), out of a total of 3 688 doctoral and masters programmes in 2015, 1 049 programmes were doctoral programmes adapted to the EHEA through RD99/2011, 918 were masters and doctoral programmes adapted to the EHEA through RD 1393/2007,[99] and 1 720 were doctoral programmes regulated by Royal Decree 56/2005. Many of the programmes regulated by previous Royal Decrees (1393/2007 and RD56/2005) have been cancelled. The report of an expert university commission, that subscribes the principles of the IU regarding Innovative Doctoral Training,[100] confirms the ongoing adaptation process of Spanish doctoral training programmes (MEDU, 2013a).

Recent relevant policy measures aimed at implementing some elements of Innovative Doctoral Training should be mentioned. The programme 'Campus of International Excellence' (CIE) promotes research excellence by encouraging university campuses to establish collaborations with other institutions, to specialise and to internationalise. Committees of national and international experts evaluate university strategic plans. The programme was launched in 2008 under the framework of the University Strategy 2015. Since then, 12 national campuses and eight regional university campuses have received this recognition. As required by the programme, the first campuses granted a CIE recognition were verified after a period of four years. The CIE verification indicates that all the principles of Innovative Doctoral Training are met.[101] The 'Severo Ochoa and María de Maeztu' sub-programmes are also worth mentioning, as they support excellent research centres and groups, including training.[102] This scheme was launched in 2011 within the framework of the NP (2008–2011). Only a few doctoral programmes that offer collaboration with foreign universities exist, and the introduction of English as a spoken language in PhD courses is still at an early stage. Interdisciplinary research options are recognised by the LCTI and EECTI, but mainly refer to researchers' mobility. Education curricula in the past only infrequently included transferable skills training. However, the Bologna Process is helping to include this aspect, at least formally, in universities' educational plans. ANECA evaluates and recognises the quality of PhD programmes, granting them a 'Mention of Excellence' if they comply with certain quality criteria.

EECTI (2013–2020) aims to promote 'Industrial PhD programmes'. PECTI has implemented this measure through the 'Industrial PhDs' calls (EUR 3 million estimated in 2005, 0.1 % of total budget; MINECO) involving universities and companies. This could help to improve the knowledge transfer system and the match between education and training supply and employment needs (OECD, 2011a, b; ERAWATCH 2012; ERAC, 2014). In addition, it aims to encourage intersectoral job mobility. The 'Torres Quevedo' sub-programme also aims at promoting researchers' intersectoral mobility (EUR 15 million estimated in 2015-MINECO).

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[98] Law 14/1970 'Ley general de educación' recognises the university automomy to design their own regulations and general organisations and introduces the departments. Law 11/1983 'Ley de Reforma Universitaria' recognises departments as the basic units of research and teaching (see Benito and Romera (2013) for more legislative changes in doctoral training programmes).

[99] It separates Masters from PhD training.

[100] The principles of Innovative Doctoral Training are: research excellence, attractive institutional environment, exposure to industry and other relevant sectors, international networking, transferable skills training, and quality assurance. See section 3.2.2 for the labour market for researchers, as this also includes PhD students.

[101] According to the Evaluation Procedure.

[102] There are currently 23 *Severo Ochoa* centres of excellence and 10 *María de Maeztu* units.

Some Spanish universities have structured their doctoral training in thematic doctoral programmes (e.g. University Carlos III, Girona University, Santiago de Compostela University and Pompeu Fabra University) (EC, 2011d).

4.4.5 Gender equality and gender mainstreaming in research

Spain had (from April 2008 until October 2010) a Ministry of Equality and each law presented in the parliament required an impact report about the effects on gender issues.[103] MINECO has a Women and Science Unit that is responsible for putting the principle of gender mainstreaming into practice in R&I. Its mission is to promote gender perspective in R&I policies by (1) removing biases, barriers and disincentives for women; (2) promoting gender mainstreaming in research, and gender and women studies; and (3) promoting gender mainstreaming in technological development and innovation. The Strategic Plan on Equal Opportunities (2014–2016) covers gender issues in R&I and aims to reduce the gender gap in high positions in research institutions. The 'Action Plan for Gender Equal Opportunities in the Information Society' 2014–2017, established in September 2014, aims to promote gender equality in information and communication technologies.

The LCTI and other R&I policy measures (e.g. EECTI and PECTI) have included important positive changes with regard to gender equality and gender mainstreaming in research.

LCTI 2011 has improved several aspects of research careers. The replacement of the '2 + 2' system (a two-year scholarship and then a two-year contract) for PhD students by a four-year employment contract allows the full recognition of certain rights, such as unemployment benefits and maternity leave. However, non-permanent contracts (including researchers that have to be self-employed to work at some universities) mean that female researchers lose out on several rights that other mothers are entitles to. Similarly, the four months of maternity leave is not always compensated for with a four month extension of a contract (Villaroya et al., 2007). For example, fixed-term contracts associated with fixed-term research projects are not usually extended. In the case of fixed-term contracts associated with calls for the promotion human resources for research, such as Ramón y Cajal, 'Formación' and the Torres Quevedo programme, such an extension is allowed.[104]

The LCTI could also be considered as the most important action that encourages cultural and institutional change on gender, affecting funding agencies, research organisations and universities. In particular, the sixth point of the 13th additional provision establishes that 'Public Research Bodies should adopt within 2 years "gender balance Plans" that will be yearly monitored. These plans should include measures to award institutions that improve their gender balance indicators.' Access university plans on gender equality can be accessed from the following link. Equal opportunity plans in state OPIs have been developed. The elaboration of plans on gender equality in companies and other institutions has been supported by the Ministry of Health, Social Security and Equality (formerly known as the Ministry of Equality) since 2009. The LCTI also addresses the issue of the monitoring of gender balance at organisation level with two specific requirements: (1) the second point of the 13th additional disposition establishes that the 'Information System of Science, Technology and Innovation (SICTI) should collect, treat and disseminate data disaggregated by sex, including indicators on the share of females and productivity'. National and regional institutes for women have developed important work to foster cultural and institutional change on gender (including research programmes) (see, for example, Institute for women).

[103] The Ministry aimed at promoting social policies on gender included in the Law for the Equality (3/2007) and in the Law Against Gender Violence (1/2004) and other social programmes of the Institute for women.

[104] See Art. 54 (Ramón y Cajal); Art. 68 (formación); and Art. 83 (Torres Quevedo). Available online: http://boe.es/diario_boe/txt.php?id=BOE-A-2013-13832

The new LCTI addresses the issue of gender imbalances in decision-making process. Action MS39 of the LCTI supports a balanced gender representation within committees involved in (1) recruitment and career progression and (2) programme and/or project evaluation. In addition, the first point of the 13th additional provision establishes that 'all the institutions and committees regulated by the law, as well as, all the evaluation and selection committees of the Spanish R&D and Innovation system should follow the gender balance principle established by the Law 3/2007, 22 March.' This implies that any gender will account for neither more than 60 % nor less than 40 % of the total. Therefore, there are regulations and policy actions that promote gender representation in academic research committees, boards and governing bodies of the Spanish R&I system (namely the LCTI, EECTI and PECTI). The LCTI affects all public and private bodies 'in charge of financing, executing and coordinating, as well as, all actions that taken to promote research, development and innovation policies regardless of the economic and social sectors' (Art 3.1). Research funders [105] and universities [106] are bounded by this law.[107]

The new LCTI also aims to encourage the gender dimension in research programmes. The second point of the 13th additional provision establishes that EECTI and PECTI should 'include the gender dimension in research programmes in all the process, including definition of priorities in research, research problems, theoretical frameworks, methods, collection and interpretation of data, conclusions, technological development and future research. They should also encourage studies with a gender perspective and the analysis of the situation of women and promote and increase recognition of female researchers in research groups.'

In accordance with the LCTI, the EECTI includes 'gender equality' and 'gender dimension in research' as parts of one of its five basic principles (principle 5). In the same way, PECTI mentions these issues (see p. 28) as a horizontal measure. However, there is not a specific programme to tackle these issues. In addition, the list of indicators to measure progress does not include any indicator to measure gender balance. Therefore, PECTI appears to be vague in the application of the 'gender equality' and 'gender dimension in research' established by the LCTI. The calls included in PECTI are also quite vague with regard to implementing these measures. For example, the 'R&D call for societal challenges for research' ('Retos Investigación: Proyectos I+D+i') only establishes that, as well as 'Human and Social Sciences research', research with a gender dimension perspective will have a transversal character and could be applied in all research proposal and research challenges (p. 89 297).

Spain takes part in the GENDER-NET research project initiative of 12 national programme owners (e.g. ministries and funding agencies) with a shared commitment to promoting gender equality through structural change in research institutions.

[105] Research funders are also bound by Law 38/2003 of General Subsidies, which establishes that their procedures should be open, transparent and non- gender biased in order to reach efficiency and effectiveness, as established by Art. 8.3.

[106] Universities are bound in the selection procedures by Law 6/2001. This law establishes that procedures should be transparent and non-discriminant. It does not establish specific gender discrimination measures.

[107] The LCTI also mentions that the evaluation and researcher selection procedures should follow EC Directive 20078/EC of 27 November 2000, the principles of the European Charter for Researchers and its code of conduct (2005/251/CE), and National law 7/2007, of 12 April (Art. 5 and Art. 16 of the LCTI).

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers electronic identity

In accordance with strategies for the promotion of open access (OA) (see section 4.5.2), new national, regional and institutional initiatives aim to encourage the development of research- and education-related e-infrastructures and digital research services for the dissemination of knowledge. At national level, the new LCTI, EECTI (2013–2020) and PECTI (2013–2016) are the most important initiatives. As a consequence of the implementation of the LCTI by PECTI, institutional research and data repositories are becoming increasingly frequent, RECOLECTA being the main national harvester of institutional repositories.

Similarly, the measures to support researchers' access to digital research services are supported by OA data initiatives. At the national level, researchers working at national research organisations have access to bibliographic research information (Web of Knowledge and Scopus) through national licences managed by FECYT. At regional and institutional levels, purchases by a consortium of university libraries are common. Research institutions, universities and library consortia support online subscriptions.

The Open Science Harvester, RECOLECTA, is a platform that gathers all national scientific repositories and provides services to repository managers, researchers and policy makers in OA science matters. RECOLECTA is probably the most significant national joint programme for the promotion of OA science in Spain. It was launched in 2007 in collaboration with the Spanish Public Universities and Research Libraries Network (REBIUN),[108] and is supported by CRUE, in collaboration with the FECYT. This network has been holding regular meetings since 2002 (EC, 2011). It published a report on OA to scientific knowledge (FECYT, 2012b), including guidelines and national and international initiatives. Since then, it has produced regular reports on OA guidelines for the implementation of the LCTI measures on OA to research knowledge (Art. 37) (e.g. FECYT, 2014c), guidelines for the evaluation of institutional repositories (e.g. FECYT et al., 2014) and includes links to relevant national and international initiatives.

The eduroam ES project, coordinated by the IRIS Network, supports a common roaming environment between Spanish research organisations, allowing individual researchers to access network services in other public research organisations.

The LCTI (Art. 37) promotes OA by encouraging the development of OA archives of researchers' publications, including access to other similar initiatives at national and international level. EECTI (2013–2020) implements this by including an 'articulation mechanism' (number 2) to promote OA to data, publications and research results financed by public funds, including guidelines for creating shared archives. At national and regional levels, there are several initiatives for collecting information on researchers through the standard 'Curriculum Vitae *Normalizado*' (CVN), which is a format for exchanging research information among systems launched by the FECYT in 2006. It is implemented in approximately 90 Spanish institutions (including 50 universities) and nearly 60 000 researchers have created their CV in the CVN format. Moreover, FECYT is working on the standardisation of CVN with the European standard CERIF (Common European Research Information Format). The Andalusian System of Research Information (SICA) is the curriculum manager for the production of scientific activity, structured according to the CVN standard. It also aims to help researchers to find research partners. Spain has 'also created a quality certification service based on international standards, similar to the German DINI Certificate' (EC, 2011c: 27)

In addition to the RECOLECTA recommendations (e.g. FECYT, 2012b; FECYT et al., 2014), it should be noted that there are no new significant measures at national level to address challenges such as personal data security, the scope of personal data use, and

[108] It provides access to searches of the archives of 74 state universities and exchanges.

identity validation and tracking. The LCTI (additional disposition 9) follows Law 15/1999 on personal data protection, extending it to the treatment and sharing of research data. It indicates that the government will regulate, with the help of the Spanish Data Protection Agency, the academic content of researchers' CVs which funding and implementing agencies can make public without their consent. In addition, the LCTI (Art. 15) recognises the obligation of researchers to protect data and confidentiality agreements in their work. The Strategic Action digital economy and society programme 'Big IT projects' aims to promote R&I projects on cybersecurity within its thematic priorities.

4.5.2 Open Access to publications and data

Spain has maintained important initiatives in favour of OA to scientific information. The LCTI, the regulation on official PhD training programmes, EECTI (2013–2020) and PECTI (2013–2016) are considered the most important initiatives. Similarly, RECOLECTA is an important national initiative for providing OA information in institutional repositories, helping to implement the LCTI with regard to OA.

The LCTI includes a disposition (Art. 37) on OA. It states that public research organisations have to promote the development of OA archives of researchers' publications, including access to other similar initiatives at national and international level; researchers should publish a digital version of the results of their publicly funded research no later than 12 months after their publication; these should be uploaded in OA archives; and the Ministry should facilitate central access to those archives and promote links with international archives.

Royal Decree 99/2011, of 28 January, which regulates official PhD training programmes, states that an electronic copy of every doctoral thesis approved in any Spanish university should be deposited into an OA institutional repository.

EECTI (2013–2020) includes, as an 'Articulation mechanism' (number 2), the promotion of OA to data, publications and research results financed by public funds, including guidelines for creating shared archives.

PECTI (2013–2016) includes a sub-programme for the development of new technologies (AEESD2.2). This programme includes the promotion of 'Open Access' through technological forums and platforms.

The Digital Agenda for Spain, adopted in February 2013, provides a framework reference and a roadmap for the Digital Agenda Strategy for 2013–2015 aimed at developing the digital economy and society. One of its main objectives is to increase the efficiency of information technology investments in R&I.[109]

In Spain, there is an important set of infrastructures that allow researchers to archive their work as OA : institutional repositories, thematic repositories, open research journals and open research journal portals. Among these, institutional repositories play a central role in the proper implementation of the National OA public policy.

As mentioned, RECOLECTA is a national joint initiative of REBIUN and the FECYT to create an e-infrastructure (harvester) for repositories in Spain and its integration with international repositories. RECOLECTA is an open platform that gathers all the national scientific repositories together in one place and guarantees that all OA repositories are interoperable among them. It plays a key role in allowing a proper implementation of the national OA to science policy. It promotes and coordinates the national infrastructure of

[109] There are also some regional regulations that promote access to open repositories containing peer-reviewed scientific articles. For example, the Autonomous Region of Asturias requires articles to be deposited in its institutional repository with an embargo period of no more than six months; and the Autonomous Region of Madrid considers papers, working papers and data, and a field-dependent embargo period of no longer than six months (EC, 2011b).

OA digital scientific repositories in an interoperable manner based on the standards adopted by the global community. There are 81 institutional repositories in RECOLECTA and 42 Spanish research institutions have signed the Berlin Declaration (Berlin9: accessed 13.09.2015).

There are an increasing number of public universities with institutional policies in favour of OA. A total of 20 universities have policies on OA (RECOLECTA: 2015). Open institutional repositories are becoming frequent in public universities, especially OA to PhD dissertations. Some of them include 'Creative Commons' licences. Some universities, like the University of Alicante, give direct financial help to departments or research groups according to the number of documents they deposit in the institutional repository (Open Aire; EC, 2011b). The Alhambra Declaration was signed in May 2010 by a group of OA stakeholders (editors, librarians, funding agencies, university rectors and authors) from countries in southern Europe (Spain, Portugal, France, Italy, Greece and Turkey), whose main languages are different from English, to promote OA to scientific productions. OpenDOAR, a website directory of academic OA repositories, indicates that Spain has 122 OA repositories, four of which are institutional datasets, namely Digital CSIC; Repositorio de Investigación Olavide; Politecnic University of Catalonia Repository; and Pompeu Fabra repository (accessed 13 October 2015).

Calls for research proposals launched in 2013–2015 in the framework of PECTI implement Art. 37 of the LCTI, which makes it compulsory for researchers to either publish in OA journals or to self-archive the publication in institutional or field-related OA repositories. It also makes it compulsory for researchers to make their micro-data collected with public funds available within a period of 12 months after finishing the project. These micro-data have to be transferred to databases, such as the Data Bank for Social Sciences in the Centre for Sociological Research (CIS). The access to these data depends on the condition imposed by these hosting institutions and the type of data. These OA conditions are, for example, imposed in the 'R&D call for societal challenges for research' ('*Retos Investigación: Proyectos I+D+i*') (Art. 6 – publications and Art. 8 – data).[110]

Data on OA collected by RECOLECTA (accessed 13 October 2015) for Spain indicate that more than 830 000 publications from Spain are OA, from 81 Spanish institutional repositories (RECOLECTA, 2015). With a sample of 35 577 papers, the distribution of Spanish articles across the different types of OA between 2008 and 2013 is as follows: 12 199 'Hybrid' (34.1 %); 4 074 'Gold' (11.5 %); 3 577 'Green' (9.9 %) (Science-Metrix, 2013, 2014). It appears that Spanish researchers tend to publish more often than the EU-28 average researcher in 'Gold' or 'Green' OA format (8.6 % Gold OA EU average and 9.4 % Green EU OA average between 2008 and 2013) (Science-Metrix, 2013, 2014).

In summary, measures that ensure OA to scientific research and publications are being taken. Spanish researchers published in 'Green' and 'Gold' OA repository types more frequently that their European colleagues. Funding for national programmes includes specific conditions that make it compulsory for researchers to grant OA to their publications and to deposit the micro-data collected. The cost of publications in OA journals should be considered as research costs and are specifically mentioned in the calls. OA repositories are becoming more frequent. However, it appears that they mainly include publications and, less frequently, data.

[110] They also follow the recommendation of the European Commission of 17 July 2012 regarding access to and preservation of scientific information.

5. Framework conditions for R&I and Science-Business cooperation

5.1 General policy environment for business

Spain stands 74th in the ranking of 189 countries in relation to the ease of starting a new business and 23rd with regard to the ease of resolving insolvency (WB, 2014). Through the Entrepreneurship and Internationalisation Support Act (Law 14/2013), Spain has improved its legal framework for doing business and becoming an entrepreneur. Among the changes (see section 2.2), the new legislation has limited the responsibility of entrepreneurs and included provisions for granting new opportunities to those that have failed in their entrepreneurial venture. The law has implemented a legal status of 'Limited Liability Entrepreneur' (*Emprendedor de Responsabilidad Limitada*) and 'Progressively Formed Limited Liability Company' (*Sociedad Limitada de Formación Sucesiva*); has reduced the time for creating a limited liability company; and has created an extra-judicial payment mechanism in order to grant entrepreneurs a second chance. These changes appear to have improved the ease of starting a new business in the country, and have consequently improved Spain's ranking, from 115th last year to the current ranking of 74th (WB, 2014). Spain has also significantly reduced the number of procedures and days necessary for starting a new business, from 10 to 6 and from 23 to 13, respectively, over the last two years (WB, 2014). However, the country's score on the strength of the insolvency framework has not changed over the same period: Spain stills scores 12 in a range of 0–16. Regional differences are important in Spain with regard to the ease of starting a new business. Spanish entrepreneurs face different regulations depending on the regional locations of the business entity. According to 'Doing Business in Spain' (WB, 2015), La Rioja and Madrid rank first, while Aragon and Galicia are at the bottom of the ranking with regard to the ease of starting a new business. All the Spanish regions are below the European average on the easiness of starting a new business (WB, 2015).

5.2 Young innovative companies and start-ups

Several policies and funding schemes are targeted at young innovative companies to help them to commercialise ideas rapidly and promote their internationalisation. The NEOTEC programme targets, in particular, young innovative companies of less than four years old. In addition, the new programme 'PYME Horizon' might help young companies to internationalise their activities, as it targets companies that have already applied to a Horizon 2020 call (see section 3.5.1). However, this programme is not exclusively targeted at young innovative companies.

Support measures for SMEs targeted at industries with a growing market are offered through the 'CDTI Eurostars International interfirm cooperation programme' (which funds 15 projects), as an SME must lead the project; 'CDTI Global innovation direct line' for SMEs (which funds 12 projects); and the new 'CIEN Strategic private consortia for innovation' (which funds 21 projects).[111] However, some of these programmes fund a small number of projects (e.g. NEOTEC grants offer funding for a total of 50 projects).

Policies and instruments to encourage cooperation and knowledge sharing and to create a more favourable business environment for SMEs exist. For example, the 'CIEN Strategic private consortia for innovation' requires that consortia include at least one SMEs among their members and that consortia collaborate with public research centres, which aims to increase cooperation and knowledge sharing.

[111] In addition, FOND-ICO was established on 2013 and is a Spanish public venture capital fund that aims to promote privately managed venture capital for Spanish companies at different development stages.

5.3 Entrepreneurship skills and STEM policy

One of the strengths of the Spanish R&I system lies in its human resource base. The level of tertiary education attainment in Spain is above the European average (42.3 % of the population aged 30–34 in Spain versus 37.9 % of the EU population in 2014) (Eurostat, 2015). The number of doctorate graduates is also increasing (see section 4.4.4). However, increasing unemployment levels among the highly educated and the unattractive labour market for researchers might worsen the human resource base.

Policies to ensure a sufficient supply of postgraduates in science, technology, engineering and mathematics (STEM) fall into the general programme of supply of human resources for science and technology. Data on the number of graduates in 'Engineering and Architecture' and 'Science' have decreased over the last decade (the former field by 24.6 % and the latter by 24.9 % between 2003–2004 and 2013–2014) (MEDU, 2015). The appropriate mix of skills among the population (including strong vocational and education and system skills) in the medium to longer term is difficult to assess, but, in more general terms, it is recognised that there is a mismatch in skills and the areas of scientific specialisation (ERAC, 2014).[112]

The Bologna Process has improved the focus of education and training curricula on equipping people with the capacity to learn and develop transversal competences, such as critical thinking, problem solving, creativity, teamwork, and intercultural and communication skills (MECES, 2014). However, this process was implemented with a low degree of consensus among stakeholders and a small budget for its enactment (Tarrach et al., 2011; MEDU, 2013a), which might have reduced its effectiveness in incorporating these aspects. ANECA evaluates the education and training curricula through the programme VERIFICA and by applying the 'Spanish Qualifications Framework for Higher Education' (MECES) within the 'Framework for Qualifications of the European Higher Education Area (FQ-EHEA) (MECES, 2014). Increasing the adaptation of PhD programmes to EHEA might indicate a positive trend with regard to the development of transversal competences (see section 4.4.4)

COTEC reports (2011, 2012, 2014a, 2015) appear to indicate an increase in the innovative culture of universities and research centres.[113] However, improvements in the curricula of universities and the evaluation of innovative activities of researchers appear to be necessary (ERAC, 2014).[114] The new Entrepreneurial Support Act might help to increase entrepreneurial activities, for example by reducing the time and administrative procedures required to create a new business (see section 2.2). The Entrepreneurial Support Act also includes training aspects, but these are not pre-eminent. Human resources policies on private R&I focus on the hiring of staff with PhDs and R&I managers, leaving the training in the private sector to other policy areas.

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[112] The ERAC report attributes this mismatch to the different attainment of education and the publications and patents by fields. Spain 'displays at the same time a very high share of its population having achieved ... tertiary level education (40% against 34.7% for the EU) and another share of the population having only attained lower secondary education level (25% against 12.5%)' (ERAC, 2014: 17). It also has a mismatch in all the scientific and technological fields except for food and agri-food, and health.

[113] For example, 43.8 % of experts interviewed consider that researchers and technicians are increasingly aware of the need to provide more market-oriented research (COTEC, 2014a: 137). However, the financial crisis has caused experts' opinions to evolve negatively with regard to the general trends of the Spanish innovation system for companies and public administration (COTEC, 2014a: 139).

[114] For example, policy documents establish a suitable agenda that needs to be accelerated. In addition, there is currently a lack of recognition of these entrepreneurial activities for the career development of researchers.

5.4 Access to finance

EVCA (2013) reported that the Spanish fund structure and investment vehicles are characterised by a structure led by Sociedad de Capital Riesgo (SCR) and Fondo de Capital Riesgo (FCR) with no domestic and non-domestic transparency; no permanent establishment tax; undue restrictions; no VAT on management fees; a 0.30 % capital gains tax;[115] a 0 % withholding tax; a requirement for stamp duties, but not transaction taxes; anti-abuse rules; a 30 % company tax rate; a special tax regime for SMEs; limited related-party loans interest deduction; limited unrelated-party loans interest deduction; a 24.35 % minimum and a 51.9 % maximum income tax; social security between a minimum of EUR 391.68 and a maximum of EUR 1 276.07;[116] a capital gains tax that ranges from 21 % to 27 %; and a tax on stock options from 24.35 % and 51.9 %, with special tax regimes (EVCA, 2013).

According to the same report, Spain has fiscal incentives for investors, fund managers, business R&D expenditure, and R&D capital expenditure, contracting researchers, technology transfer and cooperative external research, but not for innovative spin-off and young and innovative companies (EVCA, 2013). The Entrepreneurship and Internationalisation Support Act (Law 14/2013) has improved some of these conditions by improving the tax incentives for investments in entrepreneurs (e.g. including tax incentives for companies that re-invest their benefits or tax incentives in new business investments) (see section 2.2). Spain approved Law 5/2015 on private funding encouragement on 28 April 2015; this law includes legislation on investment crowdfunding platforms (lending and equity crowdfunding). It should be noted that this may considerably restrict the crowdfunding investment market (See RIO Country Report 2014).[117]

The investments in risk capital, including seed capital, start-up funds and funding for other stages of the business creation, amounted to EUR 975 million in 2014 and represented less than 0.1 % of the Spanish GDP, which is lower than the 2014 European average of 0.3 % (Eurostat, 2015). This investment has decrease significantly since 2010, when it reached its peak (EUR 2 480 million), but 2014 showed some positive signs with a yearly growth rate of 26.9 % (Eurostat, 2015). Data detailed by stages of development indicate that most (78 %) of this funding goes to buyouts, 4.4 % to later-stage venture capital, 4.2 % to the start-up stage and 0 % to seed stage capital (Eurostat, 2015).

The investment in risk capital might indicate that early stage investments in Spain are, to a certain extent, limited.[118] Diverse programmes exist that cover the entire value creation chain and some new programmes have been recently launched (see section 2.5), but it appears that funds for young innovative firms are limited, dispersed and technologically oriented. For example, the NEOTEC initiative funded 50 projects, which is a relatively small number for a country the size of Spain (ERAC, 2014) and this initiative focuses on 'Technology Based Companies'. The new 'Pyme Horizon' programme might provide new funds to enable growth of start-ups. In Spain, there were about 54 networks and groups of 'Business Angels' in 2009 (OECD, STI Scoreboard 2011).

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[115] Spanish law establishes a 99 % tax exemption for capital gains. The remaining 1 % is taxed at the company tax rate of 30 %.

[116] These figures are an approximation of the total contribution to social security to be paid by the employer in the event of (i) an employee in the category of engineer and university graduate, (ii) economic activity of office work and (iii) no extraordinary hours being worked by the employee. The employee's contribution is deducted from their gross salary.

[117] It limits the amount allowed per private investor per project (EUR 3 000 for incomes lower than EUR 50 000 per year) and platforms (EUR 10 000 per year), as well as the quantity that a firm can raise through this mechanism (EUR 2 million). It also sets important limitations to this type of platform (e.g. setting an initial capital of EUR 60 000, annual administrative costs of more than EUR 3 000).

[118] Although an upward trend have been pointed by ASCRI in 2014.

Since 2006, there have been various initiatives to promote Business Angels in Spain. For example, some autonomous communities (Madrid, Catalonia, Galicia and Navarre) have introduced fiscal support measures, but these are of limited scope because of the conditions and restrictions on the maximum amount to be tax deductible (EUR 4 000 in Catalonia, which was then increased to EUR 6 000). At the national level, in July 2011, the government introduced a favourable tax treatment for tax on capital gains from investment in newly created companies. In particular, the capital gains generated by the transfer of shares or units in such initiatives are exempted from tax if the investment is in new or recently created companies (there is exemption from tax on capital gains from the sale of shares whose value does not exceed EUR 25 000 per year).

The Entrepreneurial Law adopted in December 2013, fosters entrepreneurship via fiscal incentives (e.g. for 'Business Angels', the re-investment of profits, changes to Patent Box), lighter bureaucracy, support for international expansion and the creation of a limited personal liability regime.

5.5 R&D related FDI

Spain was the second largest recipient of FDI and the fifth largest investor in the EU in 2014 (UNCTAD, 2015). Following the global and European decline over recent years, FDI inflows in Spain decreased from $41 733 million in 2013 to $22 204 million in 2014. The number of greenfield investments declined by 3.6 % during the same period, reaching a figure of 371. Spain was also the third most promising home economy investor for FDI in 2014–2016 in Europe. Volumes of R&D-intensive FDIs are not available. The information and communication technologies field appears to be one of the most appealing research fields for FDI (Santander, 2015).

The generous Spanish tax incentive portfolio for R&D could attract FDI. Social security bonuses for full time R&I personnel and fiscal incentives for R&I projects could be considered as one of the country's strengths in terms of FDI (see section 3.5.2). Similarly, increasing multilateral and bilateral cooperation R&I agreements (see section 4.3) might attract FDI. The new roadmap of R&I infrastructures could be an opportunity to attract either greenfield or brownfield FDI.

5.6 Knowledge markets

LCTI 2011 has changed the regulation of the ownership of intellectual property rights (IPRs) produced by the staff of university and OPIs. It modifies the previous Law of Sustainable Economy (Law 2/2011) to allow researchers to profit from their patent earnings. It is difficult to judge whether the system is efficient, affordable and effective, as support might change across research institutions and regions. The LCTI allows regions to develop their own regulations for researchers working in research public institutions under their administrative control, such as, universities.

The Entrepreneurship and Internationalisation Support Act (Law 14/2013) published on 27 September 2013 aims to improve the training of entrepreneurs by encouraging creativity at different educational levels (Chapter 1; Articles 4, 5 and 6).

EECTI (2013–2016) includes, as an articulation mechanism (number 5), the harmonisation of criteria and practices of ex ante and ex post evaluations and aims to improve collaboration between administration and the private sector to eliminate regulatory barriers. However, it does not specify a screening process of new or existing regulations with regard to their impact on innovation.

In 2014, Law 21/2014 improved the protection of IPRs through a reform of the Codified Text of the Law on Intellectual Property Rights. It envisages the creation of 'one-stop-shop' for managing IPRs, which should facilitate the online payment of IPRs. It also aims to increase transparency in the entities that manage IPRs, by promoting competition and allowing new operators to enter this market, and to transpose some EU directives onto the Spanish legal system (Directive 2011/77/EU, amending Directive 2006/116/EC on the term of protection of copyright and certain related rights). In 2015, Law 24/2015

was passed, which aims to simplify the procedure for registering and granting a patent. This law will enter into force in April 2017.

Because of objections to the requirement that translations should be in only English, German and French, Spain has neither signed nor ratified the European Agreement on the Unified Patent Court, and no publicly available specific policy measures appear to be applied to support the use of the Guidelines on Horizontal Cooperation Agreements regarding standard setting. However, legislation appears to be applied as judged by the court ruling on decisions based on the agreement. The 'Technology Platforms' (before INNFLUYE) programme might be considered as an instrument to develop knowledge markets for patents and licencing. Similarly, the 'Collaboration Challenges' programme is also an instrument to develop knowledge markets. However, the 'Technology Platforms' programme is not envisaged for 2015.

5.7 Knowledge transfer and open innovation

5.7.1 Knowledge Transfer Indicators

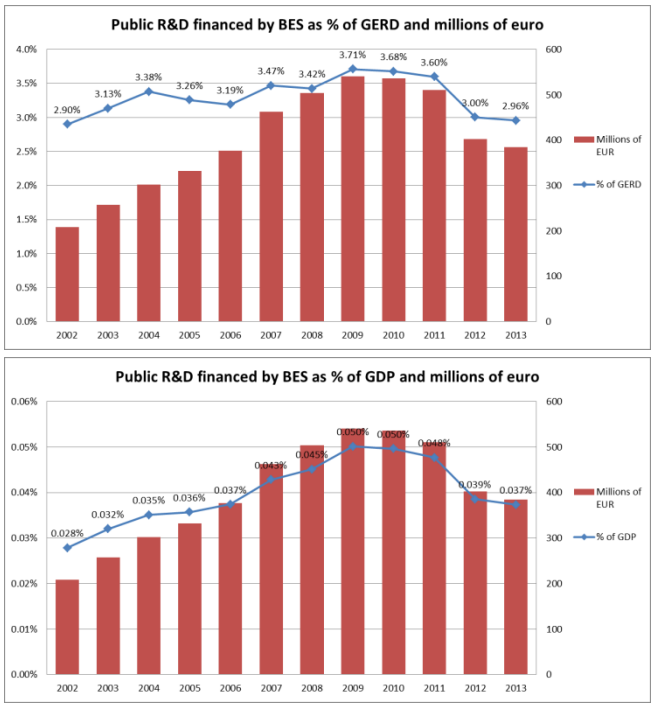


Figure 14. BES-funded public R&D in Spain as a percentage of GERD (in million EUR) and as a percentage of GDP

The level of Spanish BES-funded public R&D expenditure as a percentage of GERD increased between 2002 and 2004, then decreased until 2006 and returned to a general growth trend until 2009; it constantly decreased between 2009 and 2013.

The indicator expressed as a percentage of GDP shows an upwards trend from 2002 until 2009. It then decreased until 2013, at which time it reached a value of 0.037 % of GDP.

In both cases, the decrease from 2009 stems from the economic crisis that severely affected the Spanish R&I system and economy.

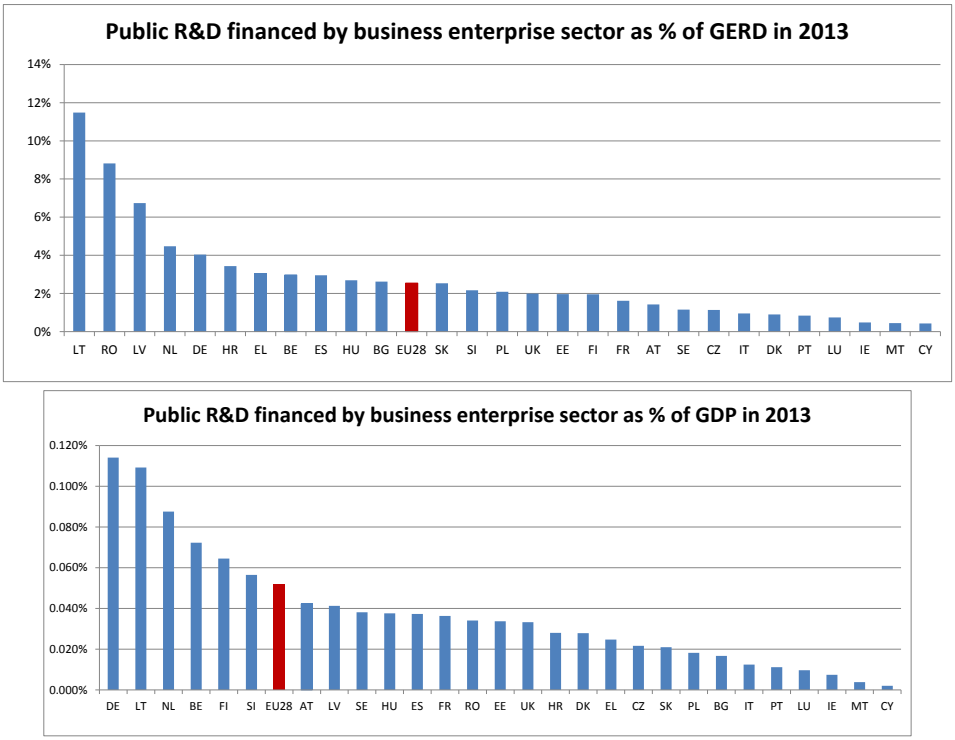


Figure 15. BES-funded public R&D as a percentage of GERD and as a percentage of GDP in 2013 in Member States

The two charts in Figure 15 show the values of BES-funded public R&D in all EU-28 as percentages of GERD and GDP, respectively.

Spain's levels are slightly above the EU-28 average for publicly funded R&D financed by BES as a percentage of GERD. If expressed as a percentage of GDP, it is below the EU-28 average.

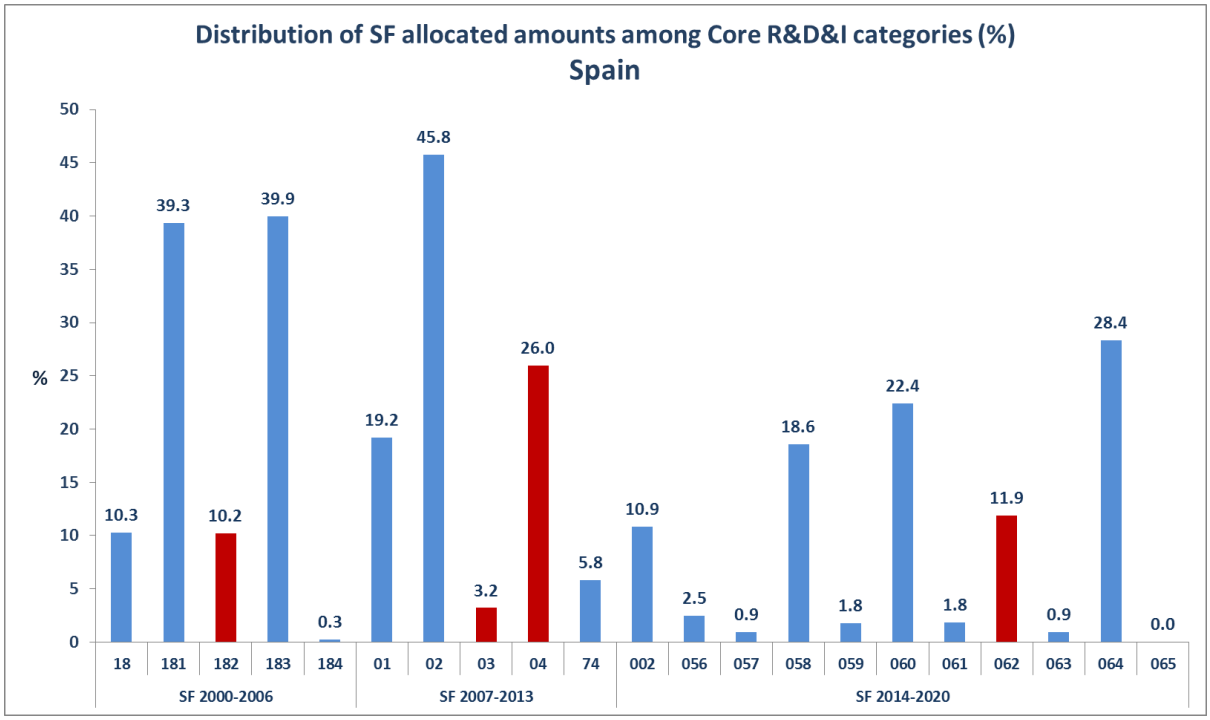


Figure 16. Structural Funds for core R&D activities for 2000–2006, 2007–2013 and 2014–2020. We use the categories 182 (2000–2006), 03 and 04 (2007–2013) and 062 (2014–2020) as proxies for Knowledge Transfer activities.

Spain has allocated 11.9 % of its structural funds for core R&D activities to 'Technology transfer and university-enterprise cooperation primarily benefiting SMEs' for the 2014–2020 period (compared with 10.2 % for the 2000–2006 and 29.2 % for the 2007–2013 programming periods). This allocation is lower than the EU average of 15.7 % (the EU average was 26.1 % in 2000–2006 and 30.1 % in 2007–2013).

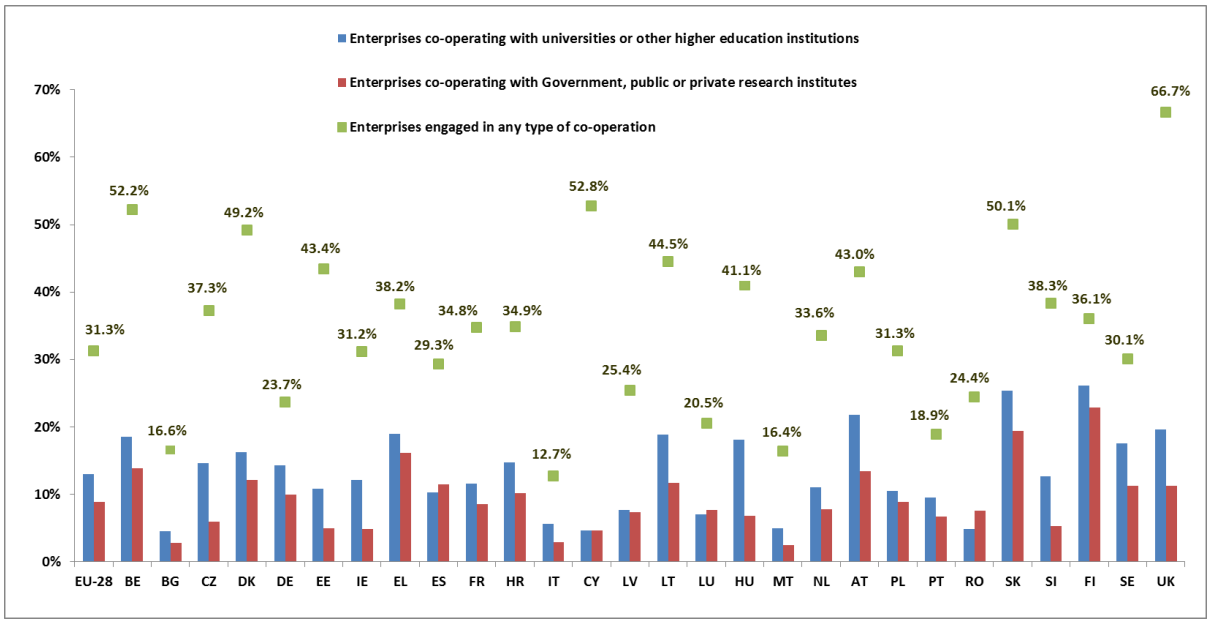


Figure 17. CIS survey 2012 – proportion of enterprises cooperating with academia

Figure 17 depicts the level of cooperation activities of innovative companies in the EU-28, according to the CIS (2012). In Spain, 29.3 % of innovative companies engaged in

any type of cooperation with public or private partners (green dot in Figure 17),[119] which is just below the EU average (of 31.3 %). One-third of these companies (i.e. **10.3 % of the total sample of innovative companies**, as shown by the blue bars) cooperate with universities and HEIs (EU average: 13.0 %). A bit more – **11.5 % – cooperate with government or public or private research institutes (red bar).**

Cooperation: technology transfer offices, incubators and technological parks

In 2013, Spain disposed of 40 technology transfer offices (TTOs or technology platforms)[120] and 68 science and technology parks.[121]

Proportion of public–private co-publications

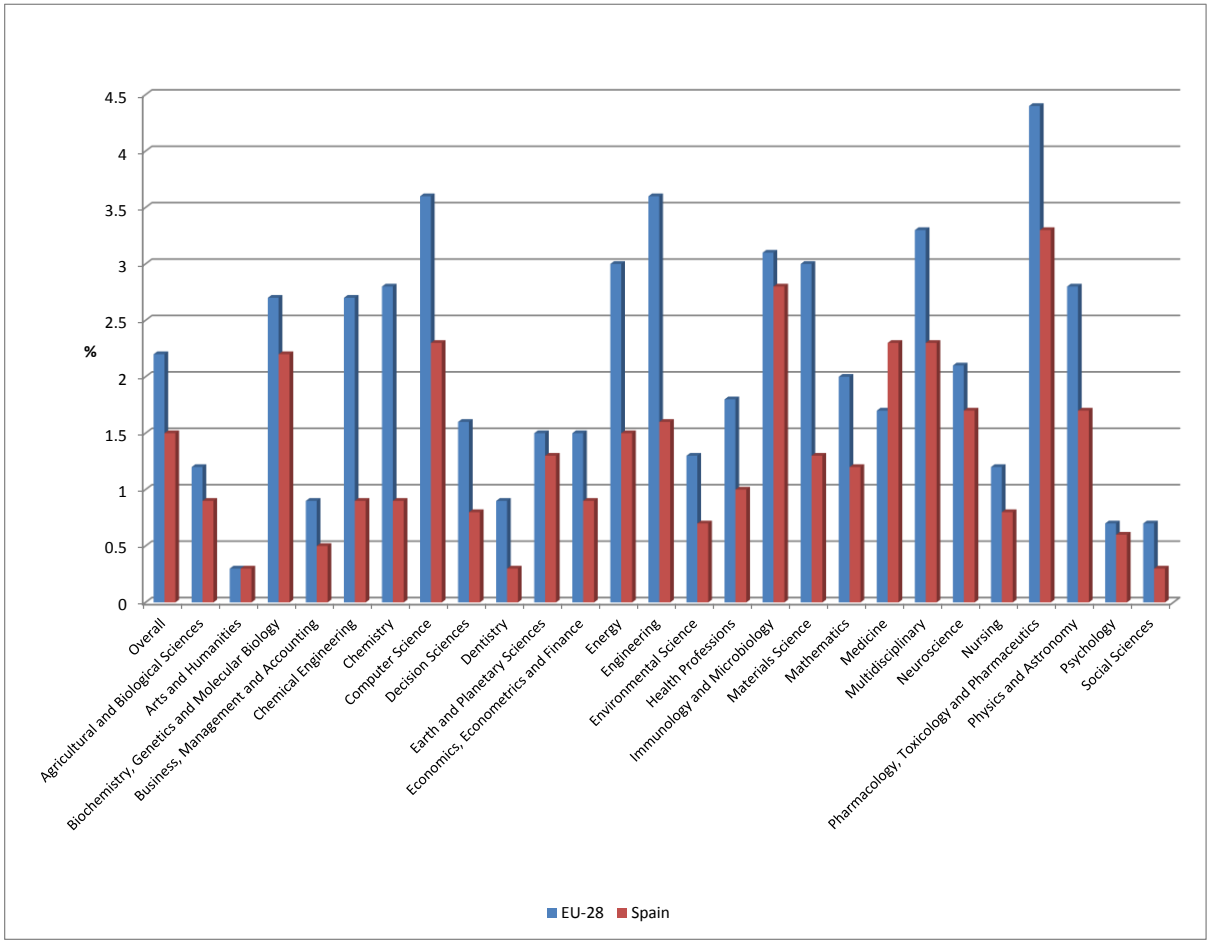


Figure 18. Co-publications by field for 2003–2013 in Spain. Source: Scopus database

Figure 18 shows the 2003–2013 average percentage of academia–industry co-publications by field in Spain compared with the European average. The total proportion

[119] These partners include other enterprises within your enterprise group; suppliers of equipment, materials, components, or software; clients or customers from the private sector; clients or customers from the public sector; competitors or other enterprises in your sector; consultants and commercial labs; universities or other higher education institutions; government, public or private research institutes.

[120] http://www.idi.mineco.gob.es/stfls/MICINN/Innovacion/FICHEROS/Listado_plataformas_tecnologicas_espanolas.pdf

[121] According to the Association of Science and Technology Parks of Spain, http://asp-es.secure-zone.net/v2/index.jsp?id=5766/10010/30097&lng=es

of co-publications, displayed by the red 'overall' bar on the left of the chart, is 1.5 %, which is below the EU-28 average of 2.2 %.

Spain is generally improving its knowledge flows between the public and the private sector. The number of public–private co-publications per million of population increased from 23.89 in 2009 to 24.6 in 2013 (29 for the EU-28).[122] The domains with the highest percentage of co-publications are '**Pharmacology, 'Immunology and Microbiology', 'Computer Science' and 'Medicine'.** Despite this positive trend, decreasing public and private funding for R&D over recent years might reduce the opportunities for Spain to further increase knowledge transfer levels up to the European average (see section 3.5.1).

Cooperation: patenting activity of PROs and universities together with licensing income

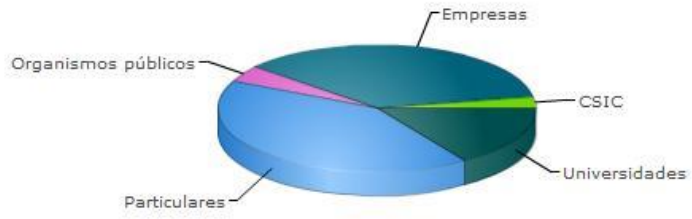


Figure 19. Proportion of institutional of patent applications in Spain, 2014[123]

In 2014, 505 patent applications were filed by universities (17.4 % of all patent applications in Spain), 91 by the CSIC (i.e. 3.1 % of all patent applications) and 81 by other public institutions (2.8 % of all patent applications).[124]

According to the Knowledge Transfer Study, in 2011–2012 Spain was below the EU average in terms of number of licence agreements per 1 000 research staff (2.7/1 000 versus 6.5/1 000, respectively).

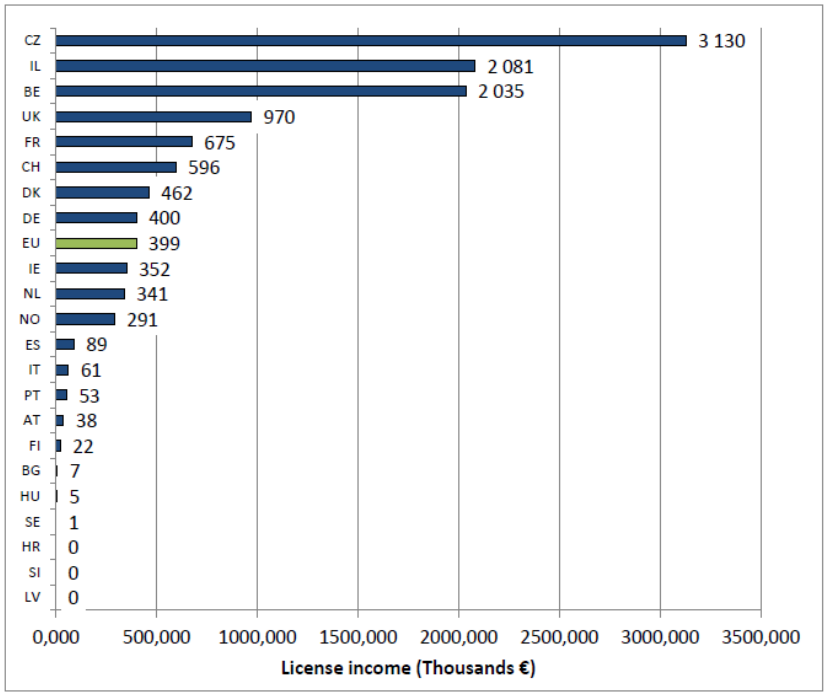
Similarly, Spain was below the EU average with regard to the number of research agreements per 1 000 research staff (72.7/1 000 versus 82.8/1 000, respectively).

The number of patent grants per 1 000 research staff was 3.0 in Spain, below the EU average (of 4.5).

With regard to the licence income per 1 000 research staff, Spain is well below the EU average ((EUR 89 000 versus EUR 399 000, respectively).

[122] RIO elaboration based on Scopus data.
[123] Source: Oficina Española de Patentes y Marcas, http://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=115
[124] http://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=115

Exhibit 3-35: Thousands Euros of license income per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 20. License income per 1 000 research staff by country. Source: EKTIS 2011–2012 survey

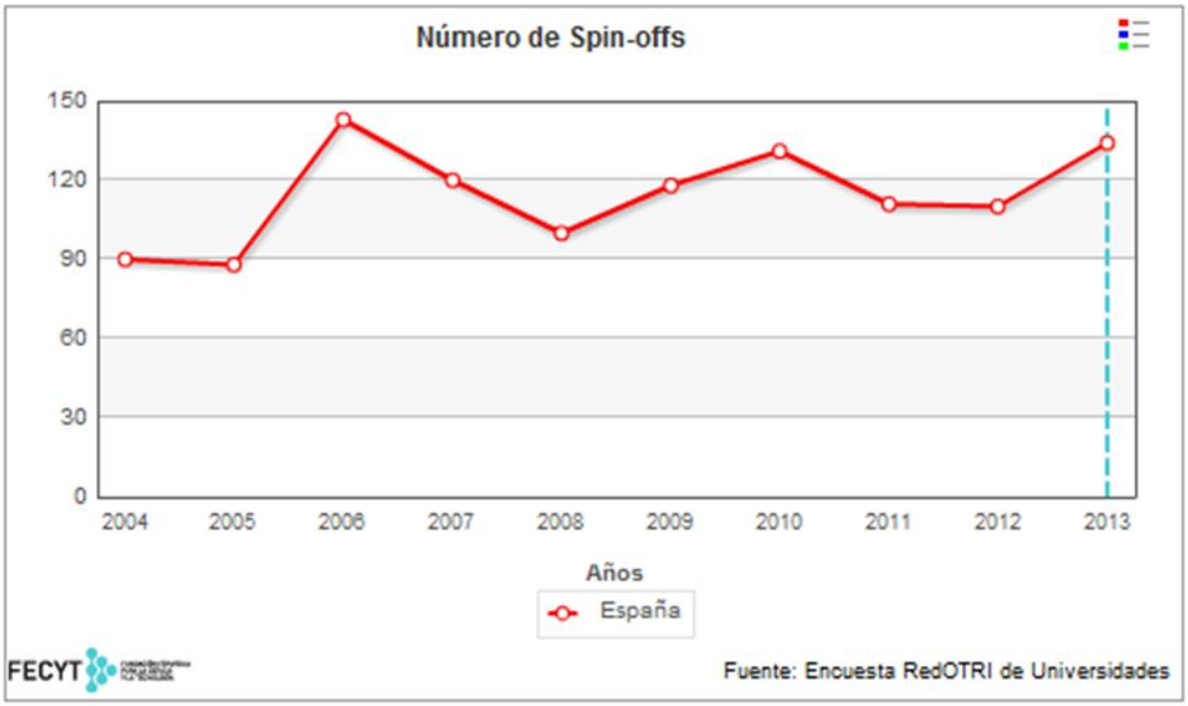


Figure 21. Evolution of the number of spin-offs in Spain[125]

[125] Source: FECYT. http://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=122

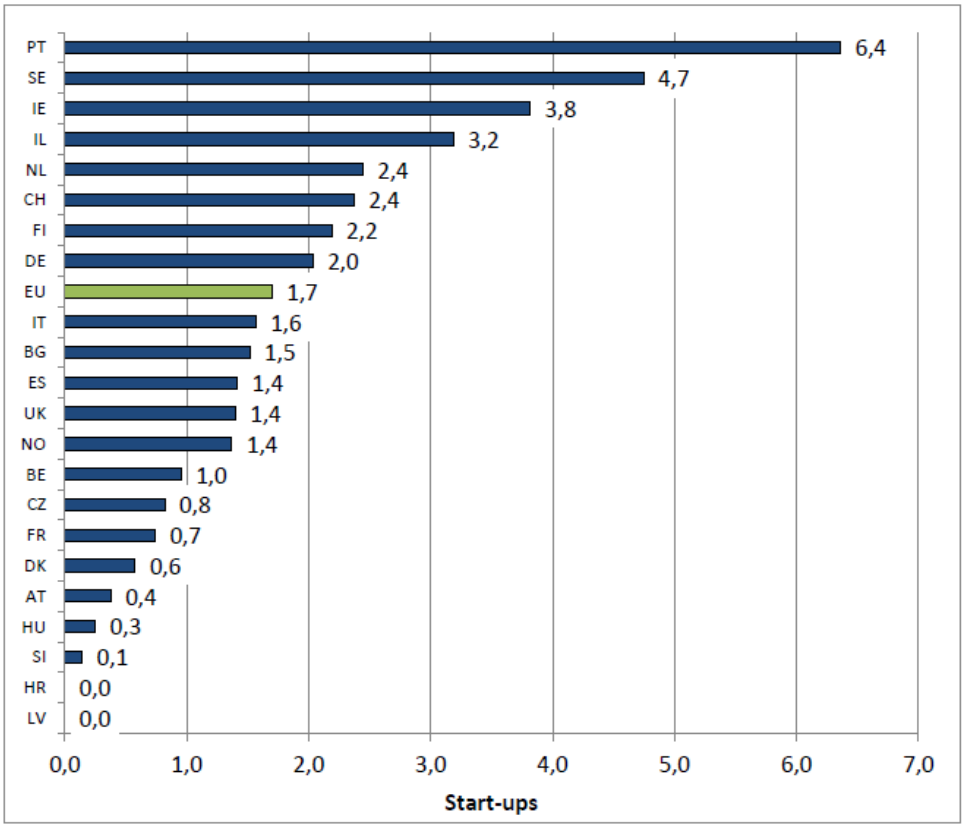
Table 10. Researchers involved in spin-off creation[126]

Year	2006	2007	2008	2009	2010	2011	2012	2013
Total Spain	215	197	185	350	259	201	132	198

The Spanish observatory of R&D policies identified 134 spin-offs in Spain in 2013. A total of 198 researchers were involved in their creation.

The creation of spin-offs has been encouraged by EECTI (2013–2020) and PECTI (2013–2016). These documents follow previous efforts (e.g. INGENIO 2010, the National Plan for R&D (2008–2011) and e2i) to encourage intersectoral collaboration, knowledge transfer and the creation of TBEs; the promotion of R&D projects in general and more specifically public–private cooperation in long-term strategic projects (e.g. the sub-programme of collaborative R&I); policies to foster human capital, such as the incorporation of PhD holders into the private sector; offering extra financial support for R&I in general and specifically for risk capital, paying attention to societal challenges and public procurement for the acquisition of innovative goods and services.

Exhibit 3-33: Number of start-ups per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 22. Number of start-ups per 1 000 research staff by country. Source: EKTIS 2011–2012 survey

[126] http://icono.fecyt.es/indicadores/Paginas/default.aspx?ind=123

5.7.2 Policy Measures

Spain has designed a large number of support schemes to foster R&D cooperation and knowledge transfer. These programmes aim to improve the level of public–private collaboration, which is considered low (OECD, 2006; COTEC, 2012, 2015). Public funds for innovation and knowledge transfer are mainly included in the 'Business leadership programme' of PECTI (which represents 21 % of the provisional budget for 2015). It includes three sub-programmes: (1) 'Private R&I'; (2) 'Enabling technologies'; and (3) 'Collaborative R&I'. The 'Collaborative R&I' sub-programme, through the 'CIEN Strategic public–private consortia for innovation', receives a significant percentage of total public budget (5.3 % of the provisional budget for 2015) (see RIO Country report 2014 for specific instruments in previous programmes).

Some relevant instruments for promoting knowledge transfer and open innovation are the 'Collaboration Challenges: R&I projects' for cooperative projects (20.4 % foreseen budget for 2015); the EMPLEA and Torres Quevedo programme, for hiring R&D managers and PhDs in the private sector (3.6 % and 0.5 % foreseen budget for 2015); EQUIPA (Technology parks) (foreseen budget for 20 for 2014); NEOTEC (New Technology Based firms) (0.4 % for 2015); the 'Innovative Companies Associations and Clusters' (AEI) Programme; 'Technology platforms' programme[127] (EUR 5.5 million for 2014) (see section 3.5.1 and Annex 4).

LCTI 2011 introduced several changes in order to improve the mechanisms of knowledge transfer: (1) increasing the value of transfer activities (e.g. by detecting research groups whose knowledge could be applied or by increasing the role of OTRIs); (2) promoting the 'units of excellence' (Art. 33.1); and (3) developing an OA archive with research results. It encourages the creation of TBEs by allowing researchers to work part-time in private firms created by the organisations in which they are working and by eliminating restrictions on the maximum share ownership of a private company (10 %) and the restrictions on being a board member in private companies. However, academics engaged in cooperation with industry are not usually rewarded. Access to an academic career and career promotion are based mainly on traditional research output indicators.

Open innovation is mentioned in EECTI (2013–2020) within priority axis 5.) – knowledge transfer and management. It states that 'open innovation involves different internal and external agents, includes new management of property rights, knowledge value and all intangibles of the knowledge process' (p. 34). It considers that in order to achieve this, measures should be directed towards (1) detecting innovative research and technology; (2) developing tools for business intelligence and the dissemination of results; (3) defining a way to protect knowledge and results from research to facilitate knowledge sharing and usage; (4) establishing efficient mechanisms for technology transfer and commercialisation; (5) promoting public–private partnerships and research mobility between sectors; and (6) including professionals of R&D management in the public and private system. The support schemes mentioned above implement, through PECTI, this agenda, which was defined by the EECTI strategy on knowledge transfer and open innovation.

Intersectoral mobility is encouraged through the 'Industrial PhD programme' and the abovementioned 'Torres Quevedo programme' for hiring PhD graduates in industry. The LCTI facilitates intersectoral mobility mechanisms for researchers working in the public sector with permanent contracts, as well as the creation of university spin-offs (see section 2.2 and Annex). EQUIPA provides funds for technology parks (see above).

[127] Not included in the working plan for 2015. In addition, Technology Transfer Offices had been funded through the INNCIDE programme of the previous national plan (2008–2011).

5.8 Regulation and innovation

MINECO and the CDTI have undertaken some studies on the efficiency and use of the tax deductions in Spain (e.g. MINECO, 2012, 2014b; CDTI, 2014b). These studies show that firms might face problems accessing information on R&D tax incentives, perceiving the process as complex and uncertain. Large firms appear to be more able to benefit from tax deductions than SMEs (MINECO, 2011). In addition, MINECO (2014b) indicates that large companies and SMEs increasingly use 'motivated reports', which were introduced to reduce uncertainty (see section 3.5.2). However, other specific policy actions at national level to assess the impact of regulation on innovation appear to be missing. COTEC (2014b) reviews the available literature and empirical evidence on the impact of the regulation on innovation. However, these refer to studies carried out in other countries. Sanchez Granados (2012) finds some evidence on the consequences of the RD 1432/2003 that regulates the 'Informes Motivados' on tax deductions. Sanchez (2012) relates the increase in SMEs reporting R&I activities to the increase in transparency on tax control. This study also reports an increase in the information available on R&I company activities and on consultancy services.

5.9 Assessment of the framework conditions for business R&I

In order to assess to what extent the framework conditions in place are conducive to business investment in R&I, this section reviews the Spanish R&I system following the criteria defined by the Innovation Union self-assessment tool.

(1) Firstly, in Spain, the promotion of R&I is formally considered a key policy instrument to enhance competitiveness and job creation, address societal challenges and improve quality of life (see EECTI or the NRPs 2013, 2014 or 2015), but this formal policy discourse has been set back by the severe public budget cuts and by the lowering of the target of R&D per GDP (see section 2.1).

(2) Secondly, the design and implementation of R&I policy are based on a multiannual strategy with policy measures increasingly targeting and exploiting current or emerging national/regional strengths within an EU context. For example, this is done through the implementation of the RIS3 strategies (see section 2.4). However, this design and implementation policy framework is challenged by the lack of coordination between national and regional R&I policies and the small role of the evaluation tools (see section 2.2).

(3) Innovation policies are increasingly pursued and in a broader sense, but innovation is still conceived as mainly technologically driven (see section 5.2). The level of innovation culture is low, but is increasing among research actors (see section 4.4). Supply-and-demand-related policies could be developed in a much more consistent manner (see sections 4.4 and 5.1).

(4) The predictability of the framework for public investment in R&I is limited (see section 3.1). Private investment is increasingly encouraged (see sections 3.5 and 5), but the limited role of strategic management and evaluation policy systems reduces the efficiency and effectiveness of these instruments and their synergies with other policy initiatives. For example, innovative financing solutions are implemented (e.g. public–private partnerships), as well as tax incentives, but their use is not sufficiently evaluated (see section 3.5.2).

(5) Excellence is formally a criterion for research and education policy, but is not sufficiently considered when allocating funding to researchers and research institutions, or ensuring the career development of researchers (see section 4.4).

(6) The mix between education and training skills provided by the system could be improved. For example, the increasing unemployment among PhD holders and the decreasing labour market for young researchers shows significant imbalances between supply and demand (see section 4.4.1). Education and training is increasingly aimed at developing transversal competences (see section 4.4.4).

(7) Partnerships between HEIs, research centres and businesses, at regional, national and international levels are increasingly promoted, but mobility levels between the public and private sector are low (see section 5.7).

(8) Framework conditions for the promotion of business investment in R&D, entrepreneurship and innovation are facilitating a move towards a better connection, but the role of non-technological innovation and the involvement of SMEs in the R&I system needs to be improved (see section 5.6).

(9) Public support for R&I in business is not simple, not easy to access and not of a high quality. The support schemes are high in number, not clearly differentiated and difficult to access. Funding support is not tailored to the needs of SMEs. The emphasis is placed on the inputs and controls rather than on the outputs, the amount of bureaucracy is high, payments are often delayed and funding schemes are not regularly evaluated (see section 2.2.1).

(10) The public sector itself might improve its role in being a driver of innovation. Despite the increasing role of public procurement and the encouragement towards open data (see section 4.5), public funding for R&I declined significantly in total and relative terms after the financial crisis, indicating that R&I funding has not been used as a counter-cycle mechanism to overcome the financial crisis (see section 3.1).

6. Conclusions: meeting the structural challenges

The main weaknesses and opportunities with regard to increasing the level of performance of the Spanish R&I system are presented across five structural challenges (Table 11). The identification of these challenges is based on previous studies (OECD, 2006; ERAWATCH, 2009; EC, 2011a, 2014; ERAC, 2014), and recent policy documents (e.g. EECTI) and measures (see Table 12 in Annex i for challenges identified by the OECD, EECTI and ERAC evaluation documents).

Table 11. Five main structural challenges of the national R&I system

Challenges/opportunities	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
Improving the public labour market for researchers	Regulatory measures to correct the public deficit (e.g. Royal Decree-Law 20/2011) have limited staff recruitment and the filling of positions left vacant by retirees to 10 % over recent years. These were increased to a maximum of 50 % for 2015 and 100 % for 2016 LCTI (2011) measures on human resources. PECTI measures on human resources.	Spain has a dual labour market. Limited actions to make it more flexible and establish additional measures have created the most pressing problem of the Spanish R&I system (ERAC, 2014). The implementation of some new figures envisaged by LCTI (2011) has been limited (e.g. contracts 'for distinguished researchers or scientists of great prestige'), which indicates low efficiency and effectiveness in the implementation of the policy measures aimed at changing the dual market for researchers. The small size and fluctuation trend for some programmes for human resources have reduced the efficiency and effectiveness of existing measures (e.g. Ramón y Cajal) that could have alleviated the negative consequences of the financial crisis for young researchers. Unemployment levels and some indications of a brain-drain problem suggest that some additional measures to address the situation for young researchers should have been envisaged.
Improving funding and governance of the public research system	LCTI 2011 includes mechanisms to improve the governance system. EECTI (2013–2020) and PECTI (2013–2016) offer a policy framework for the R&I Spanish system. RIS3 strategies might help to increase R&I funding and to coordinate national and regional efforts to address structural changes .	Measures envisaged to improve the governance system could be considered as limited as they have failed in providing a sustained and sustainable policy framework. Public Budget cuts in R&I threaten to aggravate existing structural challenges and to set back the progress achieved in previous years. The high levels of non-executed budget and the increasing role of loans diminish the strengths of the R&D system (e.g. international publications). The low execution rate of R&I budgets (about 55 %) indicates that the policy mix needs to be improved. Crucial measures to improve the governance of the research system have been delayed (e.g. the creation of the AEI), which indicates a lack of effectiveness or coordination in the governance structure.

Promoting the culture for innovation and stimulating performance in business R&D and innovation	The role of innovation in the policy mix has increased. LCTI 2011, EECTI (2013–2020) and PECTI (2013–2016) also address these challenges. The new Entrepreneurship and Internationalisation Support Act (Law 14/2013) aims to improve finance for entrepreneurs and reduce the administrative burden for starting a new business. New policy measures to increase public–private cooperation and knowledge transfer have been undertaken. New policies targeting SMEs have been designed.	The results appear to be positive although more studies on the efficiency of these programmes seem necessary. COTEC reports appear to indicate an increase in the innovative culture of universities and research centres. However, improvement in the curricula of universities and evaluation of innovative activities of researchers appear to be necessary. The new Entrepreneurial Support Act might help to overcome these limitations. In addition, the new programmes targeting SMEs and encouraging public–private cooperation and knowledge transfer might help to address this challenge.
Stimulating regional R&I potential and performance	The Law of Science, Technology and Innovation (LCTI 2011) aimed at improving national and regional coordination through the Council of Science, Technology and Innovation (CPCTI). Research and Innovation Strategies for Smart Specialisation (RIS3).	Regional differences have persisted over time. However, RIS3 strategies have been conceived in a reasonably systematic manner taking the strengths of the regions into consideration. This could offer an opportunity to improve national and regional coordination and to align research agendas.
Promoting effective policy evaluation mechanisms	Law LCTI (2011) EECTI (2013–2020) ANECA	R&D indicators are increasingly available. However, the evaluation culture is limited as it ranges from a cumbersome fiscal control to a report of the policy instruments implemented without generally taking into account efficiency and ex ante and ex post mechanisms.

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Abbreviations

AEI Spanish Research Agency Agencia Estatal de Investigación

AEVAL Spanish Agency for Evaluation Agencia de Evaluación y Calidad

AGE National State Administration Administración General del Estado

ANEP National Agency of Evaluation and Prospective Agencia Nacional de Evaluación y Prospectiva

ANIRC National Association of Ramón y Cajal Researchers Asociación Nacional de Investigadores Ramón y Cajal

BERD Business R&D Expenditures

CACTI Advisory Council of Science, technology and Innovation Consejo Asesor de Ciencia, Tecnología e innovación

CDCTI Executive Committee for Science, Technology and Innovation policy Comisión Delegada del Gobierno para Política Científica, Tecnológica y de Innovación

CDTI Centre for Industrial Development Centro para el desarrollo tecnológico Industrial

CIEMAT Research Centre for Energy, Environment and Technology Centro de Investigaciones Energéticas, Medioambientales y Tecnológicas

COSCE Spanish Confederation of Scientific Societies Confederación de Sociedades Científicas de España

CPCTI Council of Science, Technology and Innovation Consejo de Polítia Científica, Tecnológica y de Innovación

CRUE Spanish Conference of University Rectors Conferencia de Rectores de las Universidades Españolas

CSIC Spanish National Research Council Consejo Superior de Investigaciones Científicas

EECT Spanish Strategy for Science and Technology Estrategia Española de Ciencia y Tecnología (before ENCYT)

EEI -e2i Spanish Strategy for Innovation Estrategia Española de Innovación

EECTI Spanish Strategy for Science, Technology and Innovation Estrategia Española de Ciencia y Tecnología y de Innovación

ENCYT National Strategy for Science and Technology Estrategia Nacional de Ciencia y Tecnología

ERAC European Research and Innovation Area Committee

EU European Union

EW Erawatch

FECYT Spanish Foundation for Science and Technology Fundación Española para la Ciencia y la Tecnología

FEDIT Spanish Federation of Technology Centres Federación Española de Centros Tecnológicos

FJI Spanish Federation of Young Researchers Federación de Jóvenes Investigadores

FTE Full-Time Equivalent

GBAORD Government Budget Appropriations or Outlays on R&D

GDP Gross Domestic Product

GERD Gross Expenditure on Research and Development

GSTC General Council of Science & Technology

HEIs Higher Education Institutions

ICONO Spanish Observatory of R&D Observatorio Español de I+D+i

IEO Spanish Institute of Oceanography Instituto Español de Oceanografía

IGME Geological and Mining Institute of Spain Instituto Geológico y Minero de España

INE Spanish Institute of Statistics Instituto Nacional de Estadística

INIA National Institute for Agricultural and Food Research and Technology Instituto Nacional de Investigación y Tecnología Agraria y Alimentaria

INTA National Institute for Aerospace Technology Institutio Nacional de Técnica Aeroespacial.

ISCIII Carlos III Health Institute Instituto de Salud Carlos III

IWL Instumental Working line Líneas instrumentales de Actuación

LCTI Law of Science, Technology and Innovation Ley de Ciencia, Tecnología e Innovación

MDEF Ministry of Defence Ministerio de Defensa

MEC Ministry of Education Ministerio de Educación

MEDU Ministry of Education, Culture and Sports Ministerio de Educación Cultura y Deporte

MICINN Ministry of Science and Innovation Ministerio de Ciencia e Innovación

MINECO Ministry of Economy and Competitiveness (before MICINN) Ministerio de Economía y Competitividad

MINETUR Ministry of Industry, Energy and Tourism Ministerio de Industria Energía y Turismo

MINHAP Ministry of Finance Ministerio de Hacienda y Administraciones Públicas

NP Spanish National Plan for R&D and Innovation Plan Nacional de Investigación Científica, Desarrollo e Innovación Tecnológica

Np National programmes Pogramas nacionales

NRP National Reform Programme Programa Nacional de Reformas

OPIs Public Research Bodies Organismos Públicos de Investigación

PROs Public Research Organisations

PAA Working Plan Programa de Actuación Anual

PDI Platform for Dignifying Research Plataforma por una Investigación Digna

PECT Spanish National Plan for Scientific and Technical Research Plan Estatal de Investigación cientifífica y técnica (before NP)

PECTI Spanish State Plan of Scientific and Technical Research and Innovation (2013–2016) (It merges the envisaged PECT and PEI) Plan Estatal de Investigación Científica y Técnica

PEI Spanish National Plan for Innovation Plan Estatal de Innovación

PGE Central Government Budget Presupuestos Generales del Estado

PNP Private non-Profit Instituciones Privadas sin Ánimo de Lucro

RIS3 Research and Innovation Strategies for Smart Specialisation

R&D Research and Development

SETSI State Secretary of Technology and Information Society Secretaría de Estado de Telecomunicaciones para la Sociedad de la Información.

SICTI Information System of Science, Technology and Innovation Sistema de información sobre ciencia, Tecnología e innovación

SGCTI General Secretariat of Science, Technology and Innovation Secretaría General de Ciencia, Tecnología e Innovación

SMEs Small and Medium Enterprises

SEIDI State Secretary of Research, Development and Innovation Secretaría de Estado de Investigación, Desarrollo e Innovación

TBEs Technology based enterprises Empresas de base tecnológica

Annex 1 – List of the main research performers

Top 10 R&D University research performers (UNE and ARWU Rank)

UNE	Web of Science Scientific Production 2003–2012	World Rank	ARWU Ranking 2015
Universidad Autónoma de Barcelona	31.008	151–200	Universidad de Barcelona
Universidad Complutense de Madrid	26.581	201–300	Universidad Autónoma de Barcelona
Universitat de València (Estudi General)	23.593	201–300	Universidad Autónoma de Madrid
Universidad Autónoma de Madrid	20.01	201–300	Univerdidad Complutense
Universidad de Granada	19.619	201–300	Universidad Pompeu Fabra
Universidad de Santiago de Compostela	15.812	301–400	Politécnica de Valencia
Universidad del País Vasco/Euskal Herriko Unibertsitatea	13.071	301–400	Universidad de Granada
Universidad de Sevilla	13.026	301–400	Universidad de Valencia
Universidad Politécnica de Catalunya	12.419	401–500	Universidad Politécnica de Catalunya

Source: Own elaboration from UNE (Hernández Armenteros and Pérez García, 2014) and ARWU.

Top 10 R&D performers (R&D investments)

EU rank	world rank	Name	Industrial sector (ICB-3D)	R&D 2013 (€million)
27	81	BANCO SANTANDER	Banks	1229.0
30	97	TELEFONICA	Fixed Line Telecommunications	1046.0
62	196	AMADEUS	Software & Computer Services	505.4
126	424	INDRA SISTEMAS	Software & Computer Services	195.3
139	461	ACCIONA	Construction & Materials	173.2
153	487	IBERDROLA	Electricity	159.3
188	602	ALMIRALL	Pharmaceuticals & Biotechnology	126.7
187	616	GRIFOLS	Pharmaceuticals & Biotechnology	122.5
197	669	ABENGOA	General Industrials	107.4
204	650	REPSOL YPF	Oil & Gas Producers	112.0

Source: Innovation Union Scoreboard 2014. EC (2014b)

Annex 2 – List of the main funding programmes

List of funding programmes of plan PECTI (2013–2016) (AGE). Timeline, total budget,%, managing unit and target group for 2015 *

Instruments	Timeline	2015 Total (mill. €)	%	Nº	Managing Unit	Target group
Recognition and promotion of talent and employability Program		389.0	13.9%			
Subprogram of Education and training		180.3	6.4%			
Starting collaboration grants for research	1 year	4.7	0.2%		MECD	University students
Doctoral Training programs (1)	4 years	94.4	3.4%	1,022	MINECO	PhD students
Industrial Phds	Max. 4 years	3.0	0.1%	50	MINECO	Firms and PhD students
University Doctoral training (FPU) (2)	4 years	65.8	2.3%	800	MECD	PhD students
Doctoral Training European University Institute -IUE	4 years	1.1	0.0%	12	MECD	PhD students
Postdoctoral training "Juan de al Cierva-training"	2 years	11.3	0.4%	225	MINECO	PhDs
Subprogram of Employability		193.2	6.9%			
"Ramón y Cajal" programme	5 years	54.0	1.9%	175	MINECO	PhDs with less than 10 years of career experience
Grants for the employability of PhDs (3)	3 years	1.3	0.0%	13	MINECO	Ramón y Cajal researchers without permanent position
"Juan de la Cierva-employability"	2 years	14.4	0.5%	225	MINECO	Young PhDs (Degree 2011–2013)
Hiring of Technicians for R&D	3 years	7.0	0.3%	180	MINECO	University Students and technicians

Torres Quevedo program	3 years	15.0	0.5%	300 (estimation)	MINECO	Firms and PHDs
"Emplea". Grants for hiring R&D managers in firms	1–3 years	101.5	3.6%		MINECO	Firms and other R&I related entities (e.g. Foundations)
Subprogram of Mobility		15.5	0.6%			
Pre-Phd. Mobility grants	2–4 months	5.0	0.2%		MINECO	PhD students (FPI-U) 2013–2014
Mobility grants for Spanish researchers abroad (1)	3–6 months	9.4	0.3%	360 +260	MECD	Researchers
International cooperation mobility grants - Brasil	n.a.	0.5	0.0%		MECD	University research groups
International cooperation mobility grants - France	n.a.	0.5	0.0%		MECD	University research personnel and Phd Students
Promotion of excellence Programme		347.8	12.4%			
Subprogram for knowledge generation		139.1	5.0%			
R&D projects (4)	3–4 years	125.5	4.5%		MINECO	Research groups
"Science Scanning" and "Technology Scanning" Projects	1–2 years	5.0	0.2%		MINECO	Researchers and research groups
"Europe Excellence" action	1–2 years	1.2	0.0%		MINECO	non-awarded ERC Starting Grants 2014 (A level) or EMBO YIP Award nominees 2012–

						2013
"Excellence networks" action	1–2 years	7.4	0.3%		MINECO	Research groups
Subprogram of Institutional strengthening		58.8	2.1%			
"Severo Ochoa" and "María de Maeztu" excellence centre programme	4 years	52.0	1.9%		MINECO	Research Centres and Research groups
"Technology Centres Europe"	2 years	3.5	0.1%		MINECO	Technology Centres
Grants for the promotion of scientific and innovation culture	1 year	3.3	0.1%		FECYT	Researchers, Research Centres, firms and other institutions
Subprogram for scientific and technological infrastructures		150.0	5.3%			
Grants for the acquisition of R&D equipment (5)	2 years	150.0	5.3%		MINECO	Public Universities and Public Research Centres
Business leadership programme		591.0	21.1%			
Subprogram for business R&D and Innovation		331.0	11.8%			
R&I projects	3 years	183.0	6.5%	375	CDTI	Firms and Consortia
"CDTI Eurostarts" International Interfim cooperation	3 years	5.0	0.2%	15	CDTI	Firms and consortia non-awarded Eurostars programme
NEOTEC grants	1.5–2 years	10.0	0.4%	50	CDTI	Young and innovative firms (less than 4 years)
"CDTI innovation direct line" Technology innovation projects	1.5 years	104.0	3.7%	210	CDTI	Firms
"CDTI Global innovation direct line" Innovation projects	2 years	20.0	0.7%	12	CDTI	PYMES and midcaps (less than 1500 employees)
"PYME Horizon"	6 months	9.0	0.3%		MINECO	non-awarded Horizon 2020 PYMES
Subprogram of enabling technologies		110.0	3.9%			

CDTI projects R&I	1–3 years	81.0	2.9%	160	CDTI	Firms and Consortia
"CDTI innovation direct line "Innovation technology projects	1.5 years	29.0	1.0%	60	CDTI	Firms
Subprogram of collaborative business R&D and Innovation		150.0	5.3%			
"CIEN" Strategic private consorzia for innovation	3–4 years	150.0	5.3%	21	CDTI	Firms and Consortia
Promotion of R&D and innovation towards societal challenges		1,479.2	52.7%			
Challenges and actions		1174.5	41.8%			
"Collaboration Challenges" R&I projects	2 years	573.9	20.4%		MINECO	Firms, Universities, Resarch Centres, and other research and technology centres
"Research Challenges". R&I projects (6)	3–4 years	243.9	8.7%		MINECO	Public and PNP research entities
R&I projects for young researchers (7)	1–3 years	20.6	0.7%		MINECO	Public and PNP research entities
"Firm Challenges". R&I projects	1–3 years	141.0	5.0%	284	CDTI	Firms and private consortia (Economic Associations - AIE)
"FEDER interconnection" (8)	2–3 years	110.0	3.9%	88	CDTI	Private consortia (2–6 firms) in FEDER regions
"CDTI innovation direct line" Firm Challenges	1.5 years	57.0	2.0%	100	CDTI	Firms
"Europe Research" Action	2 years	3.0	0.1%		MINECO	Research Centres
Joint programming actions. International	1–3 years	10.0	0.4%		MINECO	Research Centres
Action for the dissemination of R&I results in International Congresses	1–2 years	0.7	0.0%		MINECO	Public and PNP research entities
INIA R&I projects	3 years	14.3	0.5%		INIA	Public Research Centres
INIA complementary actions	1–3 years	0.2	0.0%		INIA	Research Centres
Strategic Action in Health		104.6	3.7%			

PFIS Contracts	4 years	1.0	0.2%		ISCIII	Health Research Institutes
Phd training in managing health research	2 years	0.8	0.2%		ISCIII	University graduates
"Río Hortega" contracts	2 years	2.5	0.2%		ISCIII	Centres listed in art.4.1b ECC/1051/3013
IIS- managing health research contracts	3 years	0.3	0.2%		ISCIII	Health Research Institutes
"Miguel Servet" contracts	5 years	12.5	0.2%		ISCIII	PhDs (2000–2010)
"Sara Borrel" Contracts	3 years	2.4	0.2%		ISCIII	PhDs (after 2011)
"Juan Rodés" Contracts	3 years	3.2	0.2%		ISCIII	Health Research Institutes
SNS research intensive contracts	1 year	2.4	0.2%		ISCIII	Public and private entities
Grants for research mobility	2–6 months	0.8	0.2%		ISCIII	Researchers under a health grant (e.g. Miguel Servet)
CIBER hiring programme	n.a.	0.8	0.2%		ISCIII	Research groups
IIS excellence projects	3 years	6.8	0.2%		ISCIII	Health Research Institutes
Health research projects	3 years	63.8	0.2%		ISCIII	Research Centres
Joint programming actions. International	n.a.	2.9	0.2%		ISCIII	Research Centres with positive evaluaton of joint activity programmes
Research projects for personal health care	4 years	4.5	0.2%		ISCIII	Health Research Institutes
Strategic Action digital economy and society		200.0	7.1%			
Big IT projects	n.a.	60.0	0.2%		SETSI	Firms and AIE
Technology forward projects	n.a.	140.0	0.2%		SETSI	Firms and AIE
TOTAL		2807.0	100.0%			

Source: PECTI (2013–2016) working plan (PAA) 2015. (*) Budget figures include multiannual budgets.

(1) Includes pre-PhD grants for Severo Ochoa and María de Maeztu excellence Centres.

(2) Includes funds international stays (€3.4 million).

(3) Replaces I3 programme.

(4) Includes €8.5 million grants up to a €35 million of FEDER advanced payments.

(5) FEDER advanced payments. (6) includes €153.9 million of FEDER advanced payments.

(7) Includes €12.3 million of FEDER advanced payments.

(8) Projects included in less developed or regions in transitions (max. 60 % of advanced payments of eligible budget).

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Annex i

NEW LAW OF SCIENCE, TECHNOLOGY AND INNOVATION (LCTI)

The new **Law of Science, Technology and Innovation (LCTI)** (1st June 2011) replaced the so-called Law of Science of 1986. The new law aims to improve coordination with regional and European authorities, to take into account the growth of the Spanish R&D and innovation system, to improve research careers and to help the transition to an economy based on knowledge and innovation. It also mentions gender issues and ethics. The emphasis on innovation, which was missing in the Law of 1986, the design of several mechanisms aimed at improving national and regional coordination, and the project of the Spanish Research Agency are the main relevant aspects of the new Law. It modifies the governance and human resources for R&D and improves the mechanisms for the transference of knowledge.

Governance of the R&D and innovation system

The LCTI organises the governance of the R&D and innovation system as follows. The Ministry of Science and Innovation (MICINN) now – the Ministry of Economy and Competitiveness (MINECO) – is responsible for drafting and managing the R&D and innovation strategies and plans proposals. The LCTI envisaged two strategies and two plans that have recently merged into single documents.

The **Spanish Strategy for Science and Technology and Innovation (EECTI) (2013–2020)** is a multiannual plan that sets the rationale, objectives and indicators of the Spanish R&D and innovation policy (see below a specific section for this document).

The **Spanish State Plan of Scientific and Technical Research and Innovation (PECTI) (2013–2016)** is a multiannual plan that implements the EECTI by setting its priorities, programmes, coordination mechanisms, costs and sources of funding.

Both documents were approved on 1st February 2013 (see the specific section for this document).

The **Executive Committee for Science, Technology and Innovation policy (CDCTI)** is an inter-ministerial body responsible for the planning, evaluation and coordination of the main Spanish instruments for R&D and innovation.

Two main consultative bodies support the design and implementation of the R&D innovation strategies and plans:

Council of Science, Technology and Innovation (CPCTI) – in charge of coordination with regional governments and other actors in the R&D system. It also supports the drafting of the national strategies. Its members are the Secretaries of State of the Ministries with R&D and innovation responsibilities and representatives of each of the regional governments "Comunidades Autónomas". It replaces the General Council of Science & Technology (GSCT).

Advisory Council of Science, Technology and Innovation (CACTI) in which the research community, enterprises and trade unions are represented. It reports on the strategies and plans and offers information, suggestions and opinions. It replaces the Advisory Council for Science and Technology Policy (ACSI).

The Ministry, in collaboration with other ministries, drafts the R&D and innovation plans. The CDCT and CACTI report on the drafts before these are subjected to the approval of the Government.

The LCTI 2011 envisages the creation of the Spanish Research Agency (created on 27th November 2015). This Agency aims to be an autonomous entity that will assign R&D funds on grounds of scientific merit. The draft of the General State Budget (PGE) of 2012 forbade the creation of any public agency, making it necessary to include an amendment to allow the creation of the Research Agency. The LCTI does not include specific details about the structure and responsibilities of this agency, which will be, together with the

Centre for Industrial Development (CDTI), the main funding bodies of the R&D and innovation system. It is assumed that the Agency will be responsible for the research-oriented projects whereas the CDTI will manage policy instruments oriented towards the enterprises. Other organisations, such as the Carlos III Health Institute, also fund research.

The **Information System of Science, Technology and Innovation (SICTI)** is responsible for the data collection and analysis for the monitoring of all policy programmes and instruments of the R&D and innovation policy. The system aims to gather information coming from national and regional actors (the National State Administration – AGE – and the Regional Administrations – "Comunidades Autónomas"). The system is under the umbrella of the MINECO and the Council of Science, Technology and Innovation (CPCTI). The LCTI emphasises the coordination between national and regional information systems through the SICTI and the CPCTI.

The **Committee of Ethics in Research** is an advisory body on the ethics of research and technology.

The design of several mechanisms aimed at improving national and regional coordination, such as the Council of Science, Technology and Innovation (CPCTI) and the new information system (SICTI), as well as the project of the Spanish Research Agency are the main changes in the governance of the R&D and innovation system brought by the new law.

Human Resources

The LCTI includes four types of private (non-civil servant) labour contracts: (1) to carry out a PhD degree (four years maximum with minimum wages) (Art. 21); (2) of access (five years and maximum of 80 hours of teaching) (Art. 22); (3) for researchers working on research projects (D.a 23a); and (4) for distinguished researchers or scientists, "of great prestige" who will be able to occupy key positions in management or in "important" programmes (which can be permanent) (Art.23). The pre-PhD contract will be delayed till 2014 and the access ones could be conditioned by the State budget and public employment supply. Moreover, it has created a unified professional career. The different official professional scales for scientists with a civil servant status in public research organisations (PROs) will be unified in three, comparable to those of the Spanish National Scientific Research Council (CSIC): (1) research professor, (2) scientific researcher and (3) permanent scientist. This unification facilitates staff mobility between the PROs (see Figure 23 below).

The LCTI also improves several aspects in the career of the researchers. The future replacement of the 2+2 system (two years scholarship and then a two year contract) by a four-year employment contract implies the full recognition of certain rights such as unemployment benefits and maternity leave. In addition, the LCTI improves mobility between private and public organisations by allowing an extended leave for a maximum of 5 years and reducing partially the incompatibility for working in private firms (see section below).

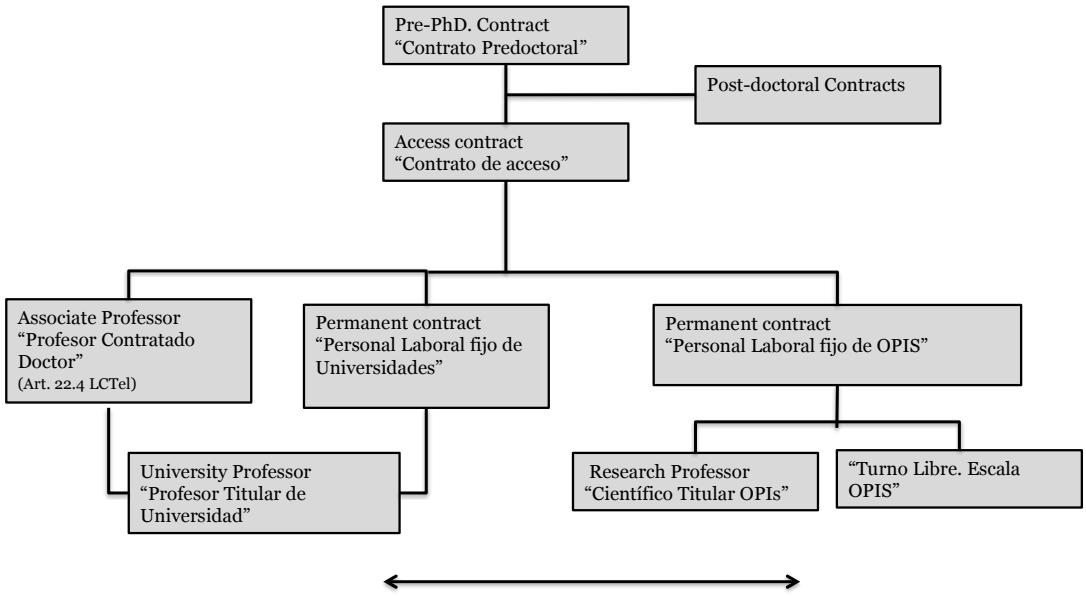

Figure 23. Number of start-ups per 1 000 of research staff per country. EKTIS 2011–2012 survey

Source: MINECO

Mechanisms for knowledge transfer

The LCTI emphasises the role of innovation, technology and knowledge transfer by improving the mechanisms of knowledge transfer, granting property rights to researchers and reducing the incompatibly for researchers employed at public institutions to work in private firms. It aims at improving mechanisms of knowledge transfer by: (1) increasing the value of transfer activities (e.g. by detecting research groups whose knowledge could be applied or by increasing the role of OTRIs) (2) promoting the "units of excellence" (art. 33.1) or (3) developing an open-access archive with research results. It encourages the creation of Technology Based Enterprises (EBTs) by allowing researchers to work part-time in private firms created by the organisations in which they are working and by eliminating restrictions on the maximum share ownership of a private company (10%) and the restrictions on being a board member in private companies. It modifies the previous Law of Sustainable Economy (Law 2/2011) to allow researchers to profit from their patent earnings.

Table 12. Challenges/opportunities identified by OECD (2006), EECTI (2013–2020) and ERAC (2014) evaluation documents.

OECD (2006)	EECTI (2013–2020)	ERAC (2014)
Strengthen science and technology base achieving excellence and critical mass (1) Fragmentation of funding (2) Low accountability and use of financial incentives (3) Lack of mobility and managerial and strategic planning autonomy of research institution Improve support for business R&I (4) Low efficient tax incentives system and lack of efficiency	(1) Low intensity of R&D effort; (2) Low private R&D investments; (3) Lack of instruments for financing private R&D; (4) Lack of venture capital; (5) Regional disparity in R&D; (6) Fragmentation of R&D groups; (7) Lack of public–private collaboration; (8) Inefficient mechanisms for Knowledge transfer;	*Public sector* (1) Unequal quality and fragmented scientific activity; (2) Lack of flexibility and inadequate incentives; (3) Human resources constrains; other governance problems *Private sector* (4) Underperformance in business R&D an Innovation; (5) Insufficient attention to wider innovation (non R&D-based innovation)

in other recent policies to improve access to seed and start up (5) Low focus on the specific needs of SMEs. Foster industry-science linkages (6) Lack of technology transfer and networking (7) Low cooperation between regions and national government Foster mobility and strengthen human resources for science and technology (8) Lack of mobility (9) Improve career development for young researcher Improve the governance and evaluation of policy and foster policy learning (10) Improve coordination among ministries and regions and improve synergies between policy design and implementation (11) Clarify and simplify number of instruments, improve transparency and reduce administrative burden (12) Involve stakeholders (13) Improve management of public support and quality of policy implementation (14) Improve coordination and strategic planning and policy evaluation and the use of suitable indicators to monitor progress	(9) Low R&D activity in traditional sectors and SMEs; (10) Small size and number of enterprises doing R&D activities; (11) Inter-sectorial mobility barriers for scientists; (12) Small survival business rates; (13) Low internationalisation of R&D actors (specially firms); (14) Low rate of firms in medium high sectors.	National-Regional (6) Diversity in regional R&D potential and performance; (7) Fragmented business support services and insufficient evidence of effectiveness (8) Large potential but limited use of EU Cohesion funds to support innovation in Spanish Regions (9) Weak coordination mechanism between national and regional strategies (10) Synergies or duplications in smart specialisation strategies *Cross-cutting* (11) Enhance the critical mass and long term public–private synergies (12) Reinforcement of a monitoring and evaluation system

Source: Own elaboration from challenges and recommendations from these reports. The numbers in the challenges are including ex-post in the case of the OECD (2006) report.

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Working in close cooperation with policy Directorates-General, the JRC addresses key societal challenges while stimulating innovation through developing new methods, tools and standards, and sharing its know-how with the Member States, the scientific community and international partners.

Serving society
Stimulating innovation
Supporting legislation

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