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Research & Innovation in Spain 2016

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Executive summary

The economic situation in Spain continued to improve in 2015, with growth in gross domestic product (GDP) of 3.2% - well above the EU-28 average of 2.2% (Eurostat-2016). The budget deficit as a percentage of GDP reduced over the year by 0.9%, reaching a figure of 5.1%. However, government debt increased to 99.8% of GDP. The unemployment rate has improved considerably over the last year (by 9.8%), but remains among the highest in the EU-28.

Spanish business relies heavily on small and medium enterprises (SMEs), particularly micro-companies of less than ten employees (EC, 2016a). Although the share of SMEs in Spain is similar to other EU Member States (MS), the role of SMEs in employment creation and value added is high in European terms (EC, 2016a). There is a significant productivity gap between large enterprises and micro-companies in Spain. Additionally, Spanish firms show a growth rate below the European average (EC, 2016a).

Entrepreneurship performance indicators show that Spain is increasing its business creation rate, but it is suffering from increasing firm destruction and decreasing firm survival rates (see section 1.1.2). Self-employment figures have remained quite stable over the crisis period, representing 17.7% of total employment in 2008 and 17.4% in 2015 (OECD, 2016a). However, lack of access to the labour market underlies the increasing figures of entrepreneurship 'out of need' (GEM, 2014).

Research and innovation (R&I) investment figures remain far from pre-crisis period levels, in both total and relative terms (see section 2). Gross Expenditure on Research and Development (GERD) has declined by 9.8% between 2010 and 2015, reaching a figure of EUR 13,158 million (similar to the levels of 2007). In relative terms, R&D investments declined up to 1.22% of GDP, returning to 2006 levels. This decline in R&D investments indicates that it will be very difficult for Spain to meet the GERD target of 2% of GDP by 2020, which was set in the Spanish Strategy for Science, Technology and Innovation (EECTI) (2013–2020). GERD is also far from the targets set by the Spanish State Plan of Scientific and Technical Research and Innovation (PECTI) (2013–2016) (1.33% for 2013 and 1.48% for 2016).

After a slight increase in 2014, the public budget for R&I declined again in 2015 by 6.6% and remains much lower than in the pre-crisis period. Government budget appropriations or outlays on R&D (GBAORD) reached a total figure of EUR 5,388 million in 2015,

lower than in 2003 (EUR 5,742). The declining trend of the public budget for R&D (Presupuestos Generales del Estado – PGE-46) hashalted, but was greatly reduced over the crisis period: from EUR 9,673 million in 2009 to EUR 6,425 million in 2016 (ICONO-Ministry of Finance -MINHAP, 2016). In 2016, the R&I budget represented 1.47% of the total budget, a figure that is lower than for 2001 (1.49%) and far from the maximum of of 2.7% achieved in 2008 (ICONO-MINHAP, 2016). Not surprisingly, the role of government in R&D investment is declining and slipping further behind the EU-28 average.

There has also been a considerable reduction in the rate of improvement of the main output indicator of the academic sector (scientific publications), the strongest innovation performance indicator of Spain (EC, 2016b). The annual growth rate of international scientific co-publications per million population has dropped form 12% in 2011 to 4.6% in 2015, decreasing the opportunities of the academic sector to become more competitive in international terms. In fact, growth in Spanish participation in world scientific production started to decline in 2013, slowinging from 3.24% in 2012 to 3.21% in 2013 (FECYT, 2016a).

Reduction of investment in R&D by the business sector has continued over the post-crisis period (see section 2.3). Business R&D expenditure (BERD) has been declining since 2008, falling behind the EU-28 average. BERD represented 0.64% of GDP in 2015, less than the figure of 0.74% in 2008 and far from the EU-28 average (1.3% in 2015). Whilst the business sector remains the main source of R&D funds (0.57% of GDP in 2014), this is well below from the EU-28 average (1.13% in 2014).

The combination of increasing labour productivity of Spain and high unemployment levels indicates that competitive gains are relatively inefficient. The lack of R&I investments explain the overall declining innovation performance of the Spanish R&I system (EC, 2016 b) and could partially explain this inefficient economic growth.

In order to identify the most important challenges of the Spanish R&D system it is necessary to take into account both the already existing long-term challenges of the R&I system (OECD, 2006; EC, 2011; ERAC, 2014) and the effect of the economic crisis on the system. The main weaknesses and opportunities with regard to increasing the level of performance of the Spanish R&I system, as identified by Fernández-Zubieta and colleagues (2017), are summarised in the Box below.

Box 1 Challenges of the Spanish R&I System

CHALLENGES OF THE SPANISH R&I SYSTEM

Challenge 1. Improving framework conditions for innovation

The Spanish industrial structure is characterised by a significant proportion of small and medium-sized firms in low-tech traditional sectors (RIO Country Report, 2015). During the crisis, Spain suffered a significant reduction in the number of companies active in R&D, which decreased from 12,997 in 2008 to 7,628 in 2014 (INE- 2016). The innovative performance of Spain is therefore declining (EC, 2016b), although some measures have been taken to encourage SMEs participation in R&I activities. The low productivity of SMEs and, especially, micro-companies of less than ten employees, in European terms, indicates that additional efforts are required to improve the framework conditions for innovation by targeting these companies. In addition, improving synergies between the public and private R&I system and between small and large firms could help to improve the R&I system.

Challenge 2. Improving funding and governance of the R&I system

Since the beginning of the crisis, public investments in R&I have been reduced. GBAORD decreased by 38.1 % between 2009 and 2015. In relative terms, the central government's budget for R&I (PGE-46/PGE) has decrease from 2.7% of the total budget in 2008 to 1.47% in 2016 (ICONO-MINHAP, 2016). In 2016, this budget has increased by only 0.3%, equivalent to 2005-2006 levels (ICONO-MINHAP, 2016). In addition, the levels of execution of R&I public budgets has continued to decline since 2006 (i.e. from 96.2% in 2006 to 53.4% in 2014) (FECYT, 2016a). Further, no significant reforms have been introduced that seek to prioritise funding and make the R&I system more efficient. This indicates the need to implement an effective R&I policy evaluation mechanism (ERAC, 2014). An effective policy evaluation mechanism could help to improve efficiency and increase transparency of the R&I system.

Challenge 3. Improving the public labour market for researchers

Human resource constraints are the most pressing challenge of the Spanish research and innovation (R&I) system (ERAC, 2014). The numbers and future prospects of Spanish researchers continue to decline, by 9.2% between 2010 and 2014. Without considering the negative personal and professional consequences of this situation, the declining trend in human resources for science and technology makes it impossible to reach the GERD target of 2% of GDP, as indicators on R&I funding and human resources are highly correlated.

Challenge 4. Stimulating regional research and innovation potential and performance

Regional differences in R&I are very important in Spain. The Basque Country is the single region that displays an R&D intensity at the EU average level, being the unique region in Spain considered as a 'strong innovator' (EC, 2016d). R&D activities are highly concentrated in four regions, which accounted for 70.4 % of all R&D expenditure in 2014: Madrid (25.8 %), Catalonia (22.9 %), Andalusia (11.4 %) and the Basque Country (10.2 %) (ICONO-INE, 2016). Coordination mechanisms included in the Law 14/2011 appear not to have reduced regional fragmentation. The overlapping priority areas in many Spanish regions points towards the need to improve national-regional and regional-regional coordination mechanisms.

1. Innovation ecosystem

1.1. Structure of the economy

1.1.1. Sectoral structure

Spain has the fifth-largest economy in the European Union, based on nominal Gross domestic product (GDP) (Eurostat-2016).[1] GDP per capita in 2015 was EUR 23 300 (see Table 1). This value has increased by EUR 900 from 2014 to 2015, but it is far from the EU-28 average of EUR 28 700 in 2015. Spanish economy has strengthened its recovery in 2015, with a growth rate well above the EU-28 average (3.2 % against 2.2 %). Budget deficit as a percentage of GDP continued to shrink from 2014 to 2015 (5.1 % in 2015 against 6 % in 2014). Despite the efforts to reduce the budget deficit, government debt as a percentage of GDP increased over the same period, reaching a figure of 99.8 % in 2015 and departing further from a declining EU-28 average (85.2 % in 2015). The unemployment rate as a percentage of labour has decreased importantly from 2014 to 2015 by 9.8 % (to 22.1 %), but remains among the highest in the EU-28.

EC assessment of the Spanish economic situation recognises that the Spanish economy has considerably improved over the last years due partially to the structural reforms undertaken (see section 3.1) and a favourable external conditions (i.e. low oil prices) (EC, 2016a). These have helped the Spanish economy to recover grow in 2014 and to improve its account balance. However, this assessment also identifies several main important external and internal potential risks to Spanish economic growth. It identifies an increase in oil prices as one of the main external potential risks, while it points to a deceleration in the reform agenda of 2015 as the main internal risk (EC, 2016a) (see section 3.1). The fact an acting government was ruling the country from December 2015 to October 2016 might have affected the implementation of the reform agenda.

In addition, investments in knowledge-based capital (KBC), such as R&D investments (see section 2), have declined considerable since 2010 in Spain, which might reduce the opportunities to increase productivity and competitiveness of the country.

[1] Unless specifically referenced, all data used in this report are based on Eurostat statistics available in July 2016. Spanish economy ranks fifth after Germany, United Kingdom, France and Italy.

Similarly to other advanced economies, the economic structure of Spain is dominated by the service sector, which accounted for 68.4 % of its GDP in 2014 (INE-2016). The same year, the industry sector contributed 15.5 % to the nation's GDP, followed by the construction sector (4.9 %) and the agriculture sector (2.3 %) (INE-2016). The weight of the construction sector, in terms of Spain's economy, declined from 10.1 % in 2008 to 4.9 % in 2014 (INE-2016). Service sector has also increased its weight in the Spanish economy after the economic crisis, increasing from 63 % to the current 68.4 % over the same period. The Spanish economy was positively moving towards a more innovative economy until 2013, but it has suffered an important decline over the last two years distancing itself from the European average (EC, 2016b). Spanish innovation performance index reached a maximum of 0.394 in 2013, declining up to 0.361 in 2015 (EC, 2016b)

Compared to other European countries, Spanish service sector plays a more important role than the manufacturing sector in the relative creation of value added and in employment terms (see Table 1). Value added of services as a share of the total value added increased from 2010 to 2014, reaching a figure of 74.25 % in 2014, but it has declined over the last year up to 73.8 % (see Table 1). The same indicator for the EU-28 average was 74 % in 2014. Value added of manufacturing is increasing since 2012 and reached a figure of 14.2 % in 2015, which is lower than the EU-28 average (15.5 % in 2014). Spanish value added of knowledge-intensive services was 33.4 % in 2015, nearly 10 percentage points above the EU-28 average (23.6 % in 2014). On the other side, value added in high and medium tech manufacturing as a share of total value added was 5.3 % in 2014 far from the EU-28 average (7.2 % in 2013). Service sector is also increasing its share of total employment, reaching a figure of 78.2 % in 2014 and becoming about 5 percentage point higher than the EU-28 average (73.1 %). Employment in manufacturing sector is declining, reaching a figure of 11.1 % in 2014. Employment in knowledge-intensive service sectors and in High and Medium High Tech manufacturing sectors as a share of total employment are lower in Spain than in other European countries. Spain had a share of knowledge-intensive employment of 33.9 % in 2014 against 36.9 % of the EU-28 and a share of high and medium high tech manufacturing of 3 % in 2013 against 4.7 % of the EU-28.

Spain shows stock imbalances coming from external and internal debt, private and public (EC, 2016a). External balance has improved from a deficit into a surplus, with a net flow

of foreign direct investments (FDI) of 1 % of GDP in 2014. In addition to improved R&I measures, policy measures aiming at attracting FDI remain as important challenges to reduce vulnerabilities of the Spanish account balance and competitiveness (EC, 2016a).

Table 1: Main economic indicators

	2010	2014	2015
GDP per capita	23200	22400	23300
GDP growth rate (% change)	0	1.4	3.2
Budget deficit as % of GDP	-9.4	-6	-5.1
Government debt as % of GDP	60.1	100.4	99.8
Unemployment rate as percentage of the labour force (%)	19.9	24.5	22.1
Value added of services as share of the total value added (%)	71.44	74.25	73.8
Value added of manufacturing as share of total value added (%)	13.28	13.78	14.24
Value added of knowledge-intensive services as share of total value (%)	34.12	34.25	33.42
Value added of high & medium tech manufacturing as share of total value added (%)	4.61	5.33	0
Employment in knowledge-intensive service sectors as share of total employment (%)	32.85		
Employment in High and Medium High Tech manufacturing sectors as share of total employment (%)	3.1		
Employment in manufacturing as share of total employment (%)	11.77		
Employment in services as share of total employment (%)	74.62		
Share of Foreign controlled enterprises in the total number of enterprises (%)	0.37		
Business Structure of the economy: Share of enterprises by size class (%):			
• Share of "250 persons employed or more" enterprises (%)	0.12	0.12	0
• Share of "From 50 to 249 persons employed" enterprises (%)	0.68	0.6	
• Share of "From 20 to 49 persons employed" enterprises (%)	1.85	1.54	
• Share of "From 10 to 19 persons employed" enterprises (%)	3.56	2.94	
• Share of "From 0 to 9 persons employed" enterprises (%)	93.79	94.8	
Entrepreneurship performance indicator:			
• Firm births rate	8.04	0	0
• Firm death rate	8.95	0	0
• Firms survival (3 years threshold)	54.42	0	0
Labour productivity (Index, 2010=100)	100	105.2	105.6
Innovation output indicator (Rank, Intra-EU Comparison)	0	19	0
Summary Innovation Index (Rank)	23	24	25
Summary Innovation Index (Score)	0.39	0.39	0.36

Source: ESTAT 2016.

1.1.2. Firm organization and entrepreneurship performance

The business structure of Spain relies heavily on small and medium enterprises (SMEs) and, specially, on micro-companies of less than 10 employees. Although the share of SMEs over total enterprises in Spain is quite similar to other European countries, SMEs play a more important role in employment and value added (EC, 2016a). In 2014, it was estimated that SMEs accounted for 99.9% of total enterprises, similar to the EU-28 average of 99.8% (EC, 2016a: 2). However, the same year Spanish SMEs accounted for 73.3% of total employment and 62.8% of value added, much higher than the EU-28 average (66.9% and of 57.8%, respectively) (EC, 2016a: 2). Micro-companies of less than 10 employees are especially important in the Spanish economy in number, value added and, especially, in employment. In 2018, the share of Spanish micro-companies were about 2 percentage points above the EU-28 average of 92.7%, its value added was about 5 percentage points higher than the EU-28 average of 21.1%, while its employment reached a difference of nearly 11 perceptual point above the EU-28 average of 29.2% (EC, 2016a). Consequently, the role of large firms is less important in the Spanish economy in size, employment creation and value added. This productivity gap is higher in the service sector (EC, 2016a).

Innovation technology expenditures in Spain decreased by 2.1 % in 2014, reaching a figure of EUR 12 960 million and representing 1.8 % of the overall business volume of firms with more than 10 employees (INE-2016). A total of 28.6 % of the Spanish firms with more than 10 employees were innovative firms between 2012 and 2014. Spanish firms devoted 23.4 % to market or organization innovation and 13.3 % to product or process innovation over the same period. Innovative firms invest mainly in internal and external R&D, representing respectively 18.7 % and 17.7 % (INE-2015). Due to the importance of the micro-companies in Spain it could be very important to have more information on the innovation activities of these firms.

Global multinational enterprises (MNEs) represent a much lower share compared to their European counterparts. In 2013, MNEs, proxied by the share of foreign controlled enterprises in the total number of enterprises was 0.48% in Spain, far from the European average of 1.14% (see Table 1).

Spanish companies included in the 2015 top 1 000 EU R&D investment companies have shown an average R&D growth rate of 7.1 %, much higher than the EU average of 3.3 % (EC, 2015). This top includes a total of 22 Spanish companies that represent 2.6 % of the R&D share within the EU. However, its net sales over the last year have decreased by 6 % (EC, 2015). The construction & materials sector and the Pharmaceuticals & biotechnology sector had the highest number of companies ranked in the top 1 000 EU R&D investments companies (see Annex 5).

Entrepreneurship performance indicators points that Spain is increasing its business creation rate, but firm destruction is also increasing and nowadays a Spanish firm has less opportunities to survive. Firm births rate has increased from 8% in 2010 to 8.6% in 2013 (see Table 1). Firm death rate has also increased from 8.9% in 2010 to 9.6% in 2012. Survival rate in a 3 years threshold has decreased from 54.4% in 2010 to 52% in 2013. Self-employment represented 17.4% of total employment in 2015, a figure similar to the one in 2008 (17.7%) (OECD, 2016a). GEM data indicated that entrepreneurship 'out of need' (lack of access to the labour market) has increased in recent years (GEM, 2014). The increase in entrepreneurship out of need might negatively affect survival rate and growth of Spanish firms (GEM, 2014).

1.1.3. Integration in global value chains

OECD (2015) analysis of the Spanish integration in global value chains (GVCs) points that Spanish exports are recovering up to a marginally lower levels than the pre-crisis. After Coke & petroleum, the industry with highest value added was motor vehicle with 46.1 % in 2011. This is consistent with a economy highly dependent on imports of energy products. Similarly, Spanish exports industries (e.g. automobile) tend to be net recipients of FDF due to the presence of multinationals that have a high import content (EC, 2016a).

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

1.1.4. Productivity

Labour productivity (or productivity GDP per hour worked) has increased in Spain since 2010, reaching a figure of 105.6 in 2015, just above the EU-28 average of 105 (see Table 1). However, increasing unemployment indicates that this productivity growth comes mainly from job destruction. Therefore, the contribution to productivity growth in Spain relies less on capital inputs and on total factor productivity (TFP) than on labour inputs. Spanish TFP was positive but low in the post-crisis period of 2009-2010 (OECD, 2016b: 57). This relative non-efficient competitive gains might be partially explained by the lack of R&I investments, among other factors such as, the reliance of the economy in low productive sectors and firm size, overreliance on temporary workers, rigid labour market and lack of completion.

Spain shows an above the European average productivity gap between largest and micro companies (EC, 2016a). High technological development is inversely correlated with the technology gap between largest and micro companies (EC, 2016a), which might indicate that technological development could help to reduce this productivity gap between largest and micro companies.

Spain ranks 35th, out of 144 countries, in the Global Competitive Index (GCI) with a total Score of 4.5 in the GCI 2014-2015 (World economic forum - WEF, 2014). Spanish score has decreased 0.1 score points over the last year. A more competitive economy has higher opportunities to grow faster over time, but many factors affect the level competitiveness of a country and its productivity. The GCI index includes 12 of these factors[2] grouped in three main sets: basic requirements, efficiency enhancers and Innovation and sophistication factors. According to the GCI, Spain shows its lowest score in the innovation and sophistication factor (4.1), with innovation showing its lowest score (3.7) and with a business sophistication score of 4.4 (WEF, 2014). Institutions and macroeconomic environment are the weakest areas (below the average of other advanced economies) within the basic requirements to have a more competitive economy (scores 3.8). Similarly, labour market efficiency and financial market development are the

[2] These are: 1. Institutions; 2. Infrastructure; 3. Macroeconomic environment; 4. Health and primary education; 5. Higher education and training; 6. Goods market efficiency; 7. Labor market efficiency; 8. Financial market development; 9.Technological readiness; 10. Market size; 11.Business sophistication; 12. Innovation. Basic requirements include indicators 1-4; Efficiencyiy enhancers include indicators 5-10; and Innovation and sophistication factors include indicators 11 and 12 (WEF, 2014).

weakest areas to enhance the efficiency of the economy (WEF, 2014). The strongest areas in the Spanish economy are: infrastructures; health and primary education; technological readiness; market size; and higher education and training, with scores higher than 5 and above or close to the average of other advanced economies (WEF, 2014).

1.2. Business environment

1.2.1. Ease of doing business / barriers to entrepreneurship

Spain has improved its position on the most business-friendly regulation ranking from 34th position in 2014 to 33th position in 2015 (see Table 2), close to the EU-28 average position (30.8th). Considering the changes over the last years (2010-2015) in DTF scores[3], Spain has made it easier to start a business and improve its protection to minority investors, but nowadays it is more difficult to get credit in the country (WB-Spain, 2016: 10).

Spain has importantly reduced the number of procedures and days necessary for starting a new business, from 10 to 7 and from 23 to 14, respectively, over the last three DB reports (WB, 2014; WB, 2015; WB, 2016). It has also slightly improved its DTF score over the last two years in 'starting a business'. However, as other countries made it better, Spain has decreased its rank position in starting a business from 78 in 2014 to 82 in 2015 (DB reports 2015 and 2016 respectively).

[3] "The distance to frontier score shows how far on average an economy is from the best performance achieved by any economy on each Doing Business indicator. (…) The measure is normalized to range between 0 and 100, with 100 representing the best performance (the frontier)." (WB-Spain, 2016: 10). Similarly, distance to frontier (DTF) rank has improved from 73.8 in 2014 to 74.9 in 2015 (WB, 2016). In 2015, the strongest areas in rank terms of Spain were (ranks in brackets): 'trading across borders' (1); 'resolving insolvency"' (25); and 'Protecting minority investors' (29) (WB-Doing business-Spain, 2016: 9). Worst ranks are for: 'dealing with construction permits' (101) and 'starting a business' (82) (WB-Spain, 2016: 9). In DTF terms for the same year, highest scores are shown in (scores in brackets): 'trading across borders' (100) and 'starting a business' (86.3), while lowest scores appear in 'getting credit' (60) and 'Protecting minority investors' (65).

Table 2: Main business environment indicators

	2010	2014	2015
Country position in Doing Business WB (Ease of doing business index WB) (1=most business-friendly regulations)		34	33
Product market regulation (OECD) (rank)		13 (2013)	
Product market regulation (OECD) (score)		1.44 (2013)	
Ease of getting credit (WB GII) (rank)		48	
Ease of getting credit (WB GII) (score)		60	
Survey on the Access to Finance of Enterprises (SAFE) Share of companies which identified access to finance as one of their most important (SAFE)			0.11
Venture capital indicators (EVCA) Venture capital investment as % of GDP (seed, start-up and later stage)	0.01	0.008	0.01
Innovative enterprises as a share of total number of enterprises CIS data 2012 (%)	33.6 (2012)		
EC Digital Economy & Society Index (DESI) (rank)	16 (2014)	17 (2015)	15 (2016)
EC Digital Economy & Society Index (DESI) (value)	0.44 (2014)	0.49 (2015)	0.52 (2016)

Sources: ESTAT 2016, OECD, World Bank, EVCA.

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 3.1 and 4.3), 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 Spanish business environment, and

have consequently improved Spain's overall ranking in the most business-friendly regulation (WB, 2016).[4]

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). Therefore, homogenizing regulations across regions might improve business environment and business creation (see also next section about efficient judicial systems).[6]

1.2.2. Access to finance

In 2014, Spain ranked 48th in the easiness of access to credit[5] and had a value of 60 (see Table 2). The strength of its legal system[6] was 5 the same year in a 0-12 index, lower than the OECD high-income of 6. Its depth of credit information index was 7 in a 0-8 scale, 0.5 higher that the OECD high-income figure[7] of the same year (WB, 2016). Improvements in its legal system could be applied, for example, by integrating the legal framework for securing transactions (WB, 2016). In addition, some studies point that Spanish regions with more efficient judicial systems (quality of 'enforcement institutions') show higher firm growth and higher firms entry rates (e.g. García-Posada and Mora-Sanguinetti, 2014).

The share of companies that consider access to finance as one of their most important problems was 0.11 in 2015 (see Table 2). According to the GEM information, access to

[4] Other positive measures signalled by DB report (WB, 2016) include: the improved protection to minority investors by requiring the shareholders approval for majors sales of company asset; the reduction of rates for corporate income, capital gains and environment taxes; the introduction of the Cl@ve system for filling VAT returns. In addition, Spain "reduced the amount allowable for depreciation of fixed assets and raised the celling for social security contributions" (WB, 2016: 180).

[5] It measures "the strength of credit reporting systems and the effectiveness of colateral and bankrupcy laws in facilitating lending" (WB, 2016)

[6] This index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending.

[7] This index measures rules and practices affecting the coverage, scope and accessibility of credit information available through either a public credit registry or a private credit bureau.

finance, together with the bureaucratic governmental procedures (e.g. paper-work and administrative burden) and multiple taxes (e.g. higher contribution to social security and corporate income tax), are considered as the most important factors that hamper the entrepreneurial process, from start-up to frim growth (GEM, 2014).

Despite its increasing trend since 2013, venture capital investment is very low in Spain, representing just 0.01 % of GDP in 2015 (see Table 2) The investments in risk capital, including seed capital, start-up funds and funding for other stages of the business creation, amounted to EUR 1 051 million in 2015 (Table 2). Despite its increasing trend since 2013, venture capital investments figures are far from their pre-crisis levels (e.g. EUR 2 923 million in 2007 (Eurostat-2016). Data detailed by stages of development indicate that most venture capital goes to start-up stage (59 % in 2015), 38.1 % to later-stage venture capital and 2.9 % to seed stage capital (Eurostat-2016). In addition, the number of innovative enterprises is very low in international terms. Innovative enterprises represented 33.6 % of the total number of enterprises in 2012 (see Table 2), far from the EU-28 average of 48.9 %.

In 2014, Spain stood fifth in Europe regarding the volume of alternative funding or crowdfunding with EUR 62 million funding raised from about 35 crowdfunding platforms (Wardrop et al., 2015).[8] Spain is part of the leading country group, but its per capita funding raising capacity is lower in international comparison terms. Most funding comes from reward-based crowdfunding platforms (EUR 35 million), while equity-based crowdfunding was EUR 10.5 million in 2014 (Wardrop et al., 2015). Spain introduced a new regulation affecting lend and equity crowdfunding platforms (Law 5/2015). This regulation was perceived by restrictive for a 73% of the surveyed (Wardrop et al., 2015), which might decrease the crowdfunding investing market in the future. Several crowdfunding platforms for R&I were created since 2012: Vórticex, F4R, ILoveSciences and Precitita, launched by the FECYT after the failure of Tararcea.

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 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

[8] After UK, France, Germany and The Netherlands.

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).

1.2.3. Digital infrastructure and services

Spain ranked 15th out of the EU-28 member states and had a score of 0.52 in the Digital economy and society index (DESI) in 2016 (Table 2). Spain has improved or maintained its performance in all DESI areas over the last year: connectivity; human capital; use of internet; integration of digital technology; and digital public services. Spain is a 'catching up' country as its performance is usually below that of the EU average. However, its scores are growing faster than the European average (EC, 2016c). Spain outstands in Digital public services area (rank 5th among EU member states) with all indicators included in this area showing averages well above those of the EU ones: eGovernment users; pre-filled forms; online service completion; and open data. Within this area Spain outstands in open data where it ranked 2nd in 2015. The worst performing area is the use of internet, with the lowest rank (21st) and declining performance.

Considering Integration of digital technology by business, Spain is just above the European average, 0.37 against 0.36 in 2015 (EC, 2016c). However, indicators of eCommerce turnover and selling online cross-border are among the ones where Spain shows lowest performance (20th in both in 2015) (EC, 2016c). This indicates that Spanish business could get more out of new technologies. As DESI report (EC, 2016c) indicates, Spanish good scores on the integration of digital technology by business are to great extent driven by the offer of eGovernment services. Particularly, the law on eInvoicing made compulsory, since 15 January 2015, the electronic invoicing for all suppliers selling to the central public administration (for invoices higher the 5000 euros). The percentage of SMEs selling online was only 16 % in 2015, despite being similar to the EU average. The use of social media and cloud services by business is growing slowly. Improvements in these areas could benefit the Spanish business economy.

1.3. Public sector innovation

1.3.1. Public sector modernisation agenda

Spanish government sector plays an important role in R&D and innovation. The number of researchers and technicians working in government as share of total R&D personnel was 86.65% in 2014, nearly 30 perceptual points higher than the EU-28 average of the same year (see Table 3).

Table 3: Public sector innovation indicators

Researchers and technicians working in government as share of total R&D personnel	86.65 (2014)
Online availability of public services – for citizens and businesses (Estat) - Percentage of individuals having interactions with public authorities via Internet (last 12 months)	49 (2015)
E-Government Development Index (UN)[1] (rank)	17 (2016)
Government procurement of advanced technology products (WEF) (rank)	101 (2015)

Sources: ESTAT 2016, OECD, World Bank, EVCA.

Spain made a great effort to make available its public services on-line. As a result, 49% of Spanish citizens interacted with the public authorities via Internet in 2015, 15 percentage points higher than in 2009 (see Table 3). Spain ranked 17th in the E-Government development index in 2016 and ranked 101 in the government procurement of advanced technology products (WEF) in 2015. Spain has declined in the WEF rank from the 85th position in 2012, which might indicate that the demand conditions for innovative products is not improving as quickly as it does in other countries. Spain ranks 2nd among EU Member States regarding open data (EU, 2016c), with shows the Spanish commitment to open data.

The European Public Sector Innovation Scoreboard (EPIS) 2013 (EC, 2013) shows that Spain is above the EU-27 average in most of the indicators (13 out of 22). Although the government effectiveness in Spain has decreased from 1.82 in 2000 to 0.98 in 2010, it shows one of the highest improvements in the e-government development index (EgdI), in providing public services through the use of Information and Communication Technology (ICT) in the period of 2003-2012. The share of in-house service innovators is high (89%) and the perception of the importance of innovation for winning procurement tenders from public administration organisations is that it is greater than the importance of low cost (EC, 2013).

Joined initiatives with citizens, businesses and different branches of government are less frequent. However, synergies in digital government initiatives from central government appear to spread out to regional governments (EC, 2016c).

Digital Agenda for Spain (ADE) sets the strategy of the country in the area for the period 2013–2015 (MINETUR, 2013). This strategy is aligned with the European Digital Agenda. It aims at maximizing the use of ICT to gain productivity and competitiveness and to modernize Spanish economy and society through the promotion of the use of TICs by the citizens, enterprises and public administration. ADE has six main objectives (p.4):

a) Facilitating the provision of networks and services
b) Developing the digital economy in order to gain competitiveness and increase the internationalisation of the Spanish companies
c) Improving e-government digital solutions in order to increase the efficiency of public services
d) Promoting trust in the use of digital services
e) Promoting R&I system in ICT
f) Reducing the digital divide and promoting digital learning

The strategy is implemented through 9 coordinated plans, including the Plan for Digital Public Services (MINETUR, 2014). This plan includes specific objectives in health, education and justice.

The Observatory of E-Governmet (OBSAE) analyses and disseminates the different actions in e-government (see section 1.3.2).

1.3.1. Public sector innovation culture

The Digital Agenda for Spain (ADE) (MINETUR, 2013) has made an effort to improve the innovation culture in the public sector. Its third objective about e-government recognises the need to better integrate public administration to citizens and private companies by providing more efficient services. This objective includes several specific measures (‘Líneas de actuación’), which address the need to jointly design policies and services with citizens and private companies. These measures specifically include the transparency of policy making by (ADE: 34-35):

a) Granting access to information and actions of public administration;
b) Promoting citizenship participation in the policy-design by gathering suggestions and comments; and
c) Collaborating with citizens, private companies and other public administrations in the design, implementation and delivery of digital services.

The records of the OBSAE in 2014-2015 indicate that Spanish e-government is improving. Only three out of 34 the indicators included in the OBSAE show a significant negative growth in the use of e-government initiatives by citizens and enterprises. These three negative indicators were (2014-5 average growth rate in brackets): the number of 060 offices -a one-stop shop that provide access to all public administrations (central, regional and local) (by 4.5%); the number of visits to the EUGO portal a one-stop shop for enterprises that grants electronic access to all processes necessary to carry out a remunerated economic activity in the country (by 11.7%); and the percentage of electronic use of services (by 4.4%). The rest of indicators grew importantly over the same period.

Risk management is addressed by public administration mainly by guaranteeing citizens and firms a safe use of internet. "Promoting trust in the use of digital services" is one of the main objectives of the ADE. It has a specific plan (number 5) that implements simultaneously the ADE strategy, the European Strategy on cyber-security (EUCS) and the Spanish Strategy on Security (ESN). This plan has 59 millions. INTECO 2.0 is probably the main action in this area, including the management of a centre of digital trust (Spanish Institute for National cyber-security (INCIBE) previously (National Institute of Technologies and Communication (INCOBA).

1.4. Civil society innovation

1.4.1. Citizen science initiatives

Several citizen science initiatives exist at national level.

The Spanish Observatory of Citizen Science includes a registry of 107 citizen projects. It is a voluntary registry, which might indicate that some important initiatives might have not been covered. This web was launched within the European project Socientize. In addition, The FECYT promotes science dissemination, including science citizen projects.

Ibercivis is a private foundation that aims at encouraging citizen science and the dissemination of science. The MINECO and the Aragon regional government is among its founders. It was created in 2011 and has launched 9 different citizen projects, including the Spanish Observatory of Citizen Science.

Crowdcrafting is an international crowdsourcing research platform that also operates in Spain. In addition, some crowdfunding platforms for science exist also in the country (see section 1.2.2).

At city level, several large cities have launched important citizen science projects. BarcelonaLab and Medialab-Prado are probably the most important ones, in Barcelona and Madrid respectively. The main aim of these projects is to promote citizen innovation through the collaboration of artists, scientists and technologists. Both projects are promoted by local authorities and gathering several already existent citizen science initiatives (e.g. CCCB Lab in Barcelona).

1.4.2. Role of non-profit in supporting innovation

A total of 36.6 % of the Spanish foundations have the promotion of research among their objectives (INAEF, 2011). Rey-García and Álvarez-González (2015) in their study of 229 Spanish R&I foundations showed that they are young, dynamic, diverse and with a predominant local-regional geographical scope. This study shows that most Spanish R&I foundations initiated their activities in the 21st century, but previously funded foundations are increasingly including R&I activities among their main objectives. They tend to be big in average income and assets relatively to the foundation sector. They tend to be research applied oriented, but they also frequently include innovation in their activities. They are diverse in their funding portfolio, the type of R&I activities developed (although dissemination is the dominant one), and their thematic field orientation, being medical the main area (Rey-García and Álvarez-González, 2015).

One of the most outstanding characteristic of the Spanish R&I foundation sector is the active role of the public sector in their promotion (INAEF, 2011). Approximately 9 % of the foundations come from public initiative, with public administrations and agencies controlling their boards (INAEF, 2011). This is especially significant in the case of R&I as an important set of R&I foundations was created by universities, hospitals or development agencies (Rey-García and Álvarez-González, 2015). Foundations as legal entities offer more flexible organisational system compared to the public one and can offer tax benefits to their promoters. On the negative side, lack of transparency appears to be one of the main weaknesses of the sector (Rey-García and Álvarez-González, 2015). In addition, regions have diverse regional foundation regulation.

The diversity of the sector makes it necessary to distinguish between 5 main types of R&I foundations (Rey-García and Álvarez-González, 2015): (1) Created by entrepreneurs and wealthy families (e.g. Rafel del Pino Foundation); (2) Corporate R&I foundations (e.g. Mapfre Foundation, Caixa Foundation and BBVA Foundation); (3) Promoted by other non-profits (e.g. Spanish Association against Cancer, AECC); (4) Instrumental R&I foundation for public entities (e.g. Pro-CNIC Foundation); and (5) Technological centres, parks and R&I institutes or groups (e.g. Tecnalia Foundation).

Non-for profits sponsor several R&I prices, such as, the BBVA Foundation Frontiers of Knowledge Awards (about 400.000 per category and an international character), the Lilly Foundation Awards on Biotechnology (40.000 euros). Probably the most well recognised R&I Spanish prizes are the ones granted by the Princess of Asturias Foundation[9], with an international character, and the Jaume I Foundation that awards national researchers. These last two foundations are supported by regional or national governments. Many prices and programs for entrepreneurs have been launched over the last years.[10]

In addition, private companies, such Banco Santander or Telefónica, support entrepreneurial initiatives internally or through their foundations. For example, the Wayra program for starts ups of Telefónica (50,000 support plus training and access to the incubator.

Some innovative initiatives involving R&I foundations are mentioned below (Rey-García and Álvarez-González, 2015: 40-44):

- Public-private partnerships involving foundations include the Cenit programme; research centres incorporated or created as foundations (e.g. Institute of Photonic Sciences); endowed foundations supporting the transferer of technology by public universities and research centres (e.g. Botin Foundation); Commpany-sponsored university chairs at public universities (e.g. Telefónica); foundations from public universities providing professional counselling and the collaboration of academics with firms (e.g. Firms foundations in several universities)
- Foundations promoting an innovative culture (e.g. The Bankinter Innovation Foundation and its Future Trends Forum)

[9] Research and technology is one of the several prizes granted by this foundation.

[10] A list of the main prizes for entrepreneurs could be found in El Referente 14/09/15.

- Supporting science dissemination (e.g. Princess of Asturias Foundation prizes and La Caixa Foundation science museums
- Foundations encouraging the links between R&I and entrepreneurship (e.g. Celera and InLea foundations)
- Development of socially innovative products, services and technology (e.g. Once Foundation supporting technology development for disable people)

1.4.3. Mediating structures

Mediating structures, such as fab labs, co-working spaces, start-ups associations and other bottom-up initiatives are frequent in Spain. Some of these bottom-up initiatives are being promoted and integrated into local public initiatives, especially in large cities. For example, the CCCB Lab in Barcelona. They tend to be connected with other international initiatives, such as, the European Network of Living Labs (ENoLL). Similarly, co-working spaces are growing. CoworkingSpain is an online platform that helps users to find coworking spaces in most of the Spanish regions. The Catalan Coworking Association (COWOCAT) gathers important coworking spaces, disseminates coworking initiatives and collaborates with public administrations and private enterprises. Since 2012, the Coworking Spanish Conference has had a yearly meeting. The Spanish Association of Start-ups was recently created.

1.5. Supply of human resources

1.5.1. Public sector modernisation agenda

Spain has considerably reduced its researcher base over the last years. The number of researchers per thousand population has decreased between 2011 and 2014 by 4.2%, reaching a figure of 4.5 in 2013 (see Table 4). Spain is therefore getting further away from the EU-28 average of 5.4 in 2013. The total number of researchers has passed from 134 653 in 2010 to 122 235 in 2014, decreasing by 9.2 % and reaching its levels of 2007. However, the ratio of new doctorate graduates follows an opposite trend. It has increased from 1.79 in 2010 to 2.28 in 2014 and it is higher than the EU-28 average (1.1 in 2013). This indicates an imbalance between the supply and demand of human resources for research and innovation. The increasing age of the Spanish academics also illustrates this imbalance. The number of academics with more than 50 years working at the Spanish

universities has increase from 38.5 % in 2008-2009 to 45.5 % in 2014-2015 (MEDU-2016).

The share of female researchers is increasing and above the EU-28 average. This indicator reached a figure of 39.6 % in 2014 (see Table 4) and it is nearly 6 perceptual points higher that the EU-28 average. However, the share of female researcher in full time equivalent has remained quite stable which might indicate that female researchers are hired more frequently under temporary contracts. The percentage of female in FTE has even decreased over the last year from 38.8 % in 2013 to 38.6 % in 2014 (a figure quite similar to the one of 2009 (38.5 %) (ICONO-INE: 2016). The reports on the situation of female researchers working at the CSIC indicate that gender differences become more significant across the career ladder (e.g. from 'científico tilular' to 'profesor investigador'). These reports also indicate that the crisis might have affected more to female researchers under temporary contracts, increasing gender differences of researcher working under non-permanent contracts (CSIC, 2016).

Table 4: Supply of human resources

	2010	**2014**
New doctorate graduates (ISCED 6) per 1000 population aged 25-34	0.71	0.96
New graduates in STEM per 1000 population	1.79	2.28
Number of researchers per thousand of population	4.72 (2011)	4.52
Share of women researchers (2014)	39.59	

Source: ESTAT 2016.

The number of graduates in Science and Engineering per 1000 population has also increased from 1.79 in 2010 to 2.28 in 2014, close to EU-28 average of 2.3 in 2014) (see Table 4). However, this data might reflect a 'crisis effect', changing preferences of young people for university studies over job market alternatives. Considering changes between over the last decade, the number of graduates in 'Engineering and Architecture' and 'Science' has decreased between 2003-2004 and 2012-2014 (the former field by 24.6 % and the latter by 24.9 %) (MEDU, 2015). The number of female students in architecture and engineering degrees is very low, reaching a figure of 25.8 % of undergraduates in 2015-2016 (MEDU, 2016). The percentage of female graduates is higher, which might

indicate that dropout levels are lower for females. The percentage of female architecture and engineering degrees was 27.9% in 2015-2016 (MEDU, 2016).

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. There are no specific policies to encourage girls to engage in STEM studies.

The appropriate mix of skills among the population 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).[11]

[11] 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.

2. R&D and innovation structure and actors

2.1. Government

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, and by difficulties in coordinating national and regional authorities. This prevents the improvement of the R&D policy-making process (ERAC, 2014). The central government provides an R&I policy framework which defines a 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 (see Annex 6) for a more detailed explanation and organigramme:

a) the policy-making bodies include: the Ministry of Economics and Competitiveness (MINECO); and other ministries distributing R&D funding, such as, the Ministry of Industry; Energy and Tourism (MINETUR); the Ministry of Defence (MDEF); the Ministry of Education, Culture and Sports (MEDU); and the in inter-ministerial body the Executive Committee for Science, Technology and Innovation Policy (CDCTI)

b) The implementation bodies comprise: the State Secretary for Research, Development and Innovation (SEIDI); the Spanish Research Agency (AEI)12; the Centre for Industrial Technological Development (CDTI); the Carlos III Health Institute (ISCIII); the National Institute for Agricultural and Food Research and Technology (INIA); the State Secretary of Technology

[12] The AEI will be operational on 2017.

and Information Society; the State Secretary of Education, Professional Education and Universities (MEDU); and FECYT

c) The bodies that provide science policy advice and support include: the Council of Science, Technology and Innovation (CPCTI) and the Advisory Council of Science, Technology and Innovation (CACTI)

Gross expenditure on research and development (GERD) in total and relative terms in Spain follow a decreasing trend from 2010 to 2014 (see Table 5). In 2015, total GERD in increased by 2.6 %, reaching a figure of EUR 13,157.9 million. However the same year, R&D intensity (GERD as a percentage of gross domestic products- GDP) continued decreasing up to 1.22 % far from the EU-28 average of 2.04 % in 2015. Therefore, the recovery signs of the Spanish economy (e.g. GDP indicators) are not visible yet in the research and innovation sector in relative terms.

Table 5: Main R&D indicators

Indicator/inputs & outputs	**2010**	**2012**	**2014**	**2015**	**EU average**
GERD (as % of GDP)	1.35	1.29	1.24	1.22	2.04 (2015)
GERD in national currency	14588.5	13391.607	12820.756	13157.899	
R&D funded by abroad (% of GDP)	0.08	0.09	0.09		0.2 (2014)
R&D funded by EC (% of GDP)	0.04	0.05	0.05		

Source: ESTAT 2016.

Disinvestments from the government sector in R&D have been important. Government budget appropriations or outlays on R&D (GBAORD) has decreased by 35.1 % between 2010 and 2015 (see Table 6), reaching a figure of €5 388 million in 2015. Public budgets for R&D from the State have also been greatly reduced: from EUR 9 673 million in 2009 to EUR 6 425 million in 2016. In relative terms, this budget has decrease from 2.7 % of total government budget in 2008 to 1.47 % in 2016. (ICONO-Ministry of Finance - MINHAP, 2016). Despite that State budget for R&D has been increasing since 2014 (by 0.3 % in 2016), State budget levels are far from their pre-crisis levels. In total terms, 2016 budget levels are lower than 2006 ones. In relative terms, 2016 share of the total central budget is similar to the share of 2001 (i.e. 1.49 %) (ICONO-MINHAP, 2016). In

addition, the levels of execution of R&I public budgets continue declining since 2006 (i.e. 96.2 % in 2006 to 53.4 % in 2014) (FECYT, 2016a).

The role of government in R&D has been declining, with decreasing shares of R&D funded and performed by this sector (see Table 6). The percentage of R&D funded by government as a percentage of GDP have changed from 0.63 % in 2010 to 0.51 % in 2014, getting further away from the EU-28 average of 0.66 % in 2013. The percentage of R&D performed by the government sector has declined 0.05 percentage points, reaching a figure of 0.23 % in 2015 and becoming lower than the EU-28 average (0.24 % in 2015).

Table 6: Main R&D indicators-government

Indicator/inputs & outputs	2010	2012	2014	2015	EU average
GBARD in national currency	8308.156	6185.179	5776.662	5388.219	
GBAORD as % of GDP	0.77	0.59	0.55	0.5	0.64 (2015)
R&D funded by GOV (% of GDP)	0.63	0.56	0.51		0.66 (2014)
R&D performed by GOV (% of GDP)	0.27	0.25	0.23	0.23	0.24 (2015)

Source: ESTAT 2016.

In 2014, the government sector (which, as a whole, contributed 18.8 % of GERD) included 8 OPIs, 56 other public national centres, 356 regional and local public centres, and 69 other centres, which contributed 41.3 %, 12.3 %, 35.6 % and 10.8 % of government sector GERD, respectively (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 2016, the main OPIs are the CSIC, which represents 47.7 % of the total OPI budget (EUR 1 316 million), followed by the ISCIII (20.7 %) and INTA (10.4 %) (Molero and de Nó, 2016). 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.

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.[13] Differences in R&D efforts among regions are important. In 2014, four accounted for 70.4 % of all R&D expenditure in 2014: Madrid (25.8 %), Catalonia (22.9 %), Andalusia (11.4 %) and the Basque Country (10.2 %) (ICONO-INE, 2016). Out of the 17 Spanish autonomous communities, only the Basque Country display a R&D intensity at the EU average and is the single region considered, by the Innovation Union Scoreboard 2016, to be a 'strong innovator' (EC, 2016d). This fragmentation creates important challenges for the Spanish R&I system with regard to stimulate R&I potential and performance.

Although they have increased in recent years, the contributions to R&D from abroad and, more specifically, from the European Commission remain too marginal to compensate for the decline in direct public funding. R&D funded by abroad as a percentage of GDP increased form 0.08 % in 2010 to 0.09 % in 2014, far from the EU-28 average of 0.2 % in 2014 (see Table 5).

Fiscal consolidation in Spain has been successful in general terms, as fiscal deficit has been decreasing significantly since the beginning of the economic crisis. However, this may have been achieved by squeezing out R&I public investments. Therefore, it can not be said to have deployed a policy of smart fiscal consolidation with regard to R&I.

[13] 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.

2.2. Academia

Most R&D indicators of the academic sector have been negatively affected by disinvestments in R&I (see Table 7). R&D performed by higher education sector (HES) has declined from 0.38 % of GDP in 2010 to 0.34 % in 2015, far from the EU-28 average of 0.47. Similarly, R&D performed by higher education sector (HES) and funded by Government have declined from 0.28 % of GDP in 2010 to 0.25 % in 2014, far form the EU-28 average of 0.37 in 2014. R&D performed by HES and funded by business enterprise sector (BES) and private non-profit sector (PNP) has also declined from 0.3 % in 2010 to 0.02 % of GDP in 2014.

The rate of improvement of the main output indicators of this sector has reduced most probably due to the disinvestments in R&D (see Table 7), the strongest innovation performance indicator of Spain (EC, 2016b). The number of international scientific co-publications per million population has increased in Spain from 434.6 in 2010 to 645.2 in 2015. However, the annual growth rate of this indicator has dropped from 12 % in 2011 to 4.6 % in 2015. In fact, the overall increasing trend of the Spanish participation over the world scientific production started to decline in 2013, dropping from 3.24% in 2012 to 3.21% in 2013 (FECYT, 2016a). Spain has the highest percentage of the world scientific production in the fields of: agriculture (4.6 % in 2014), health (4.4 %), social sciences (4.2 %), arts and humanities (4.1 %), environment (4 %) and space (4 %) (ICONO-FECYT, 2016).

Apparently, the level of excellence of the Spanish research production is not declining yet. After three years of stagnation having a 12.9 % in the 10 per cent most cited publications, this indicator has improved in 2014 reaching a figure of 13.4 % (ICONO-FECYT, 2016).

The success rate of European Research Council (ERC) grants was 0.07 in 2015, lower than the one of 2010 (0.11). Spain generally shows a below the average success rate (FECYT, 2015a). However, data from 2009 to 2013 indicates that Spanish researchers were suffering from increasing international competition in getting ERC grants with a declining share of ERC grants over total grants (FECYT, 2015a).

National and regional strategies try to foster the interaction between the academic sector and business (see section 3). However, due to the low (in international terms) and declining contribution of the R&D performed by HES and funded by the government

(see Table 7) it is quite difficult to draw conclusions about its influence in the general funding trend.

The potential for the emergence of entrepreneurial universities it is mainly tapped by the declining investments in R&D (Rakovska et al., 29). CRUE (2016) shows that the decline of the income of the Spanish universities coming fromm research and technology transfer activities between 2010 and 2014 comes mainly from the competitive funding provided by R&D projects. The total decline of this source of income between 2010 and 2014 was EUR 303 million (R&D projects), while the second source of income (research contracts) amounted EUR 326 million in 2014 (CRUE, 2016: 47). Income from patents has increased but represents an anecdotal share of income from third activities, reaching EUR 3 million in 2014 (CRUE, 2016: 47). In fact, university owned patent grew considerable from 2008-2011, from 256 to 502 (Hernández-Armenteros and Pérez-García, 2015a). Institutional frameworks are also an important constrain due to the to some extent rigid university law system. Some universities have tried to overcome this limitation by creating other legal entities, such as foundations, linked to the university (Rey-García and Álvarez-González, 2015). For example, the General Foundation of the Autonomous Community of Community of Madrid (FGUAM) (see section 1.4.2).

Table 7: Main R&D indicators - academia

Indicator/inputs & outputs	2010	2012	2014	2015	EU average
R&D performed by HES and funded by GOV (% of GDP)	0.28	0.26	0.25		0.37 (2014)
R&D performed by HES and funded by private BES+ PNP (% of GDP)	0.03	0.03	0.02		0.02 (2015)
International scientific co-publications per million population	434.58	531.42	616.89	645.2	
Scientific publications among the top 10% most cited publications worldwide as % of total scientific publications of the country	9.16	9.08			
Research excellence composite indicator		12			
ERC success rate (granted over evaluated)	0.11	0.06	0.08		
R&D performed by HES (% of GDP)	0.38	0.36	0.35	0.34	0.47 (2015)

Source: ESTAT 2016, Scopus 2016.

2.3. Business

Disinvestments in the business sector in R&D have been also important between 2010 and 2015 (see Table 8). BERD represented 0.64 % of GDP in 2015, 0.05 percentage points lower than in 2010 and far from the EU-28 average (1.3 % in 2015). Business sector is the main source of R&D funds (0.57 % of GDP in 2014), but it is far from the EU-28 average (1.13 in 2014). Business sector have also suffered from declining R&D government funds, R&D performed by business sector and funded by the government have significantly declined since 2010, reaching a figure of 0.06 % of GDP in 2014. Turnover form innovation is declining, but it is still well above the European average. This indicator has declined from 19 % of total turnover in 2010 to 14.3 % in 2012, but it is nearly 2.5% higher than the European average of 2012. Spanish SMEs are more innovative than the European average. SMEs introducing any kind of innovation was 27.2 in 2012, while the European average was 25.4. A declining trend is also evident in the share of patent applications, changing from 1.16 in 2010 to 0.83 in 2014.

Table 8: Main R&D indicators - business

Indicator/inputs & outputs	2010	2012	2014	2015	EU average
BERD as % GDP	0.69	0.68	0.65	0.64	1.3 (2015)
R&D funded by BES (% of GDP)	0.58	0.59	0.57		1.13 (2014)
R&D performed by BES (% of GDP) funded by GOV	0.12	0.09	0.06		0.09 (2012)
Turnover from innovation as % of total turnover	19	14.3			11.9 (2012)
SMEs introducing product or process innovations/ marketing or organisational innovations		27.2			25.4 (2012)
World Share of PCT applications	1.16	0.94	0.83		26.09 (2014)

Source: ESTAT 2016, WIPO.

SMEs constitute 90.6 % of the total number of firms that perform R&D (9 307 in 2014) and these enterprises contributed 24.5 % of GERD in 2014 (EUR 3 139 million; 46.3 % of BERD) (INE-2016). Large firms (which represent 9.4 % of the total number of firms that perform R&D) performed 53.7 % of private sector R&D the same year. 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-2016).

The main national public programmes aimed at stimulating R&I in the private sector are included in the 'Business leadership' programme (19.6 % of the total provisional budget in 2016) and in the 'Promotion of R&I towards societal challenges' programme (19.7 % of budget managed by the CDTI). The 'Business leadership' programme had a provisional budget of EUR 493 million for 2016, decreasing by 16.5 % compared to the provisional budget of 2015. The distribution of percentage across programmes, sub-programmes and instruments for private R&I according to the provisional budget to be distributed by AGE in 2016 are included in the Annex 3.

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.[14] The limited use of tax incentives, despite its formal generosity, 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 (see section 4.2).

2.4. Private non-profit

Private non-profit sector represent a small percentage of Spanish R&D funds (see Table 9). This sector invested in R&D 0.01 % of GDP since 2010 and it is far from the European average (0.03 % in 2014). The role of non-profit sector is even smaller in the performing side of R&D with figures close to zero percent of GDP. In contrast, this sector performed on average 0.02 % of R&D as a percentage of GDP in 2014.

[14] 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.

Despite this minor role in funding terms, the public sector has an active role in the promotion of non-profit organisations related to R&I (INAEF, 2011; Rey-García and Álvarez-González, 2015). National and regional governments, universities and hospitals have promoted R&I related foundations in order to gain flexibility in their operations (see section 1.4.2).

Table 9: Main R&D indicators – private non-profit

Indicator/inputs & outputs	2010	2012	2014	2015	EU average
R&D funded by PNP (% of GDP)	0.01	0.01	0.01		0.03 (2014)
R&D performed by PNP (as % of GDP)	0	0	0	0	0.02 (2015)

Source: ESTAT 2016.

2.5. Networks, cluster, platforms, linkages

A declining trend is also visible when considering the main input-output linkages indicators (see Table 10). Public R&D funded by business has decreased from 0.05 % of GDP in 2010 to 0.03 % in 2014. This indicator that was similar to the EU average in 2010 it is now 0.02 percentage points below it. Spanish enterprises tend to cooperate more with government and research institutes than with universities. In 2012, the percentage of enterprises cooperating with universities or other higher education institutions was 10.3 %, lower than the EU average of the same year (13 %).

Table 10: Main R&D indicators - linkages

Indicator/inputs & outputs	2010	2012	2014	2015	EU average
Public R&D funded by business (% of GDP)	0.05	0.04	0.03		0.05 (2014)
Enterprises co-operating with universities or other higher education institutions (%)		10.3			13 (2012)
Enterprises co-operating with Government, public or private research institutes (%)		11.5			8.9 (2012)
Enterprises engaged in any type of co-operation (%)		29.3			31.2 (2012)
Public-private co-publications per million population	19.55	20.53	16.32		33.88 (2014)

Sources: ESTAT 2016, Scopus.

However, the number of enterprises cooperating with government, public or private research institutes in 2012 was 11.5 %, higher than the EU average of 8.9 %. The total number of enterprises engaged in any type of co-operation in 2012 was 2 percentage points below the EU average (29.3 % against 31.2 %). The number of public-private co-publications per million population has decline between 2010 and 2014 and it is now nearly half of the EU average (16.3 % against 33.9 % in 2014).

3. Innovation policy

3.1. Recent developments in innovation policy

One of the most relevant formal R&I policy initiatives taken in the last few years, that has defined the Spanish policy agenda since then, is the Law of Science, Technology and Innovation (LCTI), adopted in 2011 to replace the 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. 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). 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.

Some (still limited) further steps in the development of those mechanisms and projects have been implemented in 2016:

The National Research Agency (AEI) (Real Decreto 1067/2015 dated 27 November 2015) appointed the 15 members of its governing board (*Consejo Rector*) on the 20th June 2016. The board will be responsible for running the AEI, which is expected to become fully operational in 2017, once its budget is approved. In order to incorporate the new directing role of the AEI, it was necessary to implement some general modifications in the regulation of competencies (Resolución 21st June 2016), especially in the 2015 national programs for research projects and other scientific-technical grants (Resolución 24th June 2016). Additionally, there has been a temporary delegation of some powers and duties in economic and budgetary management vested by the MINECO to the AEI (Resolución 1st July 2016, chapter III). From 7th July 2016 the AEI also assumes executive capacity to manage the allocation of funds and monitor the remaining state actions within the PECTI 2013-2016. Likewise, the AEI will supervise the existing collaborative agreements for infrastructures projects in R&D and innovation (Resolución

7th July 2016). According to NRP 2016, the AEI will be based on more management flexibility to allocate available remnant budget. The AEI is also expected to manage 75% of the SEIDI grants and to become the main interlocutor with the EU financing agents.[15] The LCTI 2011 first envisaged separate strategies and plans for research and for innovation, but these were finally merged into a single strategy (EECTI 2013-2020) and plan (PECTI 2013-2016) in order to improve the synergies between research and innovation. However, despite the progress and the spirit of the strategy, the structure of the Spanish R&D system presents some fragmentation at different levels of government. MEDU is in charge of designing education policies at the national level, while the regions are responsible for universities. 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 (expected for 2017) 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. Because of this fragmentation, efforts must be made to encompass research, innovation and education in the policy-making process. In order to improve synergies, 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).[16]

Investment in research infrastructures is also considered in policies and strategies. Spanish government's subsidies for strategic plans to develop the Map of Unique Scientific and Technological Infrastructures (ICTs) amount to 7 million euros in 2016 (Resolución 8th June 2016). Additionally, public grants for promoting technological centres (Resolución 3rd March 2016) and technological platforms (Resolución 15th March 2016) were launched within different PECTI 2013-2016 programs. NRP 2016 envisages complementary actions to continue promoting and reviewing the existing map of ICTs in 2017.

[15] Apparently, there have not been recent noticeable changes in CPCTI and SICTI.

[16] '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 main changes in the Working Plan (PAA) 2016 of PECTI across programmes are the following:

Recognition and promotion of talent and employability programme

- Doctoral grants granted by the MEDU had increased its budget in order to make them equivalent to the ones granted by the MINECO (from 17,768 to 20,333 euros per year).
- EMPLEA grants focused exclusively on SMEs, young innovative enterprises and spin-offs to hire R&D personnel. These have been changed from loans to grants.
- Travel grants for doctorate grant holders have been simplified, allocating an additional budget of 4,750 per grant instead of making grantees to apply from these travel grants through an independent call.
- The number of 'grants for the employability of PhDs' has been increased compared to the last year call.

Promotion of excellence programme

- 'Europe Excellence' action included researchers that have been applied for 'Starting' and 'Consolidator' EU grants.
- A new call has been included to fund research infrastructures included in the new roadmap of 2014.

Business leadership programme

- Innoglobal instrument has been launched. It is an instrument targeted to firms to increases its international collaboration R&D activities through bilateral, multilateral cooperation projects or projects in cooperation with big research infrastructures (EUR 10 million in PAA 2016).
- The programme "Horizon PYME" increases its duration from six months to one year.
- The "Neotec" instruments have been increased in 5 mill euros.
- CDTI improves its financing conditions.

Promotion of R&D and innovation towards societal challenges programme

- Launch of the CDTI-ERA-NET instrument for Spanish firms applying to the ERANET programme.
- The Health strategic acting increases its funding to promote the integration of research groups into the CIBER consortia.
- The call to fund the Networks in cooperatives research in health (RETICs) has been launched.

In addition to the LCTI, another relevant R&I policy initiative in past recent years is the Entrepreneurship and Internationalisation Support Act, which was published in 2013 (Law 14/2013), and includes measures to boost entrepreneurship (e.g. fiscal measures, new instruments for entrepreneurs), to promote business growth and to boost the internationalisation of the Spanish economy (see section 4.3).

In line with an internationalisation strategy, MINECO, in coordination with the Ministry of Foreign Affairs and Cooperation, has been promoting the so-called STI diplomacy with the participation of some other government's units. The government identified the main international challenges ahead for the STI diplomacy[17], which encompasses issues related to: global climate change, sustainable growth, international STI collaboration or business competitiveness, as well as a set of general recommendations to improve the Spanish performance in reaching such international goals. Some proposals for a working plan to be developed in 2017 referred to both enhancing communication flows between different Spanish STI agents abroad and tracking STI progress through reliable indicators, which could contribute to create a joint strategy.

Policy programmes, such as the 'CIEN Strategic private consortia for innovation' (adopted in 2014) 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 to the maintenance of the CDTI's programs for stimulating performance in business R&D and innovation in 2016 (e.g. April, July), regulatory bases for subsidies to support innovative business groups (Orden IET/1009/2016 dated 20 June 2016) aims at improving SMEs' competitiveness.

Ongoing SEIDI sub-programs promoting knowledge transfer have continued in 2016 with some policy initiatives embracing different fields of action (e.g. technology transfer; venture capital; private equity fund; digital technologies; health) with the common objective of enhancing public-private collaboration in R&D and innovation. Similarly, a

[17]A report on STI diplomacy ('Informe sobre diplomacia científica, tecnológica y de innovación'), was presented by MINECO in July 2016.

new regulation on the requirements for the accreditation of institutes in biomedicine or health (Real Decreto 279/2016 dated 24 June 2016) aims at encouraging partnerships between university hospitals in the National Health System and public or private research organisations to launch new multidisciplinary research institutes with a priority in translational research.

Nevertheless, those policy initiatives seem to be insufficient to reach 2020 targets. According to References to Research and Innovation in the 2016 European Semester Country Report for Spain, "Spain's R&D intensity is losing ground" by both the private and public sectors and "Spain's innovation performance is also falling, with the country's gap with the EU average increasing" (EC, 2016: 2)

The agenda of reforms of NRP 2016, NRP 2015 and NRP 2014 aimed to tackle the restriction of growth and employment creation. The NRPs recognise the importance of R&I with regard to boosting economic growth and social development (NRP 2016: 23; NRP 2015: 32; NRP 2014: 50). NRP 2016 recognises the need of R&I measures to boost both public and private sector innovation. NRP 2016 indicates that measures have been taken to increase the stability of the policy framework by improving strategic planning through the PAA 2015 and the monitoring system of the public initiatives (CSR 3.5.20). It refers to the creation of the AEI in 2015 (CSR 4.5.21). In addition it mentions the improvement of the "Roadmap of scientific and technical singular infrastructures" (CSR 4.5.22), which has been designed in coordination with the Regional Governments.

NRP 2015 and NRP 2014 highlight the efforts of the Spanish government to improve public and private R&I funding through direct and indirect mechanisms. They state, despite the fiscal consolidation measures, the improvement of public funding for R&I as important measures. Indirect mechanisms include the implementation of the tax incentives envisaged by Law 27/2014 of 27 November 2014 in NRP 2015 and the reintroduction of social security benefits for hiring researcher in NRP 2014. Other important measures mentioned in these NRPs were: the design of specific mechanisms to increase international participation (e.g. 'Europe Excellence'); the use of European Regional Development Fund (ERDF) to boost R&I; the reduction of the replacement rate of retirees from permanent positions; and the implementation of the Spanish Research Agency.

NRP 2016 is structured across CSRs adopted by the Council of the European Union on 14 July 2015. NRP 2016 includes seven specific measures that addressed the CSRs (CSR 4.5.20-27). These measures are presented across five main R&I objectives as follows (NRP 2016: 23-24):

- To improve R&I funding by increasing the central budget for R&I (PGE-46) and to increase the non-financial budget by 12% in 2016 (CSR 4.5.23);
- To prioritise policy instruments targeting human resources for R&I by setting a 100% replacement rate of retirees from permanent positions (CRS 4.5.25);
- To increase Spanish participation in R&I projects within the European Research Area (ERA) and other international calls (CSR 4.5.26);
- To promote private sector participation in R&I (CSR 4.5.27);
- To promote firm innovation, especially for SMEs by creating a registry of innovative SMEs (CSR 4.5.24) and by promoting the public-private cooperation through the 'Collaboration Challenges' programme (CSR 4.4.5.23).

The CSR indicates that the Spanish R&D system show structural weaknesses that limit Spanish growth potential. It points that its "essential to identify new sources of funding, ensure effective and efficient use of resources, set up the new research agency and promote measures to make the business environment more innovation friendly" (p.3). However, despite efforts mentioned in the NRPs, government public R&I budget in 2016 has increased only by a 0.3% in 2016 (ICONO-MINHAP, 2015). R&I intensity of public budget (PGE-46/PGE) has increased over the last three years but it is far below its pre-financial crisis levels (1.47% in 2016 compared to 2.7% in 2008). This indicates that it will be very difficult for Spain to reach the 2% GERD per GDP national objective for R&I. The creation of the AEI was repeatedly announced in previous NRPs and it was finally created in 2015 (27 November 2015) and implemented partially in 2016. 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.

In sum, given the persistence of decisive challenges for the Spanish STI system in 2016, "further efforts are needed to increase the participation of R&D in the generation of wealth and welfare in Spain" (NRP 2016, Executive summary, III).

3.2. National and Regional Smart Specialisation Strategies

A dual purpose which inspired the smart specialization approach was: "(1) to expedite agglomeration processes by reducing duplicative regional investments in science and technology; and (2) to encourage regional players, especially regional governments, to 'particularize themselves by generating and stimulating the growth of new exploration and research activities, which are related to existing productive structures'" (Morgan, 2015: 480). Therefore, "The main goal of a smart specialisation policy is to concentrate resources on the development of those activities that are likely to effectively transform the existing economic structures through R&D and innovation" (Foray, 2014: 3).

Following those premises, 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 17 Spanish regions had made public their RIS3 strategies by mid-2014, and are currently registered in the S3 Platform. Strategies appear to have been developed using a similar structure, which includes financial requirements, measures to stimulate private investment, and monitoring and evaluation mechanisms. 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).

Regional undertakings seem to continue the implementation of their strategies to some extent. Some regional governments' actions carried out in 2015 and 2016 include:

- Revised/updated versions of their corresponding RIS3 strategies (Andalusia, Aragón, La Rioja).
- Meetings with varied regional R&I agents in workshops, fora or seminars to discuss the implementation phase as well as potential strategic plans (Balearic Islands, Canary Islands, The Basque Country, Valencian Community).

- Annual RIS3 working plans (Castille and León), or other wider operational or industrial development plans in line with their respective strategies (Asturias, La Rioja)
- The selection of a technical team to drive the strategy project forward (Andalusia)
- Regional subsidies programs for innovation and technology with priority to RIS3 sectors (Cantabria, Community of Madrid)
- A call for regional strategic sectors structured into the so-called RIS3CAT Communities[18] (Catalonia)
- A RIS3 governance proposal to social agents (Navarre)

In this context, the promotion of regular and appropriate monitoring mechanisms by policy-makers becomes essential to identify policy initiatives in the development of each regional strategy. "Monitoring mechanisms perform three fundamental functions: (1) inform about what the strategy achieved and whether implementation is on track and making this information available to decision makers; (2) clarify the logic of intervention of the strategy and make it comprehensible to the broader public; (3) support the constructive involvement and participation of stakeholders through transparent communication and promote trust building (Gianelle and Kleibrink, 2015: 1). Nevertheless, in spite of the importance of capturing the relevant expected changes and outputs that are foreseen in each RIS3, information in the Spanish regions is scattered, which makes effective RIS3 implementation difficult to track and assess.[19] In fact, monitoring documents are announced to be available in Extremadura, but only the regional government of The Basque Country has published a full report on the implementation of its RIS3. According to that report, among the main achievements reached, "The Basque Country has taken full advantage of the opportunities presented by RIS3 to review and reform both its regional innovation system and its regional innovation strategy" (p. 31). The conjunction of both the political commitment of the Basque Government and the cooperation of its partners within the Basque system of innovation seem to become crucial in that process. The principal remaining challenges

[18] "Each community is expected to carry out initiatives to facilitate collaboration among sectorial stakeholders, to improve competitiveness and to generate solutions to society's changing needs" (Marinelli et al., 2016: 7).

[19] Four regions were peer reviewed in the past and two others were subjects of case studies on smart specialisation in 2012.

ahead for The Basque Country strategy are related to: keeping RIS3 alive, collaborative and distributed leadership, funding the RIS3 policy mix, multi-departmental coordination and multi-level coordination.

As part of the S3 platform activities, targeted support to RIS3 implementation seeks to help in the refinement and implementation processes in selected EU lagging regions, as it is the case of Extremadura. The focus is on nine regions in Eastern and Southern Europe with low comparative growth in terms of GDP per capita, and that did not converge to EU average in the post-crisis era. Aid provided covers governance-related issues, transnational cooperation or sustainable RIS3 implementation.

The role of universities within the RIS3 is analysed in the specific case of Catalonia and the RIS3CAT Communities in Smart Specialisation Policy Brief 18/2016. The study observes that Catalan universities are playing an active role in the interaction with other research and innovation stakeholders in the region. Taking part of the RIS3CAT Communities has provided the universities with "a strategic vision of the region and its key sectors" as well as opportunities to "met partners that were previously out of their radium for research and innovation activities". For those reasons, "RIS3CAT Communities appear as a valuable instrument to engage stakeholders in a continuous EDP [Entrepreneurial Discovery Process]. They are also valuable to emphasize the role of universities as strategic partners in regional development" (Marinelli et al., 2016: 5).

Among the EU regions that have earmarked blue growth as a priority in their RIS3, which is expected to stimulate their respective maritime economies, are Galicia, The Basque Country and the Region of Murcia. Additionally, the PLOCAN's project aims a multi-purpose offshore platform, which will be located four kilometres off the east coast of the Canary Islands, to further marine science and develop new technologies. According to Smart Specialisation Policy Brief 17/2016, pathways to building so-called 'Blue Value Nets' requires determined actions to transform existing value chains from both the private sector - by expanding nets, sharing infrastructure or boosting clusters - and the public sector - by enabling and supporting that process - (de Vet et al., 2016).

At this early stage of practice, there is still substantial room for improvement in the development of RIS3 in Spain in terms of:

- Keeping a strong and steady thrust to propel genuine regional strengths which can contribute to the objective of creating more focus and more critical mass in the

research system. In that sense, public agents have to play a proactive role in the EDP, as a key mechanism of the smart specialization process (Foray, 2014; Morgan, 2015)

- Furthering mechanisms for intra- and inter-regional cooperation. Smart specialization "gives a chance to all regions, provided that they mobilise their resources and connect to resources outside their own territory" (ERAC, 2014: 60). Nurturing and expanding diversified networks beyond constrained administrative boundaries become essential to obtain the multiple benefits of inter-regional collaboration in R&I. "Neighbouring regions should be encouraged to offer each other innovation services by forming alliances that could compete for business or consolidate their activities to achieve supra-regional economies of scale and scope" (ERAC, 2014: 61). According to Smart Specialisation Policy Brief 16/2016, inter-regional collaboration in RIS3 across Europe clearly brings direct and immediate benefits through the involvement of low-intensity activities. It is also recommended that regions engage more with private sector actors and civil society (Sörvik et al., 2016).
- Enhancing transparency and monitoring mechanisms for better public accountability of the developments in the implementation phase. Currently, action plans are difficult to monitor at regional level as these are rarely publicly available. RIS monitoring mechanisms could face problems 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. As a plausible solution, building on existing monitoring structures could be complemented with underpinning new internal capacities in the application of simple indicator systems and the consolidation of reviewing practices.
- Improving coordination between national and regional strategies to increase the potential synergies in the Spanish system. In that sense, REDIDI plays a supporting role to promote 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. Some of the main objectives of REDIDI with regards to RIS3 are to avoid overlapping in the definition of supporting programs and the use of resources, to extend cooperation and dialogue mechanisms and to reinforce information systems.

Nevertheless, there are no available updates on those REDIDI activities in 2016. Additionally, 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 contributes to a better understanding of the Spanish R&I system. 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. However, data on the use of SICTI for national-regional coordination do not appear to be publicly available yet. Thus, taking into account the situation described above, ERAC's statements in this regard are still valid: "the articulation with the National Strategy will need to be clarified at the stage of implementation of the strategies in the regions" and "the Spanish Strategy should be updated as a mechanism to build regional-national synergies" (ERAC, 2014: 59-60).

Less tangible effects associated with RIS3 could take place in the long run, according to Kroll (2015: 2079): "the main merit of RIS3 processes may, in fact, lie in their contribution to changing routines and practices of governance even if those, for now, remain without measurable effect on policy". RIS3 implementation, therefore, could have a positive impact for the whole R&I system in the future.

3.3. Stakeholders' initiatives

The Spanish Foundation for Science and Technology (FECYT) and the Centre for Industrial Development (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. These types of reports have examined R&I activity since 1990. Previously, the FECYT conducted yearly reports on national plans (i.e. FECYT, 2013).

The FECYT also reports on the results of the Panel on Innovation and Technology (PITEC). 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. These reports are mainly descriptive. In addition, the FECYT 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.

The most recent publications in the FECYT's series are the following:

- PECTI follow-up: The *2016 PAA* (FECYT, 2016h). The PAA is the main operational planning tool of PECTI comprising both a general timetable and the allocation of budgetary resources for each of the annual programmes. Thereby, it presents some descriptive features of all the expected state government R&I calls.
- R&I indicators: A series on Spanish scientific outputs in some strategic sectors of the Spanish economy analyses the main indicators of scientific production in some key sectors such as Aerospace Engineering (FECYT, 2016g). Additionally, *Indicators of the Spanish Science, Technology and Innovation* is published annually (FECYT, 2016f).
- R&I analysis: *PITEC report on finance and human capital in innovative companies* (FECYT, 2016e) examines the behaviour of PITEC companies in 2013 regarding the sources of funding to finance their innovation activities as well as the lack of funding as an obstacle to innovation. The report also observes the staff dedicated to internal R&D and the resources that companies use for training activities related to the innovation of their workforce.
- Scientific culture: *Social Perception of Science and Technology in Spain* (FECYT, 2015). Since 2002 this study presents every two years the analysis and the results of a national survey conducted by a group of researchers and coordinated by the FECYT Department of Scientific Culture and Innovation. This study contributes to a better understanding of the relationship between science, technology and society through the analysis of the public perception about scientific and technological advances and their effects in the general well-being and the improvement of the quality of life of the population. In addition, ICONO offers microdata from all surveys and questionnaires.
- Working papers: ICONO papers published in 2016 addressed a wide set of topics from a descriptive quantitative perspective: "Excellent research institutions by

disciplines 2005-2014" (FECYT, 2016a), "Statistics on the use of biotechnology 2014" (FECYT, 2016b), "Statistics on R&I 2014" (FECYT, 2016c), and "Indicators of high tech sector 2014" (FECYT, 2016d).

Similarly, the CDTI reports its yearly activities related to the management of R&I programmes for companies, including information on funding and impact. Last published report refers to its 2014 activity (CDTI, 2016). The list of projects approved by CDTI appears quarterly in *Perspectiva CDTI*. It also publishes *Cuadernos* that review some specific policy programmes in detail and include some impact indicators. In addition, it commissions some impact analyses that point to positive additionalities of public R&I support to company R&I investments (Barajas et al., 2009; Huergo et al., 2009). In 2016 CDTI has published an evaluation of the 6th CENIT programme (2010 call) which identifies their principal effects from a quantitative point of view.

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. 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 last COSCE report analyses the resources allocated to R&I in the state budget for 2016 (Molero and de Nó, 2016). One of the main conclusions of the study is that the allocation of funds for R&I keeps at such low levels that is clearly insufficient to make knowledge the driving force of economic growth. The principal shortcoming of the state budget refers to the funds for scientific and technical training of personnel, which becomes one of the most critical aspects for the future capacity of the research 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's 2016 report points out the fact that Spain continued a recovery trend initiated in 2014 with a significant advance in GDP growth in 2015, but figures on education and R&I, which are fundamental pillars of the knowledge economy,

did not follow a similar path to take advantage of the emerging new cycle. COTEC also considers the negative evolution of the main indicators of innovation alarming from an international comparative point of view: At the early years of this century the country seemed to be ready to overcome its historical backwardness and aspired to converge with other countries in the euro zone (in the years before the crisis, the Spanish spending on R&D grew for the first time higher than those of Germany, France, Italy and UK rates). In the aftermath of the crisis, however, cuts in public spending and falling private investment have returned to gradually enlarge Spain's gap with Europe. In terms of convergence, this is perceived as more of a lost decade (COTEC, 2016: 8). For those reasons, COTEC emphasizes an increasingly broader social and political consensus in the public debate on the urgent need to correct that situation. In order to recover the lost path, COTEC recommends to implement enabling measures for innovation and to solve major structural deficiencies, which include: a low participation of the private sector in R&D, a lack of participation of financial actors in financing innovation, and poor results of the education system (COTEC, 2016: 9).

CRUE commissions detailed yearly reports on the R&I activity of universities (Hernández Armenteros and Pérez García, 2015b) and other evaluations of the education activities of universities. CRUE published the European University Association (EUA) *Trends 2015* report, which main goal is "to document the universities' perceptions of the changes that have taken place in European higher education in the past five years particularly in relation to learning and teaching" (Sursock, 2015: 10). Some of the latest CRUE reports comprise an analysis of university degrees in Spain in relation to the European Higher Education Area (EHEA), which concludes that the most urgent reforms should be strengthening masters degrees and updating doctorate programs. Both are believed to be complementary and priority reforms for the Spanish university system (Haug, 2015). In addition, the report *UNIVERSITIC 2015* carries out a comprehensive analysis of the use of ICTs in the Spanish universities - which has been conducted since 2006 - to identify good practices in teaching, learning and research activities and practical recommendations for the improvement of management processes. The report concludes that in the observed period (2011-2015) the Spanish university system has been marked by budget reductions, the consolidation of both IT infrastructure and academic support services, and institutional commitment to joint IT initiatives. There is then a persistent concern over budget cuts in IT, both in terms of human capital and

investments, which can be clearly detrimental to universities' future transformations (Píriz, 2015). The financing system of the Spanish public universities may have also reinforced some of their prevailing deficiencies in terms of relative low productivity levels, which makes universities' funding problems a crucial need to be firmly addressed (Hernández Armenteros and Pérez García, 2015a). CRUE also commissioned a survey report on 2014 Spanish Universities' research and knowledge transfer (KT) activities. This report - elaborated by RedOTRI (Transfer of Technology Offices Network) and RedUGI (Research Management Units Network) - observes a slowdown in decline in universities' research and KT activities in recent years, still not consolidated enough, even though responses to the recent economic and financial crisis are not based on R&I as one strategic component (CRUE, 2016).

The 'Fundación 1º de Mayo' has provided data on human resources of the main R&I OPIs (Fundación 1º de Mayo, 2014) and a report on the R&I state budget for 2016 (Fundación 1º de Mayo, 2015). The latter openly criticises the central government's timid increases in real spending, beyond a makeup for 2016 election year, as well as the delay in the implementation of the AEI and the restrictions in public funding for PROs. The study considers that the continuation of a retrenchment policy will both prevent R&I public employment and accelerate brain drain. The report demands that the Spanish R&I system devotes more both monetary and human resources to respond to H2020 challenges. It also requests further government's commitment to supporting business innovation. To put forward those demands, at the end of the report, the trade union CCOO announces further mobilizing actions in defence of R&I institutions and employees, including legislative proposals, court cases or street demonstrations.

Diverse civil society groups (e.g. researchers, associations, trade unions) sporadically raise their voices to oppose the deterioration in public R&I investment and employment through both analog and digital means (e.g. public statements, public petitions, interviews in radio programs, blogs, social media), making the public more aware of some key pending problems and needs. However, these kinds of actions are generally dispersed and fragmented, having a rather limited impact in practice. Such isolated initiatives show a mix of resistance, resignation and unenthusiastic scepticism about finding new grounds for either future agreements to reverse the set-back situation or effective changes in current policy-making.

3.4. Monitoring and evaluation culture

The R&I policy evaluation system in Spain is considered moderately developed (Eparvier, 2009; Heijs et al., 2011; Heijs and Martinez, 2011; Molas-Gallart, 2012; ERAC, 2014). SICTI is responsible for the data collection and impact assessment of all policy programmes and instruments of the R&I policy.[20] However, there is no access point to systematically gathered information monitoring performance in R&I policies, programs, and decisions. Better accessibility to updated valuable data would enable improved accountability and transparency for the assessment of progress in achieving main R&I goals. 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: 4). ERAC's 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 in yearly reports (e.g. CDTI, 2014a) – the report on CDTI's 2014 activity became available in April 2016 (CDTI, 2016) –, and include some impact indicators (e.g. Cuadernos; see CDTI, 2014b). Strategies and plans are increasingly based on some of the evaluation analyses, but these are not always publicly available.[21] Therefore, despite the improvements, there is not an effective

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

[21] 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.

monitoring and review system in place, as 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 with significant delays, which hinders the assessment on whether or not this information is used as input for designing subsequent funding cycles.[22] 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).

The National Agency for Quality Assessment and Accreditation (ANECA) evaluates research and teaching activities and reports its results.[23] It also evaluates policy programmes. However, these are mainly the programmes undertaken by MEDU and the results are not usually publicly available. In 2016 ANECA has published the 2015 revised version of "The Standards and guidelines for quality assurance in the European Higher Education Area (ESG)" translated into Spanish. This document is a useful instrument for universities and evaluation units regarding management processes and quality assessment of higher education institutions.

No significant R&I foresight exercises were carried out at national level between 2014 and 2016, or are not publicly available. R&I foresight exercises were supposed to be the responsibilities of the Observatory for Industrial Technology Foresight (OPTI) and ANEP, although ANEP does not carry out foresight activities directly. 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. 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). The most recent report, published by FECYT in 2013, was about the anticipated impact of biotechnology on agriculture and farming in 2025[24].

[22] 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.

[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).

[24] FECYT (2013) 'Impacto de la biotecnología en los sectores agrícola y ganadero 2025. Informe de prospectiva tecnológica'.

Among other significant review exercises, the draft of the 'Spanish Strategy for Bio-economy: Horizon 2030' underwent a public consultation process in September 2015. 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.[25]

According to the description above, monitoring and evaluation culture in the Spanish R&I system is weak and hardly influential in the policy cycle. There are interesting particular initiatives, but they lack regularity. Annual reports are mostly descriptive and have occasionally suffered delays. There is neither clarity in the approaches applied nor certainty in the use of modelling, experimentation or counterfactual impact analysis in the Spanish case.

From an academic perspective, different papers address evaluation related issues which can contribute some evidence for policy making. For instance, a study on the effects of the extensive use of formal research evaluations (based on the number of publications, impact factors, and journal rankings) introduced in the Spanish system to establish a national salary bonus (*sexenio*) for tenured professors that mitigated the lack of research incentives in universities and then extended to the Spanish National Research Council (CSIC) (Rodríguez-Navarro, 2009). Likewise, a recent study tries to foster innovation policy debate by identifying potential changes to improve Spain's innovation results to catch up with other European countries. The findings of this work point out important changes to be implemented. "Particularly interesting is the support found for improving the interconnections among the relevant agents of the innovation system (instead of focusing exclusively in the provision of knowledge and technological inputs through R and D activities), or the support found for "soft" policy instruments aimed at providing a homogeneous framework to assess the innovation capabilities of firms (e.g., for funding purposes)" (Salazar-Elena et al., 2016: 487).

Among the different purposes research evaluation can fulfil in practice, there are three significant ones: "to inform the distribution of public resources among competing objectives or performers, to help improve the implementation of policies and

[25] 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.

programmes, and to control the use of public funds" (Molas-Gallart, 2014). Nevertheless, the neutrality of evaluation processes is not fully guaranteed. In fact, "the hidden politics of evaluation matters because of the way in which the institutional framework provides actors with spaces of discretion that allow them to influence the process and outcomes of evaluation" (Gris Legorreta, 2015: 3). Manifold advantages for policy making processes, however, counteract potential risks. Policy evaluation benefits can be reinforced, particularly in the Spanish case, by furthering transparency, predictable recurrence, control mechanisms, participatory processes and public accountability.

4. Creating and stimulating markets

4.1. Demand driven innovation

According to the Spanish Observatory of Public Procurement (OBCP), public procurement represents about 18.5 % of Spanish GDP[26] – or, in other words, EUR 194 billion a year.[27]

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'[28], 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.

According to Cerrillo i Martínez (2016), the connection between public procurement and open government policies makes open contracting a good option to be further explored, especially in the prevention of corruption. For that purpose, some existing shortcomings in Spanish regulation should be addressed in the future regulation of public procurement. He advocates the transposition of the Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC. In his opinion, besides promoting the use of information technology applications in public procurement initiatives, the future Spanish law on public procurement should explicitly recognize the principles of open procurement and ensure its implementation through different mechanisms (e.g. an extensive open data policy,

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

[27] 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.

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

compulsory publication of ex ante reports and subcontracting practices, electronic mechanisms for information and reporting, or an agency to resolve cases of complaints, wrong-doing, conflicts of interest or corruption). A special report of the OBCP suggests that the control system of public procurement in Spain must be considered an investment, both in economic terms - it promotes real competition and, subsequently, enhances the efficiency of the model - and in social terms - it provides credibility to the institutional system, which is an important form of democratic improvement-. Thus, current budgetary restrictions may affect achievements in this line of action (Gimeno Feliu, 2015).

A number of laws emanating from some of the regional governments 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.[29] In June 2016 the regional government of Catalonia passed a plan for Public Procurement of Innovation (PPI). This plan envisages some important changes to promote PPI, including specialised training programs for regional public employees managing PPI (e.g. design, regulation, or implementation). In addition, PPI projects within this new plan must adhere to socially responsible procurement principles (i. e. social, environmental and equality clauses), in accordance with the rules on public procurement.

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.[30] 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.

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

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

CDTI can finance up to 75% of R&I costs related to Innovative Public Procurement projects[31].

Public procurement of innovative goods and services has been increasingly encouraged in Spain. The Spanish legal framework differentiates two complementary mechanisms for 'Pre-commercial Procurement' and 'Public Procurement for Innovation',[32] 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; - "PCP is not the purchase of innovation. Rather, it is an activity, that is undertaken, usually by a government or a public private partnership, to support innovation through the purchase of R&D services, which normally includes the delivery of a prototype" (Rigby, 2016: 382) -.
- 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.[33]

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.[34] 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.[35] The OBCP points out that the new MINECO's 'guide 2.0 for PPI' incorporates some conceptual and legal novelties for a strategic use of public

[31] https://ec.europa.eu/digital-single-market/en/news/innovation-procurement-initiatives-around-europe

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

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

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

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

procurement to promote innovation. It also presents a procedure for innovation partnerships and some specific procedural recommendations.[36]

The 'Law 2/2011 on Sustainable Economy'[37] (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)[38] 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 was developing the Spanish strategy for PPI in more detail[39], although there are no available updates on the results.

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.[40] The current state of progress towards the 3 % target remains unclear.

The OBCP participates in dissemination activities (e.g. experts' workshops, entrepreneurs' seminars, open fora), which contribute to spread knowledge about the PPI processes among different stakeholders.

In April 2016 MINECO launched a call for open market consultation on innovative solutions for the services of a technical secretariat for REDIDI. This consultation is a prerequisite to the PPI procedures.

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36 http://www.obcp.es/index.php/mod.noticias/mem.detalle/id.934/relcategoria.1138/relmenu.53/chk.db4c98a74fa22d8ef6ad297f2a6bf4b3

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

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

39 http://cordis.europa.eu/fp7/ict/pcp/docs/spain_pcp_v3.pdf

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

Different EU's initiatives help EU member states in the implementation of PCP/PPI. The European Assistance for Innovation Procurement initiative promotes the benefits of innovation procurement, providing training and assistance to public procurers interested in implementing ICT innovation procurements across the EU during 2015-2017.[41] The EC's guidance document published in March 2016 is designed to help H2020 beneficiaries that implement PCP grants to fill out the standard forms for public procurement.[42] The WaterPIPP project, funded by the European Commission under FP7, explores new innovation procurement methodologies in water sector. In May 2016 WaterPIPP published a guide for implementation of Innovation Oriented Public Procurement (IOPP) in Spain.[43]

Policy assessment:

The results of a model testing the impact of different innovation policy measures showed that PPI was positively and significantly related to countries' innovativeness (Detelj et al., 2016). However, tailored intermediation is needed to tackle potential procedural and capability failures in the process of PPI. It is then required "an increased effort to build up effective intermediation across procurement systems to support agencies in concrete procurement and, in doing so, to build up capacity for more intelligent public buying" (Edler and Yeow, 2016: 414).

A recent literature-based review of government initiatives supporting PPI suggests that "more efforts are needed to understand the nature of procurement-related interventions, namely the characteristics, instrument design and implementation of such measures", and that "more information is needed on the precise rationales, logic and objectives of such measures" (Uyarra, 2016: 378). A recent OECD report, based on the use of R&D and innovation survey data and administrative procurement records, checks the dynamics and incidence of PPI. This study emphasises the need that countries "should pay increased attention to improving the quality of administrative databases, ensuring their accessibility by adhering to basic data sharing standards which enable data linking to other administrative and survey data sources" (Appelt and Galindo-Rueda, 2016: 67).

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[41] http://eafip.eu

[42] http://ec.europa.eu/research/participants/data/ref/h2020/other/gm/h2020-guide-simap-forms-pcp_en.pdf

[43] http://www.waterpipp.eu/sites/default/files/WaterPiPP%20HTG%20MS%20Level%20ES%20Edited%20DEFINITE%20BIS%20Protected.pdf

In the light of the information collected in this section, the conclusions of the studies mentioned above (i.e. needs for effective intermediation, more detailed background information and quality administrative databases) would be also applicable to the Spanish case for future improvement in the assessment of PPI.

4.2. Regulations and standards

State's policy actions to assess the impact of regulation on innovation seem to be scarce in the case of Spain.. 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. In 2007, Royal Decree 2/2007 modified this regulation, granting the CDTI the right to provide these documents in those projects CDTI finances. Since 2015, an 'Informe Motivado' has to 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. Sánchez Granados (2012) finds some evidence on the consequences of the RD 1432/2003 that regulates the 'Informes Motivados' on tax deductions. MINECO (2014) indicates that large firms and SMEs increasingly use 'Informes Motivados', which were introduced to reduce uncertainty, showing a positive effect in stimulating firms' participation.

In some European countries - 12 out of 28 Member States, including Spain - R&D tax incentives play an important role in supporting R&D in addition to direct funding of business R&D, "though the amounts disbursed through tax incentives are lower than direct government funding". "All 12 Member States except Spain are making an increased use of such tax incentives during the crisis years" (European Commission, 2016: 143). Large firms appear to be more able to benefit from tax deductions than SMEs (MINECO, 2011). MINECO and the CDTI have undertaken some studies on the efficiency and use of the tax deductions in Spain (e.g. MINECO, 2012; CDTI, 2014b; MINECO, 2014). These studies show that firms might face problems accessing information on R&D tax incentives, perceiving the process as complex and uncertain. A recent study confirms that there is no clear diffusion of existing tax incentives for innovation among firms in Spain (Salazar-Elena et al., 2016).

This study has also identified "some necessary changes in innovation policy to be addressed in Spain, such as focusing attention on SMEs' potential innovators and traditional industries and on framework conditions through open innovation". "Particularly interesting is the need for companies to manage and report their intangibles as a way to improve the likelihood of innovation funding. This issue has not received enough attention in the literature and deserves further research" (Salazar-Elena et al., 2016: final remarks). 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.

Fundación Ramón Areces is financing a new research project on the role of regulation of capital, banking and property markets in boosting innovation.[44]

Other specific policy actions at national level to assess the impact of regulation on innovation appear to be missing. COTEC (2014) 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. COTEC's findings suggest that flexible regulations, such as those based on incentives or performance standards, have a positive impact on both market and social innovation. Likewise, regulation promoting information availability is also recommended.

Nevertheless, according to some contributions to the literature on the effects of regulatory conditions (although not specifically referred to Spain), companies' reactions to regulations generate heterogeneous impacts on innovations (Blind, 2012). "Overall, the evidence on the impact of different types of regulation on innovation is patchy regarding the type of regulation, the sectors, the companies and the time horizon of the impacts. In general, the short-term impacts of regulations are often negative for innovation, in contrast to their often positive long-term implications" (Blind, 2016b: 450) Standardisation and standards can be also used to promote innovation, and they are becoming increasingly important in public procurement processes (Blind, 2016a).

[44] http://www.fundacionareces.es/fundacionareces/portal.do?IDM=167&NM=2&TR=C&IDR=1473

4.3. Increasing the internationalization of companies

The Entrepreneurship and Internationalisation Support Act (Law 14/2013) was published on 27 September 2013 and included the following measures to boost the internationalisation of the Spanish economy: a new system of visas and residence permits was planned to attract talent and investment from abroad; and a Spanish strategy for internationalisation was envisaged (see section 3.1).

NRP 2016 considers that the MINECO's Strategic Plan for Internationalisation of the Spanish Economy 2014-2015[45] has contributed to the competitiveness and growth of the Spanish exports. One of the main objectives of that strategic plan was to strengthen the export base of the Spanish economy through financial support for internationalisation – i.e. Fund for Foreign Investment (FIEX), Fund for SME's Foreign Investment (FONPYME) and Agreement on Reciprocal Interests Adjustment (CARI)-. Government's actions aimed at both improving public management of funding and expanding financing scopes (CSR 4.6.28, CSR 4.6.29 and CSR 4.6.30). The strategic plan is currently under a final evaluation to both obtain an updated diagnosis and monitor indicators by strategic areas. The resulting evaluation report (first envisaged for the first quarter of 2016) is expected to draw conclusions and recommendations for the development of the next Strategic Plan for Internationalisation of the Spanish Economy 2016-2017 (CSR 4.6.32).

NRP 2016 also comprises increased public support for the implementation and financing of private R&I projects, innovative companies and technology-based companies. In this line of action, CDTI, as the main supporting agency for Spanish companies in the Spanish R&I system, run different funding programs and initiatives for cooperation projects. CDTI programs include support for the internationalisation of SMEs (e.g. 'Línea de Innovación Global' and the 'Eurostars internationsl interfirm cooperation' in which a SME must lead the project), and the internationalisation of R&I ('INNVOLUCRA' programs to encourage participation in international projects and 'PYME Horizon' which targets SMEs that have applied for European funding for a high-quality R&I project but were unsuccessful).[46] There is also a network of CDTI's offices

[45] http://www.mineco.gob.es/stfls/mineco/comercio/140228_Plan_Internacionalizacion.pdf

[46] 39 Spanish SMEs were successful in receiving EU finding for innovative R&I projects in the last call of Horizon 2020's SME Instrument: http://ec.europa.eu/spain/pdf/2016/0302-1.pdf

in 28 countries, which offers support to Spanish companies and promotes international technological cooperation. The CDTI's Annual Operational Programme (approved in March 2016) is now being implemented (CSR 4.5.27). On April 22nd 2016 CDTI and N+1, a private equity fund, launched a 400 million fund to support the growth and internationalization of technological and industrial mid-cap companies.

In May 2016 ICEX, a state entity that aims to promote the internationalization of Spanish companies, published a guide of the main financial incentives and public subsidies at state level (some European too) (ICEX, 2016). This document has been prepared to provide a brief description (e.g. supporting mechanism, targeted economic sector, type of company, available calls, supporting agency) of different programs and tools that serve to stimulate investment and business development in Spain, including specific grants for R&I goals (pp.9-10).

Government programs seem to indicate that increasing attention is being paid to SMEs in the policy mix. Support measures for SMEs targeted at industries with a growing market are offered through some CDTI programs. 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 SMEs among their members and that consortia collaborate with public research centres, which aims to increase cooperation and knowledge sharing. In June 2016 the government published the regulatory bases for subsidies to support innovative business groups aiming at improving SMEs' competitiveness (Orden IET/1009/2016, 20th June). Attention to potential innovators among SMEs and traditional industries is particularly encouraged by experts in the Spanish R&I system (Salazar-Elena et al., 2016).

In the application of the European Structural and Investment Funds (ESI Funds) for 2014-2020 Spain is part of the SME initiative which will boost SMEs' growth and job creation (Spain country factsheet – April 2016). ESI funds are expected to contribute to "enhance the competitiveness of SMEs (including in agricultures and fisheries) by engaging start-ups in higher-added-value activities and supporting their presence in international markets". Among the ESI Funds' priorities is also the strengthening of RD&I "with an emphasis on applied RD&I and ICT, particularly in favour of SMEs" (p. 2). A European Semester Thematic Fiche on SMEs' access to finance (May 2016) acknowledges the existence of important differences in financing conditions for SMEs

between Member States - Spain is one of the European countries where venture capital investment concentrated in 2014 (p.5), but with a relatively developed securitisation markets - (p. 9). SMEs can access the European Small Business Portal (Portal europeo para las PyMES) where they can find useful information on funding options, potential partners or internationalization processes. In this portal the EU offers SMEs some pieces of practical advice as well as information on issues related to European policies. Similarly, the Directorate-General (DG) for Internal Market, Industry, Entrepreneurship and SMEs "helps the internationalisation of European businesses and their competitiveness in order to generate growth and jobs".

In a comparison of the innovation impact of national and international public R&D support programs - in a sample of 2,319 Spanish firms during the period 2002-2005 -, Huergo and Moreno (2014) find that "national subsidies have a higher impact on internal R&D intensity than EU grants, but the opposite relation is found as regards total R&D intensity. This suggests that international funding is more effective for fostering external R&D activities." (p. 26).

When observing the recent evolution in the internationalisation of Spanish companies, they seem to have increased their direct investment abroad, but still at levels far from the pre-crisis annual average in 2005-2007. Therefore, the maintenance of a steady re-internationalisation pace still represents a challenge, especially in a growth scenario for the Spanish economy (Chislett, 2015). Public institutions' stimuli for SMEs to leap into foreign markets should be followed-up with assistance measures to ensure continuity in the implementation of companies' exporting plans in order to consolidate their initial internationalisation efforts.

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. FDI inflows meant a 3.8 per cent of gross fixed capital formation in 2015 - in contrast with 8.4 per cent in 2014, 12.5 per cent in 2013 and 10.0 per cent in the pre-crisis period 2005-2007 -. However, inward FDI stock increased from 42.8 per cent of the GDP in 2014 to 44.5 per cent in 2015 (UNCTAD, 2016). 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. Similarly, increasing multilateral and bilateral cooperation R&I agreements might attract FDI. The new roadmap of R&I infrastructures could be an opportunity to attract either greenfield or brownfield FDI.

5. Conclusions

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, below). The identification of these challenges is based on previous studies (OECD, 2006; ERAWATCH, 2009; EC, 2011, 2014b; ERAC, 2014), and recent policy documents (e.g. EECTI) and measures (see Table ii in Annex ii for challenges identified by the OECD, EECTI and ERAC evaluation documents).

Improving the public labour market for researchers remains the major challenge confronting the Spanish R&I system. More urgent and ambitious policy actions in this area are required to address this challenge. Despite this, the budget for the "subprogramme of employability" decreased by 46% from 2015 to 2016, notwithstanding improvements within some specific calls (e.g. 'Grants for the employability of Phds'). The creation of the AEI may improve the governance of the public R&I system (the second challenge). However, its implementation is still pending. Improving the framework conditions for innovation represents a persistent challenge for the Spanish R&I system, which would likley benefit from ambitious measures targeting SMEs. Stimulating regional research and innovation potential and performance represents the final challenge.

Table 11: R&I challenges - summary

Challenges/opportunities	Policy measures/actions addressing the challenge	Assessment in terms of appropriateness, efficiency and effectiveness
Improving framework conditions for 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	The results appear to be positive although more studies of the efficiency of these programmes are 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 are necessary. The new Entrepreneurial Support Act might help to overcome

	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.	these limitations. In addition, the new programmes targeting SMEs and encouraging public–private cooperation and knowledge transfer might help to address this challenge.
Improving funding and governance of the R&I 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. Creation of the National Research Agency (AEI).	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. 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. The AEI will not be operational until 2017.
Improving the public labour market for researchers	Regulatory measures to reduce 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 instruments 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 fluctuating 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. Although, some specific PECTI calls have considerably improved its provisional budget from 2015 to 2016 ('Grants for the employability of Phds'), the 'subprogramme of employability' that includes this instrument has nonetheless decreased by 46.2% over the same period.
Stimulating regional research and innovation 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. Many of the autonomous communities focus on similar priorities, which could reduce the effectiveness of specialisation at national level.

Source: Author compilation.

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Annex 1 – Abbreviations

ADE: Digital Agenda for Spain

AEI: Spanish Research Agency - Agencia Estatal de Investigación

AGE: National State Administration - Administración General del Estado

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

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

DESI: Digital Economy and Society Index

DTF: Distance To Frontier

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

EDP: Entrepreneurial Discovery Process

ERAC: European Research and Innovation Area Committee

EU: European Union

FDI: Foreign Direct Investments

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

FTE: Full-Time Equivalent

GBAORD: Government Budget Appropriations or Outlays on R&D

GCI: Global Competitive Index

GDP: Gross Domestic Product

GERD: Gross Expenditure on Research and Development

HES: Higher Education Sector

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

ICT: Information and Communication Technology

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

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

MDEF: Ministry of Defence - Ministerio de Defensa

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

MNEs: Global Multinational Enterprises

NRP: National Reform Programme - Programa Nacional de Reformas

OBCP: Observatory of Public Procurement – Observatorio de Contratación Pública

OBSAE: Observatory of E-Governmet

OPIs: Public Research Bodies - Organismos Públicos de Investigación

PROs: Public Research Organisations

PAA: Working Plan - Programa de Actuación Anual

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

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

R&I: Research and Innovation

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

SMEs: Small and Medium Enterprises

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

STEM: Science, Technology, Engineering and Mathematics

TFP: Total Factor Productivity

Annex 2 – The European Research Area priorities

The European Research Area priorities

ERA Priority 1. Competitive funding and peer review

To increase the role of competitive project-based funding has gain importance in the Spanish R&I system. Figures on the share of project vs. institutional public funding for R&D are not usually publically available. However, some estimates indicate that the approximate share of national project funding over the total funding was around 37% in 2013. Institutional funding is not distributed on a competitive basis. National project funding has decreased significantly over the last five years. This funding mode has especially suffered from public budget reductions due to the more fix character of the other budget lines. The provisional budget for R&D and Innovation distributed by the State Secretary of Research Development and Innovation for 2016 was EUR 2513.8 million, this budget has decreased by 10.4 % compared to 2015 budget (MINECO, 2016).[47] The new plan PECTI (2013-2016) clearly states that most of the funds will be distributed through competitive funding mechanisms.

ERAC (2014) recognised that the Spanish R&I system lacks of an effective system of evaluation. The Spanish evaluation culture is dominated by its control functions. Evaluations are sometimes merely cumbersome fiscal controls, in which the learning function of the evaluation process tends to be absent.The need to improve the policy evaluation culture is also 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. 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 2015).

[47] This budget is only part of the Central Government share (PGE- budget line 46) (EUR 6,425 million). This provisional budget data has to be taken with caution as it has been taken from the working plan of the new plan PECTI (2013-2016) and percentages are own calculation.

ERA Priority 2. Joint research agendas and joint implementation/funding

A study on Joint and Open Research Programms (JOREP) established that Spain devotes more than 4% of its GBAORD to joint programmes including European Space Agency (ESA) (JOREP, 2012). JOREP web database is not available yet in order to update this information. ESA initiatives represent the highest volume followed by other European initiatives and bilateral agreements.

The national and international coordination of research agendas and activities is also a priority for the Spanish R&D policy system. Spain has a quasi-federal decentralised political system and so its R&D and innovation-related policies are on the same basis. Then one of the challenges of the Spanish R&D system was to improve the coordination (OECD, 2006; ERAC, 2014). Some efforts have been made to improve coordination. For example, the new LCTI (2011) is aimed at improving national and regional coordination through the CPCTI. In addition, the smart specialization strategies might help to improve research agendas and joint implementation. However, these strategies show some overlapping priorities, with several regions prioritising the same areas.

ERA Priority 3. Open labour market for researchers

Spain has a highly regulated market for researchers, with low levels of institutional autonomy for human resources management and a dual labour market for researchers (civil servants and non-civil servants). This dual labour market for researchers has made non-permanent researchers to suffer particularly the negative consequences of public budget reductions in R&I.

Open, transparent and merit-based recruitment of researchers

The labour markets conditions for young researchers has worsened over the post-crisis period 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 broken making human resource management the area that probably requires the most urgent action. The law LCTI (2011) include some changes regarding human resources for R&D, but these have been limited in their implementation.

Access to and portability of grants

Spain follows a quite open strategy and tends to grant full access to research grants for the training of individual researchers. However, foreign access to calls for R&D projects is usually restricted to nationally based researchers. Portability of grants tends to be difficult, requiring institutional agreements to make it possible.

EURAXESS

Spain joined EURAXESS in 2004. The FECYT coordinates the network at national level and provides information and support to mobile researchers. It also promotes the Charter and Code among Spanish research institutions. The network has more than 90 centres in different regions. The use of the network has increased in the last years.

Doctoral training

Within the general framework set by national regulations, universities enjoy high level of autonomy in the organisation of their doctoral programmes through internal regulations. Some policy measures aim ate implementing some elements of the Innovative Doctoral Training. For example, the Campus of International Excellence" (CIE) or the "Severo Ochoa and María de Maeztu" programmes. Intersectoral PhD training is encouraged through the "Torres Quevedo" programme.

HR strategy for researchers (HRS4R) incorporating the Charter and Code

The EESTI strategy (2013-2020) and the LCTI (2011) follow principles set out in the Charter and Code. Nearly 150 public and private research institutions have endorsed the Charter and Code (Euraxess access) (access 2016). In addition, twelve institutions have acknowledged the HRS4R (Euraxess access). However, the labour market is currently unattractive for national and foreign researchers and has additional barriers (e.g. ANECA cumbersome accreditation procedure) for foreign researchers.

Education and training systems

The number of graduates in science, technology and engineering has decreased importantly over the last ten years. Some signs of recovery are shown in the last years. However, this could be an effect of the crisis pushing young people towards university studies. The Bologna process has improved the focus of education and training curricula on equipping people with the capacity to learn and to develop transversal competences.

However, this process has been implemented with a low degree of consensus among stakeholders and small budget for its enactment.

ERA Priority 4. Gender equality and gender mainstreaming

The policies for the promotion of women in general are an important topic in Spanish society. Spain had (from April 2008 till October 2010) a Ministry of Equality and each law presented in the parliament required an impact report about the effects on gender aspects.[48] The Strategic Plan on equal opportunities (2008-2011) includes gender issues in research. The proportion of female researchers in Spain is higher than the one of the EU-28, 39.6% in 2014 (ICONO-INE: 2016) against 38% in 2008. However, the share of female researcher in full time equivalent has remained quite stable which might indicate that female researchers are hired more frequently under temporary contracts. However, gender differences appear to remain at high level (CSIC, 2016).

The new Law LCTI 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. From 2006 to 2011, most contracts and scholarships included career breaks based on parental leave. However, maternity leave still has negative effects on the career of a researcher because: (1) until recently, some scholarships did not pay social security in the first two years; (2) once the women obtain a contract it was necessary to reach the minimum time span of social security contributions to have the right to maternity leave (approximately 180 days); (3) the lack of formal contracts (including researchers required to be self-employed for working at some universities) entails female researchers losing several rights in comparison with other mothers [49] and (4) the 4 months of maternity leave is not always compensated for with a four months extension of the contract (Villaroya et al, 2007). The UMYC study showed that having children is still one of the main obstacles for the productivity and promotion for women in science.

[48] 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.

[49] Some regions ('Comunidades Autónomas') provide some benefits (e.g. access to kindergarden) or financial state deductions for young children.

The LCTI and other policy measures (e.g. EESTI and PECTI) have included important positive changes regarding gender equality and gender mainstreaming in research (see below).

National and regional Institutes for women have developed important work for the promotion of gender equality and gender dimension (including research programmes) (see, for example, Institute for women created in 1988).

ERA Priority 5. Open access to scientific information, preservation of scientific knowledge, electronic identity for researchers

e-Infrastructures and researchers' electronic identity

New national, regional and institutional initiatives aim at encouraging the development of research and education-related e-infrastructures and digital research services. At national level, the new Law (LCTI), the new Strategy (EESTI – 2013-2020) and Plan (PECTI – 2013-2016) encourage access to research results and the use of data repositories. FECYT grant access to bibliographic information to research institutions. The Spanish Public Universities and Research Libraries Network (REBIUN) provides access and exchanges between 74 State Universities. The Eduroam ES project offers a common roaming environment between Spanish research organisations.

Open Access to publications and data

Measures for Open Access (OA) to scientific research and publications are being taken. The Law LCTI includes a disposition (Art. 37) on open access that aims at facilitating access to publically funded research results and data. Following this measure, the new plan includes requirements on open access in their calls. Digital Agenda for Spain, the Berlin Declaration, The Alhambra Declaration, Latindex and Dialnet are some initiatives that encourage open access.

ERA Priority 6. Knowledge transfer

The new EESTI strategy (2013-2020) and PECTI plan (2013-2016) follow previous efforts to improve knowledge transfer and innovation (e.g. INGENIO 2010). They encourage the creation of technology-based firms and university spin-offs; the promotion of R&D projects in general and more specifically public-private cooperation in long term

strategic projects (e.g. Sub-programme of collaborative R&I). They also include policies to foster human capital, such as the incorporation of PhD holders into the private sector. They offer extra financial support for R&I in general and specifically for risk capital and pay attention to societal challenges and public procurement for the acquisition of innovative goods and services. The new Entrepreneurship and Internationalisation Support Act (Law 14/2013) also aims at improving finance for entrepreneurs and reducing the administrative burden on starting a new business.

ERA Priority 7. International cooperation

Policy efforts have been made to increase the internationalisation and orientation towards societal challenges of the Spanish R&I system. The new plan PECTI plan (2013-2016) follows previous efforts and encourages the internationalisation of the research system. The system is also moving towards a better alignment with the European agenda. Spain participates actively in different joint activities (e.g. ERA-NETS, Joint Programming Initiatives (JPI), Joint Technology Initiatives (JTI)). In addition, due to its traditional relationship with Latin America, cooperation programmes with this region are important.

Annex 3 – Policy repository

List of funding programmes of plan PECTI (2013-2016) (AGE). Total budget, percentages, number, timeline, managing unit and target group for 2016

Instruments	2015 Total (mill. €)	2016 Total (mill. €)	%	Av. Change 2015-16 (%)	Nº	Timeline (years)	Managing Unit	Target group
Recognition and promotion of talent and employability Program	389.0	309.8	12.3	-20.4				
Subprogramme of Education and training	180.3	191.5	7.6	6.2				
Starting collaboration grants for research	4.7	4.9	0.2	4.5		1	MECD	University students
Doctoral Training program (1)	94.4	97.2	3.9	2.9	1048	4	MINECO	PhD students
Industrial PhDs	3.0	3.0	0.1	0.0	50	Max. 4	MINECO	Firms and PhD students
University Doctoral training (FPU)	65.8	74.0	2.9	12.4	850	4	MECD	PhD students
Doctoral Training European University Institute -IUE	1.1	1.1	0.0	0.3	12	4	MECD	PhD students
Postdoctoral training "Juan de al Cierva-training"	11.3	11.3	0.4	0.0	225	2	MINECO	PhDs
Subprogramme of Employability (2)	193.2	103.9	4.1	-46.2				
"Ramón y Cajal" programme	54.0	54.0	2.1	0.0	175	5	MINECO	PhDs with less than 10 years of career experience
Grants for the employability of PhDs (3)	1.3	7.5	0.3	476.9	100	3	MINECO	Ramón y Cajal researchers without permanent position
"Juan de la Cierva-employability"	14.4	14.4	0.6	0.0	225	2	MINECO	Young PhDs (Degree 2011-2013)
Hiring of Technicians for R&D	7.0	7.0	0.3	0.0	180	3	MINECO	University Students and technicians
Torres Quevedo programme	15.0	15.0	0.6	0.0	200	3	MINECO	Firms and PHDs
"Emplea". Grants for hiring R&D managers in firms	101.5	6.0	0.2	-94.1		3	MINECO	Firms and other R&I related entities (foundations)
Subprogramme of Mobility	15.5	14.4	0.6	-7.1				
Pre PhD. Mobility grants	5.0	4.0	0.2	-20.0		2-4 months	MINECO	PhD students (FPI-U) 2013-2014

Mobility grants for Spanish researchers abroad	9.4	10.0	0.4	6.0	660	3-6 months	MECD	Researchers
International cooperation mobility grants - France	0.5	0.4	0.0	-31.3		n.a.	MECD	University research personnel and PhD Students
Promotion of excellence Programme	347.8	187.9	7.5	-46.0				
Subprogramme for knowledge generation (*)	139.1	134.1	5.3	-3.6				
R&D projects (4)	125.5	125.5	5.0	0.0		3-4	MINECO	Research groups
"Science Scanning" and "Technology Scanning" Projects	5.0	5.0	0.2	0.0		1-2	MINECO	Researchers and research groups
"Europe Excellence" action	1.2	1.1	0.0	-6.3		1	MINECO	non-awarded ERC Starting Grants 2014 (A level) or EMBO YIP Award nominees 2012-2013
"Excellence networks" action	7.4	2.5	0.1	-66.1		2	MINECO	Research groups
Subprogramme of Institutional strengthening	58.8	46.8	1.9	-20.4				
"Severo Ochoa" and "María de Maeztu" excellence centre programme	52.0	40.0	1.6	-23.1		4	MINECO	Research Centres and Research groups
"Technology Centres Europe"	3.5	3.5	0.1	0.0		2	MINECO	Technology Centres
Grants for the promotion of scientific and innovation culture	3.3	3.3	0.1	0.0		1	FECYT	Researchers, Research Centres, firms and other institutions
Subprogramme for scientific and technological infrastructures (5)	150.0	7.0	0.3	-95.3				
Grants for the adquisiton of R&D equipment	150.0	7.0	0.3	-95.3		1	MINECO	Public Universities and Public Research Centres
Business leadership programme	591.0	493.7	19.6	-16.5				
Subprogramme for private R&D and Innovation	331.0	256.7	10.2	-22.4				
R&I projects (6)	183.0	134.0	5.3	-26.8	255	1-3	CDTI	Firms and Consortia

"CDTI Eurostarts" International Inter-firm cooperation	5.0	10.0	0.4	100.0	32	3	CDTI	Firms and consortia non-awarded Eurostars programme
NEOTEC grants	10.0	15.0	0.6	50.0	75	1.5-2	CDTI	Young and innovative firms (less than 4 years)
Innoglobal		10.0	0.4		50	1-3	CDTI	Firms
"CDTI innovation direct line" Technolgoy innovation projects	104.0	69.0	2.7	-33.7	120	1.5	CDTI	Firms
"CDTI Global innovation direct line" Innovation projects	20.0	15.0	0.6	-25.0	8	2	CDTI	PYMES and midcaps (less than 1500 employees)
"PYME Horizon"	9.0	3.7	0.1	-58.9		1	MINECO	non-awarded Horizon 2020 PYMES
Subprogram of enabling technologies	110.0	137.0	5.4	24.5				
CDTI projects R&I	81.0	124.0	4.9	53.1	235	1-3	CDTI	Firms and Consortia
"CDTI innovation direct line" Innovation technology projects	29.0	13.0	0.5	-55.2	25	1.5	CDTI	Firms
Subprogramme of collaborative R&D and Innovation	150.0	100.0	4.0	-33.3				
"CIEN" Strategic private consortia for innovation	150.0	100.0	4.0	-33.3	16	3-4	CDTI	Firms and Consortia
Promotion of R&D and innovation towards societal challenges	1,479.2	1522.5	60.6	2.9				
Challenges and actions	1174.5	1193.2	47.5	1.6				
"Collaboration Challenges" R&I projects (7)	573.9	586.4	23.3	2.2		2	MINECO	Firms, Universities, Research Centres, and other research and technology centres
Technology platforms		5.8	0.2			2	MINECO	Firms, Universities, Research Centres, and other research and technology centres
"Research Challenges". R&I projects (8)	243.9	243.9	9.7	0.0		3-4	MINECO	Public and PNP research entities
R&I projects for young researchers (9)	20.6	20.6	0.8	0.0		3	MINECO	Public and PNP research entities

"Firm Challenges". R&I projects (10)	141.0	189.0	7.5	34.0	362	1-3	CDTI	Firms and private consortia (Economic Associations - AIE)
"CDTI innovation direct line" Firm Challenges (10)	57.0	53.0	2.1	-7.0	90	1.5	CDTI	Firms
"FEDER interconection" (10)	110.0	50.0	2.0	-54.5	54	2-3	CDTI	Private consortia (2-6 firms) in FEDER regions
CDTI-ERANETs grants		7.3	0.3		20	1-3	CDTI	Firms
Joint programming actions. International	10.0	15.0	0.6	50.0		2-3	MINECO	Research Centres
INIA R&I projects	14.3	13.5	0.5	-5.3		3	INIA	Public Research Centres
INIA complementary actions	0.2	0.2	0.0	0.0		1-3	INIA	Research Centres
Agri Research personnel contracts (INIA-FPI)		5.0	0.2			4	INIA	Research Centres
DOC-INIA PhD hiring		3.5	0.1			5	INIA	OPIs
Strategic Action in Health	104.6	159.3	6.3	52.3				
PFIS Contracts	1.0	2.5	0.1	150.0		4	ISCIII	Health Research Institutes
I-PFIS Contracts		1.0	0.0			4	ISCIII	PhD. Students
PhD training in managing health research	0.8	0.6	0.0	-25.9		3	ISCIII	University graduates
"Río Hortega" contracts	2.5	2.5	0.1	0.0		2	ISCIII	Centres listed in art.4.1b ECC/1051/3013
IIS- managing health research contracts	0.3	0.3	0.0	0.0		3	ISCIII	Health Research Institutes
"Miguel Servet" contracts	12.5	13.2	0.5	5.7		5-3	ISCIII	PhDs (2000-2010)
"Sara Borrel" Contracts	2.4	2.4	0.1	0.0		3	ISCIII	PhDs (after 2011)
"Juan Rodés" Contracts	3.2	3.2	0.1	0.0		3	ISCIII	Health Research Institutes
SNS research intensive contracts	2.4	1.4	0.1	-40.0		1	ISCIII	Public and private entities
Grants for research mobility	0.8	0.8	0.0	0.0		2-6 months	ISCIII	Researchers under a health grant (e.g. Miguel Servet)

CIBER hiring programme	0.8	15.7	0.6	1818.3		n.a.	ISCIII	Research groups
REDTICS- Cooperative health networks		46.2	1.8			n.a.	ISCIII	Research groups
IIS excellence projects	6.8	5.0	0.2	-26.5		3	ISCIII	Health Research Institutes
Health research projects	63.8	61.3	2.4	-4.0		3	ISCIII	Research Centres
Joint programming actions. International	2.9	3.3	0.1	12.1		3	ISCIII	Research Centres with positive evaluation of joint activity programmes
Strategic Action digital economy and society	200.0	170.0	6.8	-15.0				
Technology forward projects	140.0	60.0	2.4	-57.1			SETSI	Firms and AIE
Big IT projects	60.0	20.0	0.8	-66.7			SETSI	Firms and AIE
International R&I projects		12.0	0.5				SETSI	Firms and AIE
Broadband R&I projects (11)		63.0	2.5				SETSI	
ENISA digital agenda		15.0	0.6				SETSI	Entrepreneurs and SMEs
TOTAL	2807.0	2513.8	100	-10.4				

Source: PECTI (2013-2016) working plan.

(*) Total differs to the one presented in the PAA in 0.5 mill.

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

(2) INIA employability grants are included in Challenges sub-programme.

(3) Replaces I3 programme.

(4) Includes co-finance up to a maximum of €45 m FEDER advanced payments and €80.5m in grants.

(5) The call for R&I infrastructures is bi-annual.

(6) Includes FEDER advanced payments.

(7) Includes FEDER advanced payments.

(8) Includes €90m of FEDER advanced payments and 153.9 grants.

(9) Includes €8.2m of FEDER advanced payments and €12.3m grants.

(10) Includes FEDER co-funds.

(11) Includes €55m FEDER advanced payments and €8m in grants.

Annex 4 – Governance of the R&I system

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[50] among R&I activities (ICONO-MINHAP: 2016). Other ministries that are relevant to the management of R&I are the Ministry of Industry, Energy and Tourism (MINETUR) (responsible for 24.4 % of the budget in 2016), the Ministry of Defence (MDEF) (2.6 %) and the Ministry of Education, Culture and Sports (MEDU) (1.5 %) (ICONO-MINHAP: 2016).

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.[51] 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 Annex 4); the coordination with other regional R&I bodies; and the international representation of the Spanish government on R&I issues.

[50] 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.

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

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.

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 (see section Annex 5 for funding distribution across managing units).

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.[52]

Bodies providing science policy advice and support

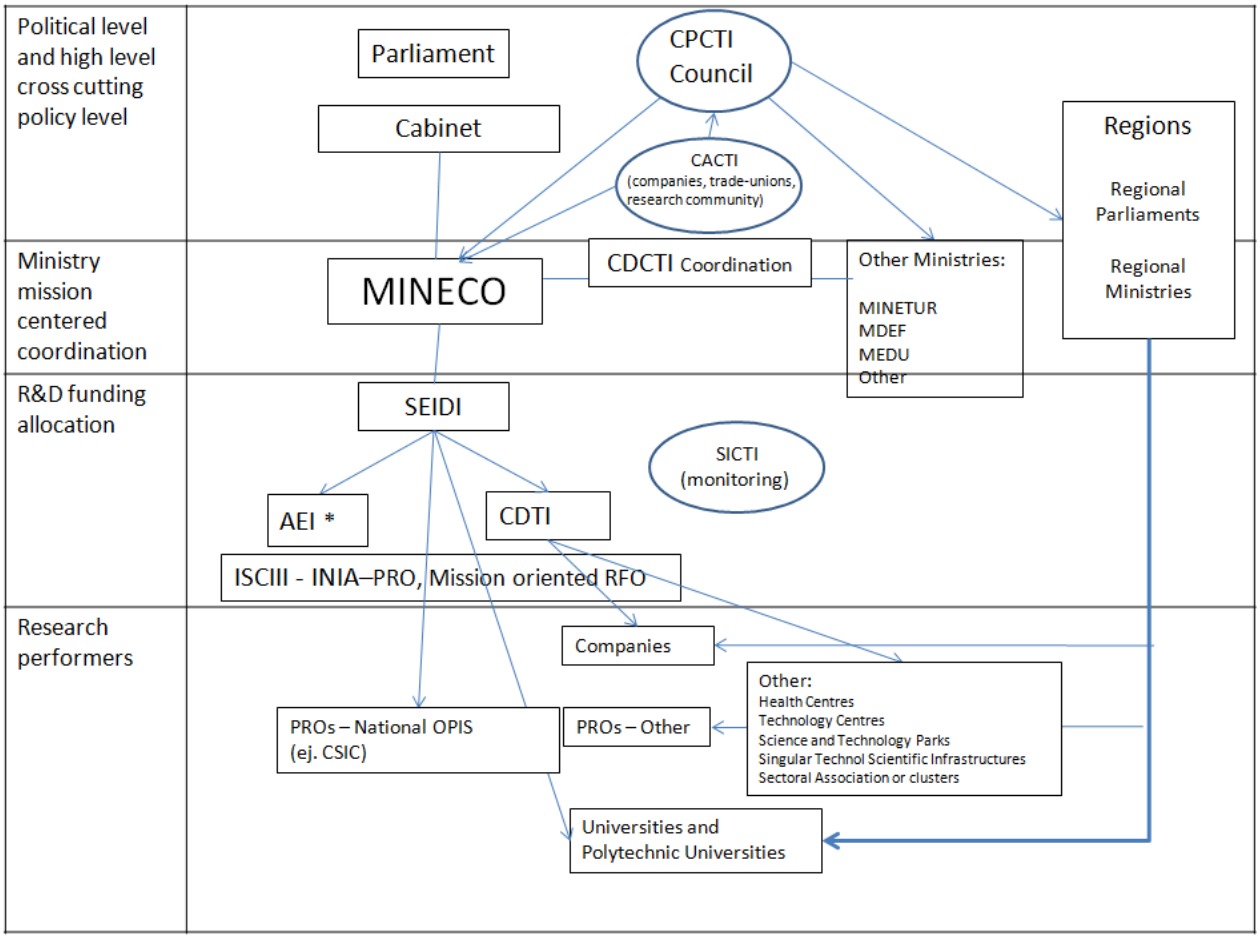
The two main advisory and supporting bodies of MINECO are the CPCTI and CACTI.

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.

[52] 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.

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.

Organigram of the Spanish R&I system



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

Annex 5 – Supporting documents

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

EU rank	world rank	Name	Industrial sector (ICB-3D)	R&D 2014 (million €)
28	89	BANCO SANTANDER	Banks	1,345.0
32	109	TELEFONICA	Fixed Line Telecommunications	1,111.0
60	200	AMADEUS	Software & Computer Services	568.4
129	457	INDRA SISTEMAS	Software & Computer Services	195.1
144	498	ACCIONA	Construction & Materials	174.9
147	504	GRIFOLS	Pharmaceuticals & Biotechnology	171.9
148	506	IBERDROLA	Electricity	170.5
231	777	ALMIRALL	Pharmaceuticals & Biotechnology	100.6
232	782	ABENGOA	General Industrials	99.7
254	872	REPSOL YPF	Oil & Gas Producers	87.0
273	935	INDUSTRIA DE TURBO PROPULSORES	Aerospace & Defence	79.0
279	962	GAMESA	Industrial Engineering	75.8
330	1196	ZELTIA	Pharmaceuticals & Biotechnology	56.3
336	1225	ACS	Construction & Materials	54.8
347	1275	BANCO POPULAR ESPANOL	Banks	51.0
390	1471	FERROVIAL	Construction & Materials	42.6
484	1912	OBRASCON HUARTE LAIN	Construction & Materials	28.5
635	n.a	ACERINOX	Industrial Metals & Mining	16.1
721	n.a	CAF	Industrial Engineering	12.9
744	n.a	LABORATORIOS FARMACEUTICOS ROVI	Pharmaceuticals & Biotechnology	12.0
822	n.a	AZKOYEN	Industrial Engineering	9.6
869	n.a	RED ELECTRICA DE ESPAÑA	Electricity	8.3

Source: Innovation Union Scoreboard 2015. EC (2015).

Annex 6 – Policy making

Challenges/opportunities identified by OECD (2016), EECTI (2013-2020) and ERAC (2014)

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 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	(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; (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.	*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) 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

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		

Source: Own elaboration from challenges and recommendations from these reports.

Note: The numbers in the challenges are including ex-post in the case of the OECD (2006) report.

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