ERAWATCH COUNTRY REPORTS 2010:
Spain

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Executive Summary

As highlighted by the Lisbon Strategy, knowledge accumulated through investment in R&D, innovation and education is a key engine of long-term growth. Research-related policies aimed at increasing investment in knowledge, with a particular focus on the private sector, and strengthening the innovation capacity of the EU economy are at the heart of the Lisbon Strategy. This focus is confirmed as the main policy challenge and the need for more rapid progress towards establishing the European Research Area, including meeting the collective EU target of raising research investment to 3% of GDP, is emphasised. The specific objective for Spain is a 2% GERD/GDP of which 55% should be financed by the private sector.

In the last few years Spain has intensified its R&D and innovation (R&D&i) policies in quantitative and qualitative terms. Total R&D expenditure increased from almost €6.500b in 2001 to €14.701b in 2008 (respectively 0.91% and 1.35% of its GDP). The private sector finances 45% of the funds (far below the Lisbon objective) and executes almost 55%. Also the policy mix was clearly reinforced by the implementation of new instruments within the framework of the INGENIO 2010 initiative of 2006 and the Spanish Innovation Strategy approved in 2010. Therefore Spain seems to be moving in the right direction in terms of R&D expenditures, although for 2009 a decrease of 2.4% of the GERD was estimated. However, the long term impact of these growing financial efforts will be almost zero if they are not accompanied with measures that ensure structural changes and modernisation of the public research system. The lack of meritocracy, the low quality and the mismatch between academic research and commercial or societal needs has a negative effect on the usefulness of the research results and the quality of human capital and makes technology and knowledge circulation more difficult. This impedes multiplier effects for the Spanish innovation system as a whole because the low average level of excellence and quality of the research results -which do not reach a sufficient level-, implies that Spanish firms will contract R&D abroad and foreign subsidiaries will not locate R&D in Spain. Concluding, the above mentioned aspects can be considered as a systemic failure and should be tackled in the planned reforms to ensure an institutional modernisation of public research and consequently a continuous growth of its R&D expenditures and knowledge circulation. Another important barrier for the increase of the R&D efforts in Spain is its productive structure, with a significant weight of small and medium sized firms, a large number of the least innovative traditional sectors and a small high tech sector with a marginal growth of the promising emerging sectors. Moreover, Spain lacks multinational enterprises that could have a leading role in creating R&D related networks or clusters based on scale and scope economies with the corresponding systemic advantages. Other barriers or systemic failures are the lack of critical mass and the fragmentation of its public research system (in public research organisations and especially in universities), the low level of integration between industrial and academic research, and the small number of new technology based firms or academic spin-offs. On the other hand, a positive effect on the innovative culture - and therefore on R&D expenditures - is generated by structural changes in the general economic environment. Spain can no longer be considered as a low wage country and the introduction of the Euro implies the loss of the exchange rate of the peseta as an instrument to gain competitiveness. These facts push the Spanish firms to compete

in innovation and quality. Moreover the European support by structural funds - clearly reoriented to innovation and R&D - and the creation of the European Technical Fund also offer an improvement of the overall Spanish innovative environment. These three framework changes generated a positive virtuous circle of an increase in the innovative culture of firms, in R&D investments and in the policy interest in R&D. However, the public research sector is still one of the main weaknesses to ensure system based synergies. The fact that Spain is no longer a low wage country implies the relocation of non-R&D enterprises of the traditional sectors to newly industrialised low wage countries. This fact in itself is not the problem if at the same time new firms in medium high tech sectors are created. Therefore the low number of business creations in the high tech and emerging sectors is one of the main risks that should be tackled. Moreover the reduction of the role of traditional sectors could be partially delayed with specific policies to foster in-house R&D in non-innovative firms. Such instruments, non-existent in Spain, together with the existing cluster policies or instruments focused on technology transfer, could be important to reactivate those low tech sectors to ensure the survival of at least some firms by creating innovative products with a high added value. Nor did Spain introduce policy instruments to attract R&D-performing firms from abroad. Such a policy could be difficult due to the low level of excellence of a large number of (public) R&D institutes. Therefore, solving the level of excellence is a requirement to attract foreign R&D performers and also to create virtuous circles to increase R&D investments in domestic firms.

Knowledge Triangle

In relation to R&D&i policies it can be highlighted that Spain introduced in 2006 several instruments focused on the main barriers of its innovation system (OECD, 2006). Also in 2010 some new measures were initiated to overcome some specific problems. The Spanish Innovation Strategy 2010-2015 (e2i) - part of the ERA 2020 Vision - reinforced some existing measures and for the first time it includes Public Procurement as an active policy option. The introduction of several new instruments in the last five years clearly improved the existing policy mix with a clear shift to knowledge transfer from science to industry and block funding lost importance in relation to competitive funding. It can be stated that there is a growing level of coordination and integration of research and innovation policies based on the Spanish National Plan for R&D and innovation (NPRDI). However, those two policy fields are not coordinated with the higher education policies (HEP). For three basic reasons the integration of research and innovation policies with the education policies is almost non-existent: (1) The academic orientation of public research; (2) the lack of influence of the private sector on education - in general study plans are made without analysing or taking into account the future needs and demand on the labour market - and (3) the state and regional government do not use the assignment of the financial support as a pressure to orient the research and education activities. Therefore a large part of the activities of the higher educational institutes (HEI) and public research organisations (PRO) are not based on the societal needs or the demand of the production sector.

Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths and weaknesses
Research policy	• The GBOARD increased from €4,000m in 2003 to €9,349m in 2008. • Development of a new Law of Science. • The "Campus of International Excellence" and the "University Strategy 2015" aims at the improvement of the quality, efficiency and effectiveness in both teaching and research.	• Lack of excellence of the public research system and the correlated low level of technology transfer. • Lack of critical mass and the fragmentation of the public research system. • Low level of integration between industrial and science. • HEIs and PROs lack strategic plans to overcome such barriers. The dependence of the rectors on their voters makes it difficult to design or implement such a plan. • These system failures impede the success of the recent policy changes.
Innovation policy	• The new e2i Strategy complements the existing policies with new measures, such as public procurement as an R&D policy in specific fields and some specific measures to foster the interregional integration of the Spanish innovation system. • Raising of financial support in general and for risk capital; the incorporation of PhD holders in enterprises and the internationalisation of the R&D in firms. • The 2009 "anti-crisis" policy included specific R&D&i. measures: The recovery plan of 2010 included R&D&i as a priority.	Important barriers to the increase of R&D efforts are: • Its production structure, with a significant weight of small and medium sized firms, oriented to the less innovative traditional sectors. • A very slow structural change from low tech sectors to novel high tech sectors and a limited creation of NTBFs. • The lack of multinational enterprises that could have a leading role for creation of R&D related networks or clusters with the corresponding system advantages. • Spain is not a low wage country anymore and lost exchange rate as a policy to gain competitiveness, thus obliging Spanish firms to compete in innovation and quality. • Some policies are still lacking such as the attraction of foreign R&D and the policies for non-R&R performing firms.
Education policy	• Separation of the "secretary of universities" from the Ministry of Science and Innovation. • "Campus of International Excellence" and "University Strategy 2015". • Accreditation of a minimum level of experience and talent for academic staff before getting a full time job as civil servant (since 2001).	• The autonomy of the scientific organisations is a tricky question because the vast majority of the organisations use it to protect their own interests or that of their staff members to the detriment of societal needs or interests. • However the lack of autonomy in relation to specific aspects (strict regulations of salaries and annual budget cycles) also impedes the application of a strategy of excellence and the attraction of talented researchers. • International reports show a low quality of Spanish education at all levels which is the result among others of the above mentioned barriers. • The English language is still a main problem and no incentives exist to resolve this problem.

	Recent policy changes	Assessment of strengths and weaknesses
Other policies	• Several policies were introduced to increase the scientific- industrial linkages (CENIT, S&T parks, etc…). • The Cohesion and Structural Funds were reoriented towards innovation.	• The academic orientation of public research and the lack of influence of the private sector and the regional or state governments on education impede a better integration of the education, innovation and research policies.

European Research Area

The ERA initiative is discussed frequently at the policy-making level. The Spanish National Plan for R&D and Innovation refers broadly to the ERA concept and Spain tries to play an active role in its development. ERA was a reference for designing the national R&D&i programmes (ERAWATCH Country Report, 2008). Moreover the first draft of the new Science Law (approved by the Council of Ministries in May 2010) includes several references to extend the implementation of the ERA initiative. This initiative is considered as a way to integrate the Spanish innovation system in the international research scene and improve its level of excellence. During the Spanish presidency Spain tried to boost ERA-related policies. In this context Spain plays an active role in the development of the European Strategy Forum on Research Infrastructure (ESFRI), the European Joint Research Initiatives and article 169 initiatives. Moreover, Spain has a broad number of outward and inward mobility schemes for EU and non EU countries and several bi and multilateral agreements for R&D with several non EU-countries especially with Latin American Countries but also with China, India, The USA and Canada.

Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	• Important increase in the budgets for Human Resources policies. • Adaptation of the study tracks to the "Bologna" requirements. • Several measures to improve the situation for female researchers. • The legislation for inward mobility is applied more strictly due to the crisis.	• R&D related employment increased between 2002-2008 by over 50%. • Spain is not very attractive for qualified personnel from abroad (low wages and bad working conditions). • Spain has a lack of qualified workers although this shortage diminished somewhat due to the crisis. • Universities protect their internal candidates against external researchers from Spain or abroad. • The problem of gender discrimination still exists but improved clearly in the last years. • New study plans are based on internal interests.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
2	Increase public support for research	• The R&D-related funds included in the National State Budget (GBAORD) rose 25% annually in the period 2005–2008 and remained more or less stable during the crisis.	• Although the total budget of 2009 and 2010 was kept stable the % devoted to loans increased in relationship to the subsidies. • The increase of public support is not accompanied by a modernisation of the public institutional framework. This impedes a real impact and perpetuates the fragmentation, lack of excellence, and technology transfer.
3	Increase European coordination and integration of research funding	• Spain is very active in the support and participation of all types of pan European research initiatives like the ERA-net, ESFR, JPI, JTI etc. • Internationalisation and the ERA are considered strategic by the Spanish policy makers.	• The % of the R&D funds coming from abroad of the Spanish Enterprises, HEI and PRO are below the EU-27 average.
4	Enhance research capacity across Europe	• Spain promotes the research capacity by its participation in ERA-nets, JTI etc for the sectors in which they have large enterprises (such as energy, telecommunications; or aeronautics)	• The lack of priority setting and the fragmentation of public research impede reaching a critical mass that would allow an increase of the overall capacity due to synergies and cross fertilising.
5	Develop world-class research infrastructures and ensure access to them	• The NPRDI promotes effective use of European infrastructures (EI); wants to contribute to 25 of the 44 European facilities and try to obtain the location of 3 of them.	• The ESFRI stimulated the coordination and the design of a national road map of infrastructural needs among the Spanish regions. • Spain is still lacking a critical mass and a sufficient demand or market for R&D based services, which hinder the creation of new S&T facilities.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
6	Strengthen research institutions, including notably universities	• The GBOARD rose from €4,000m in 2003 to €9,349m in 2008. • Development of the new Law of Science (To be approved in 2010 – beginning 2011). • "Campus of International Excellence" with special focus on the overall quality. • University Strategy 2015 aimed at getting universities in the top 100 ranking in Europe by the improvement of their quality, efficiency and effectiveness in both teaching and research.	Several systemic failures impede the impact of policies for improvement of the excellence: • The vast majority of the organisations protected the interests of the researchers or lecturers to the detriment of societal needs or interests. • The lack of critical mass and the fragmentation of its public research system. • The lack of autonomy in aspects such as the strict regulations of wages impedes the attraction of international well talented researchers. • Low level of integration between industrial and academic research are important weaknesses. • HEIs and PROs lack strategic plans to overcome the aforementioned problems. • The autonomy of individual researchers and the dependence of rectors on their voters make it difficult to design or implement strategic plans and almost impede the success of the recent policy changes.
7	Improve framework conditions for private investment in R&D	• The INGENIO 2010 initiative of 2006- had a qualitative impact on the policy mix Reinforcing the policies towards the creation of NTBFs, academic spin-offs, Public Private cooperation (PPC) in long term strategic projects and the incorporation of PhD holders into the private sector. • The 2010 "e2i" strategy has reinforced the financial support for R&D&i in general and especially the funds for risk capital. It also reinforces the financial support for cooperation between enterprises and the scientific sector.	• The role of firms is still far below the Lisbon objective and BERD decreased -6.3% in 2009. • Spain has a broad –more or less well balanced- policy mix with differentiated instruments tackling several barriers and weaknesses. But, this mix can not handle the systemic failures related to the functioning of the R&D agents. (see also point 6). • The data show that the R&D effort of the PROs and HEIs financed by private funds is similar to the EU-27 average. However the state of opinion suggests a low level of (PPC) in R&D which is hindered by the lack of excellence and quality and the scientific orientation of public research. • Lack of influence of the society and enterprises on the behaviour of PRO and especially universities.
8	Promote public-private cooperation and knowledge transfer		

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
9	Enhance knowledge circulation across Europe and beyond	• Spain has several inward/outward mobility schemes that also allow the participation of researchers from non-EU.	• The traditional and cultural relations with Latin America and the common language generated a high level of mobility between LA and Spain. • The lack of knowledge of the English language is still an important barrier for international cooperation. • The unattractive working conditions (see point 1) are a barrier to attracting foreign qualified workers.
10	Strengthen international cooperation in S&T and the attractiveness of European research in the world	• Spain tries to stimulate international cooperation by several policy measures and multi/bilateral agreements.	• The lack of knowledge of the English language and the lack of excellence and fragmentation of the Spanish research system are important barriers for international cooperation.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• After concentrating in 2008 all the R&D&I policies and activities in one Ministry in 2009 the State Secretary of Universities went back to the Ministry of Education. • Three aspects improved the regional coordination of R&D&i. (1) The National Strategy for Science and Technology approved by the Presidents of Autonomous Communities. (2) The operational plans of the European Structural Funds were designed by the national and regional governments. (3) The ESFRI generated a Spanish roadmap agreed by regional and national governments.	• To assure the better coordination between the different policy areas related to R&D and innovation Spain made a huge effort on the institutional level concentrating all the policy fields in just one ministry. • There is a low level of transparency in the policy making system. Several commissions and institutes are involved but no clear view on who is doing what. • The NPRDI offers some abstract priorities while the exact distribution is based on ad hoc decisions. • The academic orientation of public research and the lack of influence of the private sector and the regional or state governments on the education impede a better integration of the education, innovation and research policies. • Almost no integration exists between the education policies versus R&D&i policies.
12	Develop and sustain excellence and overall quality of European research	• "Campus of International Excellence" and "University Strategy 2015" (see point 6). • Accreditation of a minimum level of experience and talent for academic staff before getting a full time job as civil servant (since 2001).	• The excellence and quality of the Spanish research on universities is not systematically evaluated. • The salaries for researchers do not include real incentives for excellence, quality or productivity. • See also the assessment of strengths and weaknesses mentioned in point 6.

	ERA objectives	Main national policy changes	Assessment of strengths and weaknesses
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• Science and technological progress is widely recognised as an important factor to create wealth and is seen as the solution to overcome the crisis. • For example the state budgets of R&D&i were only downsized marginally.	• Low growth of the high tech and emerging sectors and lack of sufficient NTBFs. • The lack of large firms that could lead clusters and which have the critical mass to create economies of scope and scale makes structural change more difficult. • The financial institutions and organisations invested the last decade in housing and construction instead in industry and innovation.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• The NPRDI include special actions on societal challenges and sustainable development. • Spain is processing a new Law on Sustainable Economy (LSE). • The "e2i initiative" includes already some support for scientific fields of the LSE.	• Although sustainable growth and other societal challenges are a topic in political discussion the main preoccupation of Spain is the structural change of their production sector from traditional low tech sectors to high tech sectors with a high added value. • The sustainable growth and societal challenges are seen as opportunities to initiate the above-mentioned structural change.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• Organisation of a diverse range of activities such as the "science week" that open the doors to a broad range of R&D centres for the public. • Science and technological progress is widely recognised as an important factor to create wealth and it is seen as the solution to overcome the crisis.	• Policy evaluation is not systematic. • Several R&D&i programmes were evaluated. • Several instruments are evaluated spontaneously on an individual level by PhD students and other researchers without or with some marginal help from the public making use of the publicly available data. • Most newspapers, radio and television channels have specific programmes for science related issues.

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1 Introduction

The main objective of the ERAWATCH Analytical Country Reports 2010 is to characterise and assess the evolution of the national policy mixes in the perspective of the Lisbon goals and of the 2020, post-Lisbon Strategy. The assessment will focus on the national R&D investments targets, the efficiency and effectiveness of national policies and investments into R&D, the articulation between research, education and innovation, and on the realisation and better governance of ERA. In doing this, the 15 objectives of the ERA 2020 are put forward.

The report builds on the 2009 report streamlining the structure and updating the 2009 policy assessment in the domains of human resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. The information related to the four ERA pillars covered in the 2009 report is also updated and it is extended in order to cover all six ERA pillars and address the corresponding objectives derived from ERA 2020 Vision.

Given the latest developments, the 2010 Country Report has a stronger focus on the link between research and innovation, reflecting the increased focus of innovation in the policy agenda. The report is not aimed at covering innovation per se, but rather the '**interlinkage**' between research and innovation, in terms of their wider governance and policy mix.

2 Performance of the national research and innovation system and assessment of recent policy changes

The aim of this chapter is to assess the performance of the national research system, the **'interlinkages'** between research and innovation systems, in terms of their wider governance and policy and the changes that have occurred in 2009 and 2010 in national policy mixes in the perspective of the Lisbon goals. The analysis builds upon elements in the ERAWATCH Country Report 2009, by updating and extending the 2009 policy assessment in the domains of resource mobilisation, knowledge demand, knowledge production and science-industry knowledge circulation. Each section identifies the main societal challenges addressed by the national research and innovation system and assesses the policy measures that address these challenges. The relevant objectives derived from ERA 2020 Vision are articulated in the assessment.

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

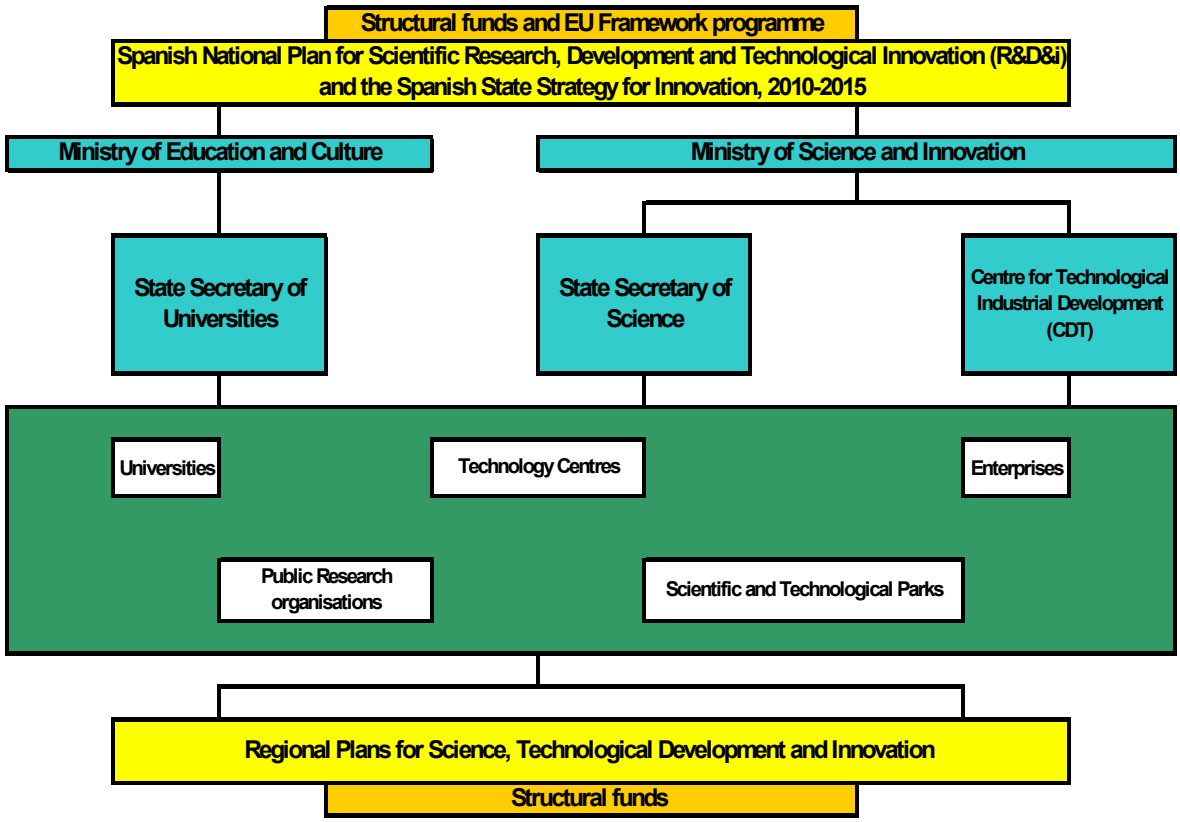
Total Spanish R&D expenditures for 2008 were €14,701,392m which is 1.35% of their GDP, still a long way short of the Spanish Lisbon Objective of 2%, established in the National Reform Programme of 2005 and the related "INGENIO 2010 programme". The R&D expenditures financed from abroad account for 5.7% of total Gross Expenditure on R&D (GERD). Despite the important growth of the GERD before the crisis, Spain is still lagging behind the most advanced economies in R&D activities. Three regions account for 58% of all R&D expenditures. Madrid (26.5%),

Catalonia (22.4%) and the Basque Country (9.2%) are the leading regions with respectively R&D intensity (GERD/GDP) of 1.93%; 1.48% and 1.88%.

Main actors and institutions in research governance

Figure 1 offers an overview of the main actors in the Spanish innovation system. The main player in R&D policy is the Ministry of Science and innovation (MICINN, created in April 2008). For the first time Spain had a ministry that was responsible for almost all public activities related to R&D and innovation. Until April 2009 the MICINN had two Secretaries of State: (Universities and Research). Moreover, the Centre for Technological and Industrial Development (CDTI) and almost all official Public Research Organisations also depend on this Ministry. The CDTI is the management agency in charge of R&D and innovation policies oriented to enterprises. In April 2009 the State Secretary of Universities was reincorporated in the Ministry of Education that for 2010 had assigned less than 2% of the R&D related State Budget.

Figure 1: Overview of the Spanish research system governance structure



Source: ERAWATCH Research Inventory

Typical for the Spanish case are the pluriannual National Plans for R&D and innovation, which have a four-year time span. These Plans establish general and broad priorities and specify the main policy programmes at national level. However, the exact financial distribution of funds is decided in annual action plans. The basic principles of the present configuration of the Spanish innovation system and R&D policy framework are based on the so-called Science Law of 1986, although at this moment a new law is in process of formal approval by the Spanish parliament.

The institutional role of regions in research governance

Spain's political structure is a quasi-federal decentralised system and this is also reflected in its R&D and innovation-related policies. Nowadays most regions

developed similar R&D plans and on both administrative levels (national and regional) there coexist a large number of – often overlapping – instruments, programmes and agencies (ERAWATCH Country Report, 2009). In fact there is no clear division of responsibility between national and regional administrative levels and a growing number of specific issues of R&D and innovation policies have been regionalised.

Table 1: R&D expenditures executed by type of organisation and R&D activities, €m, data 2008

R&D expenditures	Total		By type of R&D (%)*				Basic Research	
By agents	Euros	(%)	Basic Research	Applied Research	Development	Total	Euros	(%)
Public Administration	2,672,288	18.2	24.6	45.4	9.8	100	658,539	26.3
Higher Education	3,932,413	26.8	40.3	32.2	11.3	100	1,584,422	63.2
Enterprises	8,073,521	54.9	3.2	33.5	44.5	100	260,090	10.4
Others	23,170	0.1	21.7	62.5	15.8	100	5,027	0.2
Total	14,701,392	100.0	20.9	43.3	35.8	100	2,508,078	100.0

Source: Spanish National Institute for Statistics

Table 2: The finance and the execution of R&D in Spain, €m, data 2008

R&D FUNDERS	R&D PERFORMERS				Total	
	Public Research Organisations	Higher Education	Business Enterprises	Private non-profit	Euros	%
Government	2,353	2,894	1,445	8	6,699	45.6
Business enterprises	157	347	6,100	6	6,609	45.0
Abroad	136	189	512	1	838	5.7
Higher Education	6	465	3	0,3	474	3.2
Private non profit	21	38	15	8	81	0.6
Total	2,673	3,933	8,075	23	14,701	100.0
Total in%	18.2	26.8	54.9	0.2	100	

Source: Spanish National Institute for Statistics

Main research performer groups

As can be observed in Table 1, R&D and innovation is mainly undertaken by enterprises that execute 55% of the GERD, followed by universities (27%) and public research organisations (18%) while the Non Profit Organisations have a marginal role (0.1%). The most important players in basic research are the Public Research Organisations (PROs) and Higher Education Institutions (HEIs) carrying out respectively 26 and 63% of the basic R&D while the firms (10%) had a more marginal role. In fact only 3.2% of the private R&D expenditure can be considered as basic R&D. The most important PRO is the Spanish National Research Council (CSIC) which spent around 50% of the total resources allocated to the PROs and has 116 research centres covering a large number of scientific and technological fields. Table 2 shows that the enterprises execute almost 55% of the GERD but finance only 45% which is below the Lisbon objective of 55%. Another 46% is financed by public funds and 5.7% is funded from abroad.

2.2 Resource mobilisation

Since 2000, Europe has made evident progress towards ERA but at the same time it is clear that Europe's overall position in research has not improved, especially regarding R&D intensity, which remains too low. The lower R&D spending in the EU is mainly a result of lower levels of private investment. Europe needs to focus on the impact and composition of research spending and to improve the conditions for private sector R&D investments.

This section assesses the progress towards national R&D targets, with particular focus on private R&D and on recent policy measures and governance changes and the status of key existing measures, taking into account recent government budget data. The need for adequate human resources for R&D has been identified as a key challenge since the launch of the Lisbon Strategy in 2000. Hence, the assessment includes also the human resources for R&D. Main assessment criteria are the degree of compliance with national targets and the coherence of policy objectives and policy instruments.

2.2.1 Resource provision for research activities

Spain's innovation system is historically characterised by two main problems: a low level of R&D investment and an orientation to academic research. Since its entry in the European Union (EU) Spain has experienced an economic convergence process which has not been complemented by a technological "catching up". In 2007 Spain's level of Gross Expenditure on R&D **(GERD)** by GDP is at about 69% of the European level (EU=100) while its GDP per capita is six percentage points (105.7) above the average EU level. Between 2001 and 2008 the level of GERD by GDP rose from 0.91 to 1.35%. The first estimates for 2009 of the Spanish Institute for Statistics (INE) show a 2.4% decrease in the GERD. The private expenditures decreased 6.3% while the public ones increased 5.8%. The R&D-related funds included in the National State Budget **(GBAORD)** rose from €4,000m in 2003 to €9,349m in 2008. After a small increase in 2009 (3.3%) and a small decrease in 2010 (-4.4%) the predicted budget for 2010 is €9,272m.

R&D and innovation have a central role in the Spanish National Reform Programme (NRP) because they should ensure sustainable long term economic growth. The NRP included new instruments to tackle specific barriers of the Spanish innovation system and an extraordinary increase in the government R&D budget, 25% annually during 4 years. Moreover the NRP proposed some changes in the "statutes for Personnel in Science and Teaching". In this case the draft version includes a temporary leave for public researchers to set up their own enterprise or to work for a certain time in the private sector. The most recent change related to the NRP is the approval -in July 2010- of the Spanish State Strategy for Innovation, 2010-2015 (e2i strategy). This strategy is part of the ERA 2020 vision and has five pillars[1]. The first one reinforced the financial support for R&D and innovation in general and with specific attention to risk capital and for SMEs. The second pillar is the use of public procurement as an R&D policy especially in some specific fields such as environmental protection and the digital administration of public services. The third pillar is the internationalisation of the R&D and innovation in Spanish enterprises. Pillar four promotes inter-regional integration as part of the operational plans of the Structural funds and the European Technology Fund. Pillar five expands the human resource policies by an increase in support of the incorporation of PhD holders in

[1] No total budget was indicated.

enterprises. Some measures of this plan imply an increase in the budget of existing programmes and others - like the public procurement - are new initiatives.

The direct impact of the crisis on Spanish GBOARD and therefore on the Lisbon Strategy for 2010 is not clear. The Spanish government and political parties consider R&D and innovation as a main driver for the future competitiveness of Spain and innovation as a solution to overcome the crisis. Therefore the Spanish GBOARD for 2010 formally showed a slight increase. However, the further reductions for public expenditures announced in the beginning of 2010 could have reduced the real budget for 2010. Moreover it can be mentioned that the anti-crisis plan of the Spanish government (Plan E) of 2009 included an amount of €490m directly related to R&D and innovation (which is more than 16% of the total budget of the Plan). The 2010 Plan (The State Fund for employment and local sustainability) with a budget of €5,000m did not include a specific budget for R&D, but innovation was considered as priority and 5.3% of the funds are devoted to proposals related to economic development and/or innovation.

The main instrument of Spain's research policy is the "Spanish National Plan for Scientific Research, Development and Technological Innovation (2008-2011)" (NPRDI). The "National R&D&i Plans", which have a four-year time span, establish abstract and broad priorities and specify the main policy programmes at national level. However, the exact financial distribution of funds is decided in annual action plans so priority-setting by budget assignment is not clearly defined and can only be observed implicitly by the real distribution of the funds. The last "National Plan" (2008-2011) was designed after a thorough review of the needs and problems of the Spanish innovation system (see OECD 2006).

The **EU Cohesion Funds** play a very important and growing role and increase R&D budgets substantially in eligible Spanish regions. The implementation of the new plan (with a total fund of €17,610m for the period 2007-2013) implies a clear reorientation to R&D and innovation related policies and 31% of the funds will be used for such policies. Moreover an important indirect impact of the Cohesion Funds is that there is a marked improvement in coordination between national government and the regions, especially in the case of support for large infrastructural facilities. In fact, the main policies are focused on the creation of S&T infrastructure (including technology centres and S&T parks) and the promotion of innovation in small and medium sized enterprises. The Technology Fund is used to promote R&D projects carried out by individual firms and especially by consortia of enterprises.

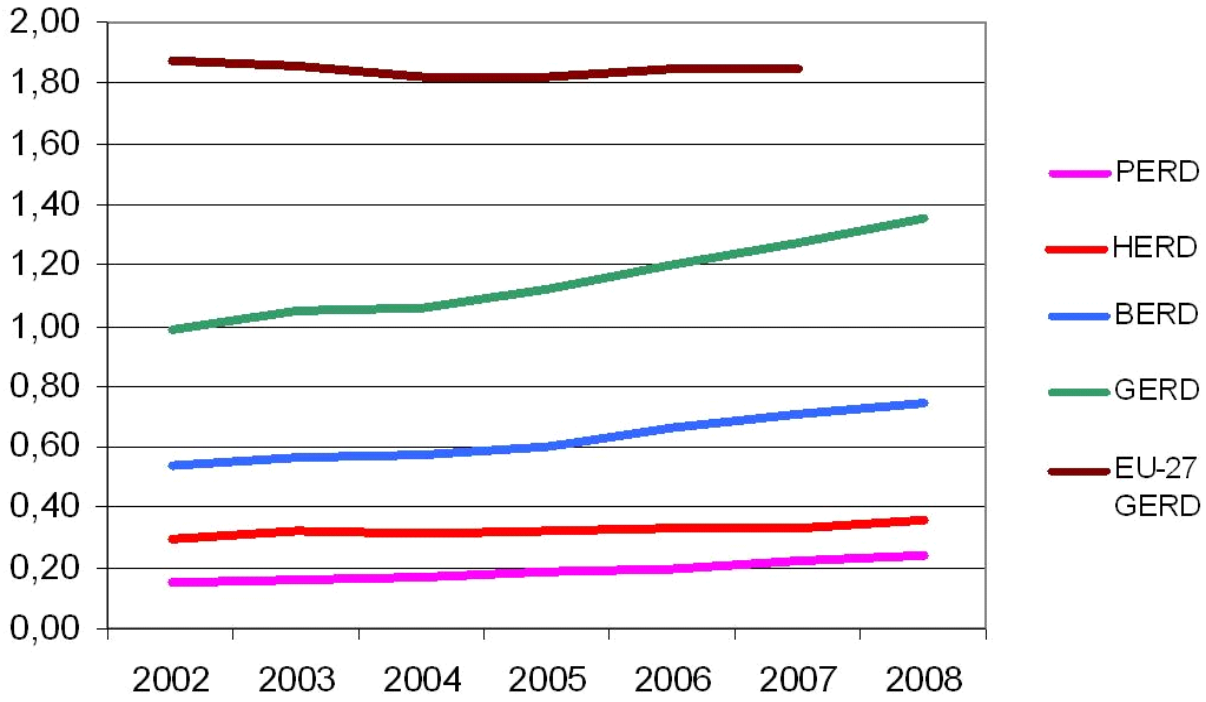
Competitive versus block funding

The Annual Report of R&D&i activities for 2006 of the Spanish Government shows that public R&D related expenditure included €1,369m of direct block funding (covering wages and maintenance expenses) for Public Research Organisations (excl. universities) which is almost 15% of the total GBOARD. However, block funding is becoming less important while consequently competitive project funding is gaining weight. In the early 80s around 60% of funds were transferred directly to PROs while at the beginning of this century this percentage was 23% (Sanz, 2005). A substantial part of their funds goes to salaries (40%), operational costs (10%) and investments (17%) while the "operational transfers" – mainly used for research – account for less than 7% of the received block funding.

University funding for teaching and operational costs is the responsibility of the regions that offer institutional funding to universities, based mainly on the number of students and teachers. Evaluating the public budget devoted to R&D (€9,349m in

2008) it has to be taken into account that around 57% of the funds consist of subsidies and 43% are reimbursable loans. The main instrument of Spanish R&D policies for public R&D is subsidies (84% of the received funds), while for private R&D and public–private initiatives the main funding takes the form of loans (63 and 53% respectively). Almost 58% of the total funds are devoted to generic public competitive tenders for projects. Another 11% is devoted to infrastructural support and 16% to human resources (HH.RR).

Figure 2: Spanish R&D expenditures by GDP



Source: Spanish National Institute for Statistics

Funding for societal challenges

The solution of the major societal challenges and the contribution to sustainable development receives a certain attention in Spanish R&D and innovation policies. However their main concern is the structural change of their production sector from traditional low tech sectors to high tech sectors with high added value. The National Plan for R&D and innovation includes several societal challenges as a priority and they are included as specific “special actions” related to strategic technological fields such as biotechnology, nanotechnology etc. The Spanish Parliament is processing the new Law on Sustainable Economy that includes the promotion of the new technologies related to the societal challenges such as clean energy and biotechnology. The Spanish Strategy on Innovation (mentioned above) includes specific support for scientific fields proposed in this new law. Both aspects - sustainable growth and structural change - are considered as complementary because technological progress to solve societal problems could generate a new high tech and high added value enterprises. (For a budgetary approach see § 2.3)

2.2.2 Evolution of national policy mix geared towards the national R&D investment targets

As mentioned in the previous section in the period 2002-2008 the Spanish GERD (in absolute and relative terms by GDP) increased notably, starting with a level GERD

by GDP of 0.99% in 2002 and reaching a level of 1.35% in 2008. The Business Expenditures in R&D (BERD) increased on a similar level to the public R&D expenditures, although the R&D expenditures of the PROs increased more than those of the HEIs. In 2008 the enterprises executed almost 55% of all GERD and the public sector 45%, of which 18.2% was by the PROs and 26.7% by the universities. In the case of the BERD for 2009 the INE estimated a 6.3% decrease while the public expenditures increased by 5.8%. The 1.35% of GERD by GDP is a percentage still far from the Lisbon objective of 2%. Also the complementary objective -a private participation of 55% in the financing of the GERD- was not reached, in 2008 the enterprise financed only 45% of the GERD and this percentage declined somewhat in 2009. Comparing the Spanish BERD with the EU-27 level in the period 2002-2007 it can be stated that Spain did start partially to close the gap. The owed a slight decrease from 1.2% in 2002 to 1.18% in 2007 while in the Spanish case this indicator increased from 0.54 to 0.71% (Eurostat, 2010).

Barriers and risks to attaining the 2% BERD

One of the main barriers to increasing the R&D efforts in Spain is probably the productive structure, with a significant weight of small and medium sized firms, oriented to the less innovative traditional sectors and with a lack of multinational enterprises that could create R&D related network and system advantages. Other barriers are the lack of critical mass and the fragmentation of its public research system (in public research organisations and especially in universities), the low level of integration between industrial and academic research, and the low number of new technology based firms or academic spin-offs. Moreover Spain has a poor performance in the structural change towards an industry based on high-tech sectors.

In particular, Spain shows an unbalanced and biased productive structure. Nearly 70% of Spanish business employment is in firms with fewer than 50 employees while the average for the European Union and the United States is respectively 50 and 36%. Moreover, only 18% of business employees are employed by large firms (more than 249 employees), compared to 34% in the EU and 50% in the United States (SOURCE). Spain lacks large internationalised firms that can play a crucial leading role for the creation of R&D-based clusters related to their network of suppliers and R&D organisations. Moreover its business R&D expenditures depend partially on the role of foreign affiliates. The foreign multinationals represent 2% of all the Spanish firms but they execute 26% and finance 30% of all Spanish BERD (Fundación Innovación España, 2010). The 2010 EU Industrial R&D Investment Scoreboard of the IPTS (IPTS, 2010) indicates that at the micro level only 27 Spanish enterprises are included in the European ranking of the 1,000 firms that invested most in R&D in 2009, and only three are included in the Top100. Between them, the 26 firms spent €2,907m on R&D in 2009. This means that they financed almost 46% of all privately financed R&D in Spain and almost 20% of the total R&D expenditures of Spain.

The sectoral structure of the Spanish economy reflects the economic importance of supplier-dominated sectors[2] based on the prominent role of traditional industries such as furniture, non metallic mineral products, textiles and the food industry, and this has led to a low demand for R&D in comparison with other countries. Moreover these sectors in the last few years faced an increase in Spanish salaries in

[2] The supplier-dominated sector is a concept based on the taxonomy of Pavitt (1984) and includes the sectors where in general the new technologies are coming from the supplier side and are not developed internally.

combination with the growing role on the export markets of the emerging low wage countries such as China or India. The high tech sectors of Spain have in comparison with the most advanced countries a lower and decreasing weight in the Spanish GDP and employment. The INE data show that high tech sectors represented in 2008 around 6.6% of the total Spanish employment (7.3% in 2007 and 7.9% in 2000) and these sectors represent almost 69% of all researchers in the private sector and account for 61% of the Spanish private R&D expenditures (67% in 2005). Moreover the Spanish firms in those sectors have a lower R&D intensity than similar firms in other European countries (based on Eurostat data). Concluding, the very slow structural change from low tech sectors to new high-tech sectors, the limited creation of new technology based firms (NTBF) and the lack of multinational enterprises are still the main weaknesses of the Spanish economy. Such firms could have a leading role for the creation of R&D related networks or clusters based on scale and scope economies with the corresponding systemic advantages.

Route 1: Promoting the establishment of new indigenous R&D performing firms

The Spanish national and regional policymakers introduced a broad number of instruments to promote the creation of new technology-based firms (NTBFs). Some experts from public support schemes claim that there is a lack of venture capital for start-ups and young NTBFs, especially in the current context of financial markets drying-up. Other experts from some private funds considered that there is also a lack of good proposals[3]. Probably this disagreement could be related to the guarantees and level of risk taken by public and private players in this field. Private firms are more prone to avoiding a financial involvement in the first phases of NTBFs, when the risk of failure is more important. However, a pro-active policy not only based on financial support but based on a more intensive connection with knowledge-generating organisations should increase the supply of entrepreneurial technology-based projects and consequently the need for venture capital. Successful examples are the regional support programmes in Catalonia and Andalusia.

Route 2: Stimulating greater R&D investment in R&D performing firms

Spain boasts a broad set of policy instruments, mostly based on low interest credits, to stimulate greater R&D investments in R&D performing firms. The total BERD financed by public support increased from 14.8% in 2002 to 22.6% in 2008. The share of BERD financed by the subsidies (excl. tax incentives) increased from 9.5% in 2002 to 17.9% in 2008 (INE data), while the tax reduction was respectively 5.2% and 4.7% of the BERD (Valadez et all, 2011). The subsidies are awarded through a broad range of instruments in support of individual firms or public private cooperation (see Route 5). The Spanish tax incentives for R&D have been considered as the most generous among OECD countries for the past few years. However, the uptake by companies was lower than expected (IPTS, 2006).The bureaucratic processes necessary to obtain the deductions are complex and uncertain, which diminishes the incentive effect. In any case it seems that the recent available data of the MICINN show a more intensive use of this scheme in the last years[4].

[3] The conclusion of this section is based on the opinion of experts of some public agencies and representatives of some associations of enterprises
[4] Conclusion based on an unpublished presentation of the MICINN (January 2009)

Route 3: Stimulating firms that do not perform R&D yet

No specific measurements exist to stimulate firms that do not perform R&D. Such instruments would be important to ensure the survival of some firms in the traditional sectors. The Technological Centres play here, given their potential to reach SMEs more effectively, an important role, as mentioned in the evaluation report of AEVAL, 2008.

Route 4: Attracting R&D-performing firms from abroad

In 2010 several studies that analysed the determinant factors to attract or to maintain R&D and innovation activities of foreign firms in Spain were published (IESE, 2010; FECYT/FIE, 2010). However, at the national level, no specific measurement exists to attract R&D-performing firms from abroad. On a regional level there exist programmes to attract foreign direct investment (multinational firms), with some specific conditions for R&D activities. However those advantages are often based on existing R&D support schemes.

Route 5: Increasing extramural R&D carried out in cooperation with the public sector

Despite the fact that industry finances 7.9% of the R&D expenditure of universities (higher than the OECD average, though below the EU-15 average of 8.8%), the level of public-private cooperation in R&D is considered low (COTEC, 2005; OECD, 2006) and the mobility of researchers between the public and private sectors are almost non-existent. Over the past years the government adapted the legal and administrative framework to promote cooperation between universities and firms. Nowadays Spain has a large number of support schemes to foster public private cooperation in R&D and innovation. A successful instrument is the programme National Strategic Consortia for Technical Research (CENIT), introduced in 2006, which promotes large strategic long term cooperative projects of consortia of large companies, SMEs and public R&D agents. Another instrument is the CONSOLIDER initiative that promotes high quality R&D cooperation to create large research groups and to overcome the existing fragmentation of the Spanish research system (see also § 2.4.2). Both types of projects promote inter-regional co-operation. This promotion of interregional co-operation was lacking in pre-existing support programmes (OECD, 2006).

Route 6: Increasing R&D in the public sector

The Spanish National R&D Plan includes project support primarily oriented to the public R&D system although they also are accessible to private organisations. The programmes have a dual aim: the advance in scientific and academic knowledge and the improvement of the competitiveness of enterprises. Although those national programmes are longstanding policy measures, changes were introduced in their design and implementation (especially the selection criteria) to promote excellence and to overcome the fragmentation of the Spanish research system.

Assessment of the importance of policy mix routes and their balance

The INGENIO 2010 initiative –approved end 2005- had an important qualitative influence on the balance between the different policy instruments. In particular it reinforced the creation of NTBFs and university spin-offs, the promotion of R&D projects in general and more specifically public-private cooperation in long term strategic projects (CENIT) and the policy directed to Human Capital, such as the incorporation of PhD holders into the private sector. Also the financing and

creation of the S&T infrastructure was heavily reinforced. Although it is difficult to offer a balance of the policy mix in budgetary terms it can be mentioned that the most recent policy initiative –The Spanish State Strategy for Innovation, 2010-2015 (e2i) - has reinforced some routes. As mentioned, the e2i strategy has five pillars. The first one reinforced route two by offering extra financial support for R&D and innovation in general and route 1 due to its specific attention to risk capital. It also reinforced route six by the extension of the support for cooperation between enterprises and the scientific sector.

Despite the fact that Spain lacks instruments in two very specific routes -3 and 4- it has at the present time a broad - more or less well balanced - policy mix with a huge set of differentiated instruments that try to tackle almost all the barriers and weaknesses of the Spanish innovation system. However, the existence of instruments is not enough because they do not handle the systemic failures related to the functioning of the R&D agents. In the long term the impact of this well balanced policy mix could be almost zero if the Spanish government does not initiate the institutional modernisation of the public research system. This is especially so in the case of the science-industrial relationships (See § 2.5.1).

Other policies that affect R&D investment

A new policy to promote innovation in the enterprises is based on the innovation-oriented procurement policies. A measure included for the first time in the State Strategy for Innovation (e2i) that for 2010 predicts a public procurement associated with the acquisition of innovative goods and services for €1,262m. The Ministry of Science and Innovation is in charge of the presentation of the annual proposal of the Innovative Public Procurement that indicated the percentage of the budgets of the departments and ministries that should be devoted to such acquisitions. Another new instrument of the e2i strategy is territorial integration based on a “network of cities of science and innovation”. Spanish cities can apply for the distinction of city of science and innovation. The cities that obtain such a distinction can obtain a certain type of support and will have preference in the installation of new S&T infrastructures and the organisation of congresses or seminars. Additionally, the investments in innovation of the “State Fund for Employment and Local Sustainability” of the Ministry of Territorial Policies were €916m in 2010.

The user friendly implementation of the policies

In recent years the Spanish government improved the policy framework creating a more transparent policy system such as the publication of the Annual Working Plan with the approximated data of the publications of the tenders or the “on line” system for most of the applications. They try to keep bureaucracy to a minimum and included the role of excellence in the selection criteria. The national Plan for R&D consists of a large number of well targeted, clearly differentiated good accessible support schemes. The existing schemes meet most of the needs of the enterprises. Although, as already mentioned, some types of instruments are lacking especially in the case of SMEs. R&D policy evaluations are still not a systematic activity although a large number of instruments were evaluated. The Centre of Industrial technological Development (CDTI) in charge of most of the business oriented instruments seems to function well and carried out several internal and external evaluations of their activities. Policy evaluation is not a systematic activity but several R&D and innovation policy programmes were evaluated. Likewise, several instruments were evaluated spontaneously on an individual level by PhD students and other researchers with or without some marginal help from the public policy agencies. They

make use of the publicly available data bases on the firm level. Most studies offer a positive view on the impact and indicate the existence of financial additionality.

2.2.3 Providing qualified human resources

The number of people employed in R&D activities in 2008 was 352,611 (215,676 persons in Full Time Equivalent - FTE) of which 62% were researchers and 38% were "other personnel" (INE data 2008). This implies an increase of more than 60% since 2002. Based on the FTE data, 44% are working in the private sector, 37% in universities and 19% in public research organisations. Compared to the rest of the EU nations, the number of scientists and researchers as a percentage of the total labour force in Spain (4.6%) is near the EU-25 average (4.8%), although it is still far behind the European countries at the top of the list.[5] Human resources in science and technology (HRST) as a share of the economically active population in the age group 25-64 are in Spain 39% which is 1.1% below the EU-27 average of 40.1% (Eurostat data for 2009).

In the academic year 2008-2009 over 67,000 students were enrolled in PhD studies of which 30.4% are studying health and experimental sciences (HES) and 14.6% engineering and technology (E&T). In the same year 7,915 PhD candidates graduated, of which 42.7% were in HES and 14.6% in E&T (INE data). The percentage of PhDs presented which were S&T-related increased from 12% in the period 2000-2005 to 13% in the period 2006-2009 while the percentage of HES related PhDs fell slightly with an average of 44% in the last three years. The duration of PhD studies is relatively long in Spain compared to other countries: up to six years instead of the four years common elsewhere. The number of persons with pre-doctoral scholarships is, due to the existence of a large number of national and regional programmes and private support schemes, not clear. An ad hoc estimation off the INE -with data of 2003- indicated that around 25,000 researchers were working with a scholarship, which is around 25% of all the Spanish researchers (FJI, 2008). Since 2003 the Spanish government has made a great effort to increase the number of scholarships so possibly at this moment there are a higher number of researchers with scholarships, although no specific data are available.

The balance between demand and supply for specific sectors

A report[6] of October 2008 stated that despite the slowing economy, Spain needs 100,000 qualified foreign workers per year until 2012 due to a shortage of IT, health and other professionals. A quarter of these needs (25,000) are engineers. Nevertheless, the specific characteristic of the education of the workers in Spanish labour has to be taken into account. First of all the percentage of workers with a university degree is much higher than the EU average and a large number of those graduates work below their intellectual capacity. At the same time professional training has a relatively low number of students. This unbalanced situation is generated by the cultural or social habits of the parents, who underestimate the value of professional training. On the other hand, education in Spain is considered as deficient and based more on the memorising of theory than on the application of knowledge. The international PISA reports indicate that the Spanish 15-year-old young Spanish students score very badly in sciences, mathematics and reading and

[5] Finland, Sweden or Germany with respectively 6.7%, 6.5% and 5.8%; Eurostat data for 2008
[6] Etnia Communications' report published on 22nd of October 2008

in compulsory secondary education the failure rate is above 33% in 2008. Moreover, the Spanish universities have low positions in the international rankings.

Articulation of education policies within the knowledge triangle

The Eurostat data **on job-training, life-long learning and vocational training** shows that in 2008 10.4% (4.7% in 2003) of Spanish employees participated in education and training. This is above the EU-27 average but below the level of some of the most advanced European countries[7]. In the last few years Spanish universities implemented the "Bologna" structure, which for Spain is a revolutionary change that should include in the education curricula -beside theoretical knowledge- the acquirement of competences such as creativity, critical thinking, problem solving, teamwork, and communication skills. The problem is that the pre-University education in this kind of aspects receives only a little or no attention. On the other hand, entrepreneurship training is not or scarcely included in education curricula.

The **integration of the policies of the knowledge triangle** is not assured in the Spanish case. It can be stated that there is a growing level of coordination and integration of research and innovation policies. However those two policy fields are not coordinated with the higher education policies (HEP). The responsibilities of the HEP are distributed by the state government and the regional government. However universities and public research organisations have a great deal of freedom and autonomy. In general study plans are made without taking into account the future needs and demand of the labour market and the financial support of the regional government is not used as pressure to compel the universities to adjust their activities to societal and labour market needs. The integration of research and innovation policies with the education policies is almost non-existent due to: (1) the academic orientation of public research: (2) the lack of influence of the private sector on education and (3) the fact that national and regional government do not use the assignment of financial budget to press the universities to orient the education activities and curricula to the societal needs or the demand of the production sector.

A substantial number of **support schemes for human resources** are available at both a national and regional level. Around 12% of funding (€533m in 2010) from the NPRDI is targeted in this area, and the regional governments also offer a large number of schemes geared to HH.RR. Over 35% of the national funds went to pre-doctoral scholarships and post-doctoral activities; 57% to convert temporary R&D research contracts for doctors into permanent ones, while international mobility for lecturers and doctorate students received altogether 8% of the funds.

2.3 Knowledge demand

The business-driven demand for knowledge is directly related to the effort in R&D and innovations. Countries with a high relative R&D effort (BERD by GDP) and a high percentage of R&D performing firms also have a high demand for knowledge. This aspect is important because a critical mass of knowledge demand enables the creation of a broad and specialised S&T infrastructure and services. In the case of Spain the relative R&D effort of 2008 is low (1.35%) compared with the EU-27 average (1.9%). The percentage of innovative firms in Spain (33.6%) is also low. The EU-27 average is almost 39% while countries like Germany (62.2%), Sweden, Austria, Finland, Denmark Ireland or Belgium have percentages around 50% (All data for 2006). However, a clear increase of both percentages was observed for the

[7] Like the Scandinavian countries, the UK or the Netherlands (with percentages between 17-32%)

last years. On the other hand it can be stated that both aspects are the combined result of the sectoral specialisation in low and medium tech sectors and the relatively small size of the Spanish firms. Moreover the absence of large firms, multinationals and the low number of high tech firms in emerging sectors impede strong growth of demand in R&D (See also § 2.2.2.).

The role of foreign firms in the domestic Spanish R&D activities can be observed from two perspectives. On the one hand in 2008 around 5.7% of total Spanish GERD was financed from abroad, while the EU-27 average of that year was 8.6%. In other words the Spanish innovation system is not attractive enough to draw in foreign funds. However at the same time the subsidiaries of foreign enterprise play an important role in the overall Spanish business expenditures in R&D especially in some specific sectors. The foreign multinationals represent 2% of all the Spanish firms but they execute 26% and finance 30% of all Spanish BERD.

The assessment of the policy response to socio-economic objectives can be analysed by the thematic distribution of the public R&D funding. The exact thematic distribution is difficult to assess for several reasons. First, no data are available on the support offered by the "autonomous communities" and for some specific fields, like agriculture and health, the political responsibilities for R&D are partially decentralised. Secondly, large part of the data at national level do not distinguish between the use of subsidies and credits. The first of them are mainly used for scientific research in the public sector while the credits are used to promote R&D and innovation in enterprises. Moreover the thematic topics were not revealed for all funds. Taking into account those shortcomings an effort will be made to cast some light on these aspects by using the distribution of the Spanish Government Budget Appropriations or Outlays on R&D (GBOARD) by thematic fields (Including subventions and credits) that shows the Spanish efforts to address major societal challenges such as energy/climate change; health and ageing and the contribution to sustainable development[8].

The Eurostat data (Eurostat, 2010) shows that the Spanish GBOARD by GDP (1.08%) is much higher than the EU-27 average (0.67%) and even higher than in the USA. In fact it is the highest of all EU-27 countries. The GBOARD in Spain rose enormously in the last 10-15 years. In the period 1997-2002 it increased (annual average growth rate) 13.2% (EU-27 average 3.6) and in the period 2002-2007 these percentages were respectively 11.7 versus 0.79. Looking to the distribution of the GBAORD10 it can be stated that the largest parts of the budget are not directly

[8] Another source of information is the budget of the National R&D&I Plan that includes 25 National Programmes grouped in nine broad areas or fields completed with a "non-oriented" research. These nine areas reveal the priorities. The data for 2007 show in global terms that the "non-oriented" support (NOP) area received the largest amount of support (22.5%), followed directly by the Information Society Technologies Area (IST - 20%) (Especially electronics and communications (10%) and service-related IST (7%)) and the broad area of chemistry, materials and industrial design and production (CMIP-17%) (especially industrial design and production, 10%). Two other important areas are the Life Science Area (LSA - 13%) (especially biomedicine (7%) and biotechnology (3%)) and the Transport and Construction Area (TC - 13%). This real distribution of the support by technological field – revealing real priorities – are only specified for the public tenders for R&D projects and special actions representing 68% of subsidies and 79% of loans involved in the NP.

[9] Source Eurostat 2010; calculation based on a purchasing power standard. This is an artificial currency unit reflecting different national price levels (EU-27 = 100)

[10] The data show first the percentage of the Spanish GBOARD devoted to each area in 2009 followed by the EU-27 average for 2007. Other scientific fields are exploration and exploitation of space (1.5 -

related to specific societal areas but are generic ones under the heading of general advancement of knowledge financed from general university funds (GUF) (26.6-32.0); and from other sources than GUF (17.8-14.5). So 46.5% of the funds could be considered generic funding and this group increased its weight clearly in the last few years. Three other fields with a high budget are "industrial production and technology" (IPT 11.4-11.5); "transport, telecommunications and other infrastructures" (TTI; 6.4-2.4) and "agriculture" (8.1-3.7). Of the specific areas of societal needs the health sector (11.8-7.8) received the highest budget followed by environment (5.0-2.6), energy (3.4-4); exploration and exploitation of the earth (1.9-1.5) and education (1.2-0.8). The fields of agriculture, health and TTI increased their participation while the IPT lost weight in the overall GBOARD. Looking to the EU-average (for 2007) it can be observed that the participation of health and IPT in the EU is also important, albeit smaller, while agriculture and TTI has a small part in the EU-27 average. The defence sector receives 2.8% of the Spanish GBOARD while the EU-27 average for this field is 11.5%. This field was important in Spain in the period 1995-2007 with participation of 10-15% but in 2009 it lost a large part of its weight and was assigned only 2.8% of the GBOARD.

2.4 Knowledge production

The production of scientific and technological knowledge is the core function that a research system must fulfil. While different aspects may be included in the analysis of this function, the assessment provided in this section focuses on the following dimensions: quality of the knowledge production, the exploitability of the knowledge creation and policy measures aiming to improve the knowledge creation.

2.4.1 Quality and excellence of knowledge production

With regard to publications, Spain produced in 2008 51,780 publications, which implies 1,099 publications per million inhabitants (649 in 1998). This is below the EU-27 average of 1,260[11]. The Spanish quotes in the total number of scientific publications all over the world in the period 1998–2008 went up from 2.24% to 2.72%. The quality of the publications (measured by the number of citations) seems to be low. Each Spanish publication is cited 15.3 times while the publications from countries like the UK, the USA or the Scandinavian countries are cited on average 20-25 times. A growing percentage of the Spanish scientific publications are based on international collaboration. In the period 1996-2002 around 28-30% of the publications were produced with foreign partners while in the last few years (2006-2008) this percentage went up to 39-41%. In the case of patents, Spanish production is also increasing although it is still at a very low level. Spain produced in 2007 over 32.8 European patents per million inhabitants, far below the EU-27 average of 117.5. In 1990 this number was 6.5, reaching almost 10 patents per million inhabitants in 1995 and almost 20 in the year 2000. Since the year 2004 the number is around 30 patents per million inhabitants. Concluding, the Spanish level of knowledge production is improving especially in the academic sector. The results of research activities in terms of absolute number of publications are at a satisfying level in comparison with the EU-27, albeit still far behind the leading countries. At the same

5.0); Culture, recreation, religion and mass media (1.4 - 1.0); political and social systems, structures and processes (1.5 - 2.2). Source: Website of the Spanish Ministry of Science and Innovation.

[11] All data on publications are based on the SCOPUS data base of the SCImago Journal & Country Rank and are taken from the reports of COTEC, 2010 and FECYT 2010. The patent data are taken form the Eurostat, 2010.

time the technical gap in the form of patents is still very wide because the number of patents per inhabitant in Spain is 28% of the EU-27 average.

2.4.2 Policy aiming at improving the quality and excellence of knowledge production

There are no systematic evaluations of the quality and excellence of the PRO and universities. However the Spanish Science and Research Council (CSIC) have its own internal assessment schemes to evaluate their institutes. One of the main policy measures to improve the excellence and quality of knowledge production is the already mentioned CONSOLIDER Programme. This instrument promotes a significant advance of the knowledge frontier with a marked character of technological transfer. The programme supports research teams that can lead science in Spain due to their proven quality and an established career in the international scientific community. The CONSOLIDER Programme seeks, among others, the following objectives; (1) The increase and consolidation of the critical mass of the research teams through the appropriate financing of their quality and development potential; (2) The promotion of research activity in cooperation with R&D&i centres and national and international teams, especially in the European area; and (3) Promotion of participation in the European and international programmes. In the case of the universities and Public Research Organisations some specific polices for the increase of excellence are implemented, such as the University Strategy 2015 or the Campus of international Excellence Programme (See § 3.3.2). In the last few years the selection procedures of most of the tenders for publicly supported projects include criteria on the quality of the proposals and researchers based on external peer review. And for the most important type of projects international experts are involved in the selection procedure. Moreover some regional governments try to introduce quality criteria in the case of block funding for HEI or PRO. In other words, block funding not only loses weight in the overall finance mechanisms (on detriment of competitive funding). However, there is also a new trend or intention to make the remaining part of the block funding directly related to research depending on the criterion of excellence and productivity.

2.5 Knowledge circulation

Tackling the challenges that European society faces in the 21st century will require a multidisciplinary approach and coordinated efforts. Many debates and conferences, e.g. the Lund Declaration recognise that such complex issues cannot be solved by single institutions, technology sectors or MS acting alone. Hence strong interactions within the "knowledge triangle" (education, research and innovation) should be promoted at all levels. Moreover, in the context of increasing globalisation, cross-border flows of knowledge are becoming increasingly important. This section provides an assessment of the actions at national level aiming to allow an efficient flow of knowledge between different R&D actors and across borders.

2.5.1 Knowledge circulation between universities, PROs and business sectors

Knowledge circulation: the basic facts

The data on knowledge circulation between the universities, PROs and business sectors are scarce and only some general trends can be mentioned. The CIS data of 2006 shows that 14.2% of the total expenditures on innovation of the Spanish enterprises are extramural, in other words are carried out by other agents (Other

firms, universities or PROs). This percentage is relatively high compared with the EU-27 average. The main difference between Spain and the most developed European countries can be observed in the acquisition of external knowledge (43.7% in Spain and 20-34% in the most advanced countries) compared to the internal R&D expenditures (39.6% in Spain versus 50-60% in the advanced countries - The CIS data of 2006). As a second indicator it can be stated that -in 2006- Spanish industry financed 7.2% of Spanish R&D expenditures of universities and governmental R&D institutes, which is exactly the same figure as the EU-27 average. Nevertheless, the state of opinion in Spain suggests that the level of public-private cooperation in R&D and innovation is low (COTEC, 2005; OECD, 2006). Moreover, interaction between science and industry is biased towards polytechnic schools (OECD, 2006). These are the CIS data of 2006 that show that around 5% of Spanish innovative firms cooperate with universities, thus occupying one of the last positions in the ranking for this indicator, with only Malta having a lower figure. In the case of cooperation in R&D between the enterprises and the government or public research institutes Spain also has a low percentage. Just above 5% of the firms are engaged in such cooperation. In this case 8 of the 25 countries have a lower percentage (all data taken from Eurostat, 2010). Especially for SMEs cooperation with the public research sector is more difficult due to their limited human and financial resources which seriously limit their endogenous technological capabilities and information about their opportunities, and consequently their absorptive capacity.

Knowledge circulation: the overall framework and policy instruments

Technology transfer from universities was first recognised in 1983 in the University Law (art. 11) that allowed for this type of collaboration; prior to that it was illegal to transfer university results to industry (OECD, 2006). In past years the government has made legal and administrative changes to the frameworks governing cooperation between universities and firms. Under the new University Law of 2007, public university professors (civil servants) will be eligible to take up to a three-year sabbatical to launch a company based on technological innovation while keeping the right to return to their post at the university. In addition to the above-mentioned regulatory reforms there exist a broad number of policies to promote knowledge circulation and the public private cooperation specific programmes to promote clusters and facilitate links between the public and private sectors (by the use of technology centres, enterprise incubators and science and technology parks). Maybe the most outstanding instruments are the already mentioned CENIT and CONSOLIDER programme implemented in 2006.

2.5.2 Cross-border knowledge circulation

An indirect indicator for cross-border cooperation is the percentage of R&D funds financed from abroad. In 2008, 4.9% of the funds of the Spanish Higher Educational Institutions and of the government sector came from abroad. Looking for the data of 2006 those percentages were respectively 5.0 and 6.1%, which is below the EU-27 average of respectively 5.5 and 6.7 percent. In the case of the enterprises in 2006 and 2008 around 6.3% of the expenditures were financed from abroad while the EU-27 average for 2006 was 10.1%.

Spanish policymakers are very active in the promotion of the **inward mobility** of researchers which is reflected in the broad range of support measures. The Spanish Foundation of Science and Technology has a special website that offers good and very complete information for foreign researchers that want to work in Spain. Moreover each regional government has a mobility centre that offers direct

information on this subject. There are a large number of regional, national and international support programmes that facilitate –indirectly- the researchers' **inward mobility.** All the Spanish programmes offer full access for students and researchers of the European Union and foreigners compete in similar conditions. A specific programme for **inward mobility** is the one to foment the Incorporation and Intensification of Research Activities (I3 Program). It favours the training or recovery of experienced Spanish and foreign researchers to incorporate them into the Spanish innovation system. Also the different Spanish Autonomous Communities offer aid for mobility and training for human resources. The National Programme for the Mobility of Human Resources has three sub-programmes:

1. The sub-programme for research visits and stays by lecturers and researchers of HEI and PROs in foreign R&D centres and universities.
2. The sub-programme for research visits of *foreign* lecturers and researchers in Spanish HEI and PROs.
3. (The sub-programme of support for postdoctoral research abroad (Including the Fulbright scholarships and the "Cátedra Príncipe de Asturias)".

2.5.3 Main societal challenges

A few tendencies can be mentioned. First of all the new the e2i Strategy –part of the Spanish ERA 2020 vision- is partially focused on sustainable development and societal challenges. Moreover Spain participates in several ERA-nets and most of them are related to main societal challenges. There is no evidence that specific research fields are prioritised for the inter-sectoral and cross-border knowledge circulation.

2.6 *Overall assessment*

Following the analysis in the previous sections, this section assesses whether the recent policy changes respond to identified systemic weaknesses and take into account identified strengths. The recent policy changes respond to identified systemic weaknesses. The INGENIO 2010 Initiative of 2006 was designed to tackle the main problems mentioned in several studies (OECD, 2006; COSCE, 2005; Sebastian and Muñoz, 2006), while the Spanish Innovation Strategy approved in 2010 did delve more deeply into some of these aspects and created a new instrument for Spain based on Public Procurement as an active way to foster innovation. These initiatives together with the changing economic environment (introduction of the Euro and the end of Spain as a low wage country) generated a positive virtuous circle with an increase in the innovative culture, R&D investments and policy interest in R&D. However this process should be accompanied by mechanisms that overcome the systemic failures, especially the need for the modernisation of the public research sectors such as the improvement of the excellence of public R&D and a major integration of public and private R&D.

Table 3: Summary of main policy related opportunities and risks

Domain	Main policy opportunities	Main policy-related risks
Resource mobilisation	• Substantial budget increases of the GBOARD before the crisis and almost no cuts in 2009-2010 • Specific programmes to increase the participation in EU programmes • Reorientation of the use of the Structural Funds to R&D related activities • Increased credit facilities for innovative activities in SMEs and venture capital	• Drop in relative level of EU Funds received from the Framework Programme • Future loss of the structural funds • No specific instruments address the attraction of foreign R&D performing firms or the stimulation of R&D in non- innovative firms.
Knowledge demand	• Attempt to meet demand for funding of large projects through simplified procedures • Public Procurement as a new instrument to promote R&D	• Little priority setting according to the industrial structure and specialisation. • The NPRDI indicates abstract priorities but does not distribute the funds by these priorities.
Knowledge production	• Specific programmes to overcome the fragmentation of the public research system, to raise critical mass and excellence (CENIT/CONSOLIDER).	• Lack of excellence in public research organisations which impedes multiplier effects in terms of new research contracts or the later transfer of the results
Knowledge circulation	• The growing importance of programmes that foster industrial and academic links • The growing importance of the possible use of research outcomes for the private sector as selection criteria for the distribution of funds.	• The mismatch between research results and the needs in innovation systems and the lack of excellence has negative effects on effective knowledge circulation. • Lack of information of SMEs about their opportunities • The almost total absence of influence of the private sector and political powers on education and R&D in universities

Table 4: Main barriers to R&D investments and respective policy opportunities and risks

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
High presence of SMEs and lack of Spanish multinational firms	Large national or multinational firms could lead R&D-oriented networks or clusters. A main risk is the acquisition of the few existing Spanish multinationals by foreign firms, which could have a negative impact on their R&D activities. This aspect is difficult to tackle by policies.
A sectoral bias to low tech sectors and a lack of high tech enterprises and NTBF	The relocation of non R&D enterprises of the traditional sectors to newly industrialised low wage countries in itself is not a risk if new firms in medium high tech sectors are created. Therefore, the low number of business creations in more innovative sectors is one of the main risks that should be tackled. Moreover the decline of traditional sectors could be delayed with specific policies to foster in-house R&D in non-innovative firms. Such instruments, non-existent in Spain- together with the existing cluster policies or instruments focused on technology transfer, could be important to reactivate those low tech sectors and encourage the survival of at least some of the firms The role of high tech sectors is low and declining and only a few NTBFs are created.

Barriers to R&D investment	Opportunities and Risks generated by the policy mix
Fragmented decentralised public research system in which researchers have a high level of freedom	Strategic planning of the Spanish research system is not well enough developed. The high level of autonomy of the Spanish researchers makes such planning and other forms of coordination almost impossible. A legal reform of the public research system should encourage the strategic decision making power at Institute level instead of decentralised short term ad hoc decisions by individual researchers.
Lack of meritocracy and transparency. Low multiplier effect of the public R&D system due to their low level of excellence.	The risks of these aspects are related to the attractiveness of universities and public research organisations as collaborators for the private sector. The low average quality and the academic orientation of public research could be considered as a systemic failure that impedes multiplier effects in which those institutes could raise extra finance for their R&D activities. If their quality does not reach a high level Spanish firms will contract R&D abroad and foreign subsidiaries will be less likely to locate R&D in Spain.

3 Interactions between national policies and the European Research Area

3.1 Towards a European labour market for researchers[12]

The Communication Better careers and more mobility: A European Partnership for Researchers proposed by EC in May 2008 aims to accelerate progress in four key areas:

- Open recruitment and portability of grants;
- Meeting the social security and supplementary pension needs of mobile researchers;
- Providing attractive employment and working conditions;
- Enhancing the training, skills and experience of researchers

The Commission has also launched concrete initiatives, such as dedicated information services for researchers, in particular through the activities grouped under the name of EURAXESS – Researchers in Motion. Based on the assessment of the national situation in the four key dimensions detailed above, this section will conclude if national policy efforts are supporting a balanced 'brain circulation', with outward mobility levels matching inward mobility levels. High levels of outward mobility coupled with low levels of inward mobility often signal an unattractive national labour market for researchers and unsuitable research infrastructures. This may trigger, despite the policy efforts supporting the mobility the 'brain drain' rather than brain circulation.

3.1.1 Stocks and mobility flows of researchers[13]

As mentioned in section 2.2.3 the number of people employed in R&D activities in 2008 was 352,611 persons and 67,000 students were enrolled in PhD studies. International mobility received broad attention by the R&D policies (See 2.5.2).

[12] For a much broader version of this section see the Spanish ERAWATCH Country Report for 2009.
[13] All data of this item for Spain comes from the Spanish National Institute of Statistics (INE) and refers to the data available on its website consulted in October 2010. While the European data are from Eurostat (except where indicated otherwise).

Table 5: International mobility of researchers

	Spain	Europe	Nat sciences and technology	Social sciences and humanities	Medical sciences and agriculture
HEI (during the whole career)	61	56	63	60	57
HEI during the last 3 years	32	29	36	36	15
PRO (during the whole career)	82	65	82	86	78
PRO during the last 3 years	41	35	41	55	29

Source: Study on mobility patterns and career paths of EU researchers (MORE, 2010a and 2010b)

The study on mobility patterns of EU researchers of the HEIs, PROs and industrial enterprises, produced by the MORE project "Study on mobility patterns and career paths of EU researchers" (MORE, 2010a-d) showed that Spanish researchers from the public research system are somewhat more mobile at an international level than the European average (see Table 5). In Spain the percentages of doctoral candidates with a non EU-27 citizenship is around 5% while the EU-27 average is around 6.5% (MORE-report, 2010a). The same report shows that more than 1500 Spanish doctorate candidates are carrying out their PhD study in other EU-27 countries.

Barriers for mobility of researchers[14]

Most support programmes in Spain are formally fully open for researchers or students of all EU countries. However there are several informal barriers that make **inward mobility** very difficult such as protection of the internal candidates; the low salaries; the instability of initial research contracts; the specific time consuming process of recognition of academic qualifications (accreditation) and the need for advanced knowledge of Spanish and in some regions of the regional languages (such as Catalan or the Basque language). The importance of those regional languages in the evaluation criteria to select researchers or to obtain promotion affects the foreign researchers and also makes internal mobility of Spanish researchers more difficult. The use of the Scientific Visa Package is not approved and its application is only partial. However a general tax measure to attract qualified workers abroad offers a 24% tax discount on their salaries and can be applied to foreign or Spanish employees that have not worked or lived in Spain in the last ten years. Since the crisis the control of inward mobility –including for scientists- is more serious and limits the possibilities to enter Spain as an employee. Also in the case of **outward mobility** some barriers exist. These include the fear of losing the personal contacts with their own department important in the Spanish "hierarchical" research system where departments select researchers and (post)doctoral students. Other thresholds are the cost of giving up a stable position as a Civil Servant or the lack of active knowledge of foreign languages (English). In any case, Spain and its regions have introduced in the last years new policies to promote inward and outward mobility and significantly increased their budgets.

[14] For the case of barriers for inward mobility see § 3.1.3

3.1.2 Providing attractive employment and working conditions

Preparing a career as a researcher in Spain is a difficult, time-consuming process with low salaries and unstable short term contracts. The average annual salaries of researchers in Spain (€34,908) are almost 10% below the EU-25 average (€37,948) and very low in comparison with the most advanced countries (EC, 2007). Moreover, the salaries of public researchers are very homogeneous without extra payments for highly qualified and prestigious researchers. The only way to reward very talented or productive employees is the increase for the formal "level" of responsibilities and the assignment of extra R&D funds. Productivity and quality of researchers is only rewarded marginally not exceeding 15% of the salary. However, with some exceptions, the mechanisms to determine this 15% are used to introduce a general increase of salaries and do not discriminate between the most talented and productive researchers compared to the non-productive ones. One mechanism to increase the salary is by contract research, but this option depends on the quality of the researchers, the interest of his academic field, and his personal contacts with firms or public institutions. All these arguments make the career of researchers less attractive and the best students prefer to work for the business sector in all kinds of activities even below their intellectual level.

Policies promoting women

The policies for 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 requires an impact report about the effects on "gender" aspects. Several specific measures were taken to promote women in the research system and a minimum gender representation in academic committees, and governing bodies. For example, in several universities the selection commissions of research positions should include women. The Spanish situation shows that the presence of female researchers in the public research system (42% in 2006) is high in comparison to other European countries (EU-25 – 34.8%). In spite of this figure and the political interest there is no doubt about it that discrimination against women in the labour market still exists and the gender gap is not closing as rapidly as desired (EC, 2007). Some data show clear discrimination and difficulties for women to enter the research system and a survey showed that men are more successful in obtaining the stable and better paid jobs (Villaroya et al, 2007). Since 2006 most contracts and scholarships include career breaks based on parental leave. However, maternity leave still has negative effects on the career of a researcher because: (1) some scholarships do not pay social security in the first two years: (2) once the women obtains a contract they do not reach the minimum time span of social security contributions to have the right to maternity leave. (3) The lack of formal contracts entails female researchers losing several rights in comparison with other mothers[15]. And (4) the 4 months of maternity leave is not always compensated for with four months extension of the maximum period to hold a scholarship (Villaroya et al, 2007).

3.1.3 Open recruitment and portability of grants

Generally the selection procedures for candidates in research positions or jobs in the Spanish public research system neglect meritocracy and competitiveness in favour of

[15] Including the right to get their children into the (free) kindergarten of the universities or financial state support for babies or young children (up to three years) of working mothers

endogamy[16]. Legally there exists full access for candidates of the European Union to research and teaching posts. However, the tacit mechanisms behind the formal process are still an important threshold, not only for foreigners, but for every outsider from a university, faculty, or even the departments of the same faculty (Fernandez Esquinas et al., 2006, P.167). The members of the selection commission and selection criteria are established ad hoc by the institutes or departments themselves. The final step to a stable job (long life contract or as a civil servant) requires an official accreditation that the applicant meets the minimum requirements of excellence. Again in this case the final selection of the candidate is made by the department (see 3.1.1) and they do not offer a stable contract until the internal candidate obtains his accreditation. On an individual level only a few Spanish universities have subscribed to the European Charter for Researchers (fewer than ten). This charter is difficult to accept for the larger institutes with a high level of decentralisation of the selection procedures and a culture of favouritism. However the Ministry of Science and Innovation requires all universities that present applications to obtain public support from tenders for Human Resources to accept and comply with the Charter. Where all universities obtained public support, it could be said that implicitly all universities subscribed to the charter. However, the practical impact of this mechanism on the transparency and openness of the selection procedures seems to be marginal. Some other specific aspects can be mentioned. For example international advertising of research vacancies supported by public funds is not common and depends on the interest and individual decision of the department or research organisation. Moreover research grants are not portable and a researcher awarded a research grant is not normally allowed to transfer it to another foreign institution. There is a simple and clear system for the recognition of professional qualifications in the case of standard studies. However in the case of studies not existing in Spain the validation of foreign academic degrees is more complicated.

3.1.4 Meeting the social security and supplementary pension needs of mobile researchers

In Spain all citizens receive healthcare and social benefits in case of need including the (young) researchers. Spain signed agreements with the European Union that the different retirement pension periods in other EU countries are added together in calculating the minimum contribution period and you may request to have the pension paid in another country. These rules also apply to the non-EU countries with a bilateral agreement (FECYT, Mobility portal). In relation to the social security of those young researchers with scholarships it can be stated that most of them are based on contracts and include almost all social security regulations. However, some exceptions exist such as the PhD Scholarships. In this case they apply the 2+2 formula (two years scholarship and two years contract) and afterwards scholarships holders receive unemployment payments. Spanish Universities and public research organisations cannot be considered as researcher friendly in terms of social security and pension systems. Avoiding payments to such a system to the detriment of the researchers is the normal money saving system of Spanish public organisations. Relatively large parts of the wages are supplements and are excluded

[16] In 70% of the competitive examinations there was only one candidate and in 94.6% the selected person was the internal candidate (the same figures for the USA, Great Britain and France were respectively 7%, 17% and 50% (data taken from Cruz-Castro et al (2006) and Corruptio (2007).

once the pension and social security payments are calculated[17]. This fact is an important barrier to attracting foreign researchers or lecturers.

3.1.5 Enhancing the training, skills and experience of European researchers

Only a few doctoral programmes exist in collaboration with foreign universities and the introduction of English as a spoken language in PhD courses or the university degrees is still in an infant stage. One of the problems is to find enough experienced lecturers that can give the subjects in English. Due to the high level of autonomy on the Spanish universities a high degree of standardization of national PhD programmes do not exist and would be almost impossible in the Spanish setting. International mobility is promoted in an intensive way but not compulsory to access to a stable position. On some occasions mobility, particularly for non-permanent staff could be penalised in the career progression due to the loss of contact with the department.

3.2 *Research infrastructures*

Research infrastructures (RIs) are a key instrument in the creation of new knowledge and, by implication, innovation, in bringing together a wide diversity of stakeholders, helping to create a new research environment in which researchers have shared access to scientific facilities. Recently, most EU countries have begun to identify their future national RI needs, budgets and priorities in the so called National Roadmaps for Research Infrastructures. These strategic documents also set out a strategic view on how to guarantee and maintain access to research facilities. Although some countries invest heavily in RIs, none can provide all the required state-of-the-art facilities on a national basis. Several large RIs have already been created in Europe. While optimising the use and development of existing RIs remains important, new infrastructures are needed to respond to the latest research needs and challenges. European Strategic Forum for Research Infrastructures (ESFRI) was established in April 2002 to support a coherent approach to policy-making on RIs in Europe and to act as an incubator for international negotiations on concrete initiatives. This section assesses the research infrastructures national landscape, focusing on the national RI roadmap and national participation in ESFRI.

3.2.1 National Research Infrastructures roadmap

In recent years the Spanish government reinforced the domestic policy for research infrastructures (RI) which is reflected in a substantial increase in the annual budgets devoted to these policies and some new initiatives. The Spanish National R&D&I Plan 2008-2011 promotes the effective use of such infrastructures by the use of specific outward mobility schemes among others. The ESFRI also boosted design and interregional coordination of the national road map of infrastructural needs and in 2007 the “Conference of Presidents” of the Spanish Autonomous Communities came to an agreement to create 24 new singular scientific infrastructural installations in the period 2007-2015 which are added to the 37 existing ones. The foreseen investments for the period 2004-2010 are €774m. As far as the Spanish RI roadmap is concerned, the NPRDI includes the **National Programme on Scientific**

[17] Some studies show that only 20-30% of the total income of university professors is basic income. Source: Federación de Asociaciones de Catedráticos de Universidades Constituidas. Taken from: http://www.aprendemas.com/Noticias/html/N606_F27102004.HTML

and Technological Infrastructure devoted to the creation and improvement of the RI which receives 16% of the total budget.

3.2.2 National participation in the ESFRI roadmap. Updates 2009-2010

Spain considers the ESFRI, to be an important initiative and plays an active role in its design. Spain contributes significantly to a broad range of these facilities and tries to participate in 25 of the 44 European RIs to enhance its percentage of return on that participation. It also promotes the role of Spanish industry in building and maintaining those infrastructures. In Spain at least three large installation of the ESFRI will be located. The first one is the construction in Catalonia of one of the five supercomputers in Europe of the Partnership for Advanced Computing. The second one is the solar research infrastructure (EU-SOLARIS) at the Advanced Technological Centre for Renewable Energy in Almeria; and the third is the European Spallation Source (ESS) in the Bask Country, being an advanced centre to research the atomic and molecular arrangement for materials

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3.3 Strengthening research institutions

The ERA green paper highlights the importance of excellent research institutions engaged in effective public-private cooperation and partnerships, forming the core of research and innovation 'clusters', mostly specialised in interdisciplinary areas and attracting a critical mass of human and financial resources. The Universities/ research institutions should be embedded in the social and economic life where they are based, while competing and cooperating across Europe and beyond. This section gives an overview of the main features of the national higher education system, assessing its research performance, the level of academic autonomy achieved so far, dominant governing and funding models.

3.3.1 Quality of National Higher Education System

The official statistics of the Spanish INE (academic year 2008-2009) show that Spain had 137 higher educational institutes (HEI) of which 50 are public universities, 23 private universities and 64 are other HEIs. The number of students is 1.4 million, of which 89.2% study in public universities and 10.8% in private ones. The Open universities registered 13.4% of the students. In the academic year 2009-2010 over 303 thousand new students were registered while 190 thousand finished their degree studies. Almost half of the students do social sciences and law, and 25.7% engineering and technical studies while 15.3% of the students are registered in experimental and health and 9.3% in humanities. However, in the case of doctoral

students and approved PhDs the experimental and health area is the most important one (30.4% of the students and 42% of the approved PhD theses) followed by the social sciences (26.3 – 19.7%) and humanities (18.6 – 13.0%) while in the case of engineering the numbers for both indicators are 14.6%.

After a significant increase in budgetary terms in the last few years, the Spanish research system has been undergoing a broad renovation in legal and organisational terms. In recent years already some aspects have been changed, such as the Law of University Organisation and the "University Strategy 2015" project which should improve the quality of the Spanish universities. Moreover at this moment the Ministry of Science and Innovation is preparing a legal review of the Law of Science.

As mentioned in section 2.4.1 the scientific quality of the Spanish academic system measured by the number of publications is just below the EU-27 level although still far from the leading European countries. Looking to the impact rate of the publications the situation is not outstanding. The 2010 report of the «Scimago Institutions Rankings» (SIR) indicates that Spain is the 10th country in the case of production of the number of publications but taking into account the impact score Spain is in 21st position. Also the international rankings of universities show the relatively low quality of the Spanish universities due to their absence in the top 100 and their scarce appearance among the lowest ranked universities[18]. A broad comparative study is made on the quality of the Spanish universities (Buesa et al, 2009) offering a general synthetic ranking and specific rankings for both teaching (18 variables) and research (14 variables). The most outstanding university for both missions was the private University of Navarra. This ranking is based on the average quality level of the activities taking into account the number of academic staff and most of the larger universities included in the international rankings are not in the top ten (with the exception of the "Autónoma of Barcelona").

Policies to improve the excellence of the universities

The main instrument to ensure a growing level of excellence is the already mentioned accreditation, which requires at least a minimum level of excellence to obtain a stable job. Initially only one national agency for accreditation was created with strict procedures and requirements. However, later on almost every region created its own agency and a certain number of them use very lax and permissive criteria. In spite of these new recruitment procedures the public research organisations and universities -at department level- still have a broad level of freedom in the application of the selection criteria. On the whole, the accreditation system at least seems to avoid the access of people with a really bad curriculum, although it does not impede the survival of the existing widespread endogamy (see also section 4.1.1.). Two outstanding policy initiatives can be mentioned in relation to the improvement of excellence. The first one is the University Strategy 2015 which is an initiative coordinated between the Government of Spain, the Autonomous Regions and the universities, aimed at the modernisation of the Spanish universities by promoting excellence in education and research, internationalising the university system, and ensuring its involvement in bringing about economic change by providing knowledge and innovative improvements. The second one is the

[18] In the Academic Ranking of World Universities – 2010 the first Spanish university is in 201st place and another 9 are ranked between the positions 200-500. In the list of the 200 best universities of the Times World University Ranking only one Spanish university (included is in 186th place) and the QS World University Ranking» (2010) placed the best Spanish university in 148th place and includes 3 other universities within the 300 best universities.

"Campus of International Excellence" Programme. This programme is aimed at making Spanish universities internationally more competitive in general, with special focus on the overall quality. However, neither of the initiatives handles the main barriers for excellence, endogamy, fragmentation and the lack of strategic planning and coordination which makes the plans partially useless.

3.3.2 Academic autonomy

The "University Autonomy" is protected by the Spanish constitution and implies a broad level of self-government. On an **individual level** the academic staff of the universities has total freedom to arrange their research activities, which hampers coordination and strategic planning and created a fragmentation of the research groups. The academic autonomy on an **institutional level** is often used to defend the personal interest of the researchers (corporative behaviour) above the general interest of society as a whole. Therefore most universities or research centres can be characterised as closed communities with a low level of transparency rather than an open dynamic organisation based on meritocracy. On one side the university and PROs have broad freedom to organise their institutes and to decide in which disciplines they recruit more new researchers. However, they have to take into account the budget restrictions, since salaries or other payments are strictly ruled and pre-defined by the national authorities. The University has a centralised decision making process and the Rector (or vice-rector for planning) has the final decision concerning the distribution of human resources between faculties and departments. The appointments of the rector, deans of the faculty or directors are decided by direct elections based on the votes of the members of the university (lecturers, administrative personnel and students). Several authors have a critical view on the use of the Autonomy of the Universities in Spain. For example Sanchez (2008) argues that the *"democratic model is not capable of managing the university with a criterion of efficiency and rationality",* because the chosen managers have debts with their voters and the pressure groups that supported them during the elections." For example, the vast majority of the "study" plans (curricula) are designed taking into account the interests and power of the departments without any serious analysis about future needs in the labour market. Individual and institutional autonomy coexists with a reduced level of **financial autonomy.** Most financial resources come from the regional public budgets, though this economic dependency has never been used to force universities to open up and professionalize their institutions.

3.3.3 Academic funding

Block funding is based on number of students, while excellence measured by research results has only a marginal role in the funding decisions. Block funding financed the salaries and current costs while specific R&D projects and activities are mostly financed by competitive tenders and contract research. Some regional governments (such as Madrid) made an attempt to base block funding of the universities on productivity indicators. However there is clear opposition from the universities and this new trend is still in an experimental phase. As a **concluding remark** it can be pointed out that the autonomy of the universities and research organisations is a tricky question. It is not the question of more or less autonomy, but its application and the use or abuse of this freedom has to be taken into account.

3.4 Knowledge transfer

The importance of knowledge dissemination and exploitation in boosting competitiveness and contributing to the effectiveness of public research has been increasingly recognised by EC and EU Member States. Following the publication of the ERA Green Paper in April 2007, the EC Communication "Improving knowledge transfer between research institutions and industry across Europe" was issued, highlighting the importance of the effective knowledge transfer between those who do research, particularly HEIs and PROs, and those who transform it into products and services, namely the industry/SMEs.

Several Member States have taken initiatives to promote and facilitate knowledge transfer (for instance new laws, IPR regimes, guidelines or model contracts) and many others are planning to intensify their efforts in this direction. However, these initiatives are often designed with a national perspective, and fail to address the trans-snational dimension of knowledge transfer. This section will assess the national policy efforts aimed to promote the national and trans-national public-private knowledge transfer.

3.4.1 Intellectual Property Policies and Knowledge Transfer Offices

Intellectual property rights (IPR) are regulated by the General Law on Patents, Inventions and Utility Models (Law, 11/1986 – IPR law). Spain has no specific legal regulation of the ownership of the knowledge produced by the university or PRO staff. Therefore the legal base is the IPR Law that indicates in article 20 that the university owns the inventions and research results generated by its staff members. However in the same article it is stated that the inventor receives part of the benefits generated by the IPRs. The quantity is established by the Statutes of each HEI or PRO. However, the real situation of the IPR is not clear. Researchers own the copyright of their own publications and do contract research. In the latter case a certain percentage (between 10-20% depending on each university) of the total amount of the contract is for the university and Technology Transfer Office. The above described permissive situation is related to the traditional low salaries in Spanish universities and the researchers can be rewarded with this kind of extra income often generated by themselves.

In the last decades the Spanish government has tried to strengthen the science-industry-university relationships. Since 1988 it has offered specific financial support for the creation and development of the **Knowledge Transfer Offices** (KTO)19 to reinforce the “third mission” of HEIs and PROs. In 2007 209 KTOs were registered with 758 staff members. 76 KTOS are in technology centres, 65 in universities, 15 in PROs and 53 in other kinds of organisations (associations of enterprises, hospitals etc.). The activities, quality and success of these KTO offices are very heterogeneous. The general opinion of experts is that the Spanish KTOs have in general a very passive bureaucratic attitude and are basically administrative units that act to formalise the R&D related projects obtained by the researchers. Most of them are not active bodies in charge of knowledge management and looking for clients and the commercialisation of the scientific results.[20] However in some cases the KTOs have a very proactive attitude by generating added value as an

[19] All data come from the Annual report of the KTO association “RedOTRI” (2009)
[20] Based on several opinions expressed during a meeting of experts for the development of indicators to measure the quality of the Spanish universities (Meeting in January 2009 in Baeza – Andalusia)

intermediary body between the academically oriented researchers and the production sector.

3.4.2 Other policy measures aiming to promote public-private knowledge transfer

In the last decade the Spanish government has focused the changes in R&D and innovation policies on the commercialisation of the scientific results fostering public private cooperation, the creation of clusters and important support to the creation and amplification of science and technology parks and the technology centres. The public governments also pay a great deal of attention to the promotion of spin-offs. An organisation that could or should guide the influence of external stakeholders on the universities could be the Social Council of the universities. However the role of these councils is marginal or symbolic due to the lack of tradition and culture in this kind of organisation and the lack of a well defined legal framework that defines their functions and power.

The EU Cohesion Funds play a very important and growing role and increase R&D budgets substantially in eligible Spanish regions. Several measures financed by these funds promote public-private cooperation as in the case of the support for: (1) the creation of Science and Technology Parks, (2) cooperative R&D projects in SMES; (3) the creation and maintenance of large infrastructural facilities; (4) the creation of new technology based firms; or (5) technology platforms. Also the Spanish National R&D&i Plan boasts a specific programme to promote technological cooperation between SMEs and universities or public R&D centres.

3.5 *Cooperation, coordination and opening up of national research programmes within ERA*

The articulation between the R&D Framework Programmes, the Structural Funds and the Competitiveness and Innovation Programme is still underdeveloped in terms of coordination, synergies, efficiency and simplification. The policy fragmentation at EU and national level, and between EU and national policies can hinder the build of critical masses of research excellence, leads to the duplication of efforts, sub-optimal impacts of the different instruments and unnecessary administrative overheads. Differences between research selection procedures and criteria can also be an obstacle to the overall spread of excellence. This section assesses the effectiveness of national policy efforts aiming to improve the coordination of policies and policy instruments across the EU, all part of the drive to create an integrated ERA.

The ERA initiative is discussed from time to time both in the Spanish press and in society at large. However, on a policy-making level it is considered a very important topic. The National Plan for R&D&i refers broadly to the ERA concept for several reasons: (1) as a benchmark for S&T indicators and good practices; (2) ERA provides funding schemes such as the R&D Framework and the EUREKA Programme and Spain wants to increase its participation and (3) The ERA and the Lisbon Strategy were some of the fundaments to develop the Spanish National Reform Programme. Therefore it can be said that the ERA did help to define the broad framework and specific instruments of the NPRDI, for example the reorientation towards sufficient critical mass and excellence which makes it possible to assume leadership in European programmes, etc. (ERAWATCH Country Report, 2008). However, the tightly closed endogamic public research system with highly

decentralised power impedes or hinders the successful implementation and use of the ERA oriented measures.

3.5.1 National participation in intergovernmental organisations and schemes

Since 2007 Spain increased its participation in the **Framework Programme (FP)**. During the first two years of the 7th Framework Programme (FP7) Spain received annually €217.3m which represented a 12.6% increase in relation to FP6. 2009 was an exceptional year because Spain received €682.1m and a large number of proposals were led by Spanish participants. Spain obtained a rate of return (% of funds obtained) of around 6.5% which is below the pursued rate of 7.4% (equal to the Spanish contribution to the EU budget in 2007-2008). This low participation is possibly related to the criteria for project approval based on experience and excellence, which is not always ensured for all Spanish research groups. In 2009-2010 the Spanish government carried out a broad impact study of the Framework Programme and the results show a positive, important impact on the participants in terms of an increase in R&D funds, cooperation and internationalisation. Spain has an active participation in the large infrastructural facilities and research institutions. Spain obtained a satisfying number of the projects of the **European Research Council** in the case of the "Starting Independent Researcher Grants" and the "Advanced Investigators Grants" of which they received respectively 7.9 and 4.2% of the projects. Moreover Spain participates in two of the three Knowledge and Innovation Communities (KICs) of the **European Institute of Innovation and Technology.** Spain also participates actively in the **multilateral research programmes**. Its contribution to the international programmes and research institutions was in 2008 almost €332m[21] (€120m in 2004). The highest contributions went to the CERN and ESA (€55m and €197m respectively) and the EUREKA programme (€50m). These three received over 90% of all the funds. In the case of the support for the international institutions a large part of the contributions come back to Spain in the form of research contracts, though they are in fact national funds.

3.5.2 Bi- and multilateral agreements with other ERA countries

Spain participates in the following multilateral programmes: Transnational Plant Alliance for Novel Technologies - toward implementing the Knowledge Based Bio-Economy in Europe; International Union of Pure and Applied Chemistry; International Programme on Regenerative Medicine International Cancer Genome Consortium.

3.5.3 Other instruments of cooperation and coordination between national R&D programmes

ERA-nets are European research networks created under the 6th Framework Programme that focuses on different areas of R & D and that are made up of regional and national financing bodies of the member states. Their goal is to study problems and solutions in order to develop a European Research Area (ERA). Some ERA-nets

[21] The distribution of the budget is: European Space Agency (ESA – 59.4%); European Organization for Nuclear Research (CERN) (16.6%); European Molecular Biology Laboratory (1.9%); European Synchrotron Radiation Facility (0.9%); Institut Max Laue-Langevin (1.1%); European Southern Observatory (3.5%); European Conference Molecular Biology (0.3%); European Science Foundation (ESF) (0.1%); And the most outstanding International programmes with "third" countries are Iberamerican Programme of Science and Technology for Development (1.2%); and EUREKA (15.0%).

execute, in an experimental manner, joint calls for collaborative R & D projects, calls with specific objectives and restricted financing in which each participating country finances its own centres' participation. In these cases, the Spanish projects are granted by a Complementary Actions call for proposals. The information on ERA-nets is sparse and much dispersed because the Spanish participation is spread amongst all kinds of research organisations and governmental institutions on a national and regional level and no information is systematically gathered on a central level. Spain gives intensive support to the **Joint Programming** and in several fields –such as health science- Spanish Researchers are collaborating. The first draft of the new Science Law (to be approved in 2011), includes several elements for a partial solution of the legal barriers for joint programming. Spain considers the **Joint Technology Initiatives** as an important EU policy and participates in all JTI´s. Their contribution is around €12.3m and the Spanish government is satisfied with the participation of Spanish enterprises. Spain also has an active role in the **article 169 initiatives;** also in this case they participate in all initiatives (Based on a statement by the Ministry in 2009).

3.5.4 Opening up of national R&D programmes

Spain seems to have an open strategy in relation to the access of all kinds of national policy programmes for firms or individuals abroad. As already mentioned, the programmes for human resources are open to all EU inhabitants and also the tenders for R&D projects are accessible to foreign firms operating in Spain. No example is found of a public research funding scheme that allows researchers to transfer a research grant which they have been awarded within a national programme to other countries when moving to another position (EC, 2008). One of the main components of the international scope of the Spanish R&D&I Plan 2008-2011 is the opening up of the programmes to R&D groups from other countries.

3.6 *International science and technology cooperation*

In 2008, the European Commission proposed the Strategic European Framework for International Science and Technology Cooperation to strengthen science and technology cooperation with non-EU countries. The strategy identifies general principles which should underpin European cooperation with the rest of the world and proposed specific orientations for action to: 1) strengthen the international dimension of ERA through FPs and to foster strategic cooperation with key third countries through geographic and thematic targeting; 2) improve the framework conditions for international cooperation in S&T and for the promotion of European technologies worldwide. Bearing in view these aspects, the following section analyses how national policy measures reflect the need to strengthen international cooperation in S&T.

3.6.1 International cooperation

Due to its traditional relationship with Latin America Spain has several cooperation programmes with that part of the world. One of the most outstanding ones is the **Iber-American Programme of Science and Technology for Development** for multilateral cooperation in the following areas: Agro-Alimentation, Health, Promoting Industrial Development, Sustainable Development, Global Change and Ecosystems, ICT, Science and Society and energy. The support is focused on five domains: (1) Thematic Networks, (2) Research Project, (3) Consortiums Research Projects, (4) transversal interdisciplinary activities aimed at technology transfer; and (5) public and

private project cooperation. The budget was €4m in 2008 and between 1991 and 2009 the Iberoeka registered 633 projects of which 569 were with the participation of Spanish partners. Moreover the Spanish government has several bilateral cooperation agreements with countries outside Europe (such as Canada, China, India Korea, USA and Japan). Besides these general programmes Spain also has bilateral cooperation programmes with Brazil[22] and Argentina[23] to collaborate in R&D projects in some specific fields.

3.6.2 Mobility schemes for researchers from third countries

Spain has a specific sub-programme for research stays of foreign lecturers and researchers in Spanish HEI and PRO. The measure supports research and educational visits for long (one year) as well as short stays for people with broad experience and for young talented PhD holders. Moreover the National Programme for internationalisation of R&D has specific international mobility schemes for EU countries and third countries. Each year the tender includes a few specific countries and for each country different technological fields. This instrument requires the presentation of a research project, the main aim of which is to carry out exchanges of researchers between the countries for short or long research stays.

4 Conclusions

4.1 Effectiveness of the knowledge triangle

Spain has developed in recent decades an integrated and coherent framework of R&D and innovation policies and it has a multi-annual national R&D and innovation plan. However the financial distribution is decided annually and most research organisations and universities are limited in their strategic planning by annual budget cycles (except the Spanish National Research Foundation). However it has several measures that finance long term strategic research for large research groups with a high level of excellence. Some recent developments involved more coordination between the different administrative levels. This involved such things as the creation of the Ministry of Science and Innovation, the procedures to approve the Operational Plans related with the European Structural Development Funds and the approval of the National Strategy for Science and Technology (ENCYT) and the Spanish National Roadmap for S&T infrastructures. Another positive trend is the inclusion of the commercial use of the research results in the selection criteria of almost all tenders for project support. The distribution of the funds for public support for R&D is more and more based on competitive criteria and block funding lost weight in the total GBOARD. Moreover in several regions they introduced in the last few years some new regulation to relate also the block funding for research (not for education) with productivity and excellence. These trends could be an important step in normalizing the coordination between national and regional policies and integrating the R&D and innovation policies. However, besides these legal changes, the real changes have to come from the scientific world that requires a new open and competitive approach or culture on doing useful, high quality research. In fact, the research and educational activities of the vast majority of the universities and public research organisations are not being evaluated. Some indirect evaluations are made

[22] Biotechnology, renewable energies, process engineering, nano technology and health
[23] Biomedical, forensic and vegetal Genomics and Bioinformatics

on the level of the individual researchers but not on an institutional level. To attract R&D from abroad and maintain the R&D expenditures of Spanish firms in the Spanish innovation system it is necessary to improve the level of excellence of most (public) R&D institutes and the innovation related services and infrastructure. This brings us to the most important weakness of the Spanish research system which is not sufficiently tackled by the policy instruments. Spain lacks strong mechanisms that ensure a high level of excellence and productivity of research institutions. Some specific instruments are implemented but it is difficult to change the historical culture of inefficient assignments of funds and human resources often based on internal decisions of the research organisations. This aspect should therefore also be considered as a missing point in the policy mix. One of the possible solutions could be the increased autonomy of public research organisations and universities. However this is a tricky question because the benefits of this freedom in terms of increased excellence depend on its efficient implementation, which in the case of Spanish public research organisations and universities is not always guaranteed. This lack of guarantees can be observed during the selection procedures for new personnel -characterised by endogamy and personal contacts- or the low productivity reflected in the small number of researchers that passed the six-yearly research evaluations.

Concluding, the research institutions need more freedom (especially in the case of salaries and budget cycles) to allow long term strategic planning and to compete with R&D institutes abroad. However if such policies are not implemented simultaneously with mechanisms that guarantee an efficient and effective use of this freedom -based on competiveness and meritocracy- the final result will be the perpetuation of the existing situation. A positive change could be the transformation of the Spanish Research Council (CSIC) into a public agency. However in this case the CSIC is still limited in its margins of autonomy. Moreover, the exact mechanisms to ensure the excellence of the R&D are not clear. Another possibility could be the supply of more block-funding for institutions based on excellence. In this case better criteria for the evaluation of the recipients of competitive funding and more transparency and independence of the selection process are required. Therefore, at this moment the most important aspect is probably not only the GERD but the modernisation of the public institutional research framework.

Another important weakness of Spanish R&D and innovation policies that can be highlighted is the coordination of the national innovation systems. This problem is reflected in three important policy dimensions. The first dimension is the scant coordination between the policies of different administrative levels and even between the units of the same administrative levels. The second one is the low level of integration of measures oriented to scientific research with those related with innovation and technology transfer.

Table 6: Effectiveness of knowledge triangle policies

	Recent policy changes	Assessment of strengths and weaknesses

	Recent policy changes	Assessment of strengths and weaknesses
Research policy	• The GBOARD increased from €4,000m in 2003 to €9,349m in 2008. • Development of a new Law of Science. • The "Campus of International Excellence" and the "University Strategy 2015" aims at the improvement of the quality, efficiency and effectiveness in both teaching and research.	• Lack of excellence of the public research system and the correlated low level of technology transfer. • Lack of critical mass and the fragmentation of the public research system. • Low level of integration between industrial and science. • HEIs and PROs lack strategic plans to overcome such barriers. The dependence of the rectors on their voters makes it difficult to design or implement such a plan. • These system failures impede the success of the recent policy changes.
Innovation policy	• The new e2i Strategy complements the existing policies with new measures, such as public procurement as an R&D policy in specific fields and some specific measures to foster the interregional integration of the Spanish innovation system. • Raising financial support in general and for risk capital; the incorporation of PhD holders in enterprises and the internationalisation of the R&D in firms. • The 2009 "anti-crisis" policy included specific R&D&i. measures: The recovery plan of 2010 included R&D&i as a priority.	Important barriers to the increase of R&D efforts are: • Its production structure, with a significant weight of small and medium sized firms, oriented to the less innovative traditional sectors. • A very slow structural change from low tech sectors to novel high tech sectors and a limited creation of NTBFs. • The lack of multinational enterprises that could have a leading role for creation of R&D related networks or clusters with the corresponding system advantages. • Spain is not a low wage country anymore and lost exchange rate as a policy to gain competitiveness, which obliges Spanish firms to compete in innovation and quality. • Some policies are still lacking such as the attraction of foreign R&D and the policies for non-R&R performing firms.
Education policy	• Separation of the "secretary of universities" from the Ministry of Science and Innovation. • "Campus of International Excellence" and "University Strategy 2015". • Accreditation of a minimum level of experience and talent for academic staff before getting a full time job as civil servant (since 2001).	• The autonomy of the scientific organisations is a tricky question because the vast majority of the organisations use it to protect their own interests or that of their staff members to the detriment of societal needs or interests. • However the lack of autonomy in relation to specific aspects (strict regulations of salaries and annual budget cycles) also impedes the application of a strategy of excellence and the attraction of talented researchers. • International reports show a low quality of Spanish education at all levels which is the result, among others, of the above mentioned barriers. • The English language is still a main problem and no incentives exist to resolve this problem.
Other policies	• Several policies were introduced to increase the scientific- industrial linkages (CENIT, S&T parks, etc.). • The Cohesion and Structural Funds were reoriented towards innovation.	• The academic orientation of public research and the lack of influence of the private sector and the regional or state governments on education impede a better integration of the education, innovation and research policies.

And the third one is the almost non-existent integration of research and innovation policies on the one hand and the education policies on the other. For three basic reasons the integration of research and innovation policies with the education policies is almost non-existent: (1) The academic orientation of public research: (2) the lack of influence of the private sector on education and (3) The most important decisions on higher education policies are de facto taken by the universities, due to the fact that the state and regional government do not use their political power (based on the assignment and distribution of funds) to orient research and education. Therefore a large part of the educational and research activities of the public sector is not based on societal needs or the demand of the production sector.

The outward research mobility seems to be in Spain somewhat higher than in the rest of Europe. In the case of the inward mobility there exists the formal openness of the selection procedure for research jobs in Spain. However the inward mobility is limited by the informal application of the selection criteria during the recruitment procedures. This seriously limits openness and discourages participation of non-national and even national external applicants in the tenders for permanent positions in universities and public research institutes.

4.2 ERA 2020 objectives - a summary

The main difficulties -mentioned in section 4- in implementing a national ERA related policy are: (1) The low average level of excellence of the Spanish research system and its endogamy, which make Spain a less interesting international cooperation partner; (2) the strict, inflexible salary system for researchers of public R&D institutes, which make it difficult to attract foreign researchers; (3) the annual budget cycles of almost all public R&D organisations, which make it difficult to implement a long-term strategy; (4) the low level of speaking foreign languages –especially English. The poor foreign language skills are an important barrier to absorbing the knowledge generated abroad and to participating in European research activities. Moreover it is an important barrier for outward mobility.

Moreover, sections 3 also mention some barriers for the ERA 2020 objectives. The main ones are on the one hand the low and decreasing role of the high tech sectors and the low level of creation of NTBF in the merging most promising areas. And on the other there is the lack of multinational enterprises that could have a leading role for the creation of R&D-related networks or clusters based on scale and scope economies with the corresponding systemic advantages. Concluding, the very slow structural change from low tech sectors to new high- tech sectors and the limited creation of new technology based firms (NTBF) are still one of the main weaknesses of the Spanish economy that impede to accomplish the ERA 20202 objectives .

In relation to the effectiveness of the R&D&I policies it can be stated that Spain has made qualitative and quantitative efforts increasing the budgets for such policies and creation new instruments. Most evaluation studies showed a positive impact (Heijs/Buesa 2007; Valadez et all, 2011; AEVAL, 2007; MICINN, 2010) especially in the case of the innovation policies. However in section 4 it was made clear that these policies will be useless in the long term -in terms of the creation of a competitive excellent innovation system- if Spain does not modernise its public research system. Only parts of the system function smoothly; a substantial improvement and growth can be reached.

Table 7: Assessment of the national policies/measures supporting the strategic ERA objectives (derived from ERA 2020 Vision)

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
1	Ensure an adequate supply of human resources for research and an open, attractive and competitive single European labour market for male and female researchers	• Important raising of the budgets for policies for Human Resources. • Adaptation of the study tracks to the "Bologna" requirements • Several measures to improve the situation for female researchers. • The legislation for inward mobility is applied more strictly due to the crisis.	• R&D related employment increased between 2002-2008 over 50%. • Spain is not very attractive for qualified personnel from abroad (low wages and bad working conditions). • Spain has a lack of qualified workers although this shortage diminished somewhat due to the crisis. • Universities protect their internal candidates against external researchers from Spain or abroad. • The problem of gender discrimination still exists but improved clearly in the last years. • New study plans are based on internal interest.
2	Increase public support for research	• The R&D-related funds included in the National State Budget (GBAORD) rose 25% annually in the period 2005–2008 and remained more or less stable during the crisis.	• Although the total budget of 2009 and 2010 was kept stable the % devoted to loans increased in relationship to the subsidies. • The increase of public support is not accompanied by a modernisation of the public institutional framework. This impedes a real impact and perpetuates the fragmentation, lack of excellence, and technology transfer.
3	Increase European coordination and integration of research funding	• Spain is very active in the support and participation of all types of pan European research initiatives like the ERA-net, ESFR, JPI, JTI etc. • Internationalisation and the ERA are considered strategic by the Spanish policy makers.	• The % of the R&D funds coming from abroad of the Spanish Enterprises, HEI and PRO are below the EU-27 average.
4	Enhance research capacity across Europe	• Spain promotes the research capacity by its participation in ERA-nets, JTI etc… for the sectors in which they have large enterprises (Like energy, telecommunication; or aeronautics).	• The lack of priority setting and the fragmentation of public research impede reaching a critical mass that would allow an increase of the overall capacity due to synergies and cross fertilising.
5	Develop world-class research infrastructures and ensure access to them	• The NPRDI promotes effective use of European infrastructures (EI); wants to contribute to 25 of the 44 European facilities and try to obtain the location of 3 of them.	• The ESFRI stimulated the coordination and the design of a national road map of infrastructural needs among the Spanish regions. • Spain is still lacking a critical mass and a sufficient demand or market for R&D-based services which hinder the creation of new S&T facilities.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
6	Strengthen research institutions, including notably universities	• The GBOARD increased from €4,000m in 2003 to €9,349m in 2008. • Development of the new Law of Science (To be approved in 2010 – beginning 2011). • "Campus of International Excellence" with special focus on the overall quality. • University Strategy 2015 aimed at getting universities into the top 100 ranking in Europe by the improvement of their quality, efficiency and effectiveness in both teaching and research.	Several systemic failures impede the impact of policies for improvement of the excellence: • The vast majority of the organisations protected the interests of the researchers or lecturers to the detriment of societal needs or interests. • The lack of critical mass and the fragmentation of its public research system. • The lack of autonomy in aspects such as the strict regulations of wages impedes the attraction of international well talented researchers. • Low level of integration between industrial and academic research are important weaknesses. • HEIs and PROs lack strategic plans to overcome the aforementioned problems. • The autonomy of individual researchers and the dependence of the rectors on their voters make it difficult to design or implement strategic plans and almost impede the success of the recent policy changes.
7	Improve framework conditions for private investment in R&D	• The INGENIO 2010 initiative of 2006- had a qualitative impact on the policy mix, reinforcing the policies towards the creation of NTBFs, academic spin-offs, Public Private cooperation. (PPC) in long term strategic projects and the incorporation of PhD holders into the private sector. • The 2010 "e2i" strategy has reinforced the financial support for R&D&i in general and especially the funds for risk capital. It also reinforces the financial support for cooperation between enterprises and the scientific sector.	• The role of firms is still far below the Lisbon objective and BERD decreased -6.3% in 2009. • Spain has a broad –more or less well balanced- policy mix with differentiated instruments tackling several barriers and weaknesses. But, this mix can not handle the systemic failures related to the functioning of the R&D agents. (see also point 6). • The data shows that the R&D effort of the PROs and HEIs financed by private funds is similar to the EU-27 average. However the state of opinion suggests a low level of (PPC) in R&D which is hindered by the lack of excellence and quality and the scientific orientation of public research. • Lack of influence of the society and enterprises on the behaviour of PRO and especially universities.
8	Promote public-private cooperation and knowledge transfer		

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
9	Enhance knowledge circulation across Europe and beyond	• Spain has several inward/outward mobility schemes that also allow the participation of researchers from non-EU.	• The traditional and cultural relations with Latin America and the common language generated a high level of mobility between LA and Spain. • The lack of knowledge of the English language is still an important barrier for international cooperation. • The unattractive working conditions (see point 1) are barriers to attracting qualified foreign workers.
10	Strengthen international cooperation in S&T and the attractiveness of European research in the world	• Spain tries to stimulate international cooperation by several policy measures and multi/bilateral agreements.	• The lack of knowledge of the English language and the lack of excellence and fragmentation of the Spanish research system are an important barrier for international cooperation.
11	Jointly design and coordinate policies across policy levels and policy areas, notably within the knowledge triangle	• After concentrating in 2008 all the R&D&I policies and activities in one Ministry in 2009 the State Secretary of Universities went back to the Ministry of Education. • Three aspects improved the regional coordination of R&D&i. (1) The National Strategy for Science and Technology approved by the Presidents of Autonomous Communities. (2) The operational plans of the European Structural Funds were designed by the national and regional governments. (3) The ESFRI generated a Spanish roadmap agreed by regional and national governments.	• To assure the better coordination between the different policy areas related to R&D and innovation Spain made a huge effort on the institutional level concentrating all the policy fields in just one ministry. • There is a low level of transparency in the policy making system. Several commissions and institutes are involved but no clear view on who is doing what. • The NPRDI offers some abstract priorities while the exact distribution is based on ad hoc decisions. • The academic orientation of public research and the lack of influence of the private sector and the regional or state governments on the education impedes a better integration of the education, innovation and research policies. • Almost no integration exists between the education policies versus R&D&i policies.
12	Develop and sustain excellence and overall quality of European research	• “Campus of International Excellence” and “University Strategy 2015” (see point 6). • Accreditation of a minimum level of experience and talent for academic staff before getting a full time job as a civil servant (since 2001).	• The excellence and quality of the Spanish research on universities is not systematically evaluated. • The salaries for researchers do not include real incentives for excellence, quality or productivity. • See also the assessment of strengths and weaknesses mentioned in point 6.

	ERA objectives	Main policy changes	Assessment of national strengths and weaknesses with regard the specific ERA objective
13	Promote structural change and specialisation towards a more knowledge - intensive economy	• Science and technological progress is widely recognised as an important factor to create wealth and is seen as the solution to overcome the crisis. • For example the state budgets of R&D&i were only downsized marginally.	• Low growth of the high tech and emerging sectors and lack of sufficient NTBFs. • The lack of large firms that could lead clusters and have the critical mass to create economies of scope and scale makes structural change more difficult. • The financial institutions and organisations invested the last decade in housing and construction instead in industry and innovation.
14	Mobilise research to address major societal challenges and contribute to sustainable development	• The NPRDI include special actions on societal challenges and sustainable development. • Spain is processing a new Law on Sustainable Economy (LSE). • The "e2i initiative" already includes some support for scientific fields of the LSE.	• Although sustainable growth and other societal challenges are a topic in political discussion the main preoccupation of Spain is the structural change of their production sector from traditional low tech sectors to high tech sectors with a high added value. • The sustainable growth and societal challenges are seen as opportunities to initiate the above-mentioned structural change.
15	Build mutual trust between science and society and strengthen scientific evidence for policy making	• Organisation of a diverse range of activities such as the "science week" that opens the doors to a broad range of R&D centres for the public. • Science and technological progress is widely recognised as an important factor to create wealth and it is seen as the solution to overcome the crisis.	• Policy evaluation is not systematic • Several R&D&i programmes were evaluated. • Several instruments are evaluated spontaneously on an individual level by PhD students and other researchers without or with some marginal help from the public, making use of the publicly available data. • Most newspapers, radio and television channels have specific programmes for science related issues.

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Abbreviations

BERD	Business Expenditures for Research and Development
CDTI	Centre for the Development of Industrial Technology (Centro para el Desarrollo Tecnológico Industrial)
CENIT	National Strategic Consortia for Technical Research (Consorcios Estratégicos Nacionales en Investigación Técnica)
CERN	European Organization for Nuclear Research (Conseil Européen pour la Recherche Nucléaire)
COSCE	Confederación de Sociedades Cientificas en España (Confederation of Scientific bodies in Spain)
CSIC	Spanish National Research Council (Consejo Superior de Investigaciones Científicas)
E&T	Engineering and technology
e2i	The Spanish Innovation Strategy 2010-2015
ENCYT	National Strategy for Science and Technology (Estrategia Nacional de Ciencia y Tecnología)
ERA	European Research Area
ERA-NET	European Research Area Network
ESA	European Space Agency
ESFRI	European Strategic Forum on Research Infrastructures
EU	European Union
FECYT	Spanish Foundation for Science and Technology (Fundación Española para la Ciencia y la Tecnología)

FP	European Framework Programme for Research and Technology Development
FTE	Full-Time Equivalent
GBOARD	Government Budget Appropriations or Outlays on R&D
GDP	Gross Domestic Product
GSB	General State Budget
GUF	General University Funds
HEI	Higher education institutions
HEP	High Educational Policies
HERD	Higher Education Expenditure on R&D
HES	Higher education sector
HH.RR.	Human Resources
HRST	Human Resources in Science and Technology
ICT	Information and Communication Technologies
IP	Intellectual Property
IPR	Intellectual Property Rights
IPT	Industrial Production and Technology
IST	Information Society Technologies Area
MICINN	Ministry of Science and Innovation (Ministerio de Ciencia e Innovación)
NPRDI	Spanish National Plan for R&D and innovation
NRP	National Reform Plan
NTBF	New Technology-Based Firms
OECD	Organisation for Economic Co-operation and Development
PERD	R&D expenditures of the Public Sector (Excluding HEI)
PPC	Public Private Cooperation
PRO	Public Research Body (Organismo Público de Investigación)
R&D	Research and development
R&D&i	Research, Development and Innovation
RI	Research Infrastructures
SME	Small and Medium Sized Enterprise
TTI	Transport, Telecommunications and other Infrastructures