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COMMISSION STAFF WORKING DOCUMENT

'Research and Innovation performance in the EU. Innovation Union progress at country level 2014'

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Portugal

The challenge of fostering a more knowledge-intensive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Portugal. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 1.50 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -0.1 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[1] 2012: 27.3 (EU:47.8; US: 58.1) 2007-2012: +3.7 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 70.1 (EU: 101.6)	*Knowledge-intensity of the economy*[2] 2012: 42.6 (EU:51.2; US: 59.9) 2007-2012: +2.3 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Security, ICT, materials, new production technologies, and other transport technologies	*HT + MT contribution to the trade balance* 2012: -0.3 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

Portugal has expanded its R&I system over the last decade, increasing its investment in research at a remarkable average annual real-growth rate of 7 % between 2000 and 2007. However, after 2009, R&D followed the overall macroeconomic trend and R&D intensity decreased by an average of 0.1 % from 2007 to 2012. Public expenditure on R&D was maintained at 0.68 % of GDP in 2012, despite the economic crisis. Business enterprise expenditure on R&D (BERD) as a % of GDP increased from 0.6 % in 2007 to 0.7 % in 2012.

Portugal has also shown significant progress in the number of new doctoral graduates per thousand population aged 25-34 years, and in the share of researchers in the labour force. These evolutions have had a positive impact on scientific production and excellence. However, despite the progress observed in recent years in R&D expenditure in the business sector and the large increase in the total number of researchers, Portugal remains below the EU average in terms of public-private cooperation, knowledge transfer and employment in knowledge-intensive activities.

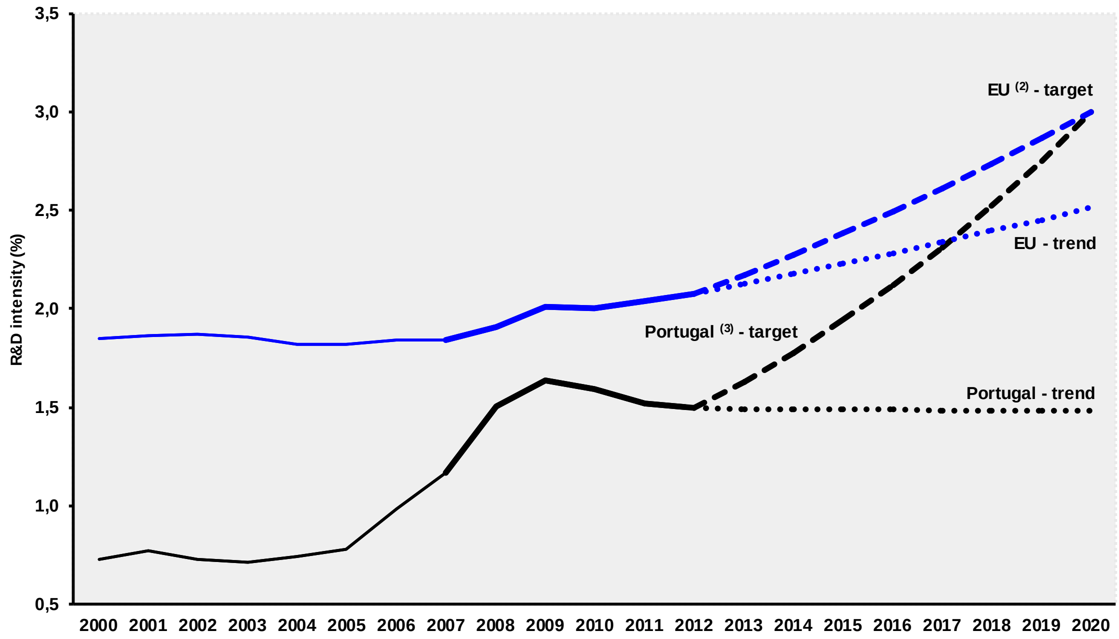
Ensuring the sustainability of the R&I system, focusing on a set of priority research fields, stimulating the emergence of new companies, particularly in knowledge-intensive activities, and strengthening the in-house technological, organisational and marketing capabilities of small and medium-sized enterprises (SMEs) are some of the main challenges facing the Portuguese R&D system.

[1] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[2] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

New initiatives, such as the System of Tax Incentives for Companies Investment in R&D (SIFIDE), the role of the Innovation Agency (AdI), the SWOT analysis of the country's R&D system, the Programme of Applied Research and Techno Transfer to Companies, or the reorientation of the cluster policy, aim to adequately support the structural change needed by the country to improve its productivity and competitiveness.

Investing in knowledge

Portugal - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2008-2012 in the case of Portugal.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) PT: The projection is based on a tentative R&D intensity target of 3.0% for 2020.
(4) PT: There is a break in series between 2008 and the previous years.

Portugal has set a national R&D intensity target for 2020 of 3 %, where public-sector R&D intensity would reach 1 % and business R&D intensity 2 %. From 2005 up to the crisis years, Portugal made very significant progress towards the R&D intensity target. However, after 2009, R&D followed the overall macroeconomic trend, and by 2012, public-sector R&D intensity was 0.68 % and business R&D intensity 0.70 %.

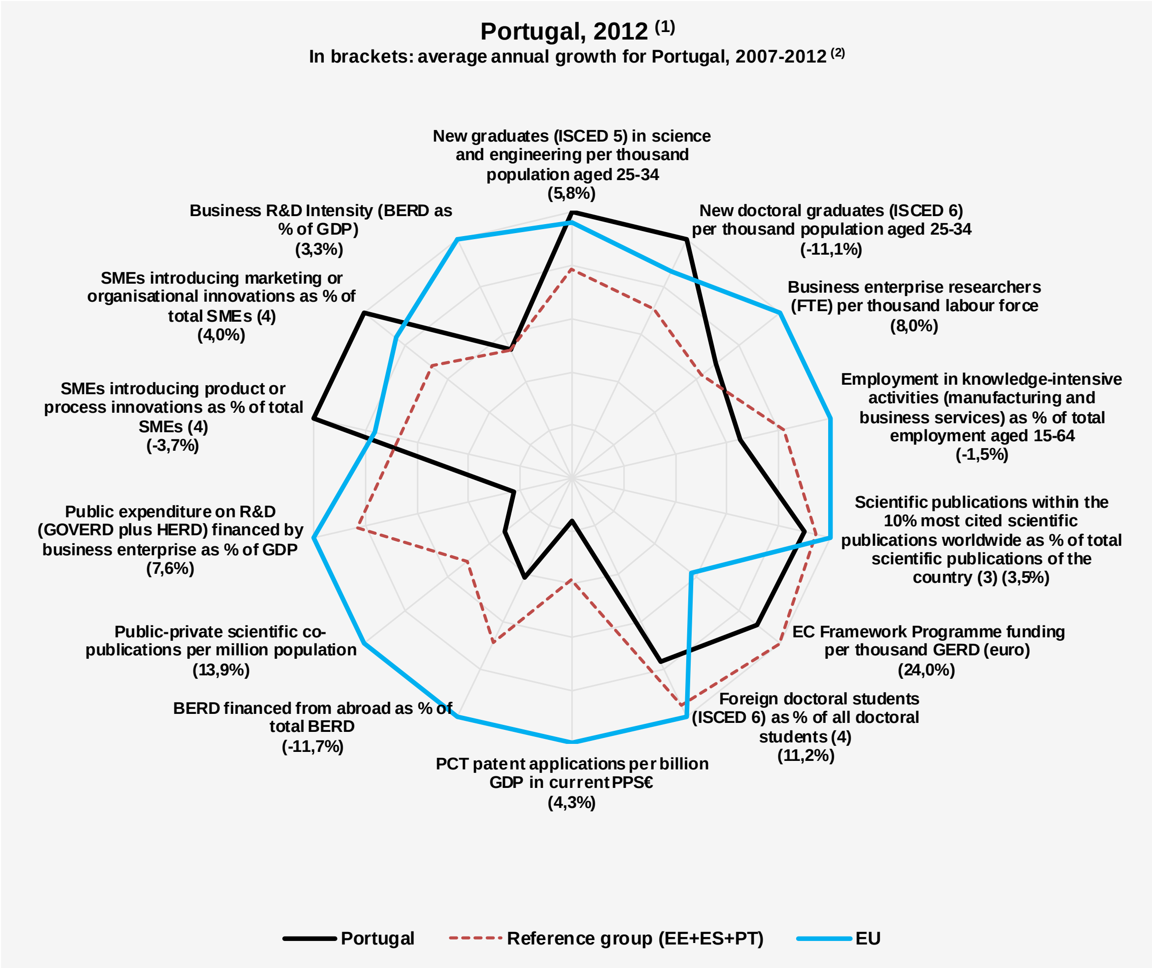
Therefore, the main challenge for Portuguese R&D is to ensure the sustainability of the R&I system, to increase the share of business R&D investment in total national R&D investment, and to attract foreign business R&D investment. Business R&D investment reached its highest level in 2009 in both absolute and relative terms after some years of significant growth. The difficult national business environment and the contraction of domestic demand have put enterprises in the position of having to find external markets while facing challenges in terms of efficiency and financing. Public funding of R&D has been sustained, despite the pressures created by reducing public expenditure. However, the conversion of investments in R&I into company competitiveness in international markets remains weak.

Private and public R&D investment also receives support via co-funding from the European budget, in particular through the Structural Funds and from successful applications to the Seventh Framework Programme (FP7). Of the EUR 21.5 billion of Structural Funds allocated to Portugal over the 2007-2013 programming period, around EUR 4.5 billion (21 % of the total) related to RTDI[3]. The success rate of Portuguese applicants in FP7 is 18.4 %, lower than the EU average success rate of 28 %. By 2013, there were over 2157 Portuguese applicants in retained proposals, with a total EC financial contribution of EUR 450 million.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Portugal's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. The average annual growth rates from 2000 to the latest available year are given in brackets under each indicator.

[3] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2010 or to the latest available year.
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

In broad terms, the graph shows that the large increase in R&D investment over the period 2000-2011 has triggered a stronger human resources component, higher scientific quality and some innovation, but with less progress in technology valorisation. All in all, while there was a good effort in training young researchers, Portugal remains below the EU average on technology development, business R&D, and the knowledge-intensity of the economy.

In the field of human resources for R&I, Portugal is achieving significant progress in the number of new doctoral graduates, which is the consequence of strong public incentives. However, the share of employment in knowledge-intensive activities has not followed the same trend, reflecting a weakness as regards its capacity to move towards more knowledge-intensive sectors. The quality of scientific production improved significantly, achieving 10 % of national scientific publications in the 10 % most-cited scientific publications worldwide, which is close to the EU average.

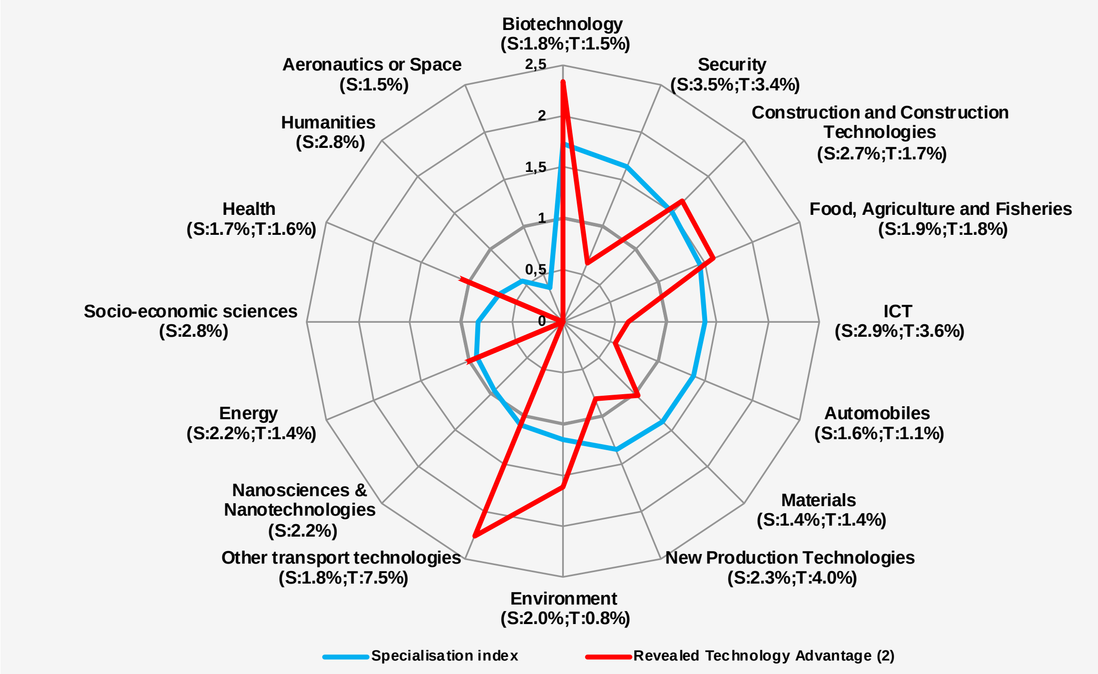
As seen in the graph above, the evolution of research output has been weaker on the business side. The overall technology development is well below the EU and reference group average. The same is true for public-private scientific co-publication, highlighting the need to emphasise the links between science and innovation.

Portugal's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Portugal shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

Portugal S&T National Specialisation(1) in thematic priorities, 2000-2010

in brackets: growth rate in number of publications(3) (S) and in number of patents(4) (T)



Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

Comparison of the scientific and technological specialisation in selected thematic priorities shows a mixed situation with some co-specialisations as well as some mismatches. In most of the sectors, scientific quality is not combined with technological and industrial specialisation, while scientific production and quality is much more limited in other sectors relevant to its industry.

The country displays relevant scientific strength in several sectors, such as security, ICT, automobile, materials, and new production technologies, construction and construction technologies, food, agriculture and fisheries, and biotechnology. However, no corresponding technological specialisation can be found for those fields, with the exception of construction and construction technologies, food, agriculture and fisheries, and biotechnology, where the scientific profile is coupled with the country's technological profile.

On the other hand, technological specialisation in other transport technologies is not backed up by a strong domestic scientific specialisation, despite the good quality of its publications. Taking into account the technological specialisation of Portugal in this field, it would probably benefit from fostering a scientific specialisation in this sector.

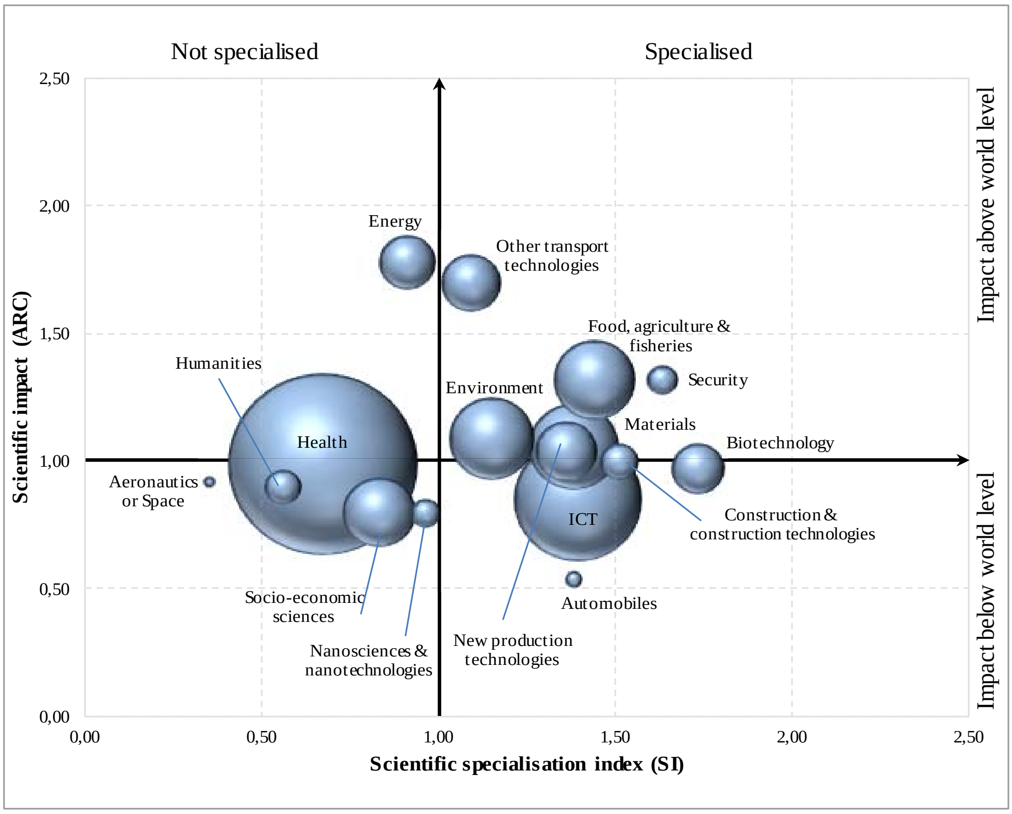
Portugal has established scientific strength in the field of food, agriculture and fisheries where scientific production and quality can be correlated with a certain technological specialisation. However, there is room for improvement in the scientific impact of some sectors which rank high on science specialisation indicator, i.e. ICT, automobile, materials, or new production technologies. Finally, scientific and technological specialisation in biotechnology is not coupled with the quality of domestic science. Conversely, scientific and technological specialisation in energy is not leveraged by the high scientific impact of domestic science in Portugal.

The definition of Research and Innovation Strategies for Smart Specialisation (RIS3) is more advanced at regional than national level, although at regional level the situations are different. Region Centro is the first of the five mainland Portuguese regions to design an RIS3 strategy which includes relevant sectors such as agriculture, materials or biotechnology[4].

The graph below illustrates the positional analysis of Portuguese publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

[4] In January 2014, a multi-level strategy for Portugal was submitted, including one national and seven regional strategies; the level of development varies among the regions.

Positional analysis of Portugal publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit

Data: Science Metrix - Canada, based on Scopus

Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

Policies and reforms for research and innovation

R&I policy is characterised by a large political consensus and continuity over time that has enabled significant progress from a relatively low base. Long-term consistency has proved to be a positive determinant in ensuring the consolidation of the R&I system. However, a few relevant initiatives took place in 2013: (1) the National Strategy for Smart Specialisation (also included in the 2014-2020 Partnership Agreement), the operational competitiveness programme COMPETE and incentive schemes in dialogue with stakeholders (universities and technological centres); (2) revision of the regulation on financing R&D organisations; (3) reorientation of the SIFIDE; (3) AdI; (4) evaluation of the clustering strategy; (5) the creation of three advisory bodies; and (6) the Programme of Applied Research and Technology Transfer to Companies.

In recent decades, Portuguese research policy has been horizontal in nature and has covered a broad spectrum. However, the Foundation for Science and Technology (FCT) launched an initiative aimed at designing a Research and Innovation (R&I) Strategy for Smart Specialisation, in the context of the preparation of the new round of European support. The first task, already performed, was a SWOT analysis of the country's R&I system – up to December 2013, there was a series of stakeholder sessions to discuss the selected national priorities and to propose vision and policy recommendations. This is seen as an important step in the policy-making process, providing a basis for more informed and accurate strategic decisions in R&I policy.

The new regulation for the evaluation of R&D aims to encourage the needs of research units to achieve a critical mass in order to be effective and to stimulate the emergence of creative environments, namely through multidisciplinary approaches to addressing complex problems and challenges.

The main policy instrument associated with indirect R&D funding has been SIFIDE. The Budget Law for 2011 extended the system until 2015, and improved the conditions granted to R&D-performing companies. The instrument was reviewed in 2013 in order to positively discriminate towards projects involving cooperation with other entities and international cooperation, and to provide access to the results. SIFIDE includes two kinds of incentives for companies performing R&D: a basic tax incentive, corresponding to 32.5 % of eligible R&D expenditure undertaken in the relevant fiscal year, and an incremental incentive, corresponding to 50 % of the increase in R&D expenditure compared to an average of the two previous years. The amount of tax credits approved under SIFIDE has been close to EUR 100 million each year.

In this regard, the only relevant change in the innovation field concerns AdI, the innovation agency. AdI has played a role in providing finance to cooperative projects between research and industry as well as in managing SIFIDE. Following a decision to integrate the agency into the Institute for Support to Small and Medium-sized Enterprises and Innovation (IAPMEI), the new law ensures that AdI will remain an autonomous organisation, reporting to the Minister for the Economy.

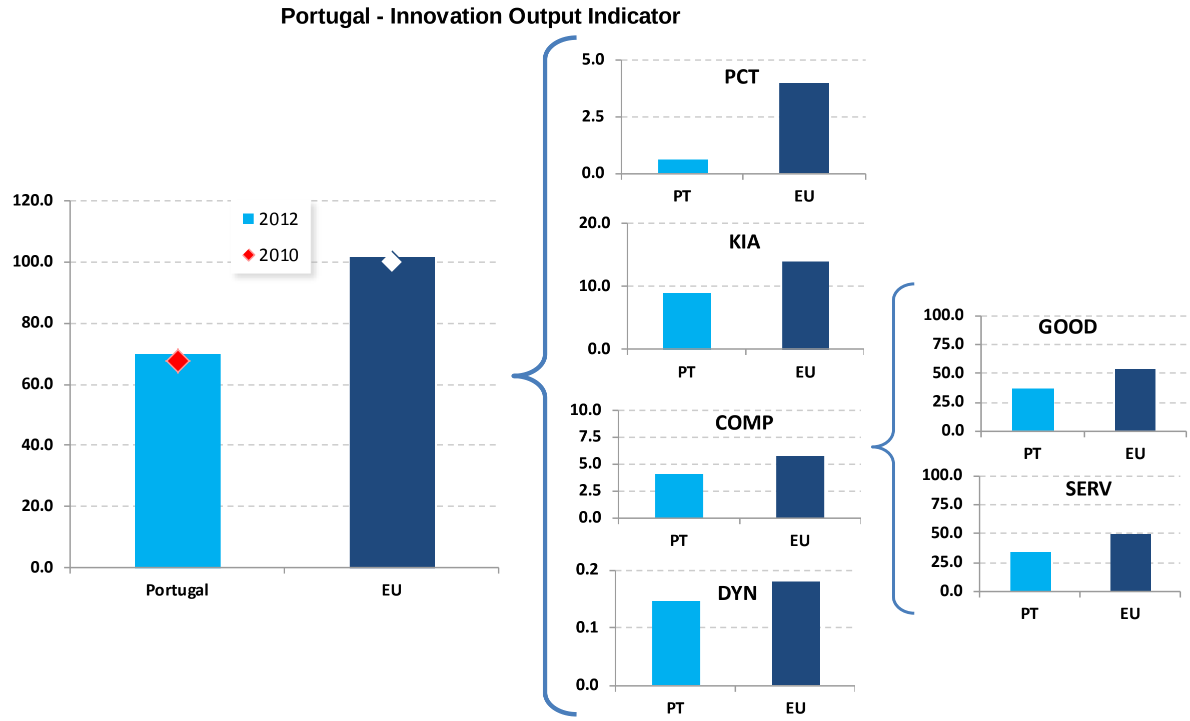
Portugal has carried out an evaluation of the clustering strategy which recognises the merits of launching a cluster policy but points out that there is still a significant gap between expectation and achievement and has identified weaknesses in the governance model, insufficient capabilities among many organisations to manage poles (CTPs) and clusters, and the excessive inward-looking approach with very weak linkages with ‘peer’ organisations abroad, among the main problems.

To enhance stakeholder involvement in defining R&I policies, three advisory councils have been created: the National Council for Science and Technology, the National Council for Entrepreneurship and Innovation, and the National Council for Reindustrialisation.

The Programme of Applied Research and Technology Transfer to Companies aims to promote ‘hybrid’ doctoral training, the revision of doctoral grants, and a greater focus of the programmes on entrepreneurship and innovation among US universities.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU’s performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Portugal’s position regarding the indicator’s different components:



Source : DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

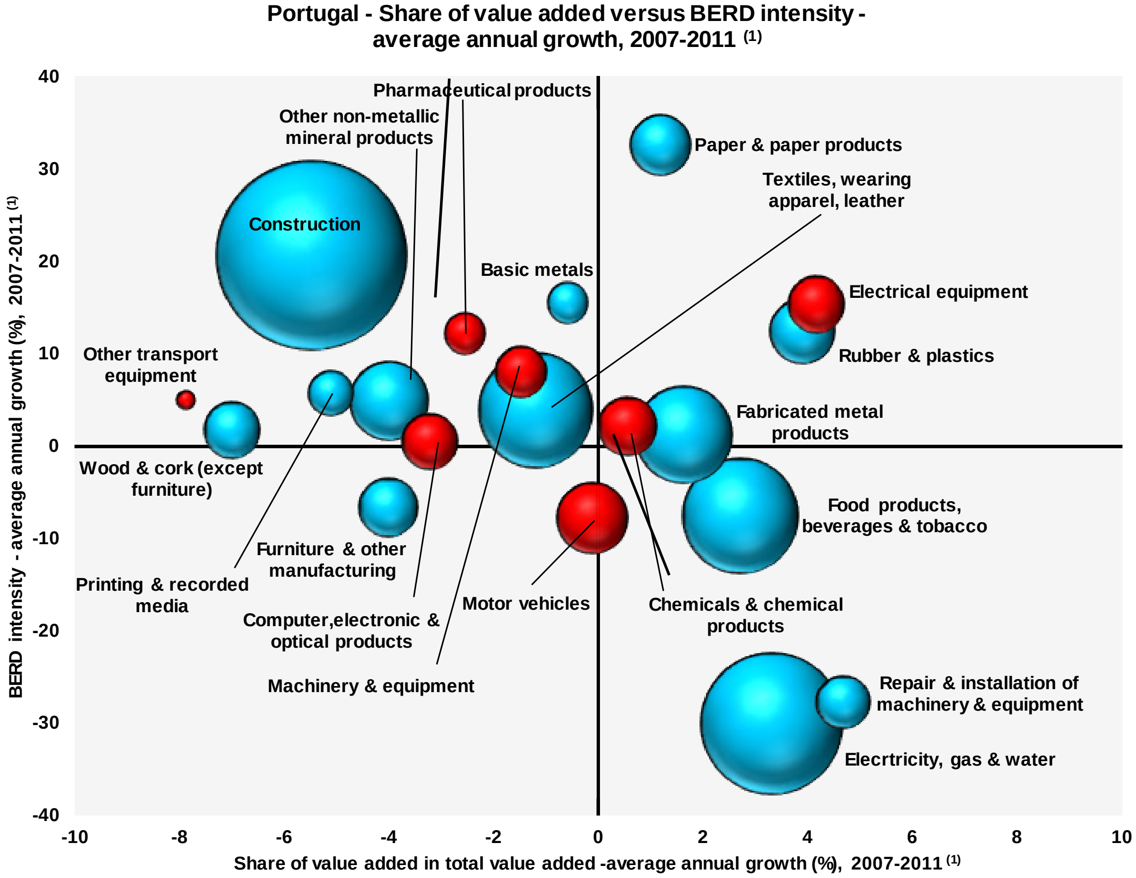
Portugal is a low performer in the European innovation indicator. This is the result of low performance in all components of the innovation indicator, although its performance has been improving since 2010.

Portugal performs at a very low level in patents partly as a result of its economic structure, with no Portugal-based international players in patent-intensive manufacturing sectors. The structure of the economy, with a high share of low-tech production, such as food, textiles and shoes, also results in a low export share of medium-high/high-tech goods and a low share of employment in knowledge-intensive activities (KIA). In addition, significant employment in agriculture and tourism-related accommodation and food services contributes to the low employment share of KIA employment. The relatively low performance in the export share of knowledge-intensive services is explained by the importance of tourism, which is classified as non-KIS. Road freight transport services (also non-KIS) have a relatively high importance in services exports, too, while this pattern is not compensated for by any strongholds in KIS exports.

Portugal performs at a low level in the innovativeness of fast-growing firms. This is explained by a high share of employment in fast-growing enterprises in less-innovative sectors, such as construction, accommodation and food-service activities, and in administrative and support-service activities.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries. The position on the horizontal axis illustrates the changing weight of each industry sector in value added over the period. The general trend of moving to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented in the graph). The red sectors are high-tech or medium-high-tech sectors.



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Printing and reproduction of recorded media': 2008-2011; 'Furniture and other manufacturing': 2010-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

For a small country like Portugal, the road to growth leads to an extended market beyond the national boundaries, where competition must be confronted with high-quality actors in sectors providing more value added. This requires reinforcing the capacity of enterprises to move into more high-tech and medium-high-tech sectors. The graph above gives a general picture of manufacturing sectors over the period 2007-2011, showing reduced shares of value added but increased BERD intensities for most of the sectors. In particular, other transport equipment, wood and cork, printing and recorded media lost important positions in terms of valued added. Construction also lost an important share of value added despite growth in R&D intensity over the period.

Paper and paper products, rubber and plastics, and electrical equipment (considered as high-tech or medium-high-tech sectors) play an important role in manufacturing value added with a high growth rate in R&D intensity. Growth in the share of value added for chemicals and chemicals products is encouraging.

The 2013, the EU's industrial R&D scoreboard, ranking the top 1000 companies investing in R&D, shows six top Portuguese companies in the following sectors: banking (two), electricity, fixed-line telecommunication, pharmaceuticals and biotechnology, and software and computer services.

Key indicators for Portugal

PORTUGAL	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	1,62	2,57	3,31	3,78	3,09	2,84	1,95	1,60	2,10	-11,1	*1,81*	9
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	466	:	:	487	:	:	487	20.9 [3]	495 [4]	16 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	*0,20*	0,30	*0,46*	0,60	0,75	0,78	0,73	0,71	*0,70*	*3,3*	1,31	16
Public expenditure on R&D (GOVERD + HERD) as % of GDP	*0,45*	0,39	*0,43*	0,46	0,63 [5]	0,72	0,70	0,69	*0,68*	*1,8*	*0,74*	11
Venture Capital as % of GDP	0,14	0,16	0,11	0,12	0,23	0,14	0,12	0,21	0,14	2,6	0,29 [6]	12 [6]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	22,8	:	:	:	:	27,3	3,7	47,8	17
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	9,0	8,8	9,2	9,9	9,9	:	:	:	3,5	11,0	14
International scientific co-publications per million population	:	338	410	434	512	546	614	698	761	11,9	343	13
Public-private scientific co-publications per million population	:	:	:	10	11	12	14	17	:	13,9	53	20
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,2	0,5	0,5	0,5	0,6	0,7	0,6	:	:	4,3	3,9	20
License and patent revenues from abroad as % of GDP	0,02	0,02	0,04	0,04	0,03	0,06	0,02	0,03	0,02	-9,7	0,59	25
Community trademark (CTM) applications per million population	34	56	97	119	108	91	84	95	94	-4,6	152	18
Community design (CD) applications per million population	:	12	13	15	14	18	16	18	16	1,8	29	19
Sales of new to market and new to firm innovations as % of turnover	:	:	13,3	:	15,6	:	14,3	:	:	-4,2	14,4	11
Knowledge-intensive services exports as % total service exports	:	22,8	26,5	28,5	28,7	28,9	29,0	30,1	:	1,4	45,3	15
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-3,61	-2,36	-1,47	-1,66	-1,30	-2,98	-3,50	-1,20	-0,28	-	4,23 [7]	21
Growth of total factor productivity (total economy) - 2007 = 100	100	98	98	100	99	97	100	100	100	0 [8]	97	5
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	38,1	:	:	:	:	42,6	2,3	51,2	16
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	8,8	8,8	8,6	9,1 [9]	9,0	-1,5	13,9	26
SMEs introducing product or process innovations as % of SMEs	:	:	38,7	:	47,7	:	44,2	:	:	-3,7	33,8	5
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,02	0,06	0,05	0,05	0,05	0,03	:	:	:	-27,2	0,44	26
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,05	0,09	0,09	0,10	0,10	0,06	:	:	:	-19,3	0,53	23
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	73,5	72,3	72,7	72,6	73,1	71,2	70,5	69,1 [10]	66,5	-1,0	68,4	17
R&D Intensity (GERD as % of GDP)	*0,73*	0,78	*0,99*	1,17	1,50 [5]	1,64	1,59	1,52	*1,50*	*-0,1*	*2,07*	14
Greenhouse gas emissions - 1990 = 100	138	145	137	133	130	124	119	116	:	-17 [11]	83	25 [12]
Share of renewable energy in gross final energy consumption (%)	:	19,8	20,9	22,0	23,0	24,6	24,4	24,9	:	3,1	13,0	6
Share of population aged 30-34 who have successfully completed tertiary education (%)	11,3	17,7	18,4	19,8	21,6	21,1	23,5	26,1	27,2	6,6	35,7	20
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	43,6	38,8	39,1	36,9	35,4	31,2	28,7	23,2	20,8	-10,8	12,7	26 [12]
Share of population at risk of poverty or social exclusion (%)	:	26,1	25,0	25,0	26,0	24,9	25,3	24,4	25,3	0,2	24,8	16 [12]

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) Break in series between 2008 and the previous years. Average annual growth refers to 2008-2012.
(6) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK. These Member States were not included in the EU ranking.
(7) EU is the weighted average of the values for the Member States.
(8) The value is the difference between 2012 and 2007.
(9) Break in series between 2011 and the previous years. Average annual growth refers to 2008-2010.
(10) Break in series between 2011 and the previous years. Average annual growth refers to 2007-2010.
(11) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(12) The values for this indicator were ranked from lowest to highest.
(13) Values in italics are estimated or provisional.

2014 Country-specific recommendation in R&I adopted by the Council in July 2014:

“Enhance cooperation between public research and business and foster knowledge transfer.”

Romania

The challenge of improving policy coordination of R&I and upgrading the economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Romania. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 0.49 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -4.2 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[5] 2012: 13.2 (EU: 47.8; US: 58.1) 2007-2012: +2.3 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 78.0 (EU: 101.6)	*Knowledge-intensity of the economy*[6] 2012: 27.5 (EU: 51.2; US: 59.9) 2007-2012: +3.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Automobiles, ICT, new production technologies, energy, nanosciences and nanotechnologies, and security	*HT + MT contribution to the trade balance* 2012: 0.4 % (EU: 4.23 %; US: 1.02 %) 2007-2012: -14.2 % (EU: +4.8 %; US: -32.3 %)

The key challenge for Romania remains its low level of competitiveness, which has significant consequences for the research and innovation system. The high-tech and medium-tech sectors of the economy do not contribute sufficiently to the trade balance, demand for knowledge remains weak, and the innovation culture continues to be underdeveloped. Romania is ranked as a modest innovator and has one of the lowest values in the EU for both R&D intensity and business R&D investments. To complete the picture of poor innovation, the Global Competitiveness Report 2013-14 still classifies the country as efficiency-driven (together with Bulgaria) while the rest of the EU economies are either in transition to, or are already at the innovation-driven stage.

Over the last decade, policy-makers have made significant efforts to reform the R&I system in Romania. Yet, the absence of a consistent long-term vision at the political level and the lack of awareness of the added value of R&I for enhancing competitiveness and securing high-quality jobs has hampered the full implementation of most of the adopted measures. In addition, a lack of both continuity in policy decisions from one government to another and coordination among ministries has also proved particularly detrimental in a domain that requires the development of capacities over time. In order to leverage the importance of R&I in the country's overall policy-mix, R&I policy measures need to be considered in the broader context of Romania's economic development and better integrated into its overarching policy objectives.

However, among the last developments, a new National Strategy for Research and Innovation for the period 2014-2020 has been developed and, following a public debate, is ready to be submitted for government approval. The new strategy is aiming at a gradual rebalance of research to innovation

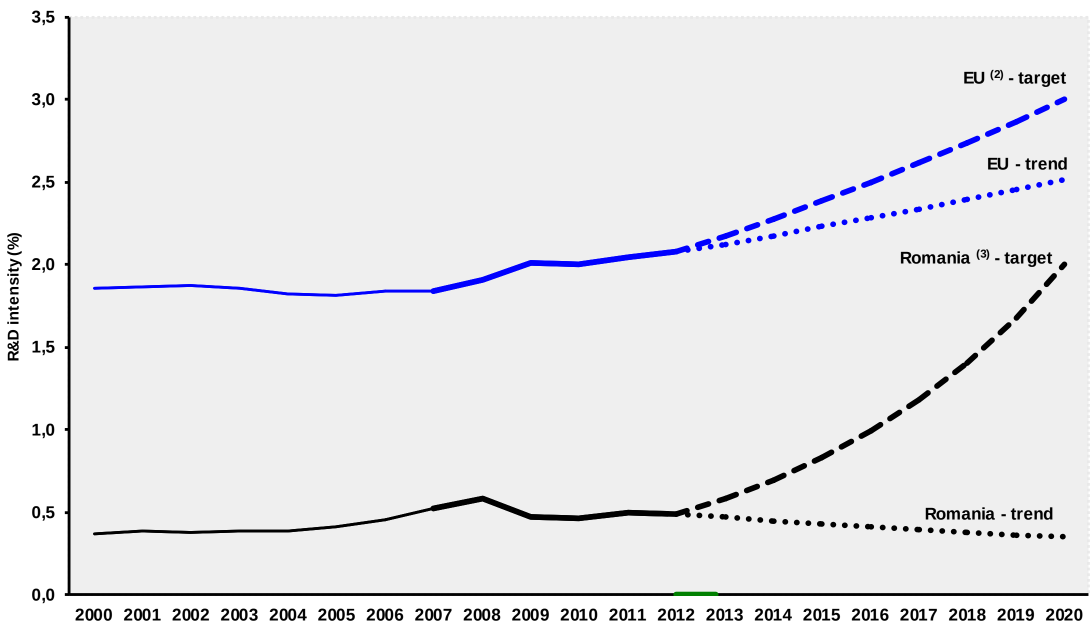
[5] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[6] Composite indicator that includes R&D, skills, sectoral specialization, international specialization and internationalization sub-indicators.

through a strong component of smart specialisation[7], and includes a well-developed monitoring system and multi-annual budgetary planning. The Strategy also includes measures that strongly support the development of R&D activities in the private sector. Although it benefits from strong ownership by the research system, having been developed by means of a large consultation exercise with experts and stakeholders, its implementation remains uncertain. It depends on the government's commitment to finance the activities included in the Strategy's implementation instrument, which is the National Plan for R&I.

The public-private collaboration shows promising bottom-up initiatives for developing clusters in economic sectors (automotive, IT) and research fields (life sciences, nuclear physics). These clusters gather around researchers, businesses and policy-makers and are increasingly able to attract funding from European and national sources. It would be sensible for the government to design well-targeted top-down measures for supporting further development of these clusters since they are a concrete solution for improving public-private collaboration in the R&D field.

Investing in knowledge

Romania - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2007-2010 in the case of Romania.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) RO: The projection is based on a tentative R&D intensity target of 2.0% for 2020.
(4) RO: There is a break in series between 2011 and the previous years.

Over the last decade, R&D intensity in Romania increased from 0.37 % in 2000 to 0.58 % in 2008, only to drop back to 0.49 % in 2012. Romania currently has the second lowest R&D intensity in the EU, at less than one-quarter of its 2 % target for 2020. In absolute terms, public R&D funding reached a peak in 2008, following the adoption of the 2007-2013 Strategy for R&D and Innovation. The Strategy foresaw a gradual rise in the R&D public budget, but the planned increase in 2009 did not

[7] The strategy identifies the smart specialisation domains (bio-economy; ICT, space and security; energy, environment and climate change; eco-nano technologies and advanced materials) and outlines three fields of specific national interest (health; heritage and cultural identity; new and emerging technologies).

take place due to the economic crisis which has severely affected the government's budget, including R&D appropriations. In absolute terms, government budget appropriations for R&D fell by 25.4 % in 2009, followed by an oscillating evolution over the period 2009-2013. The provisional value for 2013 is expected to be higher than the 2012 value (by 6.2 %). Higher education expenditure on R&D suffered a large reduction of 32.2 % in 2009, followed by a rise of 1.4 % in 2010, although it fell again by 4.2 % in 2012. The government has expressed its intention to increase the public budget in the years to come[8], by 10.8 % (2013) and by 13.8 % (2014).

In 2012, Romania had one of the lowest business R&D intensities in the EU (0.19 % of GDP and ranked 26th out of 28), and an average annual growth rate of -6.8 % between 2007 and 2010. No Romanian firm is among the top-1000 EU R&D investing firms. The recent trends show that the 2 % R&D intensity target for 2020 is very ambitious and will be difficult to reach, given both the recent low budgetary commitment and the very low level of business R&D activities. This target can only be achieved if the country prioritises R&I in the context of smart fiscal consolidation, whilst implementing – without delay – the key reforms outlined in the Action Plan for Research and Innovation, which were adopted by the government in July 2011.

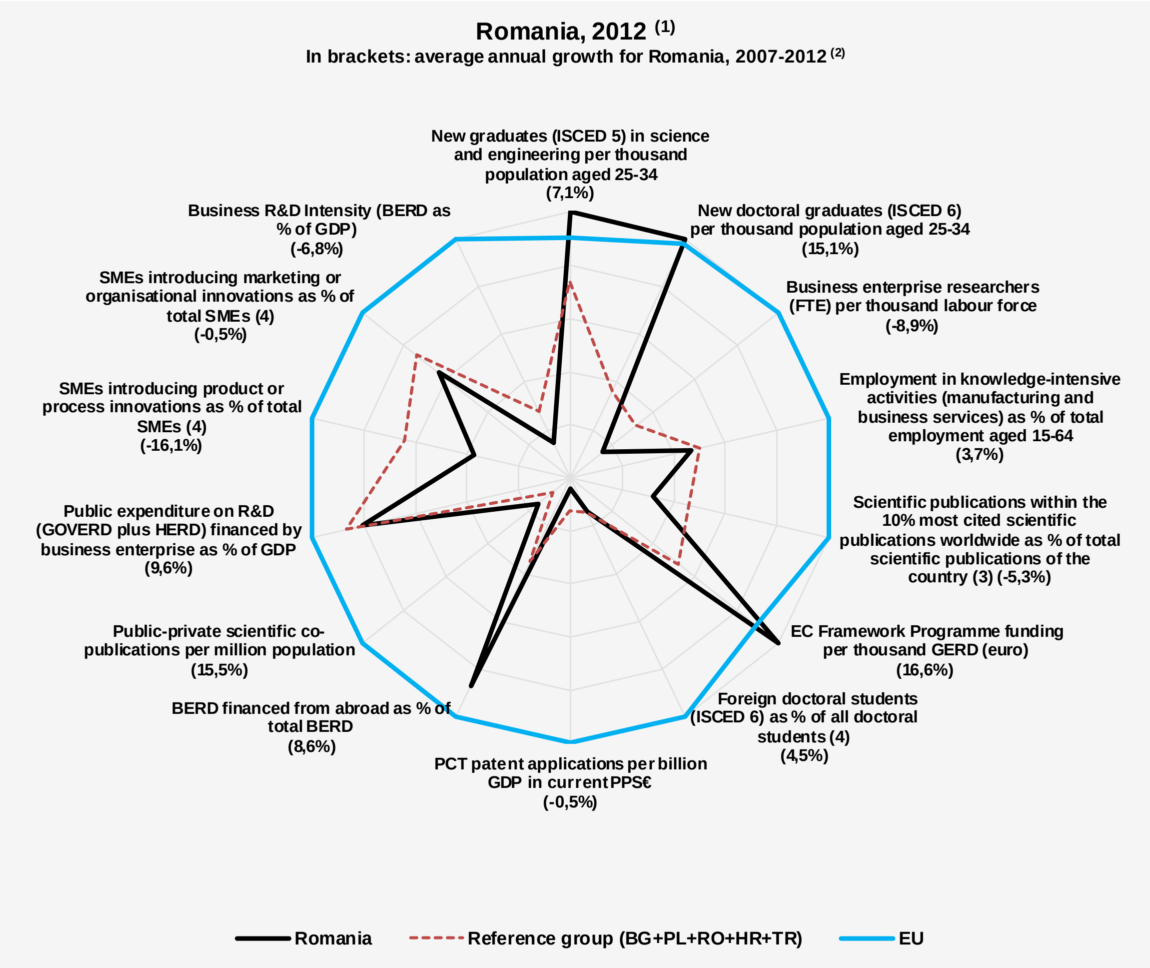
To date, the total number of Romanian participants in the EU's Seventh Framework Programme (FP7) is 1000 (out of 6848 applicants), and Romania has received EUR 148.2 million from successful applications. The participants' success rate is 14.6 %, below the EU average of 20.5 %. Romania receives the 19th largest share in the EU of FP7 funding and has most collaborative links with Germany, Italy, the United Kingdom, France and Spain. Private and public R&D investment also receives support via co-funding from the Structural Funds. Currently, only 5.9 % of the Structural Funds are allocated to RTDI[9], which is significantly below the EU average (15 %). A large part of the Structural Funds for R&I has been focused on programmes for developing R&I infrastructure and human resources, which have been developed to complement the national R&D programmes. However, the massive reduction in the R&D budget in 2009 hampered this complementarity. Although the absorption rate for Structural Funds in the R&I sector has reached 30 % (rate of approved payments), the national R&D budget has been severely cut.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Romania's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2007 to the latest available year are given in brackets.

[8] ERAC Survey, 2013

[9] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

The Romanian R&I system is primarily public-based, with only 29 % of research performed by the business sector (the EU average is 63 %). The graph above shows that Romania scores well (above the EU average) as regards the number of new S&T and PhD graduates. The two indicators are linked with the performance potential of the research system as they refer to the supply of highly skilled human resources for research. However, the overall under-financing of R&I since the 1990s has created a brain-drain effect, making Romania an important exporter of researchers. The country is suffering a net outflow of researchers with an estimated 15 000 Romanian researchers working abroad (roughly three-quarters of the total number of researchers who are in the country). As a result, it risks being left with a pool of researchers of high average age and limited career prospects.

Another structural feature is the fragmentation of the public R&D system, which has a large number of research performers but a lack of critical mass of research results. Romania performs well as regards its international participation in the research area, scoring well in the indicators on EU FP funding and the BERD financed from abroad.

However, Romanian universities are under-performing in all major international rankings and their scientific production and staff composition are less internationalised compared to other Member States. While an increase in international scientific co-publications was noted over the period 2007-

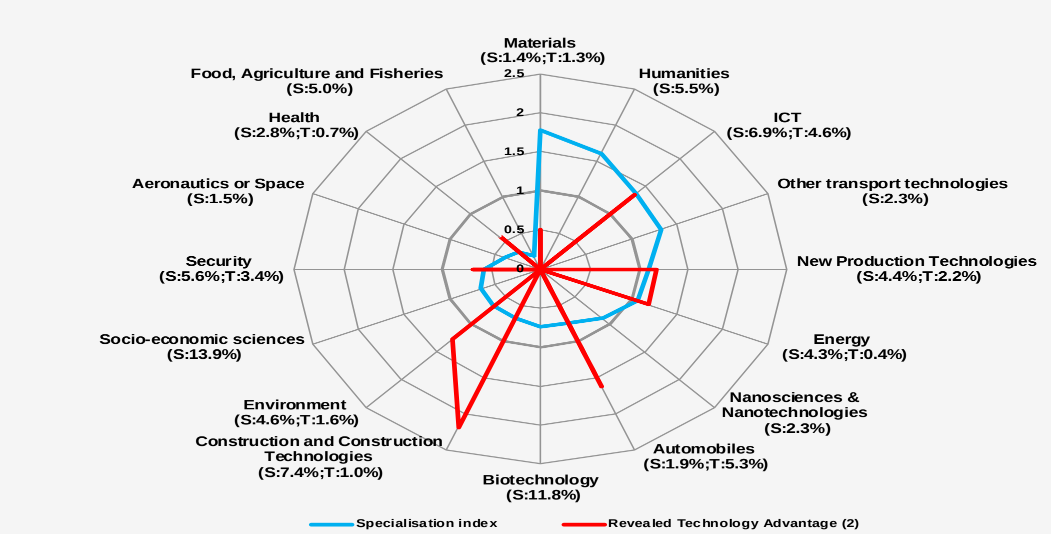
2011, the share of national scientific publications in the top 10 % most-cited publications worldwide has declined slightly in recent years. Overall, the number of international co-publications with other European countries is the lowest in Europe, suggesting that Romania does not benefit sufficiently from the international knowledge flows favoured by the ERA architecture. One positive aspect is that Romanian scientific and technological cooperation is well distributed across Europe, with France, Germany, Italy, the United Kingdom, and Spain as main co-publication partners and Germany and Ireland as co-patenting partners.

It is obvious that the Romanian business sector's interest in developing their own R&I activities is low, which is illustrated by the very low numbers of PCT patent applications and researchers employed by business enterprises, and a very low level of business R&D intensity, which is continuing to fall. The business sector is not promoting collaborative links with R&D institutes and universities in the public sector (as reflected by the very low number of public-private co-publications). Some improvements can be seen in public-private cooperation due to the development of cluster[10] initiatives that have succeeded in gathering policy-makers, public research institutions, large companies and SMEs around them. This type of initiative could be the solution for improving the overall lack of collaboration and coordination between the public sector, the private sector and the government. Well-targeted, top-down support measures will be instrumental in supporting their further development.

Romania's scientific and technological strengths

The spider graph below illustrates the areas, based on the Framework Programme thematic priorities, where Romania shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

Romania S&T National Specialisation(1) in thematic priorities, 2000-2010
in brackets: growth rate in number of publications(3) (S) and in number of patents(4) (T)



Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

[10] The scientific-driven cluster European Light Infrastructure in Măgurele, the strategic-driven cluster the Danube-Danube Delta-Black Sea Institute, and the business-driven cluster Cluj Innovation City (bottom-up initiative).

In Romania, there is no overall correlation between specialisation in science and specialisation in technologies. The science base is not generally of sufficient quality to support knowledge transfer through technologies towards industry. At the same time, the country has yet to benefit from sufficient inflows of foreign direct investments for technological activities, which would help shape more coherent industrial specialisation. Within the whole spectrum of fields analysed there are three with co-specialisation in both S&T: ICT, new production technologies, and energy. This shows a certain degree of knowledge transfer from science to technologies in these three fields, making them important candidates for a smart specialisation strategy. In addition, there are other fields, such as automobiles and construction, which show good technological specialisation. On the other hand, fields of nanosciences and nanotechnologies, aeronautics and health show no co-specialisation in S&T, no growth on the technological side over the last decade, and no science of any substantial quality.

In the field of materials – the best rated in terms of scientific production – there are several mismatches between scientific and technological developments. Despite considerable specialisation in science, the research field has been very static over the last ten years and not at all matched by technologies. In other words, industry is failing to absorb the large amount of high-quality knowledge being created in the field of materials. This may well be due to the fact that Romania's chemical industry has declined substantially over the last decade. Without an industrial revival in this field, it seems likely that research will continue to decline.

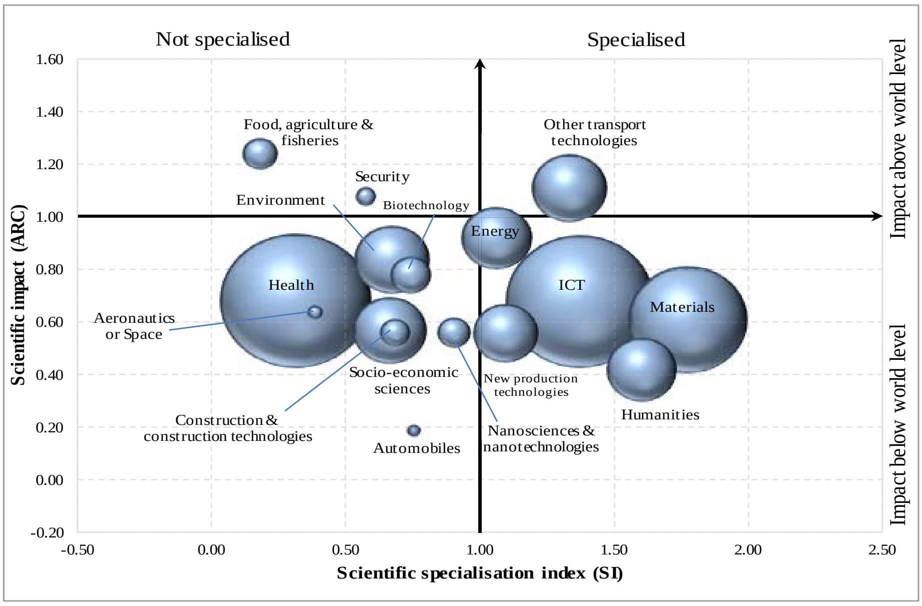
In the fields of ICT and new production technologies, co-specialisation in S&T has been backed up by visible growth rates in both publications and patents over the last decade, which is probably due to the existence of firms on the Romanian market absorbing the scientific results in related industries. Policy decisions should be oriented towards further increasing the quality of science publications, which is well below the world average in both fields. Compared to the two fields mentioned previously, the energy sector is more static as regards technologies, with few patents over the last decade. On the other hand, research results in the energy field are among the best in Romania, registering just below the world average as regards the quality of publications.

Technologies in the automobiles sector are stronger compared to other fields and show both specialisation and high growth rates in patents over the last 10 years. However, this is not sufficiently matched by science results, with the quality of publications needing substantial improvement. This seems to be a situation of apparent comparative advantage, with industrial development in place, but with the science side needing further improvements.

The field of construction and construction technologies reveals obvious development potential. Although specialisation in technology is already evident, it is the research field that has seen the most growth over the last ten years. However, the overall quality of science needs to be improved considerably. The environment field also presents certain dynamism, with specialisation in technologies and high growth rates in science.

The graph below illustrates the positional analysis of Romania's publications showing the country situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Romania publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

The fields of food, agriculture and fisheries, and biotechnologies point to interesting developments. A serious decline in the food and agriculture field after 1990 was coupled with a lack of specialisation in science and industry, despite the massive potential in terms of natural resources and primary production factors. As developments can often be rebooted bottom-up in the case of existing latent comparative advantages, over the last decade the quality of science in this field rose spectacularly, accompanied by high growth in the number of publications in the biotechnologies sector. However, the country has not yet reached the critical mass of publications required to specialise in these fields, and the related technologies are missing. In this context, there is room to further boost science in the fields of food and agriculture, and biotechnology. This is backed up by a large domestic economy (over 30 % of the population is still employed in the agriculture and food industry) and the potential to upgrade these industries' positions in international value chains. However, neither of these sectors is substantially backed up by technologies.

Finally, the field of other transport technologies benefits from considerable specialisation in science, matched by a good quality of publications (just above the world average) although this is not yet matched by any specialisation in technologies.

Policies and reforms for research and innovation

Over the last 10 years, the country has undertaken a wide range of measures in the R&I field. Development of the last two strategies for R&I, both for 2007-2013 and 2014-2020, have been based on a broad consultation exercise; Romanian scientific journals have been promoted on the international circuit; the share of competition-based funding has surpassed the share of institutional funding for research; measures have been taken to improve science-industry links by means of grants for projects with industrial partners; and innovation vouchers and tax incentives have been introduced. The certification process is ongoing for national R&D institutes and the legal framework regarding the funding of these institutes has been amended. However, such measures would have a greater impact if they were supported by a long-term vision. Indeed, the adopted/planned measures need to be better interrelated within an overarching reform in order to improve the overall efficiency of the R&I system.

A new National Strategy for Research and Innovation for the period 2014-2020 is currently being debated publicly before being submitted for government approval. The new Strategy is aiming at a gradual rebalance of research to innovation through a strong smart specialisation component and includes a well-developed monitoring system and multi-annual budgetary planning. Although the Strategy benefits from the R&I system's strong ownership, having been developed through a large consultation exercise with experts and stakeholders, its implementation remains highly uncertain. It depends on the government's commitment to finance the activities included in the Strategy's implementation instrument, which is the National Plan for R&I. With a view to better positioning R&I policy in the country's economic development, it would be beneficial to improve coordination between the R&I Strategy and the 2014-2020 Competitiveness Strategy, as well as the SMEs Strategy and current industrial policy developments.

As regards the efficiency and effectiveness of the research system, an important process started in 2013 which aimed to better coordinate and concentrate research resources in order to address the fragmentation of the system and reach the critical mass needed for highly relevant and qualitative research results. The reorganisation of the Ministry of Education, Research, Youth and Sport[11] brought the different research institutions formally subordinated to other ministries under the umbrella of the new Ministry of National Education. It could be expected that these measures would improve the efficiency of these institutions, with effectively a concentration of institutional resources, besides the formal gathering of institutions under the same ministry umbrella. However, the impact of these measures on the research system's performance will be assessed in the future.

Also, an ambitious reform of universities has begun but has slowed down in the last year. The new system, which aims to pave the way towards more autonomy and differentiation between research universities and those more oriented towards teaching and local needs, has been contested by several universities. Thus, in 2014, the university funding system returned to the old system, which only looked at quality indicators and the number of full-time equivalent students.

Private-sector R&I investments remain underdeveloped and have seen a continuous decline since 2000. The existing measures to promote private R&I investments are not fully commensurable with the challenges faced by local innovative enterprises, multinationals and start-ups. Moreover, there is visible mismatch between the skills needed by the knowledge market and the qualifications provided by academia that must be addressed. It is worth considering whether or not the system could benefit from replacing the current 'one-size-fits-all' interventions by targeted ones for innovative enterprises with proven successful track records. Moreover, the current unclear and contradictory provisions of the national framework of intellectual property rights make large companies somewhat reluctant to invest in innovation. The finalisation of the Employees Patents Law and the implementation guidelines are essential steps towards increasing foreign direct investments for innovative activities in Romania. Nevertheless, it is worth mentioning a relatively recent, bottom-up trend in the country indicating a

[11]According to the Government Ordinance of 22.12.2012, the Ministry of Education, Research, Youth and Sport has been reorganised by splitting it into the Ministry of National Education (MNE) and the Ministry of Youth and Sport. The National Authority for Scientific Research (NASR) has been dissolved and all of its attributes will be taken over by the new MNE.

concentration of innovation resources around economic sectors, such as automotive or IT, or major research infrastructures in fields such as life sciences or nuclear physics, such as:

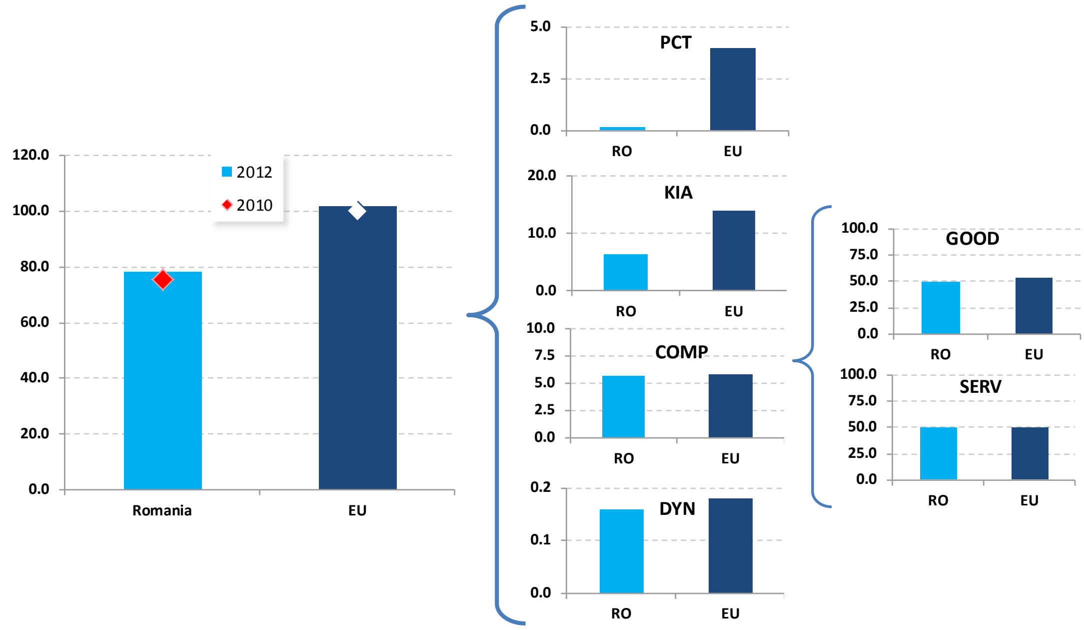
- *Cluj Innovation City*, a business-driven cluster focused around four sectors: IT, energy, environment, and healthcare;
- *European Light Infrastructure* in Măgurele, a promising scientific-driven cluster;
- *The Danube-Danube Delta-Black Sea Research Institute*, which builds on the Danube Delta's unique natural laboratory and, in addition, is strategically driven, as part of the Danube Strategy.

In this context, it would be sensible for the government to design well-targeted measures to support these clusters, given that they are solving in a bottom-up way problems in the system for which the top-down approach has not proved very successful to date. There are already some figures showing that these clusters are increasingly capable of attracting funding from both European and national sources. In addition, the problem of governance appears to have been sorted out in the case of concrete projects. These clusters gather around researchers, businesses and policy-makers, which represent the actual knowledge triangle in a national R&I system.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Romania's position regarding the indicator's different components:

Romania - Innovation Output Indicator



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Romania is a low performer in the European innovation indicator. This is a result of low performance in several components of the innovation indicator, notably in patents. However, its performance has been improving since 2010.

The very low performance in patents is linked to the weak synergies between the research system and business activities and to the economic structure, notably the lack of large Romanian multinational manufacturing companies and the division of work within international companies, including motor vehicle producers, which have production facilities in Romania but tend to do research and patenting in the headquarter country.

Relatively strong employment in wholesale and retail trade, in low-tech manufacturing sectors such as food products, and in agriculture and construction, and the relatively small size of the financial sector contribute to a very low share of employment in knowledge-intensive activities.

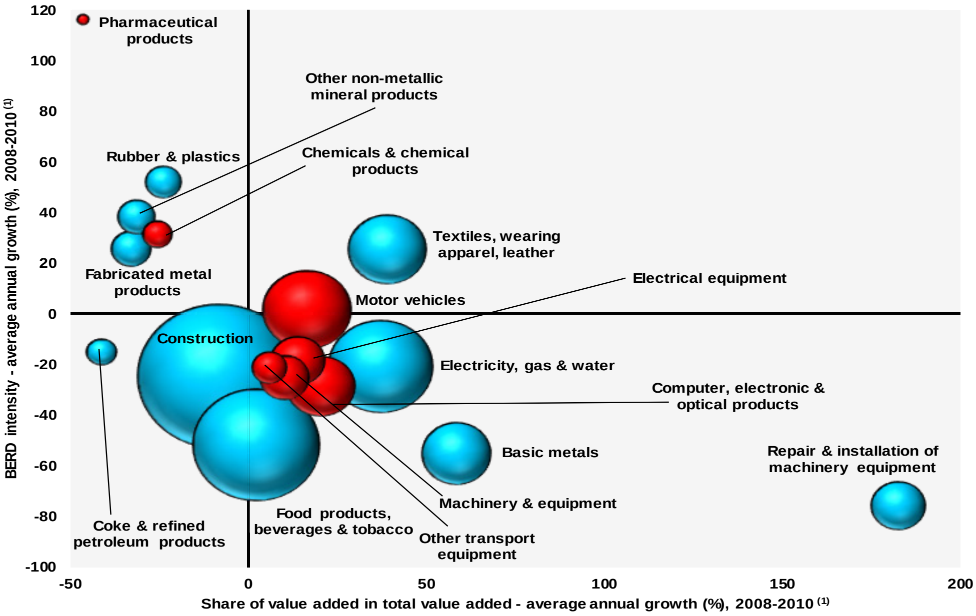
Romania is a strong performer in computer services exports, but also has significant road transport services exports, not classified as knowledge-intensive. As a result, the country performs near the EU average in the export of knowledge-intensive services.

The country performs below the EU average as regards the innovativeness of fast-growing firms in innovative sectors. This is also the result of a high share of employment in wholesale and retail trade and low-tech manufacturing sectors among employment in fast-growing firms.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries. The position on the horizontal axis illustrates the changing weight of each industry sector in value added over the period. The general trend of moving to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented in the graph). The red sectors are high-tech or medium-high-tech sectors.

Romania - Share of value added versus BERD intensity - average annual growth, 2008-2010 (1)



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Computer, electronic and optical products': 2008-2011; 'Textiles, wearing apparel, leather and related products': 2009-2010.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

Romania's limited innovation performance is reflected in its economic structure in which low- and medium-technology sectors are still prevalent. Demand for knowledge is weak and there is an underdeveloped innovation culture.

In terms of trade and industry specialisation, Romania is part of the group of lower-income countries in the EU, with lower GDP per person than the EU average and specialisation in less technologically advanced sectors. It is highly specialised in labour-intensive industries (food products, wearing apparel and accessories), in capital-driven industries (cement), and market-driven ones (footwear).

In terms of innovation, Romania is specialised in both low-innovation sectors (textiles, wearing apparel and leather) and medium-high innovation sectors (motor vehicles, computer, electronic and optical products).

In dynamic terms, a certain degree of structural change is shown in the graph above by the increasing added value in technology-driven and innovative sectors (motor vehicles, electrical equipment, computer, electronic and optical products and, to a lesser extent, machinery and equipment). On the other hand, fields with high-knowledge-intensity sectors, such as pharmaceutical products and chemical and chemical products, have declining shares of value added. However, although the quality of labour-intensive industries has improved, this is not yet the case for technology-driven ones.

Key indicators for Romania

ROMANIA	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	:	1,17	0,97	0,91	1,06	1,55	1,65	1,98	1,85	15,1	*1,81*	13
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	415	:	:	427	:	:	445	29.8 (3)	495 (4)	25 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0,25	0,20	0,22	0,22	0,17	0,19	0,18	0,18 (5)	0,19	-6,8	1,31	26
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,11	0,20	0,23	0,30	0,40	0,28	0,28	0,32 (5)	0,30	-2,4	*0,74*	27
Venture Capital as % of GDP	0,05	0,07	0,10	0,13	0,09	0,07	0,06	0,04	0,02	-33,0	0,29 (6)	18 (6)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	11,8	:	:	:	:	13,2	2,3	47,8	28
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	3,7	3,7	3,9	3,5	3,5	:	:	:	-5,3	11,0	25
International scientific co-publications per million population	:	86	91	114	130	143	155	161	177	9,2	343	28
Public-private scientific co-publications per million population	:	:	:	5	5	6	8	8	:	15,5	53	25
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,2	0,2	0,2	0,2	0,2	0,2	0,2	:	:	-0,5	3,9	28
License and patent revenues from abroad as % of GDP	0,01	0,05	0,03	0,02	0,12	0,12	0,28	0,13	0,21	53,8	0,59	13
Community trademark (CTM) applications per million population	0,2	2	6	15	13	15	19	29	27	13,1	152	27
Community design (CD) applications per million population	:	0	0	1	1	1	2	2	3	18,8	29	27
Sales of new to market and new to firm innovations as % of turnover	:	:	18,5	:	14,9	:	14,3	:	:	-2,0	14,4	12
Knowledge-intensive services exports as % total service exports	:	41,0	44,9	43,8	42,0	44,9	43,3	45,2	:	0,8	45,3	7
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-10,69	-7,26	-6,00	-4,42	-2,33	0,60	0,25	0,38	0,38	-	4,23 (7)	20
Growth of total factor productivity (total economy) - 2007 = 100	67	94	98	100	102	95	93	94	92	-8 (8)	97	23
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	23,1	:	:	:	:	27,5	3,5	51,2	28
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	5,6	5,8	6,0	6,5	6,5	3,7	13,9	28
SMEs introducing product or process innovations as % of SMEs	:	:	19,4	:	18,0	:	12,7	:	:	-16,1	33,8	28
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,00	0,02	0,01	0,01	0,01	0,02	:	:	:	33,0	0,44	28
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,01	0,03	0,02	0,01	0,01	0,002	:	:	:	-35,4	0,53	27
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	69,1	63,6	64,8	64,4	64,4	63,5	63,3	62,8	63,8	-0,2	68,4	20
R&D Intensity (GERD as % of GDP)	0,37	0,41	0,45	0,52	0,58	0,47	0,46	0.50 (5)	0,49	-4,2	*2,07*	27
Greenhouse gas emissions - 1990 = 100	55	58	60	58	57	49	48	50	:	-8 (9)	83	3 (10)
Share of renewable energy in gross final energy consumption (%)	:	17,6	17,1	18,4	20,3	22,3	23,4	21,4	:	3,8	13,0	8
Share of population aged 30-34 who have successfully completed tertiary education (%)	8,9	11,4	12,4	13,9	16,0	16,8	18,1	20,4	21,8	9,4	35,7	27
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	22,9	19,6	17,9	17,3	15,9	16,6	18,4	17,5	17,4	0,1	12,7	24 (10)
Share of population at risk of poverty or social exclusion (%)	:	:	:	45,9	44,2	43,1	41,4	40,3	41,7	-1,9	24,8	27 (10)

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies

Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard

Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.

(2) EU average for the latest available year.

(3) The value is the difference between 2012 and 2006.

(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.

(5) Break in series between 2011 and the previous years. Average annual growth refers to 2007-2010.

(6) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK, These Member States were not included in the EU ranking.

(7) EU is the weighted average of the values for the Member States.

(8) The value is the difference between 2012 and 2007.

(9) The value is the difference between 2011 and 2007. A negative value means lower emissions.

(10) The values for this indicator were ranked from lowest to highest.

(11) Values in italics are estimated or provisional.

Slovakia

The challenge of structural change to upgrade knowledge in the context of industrial globalisation

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Slovakia. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 0.82 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +12.3 % (EU: +2.4 %; US: +1.2 %)	*Excellence in S&T*[121] 2012: 25.2 (EU: 47.8; US: 58.1) 2007-2012: +8.5 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 85.7 (EU: 101.6)	*Knowledge-intensity of the economy*[13] 2012: 32.0 (EU: 51.2; US: 59.9) 2007-2012: +0.6 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food and agriculture, materials, and environment	*HT + MT contribution to the trade balance* 2012: 3.9 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +12.2 % (EU: +4.8 %; US: -32.3 %)

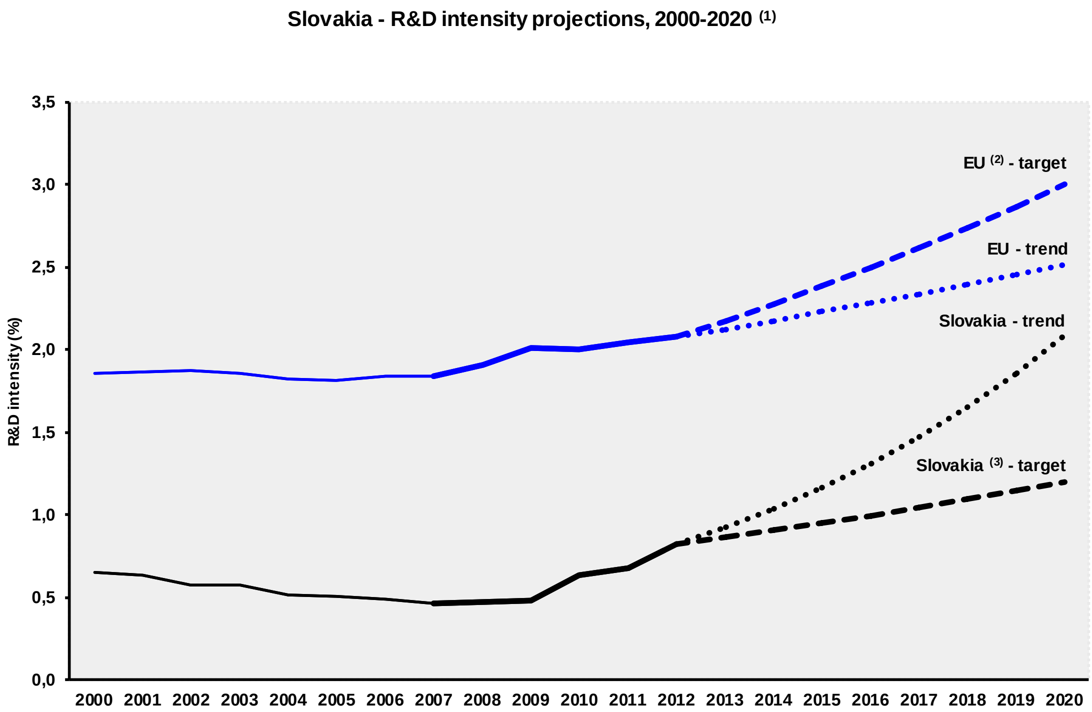
Over the 2007-2012 period, the country's performance achieved modest progress in research and innovation sectors while performance indicators remained below the EU average due to the low levels of R&D inputs corresponding with the low level of knowledge-intensive outputs. Therefore, the Slovak Republic faces the challenge of further developing its R&I system. Currently, the country ranks as the poorest R&I performer and is a moderate innovator which is catching up as regards competitiveness.

Over the last decade, R&D intensity steadily declined from a peak of 3.88 % in 1989 to 0.82 % in 2012. Slovakia's national 2020 intensity target for R&D is 1.2 %, which may be realistic providing that EU assistance to Slovakia's research system continues, and is combined efficiently with domestic funding and strategy implementation. The most important barrier to developing a strong private R&D sector and promoting innovations in Slovakia is its dual economy, which limits its indigenous R&D capacity in favour of the predominance of foreign multinational companies with high productivity, but lacking any domestic research activities. Thus, the Slovak economy is characterised by very low domestic patent production. For the first time, this weakness has been recognised clearly in the RIS3 (Research and Innovation Strategy for Smart Specialisation) document. The main challenge for the Slovak Republic is to raise knowledge intensity in Slovak firms through investments and spillovers. Moreover, existing public financing is suffering from inefficiency, a significant administrative burden and a lack of transparency concerning the procedures used – including those supporting regional innovation. The Slovak Republic has room to improve its thematic concentration, including stronger

[12] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[13] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators

coordination between the responsible public authorities, the links between business and science, and the connexion with international S&T networks.

Investing in knowledge



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) SK: The projection is based on a tentative R&D intensity target of 1.2% for 2020.

The Slovak Republic has set a national R&D-2020 intensity target of 1.2 %. In 2012, the Slovak R&D intensity was 0.82 % of GDP, below the EU average of 2.07 %. Public sector R&D intensity amounted to 0.48 % and business R&D intensity to 0.34 %. To reach the national target it must raise its annual growth in both public and private R&D investments. Austerity measures to reduce the public deficit affected national R&D funding of the Operational Programme R&D (OPRD), which provided some 80 % of total public support to R&D in Slovakia. The new national intensity target can be achieved providing the right policies are implemented. Overall, the country's R&I system is characterised by a very low R&D intensity, one of the lowest in Europe and also compared to the reference group countries – Czech Republic, Italy, Hungary and Slovenia – with an average of 1.27 %.

However, and in spite of the overall decline in the R&D intensity in the Slovak Republic over the last decade, the Slovak gross expenditure on research and development (GERD) increased from EUR 219 million in 2010 (0.48 % of GDP) to EUR 585.2 million in 2012 (0.82 % of GDP), notably due to financing from EU resources (mainly through the Structural Funds). Between the two programming periods of 2000-2006 and 2007-2013, the Slovak Republic increased its RTDI[14] by 19 %. In the

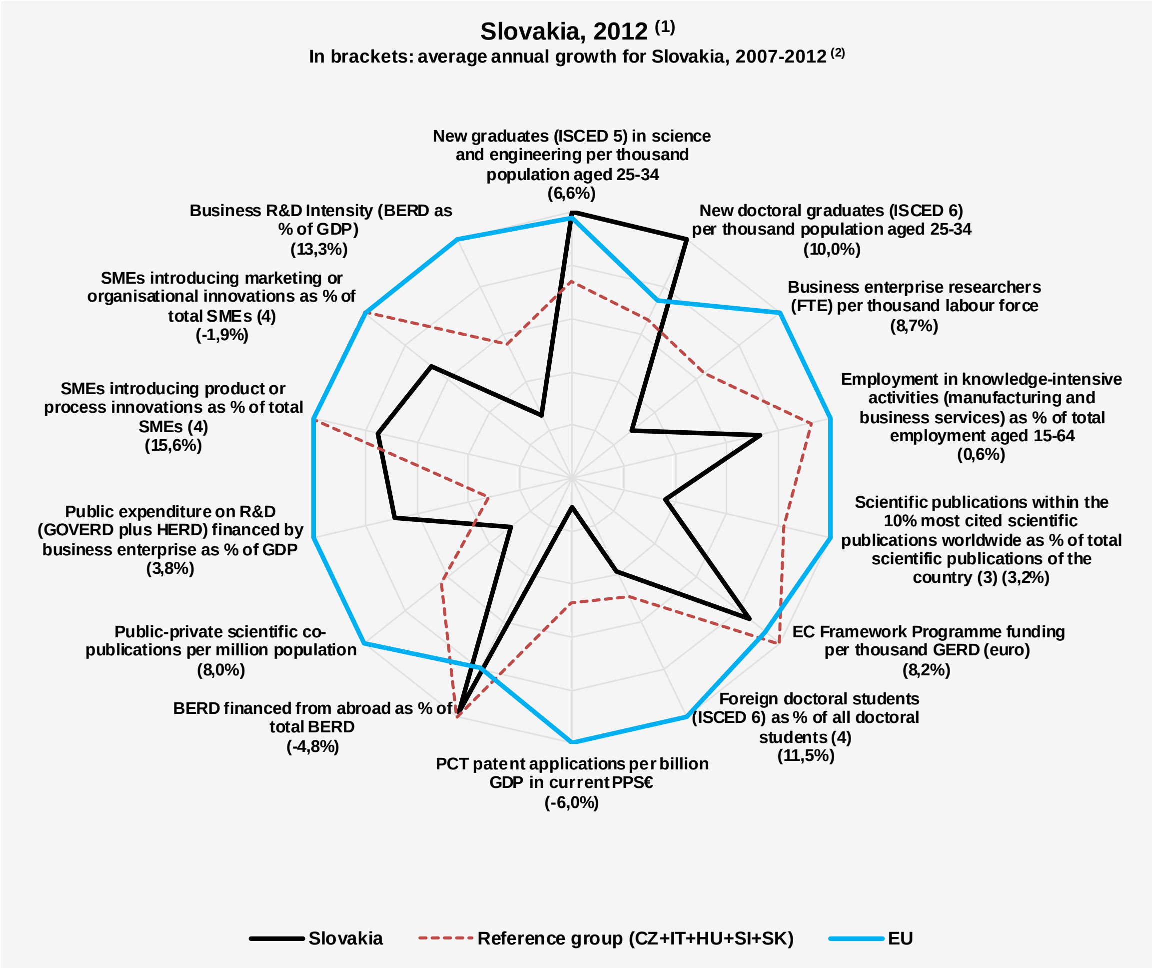
[14] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.

private sector, low R&D expenditure and productivity levels are characteristic of domestic firms, including a significant number of small and medium-sized enterprises (SMEs), and a few large companies. As a result, the production system is dominated by technology imports. In recent years, only modest national funding was allocated to address the low innovativeness among Slovak SMEs. Low shares of domestic innovative enterprises are limiting the country's competitiveness. Therefore, a major challenge facing Slovakia is to raise R&D intensity among its companies.

Slovakia achieved suboptimal performance in the EU's Seventh Framework Programme (FP7) projects. Its participation in FP7 projects in 2007-2013 period reveals a total of 1990 eligible proposals were submitted, with a success rate of 11.49 %, lower than the EU-27 applicant success rate of 22.0 % (E-CORDA database). Structural Funds are another important source of funding for R&I activities. Of the EUR 11.5 billion of Structural Funds allocated to Slovakia over the 2007-2013 programming period, around EUR 1.3 billion (11.3 % of the total) related to RTDI.

An effective research and innovation system building on the European Research Area

The spider graph below provides a synthetic picture of strengths and weaknesses in the Slovak R&I system. Reading clockwise, the graph provides information on human resources, scientific production, technology valorisation and innovation. The average annual growth rates from 2000 to the latest available year are given in brackets under each indicator.

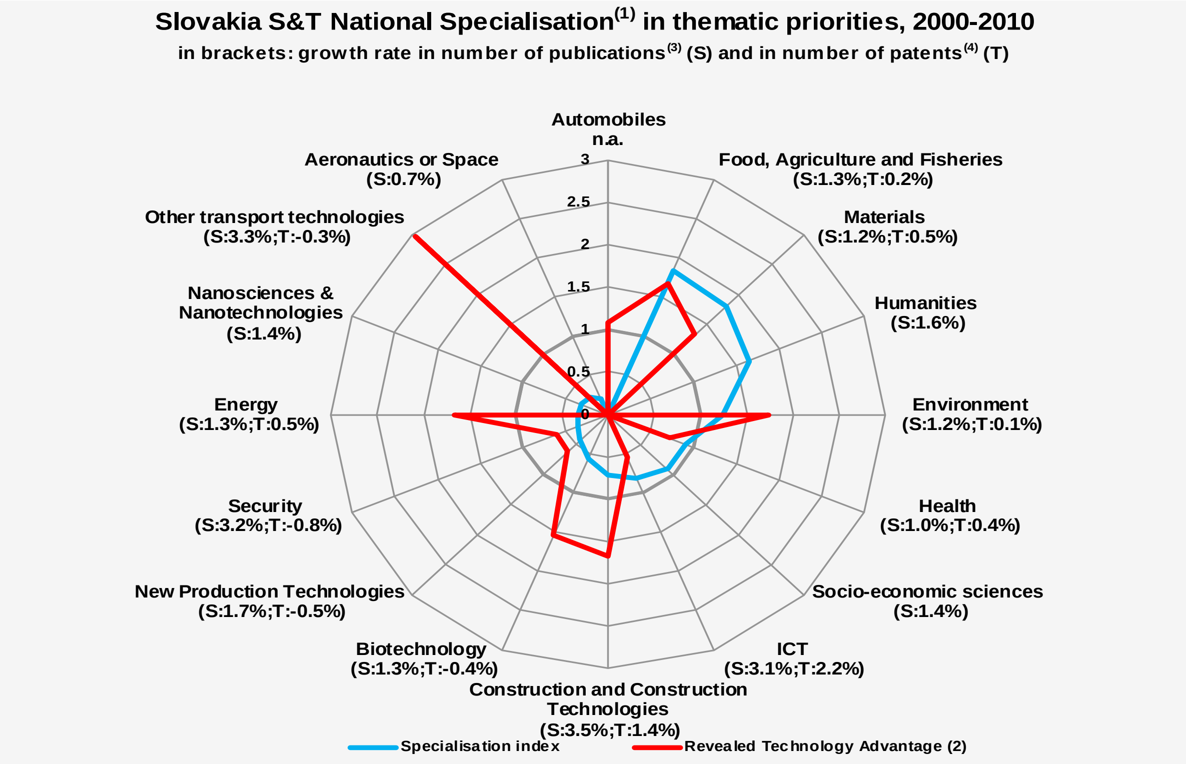


Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

The strengths in Slovakia's R&I system are found in human resources for R&I and in attracting business R&D investments from abroad. There has been a significant increase above the EU average in the number of new graduates in science and engineering and at PhD level as an alternative to unemployment for some tertiary graduates considering the shrinking numbers being employed in the business sector. However, there is need to enhance the quality and efficiency of the higher education system, and to increase the excellence and internationalisation of its universities, as the latter are not visible in major international rankings, and given the low number of scientific outputs. As regards the reference group, only a few Slovak indicators attain a better or similar position, and can thus contribute to future development. In contrast, the country's main weaknesses lay in business research activities (R&D spending over the 2007-2012 period reached on average 0.34 % of GDP as against the EU figure of 1.30 % of GDP), including very low patenting, numbers of business researchers, and R&D investments as the research field remained rather static and was not matched by technologies. In the public sector, the main challenges concern pursuing improvements in scientific quality and in public-private cooperation in R&D activities.

Slovakia's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Slovakia shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA), based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

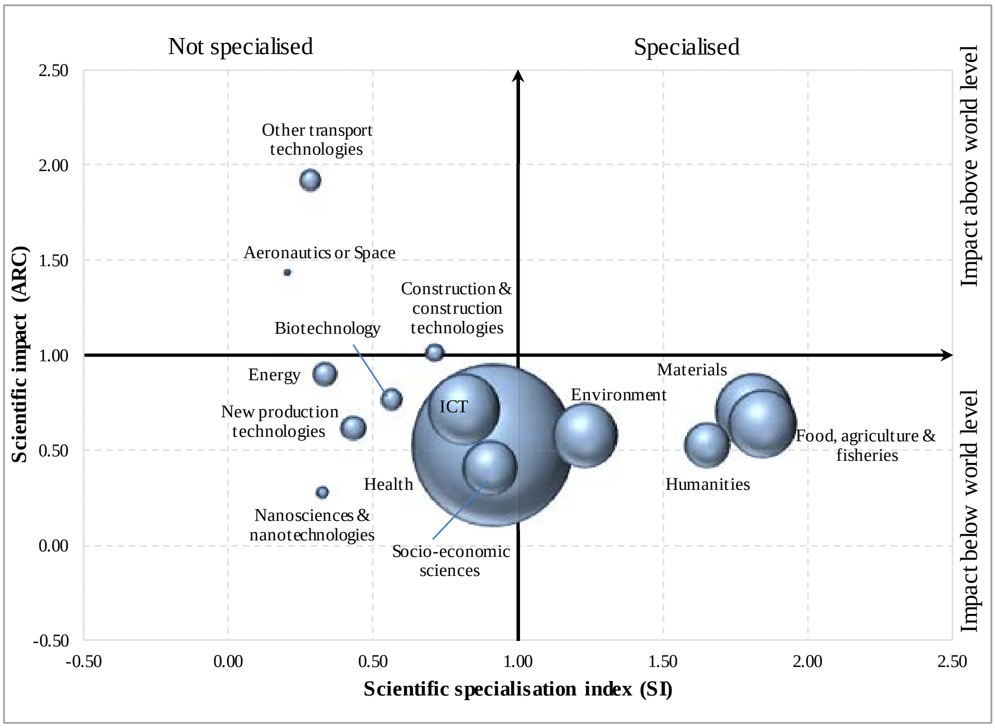


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

The graph above shows that the Slovak scientific and technological specialisation in selected thematic priorities is rather unbalanced. Naturally, sectors such as socio-economic sciences and humanities do not lead to any technological production. On the other hand, five other sectors with strong technology advantages are hardly covered by scientific specialisation (i.e. other transport technologies, energy, new production technologies, biotechnology, and construction and construction technologies). In Slovakia, the sectors with the best matches between science and technology are environment, materials, and food, agriculture and fisheries, where progress is quite well balanced, too.

The graph below illustrates the positional analysis of Slovakian publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Slovakia publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

Slovakia is well specialised in food, agriculture and fisheries, materials, environment, humanities, and socio-economic sciences, although no above-average impact is generated. Three other sectors (other transport technologies, aeronautics or space, and construction and construction technologies), with a low level of specialisation, have a certain impact. Considering the scientific specialisation index, over the period 2000-2010, Slovakia did not significantly improve either its scientific production rate or, consequently, new production technologies, which resulted in a very poor performance in intellectual assets (PCT patent applications, licence and patent revenues).

Both graphs show clearly that Slovakia's scientific capacity remains very weak. The country's key challenges are illustrated – also in relation to national drafted policy documents – but have yet to be sufficiently addressed. Among them are the weak R&D system and poor cooperation between academia and industry sectors. Low inputs (in terms of public and business R&D spending) correspond with low knowledge-intensive outputs. The Slovak economy is largely dominated by multinational companies (MNCs), which are not linked to its universities and research institutes, and carry out their research in their headquarters abroad. A very large number of domestic SMEs have no research activities because of the cost and potential risks. The low share of domestic innovative enterprises is limiting the country's competitiveness. In addition, scientific production is not of a high level and there is room to improve excellence in the sciences and the university system at national and international level as regards quality co-publications. Furthermore, there is a need to set up a 'sciences and knowledge culture', which is somewhat missing in the nation traditionally. Therefore, Slovakia must also support progress towards the European Research Area (ERA) priorities and ensure transparency, openness and a regulated competition framework of the national governance and business environment.

Policies and reforms for research and innovation

The 2014 National Reform Programme (NRP) confirms targets in R&I for 2020. It focuses on GERD and business expenditure on R&D (BERD) respectively to protect expenditure which promotes economic growth. The NRP sets out the most recent innovation policies indicating a shift towards more up-to-date measures to be implemented in the near future in terms of support for clusters, target groups and methods of funding (innovation vouchers). Since the challenges faced by the Slovak Republic today remain the same, the government has committed to supplementing its policy statement, in the shortest possible time. Further, it considers it is important to ensure that expenditure on productive areas, such as education, remain among its long-term political priorities in subsequent years too, and it will take steps to improve the quality of higher education and its relevance to market needs. It will also focus on measures that ensure smart, sustainable and inclusive growth.

The research policy priorities and policy mix were set in the ‘Long-term Objective of the State S&T Policy up to 2015’ document. The country’s commitment to the EU-2020 targets was reaffirmed, especially regarding the country’s challenges, in particular in R&D intensity as the Slovak public research system accounts for a relatively high share of funding from the Structural Funds. At present, the new strategic policies are intended to streamline national objectives towards the new EU policies in Europe 2020 and Horizon 2020. In this context, NRP includes further measures to improve collaboration between the public and private sector in terms of financial and organisational arrangements and human capital through partnerships, joint ventures and long-term contracts. People should be encouraged to run innovative businesses and this will be promoted by systematically including entrepreneurship teaching (including lessons on tax compliance) in the curricula of primary, secondary and tertiary education establishments.

Traditionally, R&I policies in Slovakia were considered to be matters for central government. Thus, Slovak regions have no legislative power in these fields. No explicit regional R&I programmes and/or policy measures have been developed. A tentative proposal to create regional innovation centres (RIC) was abandoned as being too complex. Slovak regions are characterised by both high and growing regional disparities in the R&D system. Efforts have been concentrated in the Bratislava region..

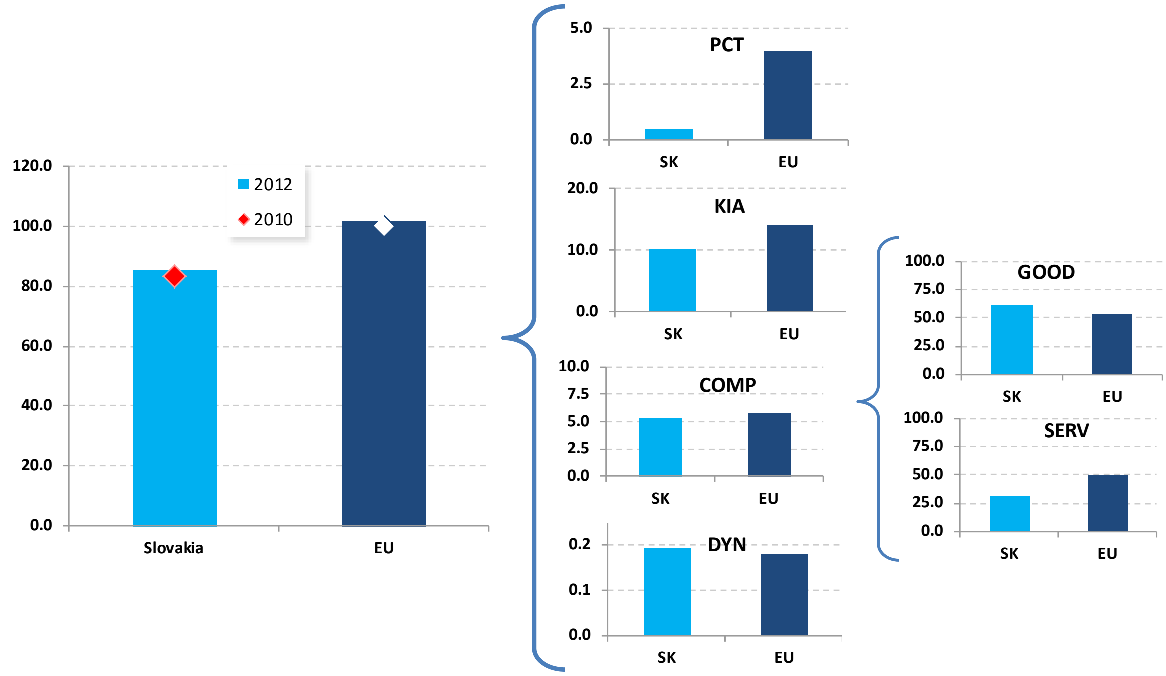
At the national level, the governance structure of the Slovak research system has changed little over last decade. Since 2007, responsibilities for the R&I policies have been divided between the Ministry of Economy (ME) and the Ministry of Education, Science, Research and Sport (MESRS). Innovation policy measures are implemented by the ME and its agencies. The ME implements the Operational Programme of Competitiveness and Economic Growth (OPCEG) and the MESRS implements the Operational Programme Research and Development (OPRD) and the Operational Programme Education (OPE). The 2014 NRP envisages the existing network of governmental implementing institutions to be merged into two integrated agencies: a research agency and a technology agency. The Research and Innovation Strategy for Smart Specialisation document suggested some important changes in innovation governance and identified key areas of economic and technology specialisation. The most important system change relates to the activities of the Slovak Government's Council for Science, Technology and Innovation (SGCSTI), established in September 2011, but only in operation since April 2013. The Council, which is chaired by the prime minister, is a cross-cutting body involving representatives of key central government ministries, higher education institutes, research institutions, and industry and employer associations. Its main task is to reduce fragmentation and secure effective work in the public R&D&I institutions. It follows coordination of the agenda and policies at the inter-ministerial level, which are of paramount importance for the efficient spending of funds in the years to come.

Overall, there is also scope for improving Slovakia’s innovation capacity and business environment, in particular through more efficient public administration, and closer integration of the Slovak R&I system in the ERA would be an explicit objective of the national policy.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Slovakia's position regarding the indicator's different components:

Slovakia - Innovation Output Indicator



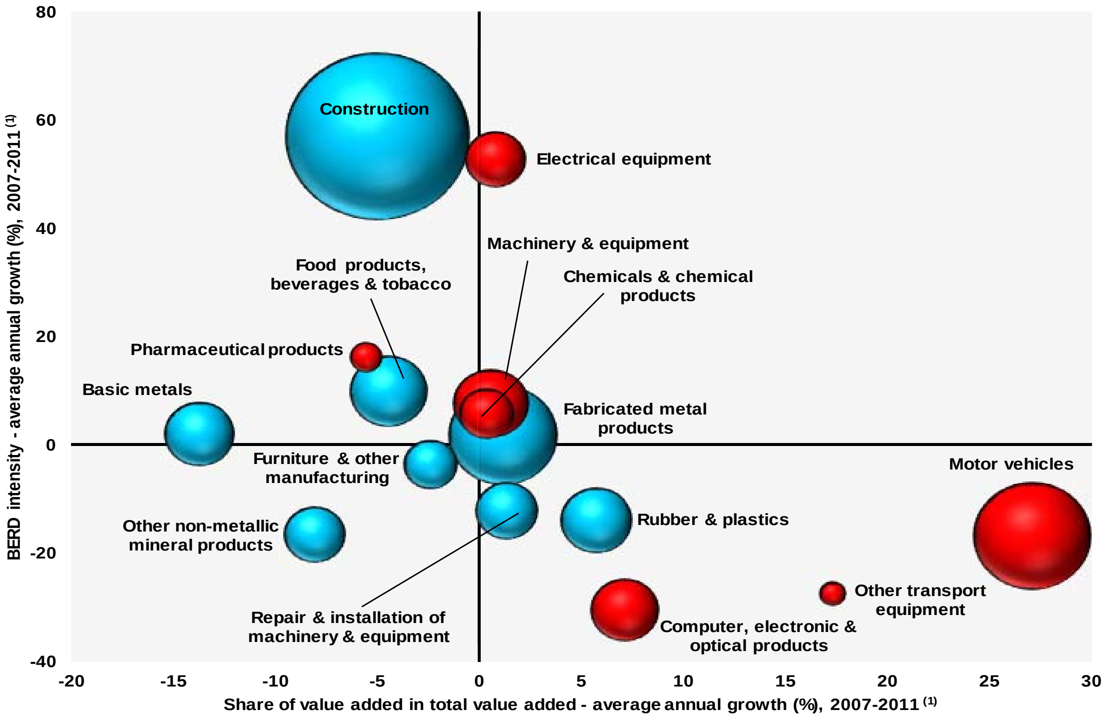
Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Slovakia is a medium-low performer in the European innovation indicator, ranked well below the EU average. However, it performs not far from the EU average in most components, with the exception of patents, where the country performs at an extremely low level. On the other hand, the export share of medium-high/high-tech goods is above the EU average, similar to that of Germany. Slovakia is among the best European performers in this component, which can be explained by strong car exports as it has the highest per-capita car production in Europe. Slovakia is under-performing in the export share of knowledge-intensive services, which is explained by the relative importance of service exports such as tourism and land-based transport, not classified as KIS. Slovakia also performs at a low level in employment in knowledge-intensive activities in business industries as a % of total employment. It performs well as regards the innovativeness of fast-growing firms (above the EU average). To improve its overall performance, the country needs to improve its business environment by implementing innovative solutions (new start-ups, spin-offs), by providing administrative support to technology transfer from public R&D institutions, and by establishing a link between universities, the Slovak Academy of Sciences, and technology incubators.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates with four variables the upgrading of knowledge in different manufacturing industries. The position on the horizontal axe illustrates the changing weight of each industry sector in value added over the period. The general trend of moving to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-aces are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (all sectors presented in the graph). The red sectors are high-tech or medium-high-tech sectors.

Slovakia - Share of value added versus BERD intensity - average annual growth, 2007-2011 (1)



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Furniture and other manufacturing': 2007-2009; 'Basic metals', 'Repair and installation of machinery and equipment': 2008-2011; 'Construction', 'Motor vehicles', 'Other transport equipment': 2009-2011; ':Pharmaceutical products': 2010-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

As a small open economy with relatively high profitability and productivity growth, Slovakia enjoys a favourable external competitiveness position. Manufacturing plays an important role and accounts for 26 % of total value added against the EU-27 average of 15.5 %. However, Slovakia's industrial base is specialised in a few capital-intensive and cyclically sensitive sectors. While technology import has been a source of major productivity gains in the past ten years, this has made the country's economy quite vulnerable, being dependent on external demand.

The graph above synthesises the structural change in the Slovak manufacturing sectors over the 2007-2011 period. It shows that three medium- and high-tech sectors (motor vehicles, computer, electronic and optical products, and other transport equipment) have grown in economic importance (value added), while knowledge-intensity (as measured by R&D investments) in medium-sized, medium- or low-tech sectors, such as other non-metallic mineral products, repair and installation of machinery and equipment, and rubber and plastics, has declined. Economic expansion has been mostly related to the traditional automotive sector, followed mainly by the three sectors cited above. Nevertheless, most Slovak manufacturing industries did not upgrade their knowledge intensity over this period, which could indicate a medium-term risk to the sector in the context of increasing globalisation. Due to the weak innovation system, the innovation capacity of domestic firms remains limited.

Key indicators for Slovakia

SLOVAKIA	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	0,57	1,17	1,37	1,52	1,82	2,13	3,18	1,86	2,44	10,0	*1,81*	4
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	492	:	:	497	:	:	482	-10.5 (3)	495 (4)	19 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0,43	0,25	0,21	0,18	0,20	0,20	0,27	0,25	0,34	*13,3*	1,31	22
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,22	0,25	0,28	0,28	0,27	0,28	0,36	0,43	0,48	11,7	*0,74*	20
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	16,8	:	:	:	:	25,2	8,5	47,8	20
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	2,4	3,3	3,7	3,2	4,0	:	:	:	3,2	11,0	23
International scientific co-publications per million population	:	254	292	321	356	357	365	390	399	4,5	343	23
Public-private scientific co-publications per million population	:	:	:	11	11	12	15	16	:	8,0	53	22
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,7	0,5	0,5	0,5	0,3	0,4	0,4	:	:	-6,0	3,9	23
License and patent revenues from abroad as % of GDP	0,08	0,16	0,16	0,20	0,17	0,11	0,05	0,004	0,005	-52,8	0,59	28
Community trademark (CTM) applications per million population	:	7	17	20	29	38	34	50	50	19,6	152	24
Community design (CD) applications per million population	:	3	6	6	5	8	6	10	8	6,7	29	24
Sales of new to market and new to firm innovations as % of turnover	:	:	16,7	:	15,8	:	23,3	:	:	21,6	14,4	1
Knowledge-intensive services exports as % total service exports	:	15,5	19,8	22,1	21,4	19,0	19,7	22,1	:	-0,1	45,3	23
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	0,20	0,32	0,95	2,19	3,18	3,31	3,96	4,35	3,88	-	4,23 (5)	7
Growth of total factor productivity (total economy) - 2007 = 100	77	90	94	100	102	97	101	102	104	4 (6)	97	1
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	31,1	:	:	:	:	32,0	0,6	51,2	26
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	10,0	10,1	10,1	10.6 (7)	10,1	0,6	13,9	23
SMEs introducing product or process innovations as % of SMEs	:	:	21,4	:	19,0	:	25,4	:	:	15,6	33,8	20
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,06	0,03	0,04	0,02	0,02	0,03	:	:	:	40,6	0,44	25
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,07	0,00	0,03	0,04	0,03	0,002	:	:	:	-80,1	0,53	28
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	63,5	64,5	66,0	67,2	68,8	66,4	64,6	65.0 (8)	65,1	-1,3	68,4	18
R&D Intensity (GERD as % of GDP)	0,65	0,51	0,49	0,46	0,47	0,48	0,63	0,68	0,82	*12,3*	*2,07*	22
Greenhouse gas emissions - 1990 = 100	69	71	70	68	69	61	64	63	:	-5 (9)	83	6 (10)
Share of renewable energy in gross final energy consumption (%)	:	6,6	6,9	8,2	8,1	9,7	9,4	9,7	:	4,3	13,0	19
Share of population aged 30-34 who have successfully completed tertiary education (%)	10,6	14,3	14,4	14,8	15,8	17,6	22,1	23,2	23,7	9,9	35,7	25
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	6,3	6,6	6,5	6,0	4,9	4,7	5,1	5,3	-4,0	12,7	3 (10)
Share of population at risk of poverty or social exclusion (%)	:	32,0	26,7	21,3	20,6	19,6	20,6	20,6	20,5	-0,8	24,8	11 (10)

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) EU is the weighted average of the values for the Member States.
(6) The value is the difference between 2012 and 2007.
(7) Break in series between 2011 and the previous years. Average annual growth refers to 2008-2010.
(8) Break in series between 2011 and the previous years. Average annual growth refers to 2007-2010.
(9) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(10) The values for this indicator were ranked from lowest to highest.
(11) Values in italics are estimated or provisional.

2014 Country-specific recommendation in R&I adopted by the Council in July 2014:

"Improve the quality and relevance of the science base and implement plans to foster effective knowledge transfer and cooperation between academia, research and business."

Slovenia

Towards a knowledge-intensive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Slovenia. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 2.80 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +12.7 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[15] 2012: 28.8 (EU: 47.8; US: 58.1) 2007-2012: +9.9 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 87.4 (EU: 101.6)	*Knowledge-intensity of the economy*[16] 2012: 50.3 (EU: 51.2; US: 59.9) 2007-2012: +3.7 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: New production technologies, materials, food, ICT, security, and construction technologies	*HT + MT contribution to the trade balance* 2012: 6.5 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +9.4 % (EU: +4.8 %; US: -32.3 %)

R&D intensity in Slovenia increased from 1.38 % in 2000 to 2.8 % in 2012, thus its R&D intensity target of 3 % for 2020 seems achievable. In spite of the economic crisis, business expenditure on R&D as a percentage of GDP increased from 0.87 % in 2007 to 2.16 % in 2012, making Slovenia one of the top performers in the EU in terms of business R&D. The country ranks third in the EU, outperformed only by Finland and Sweden.

This is a clear signal that Slovenia regards investment in R&D as a priority for the development of medium-high and high-tech competitive enterprises and for increased and sustainable economic growth. It is meeting the challenge of reaching its 2020 R&D intensity target of 3 % by mobilising incentives and resources from public and private sources (human, financial, infrastructural) and providing a smooth path for more technological innovation. Improving the overall governance and ensuring a clearer research prioritisation with a stronger focus on knowledge transfer remain the main challenges for the Slovenian R&I system to support the efficient and effective use of available resources.

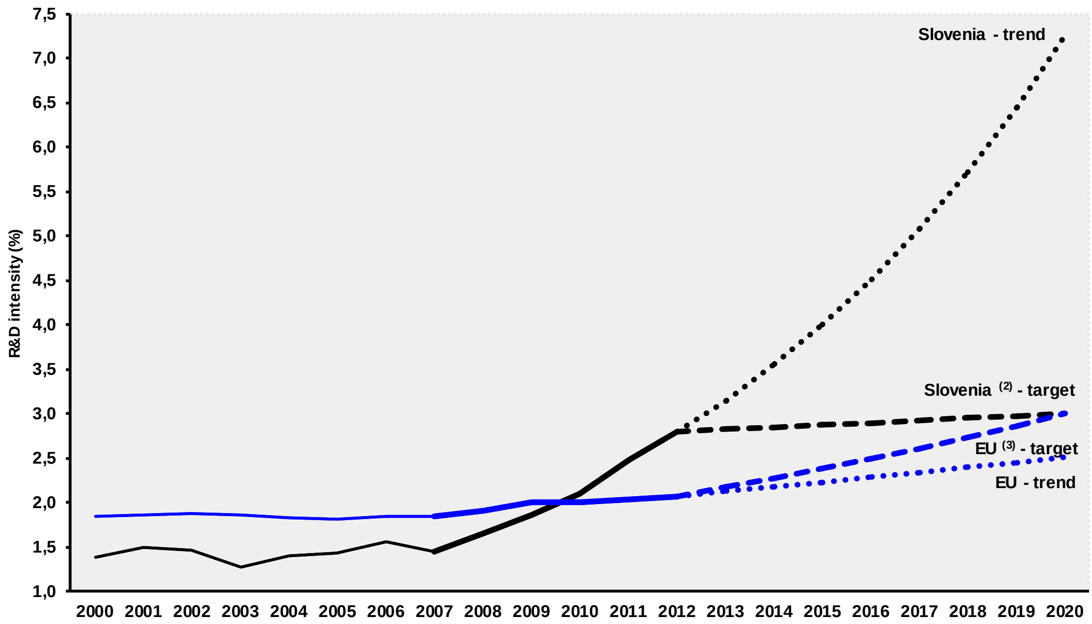
To tackle these challenges, the National Research and Innovation Strategy 2011-2020 needs to be implemented and coordinated with the 2013 industrial policy strategies as well as with the upcoming strategies on smart specialisation and transport, and to ensure their prompt implementation and assessment of effectiveness. Measures to foster knowledge transfer and commercialisation of research results – such as the introduction of funding linked to research performance, removal of obstacles to

[15] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[16] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

establishing university spin-offs and cross-border venture capital investments – would contribute to creating a favourable business environment for innovative companies in key sectors.

Investing in knowledge

Slovenia - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2008-2010 in the case of Slovenia.
(2) SI: The projection is based on a tentative R&D intensity target of 3.0% for 2020.
(3) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(4) SI: There are breaks in series between 2008 and the previous years and between 2011 and the previous years.

Since 2000, the level of R&D investment in Slovenia has increased at an unprecedented and unparalleled rate, making it one of the leading EU Member States in this respect. R&D intensity in Slovenia increased from 1.38 % in 2000 to 1.45 % in 2007 and 2.8 % in 2012. Thus, Slovenia's R&D intensity target of 3 % for 2020 is clearly achievable despite the economic crisis. This remarkable achievement is the result of strong public support and a set of ambitious innovation measures.

In spite of the economic crisis, business expenditure on R&D as a percentage of GDP increased from 0.87 % in 2007 to 2.16 % in 2012, making it one of the EU's top performers in terms of business R&D. However, it should be noted that this performance has been achieved with a very high level of public support to business R&D.

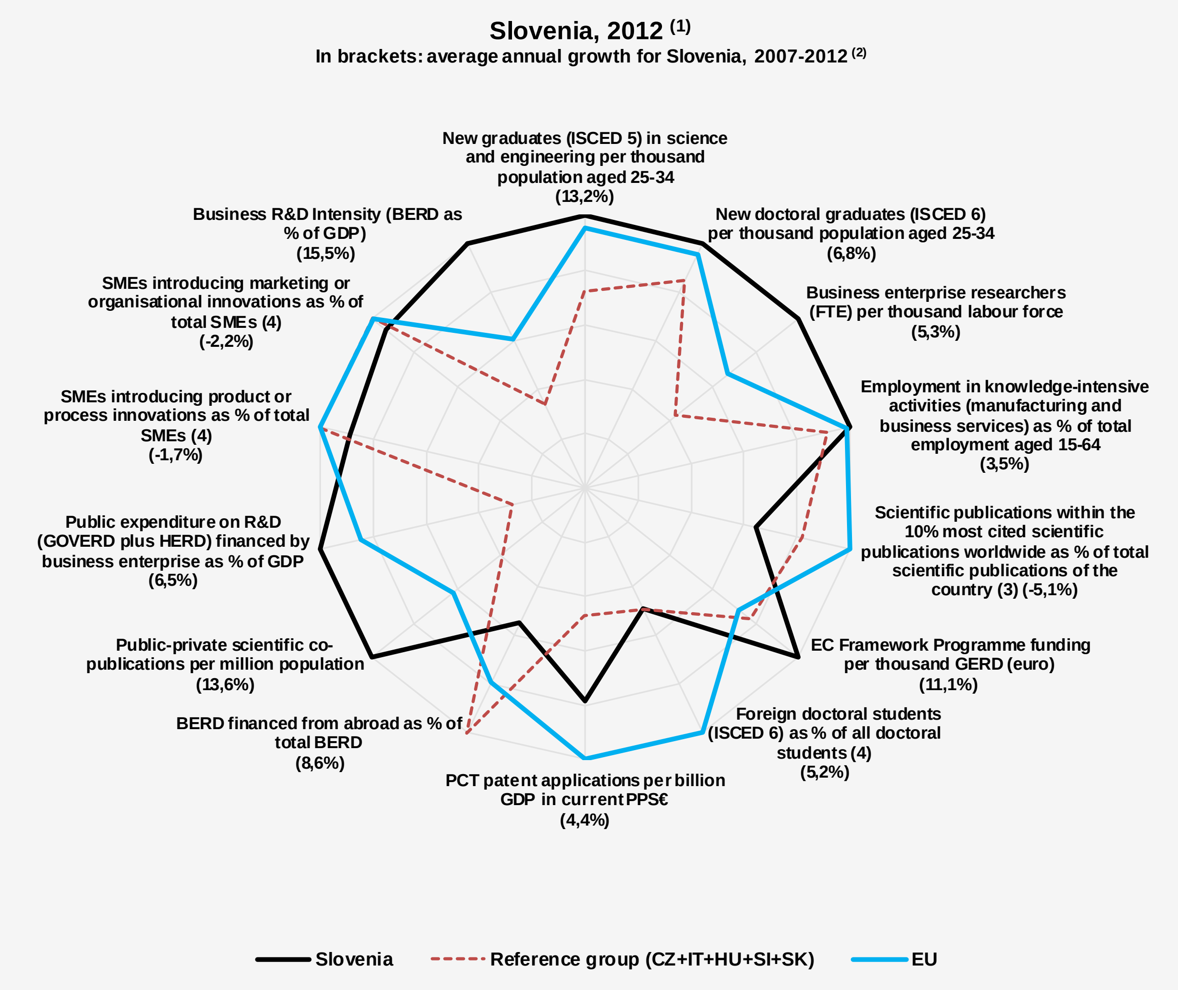
Notwithstanding budgetary constraints, public sector expenditure on R&D in 2012 was 0.64 % of GDP, slightly below the EU average but above those countries with similar research and knowledge structures.

Slovenian R&I also receive support from the EU budget through two main instruments: the Structural Funds and the Seventh Framework Programme (FP7). Of the EUR 4101 million of Structural Funds allocated to Slovenia over the 2007-2013 programming period, around EUR 1013 million (24.7 % of the total) related to RTDI[17]. A total of 849 participants from Slovenia benefited by around EUR 152 million from FP7. The success rate of participants is 15.62 %, below the EU average of 19.62 %.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Slovenia's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2000 to the latest available year are given in brackets.

[17] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

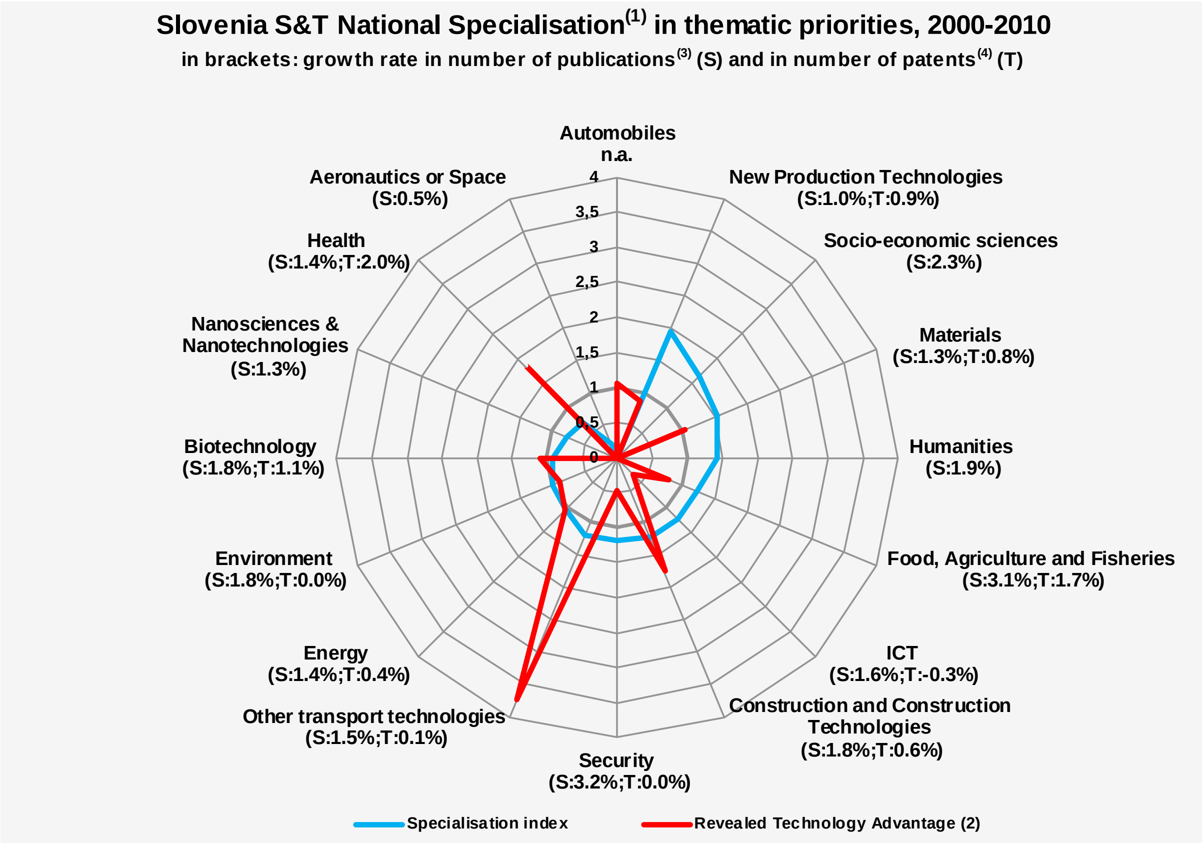
The graph above shows that Slovenia's R&I system is performing well, with several indicators close to or above the EU average and showing positive trends. These include human resources, innovation in business, and R&D expenditure. Nevertheless, there are some weaknesses in the fields of knowledge commercialisation, private and public sector internationalisation, and research quality.

As regards human resources, Slovenia already has a high level of new doctoral graduates, above the EU average, but is still catching up in terms of new graduates in science and engineering. Employment of researchers by business enterprises and in knowledge-intensive activities is also at a high level. In this respect, it would appear that highly skilled graduates are readily absorbed into the Slovenian economy. However, despite its good performance in human resources, Slovenia is still not attractive enough for foreign doctoral students.

As regards scientific production, Slovenia produces high levels of international scientific co-publications and public-private scientific co-publications but needs to improve their quality in order to perform better in terms of scientific publications within the 10 % most-cited scientific publications worldwide. In terms of knowledge commercialisation, the country has an increasing number of PCT patent applications and a high level of patent applications to the European Patent Office (EPO) in the field of health-related technologies. However, the levels of both total PCT and total EPO patent applications are below the EU average. Slovenian small and medium-sized enterprises (SMEs) perform well in terms of (non-technological) marketing and organisational innovations and fairly well in introducing product or process innovations.

Slovenia's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Slovenia shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.



Source: DG Research and Innovation - Analysis and monitoring of national research policies

Data: Science Metrix - Canada, Univ. Bocconi - Italy

Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.

(2) The Revealed Technology Advantage is calculated based on the data corresponding to the number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.

(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.

(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

Comparison of the scientific and technological specialisation in selected thematic priorities shows some co-specialisations with small mismatches. In most of the sectors, scientific production is combined with certain technological specialisation, although scientific quality is limited in sectors relevant to its industry.

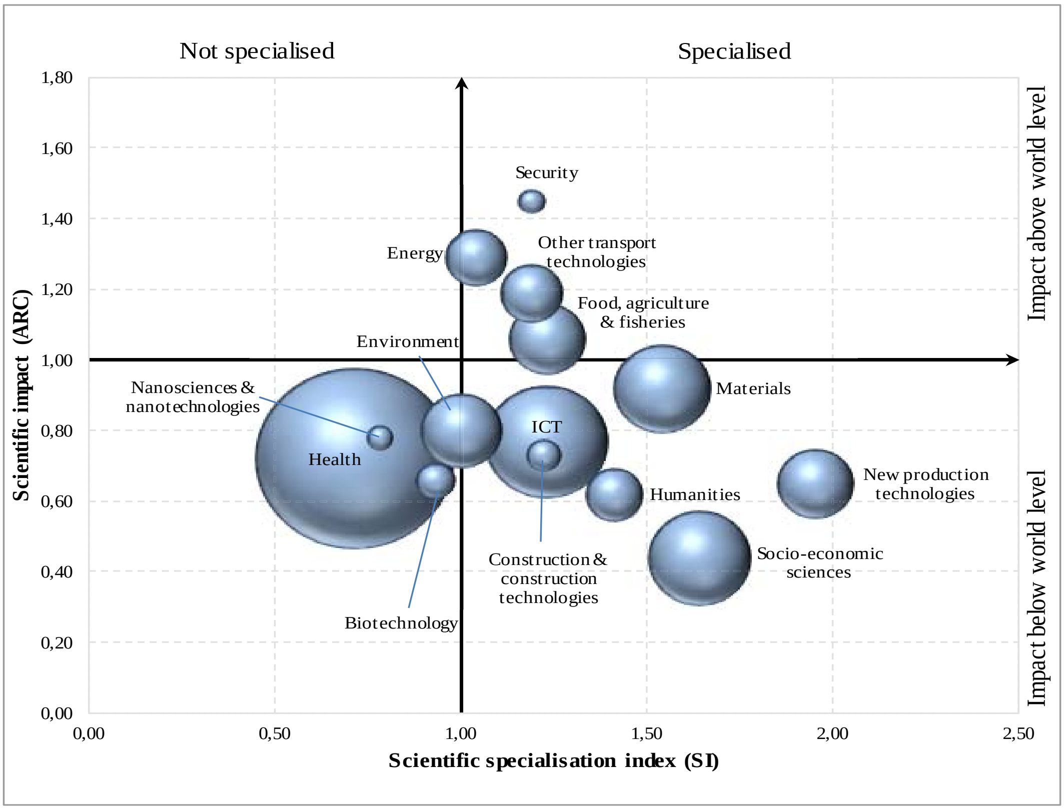
The country displays relevant scientific specialisation in several sectors, such as new production technologies, materials, food, agriculture and fisheries, ICT, security, construction technologies and, to less extent, in energy, environment, and biotechnology. The scientific profile is coupled with the country's technological profile in most of the sectors except for ICT and security.

On the other hand, the strong technological specialisation in health and in other transport technologies is not backed up by a strong domestic scientific specialisation. Taking into account the technological specialisation of Slovenia in these fields, the country would probably benefit from fostering scientific specialisation and scientific quality in this sector.

Slovenia has established strength in the field of energy, other transport technologies, food agriculture and fisheries, and energy where scientific production and quality are correlated with a certain technological specialisation. However, there is a room for improvement on scientific impact of some sectors ranking high on the science specialisation indicator – i.e. ICT, materials or new production technologies. Finally, the quality of domestic science in security is not coupled with the country's scientific and technological specialisation profile. In contrast, the strong technological specialisation in health is not leveraged by high scientific quality and specialisation of domestic science in Slovenia.

The graph below illustrates the positional analysis of Slovenian publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Slovenia publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit

Data: Science Metrix - Canada, based on Scopus

Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

As quality in research is correlated to more cooperation with researchers from other European countries and beyond, in order to increase its research quality Slovenia would benefit from actively supporting and providing incentives for its researchers to connect to Horizon 2020 networks.

Policies and reforms for research and innovation

In 2011, the Slovenian authorities approved its Research and Innovation Strategy 2011-2020 (RISS); however, the measures outlined therein have yet to be implemented and coordinated with the 2013 industrial policy strategies and with the upcoming strategies on smart specialisation and transport, and their prompt implementation and assessment of effectiveness ensured..

The Slovenian Research Agency is in charge of financing basic and applied research primarily in the public-research sector, while the newly formed SPIRIT, the agency combining the former Technology and Innovation Agency, the Public Agency for Entrepreneurship and Foreign Investment, and the Slovenian Tourism organisation should be in charge of entrepreneurial support and financing R&D activity in business sector. Yet, only some of the calls have been entrusted to the new agency and some have been performed directly by the Ministry of Economic Development and Technology. Support for business-sector R&D is also partially provided through the Slovenian Enterprise Fund, especially for start-ups in an innovation environment and bank guarantees for SMEs engaged in R&D projects and technological restructuring.

The RISS includes important measures for fostering knowledge transfer and the commercialisation of research results, such as the introduction of institutional funding linked to an assessment of research performance or the removal of obstacles to the establishment of university spin-outs and to cross-border venture-capital investments. This strategy proposed several changes in R&D financing, especially with regard to higher education institutions. The main argument for change was to give more independence and autonomy to universities and institutes, allowing them to allocate the funds internally, on one hand, and to increase the competitive funding, as suggested by the OECD and ERAC (European Research Area and Innovation Committee) evaluations, on the other. Such a change required a new or at least significantly amended Law on R&D (2002). In October 2013, the ministry appointed an expert group with the task of drafting the new law, but gave no directions in terms of new institutional/funding set-up. By the end of 2013, a draft of the new law had been prepared within the group, but it has not yet been presented to the government or the public.

The government significantly increased the R&D tax subsidy which, from 2012, has been at the level of 100 %. In 2011, a thousand companies had benefited from this measure, which has been welcomed in particular by larger enterprises that invest significantly in R&D (for example, pharmaceutical companies). The planned change of offering more subsidised credit rather than subsidies for R&D projects, which the government wanted to implement in 2012, proved not to be the measure Slovenian, especially small enterprises, would favour.

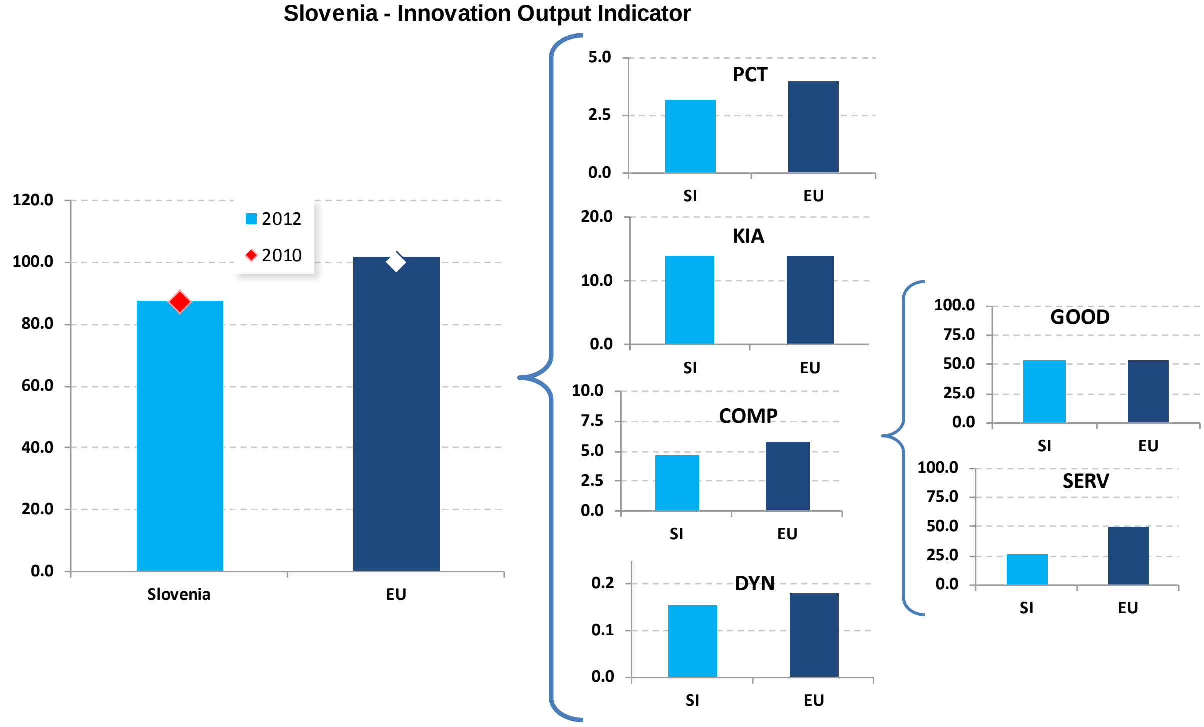
Lack of thematic funding has been identified as a weakness in several evaluations of the national innovation system. Slovenia currently only supports certain sectors through the funding of eight centres of excellence, seven competence centres and 17 development centres, all co-founded through the Structural Funds. The competence centres are led by businesses combining basic and applied research with a view to creating future market opportunities, and to some extent complement the centres of excellence, introduced in 2009. The latter focus on basic research carried out by public research organisations, in cooperation with business R&D units active in the same area. And finally, the development centres (consortia of business firms) support 'close to the market' research projects with a view to developing new products, processes and services. It is also noteworthy that tax allowances for R&I were increased in April 2012.

To improve cooperation between the public and private sectors, in 2012, Slovenia developed the research voucher (EUR 8 million) to help enterprises to commission research at R&D institutes and higher education organisations for a period of three years. The final aim was to connect companies with universities.

Slovenia has room to better address funding priorities. There is a need for more focus on, and critical mass in, sectors related to Slovenia's existing R&D strengths and economic strengths. The measures outlined in the Research and Innovation Strategy and in the Industrial Policy Strategy need to be implemented and coordinated with the smart specialisation process in order to harness the country's potential for smart growth and the knowledge economy.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Slovenia's position on the indicator's different components:



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Slovenia is a medium-low performer in the European innovation indicator. This is the result of a diversified performance in the indicator's components. It is near the EU average for employment in knowledge-intensive activities and for the share of medium-high and high-tech manufacturing goods in total goods exports, but low for knowledge-intensive service exports, for patents, and for the innovativeness of high-growth enterprises.

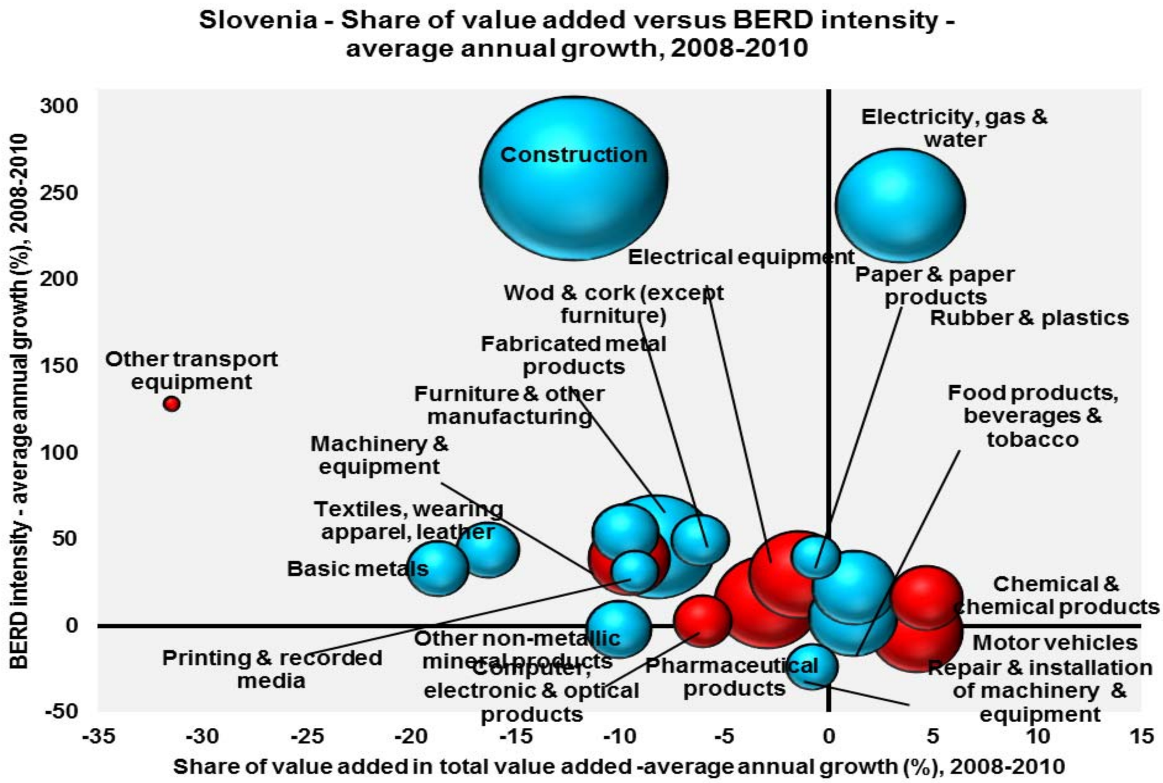
Slovenia performs near the EU average as regards the share of medium-high/high-tech goods in total goods exports. This is the result of a balance between, on the one hand, strong exports of pharmaceutical products, electrical machinery and road vehicles, and of wood products, food and textiles on the other.

The low share of knowledge-intensive service exports is explained by the relative importance of tourism and of non-KIS transport services (mainly road freight transport, but also rail freight), not compensated for by any strongholds in KIS exports.

Slovenia also performs at a low level as regards the average innovativeness of fast-growing firms. This is the result of a high share of employment in fast-growing enterprises in manufacturing sectors with low innovation coefficients. Therefore, it seems that Slovenia may not have fully developed its innovative potential. One of the reasons is that some components of the business and competitive framework have changed very little: links between the public and private sector remain weak and some structural aspects of the business environment are hindering foreign direct investment. In order to improve competitiveness, it would be beneficial to consider developing a new industrial policy, including a strategy for attracting foreign capital, notably linked to R&I. Both should be consistent mutually as well as with other Slovenian strategic documents.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries. The position on the horizontal axis illustrates the changing weight of each industry sector in value added over the period. The general trend to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented on the graph). The red sectors are high-tech or medium-high-tech sectors.



Source: DG Research and Innovation - Economic Analysis Unit
Data: Eurostat
Note: (1) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The Slovenian economy is characterised by a relatively strong manufacturing industry. Manufacturing makes a higher contribution to total value added than the EU average. Nevertheless, as in many other countries, the share of manufacturing value added is moving towards a decline (as shown by the position of most of the sectors on the left side of the graph), due to a corresponding increase in services value added.

Although some industry sectors have achieved a slight increase in their share of the economy, specialisation in labour-intensive industries has decreased considerably over the last few decades. As the graph illustrates, Slovenia’s manufacturing industries are moving towards higher research intensity in almost all sectors. Highly innovation-intensive sectors are: electrical equipment, machinery and equipment, electronic and optical products, pharmaceutical products, chemical and chemical products, and motor vehicles, with the latter showing increasing added value in the country’s economy. Slovenia has two companies in the 2011 EU Industrial R&D Scoreboard, in the fields of pharmaceuticals, and construction and materials.

Key indicators for Slovenia

SLOVENIA	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	1,00	1,24	1,31	1,37	1,34	1,52	1,51	1,72	1,90	6,8	*1,81*	12
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	504	:	:	501	:	:	501	-3.3 (3)	495 (4)	9 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0,78	0,85	0,94	0,87	1,07 (5)	1,20	1,43	1,83 (6)	*2,16*	15,5	1,31	3
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,59	0,59	0,62	0,58	0,59	0,66	0,68	0,65 (7)	*0,64*	5,3	*0,74*	13
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	18,0	:	:	:	:	28,8	9,9	47,8	15
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	6,9	6,8	7,8	7,5	7,0	:	:	:	-5,1	11,0	18
International scientific co-publications per million population	:	588	573	691	796	834	868	966	1042	8,5	343	10
Public-private scientific co-publications per million population	:	:	:	51	54	61	70	85	:	13,6	53	7
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	2,1	2,7	2,5	2,7	3,1	3,2	3,1	:	:	4,4	3,9	10
License and patent revenues from abroad as % of GDP	0,06	0,05	0,04	0,04	0,07	0,07	0,08	0,11	0,10	19,4	0,59	18
Community trademark (CTM) applications per million population	2	16	31	71	104	78	108	73	102	7,6	152	17
Community design (CD) applications per million population	:	9	19	20	24	28	30	32	36	12,3	29	8
Sales of new to market and new to firm innovations as % of turnover	:	:	13,3	:	16,3	:	10,6	:	:	-19,2	14,4	17
Knowledge-intensive services exports as % total service exports	:	18,6	17,7	18,9	23,8	21,7	20,8	21,4	:	3,1	45,3	25
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	1,34	3,74	3,96	4,16	4,77	5,79	6,06	6,05	6,54	-	4,23 (8)	2
Growth of total factor productivity (total economy) - 2007 = 100	87	95	98	100	99	92	94	95	93	-7 (9)	97	22
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	42,0	:	:	:	:	50,3	3,7	51,2	12
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	12,2	13,0	13,4	13,8	14,0	3,5	13,9	14
SMEs introducing product or process innovations as % of SMEs	:	:	31,7	:	31,0	:	30,0	:	:	-1,7	33,8	17
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,10	0,08	0,08	0,03	0,07	0,16	:	:	:	118,4	0,44	14
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,26	0,81	1,19	1,19	1,15	0,76	:	:	:	-20,2	0,53	5
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	68,5	71,1	71,5	72,4	73,0	71,9	70,3	68,4	68,3	-1,2	68,4	14
R&D Intensity (GERD as % of GDP)	1,38	1,44	1,56	1,45	1,66 (5)	1,85	2,10	2,47 (6)	*2,80*	12,7	*2,07*	6
Greenhouse gas emissions - 1990 = 100	103	110	112	112	116	105	106	106	:	-7 (10)	83	22 (11)
Share of renewable energy in gross final energy consumption (%)	:	16,0	15,6	15,6	15,0	19,0	19,6	18,8	:	4,8	13,0	10
Share of population aged 30-34 who have successfully completed tertiary education (%)	18,5	24,6	28,1	31,0	30,9	31,6	34,8	37,9	39,2	4,8	35,7	13
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	4,9	5,6	4,1	5,1	5,3	5,0	4,2	4,4	1,4	12,7	2 (11)
Share of population at risk of poverty or social exclusion (%)	:	18,5	17,1	17,1	18,5	17,1	18,3	19,3	19,6	2,8	24,8	10 (11)

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) Break in series between 2008 and the previous years.
(6) Break in series between 2011 and the previous years. Average annual growth refers to 2008-2010.
(7) Break in series between 2011 and the previous years. Average annual growth refers to 2007-2010.
(8) EU is the weighted average of the values for the Member States.
(9) The value is the difference between 2012 and 2007.
(10) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(11) The values for this indicator were ranked from lowest to highest.
(12) Values in italics are estimated or provisional.

2014 Country-specific recommendation in R&I adopted by the Council in July 2014:

"Streamline priorities and ensure consistency between the 2011 research and innovation and the 2013 industrial policy strategies with the upcoming strategies on smart specialisation and transport, and ensure their prompt implementation and assessment of effectiveness."

Spain

The challenge of effective R&I for a more knowledge-intensive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Spain. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 1.30 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.5 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[18] 2012: 33.2 (EU: 47.8; US: 58.1) 2007-2012: +0.4 % (EU: +2.9 %; US: -0.2%)
Innovation Output Indicator 2012: 80.8 (EU: 101.6)	*Knowledge-intensity of the economy*[19] 2012: 38.0 (EU: 51.2; US: 59.9) 2007-2012: +2.1 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food, agriculture and fisheries, transport technologies, construction technologies, environment and biotechnologies	*HT + MT contribution to the trade balance* 2012: 3.3 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +15.9 % (EU: +4.8 %; US: -32.3 %)

Spain's investment in research and development (R&D) grew faster than the EU average over the period 2000-2008. Total expenditure in R&D reached its peak in 2008.The strongest increase was in the business sector, where total investment in R&D grew faster than in the public sector. Recent reforms have reduced the costs of creating a business. Public investment in R&D even increased beyond the economic crisis, in a counter-cyclic effort up to 2010. However, fiscal constraints forced Spain to cut public R&D expenditure from 2011 onwards, and with the effect of the economic recession, business R&D investment has also fallen.

Excellence in science and technology improved slightly over the 2007-2012 period; nevertheless, Spain is falling further behind the EU average in terms of excellence. However, structural change towards a more knowledge-intensive economy is under way with increase growth registered in the knowledge-intensive activities (KIAs) as a % of total employment. The change in Spain is slow compared to both the EU and the USA. One positive sign is the rising contribution of high-tech and medium-high-tech goods to the trade balance, indicating that the growing Spanish competitiveness is not only based on cost factors but also on a strong technology component.

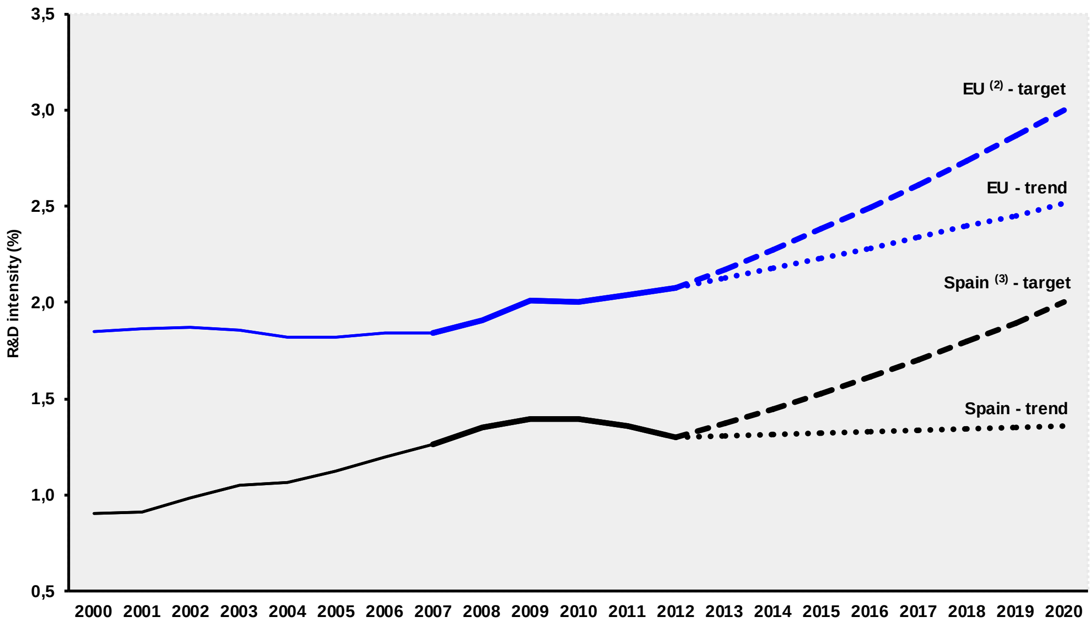
Thus, the main challenges remaining for Spain are to ensure smart fiscal consolidation by maintaining its investment in knowledge while ensuring a high quality of public spending. There is room to further improve the effectiveness of this investment with efforts towards a more performance-based funding allocation to R&I. Full implementation of the new Law for Science, Technology and Innovation, adopted in 2011, would also improve the quality of public spending, including accelerating the setting

[18] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[19] Composite indicator that includes R&D total expenditure, skills, sectorial specialisation, international specialisation and internationalisation sub-indicators.

up of the national research agency and legal changes to stimulate researcher mobility between the public and private sectors.

Investing in knowledge

Spain - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) ES: The projection is based on a tentative R&D intensity target of 2.0% for 2020.

Spain is not on track to reach its national R&D target for 2020, despite a lowering of this target from 3 % to 2 % in the national reform programme 2013. Reaching this national target of 2 % R&D intensity would require an average annual growth of 5.5 % over the period 2012-2020, implying substantial efforts by the public sector combined with strong framework conditions spurring a change in business models in the private sector towards growth built on R&D and knowledge investments.

The public sector represented about half of total R&D investment in Spain. Total expenditures in R&D amounted to EUR 13.392 million in 2012, down by 5.6 % compared to 2011. By sector of performance, the fall over the last year was higher in the public sector (-7.4 %) than in the private sector (-4.1 %). At the same time, expenditure in higher education fell by 7.2 % in 2012, although higher education expenditure on R&D did experience an average annual growth rate of 5.4 % over the period 2007-2010.

Business-sector R&D investment fell slightly every year over the 2008-2012 period (the average annual growth rate of total BERD was 13.7 % over the period 2002-2007, which changed to a negative average annual growth rate of -3.2 % over the 2008-2012 period). In the business sector, 78 % of R&D investment is made by a company’s own resources, while most of the remaining costs are financed by public administration and foreign capital.

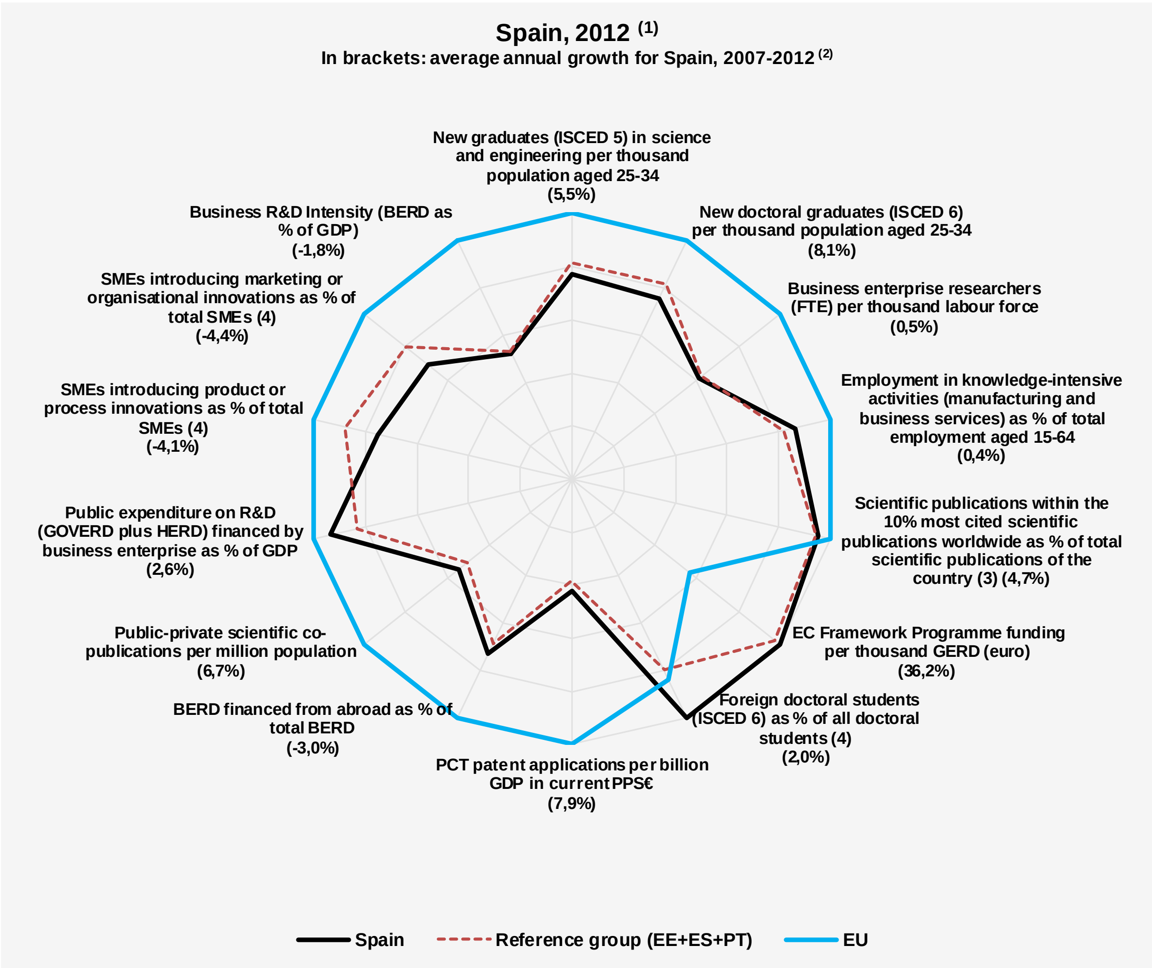
Out of almost EUR 34.7 billion of Structural Funds allocated to Spain over the 2007-2013 programming period, around EUR 5.5 billion (15.8 % of the total) related to RTDI[20]. Spain also

[20] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in

performs well in terms of the ratio of EC funding from FP7 to its GERD, well above the EU average and with a positive growth rate.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of the Spanish R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2007 to the latest available year are given in brackets.



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

Spain's R&I system is building up obvious strengths in its internationalisation, in particular in terms of integration in the EU's Seventh Framework Programme (FP7) and in attracting foreign doctoral students. Positive trends are also visible in human resource training, public-private cooperation and the

SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.

knowledge-intensity of the economy, although continued efforts are still needed to fully catch-up. The worrying trend over the period 2007-2012 was the shrinking R&I activity in the private sector, in particular among small and medium-sized enterprises (SMEs).

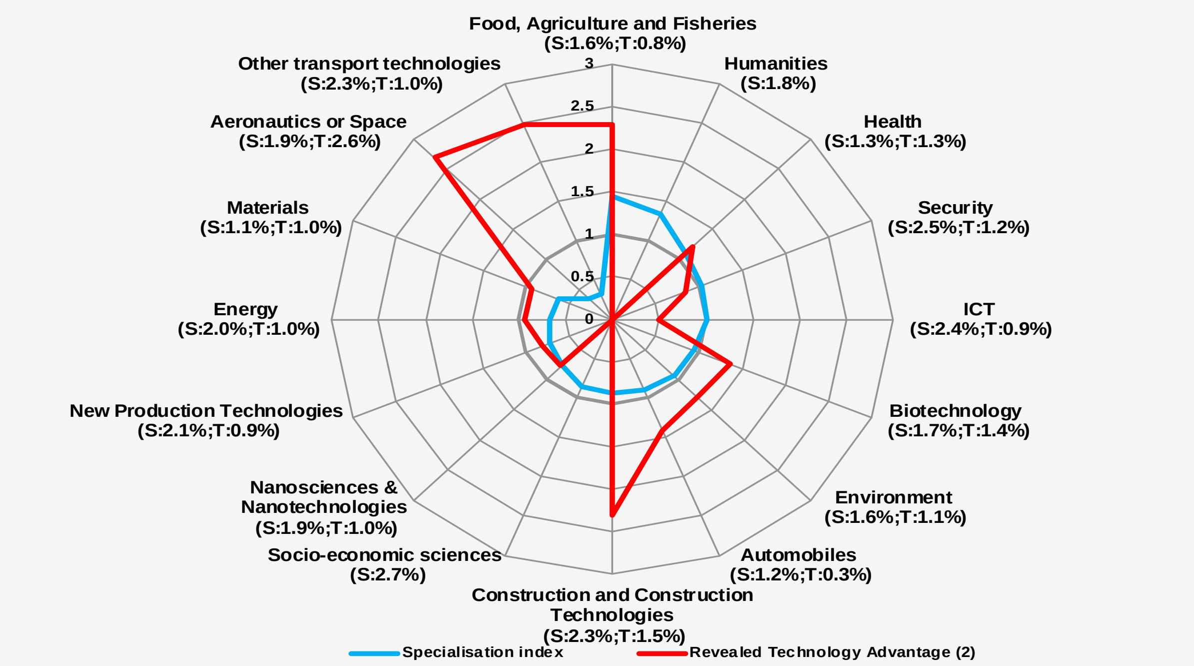
In terms of integration in the European Research Area (ERA) and beyond, Spain increased its international scientific co-publications (total number of international co-publications involving a Spanish author and at least one author from another country) by 16 % over the period 2000-2011. The level of Spain's international co-publication (29.1 %) is still below that of comparable European countries (France 35.2 % or Portugal 41 %), but is comparable to that of Italy (30.8 %). Overall, Spain is well connected to the major European research hubs, in particular in France, the United Kingdom and Germany, but also to Italy and Portugal. However, a closer look reveals that this is mainly in three autonomous communities – Cataluña, Valencia and Madrid – where close integration has developed with the European networks, while the other Spanish regions are mainly connected inside Spain.

Spain's scientific and technological strengths

The graph below illustrates the areas, based on the FP7 thematic priorities, where Spain shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

Spain S&T National Specialisation(1) in thematic priorities, 2000-2010

in brackets: growth rate in number of publications(3) (S) and in number of patents(4) (T)



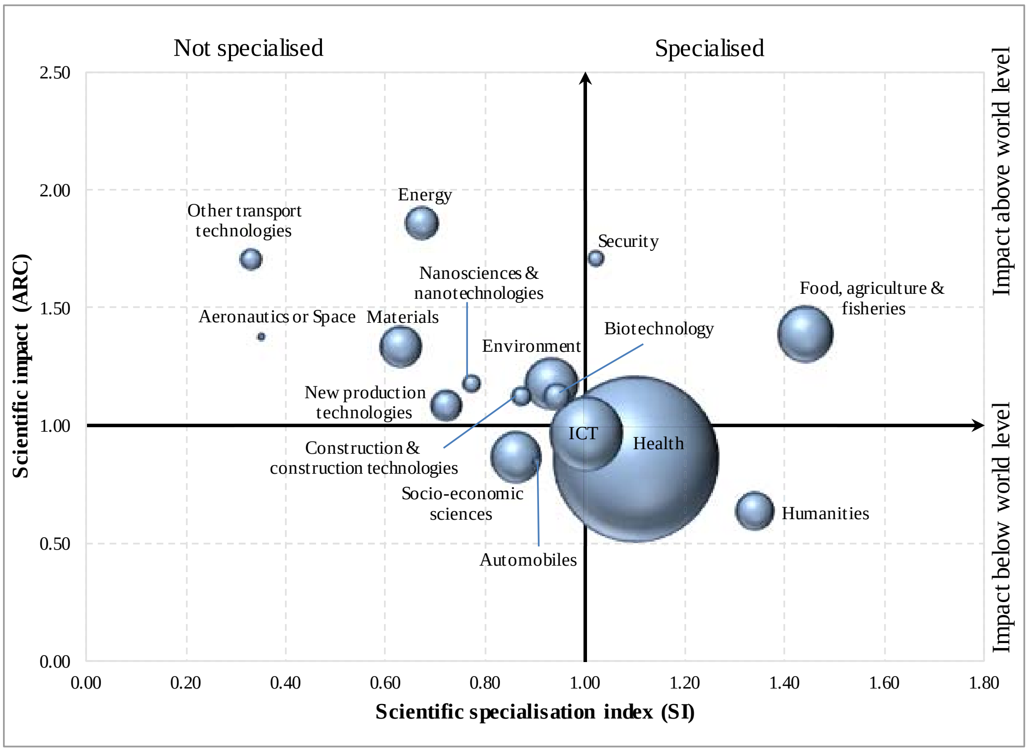
Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

Comparison of the scientific profile with the technology profile shows a good match only in the field of food, agriculture and fisheries. Spain's technology production is also specialised in transport technologies, construction technologies and, to a certain extent, in the environment, and biotechnologies. In the fields where Spain is specialised in both science and technology (food and agriculture), the ERA offers good opportunities for cooperation, in particular scientific cooperation with researchers from several Northern and Eastern European countries, and technological cooperation with Norway, Iceland, Denmark, Lithuania, the Netherlands, Switzerland, Slovakia and Portugal[21].

The relative strengths in patenting are visible in Cataluña, Madrid and the Basque country, although Aragon and Cantabria are also present in energy patenting. The main technology sectors are food and agriculture, biotechnology, ICT, aeronautics or space, other transport technologies and energy, although the core technology development in these sectors in Europe is taking place in regions outside Spain. The data on patenting in industrial sectors show that Cataluña has particular strengths in organic fine chemistry, pharmaceuticals, and food chemistry, while the Basque country has similar technology strengths in engines, pumps and turbines, thermal process and apparatus, furniture, games, other consumer goods, machine tools, electrical motors, and green energy.

The graph below illustrates the positional analysis of Spanish publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Spain publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

As shown in the graph above, scientific quality, as measured by the 10 % most-cited publications, has grown by 3.6 % over the period 2007-2012. The largest numbers of scientific articles are produced in the field of health, followed by ICT, environment, food, agriculture and fisheries. Scientific production in Spain is also important in the fields of energy, materials, and in socio-economic sciences. Scientific

[21] Innovation Union Competitiveness Report 2013, SWD(2013) 505

excellence can be found in particular in the field of energy, other transport technologies, security, materials science and in food, agriculture and fisheries. However, those areas with the highest impact are still underdeveloped in terms of the number of publications, with the exception of research in food, agriculture and fisheries. Likewise, scientific impact is only average in the fields where most scientific articles are produced, such as health, ICT, and socio-economic sciences.

Policies and reforms for research and innovation

The Spanish authorities are addressing these challenges in the Law for Science, Technology and Innovation, which was adopted with broad political support in 2011, as well as in the Spanish Strategy for Science, Technology and Innovation and the State Plan for Scientific and Technical Research and Innovation, adopted in February 2013. Reform proposals cover the governance system, the quality of human resources, the funding allocation system, and knowledge transfer between actors. Objectives and priorities are well aligned with the objectives of Europe 2020, the Innovation Union and Horizon 2020. The 2011 law simplifies the allocation of competitive funding for R&I by giving responsibility for the allocation of funds to two main bodies: the new national research agency (AEI) and the existing agency for innovation (CDTI). Public-private cooperation will be reinforced by the introduction of legal changes to researchers' contracts, thereby stimulating mobility between the public and the private sector. Legal reforms related to the recruitment and careers of researchers will encourage international outward mobility as well as inward mobility of foreign researchers with high levels of excellence. In addition to these legal reforms, agreed by all parties, a strong policy focus is being placed on technology transfer to the market and on instruments to stimulate private R&D.
The Europe 2020 country specific recommendation on R&I to Spain in 2014 (adopted by the Council on 8 July) indicates the need to identify sources of financing for the new national strategy for science, technology and innovation and to make operational the new State Research Agency.

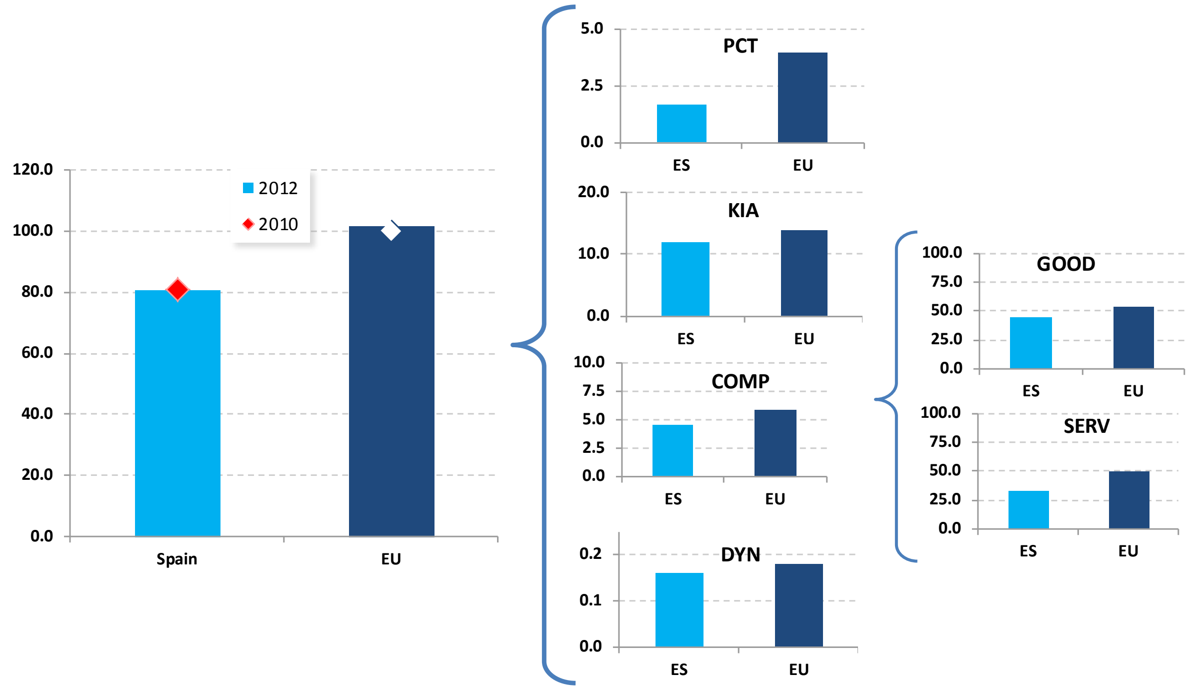
The implementation of the law and the strategy for the Spanish R&I system is ongoing. With the development of smart specialisation strategies in the 17 Spanish regions predicted to be finalised early in 2014, it is essential to ensure inter-regional links and coordination between national and regional R&I policies. Most Spanish regions have finalised their smart specialisation strategies (RIS3). Considering the drafts and final strategies, most regions have chosen to focus on sustainable agriculture and natural resources (14 regions) and on intelligent and sustainable transport (13 regions). A considerable number of regions have also proposed specialisation in sustainable energy (9) and the digital society (9). In terms of economic sectors, the smart specialisation strategies are focus mainly on the agri-food sector, industrial sector, tourism, health, energy, communication, and water. In many regions, the smart specialisation strategies are cross-sectorial, proposing innovation in new combinations of industries and sectors, such as products and services combining biofood-health and tourism, or energy-ICT-renewables. The industrial profile of the region and its connectedness to global or European value chains are taken into consideration, as are a more forward-looking vision for society and the economy of the region in 2020 in some of the regions.

In 2013, the Spanish government also launched new programmes supporting risk and equity funding for innovation-based firms, such as the 'Isabel la Catolica' programme. Legal framework conditions for business angels have been reinforced, and measures have been taken to enhance the business environment, notably the market unity law and the law for the promotion of entrepreneurship and its internationalisation. The objective is to support the internationalisation of businesses, simplify the business environment of SMEs, and to promote a second chance for entrepreneurs. There is room for further reforms enhancing the quality of public spending on R&D in line with the structural reforms pushed forward by the ERA agenda. The allocation of institutional funding to public research organisations in Spain is currently, and for the most part, not based on performance criteria. In fact, a competitive allocation of institutional funding based on performance criteria would contribute to a higher quality of scientific outputs. Moreover, the system's science base is not reliant on international peer review. In 2013, a focused international peer review of the Spanish R&I system was launched in the context of ERAC.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Spain's position on the indicator's different components:

Spain - Innovation Output Indicator



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Spain is a medium-low performer in the European innovation indicator. It performs below the EU average in all components of the innovation indicator. Furthermore, its performance is stagnating, and is particularly low in PCT patents and in the share of knowledge-intensive service exports. The latter is explained by the importance of service exports not classified as knowledge-intensive services, such as tourism and related services, in the Spanish economy.

There are around 18 000 firms in Spain actively involved in innovation in their business models. During its economic crisis, the number of companies carrying out innovation has been reduced by half (from an estimated 36 000 in 2008). The sectors with the largest share of innovative firms were R&D services, transport equipment, pharmaceuticals, electronics, chemistry, telecommunications, ICT services, banking and assurance, and machinery. The innovation intensity (firm's investment in innovation as a share of overall revenue) fell from 2.2 % in 2009 to 1.75 % in 2012. In 2011, the innovative firms cooperated with both private and public actors in their innovation process: 47 % cooperated with suppliers for innovation, 37.7 % with universities, 34.7 % with technology centres, 30.2 % with private consultants, 29 % with clients and only 21.9 % with public research organisations. Compared to 2010, the innovative firms had slightly increased their cooperation with all these actors, except for a slight fall in the cooperation with suppliers. According to Spanish companies, the largest obstacles for innovation are costs (highlighted by 44 % of the firms), lack of interest in innovation (30 %), lack of markets for innovative products (27 %) and lack of knowledge (22 %)[22].

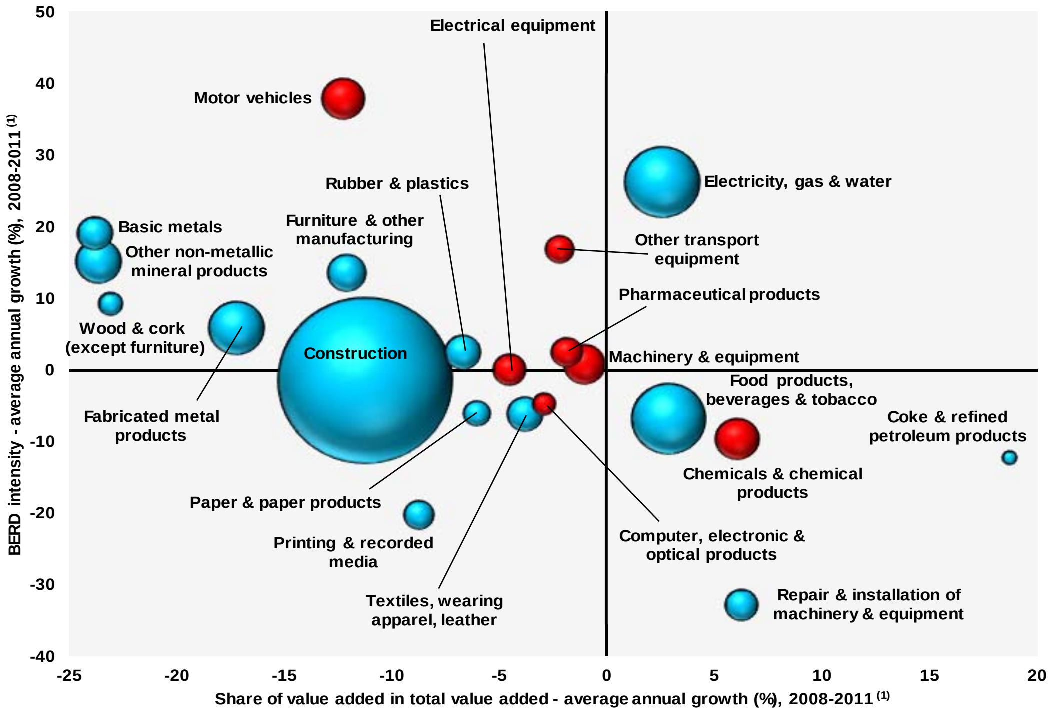
Access to finance is still among the top concerns of Spanish SMEs. In 2011, risk capital and private equity funding in Spain came mostly from foreign investors (82 %). Total risk capital reached a peak in 2007. A large number of the risk capital investments were concentrated in five large operations in 2011. However, investments (26.3 %) were also made in high-growth firms in their expansion phase. In the period 2001-2011, risk capital has invested in a total of 2930 firms in Spain. In addition, venture-capital investment fell in 2011, from EUR 242 million in 2010 to EUR 208 million in 2011. Venture capital was mainly invested in professional services, the health sector, industrial services and in the energy, and natural resources sectors.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries. The position on the horizontal axis illustrates the changing weight of each industry sector in value added over the period. The general trend to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented on the graph). The red sectors are high-tech or medium-high-tech sectors.

[22] INE 2012; COTEC 2013 report

Spain - Share of value added versus BERD intensity - average annual growth, 2008-2011 (1)



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Basic metals', 'Electricity, gas and water', 'Fabricated metal products', 'Furniture and other manufacturing', 'Motor vehicles', 'Other non-metallic mineral products', 'Other transport equipment', 'Paper and paper products', 'Printing and reproduction of recorded media", 'Repair and installation of machinery and equipment', 'Rubber and plastic products','Wood and cork (except furniture': 2008-2009.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

In the business sector, R&D expenditures can be found mainly in the R&D services sector, representing 51.9 % of total BERD (not included on the graph), ICT, pharmaceutical, aeronautic construction, motor vehicles, and the chemical sectors. Motor vehicles, other transport equipment, electricity, gas and water, and basic metals and non-metallic mineral products were the business sectors that increased their R&D intensity most over the period 2008-2011. However, with the exception of the electricity, gas and water sector, their weight in the overall Spanish economy diminished. The chemical sector, and the computer and electronic sector, where international competitiveness is largely based on R&D, decreased their R&D intensity between 2008 and 2011. Broadly speaking, electrical equipment, pharmaceutical products, machinery equipment, and the construction sector maintained their R&D intensity.

Larger firms invested more in R&D (with over 80 % of total business R&D investment in aeronautics, motor vehicles, and the pharmaceutical sector). Among these larger firms, the mid-caps dominated. In particular, the sectors with large R&D investments by SMEs were ICT services, professional activities, programming consulting, commerce, chemicals, and machinery equipment. In total, SMEs represented 47.6 % of total business R&D investment in 2011, down from 50.2 % in 2010 (and the SMEs perform 57 % of the business R&D). Compared to other similar countries, one characteristic in Spain is SMEs' high contribution to the total business R&D investment, in particular in service sectors (COTEC report 2013).

Among the world's top 2000 R&D investing firms, Spain numbers 13. These companies are mainly active in the ICT services sector (Telefónica, Amadeus, Indra Systems), in the construction and materials sector (Acciona, ACS, Obrascon-Huarte-Lain), in the pharma and biotech sector (Almirall, Grifols, Zeltia) and in the energy or industrial engineering sectors (Gamesa, Abengoa, Repsol). There is also one bank (Banco Santander) in this list. In 2012, the R&D investments by these firms ranged from EUR 1000 million from Telefónica to around EUR 100 million in the energy sector. All but one of these companies increased their R&D investments from 3-12 % over the three-year period 2009-2012. The largest increases were made by firms in the construction and material sector, registering an R&D investment growth of 20-40 %. Other Spanish firms with considerable R&D investments (among the top 1000 R&D investors in Europe) are Iberdrola (electricity sector), Fagor Electrodomésticos, Amper (telecommunications), CAF (automobiles parts), Azkoyen (industrial machinery), Rovi pharmaceutical lab (pharmaceuticals), and Pescanova (agro-industry) (EU Industrial Scoreboard, 2013).

Key indicators for Spain

SPAIN	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	0,91	0,92	0,94	0,93	0,94	1,03	1,16	1,21	1,37	8,1	*1,81*	18
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	480	:	:	483	:	:	484	4.4 (3)	495 (4)	18 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0,49	0,60	0,67	0,71	0,74 (5)	0,72	0,72	0,71	0,69	*-1,8*	1,31	18
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,41	0,52	0,53	0,56	0,61	0,67	0,67	0,65	*0,61*	*1,8*	*0,74*	14
Venture Capital as % of GDP	0,18	0,29	0,29	0,28	0,15	0,09	0,24	0,19	0,14	-12,5	0,29 (6)	10 (6)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	33	:	:	:	:	33	0,4	47,8	12
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	9,2	9,5	9,5	10,1	10,4	:	:	:	4,7	11,0	11
International scientific co-publications per million population	:	350	391	424	459	499	546	603	631	8,3	343	16
Public-private scientific co-publications per million population	:	:	:	22	22	24	26	29	:	6,7	53	16
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,9	1,3	1,3	1,3	1,4	1,6	1,6	:	:	7,9	3,9	14
License and patent revenues from abroad as % of GDP	0,07	:	0,08	0,04	0,05	0,05	0,06	0,07	:	21,0	0,59	17
Community trademark (CTM) applications per million population	86	136	145	165	153	152	169	173	174	1,1	152	12
Community design (CD) applications per million population	:	23	22	24	22	20	23	21	19	-4,3	29	17
Sales of new to market and new to firm innovations as % of turnover	:	:	15,9	:	15,9	:	19,0	:	:	9,2	14,4	2
Knowledge-intensive services exports as % total service exports	:	:	:	24,0	22,7	22,5	21,5	21,6	:	-2,5	45,3	24
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	0,29	1,35	1,75	1,58	1,97	1,92	2,56	3,05	3,31	-	4,23 (7)	11
Growth of total factor productivity (total economy) - 2007 = 100	102	100	100	100	99	99	99	100	101	1 (8)	97	2
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	34,2	:	:	:	:	38,0	2,1	51,2	20
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	11,8	11,8	11,5	11,8	11,9	0,4	13,9	19
SMEs introducing product or process innovations as % of SMEs	:	:	29,5	:	27,5	:	25,3	:	:	-4,1	33,8	21
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,05	0,09	0,10	0,10	0,09	0,14	:	:	:	19,9	0,44	15
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,16	0,28	0,23	0,22	0,22	0,23	:	:	:	2,8	0,53	15
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	60,7	67,2 (9)	68,7	69,5	68,3	63,7	62,5	61,6	59,3	-3,1	68,4	26
R&D Intensity (GERD as % of GDP)	0,91	1,12	1,20	1,27	1,35	1,39	1,40	1,36	1,30	0,5	*2,07*	16
Greenhouse gas emissions - 1990 = 100	135	154	151	154	143	130	125	126	:	-28 (10)	83	25 (11)
Share of renewable energy in gross final energy consumption (%)	:	8,4	9,1	9,7	10,8	13,0	13,8	15,1	:	11,7	13,0	12
Share of population aged 30-34 who have successfully completed tertiary education (%)	29,2	38,6	38,1	39,5	39,8	39,4	40,6	40,6	40,1	0,3	35,7	12
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	29,1	30,8 (9)	30,5	31,0	31,9	31,2	28,4	26,5	24,9	-4,3	12,7	28 (11)
Share of population at risk of poverty or social exclusion (%)	:	24,3	24,0	23,3	24,5	24,5	26,7	27,7	28,2	3,9	24,8	19 (11)

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) Break in series between 2008 and the previous years. Average annual growth refers to 2008-2012.
(6) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK. These Member States were not included in the EU ranking.
(7) EU is the weighted average of the values for the Member States.
(8) The value is the difference between 2012 and 2007.
(9) Break in series between 2005 and the previous years.
(10) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(11) The values for this indicator were ranked from lowest to highest.
(12) Values in italics are estimated or provisional.

2014 Country-specific recommendation in R&I adopted by the Council in July 2014:

"Identify sources of financing for the new national strategy for science, technology and innovation and make operational the new State Research Agency."

Sweden

World positioning in challenge-driven innovation

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Sweden. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 3.41 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -0.2% (EU: 2.4%; US: 1.2%)	*Excellence in S&T*[23] 2012: 87.9 (EU: 47.8; US: 58.1) 2007-2012: +5.5 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 122.4 (EU: 101.6)	*Knowledge-intensity of the economy*[24] 2012: 65.3 (EU:51.2; US: 59.9) 2007-2012: +2.0 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Health, environment, energy, ICT, materials, and security	*HT + MT contribution to the trade balance* 2012: 1.8 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +0.5 % (EU: +4.8 %; US: -32.3 %)

Sweden has one of the world's highest R&D intensities. The country also performs among the world leaders in terms of scientific and technological excellence, with a very positive evolution. The Swedish economy has a strong innovation output coupled with a highly knowledge-intensive structure. It has been resilient to the economic downturn, partly linked to the high and growing research excellence and knowledge-intensity.

However, despite increasing public investment in R&D, Sweden is still registering a stagnating R&D intensity, even though the trend of relative outsourcing of private R&D seems to have been reversed. Since 2002, the outflow of R&D business investment has exceeded the inflow. Sweden's good R&D position is vulnerable due to its strong dependence on a few large multinational companies, which are increasingly orienting themselves towards the global innovation system. At the same time, several larger Swedish corporations have been subject to acquisitions by foreign firms, contributing to the gradual delocalisation of strategic R&D activities.

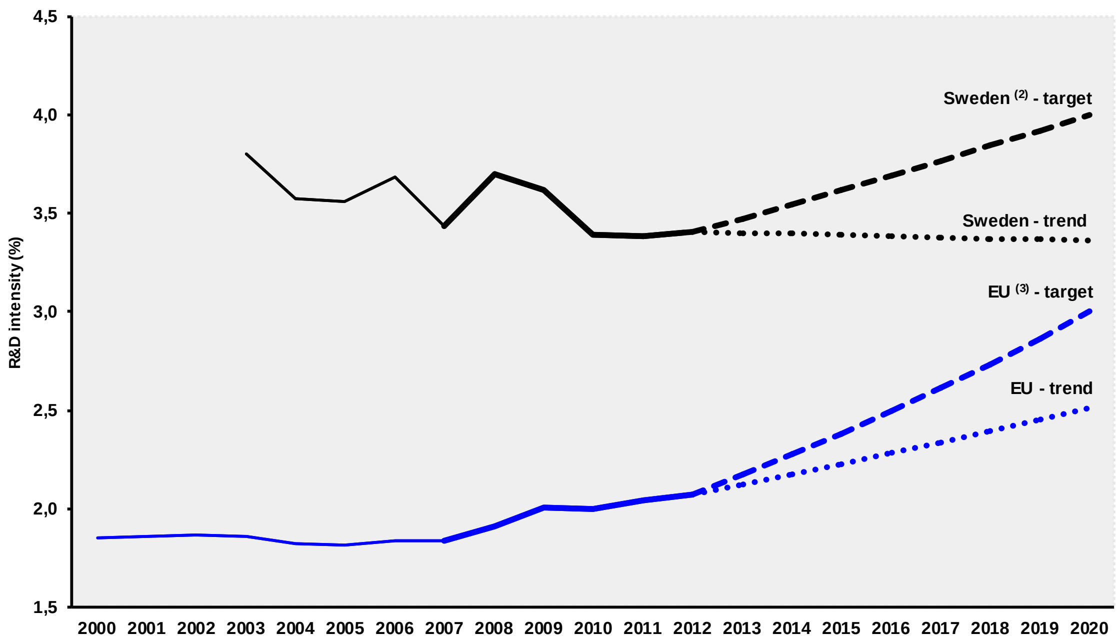
Progress is being made towards addressing these challenges. The fall in business R&D expenditure is slowing down, partly as a result of determined policies to create clusters and open innovation systems linking larger Swedish corporations to small and medium-sized enterprises (SMEs). The challenge-driven innovation approach is also being pursued, orienting innovation more closely towards global societal challenges. It aims to enhance both service and product innovations, with an increasing focus on systemic innovation. The current proposal to move towards a transport system based on non-fossil

[23] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[24] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

fuels by 2030 is a concrete example of such a broad innovative approach. Supply-side policies will be matched more closely with policies enhancing the demand for innovation, both from private actors and from public procurement and regulation.

Investing in knowledge

Sweden - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) SE: The projection is based on a tentative R&D intensity target of 4.0% for 2020.
(3) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(4) SE: There is a break in series between 2005 and the previous years.

Sweden has set an R&D intensity target of 4 % by 2020, which is more ambitious than the EU target although consistent with R&D intensity levels set by world innovation leaders such as Switzerland, Israel, the United States, Japan and South Korea. However, Sweden is not on track to meet its national target. In the period 2012-2020, the R&D intensity would need to experience an average annual growth of 2 %, which contrasts with the trend registered for 2007-2012 (-0.2 %).

The key policy for Sweden will be to continue to spur business R&D investments in the country, building on its growing clusters and the potential of lead markets. Business R&D intensity fell from 3.20 % in 2001 to 2.59 % in 2005 and to 2.31 % in 2012[25]. Within the business sector, R&D investment is highly concentrated in large, often foreign-owned companies, which makes the Swedish prima-facie good position vulnerable to change in company strategies. At the same time, R&D investment in SMEs fell almost 30 % between 2005 and 2009.

Public funding of R&D has been increasing since 2009-2016 due to investments reported in the research bills of 2008 and 2012, with a total increase of around EUR 1 billion foreseen for 2009-2016.

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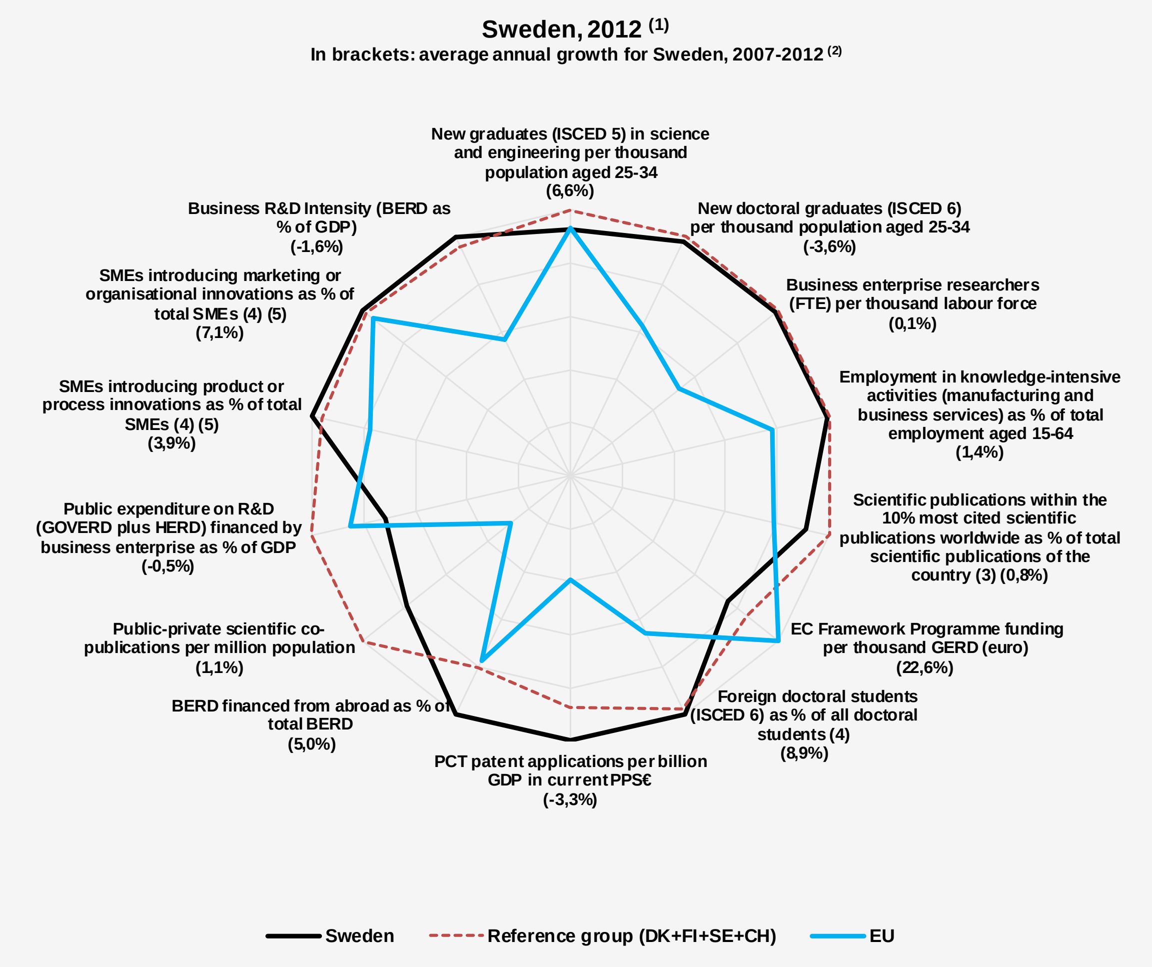
[25] There is a break in series between 2005 and the previous years for both R&D intensity and business R&D intensity in Sweden.

Sweden raised its public R&D budget by 3.2 % in 2011, 4.5 % in 2012, and an additional 5.7 % in 2013. Structural Funds are an important source of funding for research and innovation (R&I) activities. Of the EUR 1.6 billion of Structural Funds allocated to Sweden over the 2007-2013 programming period, around EUR 405 million (24.9 % of the total) related to RTDI[26]. In addition, up to 2013, 4312 Swedish applications have been successful in the EU's Seventh Framework Programme (FP7), receiving a total of EUR 1.570 billion. The success rate of applicants was 23.94 % (above the EU average of 21.95 % but below comparable countries such as Switzerland, Norway and the Netherlands).

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Sweden's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2007 to the latest available year are given in brackets.

[26] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



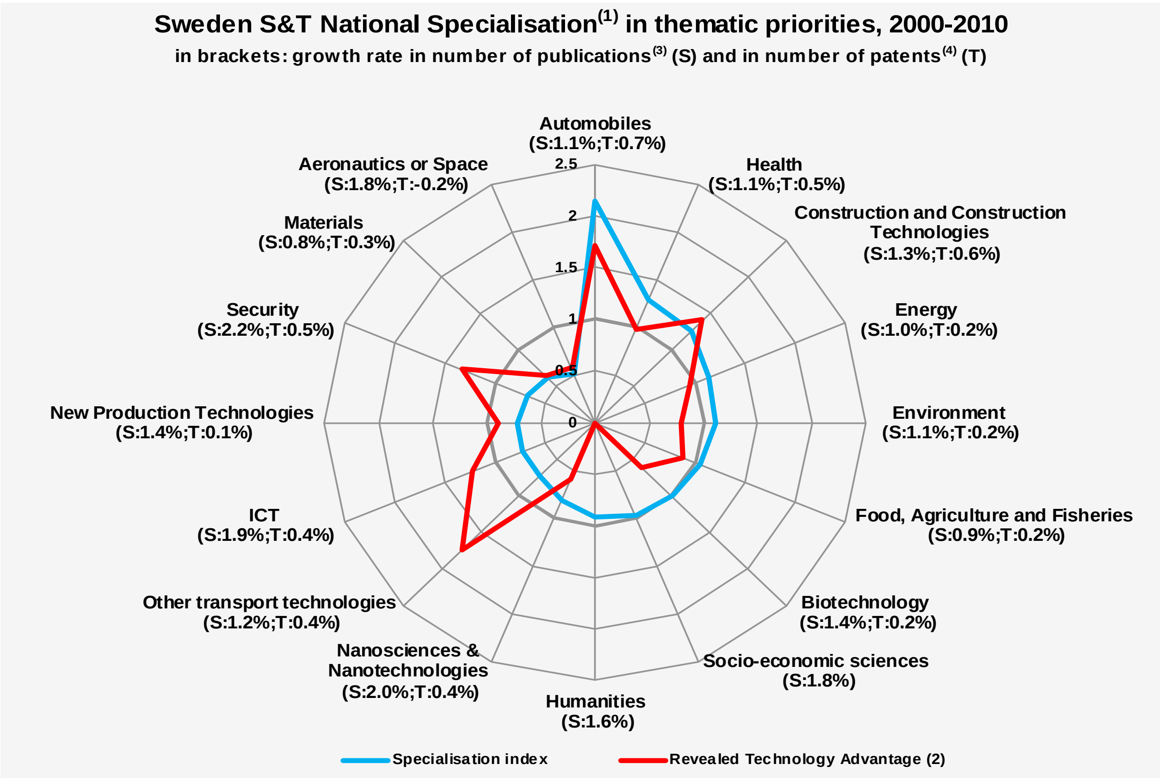
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.
(5) CH is not included in the reference group.

Compared to its reference group of other innovation leaders, Sweden stands out in PCT patent applications (in spite of a negative trend) and the internationalisation of its business R&D investment. Relative weaknesses are public-private cooperation, EU Framework Programme funding, the scientific impact of publications, and new graduates in science and engineering. Apart from the negative trend in business R&D intensity and new doctorate graduates, all other indicators of the Swedish R&I system point towards positive trends.

Higher education institutions perform over 26 % of R&D in Sweden. More than half of the funding for these institutions is competitive funding and part of their institutional funding is now subject to performance-based criteria. Given the small size of Sweden, the optimisation of R&I also depends on integration into the expanding European R&I system. In this context, Swedish research has become better connected to Europe in the health sector, while the second largest field of publications – in ICT – was linked more closely to European networks in 2000 compared to 2011. Currently, only the most research-intensive universities in Sweden cooperate extensively with international partners. In contrast, the business sector has developed strong co-patenting activities with firms in Germany, France and the United Kingdom.

Sweden's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Sweden shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

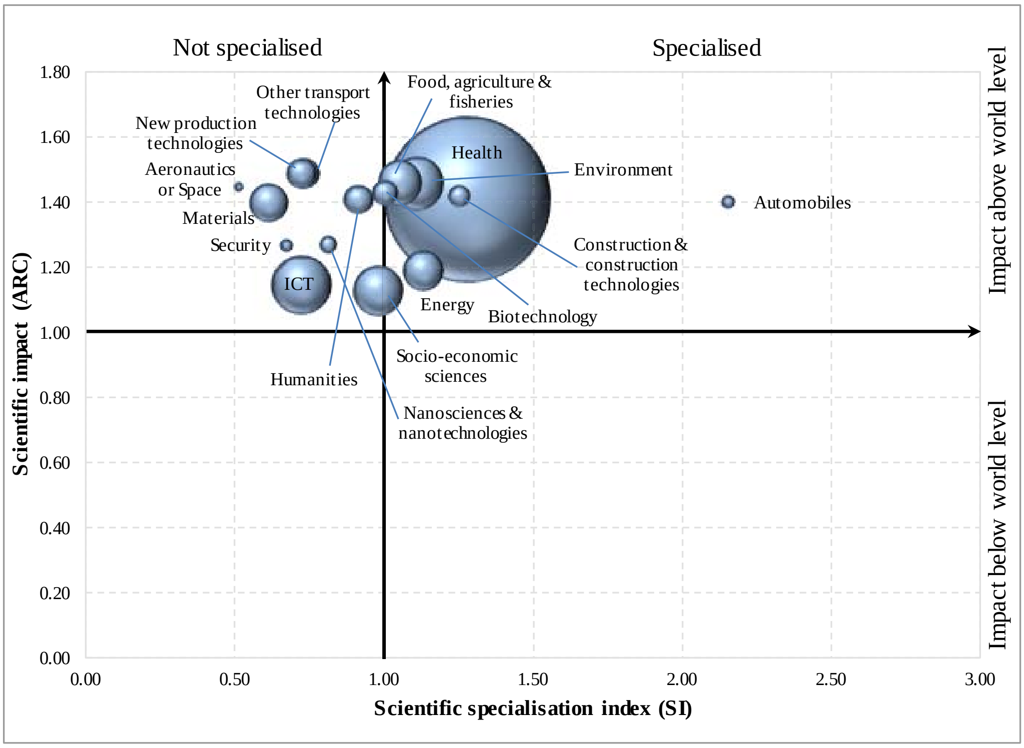


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

Sweden performs well in most areas of science and technology production. In terms of specialisation profile, the automobile and construction sectors stand out as having a high specialisation in both science and technology. The country also has a scientific specialisation in health, energy, and environment research, while its technology specialisation covers security, transport, and ICT, too. In the field of automobiles, other EU Member States, such as Germany, have a similar specialisation as Sweden, while Finland, the United Kingdom, Portugal and Hungary have a scientific specialisation in this field. In the construction sector, the United Kingdom, Lithuania, Portugal and Turkey are possible cooperation partners having a similar specialisation in both science and technology.

The graph below illustrates the positional analysis of Swedish publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Sweden publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

Overall, Sweden has a very high scientific quality in almost all fields, in particular in transport technologies, new production technologies, health, environment, and research in food, agriculture and fisheries. One of Sweden's particular strengths is the good match between the fields where it produces most research (i.e. health and environment) and the fields of scientific excellence. In this context, there is room for improvement in ICT, energy, and research in socio-economic sciences. However, the Swedish scientific specialisation profile does not correspond to its technological strengths, with the exception of research for the automobiles, construction, health, energy, and environment sectors.

Policies and reforms for research and innovation

The current Swedish policy is following the 2008 and 2012 R&I bills, which stress the links between R&I. In the broad sense of innovation policy, governance issues are crucial to actively enhancing innovation in several policy areas and reinforcing comprehensive framework conditions for business innovation. In a narrower sense, the bills reinforced the funding and strategic focus of R&I. Following the 2008 bill, public funding was boosted in 24 research areas important to the Swedish business sector and society. Within the 2012 bill, strong emphasis was given to R&D in strategic innovation and in core areas for Swedish industry, such as mining, steel, wood products and the construction of a sustainable society. Also the Swedish innovation agency, Vinnova, is moving towards a challenge-driven strategy responding to business opportunities in addressing global challenges. For this reason, the agency has currently focused its international cooperation activities on four societal challenges: information society 3.0; sustainable attractive cities; future healthcare; and competitive production.

Public funding for R&D will be increased progressively and funding allocation systems for universities will be reformed progressively to enhance scientific excellence. The Swedish Research Council has an assignment to propose additional peer-review processes to evaluate the quality of Swedish universities. It is expected that 20 % of institutional funding will be allocated to universities on the basis of specific quality criteria. Moreover, Vinnova will develop and propose a model for evaluating collaboration between universities and the surrounding society, including industry, and will distribute more than EUR 20 million to the best-performing universities during 2013-2016. As regards public-private collaboration, the Swedish programmes are also supporting changes in the approach of university managers through specific training. Many initiatives are now being channelled through the management of the universities, which means they should then be able to lead and prioritise in a way that facilitates the commercialisation of research results.

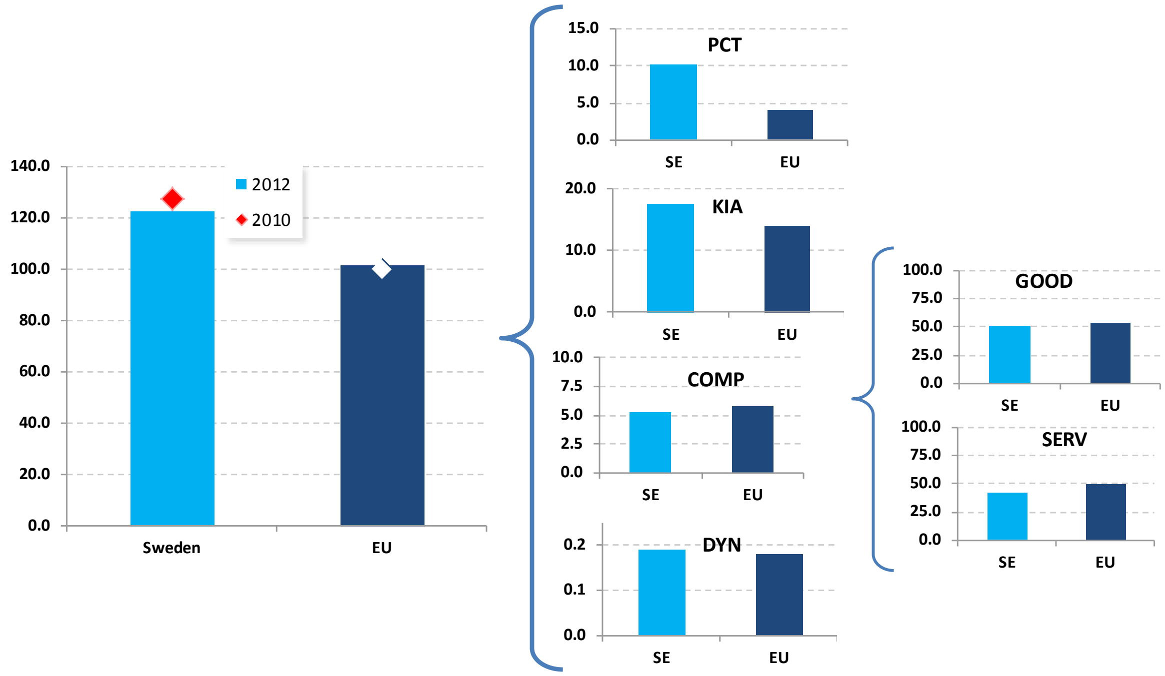
Over the last five years, several initiatives have been launched to enhance the effectiveness of the Swedish R&I system, with a focus on innovation in SMEs through reinforced public-private cooperation with universities and better access to seed funding and venture capital. Industrial research institutes have been restructured and reinforced to be specific innovation intermediates and act as an interface between academic research and product development in the business sector. The model involves the private business sector buying R&D services from the institutes, while the state funds their facilities and skills development. In addition, the bill established innovation offices at each university to foster the commercialisation of research results. In recent years, Sweden has seen quite an important increase in the number of new enterprises. This is also due to improvements in the framework conditions, thanks to a dedicated focus on final users – i.e. entrepreneurs – and less red tape. The government is also promoting measures specifically addressed to women and young people. At the same time, business vouchers have been launched for the internationalisation of SMEs. The idea is to support SMEs via consultancy services before they take their first steps in foreign markets. Companies with between two and nine employees can apply for these business vouchers.

The new National Innovation Strategy, adopted at the end of 2012, comprises a holistic approach to innovation policy aimed at the year 2020. Interesting proposals have been made for both demand-side measures (i.e. introducing a new procurement law fostering innovation-friendly procurement) and supply-side measures (in particular to fund testing, demonstration infrastructure and reinforcement of incubators for new research-based products). The role of the public sector as driver of innovation is stressed. The 2011 Innovation Procurement inquiry proposed the introduction of a new law on pre-commercial procurement. Increasing importance is given to innovation in services, mobilising knowledge in the broad sense, and enhancing societal challenge-driven innovation, new business models and design-based thinking. Vinnova funds programmes which develop new knowledge and expertise within four strategic areas for Sweden: health and healthcare; transport and environment; services and ICT; and manufacturing and working life. In 2011, an Innovation Procurement programme was launched aiming to increase and extend the development of innovation procurement, mainly in the public sector. A call for proposals under this programme was issued in the same year and remained open throughout 2013.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator on innovation focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Sweden's position regarding the indicator's different components:

Sweden - Innovation Output Indicator



Source : DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Sweden is a top performer in terms of innovation output. However, its performance declined slightly between 2010 and 2012. A particularly strong performance is visible in the PCT and KIA pillars, while there is room for improvement in the share of knowledge-intensive services in the overall service trade balance. Sweden is a good EU performer as regards the innovativeness of fast-growing firms. This is the result of a high share of computer programming, scientific R&D, and architectural and engineering companies among fast-growing enterprises. The relatively lower performance on the export share of medium-/high-tech goods is due to a high share of wood and paper exports. It should be noted that these sectors do not impede the strong technology orientation in the Swedish economy, also because they are more innovative in Sweden than in most other countries.

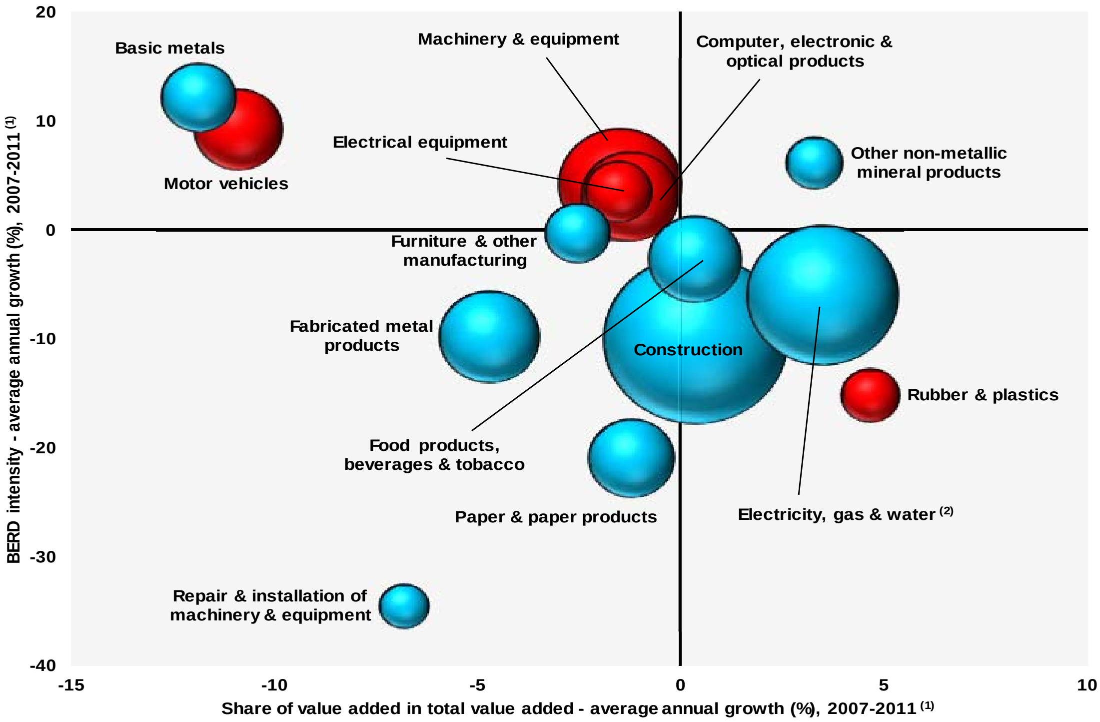
Sweden offers good framework conditions for innovation in business activities, in particular for the creation of new firms. In general, barriers to entrepreneurship are lower than in most OECD countries. The share of doctoral graduates is high (although less focused on science and technology). Clusters in some sectors (i.e. ICT, power generation, biotechnology) have grown around some of the larger research-intensive firms. Early-stage funding as a share of GDP is the highest among the EU Member States. Likewise, venture-capital investment as a share of GDP is among the highest in the OECD. However, the share of early-stage funding in total risk capital is lower than in other EU Member States and, following the financial crisis, there has been a sharp decline in risk finance.

The Swedish economy has become slightly more knowledge-intensive even during the period of economic downturn. Employment in knowledge-intensive activities as a share of total employment, both overall and in the business sector, grew between 1.0 % to 1.6 % between 2008 and 2011. Similar growth is visible in the technology sectors, measured by value added in high-tech and medium-high-tech manufacturing and knowledge-intensive services between 2008 and 2011.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries for the period 2007-2011. The position on the horizontal axis illustrates the changing weight of each industry sector in value added over the period. The general trend to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented on the graph). The red sectors are high-tech or medium-high-tech sectors.

Sweden - Share of value added versus BERD intensity - average annual growth, 2007-2011 (1)



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Construction', 'Furniture and other manufacturing', 'Repair and installation of machinery and equipment', 'Rubber and plastic products': 2009-2011.
(2) 'Electricity, gas and water' includes 'sewerage, waste management and remediation activities'.
(3) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The Swedish economy has managed to maintain an important manufacturing industry since the mid-1990s. This has also been achieved during the economic downturn. Most manufacturing sectors maintained their share of value added in the economy over the 2007-2011, with the notable exception of basic and fabricated metals and motor vehicles. In general, countries with a strong manufacturing sector have been more resilient to the economic crisis. However, over the economic downturn period, and compared to other EU Member States, the Swedish manufacturing industry presents a lower dynamic in terms of upgrading knowledge, in particular R&D. This is particularly true of the larger manufacturing sectors, such as paper and paper products, the electricity, gas and water industries, fabricated metal products, rubber and plastics, and construction – all important sectors in the Swedish economy both currently and historically. There are some promising exceptions, such as machinery and equipment, computer and electronics, electrical equipment, motor vehicles and basic metals, which all increased their R&D intensity over the period 2007-2011.

R&D-intensive firms in Sweden are found in the ICT sector (Ericsson, Axis), energy (parts of ABB), pharmaceuticals (parts of Astra Zeneca), automobiles (Volvo, Scania), industrial engineering (Alfa Laval, SKF, Husqvarna), healthcare equipment (Elektra, Getinge, Indap) and materials (Sandvik). As illustrated in the EU Industrial Scoreboard, the large Swedish R&D-intensive enterprises broadly maintained or even increased their global R&D intensities in 2011 as compared to 2009. On average, Swedish firms increased their R&D investment between 2007 and 2011, although there were exceptions – companies in the motor vehicles, software, biotechnology, and pharmaceutical sectors.

Key indicators for Sweden

SWEDEN	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	2,47	2,40	3,28	3,40	3,16	3,10	2,93	2,88	2,8	-3,6	*1,81*	1
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	502	:	:	494	:	:	478	-24.1 [3]	495 [4]	21 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	:	2,59	*2,75*	2,51	*2,74*	2,55	*2,33*	2,33	*2,31*	*-1,6*	1,31	2
Public expenditure on R&D (GOVERD + HERD) as % of GDP	:	0,96	*0,92*	0,92	*0,95*	1,06	*1,06*	1,04	*1,09*	*3,3*	*0,74*	1
Venture Capital as % of GDP	0,86	1,01	1,34	0,89	1,00	0,45	0,90	0,56	0,48	-11,5	0,29 [6]	3 [6]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	67,4	:	:	:	:	87,9	5,5	47,8	1
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	12,5	12,8	12,5	12,6	12,7	:	:	:	0,8	11,0	5
International scientific co-publications per million population	:	1164	1224	1333	1341	1451	1533	1636	1712	5,1	343	2
Public-private scientific co-publications per million population	:	:	:	140	139	140	144	147	:	1,1	53	2
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	13,3	10,1	10,7	11,1	10,5	10,9	10,0	:	:	-3,3	3,9	2
License and patent revenues from abroad as % of GDP	0,52	0,94	1,00	1,02	0,96	1,13	1,25	1,18	1,28	4,7	0,59	5
Community trademark (CTM) applications per million population	153	128	165	200	175	200	223	248	243	4,0	152	6
Community design (CD) applications per million population	:	52	52	61	63	62	58	61	63	0,6	29	3
Sales of new to market and new to firm innovations as % of turnover	:	:	:	:	9,2	:	8,4	:	:	-4,4	14,4	21
Knowledge-intensive services exports as % total service exports	:	41,2	41,2	40,4	40,7	42,3	39,9	39,8	:	-0,4	45,3	10
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	2,51	1,89	2,41	1,76	1,97	2,30	1,83	1,95	1,80	-	4,23 [7]	15
Growth of total factor productivity (total economy) - 2007 = 100	88	97	99	100	98	94	99	100	100	0 [8]	97	4
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	59,0	:	:	:	:	65,3	2,0	51,2	3
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	16,6	16,8	16,9	17,2	17,6	1,4	13,9	4
SMEs introducing product or process innovations as % of SMEs	:	:	40,7	:	40,6	:	43,8	:	:	3,9	33,8	6
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,56	0,57	0,64	0,66	0,64	0,85	:	:	:	13,6	0,44	3
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	1,94	1,78	1,71	1,50	1,03	1,25	:	:	:	-8,6	0,53	2
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	77,7	78,1 [5]	78,8	80,1	80,4	78,3	78,1	79,4	79,4	-0,2	68,4	1
R&D Intensity (GERD as % of GDP)	:	3,56	*3,68*	3,43	*3,70*	3,62	*3,39*	3,39	*3,41*	*-0,2*	*2,07*	2
Greenhouse gas emissions - 1990 = 100	96	93	93	91	89	83	91	86	:	-5 [9]	83	13 [10]
Share of renewable energy in gross final energy consumption (%)	:	40,4	42,4	43,9	45,0	47,7	47,9	46,8	:	1,6	13,0	1
Share of population aged 30-34 who have successfully completed tertiary education (%)	31,8	37,6	39,5	41,0	42,0	43,9	45,3	46,8	47,9	3,2	35,7	5
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	7,3	10,8	8,6 [11]	8,0	7,9	7,0	6,5	6,6	7,5	-1,3	12,7	7 [10]
Share of population at risk of poverty or social exclusion (%)	:	14,4	16,3	13,9	14,9	15,9	15,0	16,1	*18,2*	5,5	24,8	4 [10]

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012,
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) Break in series between 2005 and the previous years.
(6) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK, These Member States were not included in the EU ranking.
(7) EU is the weighted average of the values for the Member States.
(8) The value is the difference between 2012 and 2007.
(9) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(10) The values for this indicator were ranked from lowest to highest.
(11) Break in series between 2006 and the previous years.
(12) Values in italics are estimated or provisional.

United Kingdom

Delivering an effective innovation system

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in the United Kingdom (UK). They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 1.72 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -0.3 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[27] 2012: 63.5 (EU: 47.8; US: 58.1) 2007-2012: +5.2 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 110.3 (EU: 101.6)	*Knowledge-intensity of the economy*[28] 2012: 60.7 (EU: 51.2; US: 59.9) 2007-2012: +0.6 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Construction, health, environment, security	*HT + MT contribution to the trade balance* 2012: 4.2 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +9.2 % (EU: +4.8 %; US: -32.3 %)

The UK's overall innovation performance is above the EU average. There are particular strengths in human resources, venture capital, business angels, entrepreneurship, and international co-publications (although the number of academic-corporate co-authored publications is low). The number of collaborations by innovative small and medium-sized enterprises (SMEs) with other entities continues to increase (albeit that SME/university collaboration is limited), while rates of improvement in human resources and international co-publications are well above average. The presence of several world-class universities, a significant proportion of young doctoral graduates, and competitive strengths in sectors such as pharmaceuticals and digital technologies have helped achieve this strong performance. However, there are relative weaknesses in RDI investments by firms, the creation of intellectual assets, and SMEs introducing innovations. In addition, the UK suffers from a relatively low level of basic skills, insufficient domestic human capital to exploit research and innovation (R&I), a dearth of management skills, the concentration of R&D in a small number of sectors and firms, and a low proportion of medium-sized growth firms.

The economy has several distinctive characteristics that give it competitive advantages in the innovation sphere: a world-leading science base and information infrastructure; a prominent financial sector (although this could be better incentivised to support company creation and growth); a rich supply of high-level skills plus a proven attractiveness to globally mobile talents; strong performance by business in creating intangible assets; and a relatively large role played by the service sector for industry and export performance. These characteristics, highlighted by the UK government in its strategy for innovation published at the end of 2011, underpin the four priority areas identified for policy development: strengthening the sharing and dissemination of knowledge; fostering the

[27] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

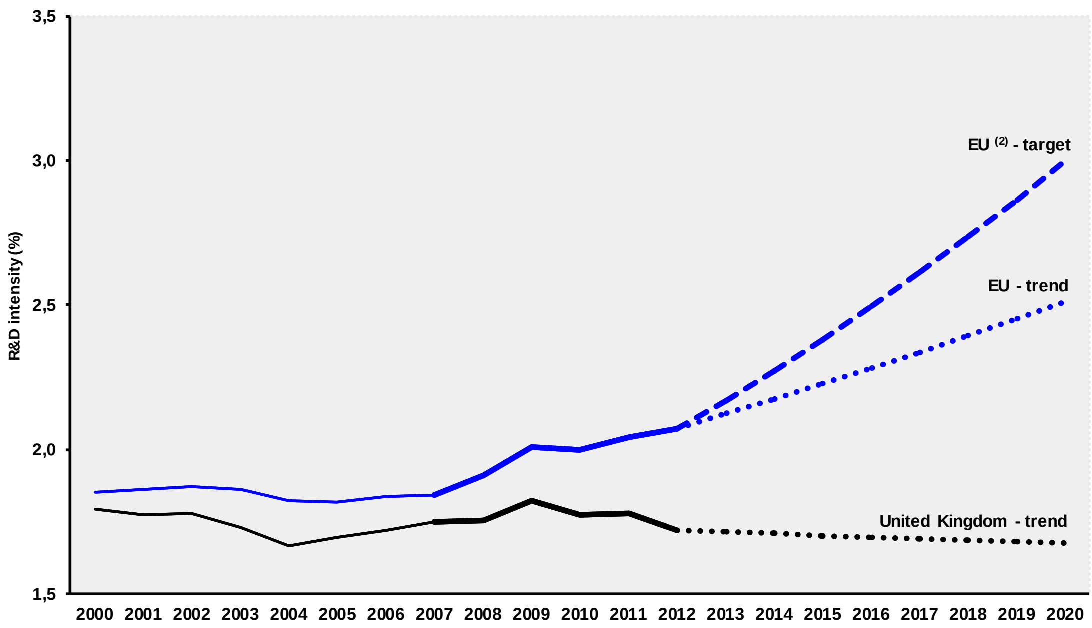
[28] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

development and use of a more coherent innovation infrastructure; driving business innovation in all sectors of the economy; and transforming the public sector into a major driver of innovation.

The UK continues to benefit from a key strength of its innovation policy governance system: a long-term, strategic perspective informed by an extensive process of review and evaluation and benefiting from a relative absence of dramatic shifts in priorities, instruments or structures.

Investing in knowledge

United Kingdom - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) UK: An R&D intensity target for 2020 is not available.

In 2012, the higher education sector was responsible for EUR 8.81 billion of R&D activities, representing 26.5 % of total R&D performed. This share increased from 20.6 % in 2000 at an average annual growth rate of 2.1 %. Business enterprise finances 45.6 % of R&D and performs around 63.4 % of R&D. Expenditure by business enterprise on R&D amounted to EUR 21.1 billion in 2012, close to the 2006 level. Government finances around 28.9 % of R&D. An important characteristic of the UK research system is the significant R&D investment financed from abroad – some 19.7 % (9 % of the EU average) – and from the non-profit sector – about 4.6 %. In 2012, the UK's gross domestic expenditure on R&D was some EUR 33.3 billion, declining by 3.1 % in real terms from the 2011 figure. UK institutions benefited from EUR 6.1 billion from the EU's Seventh Framework Programme (FP7) (15.4 % of the total, which is the second-highest share among Member States). The success rate of UK applicants in FP7 is 23.1 %, well above the average EU rate of 21.9 %. Of the EUR 9891 billion of Structural Funds allocated to the UK over the 2007-2013 programming period, around EUR 1922 billion (19.4 % of the total) related to RTDI[29].

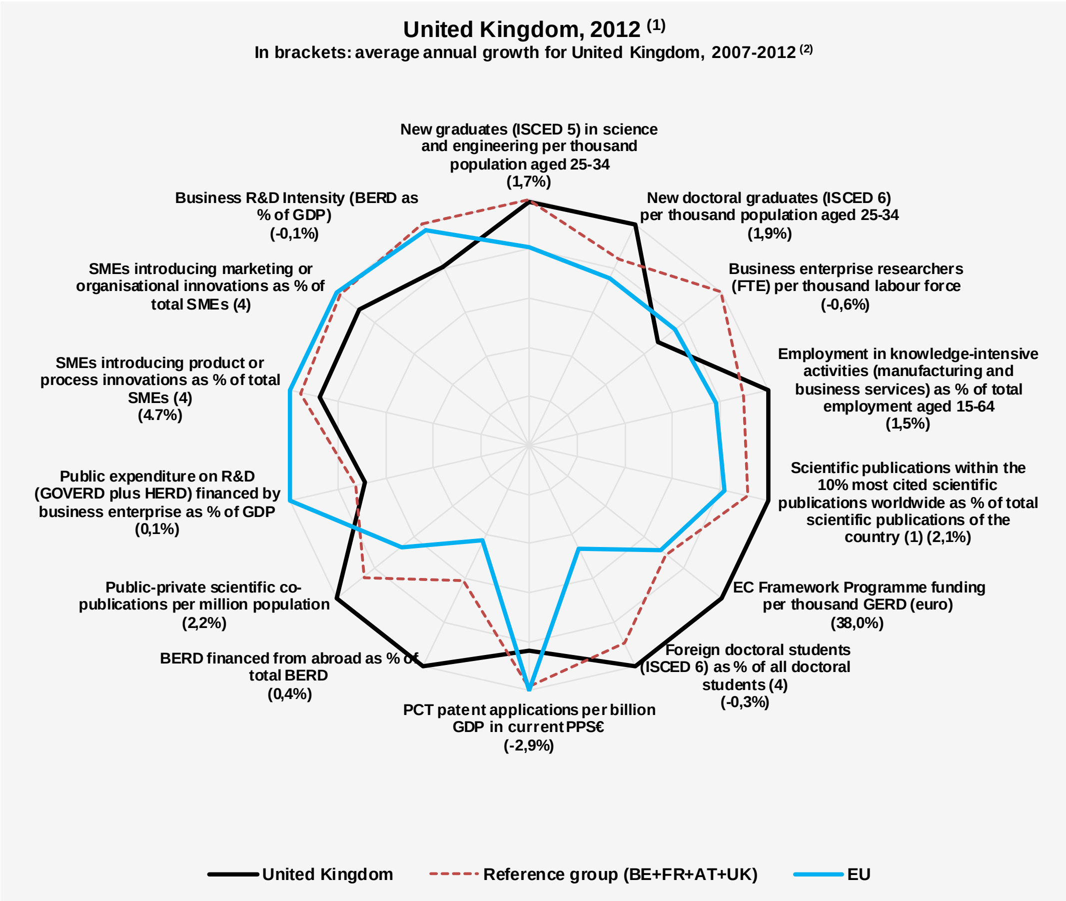
[29] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms

R&D intensity (2012) was 1.72 % of GDP, down from 1.78 % in 2011and lower than the EU average of 2.06 %. The trend since 2000 shows an initial fall, a mild recovery from 2005 (peaking in 2009), and a recent decline. Public expenditure on R&D accounted for 34.7 % of the total. Albeit with ups and downs, growth was negative overall between 2000 and 2012 (averaging out at -0.3 % per year), and business R&D intensity fell from 1.16 % in 2001 to 1.09 % in 2012. In spite of this negative trend, the UK has not set a national R&D intensity target corresponding to the European Council's request regarding Europe 2020 headline targets. As part of the government's 2010 fiscal consolidation strategy, the science budget was frozen in cash terms at just over £4.6 billion (EUR 5.4 billion) for the next four years, amounting to a cut of some 10 % in real terms over the period. The capital expenditure budget for science was not protected. However, in its 2013 spending review, the government announced that it was increasing science capital funding in real terms from £0.6 billion (EUR 7.5 billion) in 2012-13 to £1.1 billion (EUR 1.3 billion) in 2015-16, and in line with inflation to 2016-2017. The government will also set a long-term capital budget for science in the next parliament, increasing in line with inflation to 2020-21. Announcements in the March 2014 budget saw further commitments of £0.22 billion (EUR 0.27 billion) to research programmes.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of the UK research and innovation (R&I) system. Reading clockwise, it gives information on human resources, scientific production, technology exploitation and innovation. Average annual growth rates from 2000 to the latest available year are given in brackets.

directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



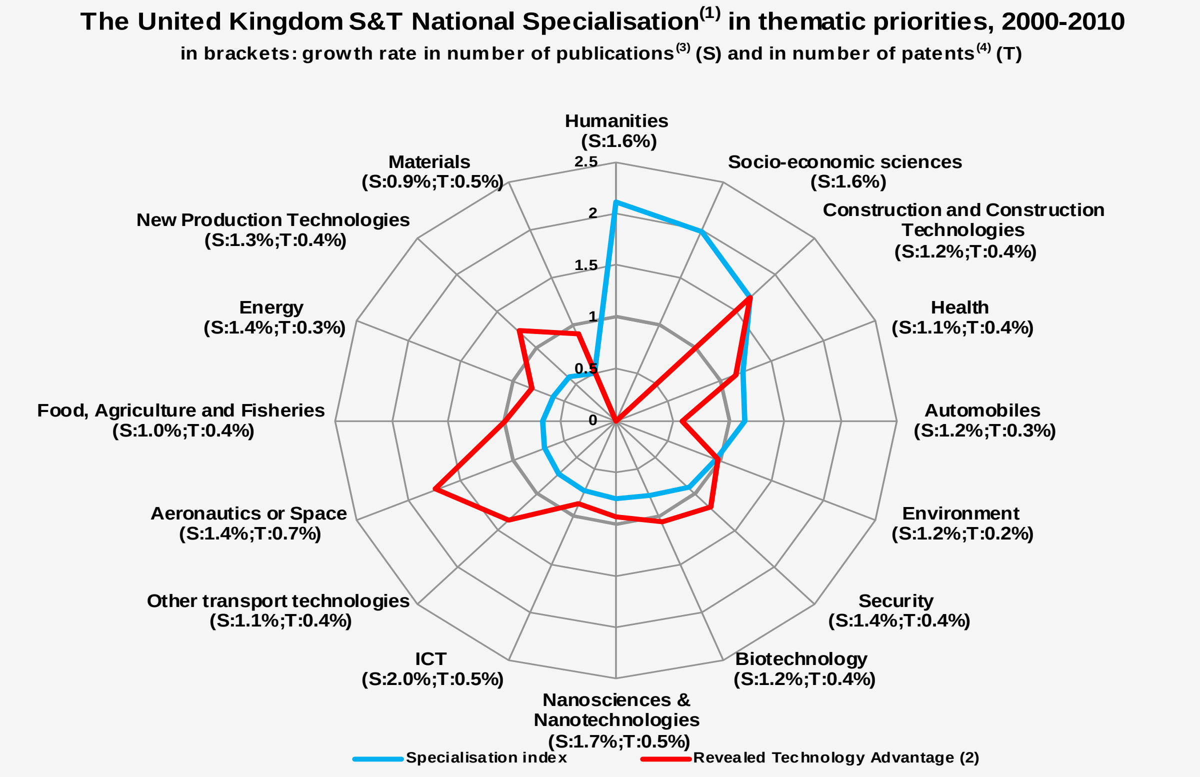
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

As a whole, the UK R&I system performs above the EU average, with strengths in the quality of research, but weaknesses in the introduction of innovations to the market. The proportion of human resources in science and technology as a share of the UK labour force is above the EU average, and has risen since 2006. High numbers of highly qualified UK-educated researchers are resident in other OECD countries, associated with the circulation of high-level human resources. On research infrastructures, the UK recognises that investment in world-class infrastructure is a prerequisite for world-class research: it hosts a large number of national and international facilities and is involved in many facilities in Europe and the rest of the world. As regards universities, greater emphasis has been placed recently on stimulating their engagement with businesses and local communities, with a Higher Education Investment Fund as the main policy stimulus. Knowledge transfer from research to business is a UK policy priority, with several initiatives providing funding to stimulate collaborative research and inter-sectorial mobility or supporting the creation of university and public-sector spin-outs.

Sectorial support is strongly focused on advanced manufacturing, covering vocational skills education, apprenticeships, high-value manufacturing technology innovation accelerators (‘catapults’), incentive prizes, fellowships and advisory services. Life sciences also attract particular support.

UK's scientific and technological strengths

The spider graph below illustrates the areas, based on the Framework Programme thematic priorities, where the UK shows potential in science and technology areas in a European context. Both the specialisation index (SI) and the revealed technological advantage (RTA) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.



Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

The UK performs well in most areas of technology production. Apart from the sectors highlighted above, current patent activity suggests that the UK is also relatively strong in the areas of organic chemistry, pharmaceuticals and medical technology. It has a world-class reputation in aerospace and nanotechnology research, and particularly significant R&D capabilities in renewables, especially offshore wind power and marine energy. However, compared to its competitors, UK R&D is concentrated in a relatively small number of sectors and is carried out by relatively few businesses. Greater business investment in R&D would be helpful across all sectors of the UK economy.

Regarding specialisation (see the graph above), there is a good match between the scientific and technological performance at the country level in the fields of construction, health, environment, and security, reflecting a particularly good absorption of science into technological products for these fields. Three out of the four fields are also among the most successful in FP7, namely health, environment, and security. The same goes for the overall research field of social sciences and humanities, where there is a strong specialisation in publications at a national level coupled with a high success rate in FP7.

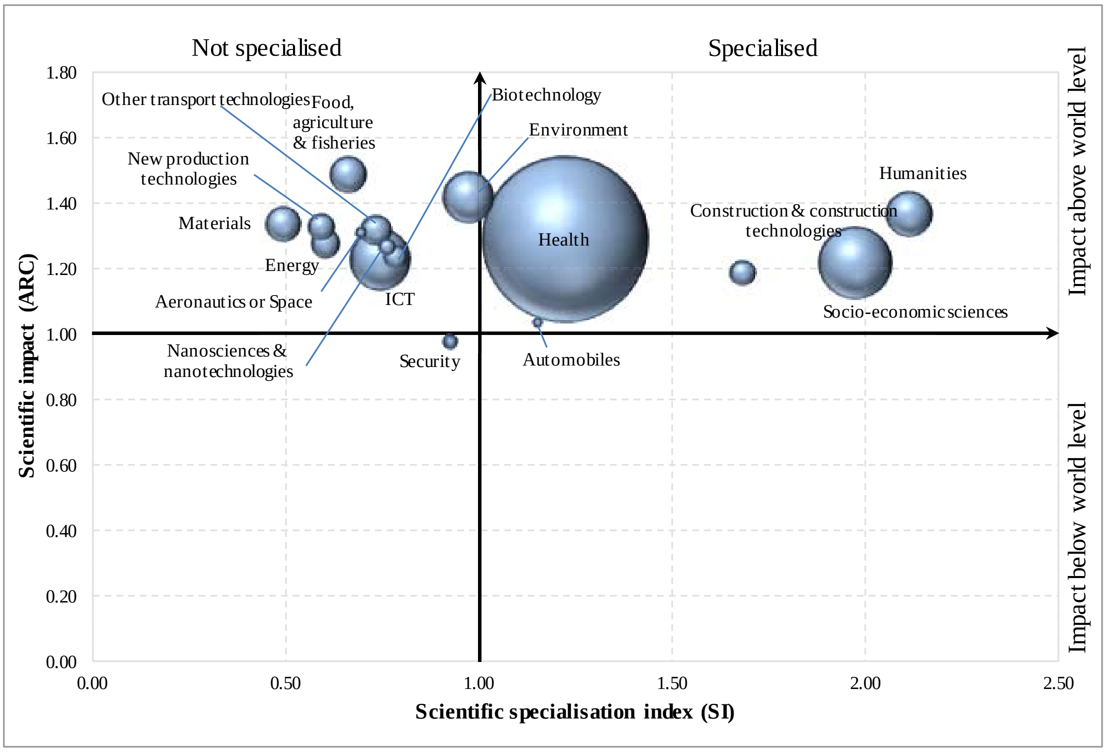
The coherence among S&T co-specialisation at home and participation in FP7 shows that the UK successfully builds on its national S&T capabilities when participating in the EU's Framework Programme.

Going deeper into the analysis, the UK's greatest technological specialisation appears to be in the field of aeronautics. This is not matched by a similar specialisation in science, although there has been a sufficiently high growth in both publications and patents over the last 10 years, and the quality of science is very good. High growth rates are also noted in the fields of ICT, and nanosciences and nanotechnologies, showing the potential for increasing specialisation in these fields in the future.
One specific case is the automobiles sector where the science created in this field is not sufficiently translated into technology. In addition, the field appears to be quite static, without spectacular growth rates in S&T over the last decade and with a rather linear quality of science.

Finally, the food, agriculture and biotech sector is among the fields where the UK is most successful in FP7. However, this is not matched by a specialisation here at the national level, so this field could be looked at more closely when evaluating the strengths of research performed at national level.

The graph below illustrates the positional analysis of the UK publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of The United Kingdom publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

Overall, as shown in the graph above, the UK has a very high scientific quality (with an impact above world level) in almost all fields, independently from the specialisation level.

In terms of scientific production, the UK research base is the most productive in the G8, generating more papers and citations per unit of investment than any other large country.[30]

Policies and reforms for research and innovation

The government has stated its commitment to prioritising, to a certain extent, spending on science and innovation while pursuing fiscal consolidation. Overall, RDI policy focuses on increasing the UK's ability to innovate and commercialise new technologies as a means for driving economic growth and creating jobs. The aim is to encourage greater levels of innovation in all sectors of the economy, supported by a better-integrated and more cohesive innovation system. The updated version of the National Infrastructure Plan, published in December 2013, brings investments related to science and innovation into the list of priority investments for the first time.

RDI policies are managed at the national level by the Department for Business, Innovation and Skills (BIS), which sponsors the seven UK Research Councils, the Higher Education Funding Council for England (HEFCE), and the Technology Strategy Board (TSB). The TSB is responsible for funding innovation and technology development within business and acts as the national innovation agency for the UK. The devolved administrations of Northern Ireland, Scotland and Wales are responsible for certain elements of funding, specifically for higher education research and for enterprise agencies.

The government has decided that all programmes for and funding linked to R&I should be delivered by national organisations. Consequently, regional development agencies, which had previously played a role in innovation funding, were dissolved in mid-2012. New Local Enterprise Partnerships are being introduced at sub-national level, although without dedicated budgets for R&I, and with no role in delivering innovation support programmes.

Funding for research in the UK is provided in two ways: competitive, project-based funding delivered through the Research Councils, for which researchers in UK universities or public-sector research can apply, with each Research Council allocating resources within its field between institutes, facilities, research studentships and projects; or via HEFCE in England and its counterparts in Northern Ireland, Scotland and Wales, covering research, knowledge transfer and infrastructure.

The TSB is the UK's prime channel for supporting business-led technology innovation. It is responsible for a range of innovation programmes, including knowledge-transfer partnerships, which embed new graduates mostly in SMEs; knowledge-transfer networks, to help industry access knowledge and information; collaborative R&D, which supports the business and research communities working together on projects; funding for proof of concept, market validation studies and the development of prototypes (the 'Smart' initiative); and the new network of 'catapult' innovation accelerators.

Tax credits are the biggest single funding mechanism provided by the UK government for incentivising investment in business R&D. The SME scheme gives companies a deduction in corporate tax of 125 % of qualifying expenditure and the possibility of a payable credit. The large-company scheme offers a deduction of 30 %.

The government has also put considerable emphasis on using public procurement to stimulate innovation capacity. The Small Business Research Initiative encourages innovative firms to tackle RDI challenges facing government departments, while the Forward Commitment Procurement programme helps public-sector organisations to develop new products and services to meet demand.

A 'Patent Box' scheme, launched in 2013, applies a reduced rate of tax to profits from patents and certain other types of intellectual property. The hypothesis is that this will encourage firms to retain

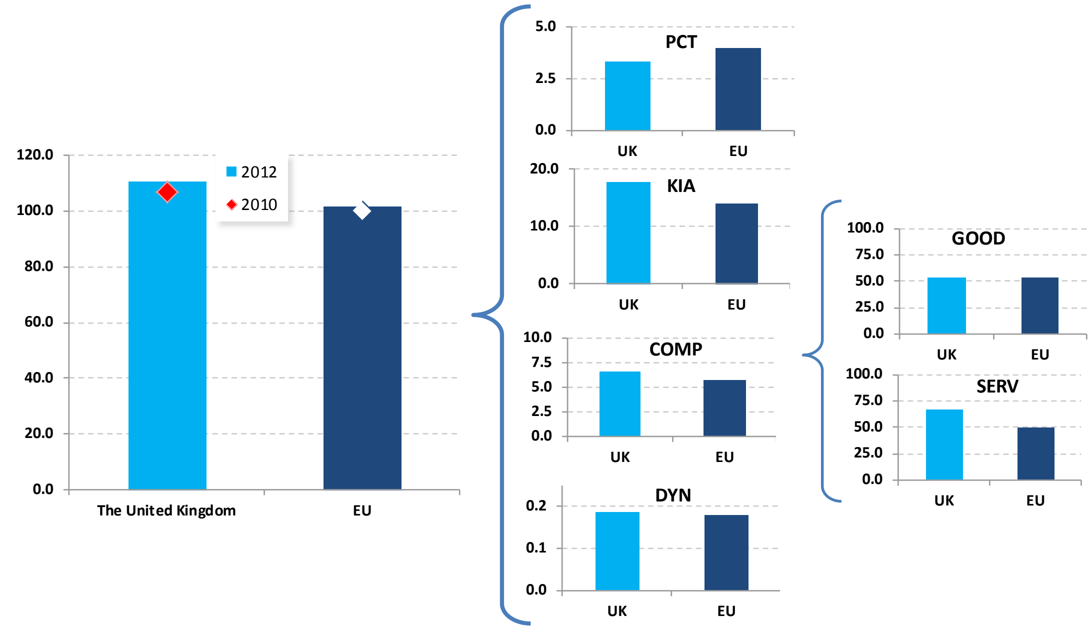
[30] International Comparative Performance of the UK Research Base, Elsevier, 2011.

existing patents, develop new, innovative technologies and patent them, and to locate jobs and activities associated with patentable activities in the UK.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of the UK's position regarding the indicator's different components:

The United Kingdom - Innovation Output Indicator



Source : DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average).
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

The UK is a very good performer in terms of the European innovation indicator. This is the result of good performance in all components of the indicator, except patent applications, where the UK's performance is below the EU average.

With its service-based economy (both agriculture and manufacturing have a low employment share), the country performs particularly well in employment in knowledge-intensive activities, and in the export share of knowledge-intensive services.

The relatively low score in patents is partly explained by the UK's economic structure, in which the patent-intensive manufacturing sector has a relatively low share of economic activities.

The relatively good performance in knowledge-intensive activities and in the export share of knowledge-intensive services stems from the relative importance of financial and information services.

The UK has relatively large financial services exports, but is also an important exporter of computer services and of other professional and technical services, including public relations, accounting, consultancy, engineering, and research. Furthermore, a high share of employment in education (the UK receives a high number of foreign tertiary students) and health also contributes to a high share of employment in knowledge-intensive services.

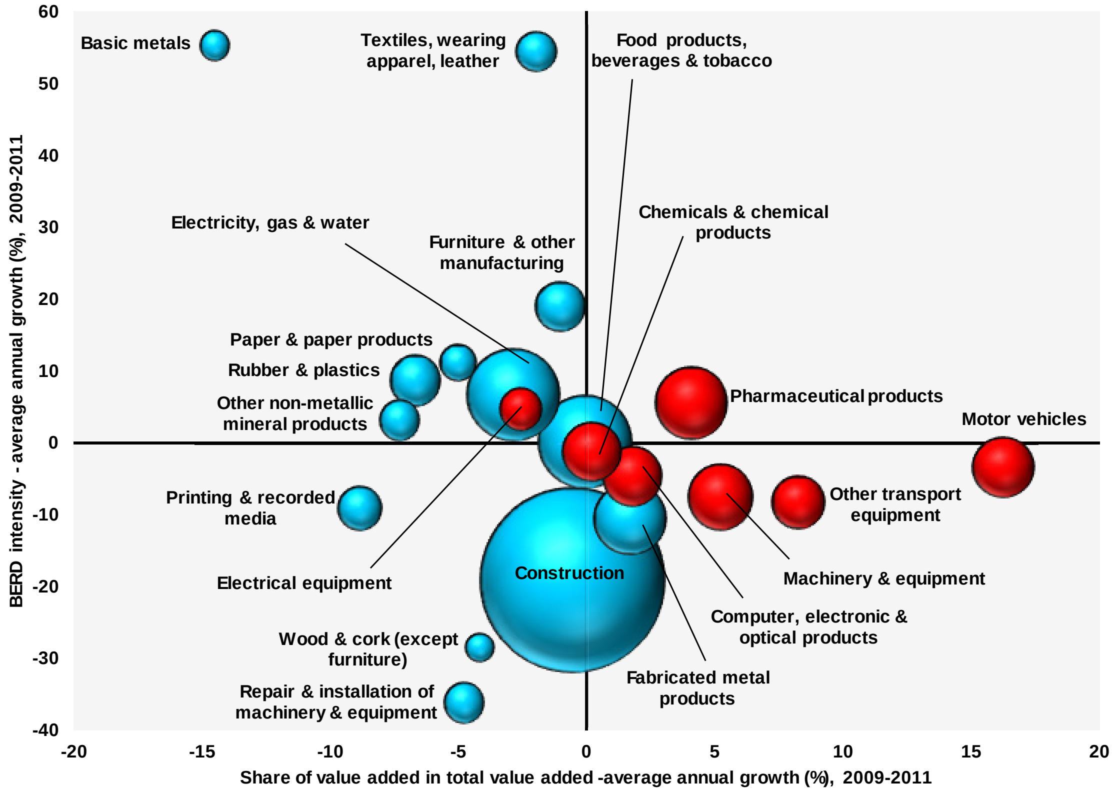
The UK also scores slightly above the EU average for the share of medium-/high-tech goods in total goods exports, a result of strong exports of machinery and pharmaceutical products.

Despite a high general level of enterprise dynamism, in recent years the high growth of enterprises has occurred in sectors, such as retail, which do not have high innovation coefficients. To some extent this explains the average score attained for the innovativeness of growing firms.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries. The position on the horizontal axis shows the changing weight of each industry sector in value added over the period 1995-2007. The general trend of moving to the left-hand side reflects the decline in manufacturing in the overall economy. The sectors above the horizontal axis are those whose research intensity has increased over time. The size of a bubble represents the sector share (in value added) in manufacturing (all sectors shown). The red sectors are those that are already high-tech or medium-to-high-tech.

United Kingdom - Share of value added versus BERD intensity - average annual growth, 2009-2011



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Note: (1) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

Manufacturing is the third largest sector of the UK economy in terms of share of GDP, after business services and the wholesale and retail sectors. In common with other leading manufacturing countries, the UK has specialised increasingly in higher-technology manufacturing industries such as medical or chemical products, and precision machinery and equipment.

Furthermore, there has been a shift in employment in manufacturing away from production towards support services, logistics and distribution, sales and marketing, and R&D activities. Current patent activity suggests that the UK is relatively strong in the areas of organic chemistry, biotechnology, pharmaceuticals and medical technology, but relatively weak in the electronics, optics, nanotechnology, and information technology sectors. In addition, the proportion of firms that are exporting is increasing in many manufacturing industries.

The graph shows that while a significant proportion of medium-tech and high-tech sectors have increased their research intensity, they have not increased their share of value added. However, the research intensity of some sectors has stagnated, or in several cases fallen, which could endanger their long-term competitiveness.

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Key indicators for the United Kingdom

UNITED KINGDOM	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	1,33	1,97	2,05	2,18	2,05	2,16	2,27	2,39	2,40	1,9	*1,81*	5
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	495	:	:	492	:	:	494	-1.5 [3]	495 [4]	13 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	1,17	1,04	1,06	1,09	1,09	1,10	1,08	1,13	1,09	-0,1	1,31	12
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,60	0,62	0,62	0,62	0,63	0,68	0,65	0,62	*0,60*	*-0,6*	*0,74*	15
Venture Capital as % of GDP	0,81	1,28	2,07	1,61	1,24	0,60	1,12	1,18	0,81	-12,8	0,29 [5]	1 [5]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	49,3	:	:	:	:	63,5	5,2	47,8	5
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	12,9	12,9	12,8	13,2	13,4	:	:	:	2,1	11,0	4
International scientific co-publications per million population	:	719	768	826	867	916	954	999	1021	4,3	343	11
Public-private scientific co-publications per million population	:	:	:	73	70	70	76	79	:	2,2	53	8
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	4,3	3,6	3,7	3,6	3,4	3,5	3,3	:	:	-2,9	3,9	9
License and patent revenues from abroad as % of GDP	0,55	0,57	0,59	0,57	0,55	0,62	0,62	0,57	0,51	-2,2	0,59	9
Community trademark (CTM) applications per million population	132	115	136	151	138	129	141	152	163	1,5	152	13
Community design (CD) applications per million population	:	24	23	29	23	22	26	26	27	-0,7	29	12
Sales of new to market and new to firm innovations as % of turnover	:	:	8,5	:	7,3	:	:	:	:	-7,4	14,4	26
Knowledge-intensive services exports as % total service exports	:	57,7	58,6	60,5	62,5	64,2	61,1	61,2	:	0,3	45,3	4
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	1,86	4,46	6,86	2,74	3,12	3,82	3,05	3,16	4,25	-	4,23 [6]	6
Growth of total factor productivity (total economy) - 2007 = 100	90	97	98	100	98	93	94	94	94	-6 [7]	97	19
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	59,0	:	:	:	:	60,7	0,6	51,2	6
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	16,8	17,5	17,0	17,4	17,8	1,5	13,9	3
SMEs introducing product or process innovations as % of SMEs	:	:	25,1	:	27,0	:	29,6	:	:	4,7	33,8	18
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,21	0,18	0,21	0,20	0,21	0,25	:	:	:	12,2	0,44	9
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,94	0,68	0,61	0,54	0,51	0,50	:	:	:	-3,8	0,53	11
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	74,0	75,2	75,2	75,2	75,2	73,9	73,6	73,6	74,2	-0,3	68,4	6
R&D Intensity (GERD as % of GDP)	1,79	1,70	1,72	1,75	*1,75*	*1,82*	*1,77*	1,78	*1,72*	*-0,3*	*2,07*	13
Greenhouse gas emissions - 1990 = 100	90	89	88	87	85	78	80	75	:	-12 [8]	83	10 [9]
Share of renewable energy in gross final energy consumption (%)	:	1,4	1,6	1,8	2,4	3,0	3,3	3,8	:	20,5	13,0	26
Share of population aged 30-34 who have successfully completed tertiary education (%)	29,0	34,6	36,5	38,5	39,7	41,5	43,0	45,8	47,1	4,1	35,7	6
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	18,2	11,6	11,3	16.6 [10]	17,0	15,7	14,9	15,0	13,6	-3,9	12,7	23 [9]
Share of population at risk of poverty or social exclusion (%)	:	24,8	23,7	22,6	23,2	22,0	23,2	22,7	24.1 [11]	0,1	24,8	15 [9]

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT. These Member States were not included in the EU ranking.
(5) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK. These Member States were not included in the EU ranking.
(6) EU is the weighted average of the values for the Member States.
(7) The value is the difference between 2012 and 2007.
(8) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(9) The values for this indicator were ranked from lowest to highest.
(10) Break in series between 2007 and the previous years.
(11) Break in series between 2012 and the previous years. Average annual growth refers to 2007-2011.
(12) Values in italics are estimated or provisional.

Iceland

More innovation for a more competitive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Iceland. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and performance	
R&D intensity 2011: 2.40 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -2.8 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[31] 2012: 38.7 (EU:47.8; US: 58.1) 2007-2012: +8.8 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 86.4 (EU: 101.6)	*Knowledge-intensity of the economy*[32] 2012: n.a (EU:51.2; US: 59.9) 2007-2012: n.a.% (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food, agriculture and fisheries, and health	*HT + MT contribution to the trade balance* 2012: -15.0 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

Iceland has one of the highest R&D intensities in Europe and an excellent science base. However, a main challenge for the country is to transform this into economic competitiveness. Prioritisation and thematic-oriented funding would help Iceland, as a small country in a globalised world, to build a more effective R&I strategy.

According to the Innovation Union Scoreboard 2014, which classifies Iceland among the innovation followers, it is the only country in which innovation has not improved over the 2006-2013 period. Evidence shows that Iceland's competitiveness in high-tech and medium-tech products and services is low, with a negative trade balance for high-tech and medium-tech products since 2000. In the Global Competitiveness Index (GCI) 2013-2014, Iceland ranks 31 (out of 148 countries), maintaining its position from previous years. Despite significant difficulties in recent post-crisis years, Icelandic competitive strengths include the country's high-level educational system coupled with a relatively innovative business sector (27th). The country's strengths are its scientific outputs (high scores for the international co-publications and public-private co-publications).

R&I were part of Iceland's recovery package for economic growth. However, in the years since the economic collapse, the higher education and research institutions have experienced budget cuts that amount to about a quarter of their pre-crisis budget, in real terms. In 2003, the establishment of the Science and Technology Policy Council (STPC), a key body giving core strategic advice on S&T policy developments, headed by the Prime Minister, centralised R&I governance at a high political level. The Ministry of Science, Higher education and Culture is responsible for the

[31] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

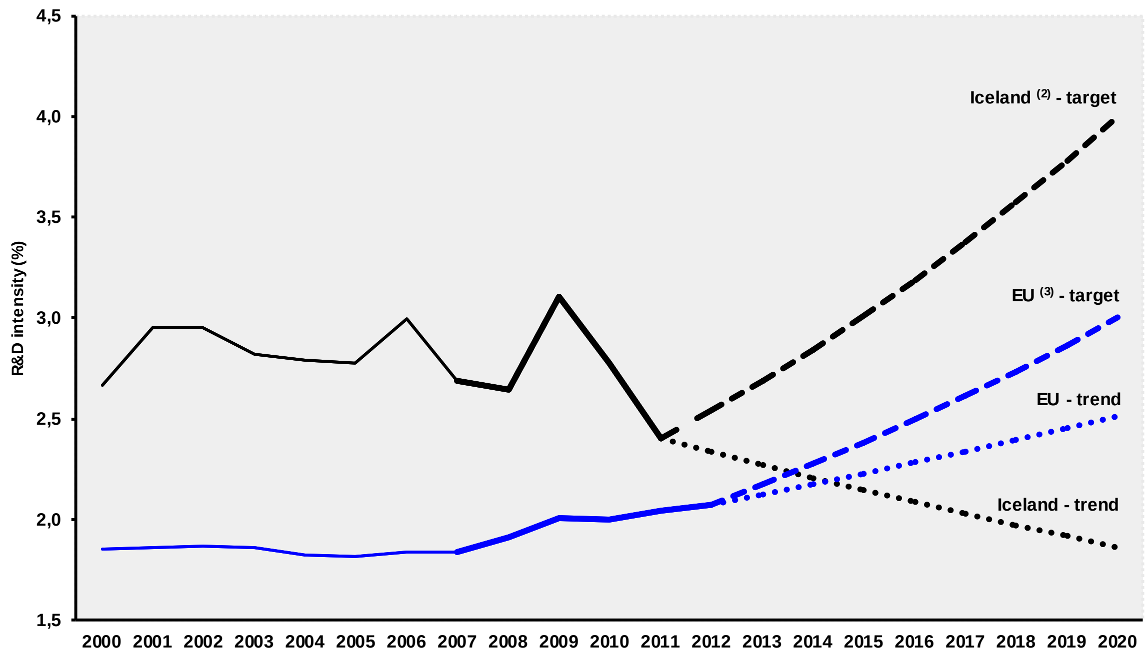
[32] Composite indicator that includes R&D, skills, sectoral specialization, international specialization and internationalization sub-indicators.

implementation of R&D policy in Iceland while the Ministry of Industries and Innovation deals with innovation policy. The Icelandic Centre for Research (Rannis) allocates most of the competitive funds and the Innovation Centre Iceland (ICI) deals with support services for innovation- and entrepreneurship-related activities. The fragmented R&I system and insufficient focus on the implementation of policies and objectives has long been conceived as Icelandic structural weakness. Two external evaluations of the system have been conducted since the STPC was set up, and a focused international peer review of the Icelandic R&I system is currently being conducted in the context of the European Research Area and Innovation Committee (ERAC).

In November 2013, the STPC adopted a new policy for the years 2013-2016 which focuses on the following priorities: increased efforts in building up human resources in science and innovation, more cooperation between universities, research institutions and companies aimed at increasing the system's efficiency, more public and private investment in R&I, and a strong focus on the quality and value creation of R&I (emphasis on evaluation and quality control). For the first time, the Council will follow up the policy with a single action plan which is currently being finalised.

Investing in knowledge

Iceland - R&D intensity projections, 2000-2020 (1)



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2007-2011 in the case of Iceland.
(2) IS: The projection is based on a tentative R&D intensity target of 4.0% for 2020.
(3) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(4) IS: The values for 2004 and 2010 were interpolated by DG Research and Innovation.

Iceland had an R&D intensity of 3.11 % in 2009, a relatively high level compared to the EU average of 2.07 % (2012). However, following the financial crisis that hit Iceland in 2008, R&D intensity went down to 2.4 % in 2011. In January 2011, ('Iceland 2020' policy statement), Iceland set an R&D intensity target of 4 %, to be reached by 2020, with the private sector contributing 70 % of the total and the public sector contributing 30 %. The new STPC policy is setting a target of 3 % R&D intensity by 2016. Taking into consideration the cuts in R&D spending, achieving this target would appear to be difficult. Icelandic R&D intensity experienced an average annual growth of -2.8 % in 2007-2011 while the growth required to reach the 2020 target is much higher at 5.8 %.

A significant share of total R&D investment in Iceland comes from the public sector. In 2011, the public sector accounted for 42 % of total R&D investment. The business sector accounted for 48 %, which shows a decline from 2007 when the share was 54.6 %. Business R&D expenditure experienced a negative average annual growth of -3.7 % in 2007-2011, reaching 1.26 % in 2011. Insufficient business enterprise expenditure on R&D is one of the key weaknesses of the Icelandic R&I system. Therefore, the new STPC policy (2013-2016) is putting emphasis on increasing funding for and supporting business expenditure on R&D (for example, tax incentives for start-ups). Since 2010, the year tax deductions for companies investing in R&D projects (up to 20 % of costs) were introduced, indirect government support to R&D has been increasing.

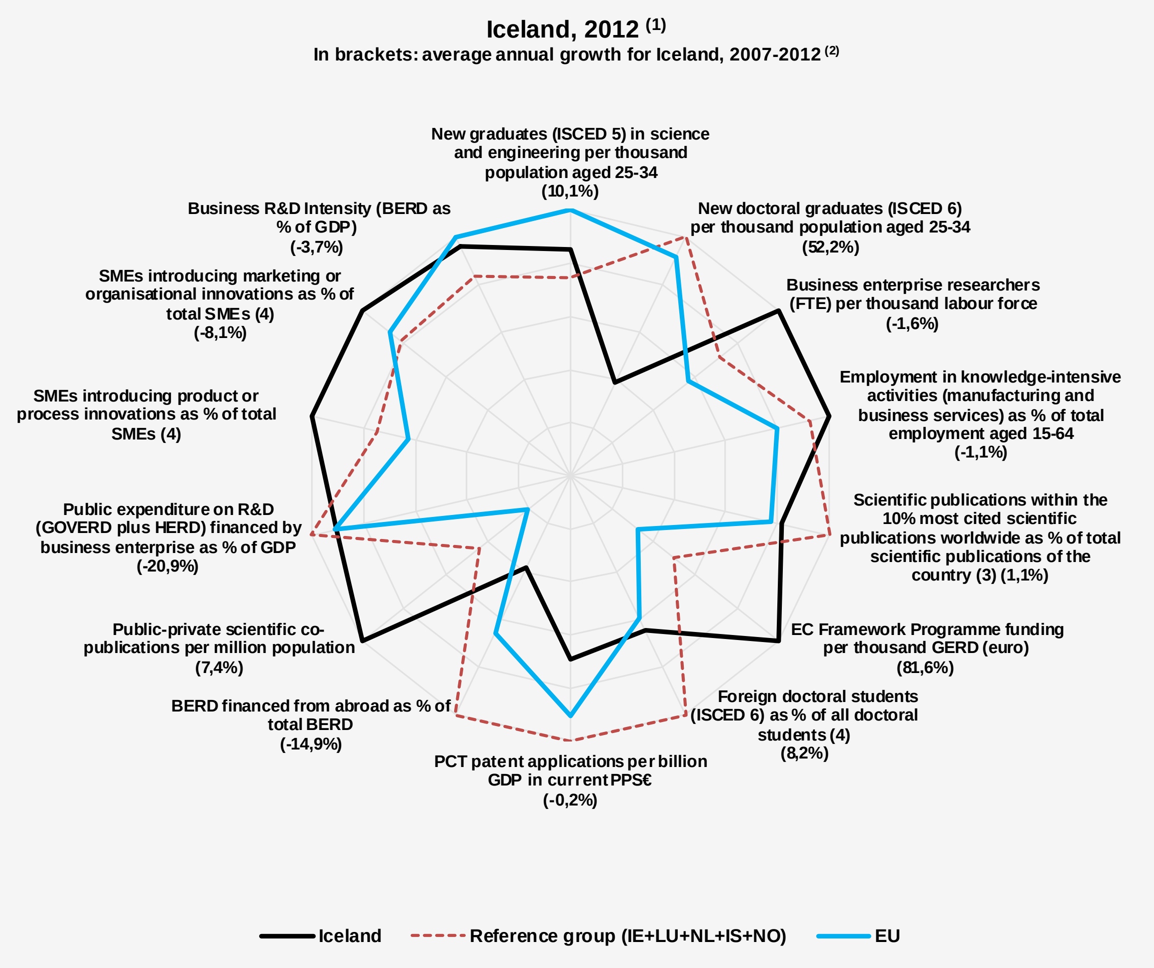
The STPC policy also addresses another challenge in the Icelandic R&D system and proposes increasing the level of competitive research funding, which accounted for only 15-20 % before the increase in 2013[33], to around 25 % of competitive funding. However, by 2016, the Icelandic government intends to withdraw all the proposed increases in funding to competitive R&D funds. With the new act on public finances proposing a five-year budgetary plan, focused government planning should be introduced which would create more financial stability for the users of R&D, too.

Public expenditure on R&D (GOVERD +HERD) as a % of GDP experienced a negative average annual growth between 2007 and 2012 (-2 %). Mobilising private R&D funding in times of economic crisis is another challenge: the level of private-sector funding of R&D in Iceland is low and has declined since 2007.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Iceland’s R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2007 to the latest available year are given in brackets.

[33] Investment Plan for Iceland 2013-2015



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) Fractional counting method.
(4) EU does not include EL.

The European Economic Area (EEA) agreement, signed in 1994, is the main pillar on which political and economic relations between Iceland and the European Union rests. It gives Iceland the right to participate in a range of EU programmes in areas such as research and education. The Icelandic Centre for Research (Rannis) coordinates and promotes Icelandic participation in collaborative international science and technology projects inside the European Research Area. In particular, Iceland places great emphasis on integration in Nordic R&D cooperation programmes, including the Nordic Research and Innovation Area.

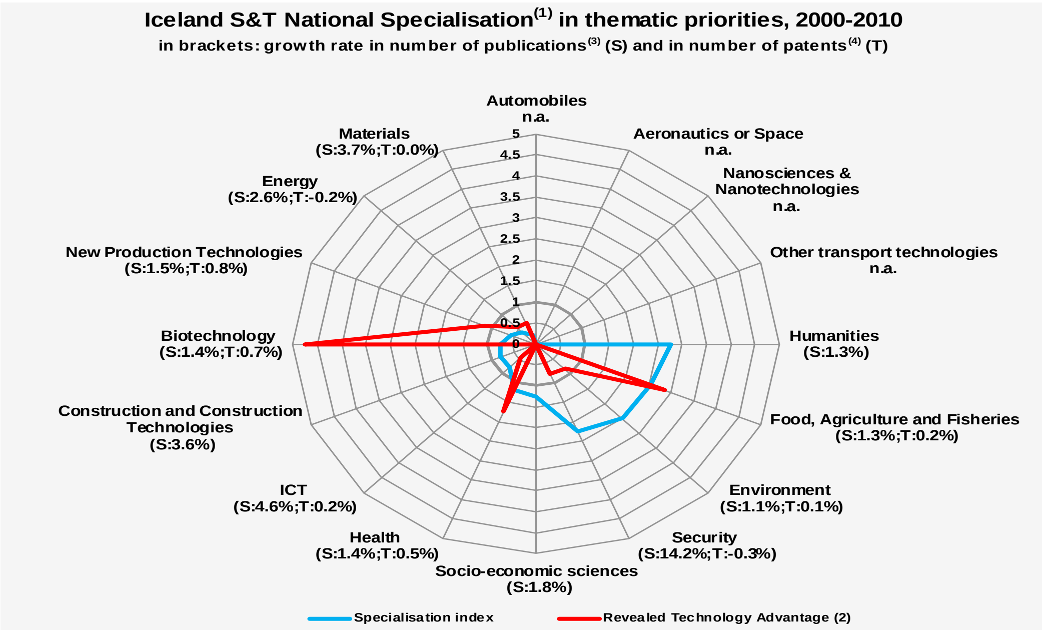
As a whole, the Icelandic R&I system performs above the EU average for most of the indicators, with strengths in scientific production (public-private scientific co-publications and the high impact of the international co-publications) and very good results in terms of participation in the EU Framework Programmes. As of February 2014, 852 eligible proposals were submitted in response to 478 FP7 calls for proposals involving 1170 applicants from Iceland and requesting EUR 344 million in EU contributions. Iceland has the closest collaborative links in FP7 with the UK, Germany, Spain, the Netherlands and France.

The Icelandic economy is very knowledge-intensive, as illustrated by both the level of employment in knowledge-intensive activities and the high number of business researchers per thousand of the labour force. A challenge for Iceland is to increase the numbers of students participating in science, engineering and doctoral studies. The impressive growth observed in new doctoral graduates indicates that Iceland is on track to address this challenge. The number of foreign doctoral students and scientific publications within the 10 % most cited worldwide is above the EU average but below the average of the reference group countries.

The biggest decrease was observed in the average annual growth of public expenditure on R&D and in the BERD financed from abroad. Iceland scores high in innovative SMEs, but it is important to note that business R&D intensity has been falling since 2007.

Iceland's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Iceland shows scientific and technological specialisations. Both the specialisation index (SI, based on the number of publications) and the revealed technological advantage (RTA, based on the number of patents) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.



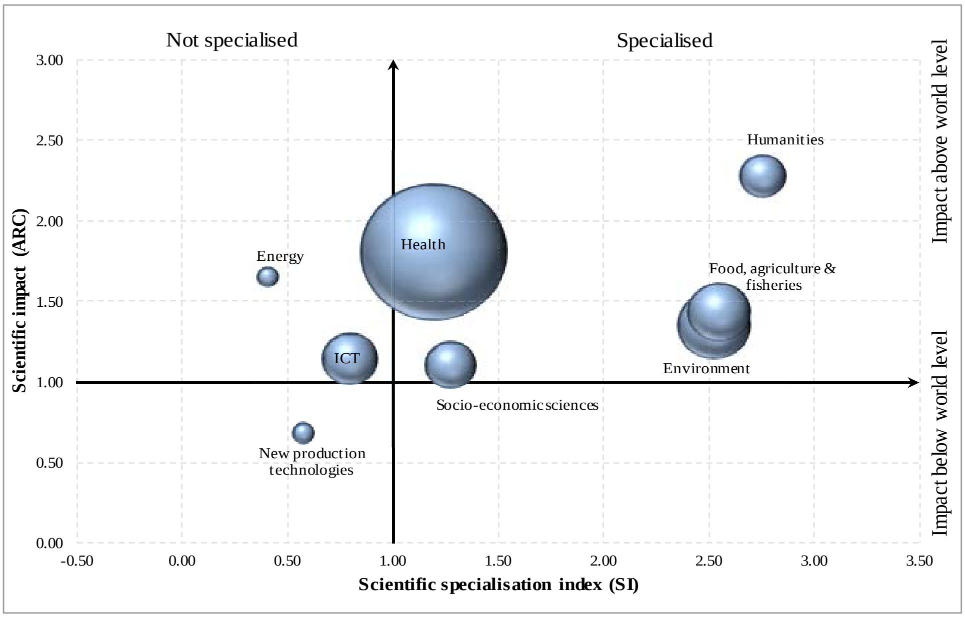
Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

Comparison of the scientific and technological specialisation in selected thematic priorities shows a mixed situation with some co-specialisations as well as some mismatches. Technology production is strongly specialised in biotechnology, food, agriculture, fisheries, and health. Iceland, together with Switzerland and the Netherlands, is among the countries with the highest scientific impact for health. In the case of health, and food, agriculture and fisheries, the co-specialisation in S&T over the last decade shows that Iceland has been successful in transferring knowledge from science to technology in those fields. However, there is no corresponding scientific specialisation for a strong technological performance in the field of biotechnology. On the other hand, the science created in the fields of security, and environment is not translated into technology. High growth rates of patenting in security, ICT, materials, and construction show the potential for increasing specialisation in those fields in the future. It is interesting to note that biotechnology and environment are among the fields in which Iceland is the most successful in FP7. However, this is not matched by S&T co-specialisation in those fields at the national level. Therefore, these sectors could be scrutinised more closely when evaluating the strengths of research performed at national level.

Iceland is among those European countries with the highest scientific impact and has a high ratio of highly cited publications per total publications. Excellence in science is noted for most of the fields. As illustrated in the graph below, Iceland's strong scientific specialisation in the fields of environment, humanities, food, agriculture and fisheries, health, and socio-economic sciences matches the high impact of those fields above the world level.

The graph below illustrates the positional analysis of Icelandic publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Iceland publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit

Data: Science Metrix - Canada, based on Scopus

Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

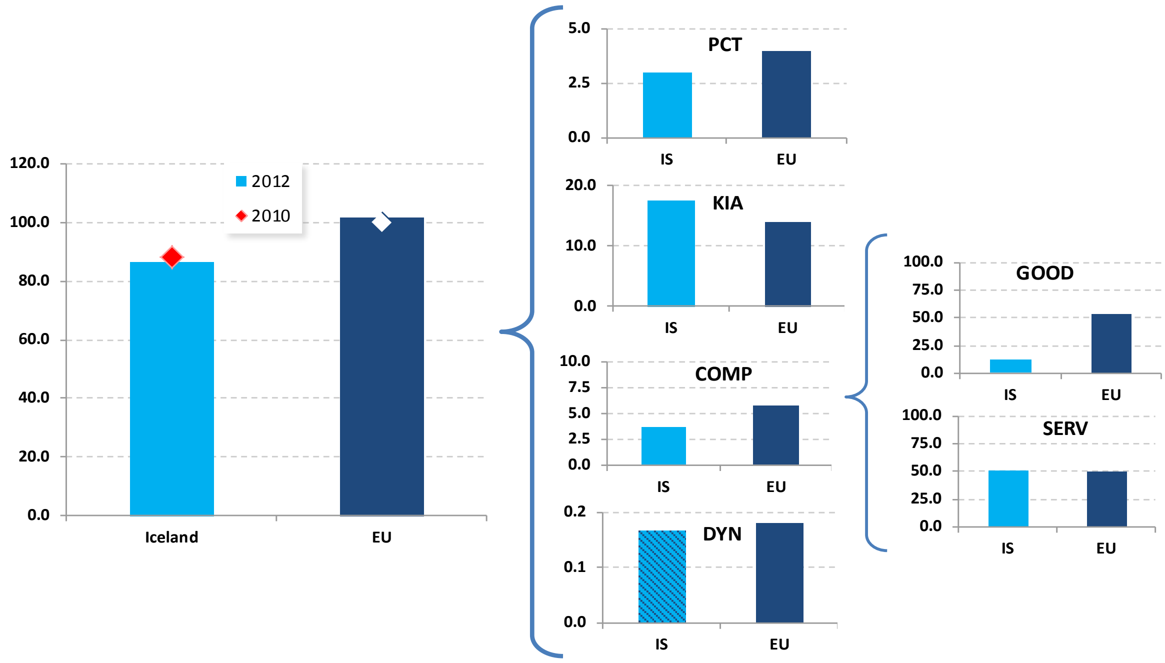
Icelandic excellence in research is correlated to important cooperation with researchers from other European countries and beyond. In general, the smaller countries, like Iceland and Luxembourg, are forced to specialise more and make strategic choices regarding their collaborative links.

In the fields where Iceland is specialised in both science and technology, the ERA offers good opportunities for cooperation, in particular with Denmark, Latvia, Switzerland and Croatia in the field of health, and with Norway, Denmark, Lithuania, the Netherlands, Switzerland, Slovakia, Spain and Portugal in the food and agriculture sector.

Innovation Output Indicator

The Innovation Output Indicator, launched by the European Commission in 2013, was developed at the request of the European Council to benchmark national innovation policies and to monitor the EU's performance against its main trading partners. It measures the extent to which ideas stemming from innovative sectors are capable of reaching the market, providing better jobs and making Europe more competitive. The indicator focuses on four policy axes: growth via technology – (patents); jobs (knowledge-intensive employment); long-term global competitiveness (trade in mid/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Iceland's position regarding the indicator's different components.

Iceland - Innovation Output Indicator



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, OECD, Innovation Union Scoreboard 2014, DG JRC
Notes: All data refer to 2012 except PCT data, which refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in knowledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-growth enterprises (employment-weighted average); estimated value.
COMP = Combination of sub-components GOOD and SERV, using equal weights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Knowledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

The indicator places Iceland among medium-low performers. This is the result of low performance in the export share of medium-/high-tech goods where the country's performance is very low. Historically, Iceland is a resource-based economy with its fishing industry and energy being the main drivers of its economy. With no sizeable high-tech industry and a high share of food exports (fish), Iceland scores at a low level as regards the share of medium-/high-tech goods in total goods exports. As a result of its high share of air-transport services, the country scores better (slightly above the EU average) in knowledge-intensive service exports.

Together with Switzerland, Luxembourg, Ireland, Sweden and Belgium, Iceland has the most knowledge-intensive economy in terms of employment. An above-EU-average share of employment in information and communication, financial services, education, health, and the arts explains the country's high share of employment in knowledge-intensive activities which, despite having dropped slightly since 2009, is still well above the EU average. Iceland is among those European countries which registered a fall in international co-patenting as a significant drop in PCT patent applications was observed in the country in the period 2009-2011.

Key indicators for Iceland

ICELAND	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)
ENABLERS											
Investment in knowledge											
New doctoral graduates (ISCED 6) per thousand population aged 25-34	0.05	0.34	0.34	0.22	0.48	0.67	0.77	:	:	52.2	*1.81*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	506	:	:	507	:	:	493	-12.7 (3)	495 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	*1.50*	1.43	1.59	1.46	1.44	1.64	1.39	1.26	:	-3.7	1.31
Public expenditure on R&D (GOVERD + HERD) as % of GDP	*1.11*	1.26	1.32	1.15	1.14	1.39	:	1.06	:	*-2.0*	*0.74*
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation											
Composite indicator on research excellence	:	:	:	25.3	:	:	:	:	38.7	8.8	47.8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	10.8	11.4	11.3	11.5	11.5	:	:	:	1.1	11.0
International scientific co-publications per million population	:	1376	1387	1737	1862	2302	2662	2648	2725	9.4	343
Public-private scientific co-publications per million population	:	:	:	192	200	216	239	255	:	7.4	53
FIRM ACTIVITIES AND IMPACT											
Innovation contributing to international competitiveness											
PCT patent applications per billion GDP in current PPS€	4.7	4.7	4.2	3.0	2.7	3.9	3.0	:	:	-0.2	3.9
License and patent revenues from abroad as % of GDP	0.00	:	0.00	0.00	0.00	1.80	1.60	1.55	:	-7.1 (5)	0.59
Community trademark (CTM) applications per million population	14	41	167	319	399	178	126	97	147	-14.3	152
Community design (CD) applications per million population	:	14	7	10	13	6	22	9	13	5.1	29
Sales of new to market and new to firm innovations as % of turnover	:	:	:	:	:	:	6.1	:	:	:	14.4
Knowledge-intensive services exports as % total service exports	:	:	:	:	:	53.1	51.6	51.0	:	-2.0	45.3
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-19.65	-16.81	-17.67	-13.22	-12.93	-11.96	-12.69	-13.57	-14.98	-	4,23 (6)
Growth of total factor productivity (total economy) - 2007 = 100	94	102	100	100	99	97	94	96	97	-3 (7)	97
Factors for structural change and addressing societal challenges											
Composite indicator on structural change	:	:	:	54.9	:	:	:	:	55.8	0.3	51.2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	18.2	18.8	18.3	18.2	17.4	-1.1	13.9
SMEs introducing product or process innovations as % of SMEs	:	:	:	:	:	:	54.2	:	:	:	33.8
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.57	0.02	0.00	0.00	0.00	0.11	:	:	:	46.8	0.44
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	1.65	2.40	1.51	0.47	0.87	0.65	:	:	:	17.5	0.53
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES											
Employment rate of the population aged 20-64 (%)	:	85.5	86.3	86.7	85.3	80.6	80.4	80.6	81.8	-1.2	68.4
R&D Intensity (GERD as % of GDP)	*2.67*	2.77	2.99	2.68	2.65	3.11	:	2.40	:	-2.8	*2.07*
Greenhouse gas emissions - 1990 = 100	110	109	124	131	142	134	130	:	:	-1 (8)	83
Share of renewable energy in gross final energy consumption (%)	:	:	:	:	:	:	:	:	:	:	:
Share of population aged 30-34 who have successfully completed tertiary education (%)	32.6	41.1	36.4	36.3	38.3	41.7	40.9	44.6	42.8	3.3	35.7
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	29.8	24.9	25.6	23.2	24.4	21.3	22.6	19.7	20.1	-2.8	12.7
Share of population at risk of poverty or social exclusion (%)	:	13.3	12.5	13.0	11.8	11.6	13.7	13.7	12.7	-0.5	24.8

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
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(3) The value is the difference between 2012 and 2006.
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(9) Values in italics are estimated or provisional.

Israel

The challenge of attracting foreign funding for innovation

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Israel. They relate knowledge investment and input to performance and economic output throughout the innovation cycle. They show thematic strengths in key technologies and also the high-tech and medium-tech contribution to the trade balance. The indicator on excellence in science and technology takes into consideration the quality of scientific production as well as technological development. The Innovation Output Indicator covers technological innovation, skills in knowledge-intensive activities, the competitiveness of knowledge-intensive goods and services, and the innovativeness of fast-growing enterprises, focusing on innovation output. The indicator on knowledge-intensity of the economy focuses on the economy's sectoral composition and specialisation and shows the evolution of the weight of knowledge-intensive sectors and products.

Key indicators of research and innovation performance	
R&D intensity 2012: 4.20 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -2.5 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[34] 2012: 64.5 (EU: 47.8; US: 58.1) 2007-2012: -2.1 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: n.a. (EU: 101.6)	*Knowledge-intensity of the economy*[35] 2012: n.a (EU: 51.2; US: 59.9) 2007-2012: n.a.% (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: ICT, biotechnology, security, and health	*HT + MT contribution to the trade balance* 2012: 5.9 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +8.7 % (EU: +4.8 %; US: -32.3 %)

Israel is a very knowledge-intensive country. It has a strong and dynamic business sector and has achieved excellence in scientific and technical education and research. This has led to high levels of technological entrepreneurship and start-ups. The economy is very knowledge-intensive with high-tech and medium-tech products contributing significantly to the trade balance. The country's main strengths are its high research intensity, mainly due to a very high business expenditure on R&D, and its patenting activity.

Nevertheless, in spite of this high performance in the field of R&I, Israel faces some structural challenges that have created a certain degree of stagnation over the last decade. Budgets for Israeli universities have not increased in line with the growth of student numbers, resulting in a decline in scientific production and the outward mobility of students. Venture capital (VC) has fallen due to the low returns on VC investments. As a consequence, the total funds available for investment are at a lower level than in previous years. Israeli fund-management firms need to raise new funds if they are to continue their important role in supporting Israeli start-ups.

Recently, the governance of the public R&I system has been reformed, and a six-year plan to revive higher education and university-based research was launched in 2011. The plan calls for a 30 % increase in budgets, a doubling of funding for competitive grants, and a 9 % increase in the number of researchers. The plan provides for the creation of 20 new CORE centres of research, four of which are already operational.

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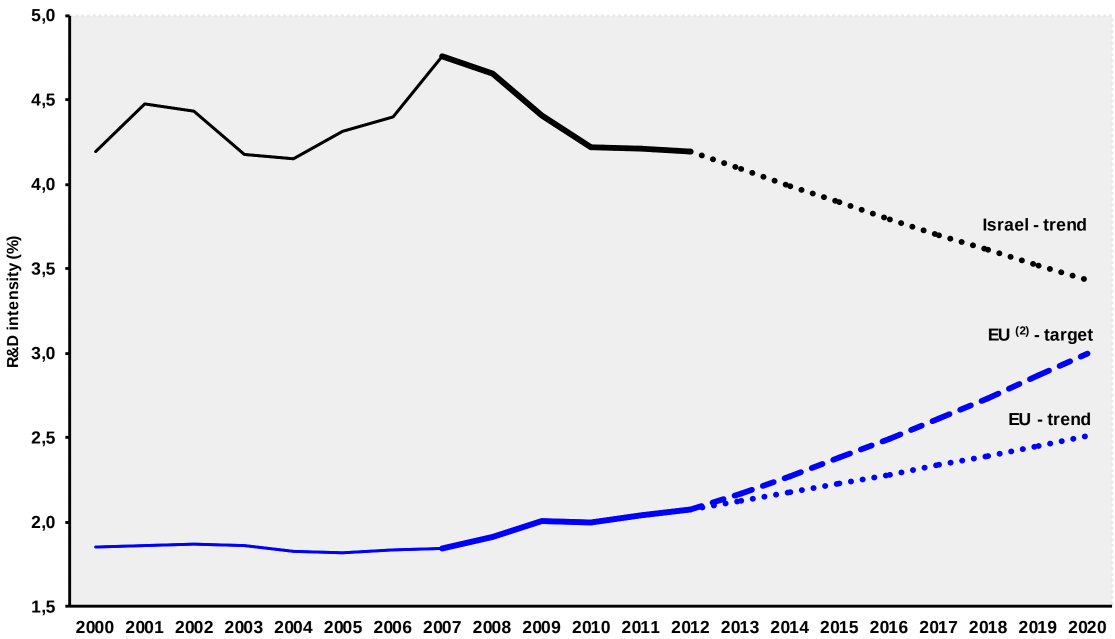
[34] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[35] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

Investing in knowledge

Israel - R&D intensity projections, 2000-2020 (1)



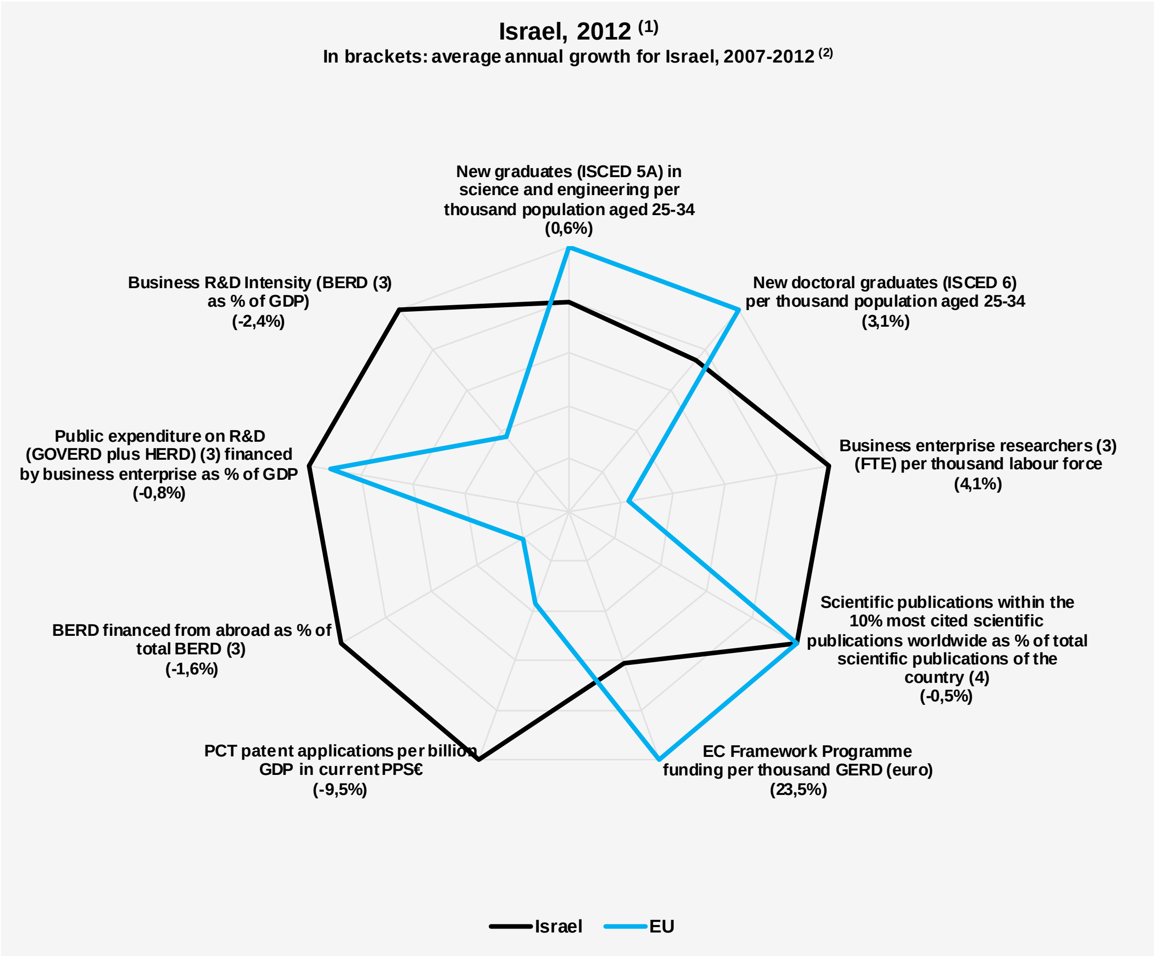
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) IL: An R&D intensity target for 2020 is not available.

In 2000, Israel's R&D intensity was already higher than 4 % and continued to increase until 2007, when it reached 4.84 %. It then fell to 4.20 % in 2012, a value which is more than double the EU average. The business sector accounts for around 80 % of total R&D expenditure. Although Israel was less affected by the global economic and financial crisis than other countries, business R&D intensity decreased from 3.9 % in 2007 to 3.54 % in 2012.

Foreign-owned firms are contributing to increasing the country's R&D intensity through inward investment in R&D. The level of this investment is an indicator of the degree of internationalisation of business R&D as well as the country's attractiveness for foreign investors. The BERD finance from abroad is 50 % of the total BERD, while the EU average is around 10 %.

An effective research and innovation system building on the European Research Area

The graph below illustrates the strengths and weaknesses of Israel's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology valorisation and innovation. Average annual growth rates from 2000 to the latest available year are given in brackets.



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates which do not refer to 2007-2012 refer to growth between the earliest available year and the latest available year for which comparable data are available over the period 2007-2012.
(3) IL: Defence is not included.
(4) Fractional counting method.

The graph shows that Israel is well above the EU average for the majority of the R&I indicators. Indeed, the country's overall level of innovation performance places it among the group of European 'innovation leaders'. Only Sweden, Switzerland and Finland show higher levels of innovation performance. PCT patent applications per billion GDP are three times higher than the EU average, which is a considerable difference.

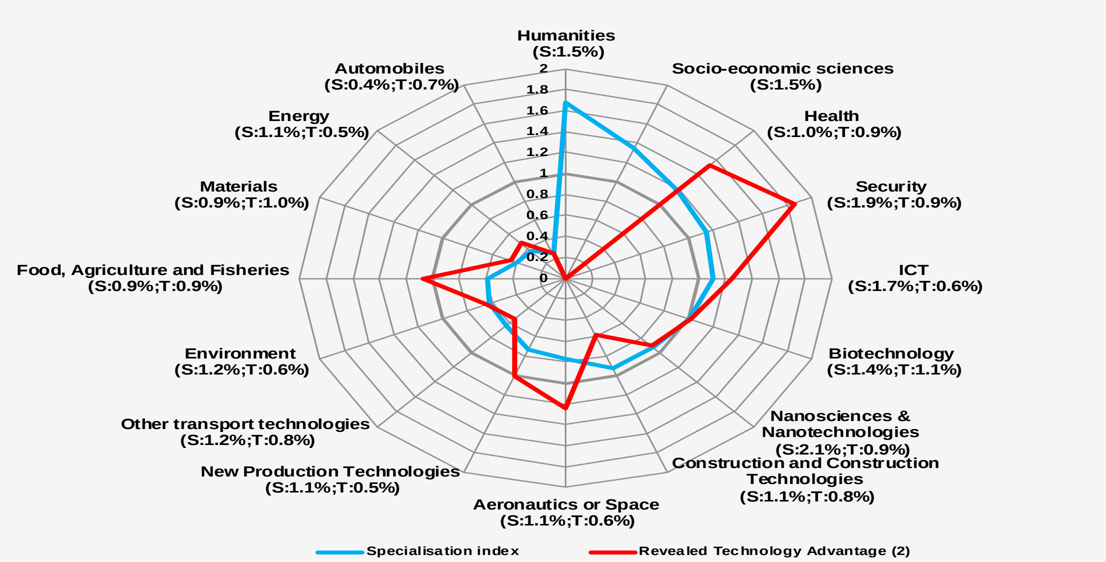
Although the supply of human resources for science and technology is below the EU average for new science and technology graduates and new doctoral graduates per thousand population aged 25-34 years, knowledge production – as evidenced by highly cited scientific publications – is at the same level as the EU average, indicating a good scientific base. This is confirmed by Israel's remarkable level of participation as an Associated Country in the EU's Seventh Framework Programme (FP7). The total number of participants is 1816 (out of 8602), receiving more than EUR 747 million. The success rate of the participants is 21.1 %, which is above the EU average.

Israel's scientific and technological strengths

The spider graph below illustrates the areas, based on the Framework Programme thematic priorities, where Israel shows potential in science and technology areas in a European context. Both the specialisation index (SI) and the revealed technological advantage (RTA) measure the country's scientific (SI) and technological (RTA) capacity compared to that at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.

Israel S&T National Specialisation(1) in thematic priorities, 2000-2010

in brackets: growth rate in number of publications(3) (S) and in number of patents(4) (T)

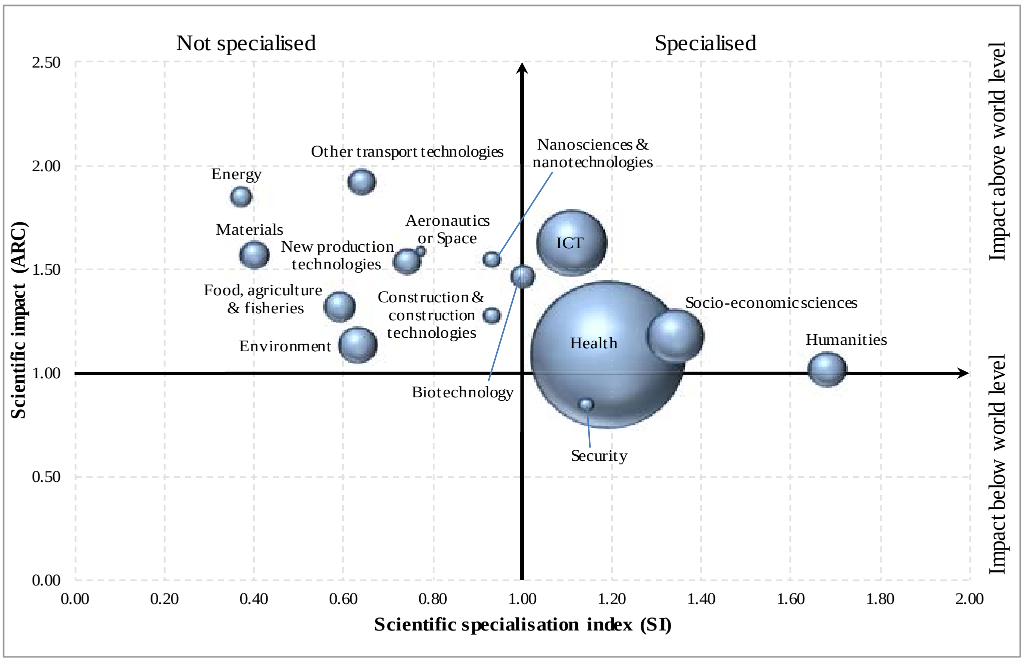


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the WIPO-PCT number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent applications in "Aeronautics or Space" refers only to "Aeronautics" data.
(3) The growth rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

The figures show that overall Israel is successful in transferring knowledge from science to technology in most of the analysed fields. In addition, there has been a general coherence in the dynamics of co-specialisation in S&T over the last decade, whereby a simultaneous growth in both publications and patents can be observed in various fields (except for socio-economic sciences and humanities, where there are no patents). Another positive aspect is reflected by the general higher level of specialisation in technology compared to science, which can be interpreted in the sense that the technological performance of the country is based on national science – with an overall excellent quality – as well as on science coming from abroad.

The graph below illustrates the positional analysis of Israeli publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share of scientific publications from a science field in the country's total publications.

Positional analysis of Israel publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Science Metrix - Canada, based on Scopus
Notes: Scientific specialisation include 2000-2010 data; the impact is calculated for publications of 2000-2006, citation window 2007-2009

As regards scientific quality (see graph above) Israel performs well in all the scientific priorities. It is worth noting that there is a good match between scientific quality and technological specialisation at country level in the fields of ICT, biotechnology, and health.

Key indicators for Israel

ISRAEL	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)
ENABLERS											
Investment in knowledge											
New doctoral graduates (ISCED 6) per thousand population aged 25-34	:	1,15	1,14	1,20	1,32	1,25	1,37	1,36	:	3,1	*1,81*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	442	:	:	447	:	:	466	24.6 (3)	495 (4)
Business enterprise expenditure on R&D (BERD) (5) as % of GDP	3,37	3,52	3,60	4,00	3,87	3,68	3,51	3,54	3,54	-2,4	*1,31*
Public expenditure on R&D (GOVERD + HERD) (6) as % of GDP	0,79	0,76	0,73	0,70	0,73	0,67	0,66	0,63	0,60	-2,8	*0,74*
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation											
Composite indicator on research excellence	:	:	:	71,7	:	:	:	:	64,5	-2,1	47,8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	11,0	11,0	11,0	11,0	:	:	:	:	-0,5	11,0
International scientific co-publications per million population	573	774	800	828	836	820	860	896	:	2,0	343
Public-private scientific co-publications per million population	:	:	:	:	:	:	:	:	:	:	:
FIRM ACTIVITIES AND IMPACT											
Innovation contributing to international competitiveness											
PCT patent applications per billion GDP in current PPS€	11,9	14,1	14,8	14,2	12,3	11,7	10,5	:	:	-9,5	3,9
License and patent revenues from abroad as % of GDP	:	:	:	:	:	:	:	:	:	:	:
Community trademark (CTM) applications per million population	:	:	:	:	:	:	:	:	:	:	:
Community design (CD) applications per million population	:	:	:	:	:	:	:	:	:	:	:
Sales of new to market and new to firm innovations as % of turnover	:	:	:	:	:	:	:	:	:	:	:
Knowledge-intensive services exports as % total service exports	:	:	:	:	:	:	:	:	:	:	:
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-4,67	-3,08	-2,29	-5,06	4,23	6,86	6,48	5,42	5,92	-	4,23 (7)
Growth of total factor productivity (total economy) - 2000 = 100	:	:	:	:	:	:	:	:	:	:	:
Factors for structural change and addressing societal challenges											
Composite indicator on structural change	:	:	:	67,8	:	:	:	:	67,8	-0,01	51,2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	:	:	:	:	:	:	:
SMEs introducing product or process innovations as % of SMEs	:	:	:	:	:	:	:	:	:	:	:
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,16	0,27	0,37	0,31	0,55	0,44	:	:	:	19,8	0,44
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	2,86	3,81	3,19	3,06	2,93	2,75	:	:	:	-5,3	0,53
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES											
Employment rate of the population aged 15-64 (%)	56,1	56,7	57,6	58,9	59,8	59,2	60,2	60,9	66,5	2,4	64,1
R&D Intensity (GERD (5) as % of GDP)	4,19	4,32	4,39	4,76	4,66	4,40	4,22	4,21	4,20	*-2,5*	*2,07*
Greenhouse gas emissions - 1990 = 100	:	:	:	:	:	:	:	:	:	:	:
Share of renewable energy in gross final energy consumption (%)	:	:	:	:	:	:	:	:	:	:	:
Share of population aged 25-34 who have successfully completed tertiary education (%)	:	:	:	:	:	:	44,2	:	:	:	34,6
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	:	:	:	:	:	:	:	:	:	:
Share of population at risk of poverty or social exclusion (%)	:	:	:	:	:	:	:	:	:	:	:

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT.
(5) Defence is not included,
(6) Defence is not included in GOVERD; Social Sciences and Humanities is not included in HERD.
(7) EU is the weighted average of the values for the Member States.
(8) Values in italics are estimated or provisional.