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

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Estonia

The challenge of continuing upgrading Estonian industry by research and innovation

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Estonia. 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 the 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: 2.18 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +15.1 % (EU: +2.4 %; US: +1.2 %)	*Excellence in S&T*[1] 2012: 29.4 (EU: 47.8; US: 58.1) 2007-2012: +13.4 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 81.7% (EU: 101.6)	*Knowledge-intensity of the econom*[22] 2012: 49.5 (EU: 51.2; US: 59.9) 2007-2012: +2.7 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Energy, environment, food and agriculture	*HT + MT contribution to the trade balance* 2012: -2.9 % (EU: 4.23 %; US: 1.02 %) 2007-2012**: n.a. (EU: +4.8 %; US: -32.3 %)

Broadly speaking, since the 2000s', the basic principles of developing R&D and innovation as well as policy and implementation system in Estonia have remained the same. While the policy mix has been set in the right direction, driven by steady development based on quality, excellence and competition, Estonia still has to develop an R&I system able to make a real difference to the economy at large, filling the remaining gaps. Further efforts are needed in terms of tackling the lack of highly skilled personnel that is hindering growth and investments, the low level of cross-sector cooperation (business/academia/government) that is hampering the effective translation of research and development results into innovation, and the weak internationalisation of the R&I system.

A rather significant challenge affecting the R&I system is coming from Estonia's industrial sector, mainly driven by a large volume of subcontracting in manufacturing. Therefore, any effort to upgrade the role of the country's industry in global value chains through R&I is of the utmost importance in raising overall productivity and added value. This requires developing a broad range of supply-and-demand policies. The small size of the country is reflected in its limited number of companies, and the lack of economies of scale and critical mass in many areas of research.

However, Estonia has been able to turn its small size into an advantage by means of specialisation. The innovation governance system has remained basically intact since 2000.The present system is uncomplicated with quite a clear division of responsibilities and a firm connection with the political leadership. The main priorities for R&D and innovation policies set down in the RDI Strategy 2007-2013 have been followed. While this strategy focused more on capacity building, the new strategic documents for 2014-2020 concentrate on obtaining social and economic results from these capacities. The effective implementation of these reforms through concrete measures, developed and defined in

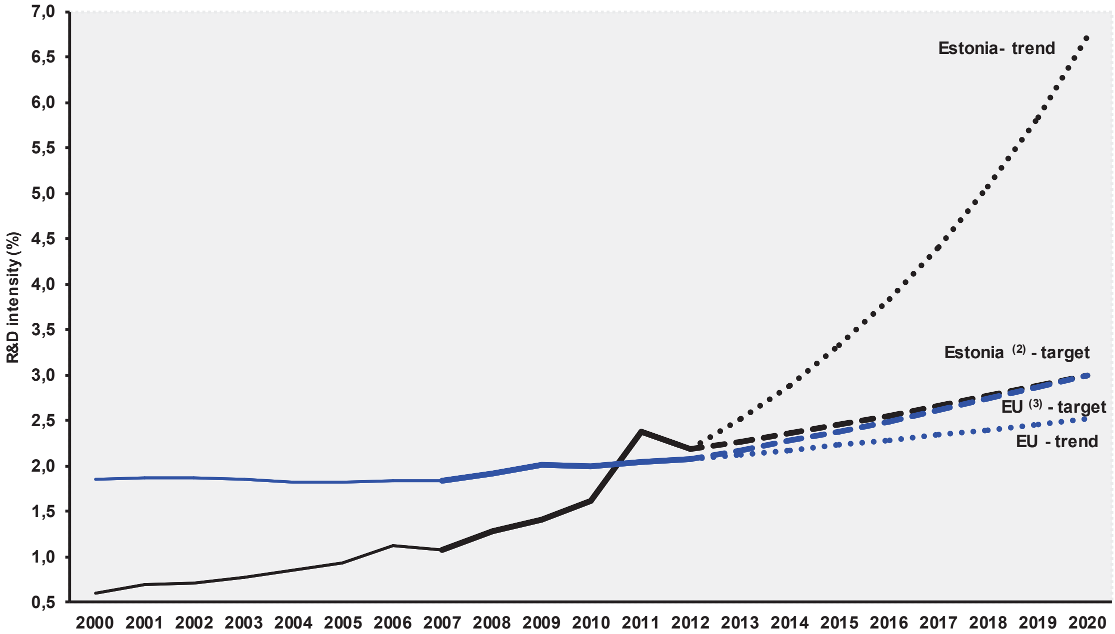
[1] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

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

cooperation with all stakeholders (government, financial institutions, industry, SMEs, academia), should enable Estonia to make further progress.

Investing in knowledge

Estonia - 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) EE: 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.

Estonia had an R&D intensity of 2.18 % in 2012, slightly above EU average, which puts the country in ninth place within the EU-28 R&D intensity ranking. Despite a slight decrease from 2.37 % in 2011, the country seems well on track to reach its 3 % R&D intensity target for 2020. Business R&D intensity was at 1.25 % in 2012, only slightly below the EU average, with an overall annual growth rate of 19.7 % between 2007 and 2012. Public expenditure on R&D reached a share of 0.91 % of GDP in 2012, above the EU average, with an overall annual growth rate of 10.7 % between 2007 and 2012. The overall growth in R&D investments has been impressive, but questions remain as to whether the current trajectory is sustainable in view of the shale-oil sector's key role in an increase in business R&D expenditure and of the European Structural Funds in an increase of public R&D expenditure.

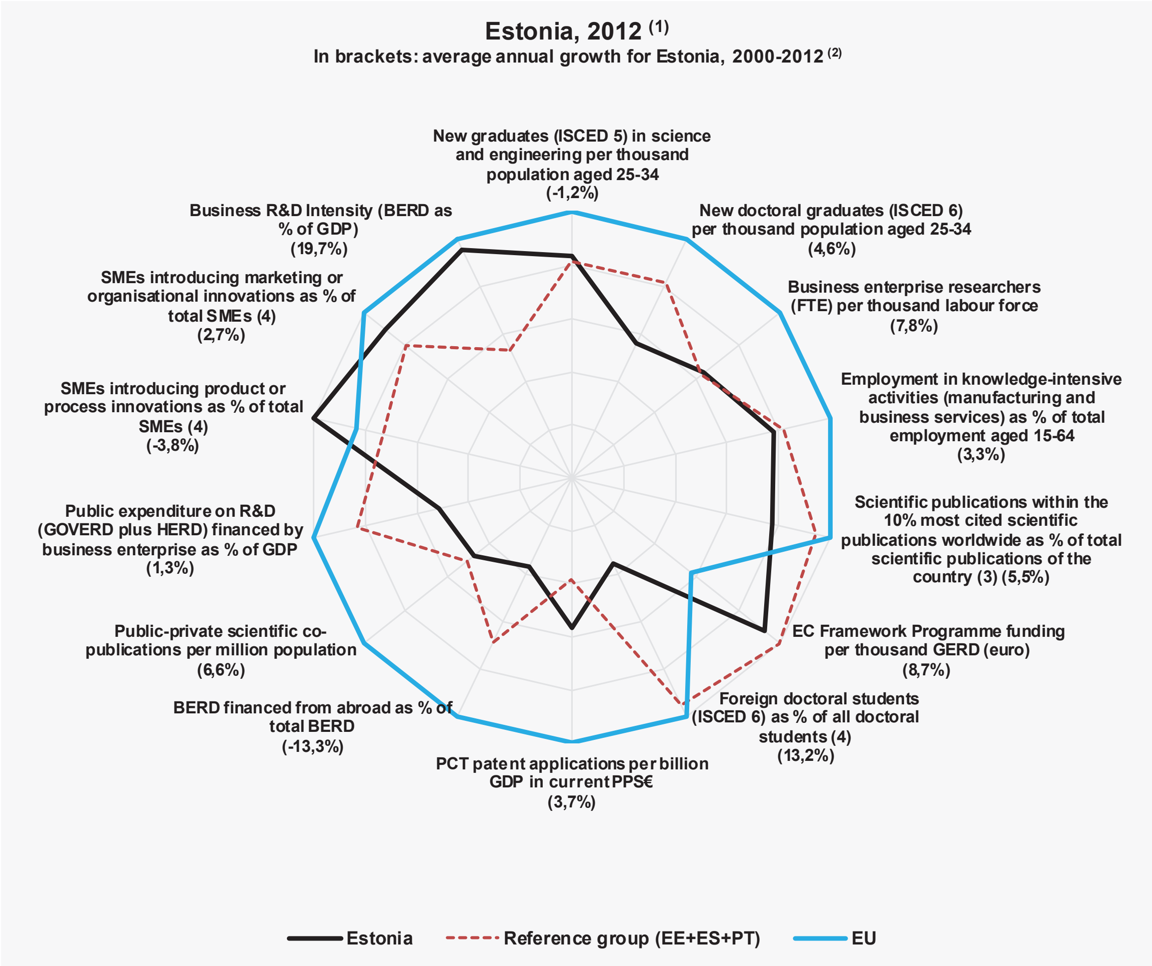
To date, the number of Estonians participating in the Seventh Framework Programme totals 489 (out of 2359 applications); in total, they have received about EUR 80.1 million. Their success rate is 15.21 % (data from E-CORDA, November 2013). Structural Funds are another important source of funding for R&I activities. Of the EUR 3.4 billion of Structural Funds allocated to Estonia over the 2007-2013 programming period, around EUR 681 million (20 % of the total) relate to RTDI[3]. The absorption rate of the funds dedicated to R&I and entrepreneurship for 2007-2013 is 85.4 %.

[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.

Notwithstanding the high level of public funding of R&D, reaching the 2020 R&D intensity target will depend both on the ability to attract R&D intensive foreign direct investments and a further significant growth in business R&D. The expected leverage effect of the front-loaded EU Structural Funds for business R&D will be monitored closely.

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

The graph below illustrates the strengths and weaknesses of Estonia'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 (2012) 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.

The graph above shows a performance above the EU average both in small and medium-sized enterprises (SMEs) introducing product or process innovation, and in funding from the EC Framework Programme. However, for the time being Estonia remains below the EU average in all four large dimensions of its R&I system: human resources, scientific production, technology development and innovation. In the field of human resources for R&I, Estonia is still suffering from a low number of new doctoral graduates and business enterprise researchers, although it has made good progress in the past year to catch up with its reference group. The share of foreign doctoral students remains at a low level, while BERD financed from abroad as part of total BERD has followed a negative trend, falling to 13.3 % for 2012.

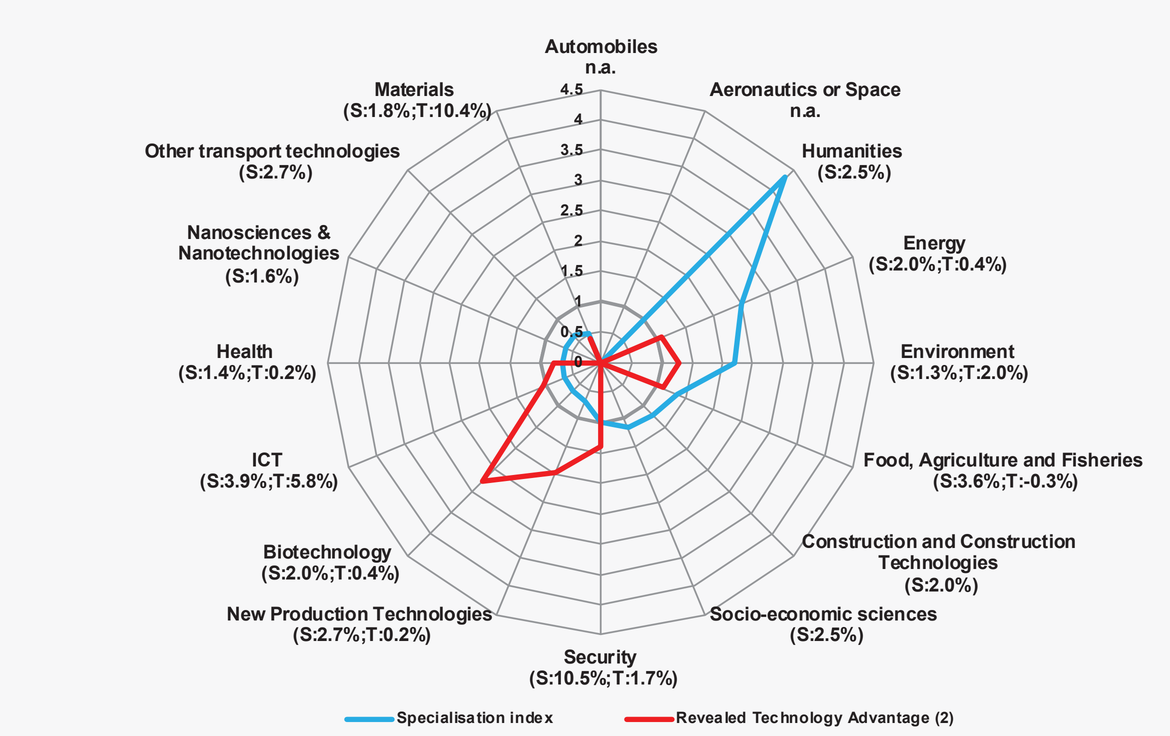
While these indicators show that the measures taken by Estonia have produced some results, they also point to the need to continue enhancing the quality of the higher education system and addressing the non-absorption of highly skilled graduates in firms. Estonia has improved its scientific quality and production but still faces the challenge of increasing the excellence and internationalisation of its research institutions. It has also made some progress in its public-private cooperation performance although it still performs well below the EU average. Knowledge valorisation takes place in clusters, where SMEs, larger firms and public research organisations cooperate and compete. Business R&D intensity and PCT patent applications have increased, although they remain below the EU average.

Estonia's scientific and technological strengths

The graph below illustrates national specialisation in thematic priorities and hence Estonia's science and technology strengths. 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.

Estonia 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.

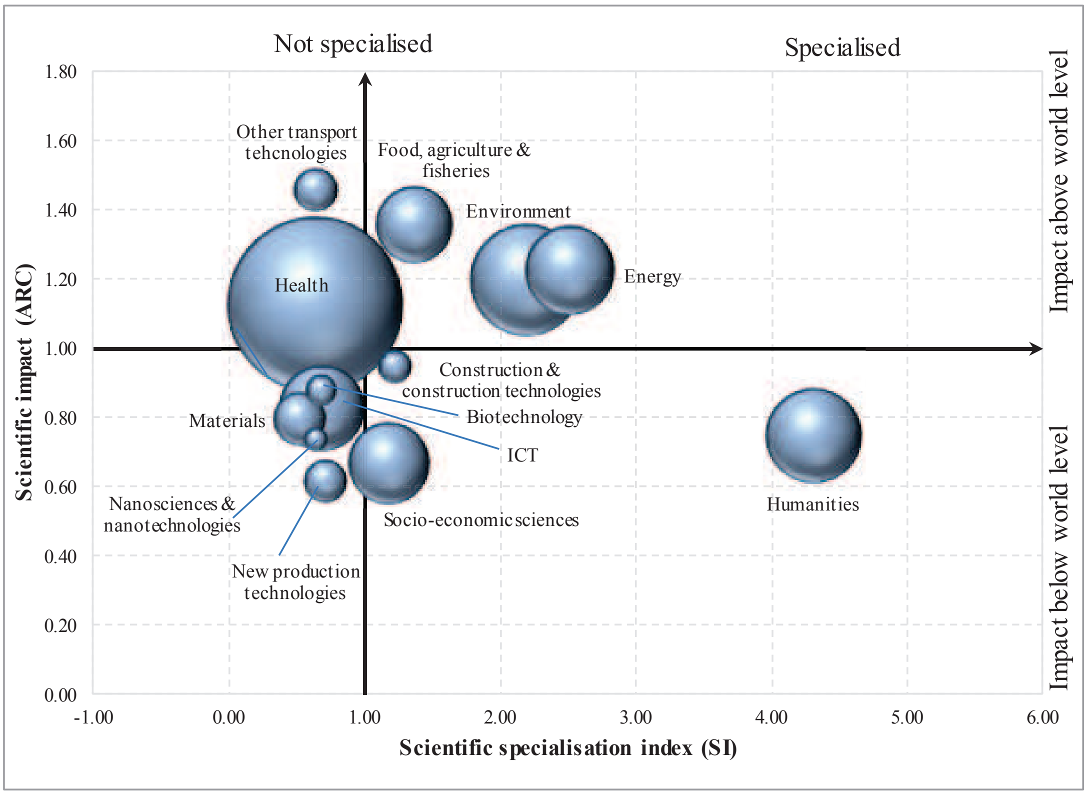
As illustrated in the graph above, there is little correlation between scientific production (publications) and technological production (patents) in Estonia. As regards publications, the country shows specialisation in the fields of humanities, energy, environment, and food, agriculture and fisheries. As regards patents (technological output), Estonia has strengths in biotechnology, new production technologies, security, and ICT.

The country has a medium-level knowledge capacity and a relatively young R&I system. Sectors with strong potential for a smart specialisation strategy are those in which it is specialised in both science and technology. Estonia's science and technology specialisation profile is built around food, agriculture and fisheries, security, energy and the environment. In other sectors, the country has no scientific or technological specialisation yet, although the overall production of publications and patents is growing significantly, indicating a possible future specialisation profile. Estonia is experiencing a very high growth rate of patents in both materials and ICT. With a focused R&I system, it has the possibility to push for economic transformation in some new knowledge-intensive fields. This may be the case for health in Estonia, an area where the country counts on excellent science and a broad participation in the Framework Programme, ensuring S&T co-creation and network building.

Estonia's main key challenges, as illustrated above, prove the special attention being given to them in the country's policy documents. Among them, the weak R&D system and poor cooperation between academia and industry sectors should be properly addressed in the implementation measures. The new RDI Strategy 2014-2020 pointed to ICT areas cross-cutting other sectors horizontally, health technologies and services, and the more efficient use of resources as sectors for country specialisation. This orientation will give the necessary push for these sectors to develop or extend their technological quality further, and to maintain their dynamism in the long term.

The graph below illustrates the positional analysis of Estonian 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 Estonia 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 country's areas of specialisation in environment, energy, food and agriculture also proved to be the areas making an impact above the world level. The only exception is the area of humanities which is performing less well. On the other hand, the impact made by good-quality scientific production in health and other transport technologies is slightly above the world level for the first specialisation and well above for the second one, even though Estonia has a low specialisation level in those areas.

Policies and reforms for R&I

Estonia's innovation governance system has remained basically intact with a rather clear division of responsibilities. The Research and Development Council (R&D Council) is an expert consultative body that advises the government on R&D and innovation matters – all policy documents seeking approval from the government have to pass through the R&D Council. The Ministry Education and Research (MoER) and the Ministry of Economic Affairs and Communications (MEAC) are the ministries responsible for the implementation of economic policy, and R&I policy. The cooperation between ministries is important for smart specialisation measures, several of which are relevant to many growth areas. A Smart Specialisation Steering Committee was created to encompass ministries in the respective growth areas.

The Estonian Development Fund is a promoter of innovation-oriented projects which carries out risk capital investments in start-up and growth-oriented technology companies as well as socio-economic and technology Foresight exercises. The Enterprise Estonia Foundation, responsible for managing business support, innovation and technology programmes, and the KredEx Foundation, which helps to increase the competitive strength of Estonian companies by improving the availability of financing and managing credit risks, are the two implementing agencies supporting MEAC.

The Baltic Innovation Fund (BIF) is a 'fund-of-fund' initiative launched by the EIF in 2012 in close cooperation with the governments of Lithuania, Latvia and Estonia to boost equity investments in those Baltic SMEs with high growth potential. With a focus on the Baltic States, over the next four years BIF will invest EUR 100 million into private equity and venture capital funds through a fund-of-fund process to attract additional private finance and to implement the best market standards for equity investing in businesses.

The Cluster Development Programme (2008-2013) and Competence Centre programme (2008-2013) are state-aid measures classified as aid for innovation clusters. A total of 19 cluster projects and eight competence centres have already received funding. In October 2013, the first Social Innovation Incubator (SEIKU), co-financed by Enterprise Estonia, was founded and began operations.

From the research policy perspective, the Ministry of Education and Research has two main agencies which deliver funding and support: the Archimedes Foundation is coordinating and implementing different national and international programmes and projects in the field of training, education and research (among the other activities it is also implementing agency for structural support). Since 1 March 2012, the Estonian Research Council has been responsible for distributing grants and handling grant applications as well as assessing the effectiveness of grants and the availability of research information. The Estonian Research Council acts as a national contact point for the Seventh Framework Programme/Horizon 2020 Framework Programme and is responsible for international, bi- and multinational research cooperation programmes and organisations.

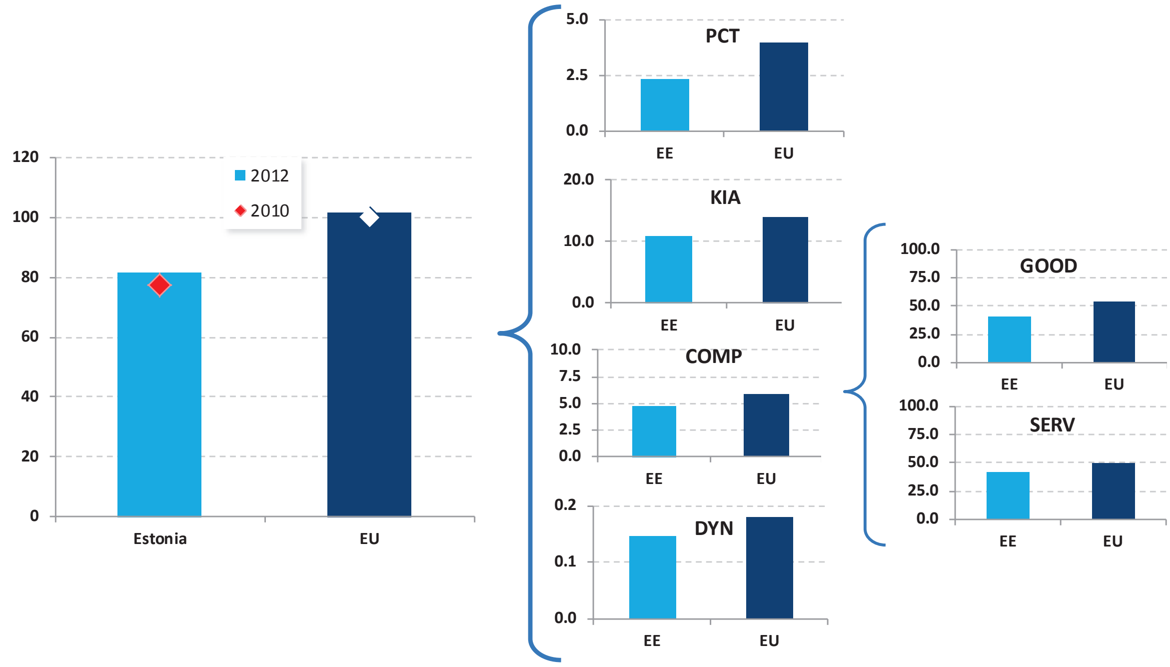
The only ministry with a sectoral RD&I Strategy (Strategy for Agricultural Research 2007-2013) and corresponding budget (EUR 10.9m) is the Ministry of Agriculture.

The Estonian approach to R&I in the new programming period is built around two strategies: the RD&I Strategy 2014-2020 'Knowledge-based Estonia', approved by *Riigikogu* (Parliament) in January 2014, and the Estonian Entrepreneurship Growth Strategy 2014–2020, adopted by the government in October 2013. The two strategies are analysing the possibility of gradually replacing current direct support actions with financial instruments, increasing the competency of the human resources – from inside the country or from abroad – enhancing national as well as international cooperation of Estonian R&D institutions and enterprises, reinforcing the framework for cooperation between the private and public sector, and developing demand-side policies for innovation solutions. However, since the implementing measures remain unclear it is difficult to assess whether or not they will meet the objectives and fill the persisting gaps, namely in the weak public-private cooperation.

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 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 Estonia's position regarding the indicator's different components.

Estonia - 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 %).

Estonia is a medium-low performer in the European innovation indicator. It has no area of strong performance and scores below the EU average for most components. However, its performance has improved slightly since 2010.

Its relatively low performance in patents is linked to its economic structure, and the lack of large manufacturing companies, which typically show high patenting activities[4].

Employment in knowledge-intensive activities is relatively low because sectors classified as not knowledge intensive, such as construction, manufacturing in general, and transport, are comparatively important in Estonia.

With no road vehicle or pharmaceutical industry and a relatively large export share of mineral fuels, wood, paper and textiles, Estonia scores low as regards the share of medium-high/high-tech goods in total goods exports.

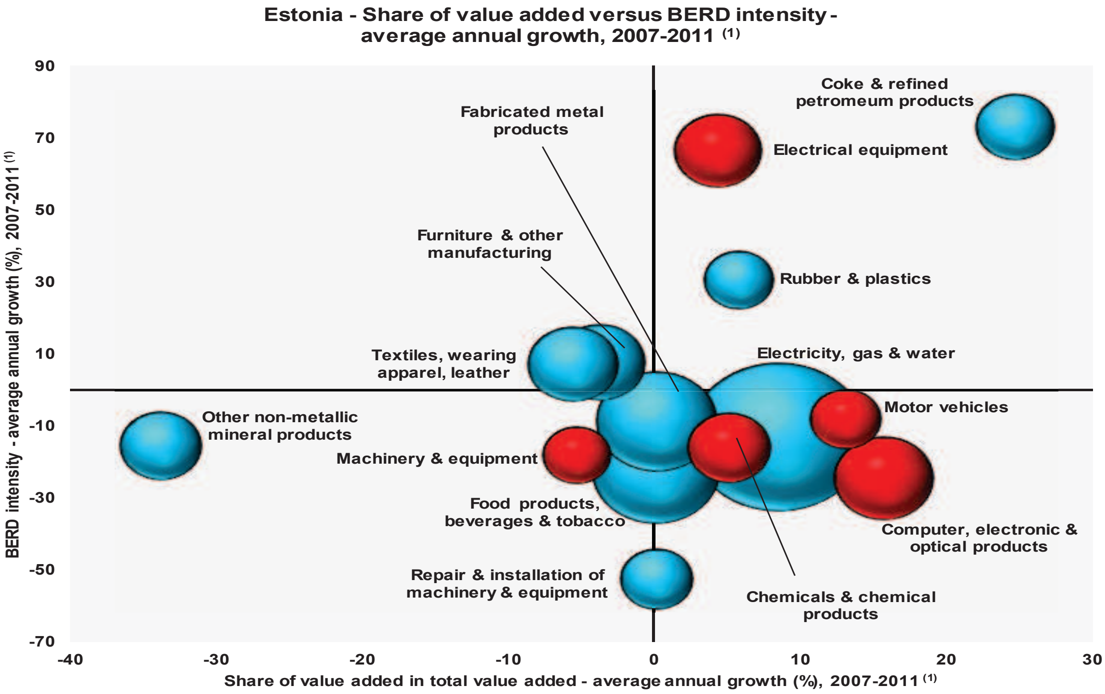
Estonia's performance is low as regards the innovativeness of fast-growing firms. This is a result of a high share of low-tech manufacturing, construction, and administrative and support activities (for example, private security companies) among the fast-growing enterprises.

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 of manufacturing in the overall economy. The sectors above the x-axis are those where research intensity has increased over

[4] However, a look at other IPR-related innovation outputs reveals that Estonia performs near the EU average in Community designs and above the EU average in Community trademarks.

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) 'Other non-metallic mineral products': 2007-2009; 'Repair and installation of machinery and equipment', 'Rubber and plastic products': 2008-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

Estonia is one of the countries catching up fast in terms of manufacturing industry: in 2011, manufacturing production represented 17.3 % of total value added (compared to an EU average of 15.6 %). Estonia is improving its competitiveness and has the clear potential to join the group of higher-income countries specialising in labour-intensive industries[5]. The country's economic structure is dominated by medium- to low-tech industries combined with high- or medium-high-tech industries in a few sectors or niche segments. In terms of trade and industry specialisation, Estonia is specialised in the manufacturing of electronic products, fabricated metal products, motor vehicles, electrical equipment, and machinery and equipment. As an innovation-driven country, it faces the challenge of upgrading its industry in response to increased global competition in the lower and medium segments of the value chains.

The graph above synthesises structural change in the Estonian manufacturing sector over the period 2007-2011. It shows that economic expansion was related to both lower-tech sectors and large consumer goods and services, in particular, coke & refined petroleum products, rubber and plastics, and electricity, gas and water but also the high-tech and medium-tech items such as electrical equipment, motor vehicles, computer, electronic and optical products, chemicals and chemical products. Among those sectors, a definite increase in R&I investment has been shown in the low-tech and traditional sectors such as rubber and plastics, textiles, coke & refined petroleum products, and also in the high-tech sector of electrical equipment.

[5] DG Enterprise, Industrial Performance Scoreboard, 2012.

Key indicators for Estonia

ESTONIA	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	0.61	0.68	0.75	0.81	0.86	0.85	0.93	1.34	1.02	4.6	*1.81*	21
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	515	:	:	512	:	:	521	6.0 (3)	495 (4)	2 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0.14	0.42	0.50	0.51	0.55	0.63	0.81	1.50	*1.25*	*19.7*	1.31	9
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.45	0.49	0.61	0.55	0.70	0.75	0.79	0.85	0.91	10.7	*0.74*	6
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	15.6	:	:	:	:	29.4	13.4	47.8	14
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	7.3	7.7	7.6	7.4	8.5	:	:	:	5.5	11.0	16
International scientific co-publications per million population	:	381	378	458	506	542	680	756	831	12.7	343	12
Public-private scientific co-publications per million population	:	:	:	19	22	26	28	25	:	6.6	53	19
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	1.2	0.6	1.5	2.0	2.0	2.4	2.2	:	:	3.7	3.9	12
License and patent revenues from abroad as % of GDP	0.03	0.04	0.04	0.05	0.11	0.13	0.11	0.10	0.09	12.4	0.59	19
Community trademark (CTM) applications per million population	3	30	43	83	65	72	119	138	178	16.4	152	11
Community design (CD) applications per million population	:	2	9	7	11	17	23	30	26	28.5	29	15
Sales of new to market and new to firm innovations as % of turnover	:	:	13.7	:	10.2	:	12.3	:	:	9.7	14.4	15
Knowledge-intensive services exports as % total service exports	:	30.3	33.2	37.5	36.9	36.8	37.3	36.4	:	-0.7	45.3	11
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-5.68	-4.61	-3.83	-4.18	-2.77	-1.53	-3.00	-2.70	-2.94	-	4,23 (5)	23
Growth of total factor productivity (total economy) - 2007 = 100	85	97	98	100	92	83	87	90	91	-9 (6)	97	25
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	43.4	:	:	:	:	49.5	2.7	51.2	13
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	9.5	10.2	9.8	10.7	10.8	3.3	13.9	20
SMEs introducing product or process innovations as % of SMEs	:	:	45.8	:	43.9	:	40.6	:	:	-3.8	33.8	10
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.01	0.00	0.00	0.17	0.13	0.20	:	:	:	8.3	0.44	11
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.03	0.05	0.27	0.11	0.31	0.17	:	:	:	21.4	0.53	17
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	67.4	72.0	75.8	76.8	77.0	69.9	66.7	70.4	72.1	-1.3	68.4	8
R&D Intensity (GERD as % of GDP)	0.60	0.93	1.13	1.08	1.28	1.41	1.62	2.37	*2.18*	*15.1*	*2.07*	9
Greenhouse gas emissions - 1990 = 100	42	46	44	52	48	40	49	52	:	0 (7)	83	4 (8)
Share of renewable energy in gross final energy consumption (%)	:	17.5	16.1	17.1	18.9	23.0	24.6	25.9	:	10.9	13.0	5
Share of population aged 30-34 who have successfully completed tertiary education (%)	30.8	30.6	32.5	33.3	34.1	35.9	40.0	40.3	39.1	3.3	35.7	14
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	15.1	13.4	13.5	14.4	14.0	13.9	11.6	10.9	10.5	-6.1	12.7	14 (8)
Share of population at risk of poverty or social exclusion (%)	:	25.9	22.0	22.0	21.8	23.4	21.7	23.1	23.4	1.2	24.8	14 (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.
(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) The value is the difference between 2011 and 2007. A negative value means lower emissions.
(8) The values for this indicator were ranked from lowest to highest.
(9) Values in italics are estimated or provisional.

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

"Further intensify prioritisation and specialisation in the research and innovation systems and enhance cooperation between businesses, higher education and research institutions to contribute to international competitiveness."

Finland

Broadening the innovation base towards new growth areas

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Finland. 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 the 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: 3.55 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.5 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[6] 2012: 69.9 (EU: 47.8; US: 58.1) 2007-2012: +5.1 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 115.7 (EU: 101.6)	*Knowledge-intensity of the economy*[7] 2012: 55.8 (EU: 51.2; US: 59.9) 2007-2012: +0.4 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: ICT, environment, materials, energy, security, food & agriculture, and health	*HT + MT contribution to the trade balance* 2012: 1.2 % (EU: 4.23 %; US: 1.02 %) 2007-2012: -5.7 % (EU: +4.8 %; US: -32.3 %)

Finland has one of the world's highest R&D intensities. The country also performs very well in terms of scientific and technological excellence, showing a strong positive evolution. The Finnish economy is knowledge-intensive and has achieved an impressive and continuous change towards a stronger high- and medium-high-tech specialisation. The country has several hot-spot clusters in key technologies on both a European and world scale, in particular in ICT, the environment, materials, energy, security, and in food and agriculture.

However, Finland's competitive position is facing challenges and its large export businesses have suffered. Considering its high level of R&D intensity, high-tech and medium-high-tech goods make a relatively low contribution to the country's trade balance. Since the start of the economic crisis in 2008, the major decline of the important electronics (telecommunications) sector, in particular, has led to a large-scale structural change of manufacturing industries in Finland. The decline of this sector is further reflected in a decrease in business R&D expenses that were previously dominated by Nokia. Consequently, as part of the Europe 2020 strategy, the Council recommended in 2014 that Finland boosted its capacity to deliver innovative products, services and high-growth companies in a rapidly changing environment. The extent to which both the business and public sector will be capable of absorbing new innovations from the ICT sector – and, more concretely, the available highly skilled human resources – is seen as a determinant for new growth.

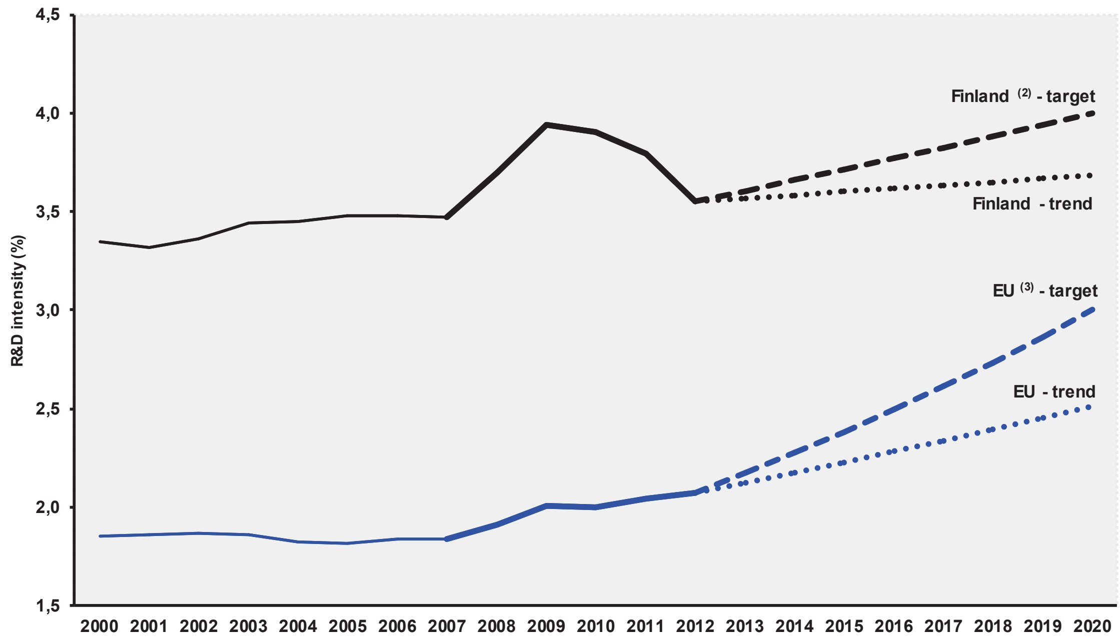
To address these challenges, the Finnish government has intensified the reform of the national R&I system. In addition to general efforts to enhance the efficiency and improve the internationalisation of the system, current and planned policy reforms are targeted, in particular, at increasing the number of

[6] 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.
[7] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

high-growth innovative firms as the major source of future employment and growth. The R&D tax incentive targets both limited companies and cooperatives and is applicable only to the fiscal years 2013-2014. The tax incentive for private investors into start-ups was introduced in 2013 to increase the volume of domestic venture capital market. These actions are expected to support in particular knowledge- and innovation-based young growth enterprises. The government has also recently fostered innovation and the country's transfer to a digital service economy by opening the non-sensitive databases it administers for public use.

Investing in knowledge

Finland - 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) FI: 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.

In 2012, R&D intensity fell in Finland to 3.55 % of GDP (3.80 % of GDP in 2011). While this remains the highest value in the EU, the decreasing trend since 2009 means that Finland is not on track to reach its R&D intensity target for 2020 of 4 %. This trend is due to a fall in business R&D intensity. As to public R&D expenses, they remained around EUR 2 billion in 2012. Due to the government's budget deficit, the volume of public R&D funding is not expected to increase in the coming years.

Finland is the top performer in the EU in terms of business R&D spending, although in 2012 its share decreased to 2.44 % of GDP (2.68 % of GDP in 2011) reflecting the major restructuring of the R&D intensive electronics sector. Although many other manufacturing and services sectors have increased their R&D intensities in Finland, in 2012 business R&D investments were still highly concentrated in Nokia and a few other large firms. This has made the country's economic position more vulnerable than it may appear. In 2012, the percentage share of venture capital of GDP amounted to 0.24 % (0.20 % of GDP in 2011).

The European Structural and Investment (ESI) Funds are an important source of funding for R&I activities. Of the EUR 1.6 billion of Structural Funds allocated to Finland over the 2007-2013 programming period, EUR 468 million (29.3 % of the total) related to RTDI[8]. In general, the share of the ESI Funds allocated to R&I has increased in Finland throughout the programming periods.

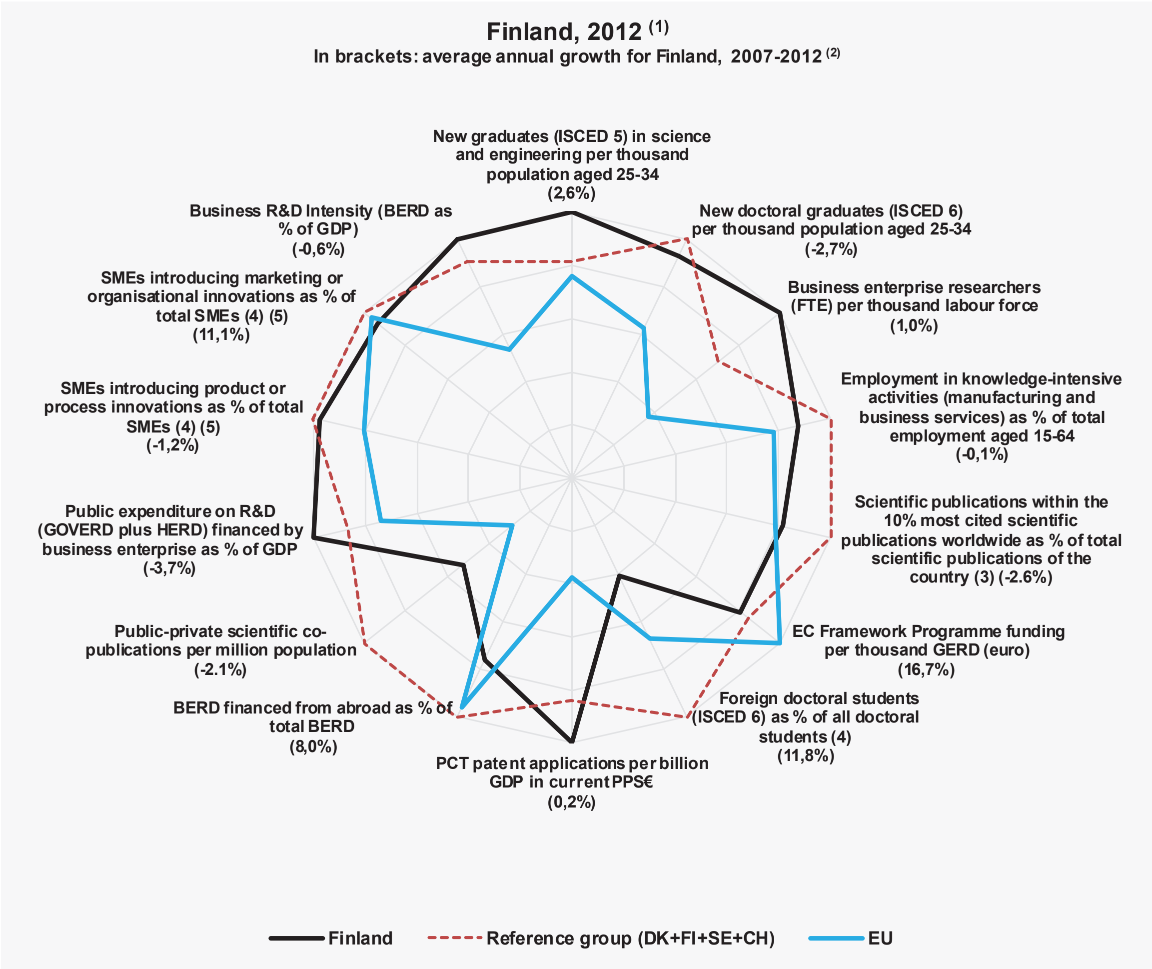
In the current period 2014-2020, Finland will receive almost EUR 1.3 billion from the European Structural and Investment Funds. R&D as well as improving the competitiveness of SMEs feature among the most important thematic objectives together with a cross-cutting theme that is seeking new solutions for development towards the low-carbon economy. The plan is for all three themes together to absorb more than EUR 822 million of the funding received from the European Regional Development Fund. Furthermore, it is proposed to allocate more than EUR 99 million from the ERDF to R&I-related activities supporting bio-economy developments in Finland.

In the past, Finland has also sought to increase its participation in the Seventh Framework Programme for Research and Technological Development. By 31 March 2014, almost 2600 Finnish entities had participated in a FP7 project, with a total EU financial contribution of EUR 848 million and a success rate of 21.2 % (slightly over the EU average of 20.5 %).

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

The spider graph below illustrates the strengths and weaknesses in the Finnish 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.

[8] 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.

Overall, Finland has a strong innovation performance and outperforms its reference group in terms of highly skilled human resources (new graduates in science and engineering as well as business enterprise researchers), public and business investment in R&D and patent applications. However, in 2012 the share of new doctoral graduates was lower in Finland than in the reference group. The main weakness in the Finnish innovation system lies in its low level of internationalisation, affecting both the public and private sectors. It performs below the EU average on inward BERD, share of foreign doctoral students and funding from EU excellence-driven programmes.

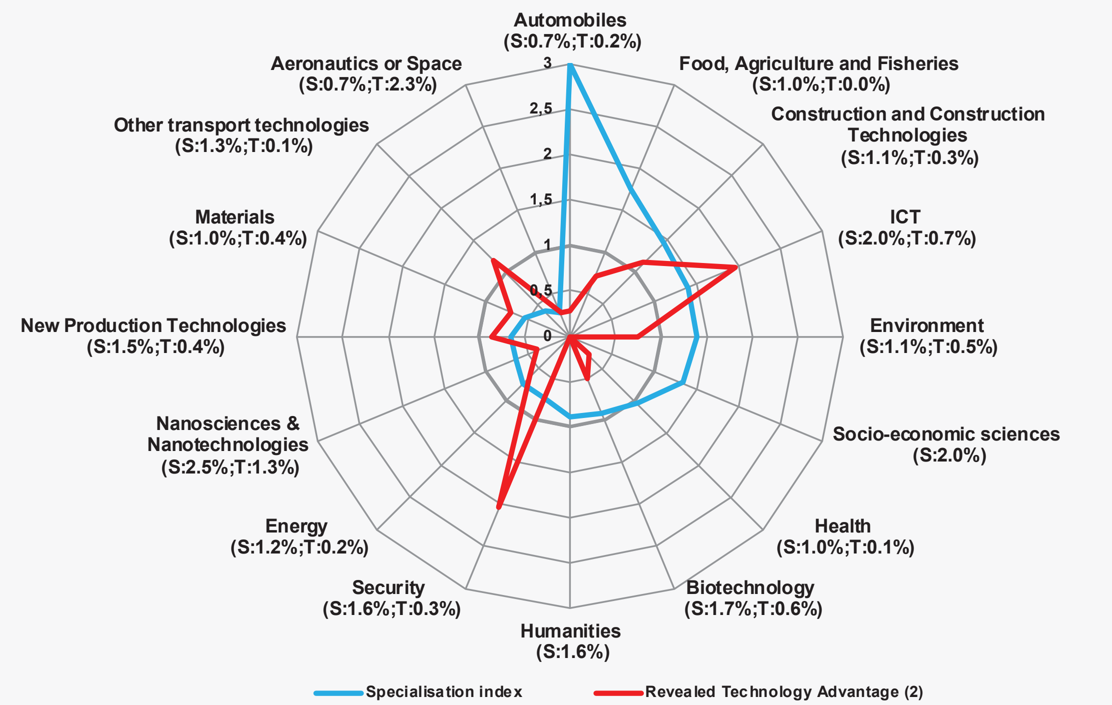
The ongoing restructuring of the ICT sector is both a challenge and an opportunity for Finnish SMEs, as much of future innovation and growth depend on them. The graph does not take this fully into account. It is expected to affect, in particular, the number of business sector researchers and business R&D intensity. In addition, the effect that the expected loss of R&D jobs in the business sector and the subsequent capacity to attract foreign researchers will have on linkages in the R&I system remains to be seen.

Finland's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Finland shows scientific and technological specialisations. Both the specialisation index (based on the number of publications) and the revealed technological advantage (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.

Finland 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 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.

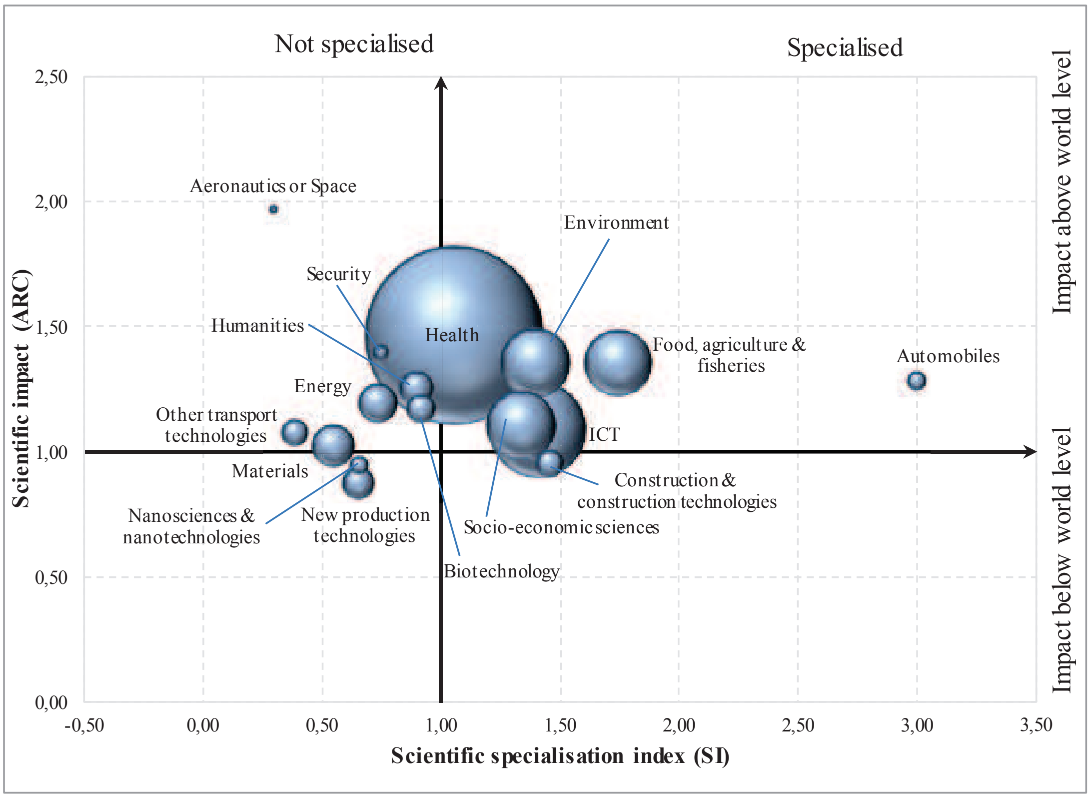
A comparison of the scientific and technological specialisations in the FP7 thematic priorities shows a mixed situation. Technology production is specialised in security, ICT, and other transport technologies.

Finland's scientific specialisation indexes show a specialisation in the scientific fields related to the FP7 thematic priorities of automobiles, food, agriculture and fisheries, construction and construction technologies, ICT, the environment and socio-economic sciences. The ICT thematic priority is where scientific and technological specialisations are best matched.

In this respect, there is room for improvement in the scientific impact related to some FP7 thematic priorities ranking high on the science specialisation index, i.e. construction and construction technologies. It is also interesting to note the above-world-level scientific impact of Finnish scientific publications related to aeronautics and space as well as to security and energy, while the specialisation indexes related to those thematic priorities are rather low.

The graph below illustrates the positional analysis of Finnish 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 Finland publications in Scopus (specialisation versus impact), 2000-2010



Source: DG Research and Innovation - Economic Analysis 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

The Finnish R&I policy documents are prepared at the strategic level by the Research and Innovation Council which is led by the prime minister. The current 'Research and Innovation Policy Guidelines' cover the period of 2011-2015, and the government has tasked the Council to prepare new guidelines for 2014-2020. At the end of 2012, the government also published a document 'Growth through expertise, Action plan for research and innovation policy' which seeks to enhance the quality, impact and internationalisation of the Finnish R&I system. The action plan emphasises the need to increase the number of high-growth innovative firms, and anticipates that the digital service economy will provide Finland with opportunities for growth.

One of the fundamental reforms launched in Finland in 2013 concerns the reform of research institutes and research funding. It marks a major restructuring of the Finnish R&I landscape with a view to strengthening multi-disciplinary and high-level research of societal significance. National sectorial research institutes will gradually be combined into larger entities. A Strategic Research Council will be established to finance research-seeking solutions to the challenges facing Finnish society and to promote the renewal of the country's economic base and competitiveness. The funding will be assembled in stages from state research institutes' appropriation, as well as from the funding for the Academy of Finland and Tekes, with a view to making EUR 70 million available for strategic research in 2017.

As the key government objective is to fortify the growth of the Finnish economy, more public funding is now being channelled into innovation activities. The activities target, in particular, growth-oriented companies as well as new and young innovative enterprises, and include measures that help knowledge-based companies to enter international markets. For example, the government budget for 2013 included two tax incentives aimed at growth-seeking businesses. The R&D tax incentive for limited companies and cooperatives is a novelty for Finland. It allows for a deduction from corporate income taxes tied to the wage costs of R&D personnel. The tax incentive for private investors targets business angels investing equity in small and medium-sized enterprises (SMEs) providing the possibility to postpone paying capital gains taxes as long as those gains are reinvested in qualifying businesses. However, the R&D tax incentive is only applicable to fiscal years 2013-2014 and the tax incentive for private investors to 2013-2015, due to the lowering of corporate income tax rate from 24.5 % to 20 %.

As to the availability of venture capital, together with pension funds the Finnish Industry Investment will launch a new growth fund for growth-stage businesses as part of the government's long-term risk finance programme. The experiences gained from the Vigo accelerator programme have been positive and it has attracted direct foreign investment in Finnish start-ups. The government has also made non-sensitive data gathered by public authorities freely available with the aim of promoting the emergence of innovative start-ups. In the area of internationalisation, the establishment of Team Finland has streamlined services for companies, and the FiDiPro programme – the Finland Distinguished Professor Programme – continues to enhance the international dimension of the universities and research institutes.

Among the most significant structural changes in Finland in recent years has been the university reform that took effect in 2010. This made universities autonomous legal entities and developed them towards more flexibility with the aim of promoting high-level research, internationalisation and the focusing of resources. As part of the reform process, a new university funding model entered into force in 2013 that seeks to build a more efficient university system with a greater emphasis on quality and impact as well as better profiling and internationalisation. In parallel, the polytechnics reform is ongoing, and a new polytechnics funding model came into force at the beginning of 2014. In the second stage of the reform, the responsibility for polytechnics funding will be transferred from municipalities to the government, and polytechnics will be made independent legal entities. These changes will come into force from the beginning of 2015. The objective is to reinforce the role of polytechnics as increasingly independent educational institutions contributing to a renewal of the working life and competitiveness of the regions. The government is currently reviewing the funding models of both universities and polytechnics with a view to reinforcing, *inter alia*, the utilisation aspect of research. Furthermore, a national road map of research infrastructures was published recently.

In Finland, R&I policies have emphasised the importance of both academic entrepreneurship through start-ups and university-industry collaboration. In that respect, the main funding instruments are the Tekes programmes and the Strategic Centres for Science, Technology and innovation (SHOKs)[9]. In the last five years, SHOKs have become one of the main

[9] Six SHOKs are in operation: Cleen Ltd (environment and energy), FIMECC Ltd (metals industry), SalWe Oy (health and well-being), Digile Oy (ICT and digital services), RYM Ltd (built environment) and Bio-economy Cluster FIBIC.

mechanisms of Finnish innovation policy and one of its ‘flagship programmes’. These are industry-driven public-private partnerships of research actors and the private sector which aim to speed up innovations and renew industrial clusters. The government is currently introducing several improvements to the SHOK concept with the view to sharpening the focus and increasing competition for funding, renewing governance and steering, and increasing international cooperation.

The ICT 2015 advisory board has been set up in the restructuring field of electronics with the mandate to coordinate the implementation of the ICT 2015 actions[10] aiming to re-establish Finland’s technological lead in ICT. These actions include the rapid development of a common architecture for all public services; establishment of a 10-year programme on ICT-related R&I; and the launch of a funding programme for high-growth enterprises. In addition, the government’s four other strategic growth targeted programmes – in the fields of clean-tech, bio-economy, health, and intangible value creation – build heavily on the increased role of ICT which is expected to be the main driver of the country’s productivity growth. If successful in boosting growth in other sectors, ICT is expected to have the potential to diversify the Finnish economy.

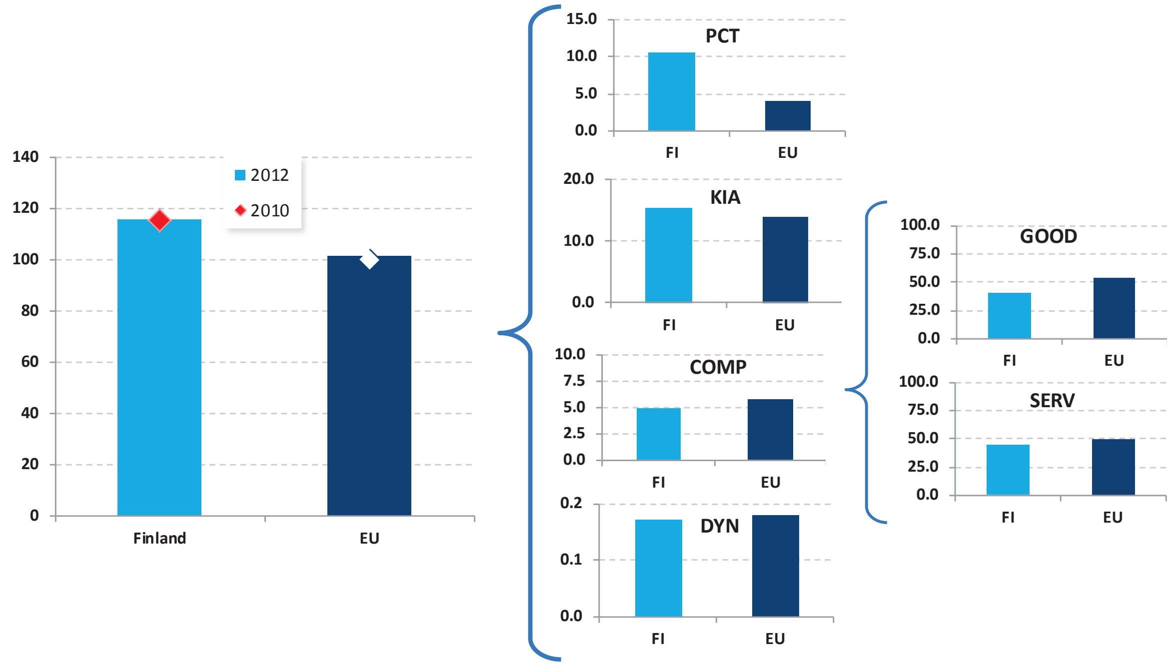
The government has launched the ‘Innovative Cities’ programme that will be implemented from 2014-2017 and represents a novel innovation policy instrument for Finland. The programme embeds the ideas and approaches of a ‘smart specialisation strategy for research and innovation’. In so doing, it supports urban regions in identifying and focusing on their strengths, encouraging them to select new types of specialisation areas, and intensifying cooperation between the public and private sectors. The programme seeks to create internationally attractive urban innovation hubs and platforms in Finland. In 2013, the government announced five thematic priorities for each lead city: health and well-being in the future (Oulu); bio-economy (Joensuu); sustainable energy solutions (Vaasa); smart cities and restructuring industries (Tampere) and cyber safety (Jyväskylä). The programme is managed by Tekes and the funding will be channelled from the government’s budget, the cities’ budgets and the European Structural and Investment Funds. The programme will also help to align the content of the Finnish national research and innovation strategy and related regional strategies.

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 Finland’s position regarding the indicator’s different components.

[10] The actions are outlined in the report of the ‘ICT 2015 working group’ set up by the government.

Finland - 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 %).

Finland is a very good performer in the European innovation indicator. It ranks fifth in the EU after Germany, Sweden, Ireland and Luxembourg. This is the result of a good or very good performance as regards all the components of the indicator, with the exception of the export of goods and services. The country's performance stagnated between 2010 and 2012.

Finland performs particularly well in patents (data refers to 2010), where it is the EU's top performer as a result of strong patenting in the ICT sector. The relatively low performance in the share of medium-/high-tech goods in total goods exports is explained by the importance of wood and paper exports, not sufficiently compensated for by strong exports of medium-/high-tech products.

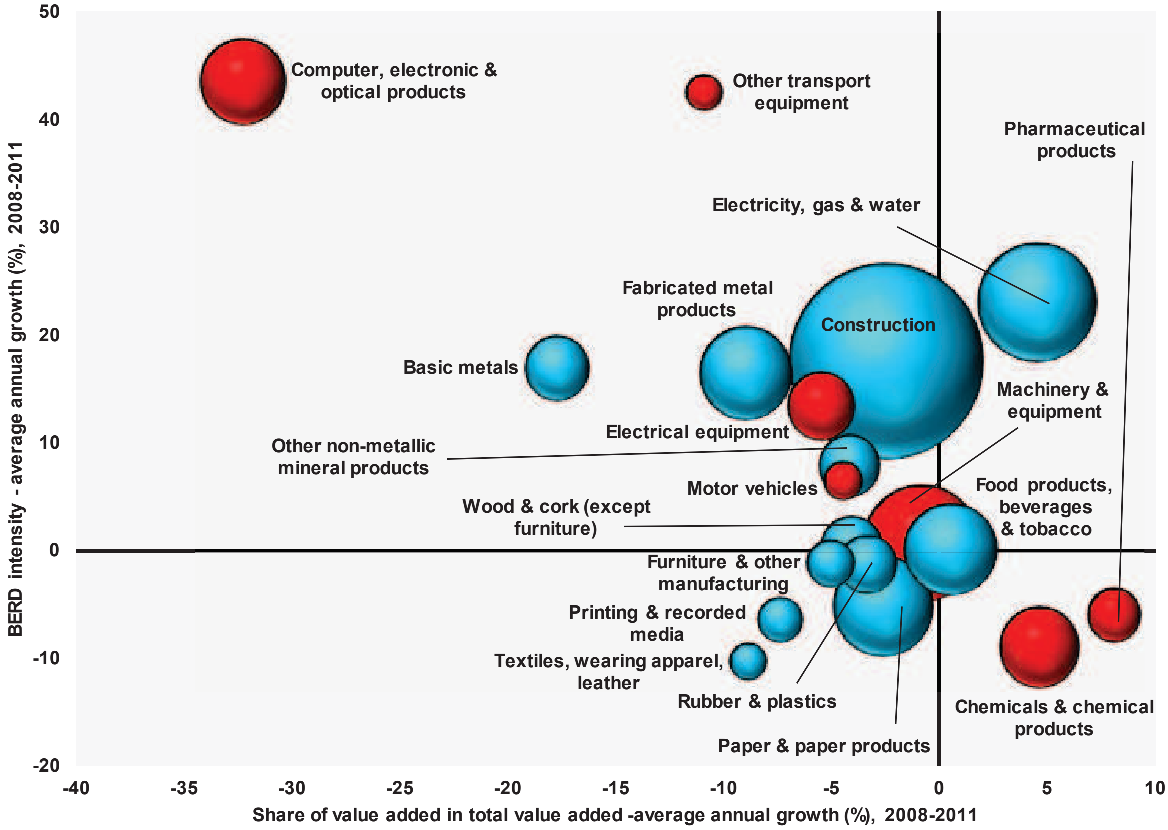
As a freight-transport transit country to and from Russia, Finland has a relatively important non-knowledge-intensive transport and merchant-related services (rail freight transport, pipeline) sector, leading to a below EU average share of knowledge-intensive services exports, despite relatively high computer services exports.

The country's performance is average in employment in fast-growing innovative firms as a % of total employment in fast-growing firms. In addition, there is a high share of computer programming, architectural and engineering companies among the fast-growing enterprises.

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 2008-2011. The general trend to the left-hand side reflects a decrease 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.

Finland - Share of value added versus BERD intensity - average annual growth, 2008-2011



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 Finnish manufacturing sector has achieved a clear upgrading of its knowledge intensity since the 1990s. Finland has evolved from having a primarily pulp and paper and machinery-driven manufacturing sector to being a producer of electronics as well as software and services. Simultaneously, the services sector, including business services, has grown significantly. However, since the start of the economic crisis in 2008, the Finnish manufacturing industries which are highly dependent on export markets have faced major difficulties. In the past five years, the country has undergone a period of major economic restructuring, and the electronics industry, in particular, has lost significant market share and employment. In effect, the 2008-2009 economic slowdown has had a more severe effect on the Finnish economy than in many other competing countries, because the recession coincided with the decline in the electronics industry.

In the period 2008-2011, the R&D intensive manufacturing sectors (red bubbles) which had contributed most to the growth of value added in the Finnish economy were pharmaceutical products and chemicals and chemical products, although business R&D intensity decreased in both sectors. The recent reorganisation of the electronics industry has resulted in a major reduction in its share of the value added to the economy, but in the period under review, the sector was still able to increase its BERD intensity substantially. Machinery and equipment continues to be an important R&D-intensive manufacturing sector in Finland. In 2008-2011, its R&D investment increased marginally while, at the same time, its share of value added fell slightly. Although the sectors of other transport equipment and electrical equipment did not make a positive contribution to the economy's added value during that period, the two sectors increased their BERD intensity, the former, in particular. Similarly, the motor vehicle sector experienced an increase in R&D investment.

As regards traditionally less R&D-intensive industries (the other bubbles), in the period of 2008-2011, the paper and paper products sector experienced reductions in both its R&D intensity and its share of value added to the economy. A renewal in R&D investment is observed in the basic metals sector – an industrial sector that is leading the mining boom mainly in the north-eastern and northern parts of Finland. The fabricated metal products sector also shows a positive upward trend in its R&D intensity. Moreover, the electricity, gas and water sector increased its R&D intensity in the same period. Finally, the country's important construction sector has also increased its R&D intensity. In that regard, it is worth emphasising that since 2007 the government has supported the renewal of traditional manufacturing sectors with a specific instrument 'Strategic Centres for Science, Technology and Innovation' that bridges innovative companies and world-class research aimed at producing globally significant breakthrough innovations.

Key indicators for Finland

FINLAND	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	2.71	3.07	2.96	3.07	2.96	2.89	2.56	2.71	2.67	-2.7	*1.81*	3
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	548	:	:	541	:	:	519	-29.6 (3)	495 (4)	3 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	2.37	2.46	2.48	2.51	2.75	2.81	2.72	2.67	2.44	-0.6	1.31	1
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.95	0.99	0.98	0.94	0.93	1.10	1.16	1.09	1.09	2.9	*0.74*	2
Venture Capital as % of GDP	0.29	0.15	0.16	0.21	0.25	0.20	0.23	0.20	0.24	2.4	0,29 (5)	6 (5)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	54.6	:	:	:	:	69.9	5.1	47.8	4
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	11.6	11.4	12.0	11.5	11.4	:	:	:	-2.6	11.0	9
International scientific co-publications per million population	:	920	995	1101	1139	1204	1286	1356	1415	5.1	343	5
Public-private scientific co-publications per million population	:	:	:	107	107	106	102	98	:	-2.1	53	4
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	12.1	10.9	11.6	10.3	9.5	10.5	10.4	:	:	0.2	3.9	1
License and patent revenues from abroad as % of GDP	0.72	0.62	0.51	0.52	0.54	0.73	0.98	1.23	1.34	21.0	0.59	3
Community trademark (CTM) applications per million population	100	104	120	139	143	148	181	187	196	7.1	152	9
Community design (CD) applications per million population	:	37	35	36	38	43	46	44	52	7.9	29	6
Sales of new to market and new to firm innovations as % of turnover	:	:	15.7	:	15.6	:	15.3	:	:	-1.0	14.4	5
Knowledge-intensive services exports as % total service exports	:	:	:	23.8	39.7	37.7	36.4	34.9	:	10.0	45.3	12
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-0.58	1.44	1.39	1.66	3.56	2.41	2.01	1.69	1.24	-	4,23 (6)	16
Growth of total factor productivity (total economy) - 2007 = 100	88	95	97	100	98	91	93	95	93	-7 (7)	97	20
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	54.8	:	:	:	:	55.8	0.4	51.2	9
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	15.5	15.2	15.1	15.3	15.5	-0.1	13.9	9
SMEs introducing product or process innovations as % of SMEs	:	:	44.7	:	41.8	:	40.9	:	:	-1.2	33.8	8
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.46	0.52	0.53	0.46	0.51	0.75	:	:	:	27.3	0.44	4
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.75	0.65	0.65	0.56	0.57	0.52	:	:	:	-3.2	0.53	10
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	71.6	73.0	73.9	74.8	75.8	73.5	73.0	73.8	74.0	-0.2	68.4	7
R&D Intensity (GERD as % of GDP)	3.35	3.48	3.48	3.47	3.70	3.94	3.90	3.80	3.55	*0.5*	*2.07*	1
Greenhouse gas emissions - 1990 = 100	99	98	114	112	101	95	107	97	:	-16 (8)	83	19 (9)
Share of renewable energy in gross final energy consumption (%)	:	28.6	29.8	29.4	30.7	30.4	31.4	31.8	:	2.0	13.0	3
Share of population aged 30-34 who have successfully completed tertiary education (%)	40.3	43.7	46.2	47.3	45.7	45.9	45.7	46.0	45.8	-0.6	35.7	7
Share of population aged 18-24 with at most lower secondary education and not in further education or training (%)	9.0	10.3	9.7	9.1	9.8	9.9	10.3	9.8	8.9	-0.4	12.7	11 (9)
Share of population at risk of poverty or social exclusion (%)	:	17.2	17.1	17.4	17.4	16.9	16.9	17.9	17.2	-0.2	24.8	3 (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) Values in italics are estimated or provisional.

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

"Continue to boost Finland's capacity to deliver innovative products, services and high-growth companies in a rapidly changing environment."

France

The challenge to revitalise industry

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in France. 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 the 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: 2.29 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +1.0 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[11] 2012: 49.5 (EU: 47.8; US: 58.1) 2007-2012: +3.4 % (EU: +2.9 %;US: -0.2)
Innovation Output Indicator 2012: 105.6 (EU: 101.6)	*Knowledge-intensity of the economy*[12] 2012: 58.1 (EU:51.2; US: 59.9) 2007-2012: +0.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Energy, ICT, materials, nanotechnologies, new production technologies, and the environment	*HT + MT contribution to the trade balance* 2012: 5.2 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +2.2 % (EU: +4.8 %; US: -32.3 %)

France is a major R&D country. It ranks sixth among world countries for gross domestic expenditure in R&D. It has a large science base, is well equipped with large world-class research infrastructures, and is well connected in Europe and internationally. However, France's scientific performance is average in terms of high-impact scientific work and its industrial base continues to be eroded.

The level of business R&D intensity is relatively low in France in comparison with other R&D-intensive countries. This reflects primarily the sectoral composition of the economy, where medium-high and high-tech manufacturing sectors represent a relatively modest share.

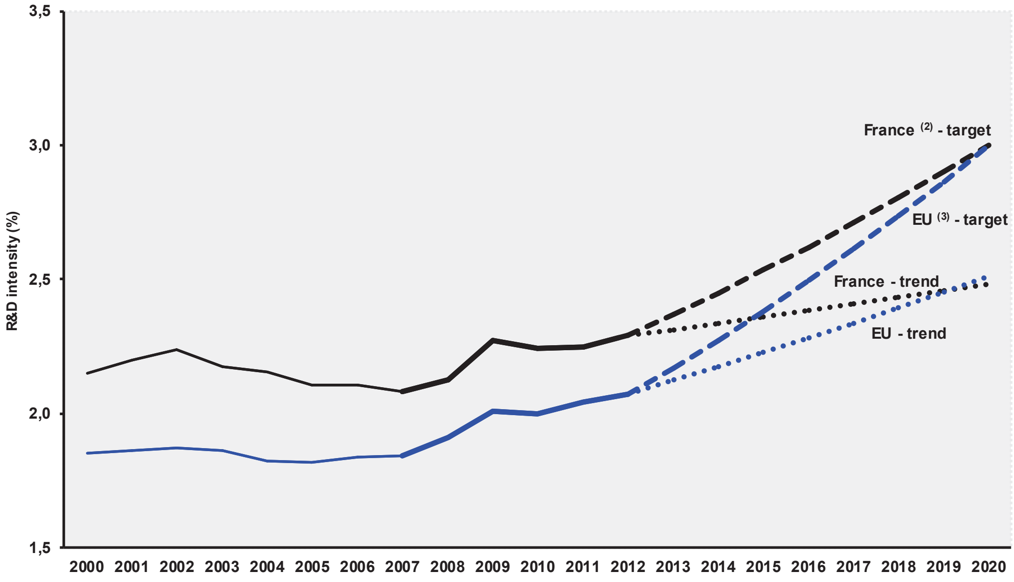
In recent years, France has substantially reformed its R&I system – new funding and evaluation agencies and mechanisms[13], *pôles de compétitivité* policy, more autonomy for universities, amplified research tax credit (CIR), innovation tax credit, *Investissements d'Avenir programme* and increased funding for the valorisation of public research results.

However, there is a limited use of evaluation and assessment tools to monitor the socio-economic impacts of research and innovation policies in France.

[11] 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.
[12] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.
[13] Agence Nationale de la Recherche, BPI France, Agence d'Evaluation de la Recherche et de l'Enseignement Supérieur.

Investing in knowledge

France - 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 2010-2012 in the case of France.
(2) FR: 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) FR: There is a break in series between 2004 and the previous years and between 2010 and the previous years.

France has set a national R&D intensity target for 2020 of 3 %. In 2012, the country's R&D intensity was 2.29 %, with an average annual growth rate of 1.0 % over the period 2010-2012. As shown above, this trend will not allow France to reach its target by 2020.

With EUR 46.5 billion of global R&D expenses representing 17.3 % of EU total, France is a major player in the EU. It ranks second, behind Germany (EUR 79.4 billion, 29.5 % of the total) and ahead of the UK (EUR 33.3 billion, 12.4 % of the total). Having peaked in 2009-2010, public R&D intensity stabilised at 0.78 % in 2011 and 2012, at the same level as at the beginning of the 2000s and slightly over the EU average of 0.74 %.

France is one of the few countries where R&D expenditure in the business sector progressed in 2009, in spite of the economic crisis. Amplification of the R&D tax credit in 2008 may have contributed to that. Together with a decline in GDP, this progress caused a marked increase in overall business R&D intensity from 1.33 % in 2008 to 1.40 % in 2009. In 2010, 2011 and 2012, business R&D intensity further progressed to 1.48 % of GDP. The country's business R&D intensity is above the EU average (1.31 % in 2012) but below that of other knowledge-intensive countries. It should be noted that a significant part of business R&D is publicly funded (public direct and indirect funding of business R&D was 0.38 % of GDP in 2011[14], which ranks France as number 1 in the EU for this indicator). In terms of economic activities, business R&D expenditure in France is dominated by motor vehicles (15.0 % of total business R&D expenditures), aircraft and spacecraft (10.6 %) and pharmaceuticals (10.3 %)[15].

[14] Cf. Maximising the benefits of R&D tax incentives for innovation, OECD, 2013.
[15] 2012. Data from the French Ministère de l'Enseignement supérieur et de la Recherche.

The 2013 EU Industrial R&D Investment Scoreboard has registered 124 French companies among the top 1000 EU R&D investors worldwide (252 in the UK and 224 in Germany). In 2012, their R&D expenses worldwide increased by 2.3 %, whereas the total growth in R&D expenses for the sample is 6.0 % (11.6 % for Germany, 0.5 % for the UK). Among the 2000 top world business R&D investors in 2012, the worldwide R&D expenses of French companies represented 5.2 % of the total R&D expenses of the top 2000 world R&D investors (10.5 %, 4.2 % and 35.1 % for Germany, the UK and the USA, respectively).

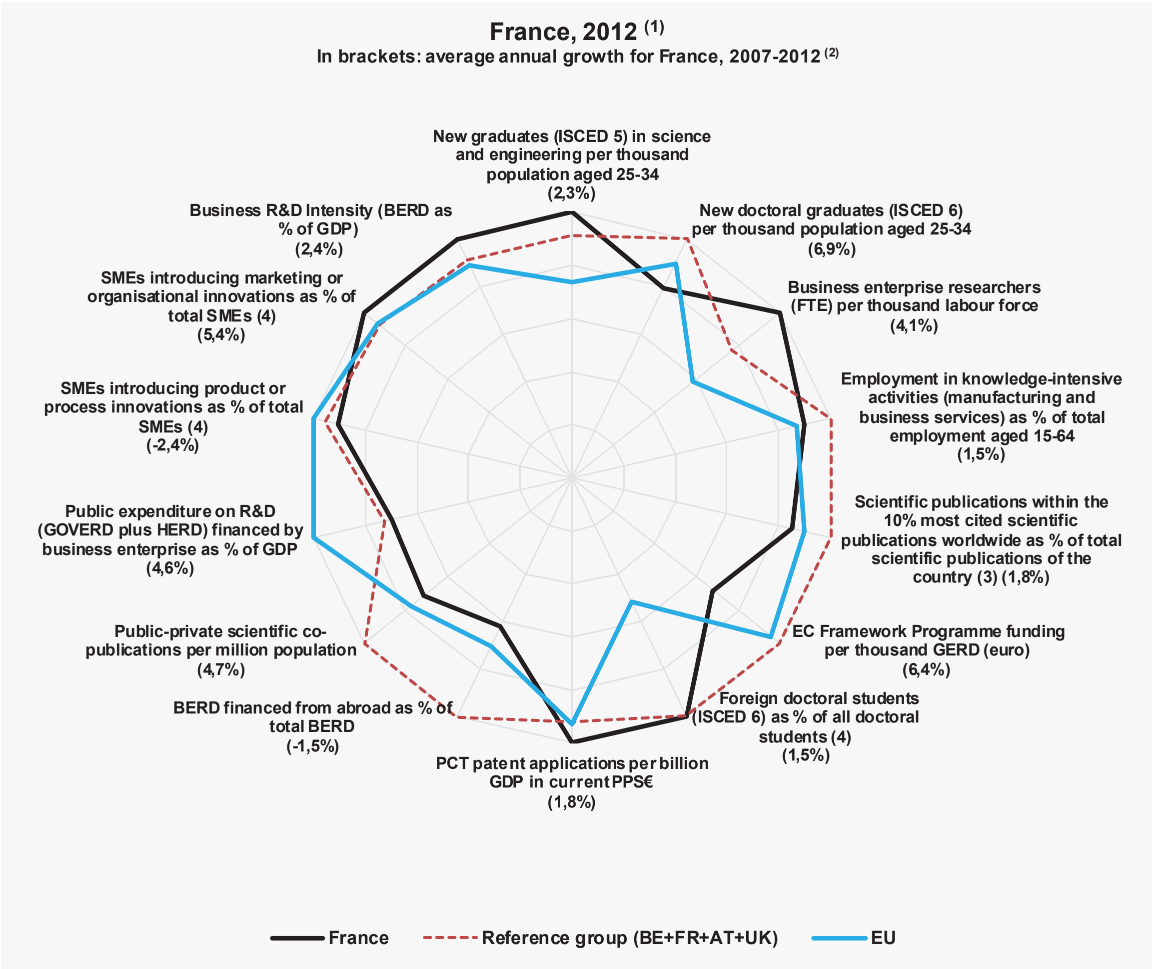
France's industrial base has been continuously eroded for more than a decade. The country's share of industry in the total value added fell from 17.8 % in 2000 to 12.5 % in 2012. France is now ranked 16th among the 18 euro-area countries, behind the UK (14.6 %), Italy (18.4 %), Finland (19.1 %) and Germany (25.8 %).

Of the EUR 13.4 billion of Structural Funds allocated to France over the 2007-2013 programming period, around EUR 2.2 billion (16.4 % of the total) related to RTDI[16]. Almost 11 700 partners from France are participating in FP7, receiving a financial contribution from the EC of nearly EUR 4.5 billion.

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

The graph below illustrates the strengths and weaknesses of France's R&I system. Reading clockwise, it provides information on human resources, scientific production, technology development and innovation. Average annual growth rates from 2007 to the latest available year (2012) are given in brackets.

[16] 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 shows that France rates well for many skills-related indicators: new graduates in science and engineering, business enterprise researchers (in spite of an eroding industrial base), and foreign doctoral students. With a rate of 4.2 % for PCT patent applications per billion GDP, France is slightly above the EU average (3.9 %), well behind Germany (7.5 %) and Sweden (13.3 %), but ahead of the UK (3.3 %). The country's performance is average for employment in knowledge-intensive activities and for new doctoral graduates, and slightly below average for highly cited scientific publications and for new doctorates. It is significantly under the average for BERD financed by abroad, as is Germany, but in France foreign-owned companies perform 20 % of BERD[17]. France is also significantly below average for public expenditure on R&D financed by businesses. Public-private research relationships take place rather in the form of collaborative research (where research is done by all collaborating parties and costs are shared among participants), which is highly state subsidised[18], than in the form of contract research (where businesses finance public research without performing research themselves).

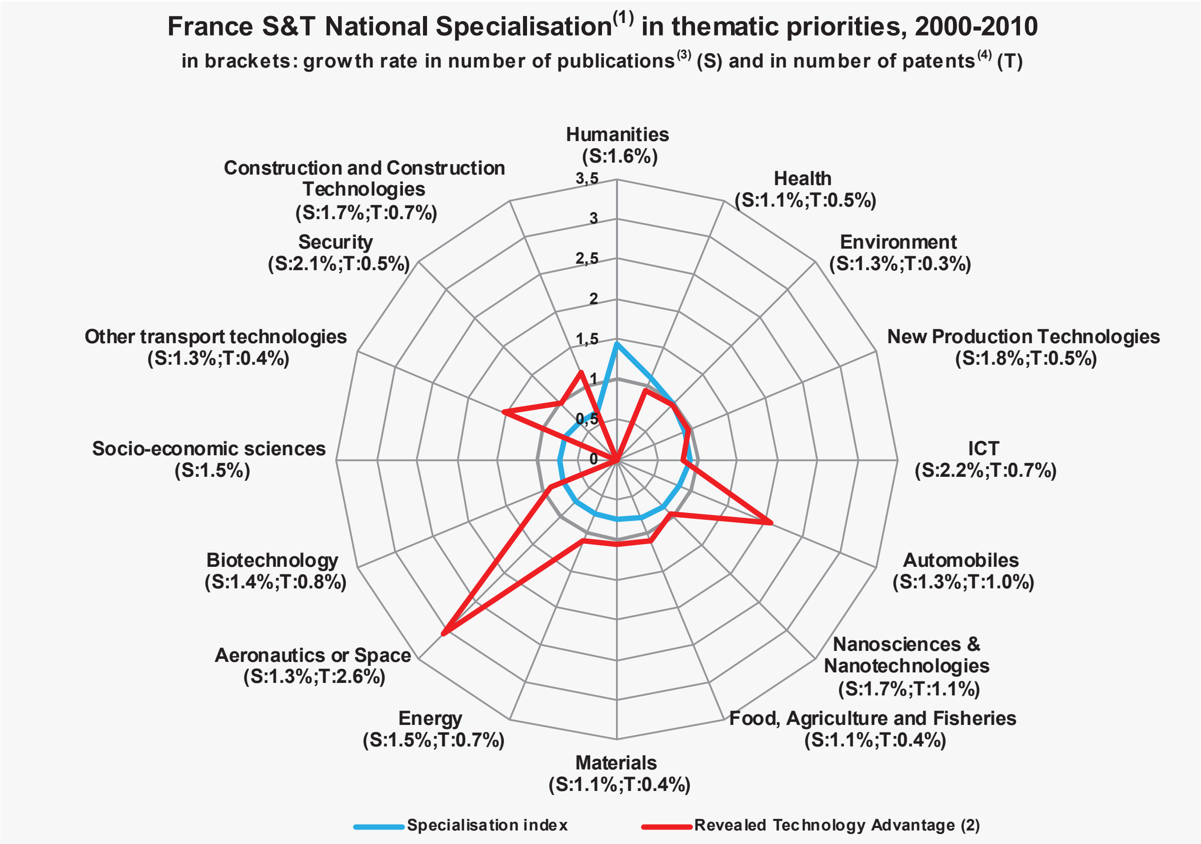
[17] 2010. Data from the French Ministère de l'Enseignement supérieur et de la Recherche.
[18] In 2011, public-private collaborative research represented a significant part of all R&D expenditure in France (about 10 %) with a public co-funding rate of around 75 % (Government Report: Mission sur les Dispositifs de Soutien à la Recherche Partenariale, 2013).

France's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where France 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.

The methods are as follows:
- *Specialisation index*[19]*:* The scientific journals indexed in Scopus have been classified according to a three-tier taxonomy of six scientific domains, 22 fields and 176 subfields, each journal being assigned to a subfield. Then, through expert judgment supported by relevant statistics, the most relevant scientific fields and subfields were identified for each of the 16 FP7 thematic priorities. The number of publications in Scopus for the FP7 thematic priorities corresponds to about 70 % of the total number in Scopus. In particular, the publications in the journals assigned to the scientific fields of mathematics & statistics and physics & astronomy are not assigned to any of the FP7 thematic priorities. The specialisation indexes refer to world publications in Scopus.
- *Revealed technology advantage*[20]*:* For the FP7 thematic priorities (except socio-economic sciences and humanities), search keys have been developed. The delineation of search keys used existing technological classifications as a starting point. Based on content analysis of the different thematic priorities, the existing classifications have been refined and adapted. The latter step benefited from input provided by EC experts involved in the thematic priority initiatives and programmes. Some technology fields in existing classifications are not related directly to FP7 categories.

[19] http://ec.europa.eu/research/innovation-union/pdf/scientific-production-profiles.pdf#view=fit&pagemode=none
[20] http://ec.europa.eu/research/innovation-union/pdf/technological-specialization-of-countries.pdf#view=fit&pagemode=none

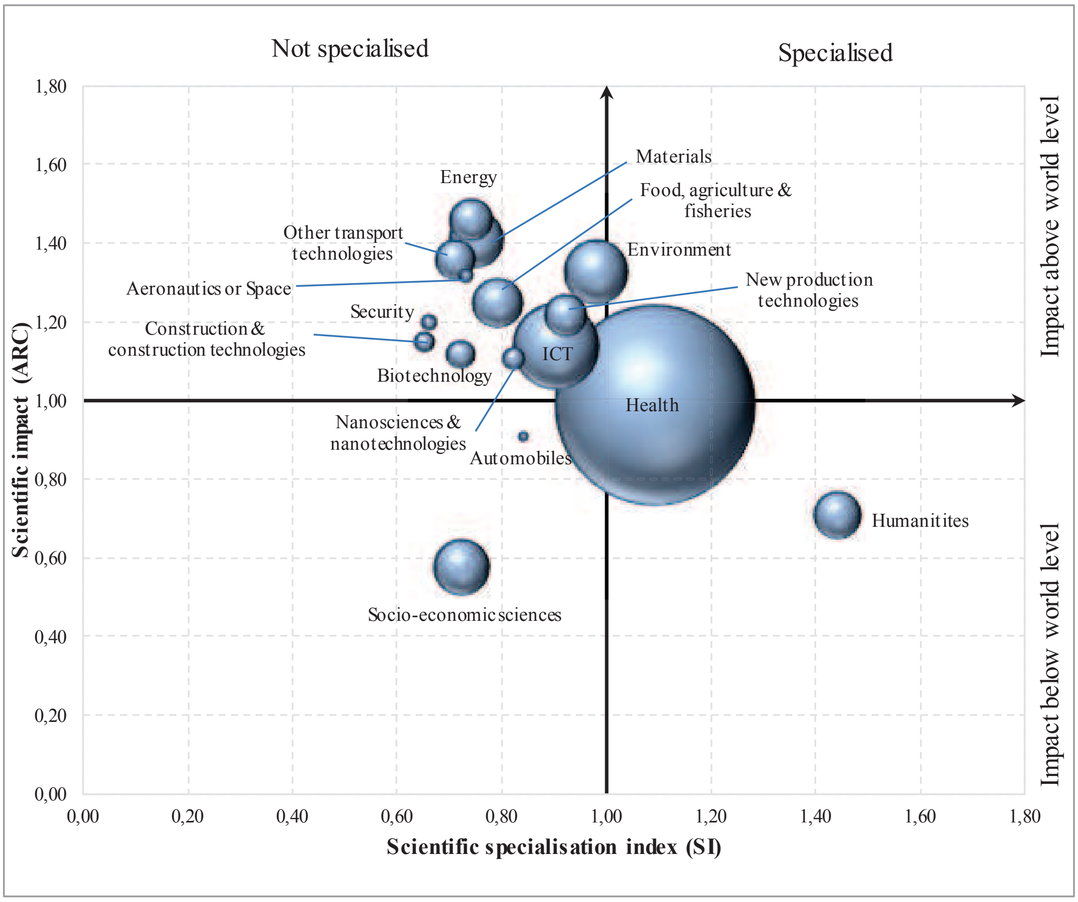


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding 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.

In scientific production, France has high specialisation indexes for publications that can be related to humanities and health. The revealed technology advantage is high in following sectors: automobiles, aeronautics or space, and other transport technologies.

The graph below illustrates the positional analysis of French 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 publication from a science field in the country's total publications.

Positional analysis of France 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 above graph shows that for most of the Framework Programme thematic priorities, the scientific impact of the scientific publications related to them is above the world level. The impact is particularly high for the energy, materials, and other transport technologies sectors.

Policies and reforms for research and innovation

A new law on research and higher education was promulgated in July 2013. Preparation of the law started with a large consultation process among the interested parties, which resulted in a report used as the key input for the law. The ongoing reformation modifies some components of the system's organisation and deals with knowledge transfer.

Organisation of the system is meant to change as regards the following five aspects:

- *Strategy:* A new National Strategy for Research will replace the present National Research Strategy for Research and Innovation. Together with the National Strategy for Higher Education, the government will present them to the parliament every five years.
- *'Site policy' and higher education institution groupings*: PRES (Higher education and research institutions clusters, which used to stand for *Pôles de Recherche et d'Enseignement Supérieur)* have been replaced by Communities of Universities and Institutions (CUE, *Communautés d'Universités et d'Etablissements*) which comprise a board of directors, an academic council and board members. A single contract per site is to be signed with the Minister of Higher Education and Research. Current PRES have a year to change status.

- *Roles of regions*: The law transfers both the mission and the budget to regions to develop and disseminate scientific, technical and industrial culture, especially among young audiences. The regions will also define "a regional plan for higher education, research and innovation, which determines the principles and priorities of its activities"; the regions' initiatives shall fit into "the context of national strategies".
- *University governance*: One new initiative is the acceptance of 'externals' as voters for the election of the university's president. In addition, an Academic Council is established, reuniting the Scientific Council and the Board of Studies and University Life, and is given a decisive role. The Academic Council is responsible for the allocation of resources, the adoption of rules for examinations and for the evaluation of teaching, laboratory operation or examination of individual issues relating to recruitment, placement, and teachers and researchers' careers. Board composition is rebalanced in favour of students, technicians and support functions. Parity is set for the elections.
- *High Council of the Evaluation of Research and Higher Education*: The Agency for the Evaluation of Research and Higher Education is replaced by the High Council of the Evaluation of Research and Higher Education, which is an independent administrative authority.

As regards PhDs, and knowledge transfer:

- *PhDs*: The law requires that 'A Class' competitions for civil servants are adjusted to allow for the participation of PhDs. A new opportunity is also given to PhD holders to access the National School of Administration (ENA), provided that they have at least three years of professional experience, and to access ENA internal competition provided that PhD holders are funded through a "doctoral contract". In the private sector, negotiations for the recognition of the PhD in sectoral collective agreements should be completed by 1 January 2016.
- *Knowledge transfer*: The transfer of research results for the service of society is added to the mission of public higher education. The law provides that preferably inventions from public research should be commercialised through SMEs and intermediate-size enterprises, in the EU.

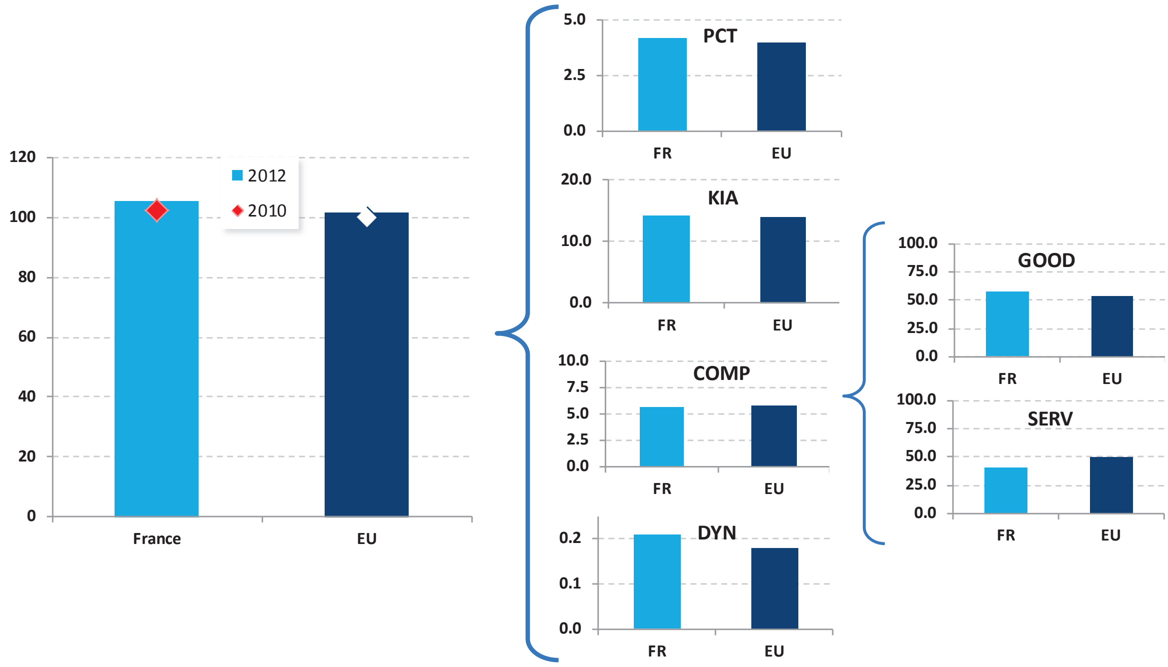
Enhancing research and innovation was confirmed as a priority with the following recent measures announced since 2012:

- 15 measures to increase the dynamism of knowledge transfer from public research (November 2012): better monitoring, training, simplification of regulatory framework, and a new research centre for innovation economy;
- New innovation tax credit for SMEs (December 2012): EUR 160 million tax debt expected in 2014, which will add to the EUR 5.8 billion expected for the R&D tax credit;
- Shift of the *poles de compétitivité* policy to more support for economic opportunities and job creation (January 2013);
- An additional EUR 12 billion allocated to the Investment for the Future Programme (July 2013);
- Build-up of 34 sectorial industrial plans (*plans industriels de reconquête*) led by industry managers, with a strong focus on innovation in sectors where France has competitive assets, partially relying on EUR 4 billion of funding from the Investment for the Future Programme budget (September 2013);
- An innovation contest in seven fields, open to all types of enterprises with EUR 300 million of funding from the Investment for the Future Programme (October 2013).
- A New Deal for Innovation plan, with 40 measures to "promote innovation for all", to be implemented by ministries and public agencies (November 2013): new R&D programmes within the existing budgets, measures to foster innovative public procurement, a programme to foster entrepreneurship in secondary school, new public late-stage VC fund, a new commission for the evaluation of innovation policies, a new "mediator for innovation", new inter-ministerial commission for coordination of innovation and knowledge-transfer policies.

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 France's position regarding the indicator's different components:

France - 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, w hich refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in know ledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-grow th enterprises (employment-w eighted average).
COMP = Combination of sub-components GOOD and SERV, using equal w eights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Know ledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

France ranks eighth in the European innovation indicator. It has particular strengths in the share of medium-high and high-tech goods in total goods exports and in the innovativeness of fast-growing innovative firms. Performance stagnated in the period 2010-2012.

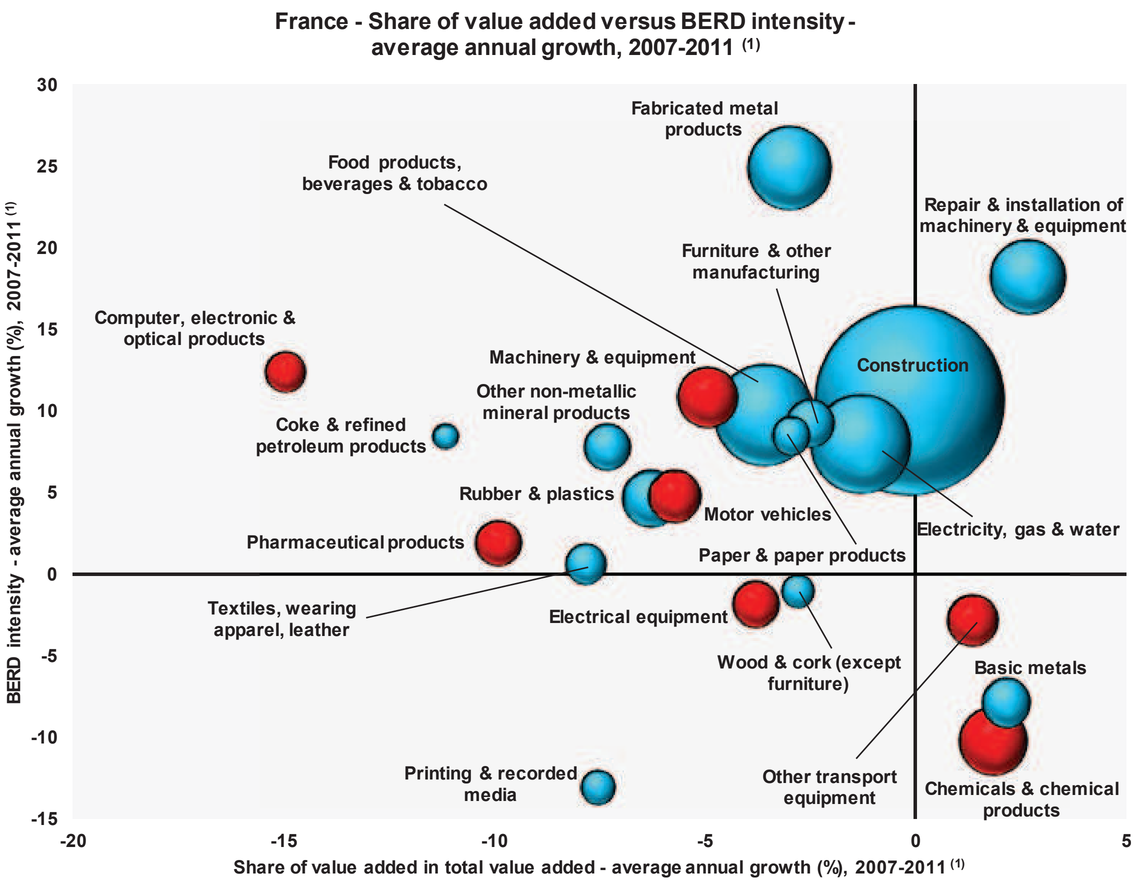
Industries contributing most to the high share of medium-high and high-tech exports in France are other transport equipment (aeroplanes and trains), medicinal & pharmaceutical products, essential oils & resinoids & perfume materials, and power generating machinery & equipment.

Tourism (leading to corresponding service exports) is an important economic sector in France, which partly explains the relatively low share of knowledge-intensive service exports. Furthermore, French companies collect a relatively high amount of royalties and licence fees, which are classified as not knowledge intensive.

France performs well as regards the average innovativeness scores of fast-growing firms in relation to the total employment in fast-growing firms. This is a result of a high share of employment in ICT and in professional, scientific and technical activities in employment in fast-growing enterprises. However, the growth of these innovative fast-growing firms might be dampened by the administrative thresholds once they reach a specific size (10 or 50 for instance, as was highlighted in the Commission's 2014 in-depth review of France).

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries for the period of 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 of manufacturing in the overall economy of France. 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 all sectors presented on 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) 'Coke and refined petroleum products': 2010-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The graph above shows that almost all manufacturing sectors have seen their weight in the economy decrease (horizontal axis) between 2007 and 2012. The only exceptions are basic metals, other transport equipment, and chemicals & chemical products, the last two belonging to high- or medium-high-tech sectors. Since manufacturing high-tech and medium-high-tech sectors (in red) are the most research-intensive sectors in the economy, the shrinking of these sectors in particular has a negative effect on total business R&D intensity in France. In contrast, research intensity (vertical axis) has increased in the majority of the manufacturing sectors, including a majority of high-tech and medium-high-tech sectors. This of course enhances the overall business R&D intensity.

Overall, the second effect has proved stronger than the first – overall business R&D intensity increased from 1.31 % of GDP to 1.44 % between 2007 and 2011. France's manufacturing industry is dominated by food products, beverages and tobacco, and the fabricated metal products sector, which do not belong to high-tech and medium-high-tech sectors. This contributes to limiting the R&D intensity of the French business sector. The graph above shows very significant growth in the BERD intensity in the fabricated metal products sector.

Key indicators for France

FRANCE	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	1.19	1.16	1.20	1.30	1.40	1.49	1.59	:	:	6.9	*1.81*	*16*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	496	:	:	497	:	:	495	-0.6 (3)	495 (4)	12 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	1.34	1.31	1,33	1.31	1.33	1.40	1.42	1.44	*1.48*	*2.4*	1.31	8
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.78	0.77	0.75	0.75	0.77	0.84	0,80 (5)	0.78	*0.78*	*-1.1*	*0.74*	9
Venture Capital as % of GDP	0.37	0.42	0.56	0.67	0.44	0.18	0.31	0.46	0.25	-17.9	0,29 (6)	5 (6)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	41.9	:	:	:	:	49.5	3.4	47.8	10
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	9.8	10.0	10.0	10.3	10.4	:	:	:	1.8	11.0	12
International scientific co-publications per million population	:	509	537	569	601	648	*668*	699	707	4.4	343	15
Public-private scientific co-publications per million population	:	:	:	41	41	42	*45*	49	:	4.7	53	10
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	3.5	4.1	4.0	4.0	4.0	4.3	4.2	:	:	1.8	3.9	7
License and patent revenues from abroad as % of GDP	0.17	0.29	0.28	0.34	0.39	0.54	0.53	0.58	0.47	6.7	0.59	10
Community trademark (CTM) applications per million population	56	75	85	94	95	102	109	114	113	3.6	152	16
Community design (CD) applications per million population	:	24	26	26	27	27	27	27	28	1.6	29	11
Sales of new to market and new to firm innovations as % of turnover	:	:	:	:	13.2	:	14.7	:	:	5.5	14.4	9
Knowledge-intensive services exports as % total service exports	:	:	:	30.7	29.8	31.2	33.7	33.7	:	2.4	45.3	13
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	3.88	4.95	5.11	4.70	5.32	4.76	4.78	4.65	5.23	-	4,23 (7)	4
Growth of total factor productivity (total economy) - 2007 = 100	97	99	100	100	99	96	97	98	97	-3 (8)	97	11
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	56.7	:	:	:	:	58.1	0.5	51.2	7
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	13.5	13.6	13.8	14.4	14.3	1.5	13.9	12
SMEs introducing product or process innovations as % of SMEs	:	:	:	:	32.1	:	30.6	:	:	-2.4	33.8	16
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.26	0.31	0.33	0.36	0.40	0.46	:	:	:	12.4	0.44	7
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.63	0.59	0.55	0.54	0.57	0.55	:	:	:	1.5	0.53	9
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	67.8	69.4	69.3	69.8	70.4	69.4	69.2	69.2	69.3	-0.1	68.4	12
R&D Intensity (GERD as % of GDP)	2.15	2.11	2.11	2.08	2.12	2.27	2,24 (5)	2.25	*2.29*	*1.0*	*2.07*	7
Greenhouse gas emissions - 1990 = 100	101	102	100	98	97	93	94	89	:	-9 (9)	83	15 (10)
Share of renewable energy in gross final energy consumption (%)	:	9.5	9.6	10.2	11.3	12.3	12.8	11.5	:	3.0	13.0	16
Share of population aged 30-34 who have successfully completed tertiary education (%)	27.4	37.7	39.7	41.4	41.2	43.2	43.5	43.3	43.6	1.0	35.7	9
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	13.3	12.2	12.4	12.6	11.5	12.2	12.6	12.0	11.6	-1.6	12.7	20 (10)
Share of population at risk of poverty or social exclusion (%)	:	18.9	18.8	19.0	18,5 (11)	18.5	19.2	19.3	19.1	0.8	24.8	8 (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 2010 and the previous years. Average annual growth refers to 2010-2012.
(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) 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 2008 and the previous years. Average annual growth refers to 2008-2012.
(12) Values in italics are estimated or provisional.

2014 Country-specific recommendation in R&I adopted by the Council in July 2014:
"Take steps to simplify and improve the efficiency of innovation policy, in particular through evaluations, taking into account the latest reforms and if necessary an adaptation of the 'crédit d'impôt recherche'. *Ensure that resources are focused on the most effective competitiveness poles and further promote the economic impact of innovation developed in the poles."*

Germany

The challenge of maintaining a high innovation capacity for an export-oriented economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Germany. 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: 2.98 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +3.3 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[21] 2012: 59.0 (EU: 47.8; US: 58.1) 2007-2012: +2.2% (EU: +2.9%; US: -0.2)
Innovation Output Indicator 2012: 124.2 (EU: 101.6)	*Knowledge-intensity of the economy*[22] 2012: 47.1 (EU: 51.2; US: 59.9) 2007-2012: +1.0 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Automobiles, environment, energy, and key production technologies	*HT + MT contribution to the trade balance* 2012: 9.2 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +1.7 % (EU: +4.8 %; US: -32.3 %)

Germany has expanded its R&I system over the last decade. Expenditure on R&D has grown substantially since 2000 to reach 2.98 % of GDP in 2012, which is already close to the 3 % national target for 2020. Public expenditure represents 30 % of investment in R&D, which is an increase compared to 2008 (28 %), but still below the EU average of 33 %. The government increased the public budget on R&I even during the 2009 economic crisis as part of a policy of prioritising spending on education and research. Business enterprise expenditure on R&D, which represents two-thirds of investment in R&D, also grew as a % of GDP over the period 2007-2011.

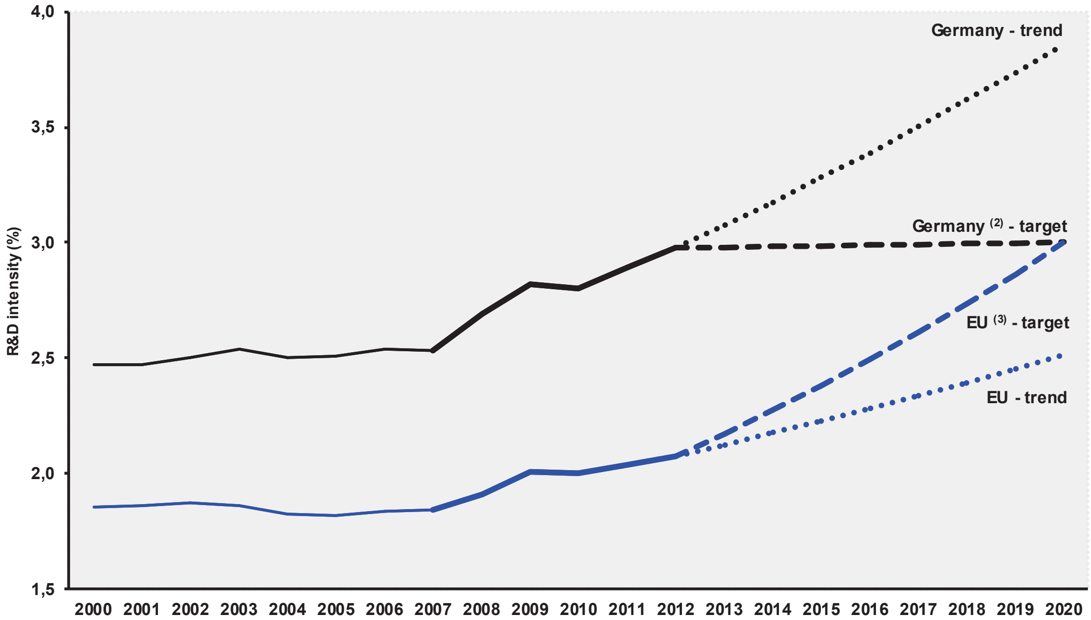
The increase in public and private expenditure on research and development in Germany has helped to maintain a high innovation capacity and a strong export performance. The German economy is based to a considerable extent on medium-high technology sectors, such as automobiles, electro-technical products, machinery, and chemical products. However, over the last decade, Germany has lost its strong market position in pharmaceuticals and in optical industries. Recently, it has only produced a few successful new international players in high-tech industries. There is also still underexploited growth potential as regards innovative and knowledge-intensive service economy sectors. Germany has come through the last economic crisis relatively well, partly as the result of a strong export sector. However, the German market position as regards medium-high-tech products may be challenged in the future by new players, such as the BRIC countries (Brazil, Russia, India and China). An ageing population with a declining share of young people represents further challenges for the German economy.

[21] 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.
[22] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

The Federal Ministry for Education and Research (BMBF) has developed the so-called High-Tech Strategy to address several important challenges. However, further structural reforms of the education, research and innovation system are required. In view of the demographic situation, a particular focus is required on the quality of human resources and further incentives for excellence and internationalisation are needed. There is room for more public-private cooperation and for implementing targeted supply-side and demand-side measures to foster innovation and fast-growing innovative firms in Germany. Such measures should in particular be targeted at high-tech sectors such as ICT, biotechnology and medical technologies.

Investing in knowledge

Germany - 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) DE: 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.

With an R&D intensity of 2.98 % in 2012, Germany is above the EU average and has almost reached the 3 % national target. The gap of only 0.02 % currently corresponds to EUR 0.5 billion (German GDP amounted to about EUR 2.6 trillion in 2012). About one-third of German R&D expenditure comes from public sources and two-thirds from private sources – a distribution that has remained fairly stable over the last decade.

In the period 2000-2011, the federal public research budgets, which represent more than half of public spending on research, were expanded substantially. Federal spending on research and education increased by a further 7 % in 2011 and by 12 % in 2012. However, at *Länder* level, growth in R&D expenditure, including university expenditure on R&D, was much lower. R&D intensities vary strongly between German *Länder*, ranging from 1.43 % in Schleswig-Holstein and 1.49 % in Saarland and Sachsen-Anhalt to 5.08 % (2011) in Baden-Württemberg, the European region (NUTS 1 level) with the highest research intensity. Berlin (3.56 %) and Bayern (3.16 %) also have R&D intensities that are already above the German national target.

Research intensity is especially high in the automobile sector, which represents nearly one-third of total German business R&D investment. A weak point for German R&D is the relatively low level of spending in high-tech areas such as pharmaceuticals and ICT.

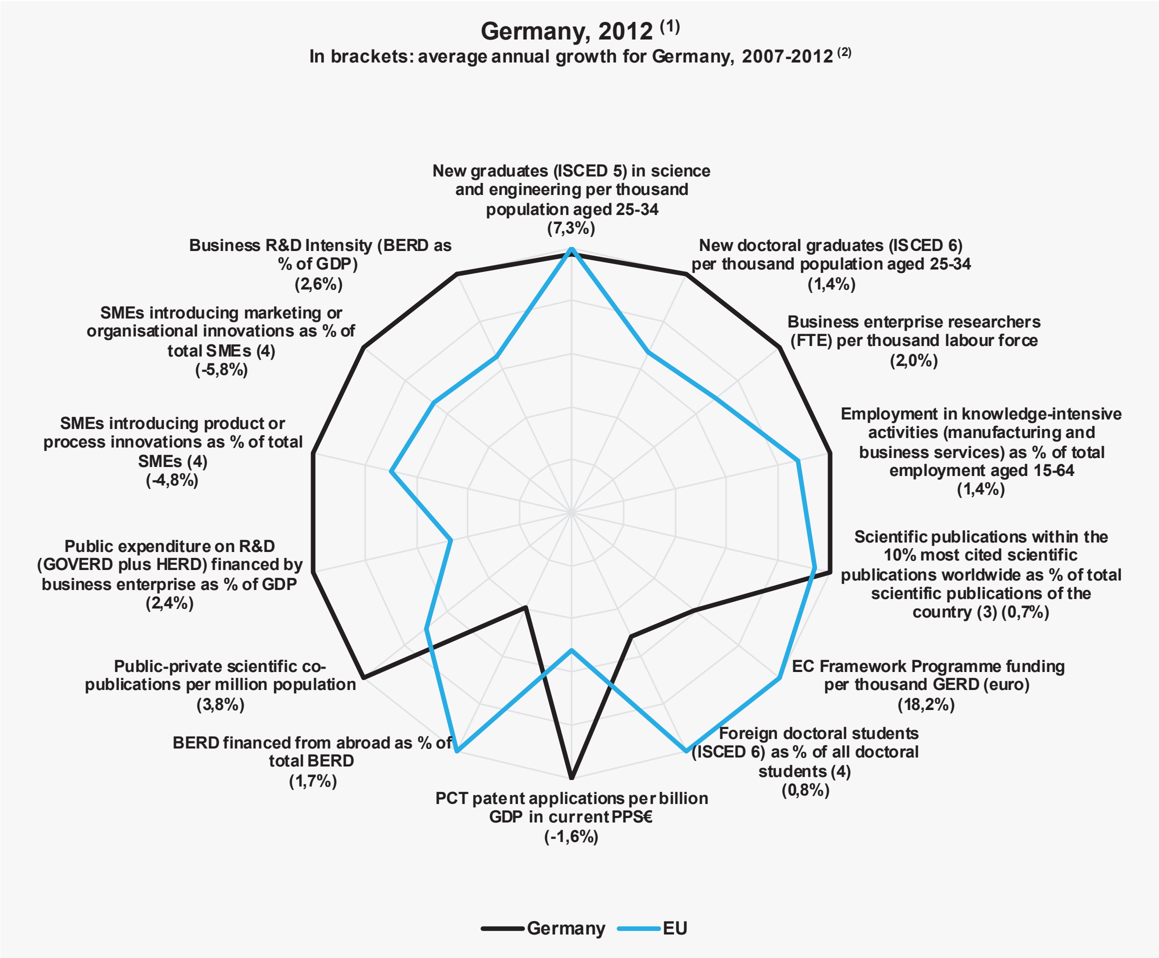
Structural Funds are an important source of funding for R&I activities. Of the EUR 25.5 billion of Structural Funds allocated to Germany over the 2007-2013 programming period, around EUR 5.0 billion (20 % of the total) relate to RTDI[23].

Germany counts 11 000 participants in the EU Seventh Framework Programme and receives the highest amount of FP7 funding in absolute terms (EUR 4.3 billion). Its application success rate is above average (24 % compared to an EU average of 20.4 %), but FP7 funding as a % of GDP is below the EU average.

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

The graph below illustrates the strengths and weaknesses of the German R&I system. Reading clockwise, the graph 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.

[23] 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.



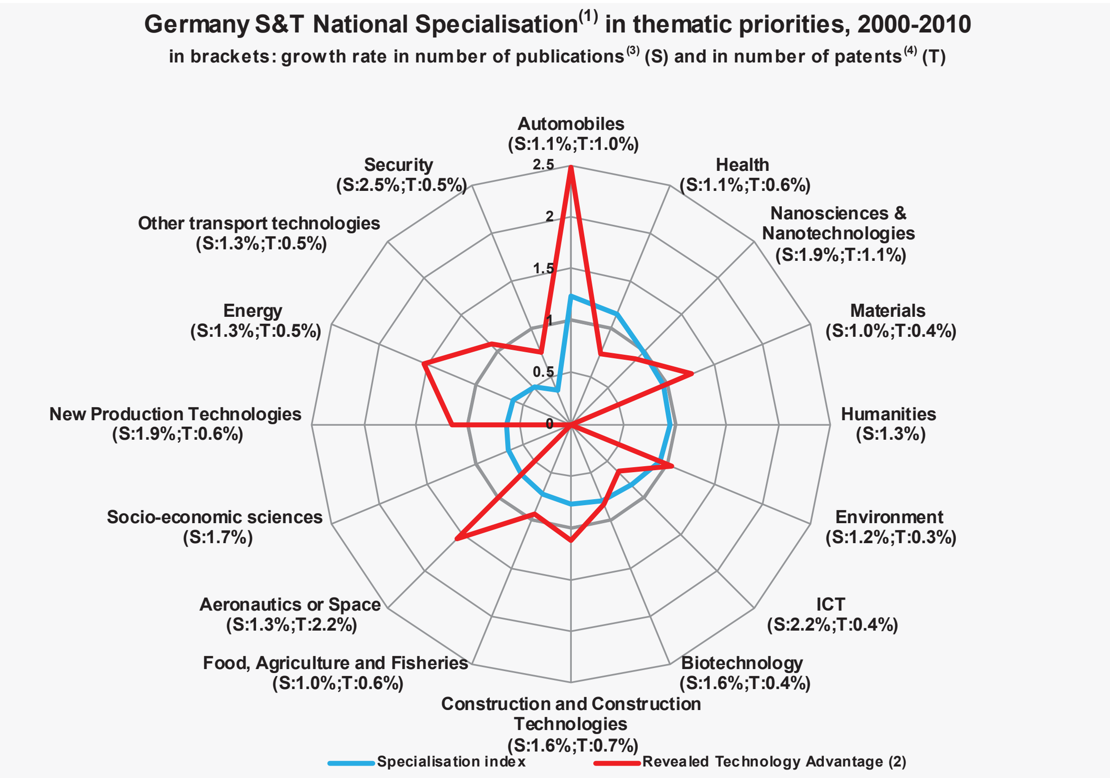
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates 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.

In general, Germany's R&I system performs very well. However, the international dimension is below the EU average, in particular in relation to foreign investment in business R&D and EU Framework Programme funding. Possible explanations relate to the country-size effect, as well as to the high level of German domestic public and private expenditure on R&D. Despite the easy access to and relative abundance of national funding for research, Germany could better use the opportunities offered within the ERA and more specifically within the Framework Programme.

Germany has a particular strength in business R&D, especially in innovative small and medium-sized enterprises (SMEs), many of which are world leaders in their particular small market segments. However, the data above show a decline in the innovation rate of SMEs since 2007. The high level of patenting is an indication of industrial leadership in several domains, most notably in medium-high-tech industries, including engineering industries, automobiles and chemicals and also in environmental and energy technologies. On the other hand, patenting in relation to GDP has fallen in recent years. Public-private cooperation in publications and in research is functioning well and is further supported by the federal government in the current new programme activities for innovation outlined in the High-Tech Strategy. While Germany performs well in terms of new doctoral graduates, its performance as regards new science and engineering graduates has only recently surpassed the EU average, and there is the risk of slower growth in the long term as a result of demographic trends, like the shrinking number of young people. In the long term, the risk of a scarcity of qualified human resources could endanger the strong German export position in engineering and science-based industries. In recent years, there has been an increase in the number of students in science and engineering subjects (MST/MINT), but efforts should be maintained to further reduce drop-out rates and improve the gender balance in terms of students and teaching staff.

Germany's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Germany 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.

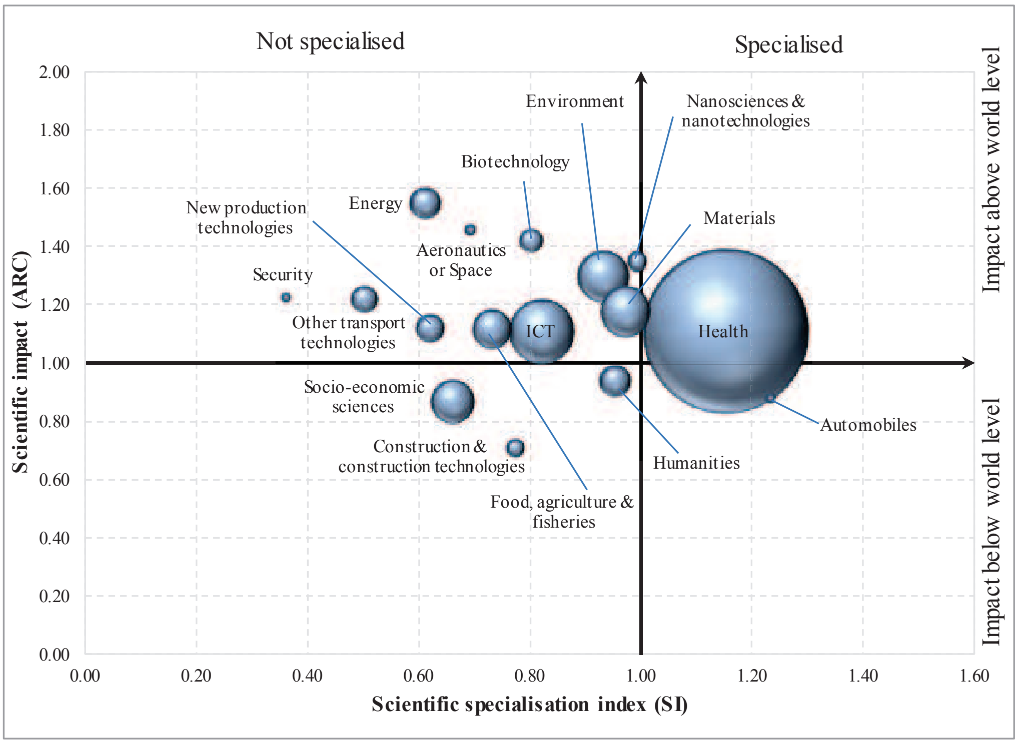


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding 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.

As illustrated by the graph above, there is a notable difference in performance between scientific production (publications) and technological production (patents) in Germany. As regards publications, Germany shows specialisations only in the fields of automobiles and health. There is a lack of specialisation in the energy, other transport technology and security sectors. As regards patents (technological output), Germany displays strengths in automobiles, materials, aeronautics, new production technologies and energy.

The graph below illustrates the positional analysis of German 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 Germany 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

Germany shows a high specialisation in publications in the fields of health and automobiles. However, in both areas the scientific impact is only at or below the world average. As regards the other areas, Germany shows no specialisation. However, for energy, aeronautics/space and biotechnology the impact of publications are noticeably above world level.

Policies and reforms for research and innovation

The High-Tech Strategy 2020, launched in August 2006 and updated in July 2010, is seen as an instrument to improve cooperation between science and industry, and to improve the conditions for innovation with a view to enhancing the international competitiveness of technology-intensive manufacturing products in key sectors of the German economy. The 2010 update of the High-Tech Strategy prioritises the targeting by public-private partnerships of prospective markets related to important societal challenges in 10 so-called forward-looking projects (Zukunftsprojekte). Strategic priorities of the High-Tech Strategy 2020 are health, nutrition, climate and energy security, and communication and mobility.

Another important element in the research policy of the federal government and the *Länder* is the 'Pakt für Forschung und Innovation' (Pact for research and innovation). In 2005, the Federal Government and the *Länder* agreed to regularly increase their joint funding for the major public German research organisations: the Fraunhofer Society, the Helmholtz Association of German Research Laboratories, the Leibniz Association, the Max Planck Society, as well as the German Research Foundation, which is the major funder for universities. The initiative aims to enable science organisations to continue to improve strategic measures, enhance the quality and quantity of existing instruments, and develop, test and establish new instruments. In 2009, the initiative was updated and the annual growth of institutional funding increased from 3 % to 5 % between 2011 and 2015.

As regards fiscal policies, Germany is one of the few countries that have not introduced R&D tax credits. Such credits tend to be requested by large international companies.

The university system, which is the responsibility of the *Länder*, is meeting challenges, given the recent strong increase in student numbers and limited funding at *Länder* level. Because of a significant rise in the number of new entrants in recent years, the Hochschulpakt (higher education pact) – voluntary agreements between the federal and the *Länder* levels – has been set up. This pact was renewed in 2009 and additional resources were allocated in March 2011 and June 2013.

As regards human resources, Germany has taken measures to remove restrictions on in-bound researcher mobility in view of a skills shortage in some science and technology domains. The federal government recently decided to reform the Immigration Act to facilitate the processing of residence permits, on an action programme to ensure an adequate supply of labour, and on programmes for enhancing international mobility. The legal parameters for the employment of foreign graduates from German universities have been improved and new initiatives are facilitating recognition of qualifications acquired abroad. This could help to increase the share of professors (2012: 6.3 %) coming from abroad. Researcher salaries in Germany are above the EU average, but below those in the United States and Switzerland, one of the reasons for a net outmigration to these countries. Better conditions for career planning and greater transparency of academic pathways could enhance the attractiveness of German universities for foreign researchers.

In June 2008, a national pact to attract more women to science and engineering (Komm mach MINT-mehr Frauen in MINT-Berufen) was set up on the initiative of the Research Ministry (BMBF) and a second phase of this pact was launched in December 2011.

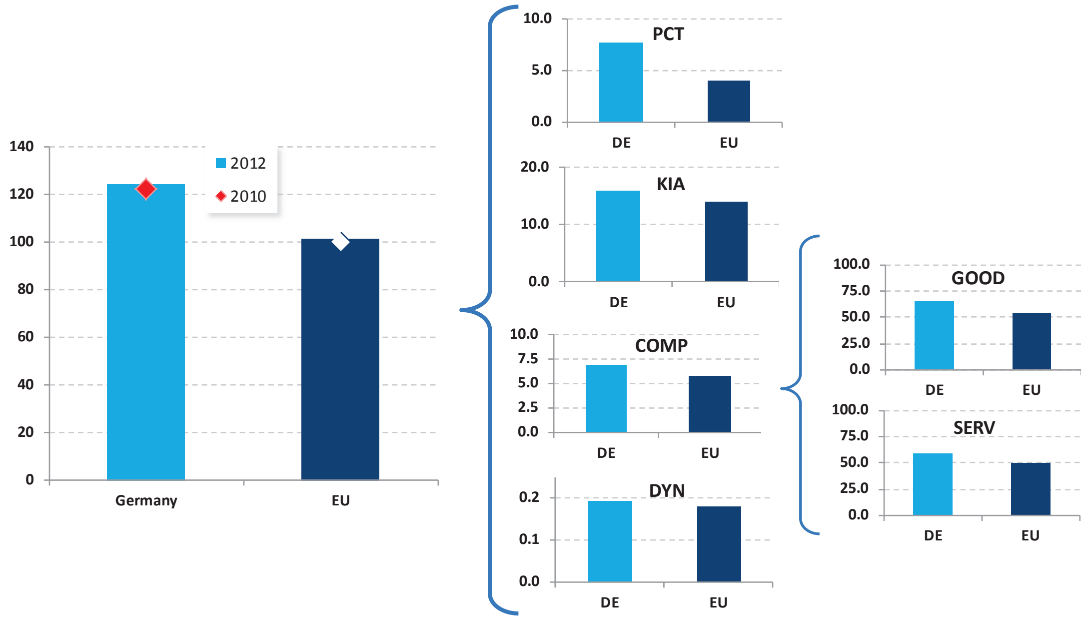
In operation since 2008, the BMBF's Female Professors Programme promotes outstanding women researchers. Since then, 270 additional women professors have been appointed in German higher education institutions. In 2012, following a positive evaluation of the programme's contribution to developing equal opportunities in higher education institutions, the Joint Science Conference of the Federal Government and the Heads of Government of the *Länder* (GWK) decided to continue the programme for a second period of five years until 2017. The programme aims to promote the equality of men and women at universities, increase the representation of women at all levels of qualification in the research system on a long-term basis, and boost the number of female scientists in leading positions in the science system.

As regards the 'knowledge triangle' and fostering innovation activities, the BMBF and the Federal Ministry for Economic Affairs (BMWi) are taking steps to better focus their activities. The BMBF fosters public/private partnerships through activities such as the 'Leading-edge cluster competition' (Spitzencluster-Wettbewerb), which promotes the formation of clusters of business and science to boost Germany's innovative strengths in specific areas and, more recently (August 2011), the 'Research Campus' (Forschungscampus), a competitive funding scheme to strengthen cooperation between companies and research organisations. The BMWi uses the EXIST programme to stimulate an entrepreneurial environment at universities and research institutions. This programme is aimed at increasing the number of technology and knowledge-based business start-ups. The Hightech Gründerfonds stimulates start-ups and young technology companies by providing venture capital.
To help SMEs to enhance R&I, a Central Innovation Programme for SMEs (ZIM, Zentrales Innovationsprogramm Mittelstand) was set up in 2008 and will run until 2014. Funding is provided for individual research projects and for national and international cooperation between research organisations and companies as well as between companies. More than 5000 projects are financed each year.

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 Germany's position regarding the indicators' different components:

Germany - 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 %).

Germany is the top EU performer in the European innovation indicator. This is a result of good performance as regards all the indicator's components.

The country's performance is notably high on patents and on the share of medium-high/high-tech exports in total goods exports, where it is the second best performer in the EU.

The good performance in patents is explained by the above-average share of industries with a high patent intensity in Germany (ICT, automobile industry, medical equipment, and energy technology). Companies like Siemens, Bosch and BASF are among the top patent producers in Europe. The large and export-oriented automobile and machinery industry also explains the high score as regards the contribution of medium-high/high-tech exports to trade balance[24]. When it comes to the export share of knowledge-intensive services, the good performance is partially explained by the fact that Germany is an important transportation hub for air and waterborne transport (both classified as KIS), an important software exporter, and a major exporter of research, professional and technical services. Germany also performs above the EU average in the share of knowledge-intensive activities as the

[24] Germany also performs above the EU average in Community trademarks and designs, but the difference compared to the EU average is smaller than for patents.

result of a high share of employment in the manufacture of electronic and optical production, in publishing activities and in employment activities.

Germany performs well as regards the innovativeness of fast-growing firms. This is the result of a high share of activities with high innovativeness scores, such as computer programming and information service activities, among the fast-growing firms.

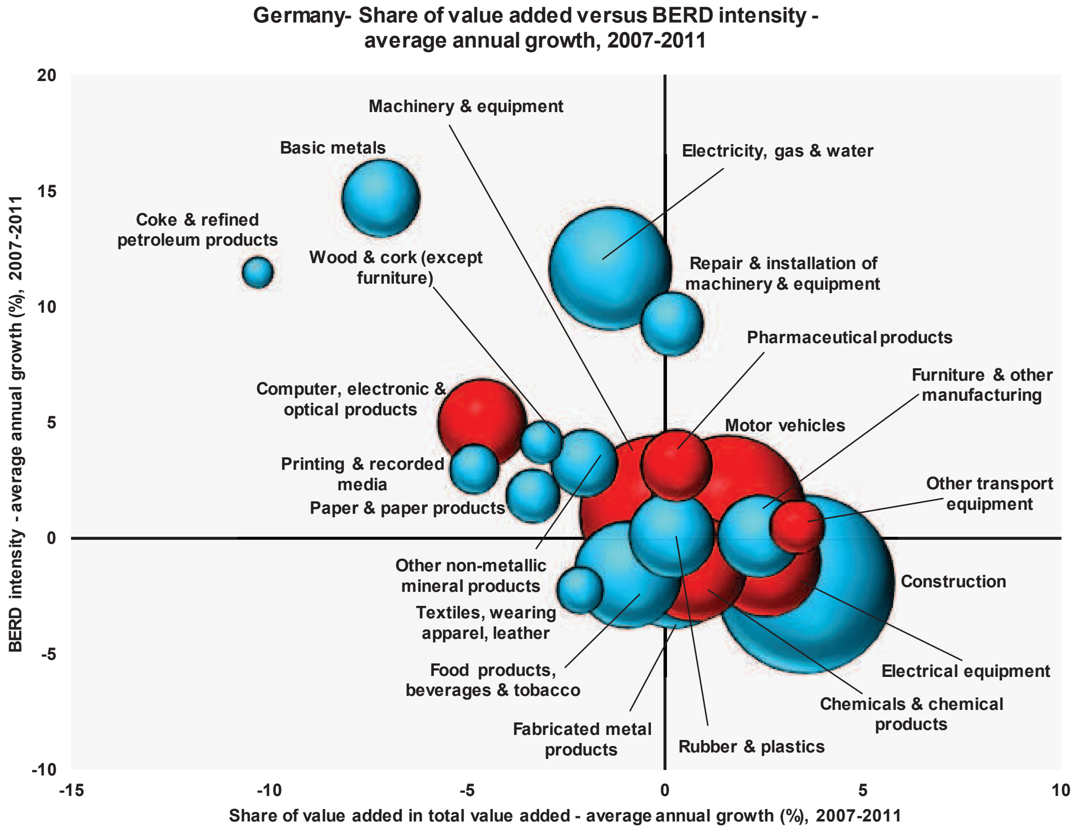
Framework conditions for entrepreneurship in Germany have improved, as indicated by the country's improved ranking in the World Bank's 'ease of doing business index'. Germany has also made progress in reducing the administrative burden related to reporting obligations in the business sector. In 2011, the Bureaucracy Reduction and Better Regulation programme was extended to cover other compliance costs. However, Germany remains at around the EU average regarding the administrative burden of the regulatory framework.

Labour productivity in the country is high and SMEs' access to bank lending is above the EU average. The quality of the infrastructure is good and the legal and regulatory framework is perceived as appropriate by business. Any remaining weak points concern the availability of broadband and use of e-government services. Furthermore, the availability of venture capital in Germany (0.19 % of GDP in 2012) remains below the EU average (0.29 %).

In the Global Competitiveness Report 2013-14, Germany is ranked second highest among EU countries (after Finland) in capacity for innovation, second highest (after Finland) in company spending on R&D, and fourth in the EU on university-industry collaboration on R&D.

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
Note: (1) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The German economy is characterised by a relatively strong manufacturing industry. Nevertheless, as in many countries, the trend in manufacturing industries' share of value added in total value added is one of decline (illustrated by a shift to the left in the graph above). This is linked to rationalisation and a relative fall in the price levels of manufactured goods, the expanding services sector, and also to globalisation and competition from lower-wage, emerging economies.

The distribution of business expenditure on R&D reflects the concentration of German industry in medium-high-tech sectors, with more than 30 % of R&D spending carried out by the automobile sector alone. Other important medium-high-tech sectors in terms of R&D expenditure are machinery and equipment and chemicals excluding pharmaceuticals. These three sectors represent around 50 % of business expenditure on R&D in Germany. Spending levels are relatively lower in high-tech areas with pharmaceuticals, radio, TV and communication equipment, and medical precision and optical instruments together accounting for only around 20 % of business expenditure on R&D. Furthermore, research is concentrated in large companies and research intensity is lower in the services sector than in manufacturing.

Compared to other EU Member States, the German manufacturing industries present an above-average dynamic of upgrading knowledge through R&D. Since 2007, growth in business research intensity has been moderate, although still faster than the EU average. The motor vehicles industry, a key sector of the German economy, has maintained its high research intensity and has succeeded in increasing its share of value added. A second important medium-high-tech sector, machinery and equipment, has kept its share of the economy and its research intensity stable. The computer, electronics and optical products sector has increased research intensity but its share of value added has declined, partly as a result of falling product prices. Research intensity has increased strongly in a number of medium- and low-tech sectors such as basic metals and coke and refined petroleum products, although from a low level.

Key indicators for Germany

GERMANY	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	2.12	2.59	2.53	2.52	2.65	2.64	2.68	2.79	2.70	1.4	*1.81*	2
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	504	:	:	513	:	:	514	9.7 [3]	495 [4]	6 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	1.74	1.74	1.78	1.77	1.86	1.91	1.88	1.96	*2.02*	*2.6*	1.31	4
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.73	0.77	0.76	0.76	0.83	0.92	0.92	0.94	*0.96*	*4.8*	*0.74*	4
Venture Capital as % of GDP	0.23	0.12	0.15	0.33	0.29	0.11	0.19	0.17	0.19	-10.5	0,29 [5]	8 [5]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	52.9	:	:	:	:	59.0	2.2	47.8	8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	11.5	11.7	11.5	11.7	11.6	:	:	:	0.7	11.0	7
International scientific co-publications per million population	:	517	542	588	609	654	689	729	746	4.9	343	14
Public-private scientific co-publications per million population	:	:	:	65	63	66	73	76	:	3.8	53	9
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	7.2	7.8	7.8	7.9	7.1	7.8	7.5	:	:	-1.6	3.9	3
License and patent revenues from abroad as % of GDP	0.16	0.26	0.24	0.25	0.30	0.54	0.45	0.41	0.40	9.7	0.59	11
Community trademark (CTM) applications per million population	119	134	165	189	189	197	224	244	245	5.3	152	5
Community design (CD) applications per million population	:	36	38	42	41	40	41	43	43	0.4	29	7
Sales of new to market and new to firm innovations as % of turnover	:	:	19.2	:	17.4	:	15.5	:	:	-5.5	14.4	4
Knowledge-intensive services exports as % total service exports	:	49.7	51.0	53.9	55.1	53.1	55.8	55.6	:	0.8	45.3	5
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	9.23	8.00	7.78	8.48	8.90	7.67	7.76	8.54	9.24	-	4,23 [6]	1
Growth of total factor productivity (total economy) - 2007 = 100	94	96	98	100	100	94	98	100	99	-1 [7]	97	6
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	44.8	:	:	:	:	47.1	1.0	51.2	14
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	14.9	15.4	15.3	15.0	15.8	1.4	13.9	7
SMEs introducing product or process innovations as % of SMEs	:	:	52.8	:	53.6	:	48.6	:	:	-4.8	33.8	1
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	1.03	0.78	0.81	0.80	0.91	1.06	:	:	:	14.8	0.44	2
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	1.06	1.13	1.04	1.01	0.90	0.93	:	:	:	-4.0	0.53	3
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	68.8	69,4 [8]	71.1	72.9	74.0	74.2	74.9	76.3	76.7	1.0	68.4	3
R&D Intensity (GERD as % of GDP)	2.47	2.51	2.54	2.53	2.69	2.82	2.80	2.89	*2.98*	*3.3*	*2.07*	4
Greenhouse gas emissions - 1990 = 100	84	81	81	79	79	74	77	74	:	-5 [9]	83	9 [10]
Share of renewable energy in gross final energy consumption (%)	:	6.0	7.0	8.3	8.4	9.2	10.7	12.3	:	10.3	13.0	14
Share of population aged 30-34 who have successfully completed tertiary education (%) [10]	25.7	26,1 [8]	25.8	26.5	27.7	29.4	29.8	30.7	32.0	3.8	35.7	17
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	14.6	13,5 [8]	13.7	12.5	11.8	11.1	11.9	11.7	10.6	-3.2	12.7	15 [10]
Share of population at risk of poverty or social exclusion (%)	:	18.4	20.2	20.6	20.1	20.0	19.7	19.9	19.6	-1.0	24.8	9 [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) 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) Break in series between 2005 and the previous years.
(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:

"Use the available scope for increased and more efficient public investment in infrastructure, education and research."

Greece

Promoting innovation as a driver of a less-dependent and sustainable economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Greece. 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: 0.69 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.6 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[25] 2012: 27.2 (EU: 47.8; US: 58.1) 2007-2012: -1.9 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 76.3 (EU: 101.6)	*Knowledge-intensity of the economy*[26] 2012: 31.6 (EU: 51.2; US: 59.9) 2007-2012: +0.8 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food, agriculture and fisheries, security, construction, health, and environment	*HT + MT contribution to the trade balance* 2012: -5.4 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

In 2012, Greek national R&D intensity was 0.69 % of GDP showing a 3.5 % increase compared to the previous year. However, it remains significantly below the EU average of 2.06 % of GDP. Regarding the excellence in science and technology indicator, Greece remains below the EU average as its performance has declined compared to 2007. It has managed to slightly raise its performance in the knowledge-intensity indicator compared to 2007, but remains well below the EU average indicating that there is still room for structural change towards more knowledge-intensive activities. In terms of innovation output, Greece is also below the EU average, which can be partly explained by its poor performance in technological innovation, measured by means of patent applications. In terms of the economy's competitiveness, the consistently negative trade balance relating to high- and medium-tech products implies the necessity to concentrate on innovative products to make the country more self-sustainable and possibly more competitive by increasing exports of cutting-edge products.

Some of the key bottlenecks and challenges for Greece include the lack of an integrated legal framework for research performers (overall the system is dominated by the universities) and the weak articulation of R&I policy with other policies, with particularly weak links in the knowledge-triangle sectors. Moreover, exploitation of research results by the business sector is very limited, with very low patenting activity.

Since 2013, significant actions have been undertaken to reform the Greek R&I system, in order to make it more modern, efficient and adaptable to the country's current economic situation. Indeed, given the current financial situation in Greece, an opportunity has been presented to move towards more knowledge-intensive activities and to concentrate more on high-tech innovative products, which will be identified through the national and regional smart specialisation processes. Such an approach

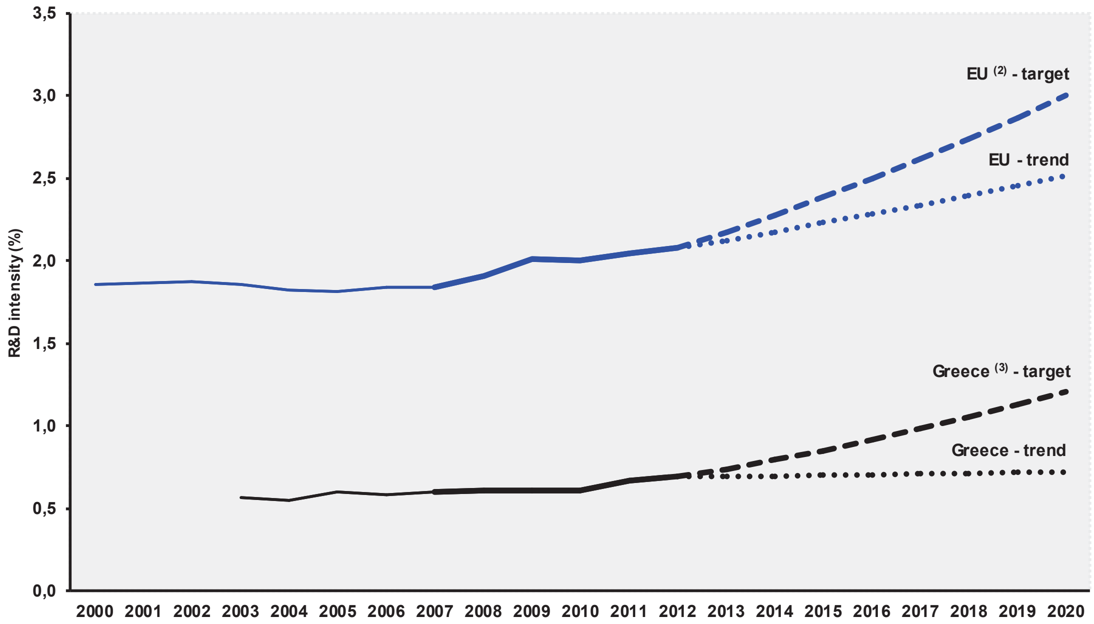
[25] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

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

will help decrease the dependency and increase the sustainability of the Greek economy, eventually driving the country out of the economic crisis.

Investing in knowledge

Greece - 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 2001-2007 in the case of Greece.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) EL: The projection is based on a tentative R&D intensity target of 1.21% for 2020.
(4) EL: There is a break in series between 2011 and the previous years; The values for 2008, 2009 and 2010 were estimated by DG Research and Innovation.

Gross domestic expenditure on R&D (GERD) in Greece was 0.69 % of GDP in 2012, a slight increase compared to the previous year (0.67 %), but still much lower than the EU average of 2.06 % in 2012.

The latest EU2020 R&D target set by Greece in the context of the 2013 European Semester process of 0.67 % of GDP has already been achieved, and the Greek authorities have set a new revised and more ambitious target of 1.21 % of GDP.

In 2012, business expenditure on R&D (BERD) increased to reach 0.24 % of GDP compared to 0.17 % in 2007. This can probably be coupled with Greek participants performing well in the EU Framework Programmes, and shows significant potential nationally in the R&I field, opening up opportunities for the country on the road to recovery.

EU Structural Funds are an important source of funding for R&I activities in Greece. Of the EUR 20.210 million of Structural Funds allocated to Greece over the 2007-2013 programming period, around EUR 2.020 million (10 % of the total) relate to RTDI[27]. The 2007-2013 Operational

[27] 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

Programme (OP) 'Competitiveness and Entrepreneurship' has a total budget of EUR 1.52 billion for which Cohesion policy provides EUR 1.29 billion (EC contribution), representing approximately 6.32 % of the total EU sum invested in Greece under the Cohesion policy (2007-13). It includes Union support for Greek regions that are eligible under the Convergence objective (Eastern Macedonia and Thrace, Thessaly, Epirus, Western Greece, Peloponnese, Ionian Islands, Crete and North Aegean). The OP includes R&I activities mainly in two of its priority axes: 'Stimulation and development of innovation, supported by research and technological development' and 'Improvement of the entrepreneurial environment'. In 2013, the Greek authorities decided to reduce the allocation to the OP's above-mentioned R&I core priority axes by EUR 67 million, as the result of implementation difficulties and absorption problems.

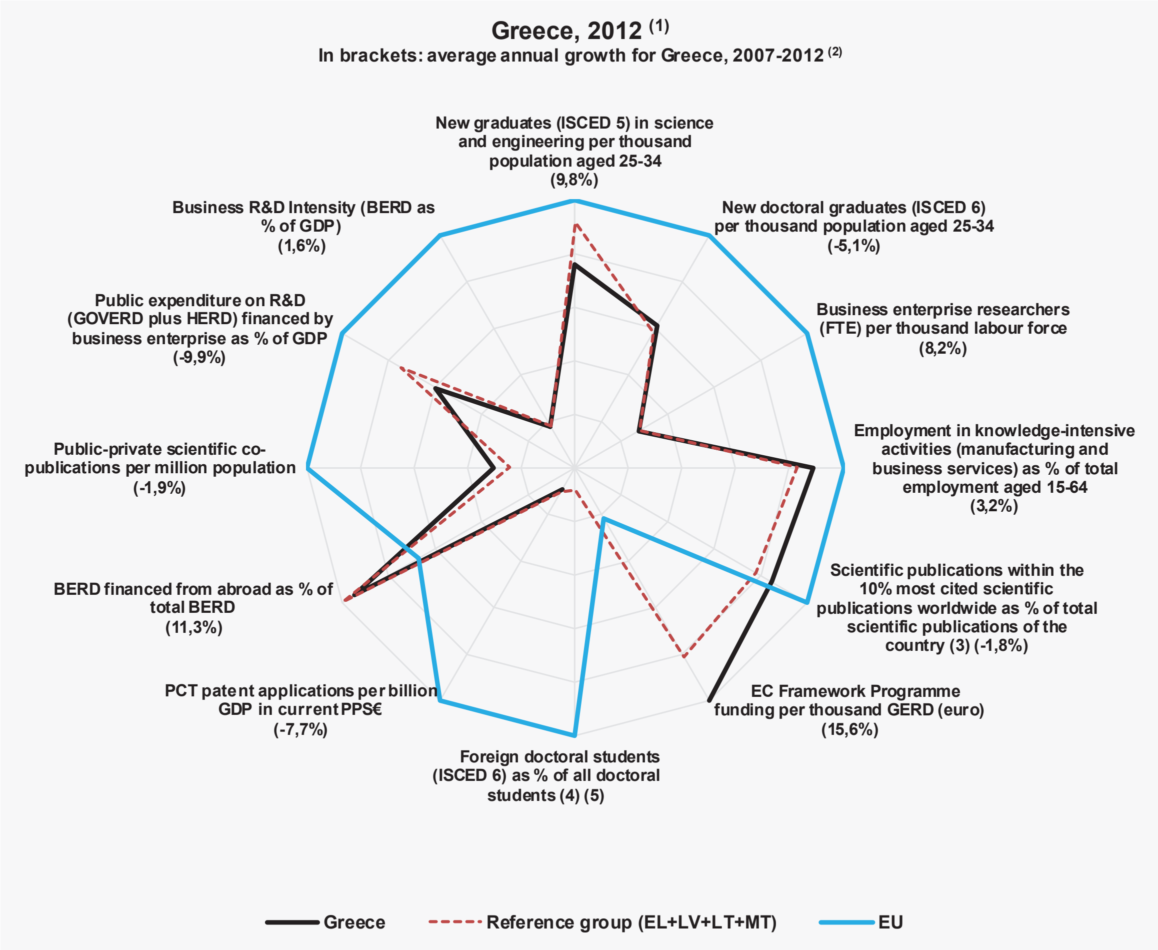
Greece has been relatively successful in terms of its participation in the Seventh Framework Programme for Research and Technological Development (FP7). Up until March 2014, 3587 participants from Greece had benefited from FP7, absorbing a total of EUR 974 million with around 15 % of that funding going to Greek small and medium-sized enterprises (SMEs). Despite the fact that Greece ranks 11th in the EU-28 in terms of budget share and ninth in terms of number of participants, success rates in FP7, both in terms of applications and of EU financial contribution, remain relatively low. On the one hand, this shows greater interest from Greek entities in EU funding programmes, while on the other, the potential for raising the level of excellence in the proposals submitted in an effort to make them more successful and to increase their chances of being retained for EU funding.

Greece's most active and successful participation in FP7 is in the ICT field, as well as in Marie-Curie actions. The most active Greek entities in FP7 are mainly research organisations and universities – the top-performing entities are the research organisations FORTH and CERTH, both ranked in the top 100 most successful performers in FP7. Greece has most FP7 collaborative links with the Germany, Italy, the United Kingdom, Spain and France.

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

The graph below illustrates the strengths and weaknesses in the Greek 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.

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.

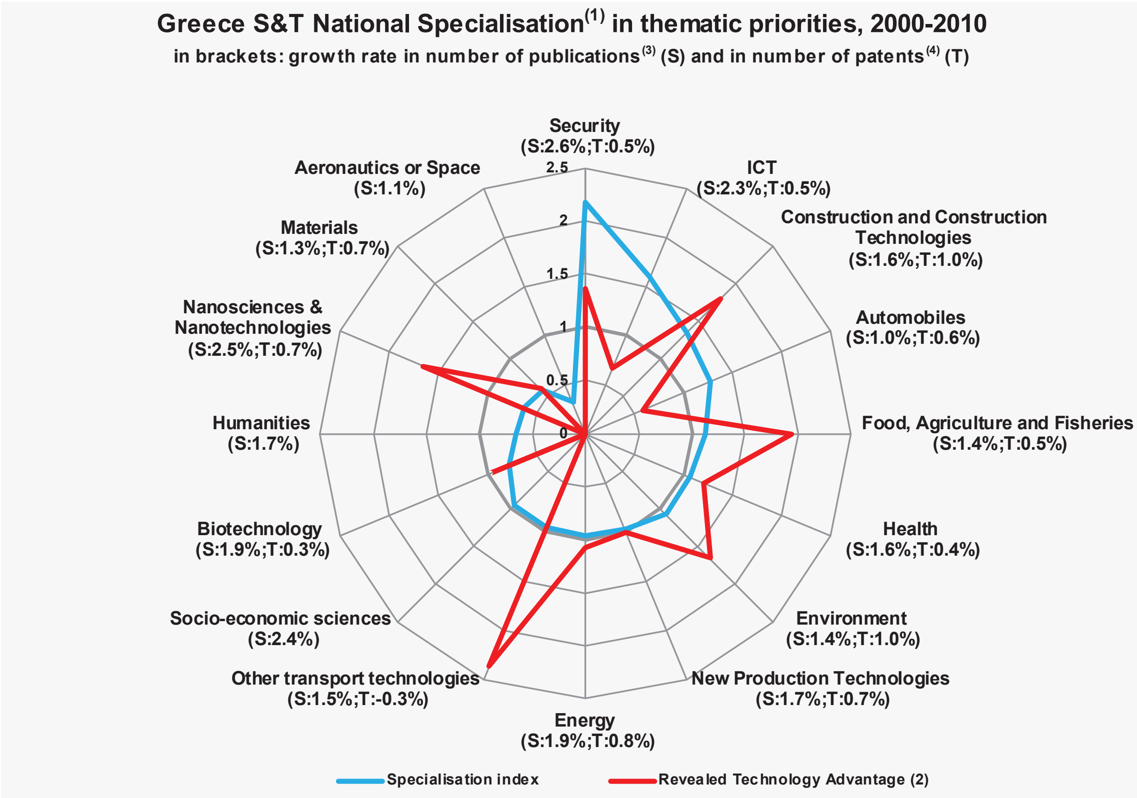


Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates 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) EL is not available and is not included in the reference group.
(5) EU does not include EL.

The graph above shows that R&D financing in Greece relies significantly more than the EU average on external funding (EC Framework Programme, private R&D funding from abroad); in particular, since 2007, there has been a significant upward trend for Framework Programme funding. On the other hand, the main challenges for the Greek R&I system lie in human resources with low levels of business enterprise researchers, foreign doctoral candidates and new doctoral candidates aged 25-34 years, with the latter indicator declining substantially since 2007. Furthermore, Greece is also lagging behind in technological innovation and business investment, with the biggest gaps between Greece and the EU average occurring for BERD as % of GDP and PCT patent applications per GDP. These findings underline the conclusion that significant efforts are needed domestically regarding both human capital and technological innovation.

Greece's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Greece 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 w ith 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 grow th rate index of the publications (S) refers to the periods 2000-2004 and 2005-2009.
(4) The grow th 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 creates an interesting picture for Greece. In particular, technology production shows a strong specialisation in various fields, namely, other transport technologies, the environment, nanosciences and nanotechnologies, security, construction technologies, and food, agriculture and fisheries. When looking for co-specialisations in both the scientific and technological aspects, there is a match between security, construction and construction technologies, food, agriculture and fisheries, health, and the environment.

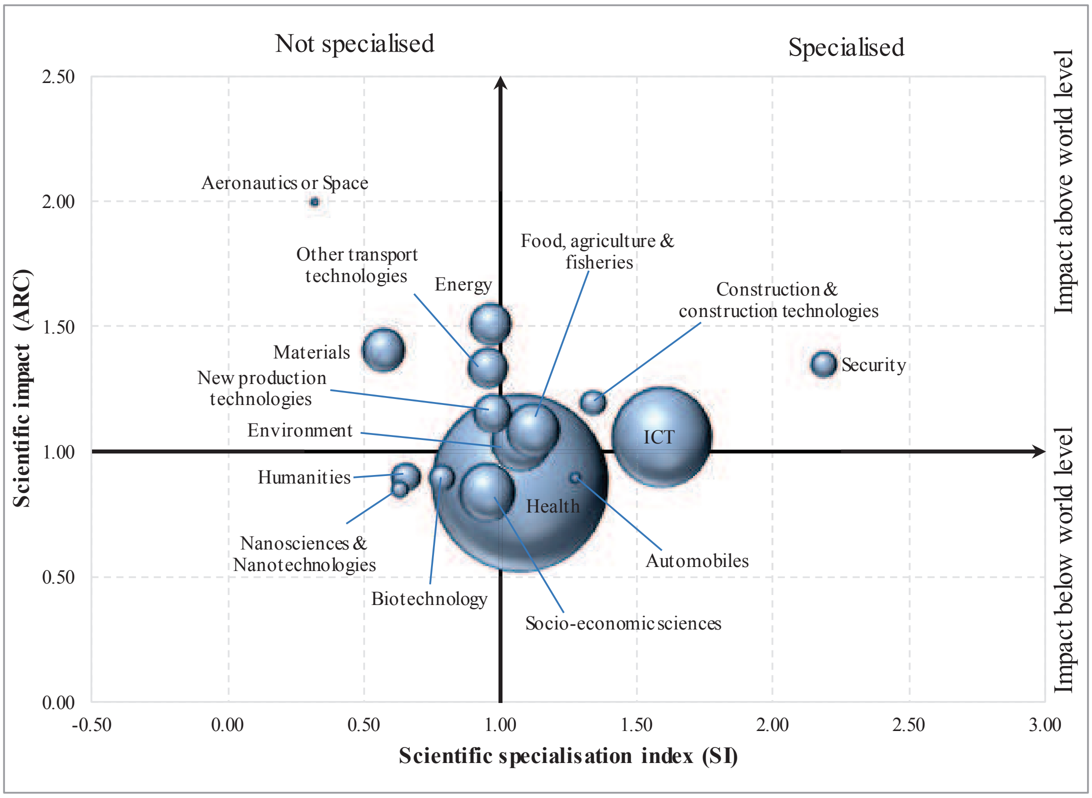
In other transport technologies, where Greece has a very strong technology advantage, it is interesting to note that there is only a marginal advantage in scientific specialisation. Some of the key areas identified in this graph seem to be in line with the key priority areas identified in the Greek national Smart Specialisation Strategy, in which transport and logistics and key enabling technologies have been identified as horizontal priority areas.

The graph below illustrates the positional analysis of Greek publications (specialisation versus impact). It can be seen that in the key area of scientific specialisation, which is the security sector, the impact made is above the world average, which is particularly important for Greece.

Furthermore, it should be highlighted that despite the relatively low levels of scientific specialisation in such areas as energy and materials, these are areas with strong potential impact, which suggests that Greece would probably benefit from concentrating efforts towards the energy technologies and materials sectors.

The graph below illustrates the positional analysis of Greek 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 Greece 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

Since the 1990s, Greece has experienced high growth rates exceeding those in many EU Member States and the EU average. However, such rates were not the result of a highly competitive economy. They were mainly driven by internal consumption, so the trade balance remained highly negative indicating a significant disadvantage in competitiveness. In Greece, the financial crisis, which started in 2008, was transformed into a debt crisis in 2009-2010, cutting off access to the international financial markets and leading the economy into recession. The debt and the persistence of the crisis indicated that relying on domestic demand could not be a reliable option for recovery. Since 2010, the economic adjustment programme for Greece has tackled the imbalances accumulated in the pre-crisis years through the stabilisation of public finances and the financial sector and a very comprehensive set of growth-enhancing structural reforms and measures to foster growth by strengthening external competitiveness, stimulating exports and accelerating the reallocation of resources from the non-tradable to the tradable sector.

A combination of structural problems and significant institutional and bureaucratic obstacles, together with a volatile policy environment induced Greek businesses to invest in activities with either high rates of return in the short-term or very low risk. To a large extent, this has shifted economic activity towards less knowledge-intensive and low value-added thematic areas. The sectors with high growth and holding dominant positions are those with relatively low exposure to international competition, such as retail trade, construction, and non-tradable services. At the same time, the share of the primary and manufacturing sectors is shrinking, resulting in a further increase in the trade deficit. The limited exposure to international competition and the privileged access to public-sector procurements have enabled significant segments of the economy to grow without investing in R&D and innovation.

Since 2013, substantial actions have been undertaken by the General Secretariat for Research and Technology (GSRT) regarding the upgrading, modernisation and improvement of the Greek R&I system. In line with policy conditionality under the adjustment programme and the *ex-ante* conditionalities for the 2014-2020 NSRF, some of the measures announced include the completion of the National Strategy for Research, Technological Development and Innovation 2014-20, the main implementation mechanism of which will be a national Framework Programme for Research and Innovation that will also be linked to the national Smart Specialisation Strategy's identified thematic priority sectors. In addition, more emphasis is expected to be given to research infrastructures with the announced imminent completion of the National Roadmap of Research Infrastructures linked to the European Strategy Forum on Research Infrastructures (ESFRI) process.

Furthermore, other structural measures being announced by the GSRT to improve the national R&I system include evaluation of research centre structures in view of meeting the requirements stemming from the administrative reform of the public sector. In addition, an in depth assessment of research centres is under consideration in terms of excellence and management in order to make them more efficient and align them with the societal challenges and current needs of the Greek economy.

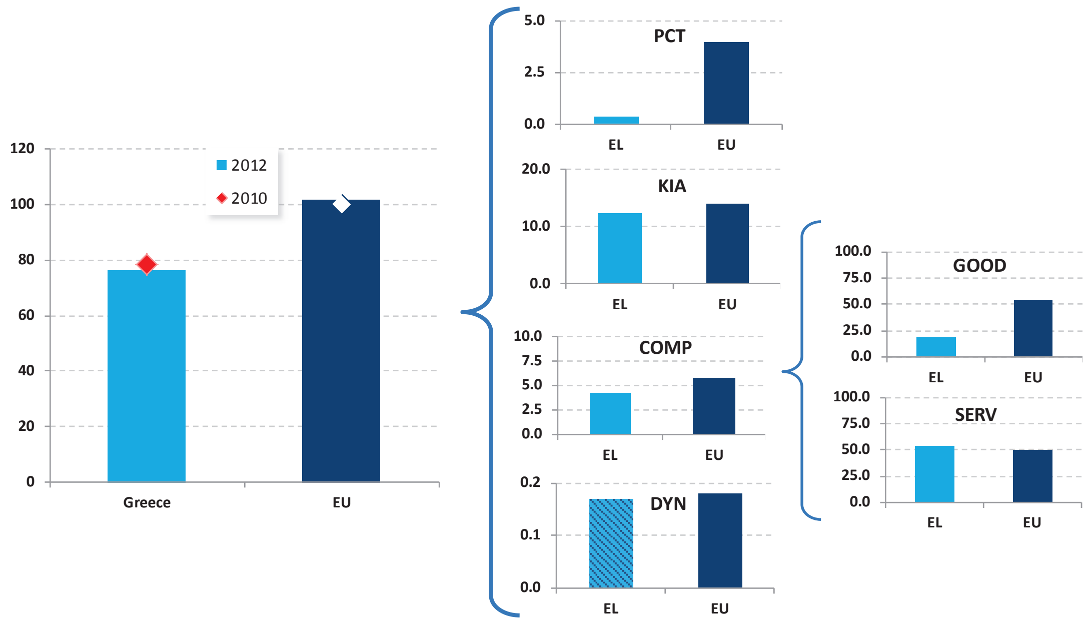
Most of the above-mentioned measures and actions will be implemented within the context of the new institutional framework for research and innovation which is in its final stages of preparation. This new Law for the Development of Research, Technological Development and Innovation, went through a public consultation that was completed at the end of 2013 and was expected to be submitted to the Parliament for adoption in July 2014, as stipulated in the adjustment programme.

In Greece, EU Cohesion funding from the European Structural and Investment Funds (ESIF) is expected to be an important source of funding for R&I activities for the 2014-20 period. As indicated in the draft Partnership Agreement for Greece, around EUR 1.2 billion is expected to be allocated to Thematic Objective 1, 'Strengthening Research, Technological Development and Innovation', which amounts to about 6.5 % of the total Cohesion funding for Greece.

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 Greece's position regarding the indicator's different components:

Greece - 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, w hich refer to 2010.
PCT = Number of PCT patent applications per billion GDP, PPS.
KIA = Employment in know ledge-intensive activities in business industries as % of total employment.
DYN = Innovativeness of high-grow th enterprises (employment-w eighted average); estimated value.
COMP = Combination of sub-components GOOD and SERV, using equal w eights.
GOOD = High-tech and medium-high-tech products exports as % total exports. EU value refers to EU-28 average (extra-EU = 59.7 %).
SERV = Know ledge-intensive services exports as % of total service exports. EU value refers to EU-28 average (extra-EU = 56 %).

Greece is a low performer in the European innovation indicator. In most components it is performing below the EU average and its performance is not improving.

The relatively low performance in patents is linked to the country's economic structure with a very small capital goods sector and the lack of large manufacturing companies in technology-intensive sectors, which normally show high patenting activities[28].

Employment in knowledge-intensive activities (KIA) is low. However, employment in agriculture, construction and in tourism-related services, not classified as KIA, still plays an important role in the Greek economy.

Greece exports few capital goods while the export share of agricultural products, mineral fuels and lubricants is high. Hence, its score is low as regards the share of medium-high/high-tech goods in total goods exports. The country performs better in knowledge-intensive services exports, thanks to an important maritime freight transport sector.

[28] Performance is similar in other IP-related outputs such as trademarks and designs.

Key indicators for Greece

GREECE	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	:	0.74	:	1.44	0.83	:	1.14	1.05	1.11	-5.1	*1.81*	19
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	459	:	:	466	:	:	453	-6.2 [3]	495 [4]	24 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	0.15	0.19	*0.18*	0.17	:	:	:	0,23 [5]	0.24	*1.6*	1.31	25
Public expenditure on R&D (GOVERD + HERD) as % of GDP	:	0.40	*0.40*	*0.42*	:	:	:	0,43 [5]	0.45	4.6	*0.74*	22
Venture Capital as % of GDP	0.14	0.004	0.01	0.04	0.10	0.02	0.01	0.004	0.00	-42.3	0,29 [6]	20 [6]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	29.9	:	:	:	:	27.2	-1.9	47.8	18
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	8.9	8.3	9.6	9.5	9.3	:	:	:	-1.8	11.0	15
International scientific co-publications per million population	:	343	405	442	459	516	519	564	590	6.0	343	17
Public-private scientific co-publications per million population	:	:	:	17	16	15	15	16	:	-1.9	53	21
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0.3	0.5	0.4	0.5	0.4	0.4	0.4	:	:	-7.7	3.9	25
License and patent revenues from abroad as % of GDP	0.00	:	0.03	0.02	0.01	0.01	0.02	0.02	0.03	14.0	0.59	24
Community trademark (CTM) applications per million population	15	22	35	43	38	36	34	38	40	-1.1	152	25
Community design (CD) applications per million population	:	1	1	3	2	3	4	4	3	4.0	29	26
Sales of new to market and new to firm innovations as % of turnover	:	:	25.6	:	:	:	:	:	:	-	14.4	*3*
Knowledge-intensive services exports as % total service exports	:	:	:	:	55.8	50.6	53.0	:	:	-2.5	45.3	6
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-10.44	-5.39	-5.60	-5.49	-3.80	-5.71	-4.20	-5.69	-5.41	-	4,23 [7]	28
Growth of total factor productivity (total economy) - 2007 = 100	88	96	99	100	98	95	91	88	88	-12 [8]	97	27
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	30.3	:	:	:	:	31.6	0.8	51.2	27
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	10.8	10.9	10.9	11.4	12.3	3.2	13.9	18
SMEs introducing product or process innovations as % of SMEs	:	:	37.3	:	:	:	:	:	:	-	33.8	13
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.04	0.05	0.12	0.04	0.01	0.04	:	:	:	-0.9	0.44	22
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.07	0.08	0.05	0.13	0.05	0.07	:	:	:	-23.9	0.53	22
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	61.9	64.6	65.7	66.0	66.5	65.8	64.0	59.9	55.3	-3.5	68.4	28
R&D Intensity (GERD as % of GDP)	:	0.60	*0.59*	*0.60*	:	:	:	0.67	0.69	*0,6* [9]	*2.07*	24
Greenhouse gas emissions - 1990 = 100	120	128	125	128	125	118	112	110	:	-18 [10]	83	24 [11]
Share of renewable energy in gross final energy consumption (%)	:	7.2	7.4	8.4	8.3	8.5	9.8	11.6	:	8.4	13.0	15
Share of population aged 30-34 who have successfully completed tertiary education (%)	25.4	25.3	26.7	26.2	25.6	26.5	28.4	28.9	30.9	3.4	35.7	18
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	18.2	13.6	15.5	14.6	14.8	14.5	13.7	13.1	11.4	-4.8	12.7	17 [11]
Share of population at risk of poverty or social exclusion (%)	:	29.4	29.3	28.3	28.1	27.6	27.7	31.0	34.6	4.1	24.8	25 [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 2011 and the previous years. Average annual growth refers to 2011-2012.
(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. Average annual growth refers to 2007-2011.
(7) EU is the weighted average of the values for the Member States.
(8) The value is the difference between 2012 and 2007.
(9) Average annual growth refers to 2001-2007.
(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.

Hungary

Improving the effectiveness of national research system and fostering innovation in enterprises

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Hungary. 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: +5.7 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[29] 2012: 31.5 (EU: 47.8; US: 58.1) 2007-2012: +2.4 % (EU: +2.9 %;US: -0.2)
Innovation Output Indicator 2012: 92.0 (EU: 101.6)	*Knowledge-intensity of the economy*[30] 2012: 54.4 (EU: 51.2; US: 59.9) 2007-2012: +2.3 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food and agriculture, automobiles, health, and environment	*HT + MT contribution to the trade balance* 2012: 5.6 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +4.5 % (EU: +4.8 %; US: -32.3 %)

Over the last decade, the Hungarian R&I system has made obvious progress in the level of private-sector investment and in overall R&D intensity, as well as in scientific quality, patent revenues and structural change towards a more knowledge-intensive economy. Although public sector R&D intensity and the internationalisation of science remains less dynamic than the EU average, Hungary's innovation performance improved in 2007-2012, despite some fluctuations.

Hungary is still facing some key challenges in R&I. These include: weaknesses in the knowledge base and knowledge production; a low level of innovation activity, especially by small and medium-sized enterprises (SMEs), together with a low level of cooperation in innovation activities among the key actors; unfavourable framework conditions for innovation, in particular an unstable business environment, a high administrative burden, and competition not conducive to innovation; and insufficient human resources for research. The policy evaluation culture is weak in Hungary and the separation between science policy and R&I policy makes it difficult to coordinate the overall STI policy governance. Moreover, public R&D funding has fallen in Hungary since 2007 which points to some risks regarding the continuous policy commitment needed to further address these important challenges.

The new Innovation Strategy 2013-2020 focuses on three main areas of intervention: knowledge creation, knowledge transfer, and knowledge utilisation. Encouraging intelligent specialisation, building a sustainable system able to create equal opportunities, providing stable financing conditions, raising public awareness and strengthening the acknowledgment of knowledge and technology, and

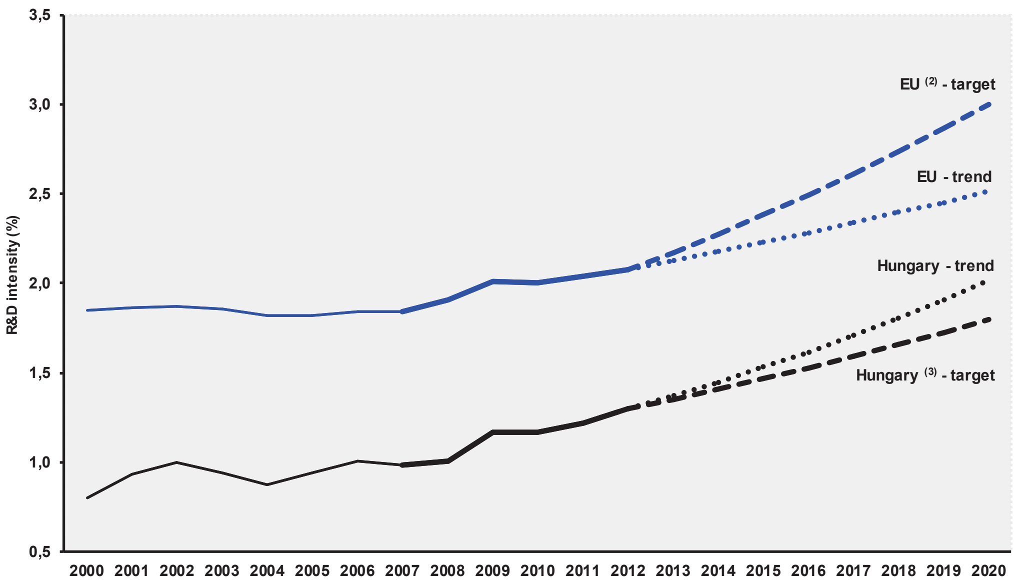
[29] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

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

creating a stable, innovation-friendly economic and regulatory environment – these could all lead to rising levels of R&D intensity in the coming years. The strategy and its implementation are being supplemented by the Strategy of Intelligent Specialisation (S3) which is currently being developed. The Science Policy Strategy 2014-2020 (under preparation) aims to enhance the attractiveness of the research environment, increase scientific excellence, and reverse the brain drain.

Investing in knowledge

Hungary - 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) HU: The projection is based on a tentative R&D intensity target of 1.8% for 2020.
(4) HU: There is a break in series between 2004 and the previous years.

In the recently adopted National Research and Development and Innovation Strategy (2013-2020), entitled 'Investment into the Future', Hungary commits to increasing its research and development expenditure to 1.8 % of the GDP by 2020 and to 3 % by 2030. A complementary target for the strategy is that BERD will reach 1.2 % by 2020. Moreover, the implementation of the R&D&I Strategy aims to reach the R&D intensity targets as priority indicators for an investment in the future.

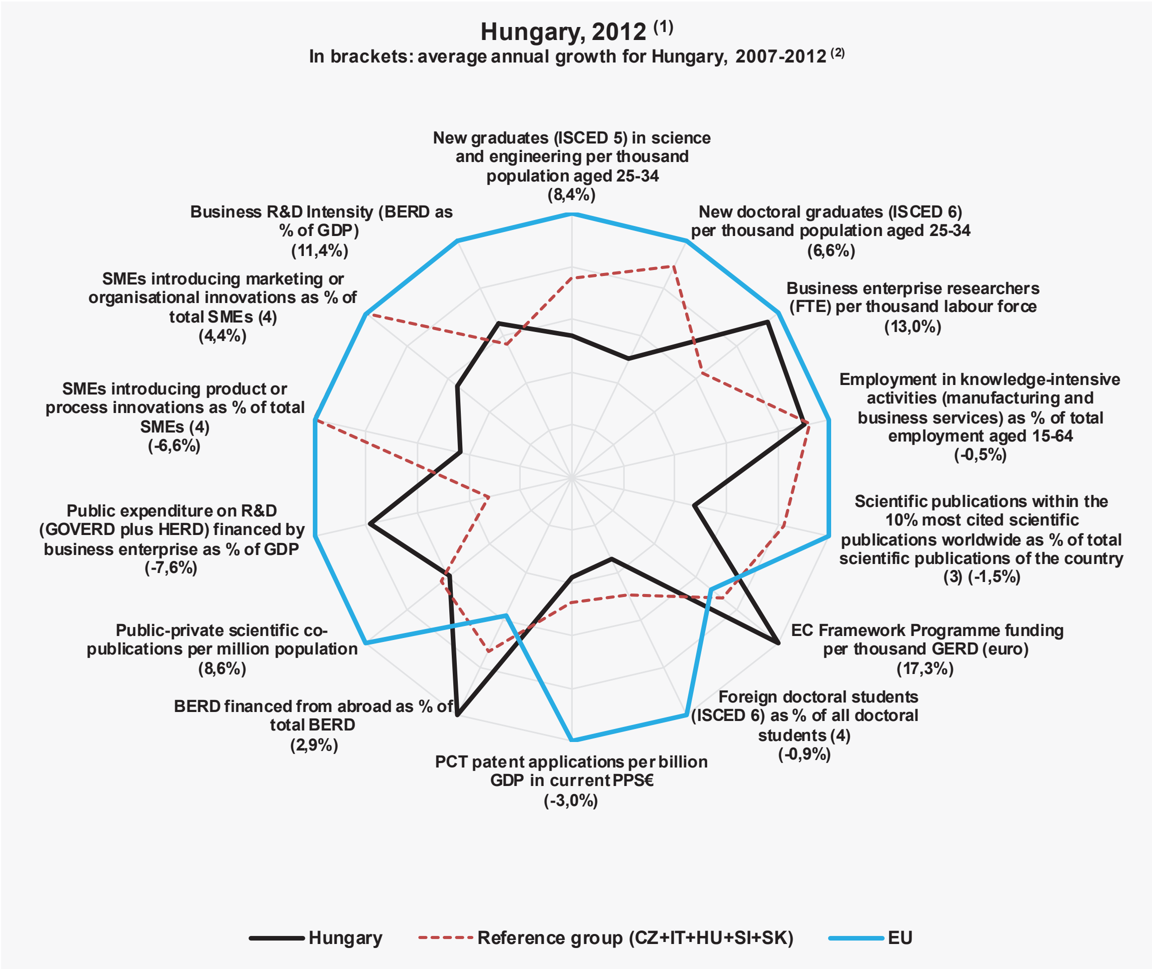
Since the R&D intensity grew in 2007-2012 each year by 5.7 % on average to reach 1.3 % of GDP in 2012, Hungary is on track to achieve its national R&D intensity target of 1.8 % by 2020. This is mainly due to an increasing trend in business expenditure on R&D which grew by 11.4 % on average during 2007-2012. However, public R&D intensity (public-sector expenditure on R&D as % of GDP) fell from 0.48 % in 2009 to 0.43 % in 2012. Hungary, Bulgaria and Croatia are the only EU countries in which public R&D intensity has declined since 2007. This trend threatens to undermine the already weak supply of human resources for science and technology and the quality of the research performed. In 2009-2012, the breakdown of total R&D expenditure by funding source and performance sector was similar to the EU-28 average. The share of R&D financed and performed by the business enterprise sector increased from 57.2 % to 65.6 % during this period, which is above the EU average of 63.0 %. On the other hand, the share of R&D performance by Higher Education Institutes (HEIs) decreased from 21.7 % in 2009 to 18.4 % in 2012, receding from the EU average of 23.8 %. The research performance of the government sector also fell in the period 2009-2012 from 20.1 % to 14.4 % which is close to the EU average of 12.4 %.

Up to February 2014, Hungary's participant success rate in the EU's Seventh Research Framework programme (FP7) reached 20.2 %, which is close to the EU-28 average of 20.5 %. However, the Hungarian EC financial contribution success rate of 15.0 % is lower than the EU-28 rate of 19.1 %. Structural Funds are an important source of funding for R&I activities. Of the EUR 24.908 billion of Structural Funds allocated to Hungary over the 2007-2013 programming period, around EUR 2.126 billion (8.5 % of the total) relate to RTDI[31].

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

The graph below illustrates the strengths and weaknesses of Hungary'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.

[31] 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.

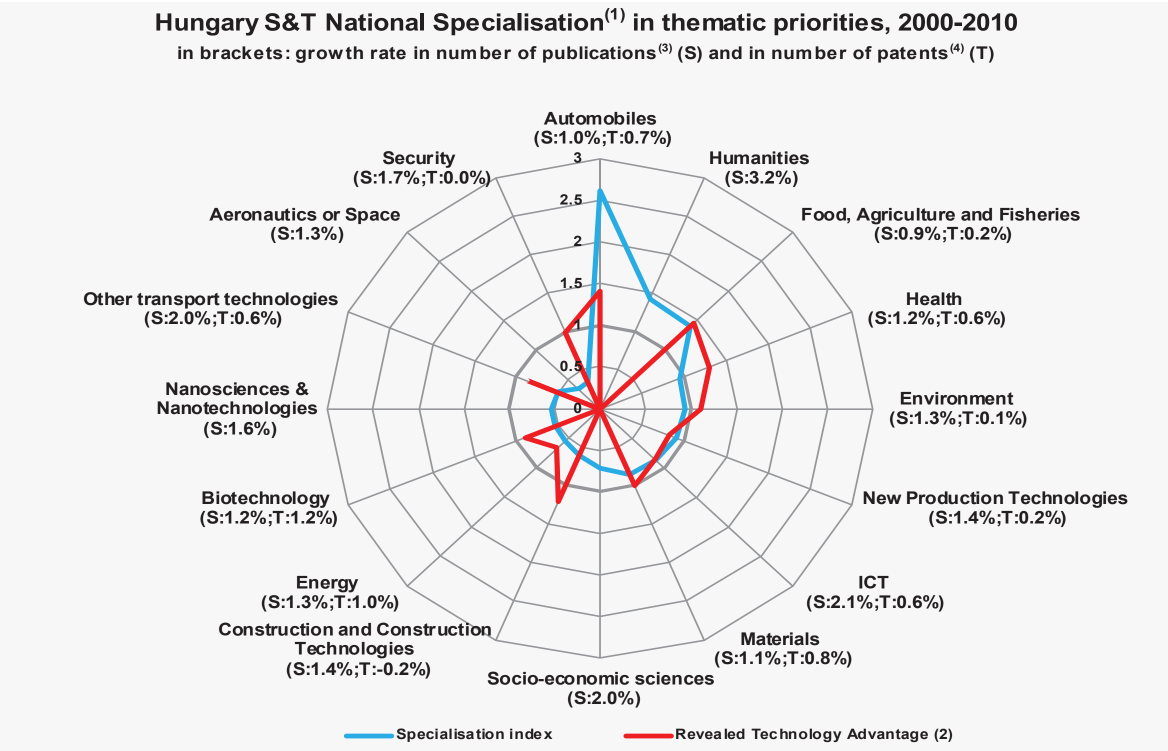
Hungary is below the EU average in most of the areas. However, the rate of BERD financed from abroad and EU FP7 funding are significantly higher than the EU average. The share of employment in knowledge-intensive activities and the number of business enterprise researchers are very close to the EU average.

Vulnerable areas include human resources, scientific production, innovation, and technology production. Innovation activities in small firms are at a low level with only around 14.7 % of Hungarian small and medium-sized enterprises (SMEs) innovating by introducing a new product or a new process and 22.4 % introducing marketing or organisational innovation. Only 5.2 % of Hungarian scientific publications are in the top 10 % of most-cited scientific publications, compared to the EU average of 11.0 %. Hungary has a low level of PCT patent applications and this trend is on the decline. The country performs better in terms of licence and patent revenue from abroad (not shown on the graph), which is probably due to the increased role of large foreign-owned enterprises in business R&D investment.

Hungary seems to be relatively well integrated in pan-European research collaborations in FP7. The top collaborations involving Hungarian researchers are mainly with colleagues from Germany, the United Kingdom, Italy, France and Spain.

Hungary's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Hungary 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 food, agriculture and fisheries, health, environment, construction and construction technologies, security and automobiles. A strong corresponding scientific S&T co-specialisation is noted for automobiles, food and agriculture, while a marked potential for co-specialisation is observed for health, and the environment.

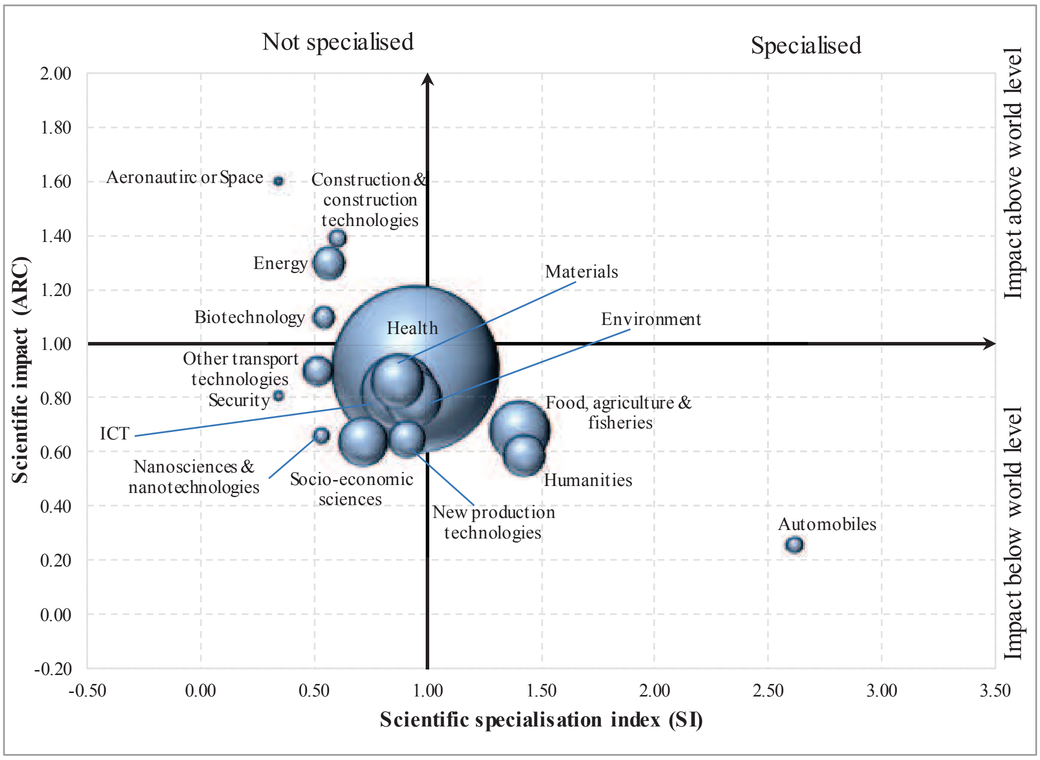
Together with the Czech Republic, Slovakia, Slovenia and Italy, Hungary is classified as having a medium-low knowledge capacity with an important industrial base[32]. Among those countries, Hungary does not exhibit a broader technology development compared to the country's science base. Given that the general quality of science is not high, it may be the case that industry's technological base is founded less on high-tech and medium-tech products than in the other three countries in the same group (except Slovenia). Following this rationale, Hungary will benefit both from intensifying efforts

[32] Source: Innovation Union Competitiveness report 2011.

to attract Foreign Direct Investment (FDI) for more knowledge-intensive activities and from continuing to improve the quality of the science base in order to create the basis for raising knowledge-transfer from science to technology and industry.

The graph below illustrates the positional analysis of Hungary 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 Hungary 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

It would appear there is room for improvement regarding the scientific impact of some of the sectors in which Hungarian science is strongly specialised, i.e. automobiles, food, agriculture and fisheries, humanities, and health. It is very interesting to note the high level of scientific excellence attained by the country in aeronautics, energy, construction, and biotechnology, although all those fields have a rather low scientific specialisation index. Taking into account Hungary's technological specialisation in energy and construction, it would probably benefit from fostering a scientific specialisation in those fields.

As its excellence in research is correlated to more cooperation with researchers from other European countries and beyond, Hungary would benefit from actively supporting and providing incentives for its researchers to connect to Horizon 2020 networks. Considering its share of grants in FP7 fields, there is room for improvement, for example in the ICT sector.

From the EU perspective, production fragmentation and the specialisation of different countries and regions in certain production activities can yield overall benefits for all the partners involved. Hungary, together with Germany, Austria and a number of Eastern European countries, has used this strategy to develop an automobile cluster which enables these countries to integrate their respective production lines.

Policies and reforms for research and innovation

The recently adopted new national RDI Strategy (2013-2020) entitled 'Investments into the Future' aims to raise RDI investments and, as result, to mobilise the Hungarian economy and strengthen its competitiveness. To ensure that the public and private resources spent on the country's RDI sector will be profitable for its economy, the strategy builds around three priority axes: internationally competitive knowledge bases which can underpin economic and social progress; cooperation in knowledge and technology transfer which is efficient at both national and international levels; and innovative enterprises intensively utilising the results of modern science and technology.

The strategy focuses on knowledge creation and knowledge transfer and aims to reconsider and renew the incentive system to promote market-driven and society-driven innovation processes. By proposing measures explicitly directed at innovative enterprises, the strategy aims to overcome the main weakness in the Hungarian RDI system which is the low share of domestic innovative companies. According to the strategy, Hungary will increase its gross domestic expenditure on R&D to 1.8 % by 2020 and to 3 % by 2030. Moreover, the results expected for the specific targets set in the strategy are the stimulation of RDI demand, establishment of an efficient support and funding system, as well as completion of the start-up ecosystem.

The strategy is the guiding document for planning the budget allocations for RDI for the next programming period 2014-2020. The regional-technological-sectoral aspects of the RDI Strategy will be determined by the national Smart Specialisation Strategy (S3). Preparations for this began at the beginning of 2013, with the drawing up of strategy documents by the Regional Innovation Agencies and, according to the government resolution on the collaborative governance of the planning of the Smart Specialisation Strategy, draft S3 should be ready by the end of September 2014. The correct implementation of the newly introduced and planned strategies will be crucial for the creation of an effective national R&I ecosystem.

The new advisory body, the National Science Policy and Innovation Board (NTIT) was established by government decree in September 2013 with the aim of providing advice, evaluation, and making recommendations on strategic issues concerning RDI programmes. The president of the NTIT is the prime minister, co-chaired by the president of the Hungarian Academy of Sciences (MTA). However, to date the NTIT has not held any meetings, and one activity in the RDI Strategy action plan is actually to revise the governance system for the STI policy.

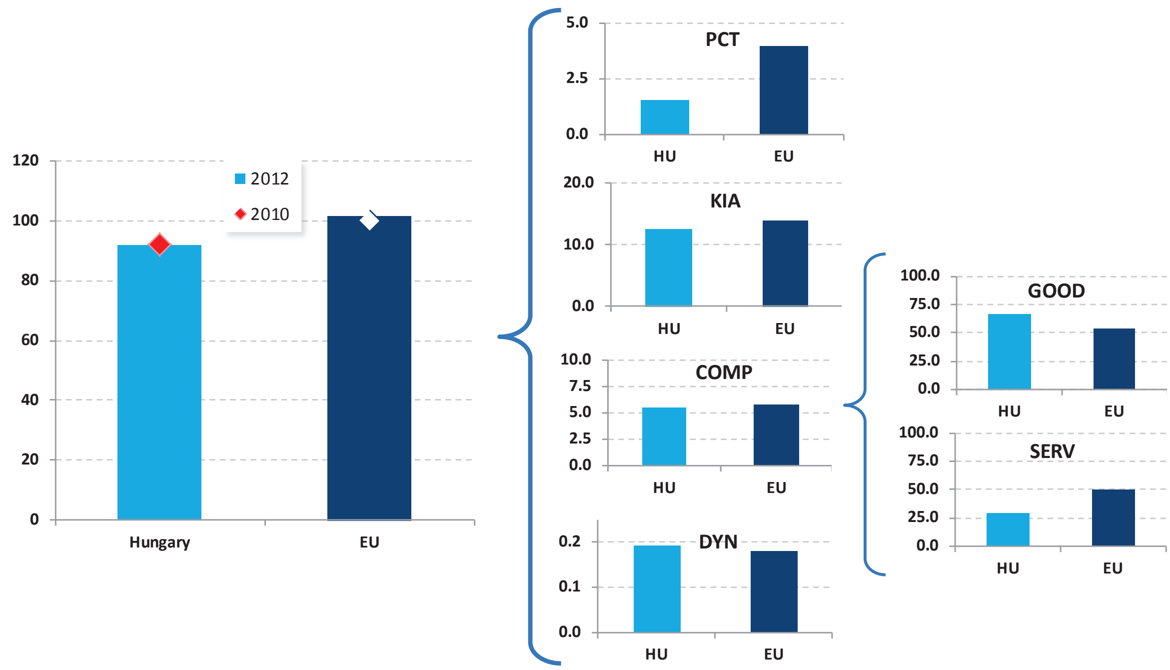
A new scheme 'Start-up_13' was launched in June 2013 in order to support the development of young, technology companies. Based on an international peer-review organised by the National Innovation Office (NIH), in October 2013, four companies received the title of 'accredited technology incubator' which would enable them to participate in the Start-up_13 programme.

Until now, the allocation of institutional funding to higher education institutions and research-performing organisations is based on student numbers, disciplines taught, number of full-time professors and the number of professors holding scientific degrees, meaning that the allocation of academic funding is not based on competition. A working group was set up for the preparation of a science policy strategy which aimed to improve the system for supporting fundamental research and financing in the academic sector. This strategy will also improve access to scientific information and publications, strengthen the links between science and business, and foster international cooperation and networks. Moreover, the 'TOP 200 programme' aims to develop the scientific, research and innovation capacity at major universities to enhance their international prominence.

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 Hungary's position regarding the indicator's different components:

Hungary - 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 %).

Hungary is a medium performer in the European innovation indicator scoring slightly below the EU average. This is the result of an above-average performance in two components and below-average performance in patents and knowledge-intensive service (KIS) exports. The country's performance is currently stagnating.

The relatively low performance in patents is linked to limited research capacity, economic structure and the division of work within international companies, including motor-vehicle producers which have production facilities in Hungary but tend to do research and patenting in the headquarter country. The export of power-generating machines, telecommunication equipment, and road vehicles results in high scores as regards the share of medium-high/high-tech goods in total goods exports (the highest share in the EU).

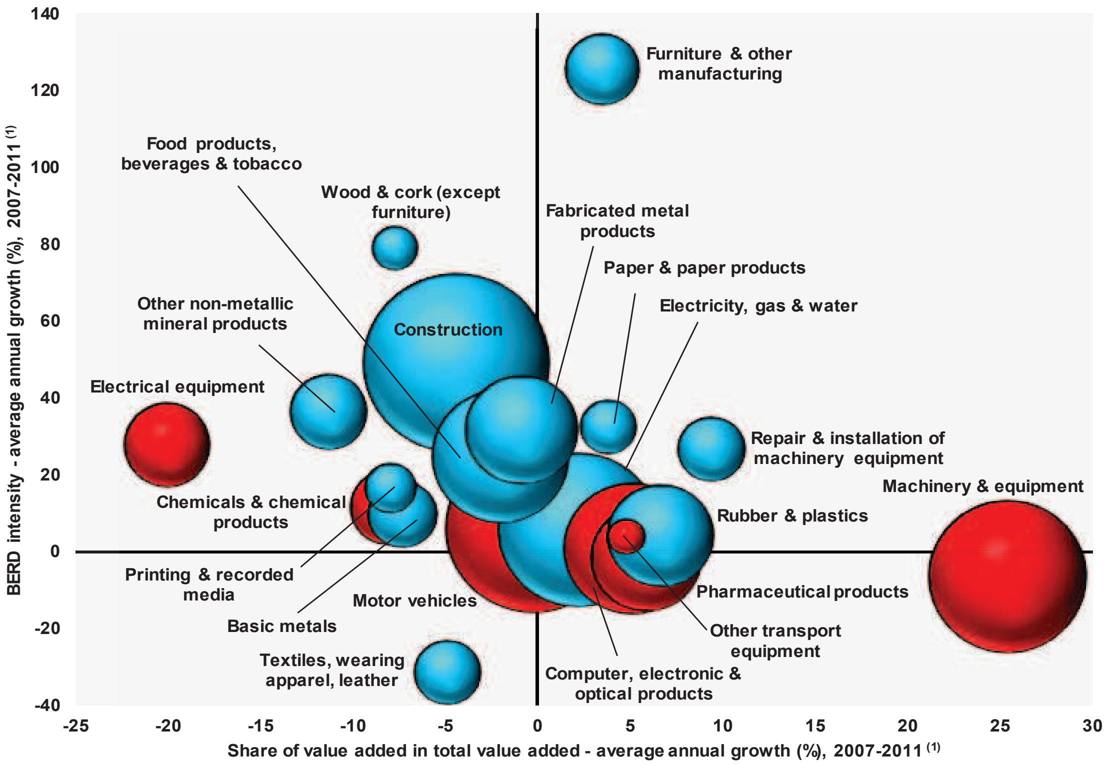
The low share of knowledge-intensive service exports is explained by the relatively high level of non-KIS transport services (road transport) and of tourism-services exports, which are not compensated for by any strongholds in KIS exports.

Hungary performs well regarding the innovativeness of fast-growing firms. This is the result of a high share of employment in innovative sections of the manufacturing sector among fast-growing enterprises, such as the manufacture of motor vehicles and of computer, electronics and optical products.

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.

Hungary - 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) 'Electricity, gas and water', 'Printing and reproduction of recorded media': 2007-2010.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The graph shows that throughout the economic crisis the shares in total value added of numerous manufacturing sectors declined between 2007 and 2011, which is particularly notable in high-tech and medium-tech sectors such as electrical equipment and chemicals.

On the contrary, 'machinery and equipment' had very good dynamics of strong growth in value added although coupled with a strong decline in R&D expenditure. Manufacturing in Hungary is concentrated mainly in low-skills sectors, such as construction or electricity, although some high-tech sectors, mainly machinery and equipment, motor vehicles and computer, electronic and optical products, display a significant weight in the economy.

It is important to note that Hungary is one of the countries in which business R&D intensity made the most progress between 2007 and 2011 in relation to the 2007 level. The sectors for which R&D intensity increased the most in 2007-2012 include numerous low-tech sectors such as furniture & other manufacturing, wood and cork, and construction. Along with Poland and the Czech Republic, Hungary is one of the countries in which employment in manufacturing has declined the least in recent years.

Key indicators for Hungary

HUNGARY	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	0.50	0.67	0.63	0.66	0.71	0.86	0.82	0.82	0.90	6.6	*1.81*	24
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	491	:	:	490	:	:	477	-13.9 (3)	495 (4)	22 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0.36	0.41	0.49	0.49	0.53	0.67	0.70	0.76	0.85	11.4	1.31	15
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.40	0.50	0.50	0.47	0.46	0.48	0.45	0.44	0.43	-1.8	*0.74*	23
Venture Capital as % of GDP	0.10	0.05	0.04	0.05	0.03	0.21	0.05	0.08	0.11	17.0	0,29 (5)	14 (5)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	28.0	:	:	:	:	31.5	2.4	47.8	13
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	4.8	5.3	5.4	4.8	5.2	:	:	:	-1.5	11.0	21
International scientific co-publications per million population	:	313	313	338	341	356	362	396	412	4.0	343	21
Public-private scientific co-publications per million population	:	:	:	22	23	25	31	31	:	8.6	53	15
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	1.7	1.4	1.4	1.6	1.4	1.5	1.5	:	:	-3.0	3.9	16
License and patent revenues from abroad as % of GDP	0.24	0.76	0.49	0.67	0.56	0.65	0.80	0.75	0.88	5.6	0.59	6
Community trademark (CTM) applications per million population	2	17	19	27	28	30	39	36	37	6.9	152	26
Community design (CD) applications per million population	:	4	3	6	5	6	7	5	6	-1.5	29	25
Sales of new to market and new to firm innovations as % of turnover	:	:	10.5	:	16.4	:	13.7	:	:	-8.8	14.4	13
Knowledge-intensive services exports as % total service exports	:	21.0	23.5	26.0	25.9	26.1	26.5	26.3	:	0.3	45.3	20
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	2.25	4.64	5.74	4.47	5.20	6.15	5.99	5.84	5.56	-	4,23 (6)	3
Growth of total factor productivity (total economy) - 2007 = 100	89	100	102	100	100	94	94	95	93	-7 (7)	97	21
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	48.6	:	:	:	:	54.4	2.3	51.2	11
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	12.8	12.3	12.8	13.0	12.5	-0.5	13.9	16
SMEs introducing product or process innovations as % of SMEs	:	:	16.8	:	16.8	:	14.7	:	:	-6.6	33.8	25
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.08	0.08	0.06	0.21	0.14	0.06	:	:	:	-46.5	0.44	18
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.40	0.29	0.16	0.27	0.21	0.26	:	:	:	-0.4	0.53	14
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	61.2	62.2	62.6	62.6	61.9	60.5	60.4	60.7	62.1	-0.2	68.4	24
R&D Intensity (GERD as % of GDP)	0.81	0.94	1.01	0.98	1.00	1.17	1.17	1.22	1.30	5.7	*2.07*	17
Greenhouse gas emissions - 1990 = 100	80	81	79	77	75	68	69	67	:	-10 (8)	83	7 (9)
Share of renewable energy in gross final energy consumption (%)	:	4.5	5.0	5.9	6.5	8.0	8.6	9.1	:	11.4	13.0	21
Share of population aged 30-34 who have successfully completed tertiary education (%)	14.8	17.9	19.0	20.1	22.4	23.9	25.7	28.1	29.9	8.3	35.7	19
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	13.9	12.5	12.6	11.4	11.7	11.2	10.5	11.2	11.5	0.2	12.7	19 (9)
Share of population at risk of poverty or social exclusion (%)	:	32.1	31.4	29.4	28.2	29.6	29.9	31.0	32.4	2.0	24.8	23 (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) Values in italics are estimated or provisional.

Ireland

Prioritising increased public investment in research while better exploiting results

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Ireland. 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: +6.1 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[33] 2012: 60.9 (EU: 47.8; US: 58.1) 2007-2012: +14.6 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 116.5 (EU: 101.6)	*Knowledge-intensity of the economy*[34] 2012: 68.2 (EU: 51.2; US: 59.9) 2007-2012: +3.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food and agriculture, medical technologies, nanotechnologies, biotechnology, ICT, and new production technologies	*HT + MT contribution to the trade balance* 2012: 2.0 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +11.6 % (EU: +4.8 %; US: -32.3 %)

Ireland has expanded and consolidated its research and innovation system over the last decade. Investments in R&I have grown substantially, and public investment in R&I grew considerably until the financial crisis. Since 2007, however, business enterprise investment in R&D has increased at a much higher rate than public investment in R&D.

The considerable increase in public and private R&D expenditure since 2000 has resulted in a clear shift to a knowledge-based economy, including a trend towards services. The Irish economy has a high proportion of knowledge-intensive products and services, which has not changed substantially over the last decade. Although the recession hit Ireland particularly hard, since then the economy has partly recovered because of the strength of exports by companies in the high-tech sectors. These firms are mainly affiliates of multinational enterprises (MNEs).

In contrast, in a number of sectors those domestic firms which do not have a propensity to export have struggled. Accordingly, the main challenges are to return to the previous policy of increasing public R&D expenditure and to complement the policy to promote the procurement of innovation with budgetary allocations to procurement authorities[35].

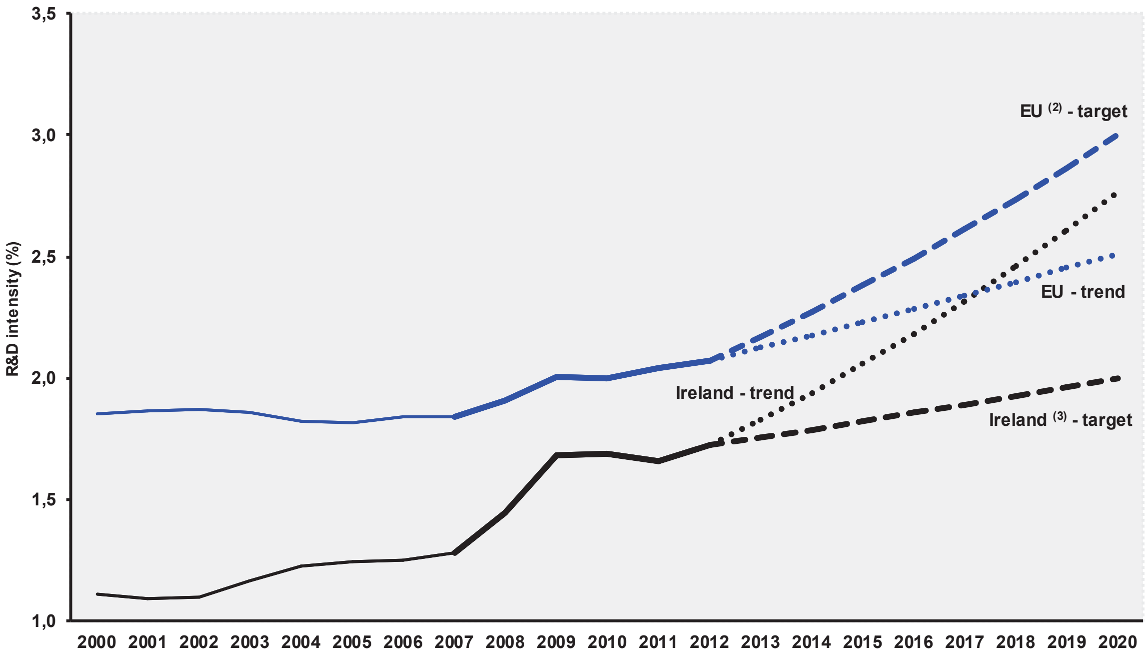
Prior to the crisis, policy was based on a Strategy for Science, Technology and Innovation which articulates the ambition to be a leading knowledge economy. More recently, the focus has been on accelerating growth and job creation. The government has also adopted the report of a research

[33] 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.
[34] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.
[35] Concrete measures were presented in the Commission Communication Europe 2020 Ireland, June 2012.

prioritisation group which sets out the basis for the country's national R&I Smart Specialisation Strategy which recommended targeted competitive research investment in 14 priority areas as well as a new IP protocol on putting public research to work for Ireland.

Investing in knowledge

Ireland - 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) IE: The projection is based on a tentative R&D intensity target of 2.0% for 2020.

Ireland has a national R&D intensity target for 2020 of 2.5 % of GNP (estimated to be equivalent to 2.0 % of GDP). In 2012, Ireland had an R&D intensity of 1.72 %, with a public sector R&D intensity of 0.53 % and a business R&D intensity of 1.20 %.

Over the period 2007-2012, R&D intensity in Ireland grew at an average annual rate of 6.1 %, which is the eighth highest growth rate in the EU. Whereas this increase is greater than that for the period 2002-2007, it occurred in the context of an economic contraction during which the government budget for R&D decreased steadily. Thus, one of the main challenges for Ireland would be to return to a trend of increasing public investment in R&D which, if it was better related to business needs, would raise the R&D intensity of Irish firms. If this line were followed, a shift in the Irish economy towards a knowledge-based economy, already very visible, could be pursued and a more ambitious target could be envisaged on the occasion of the mid-term review of the Europe 2020 targets (2014/2015). This would be more in line with the country's clear potential, illustrated by the trend in R&D intensity above.

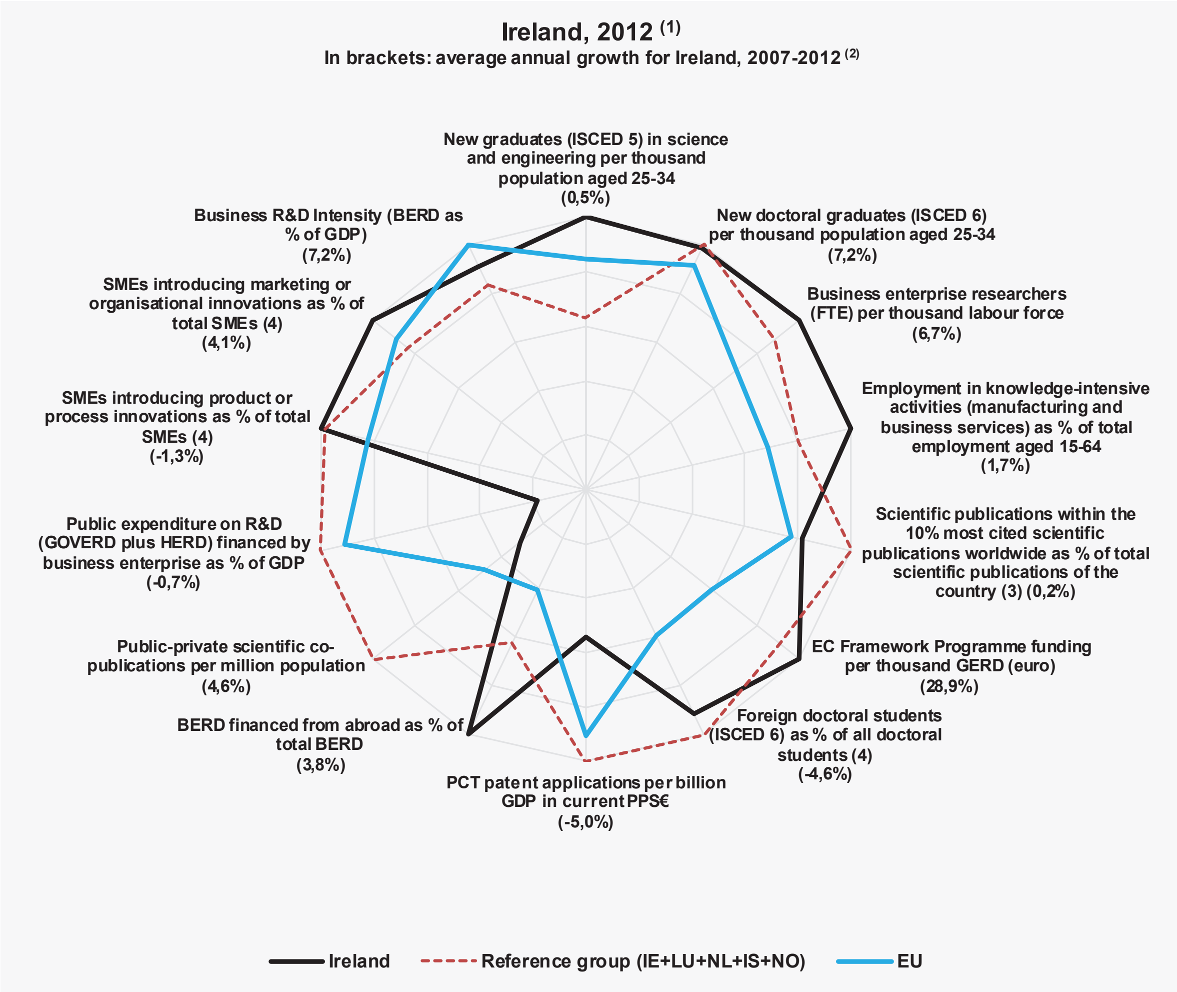
In absolute terms, public R&D funding reached a peak in 2008. R&D investment by firms appears not to have been seriously affected by the economic crisis. The increase of 42 % in BERD intensity over the period 2007-2012 was double that of public R&D intensity at 21 %. Ireland has a relatively low level of direct government support for BERD, although indirect support amounts to 75 % of public support of private R&D. In real terms, business R&D investment continued to rise and reached a peak in 2012. At 20.4 %, the share of GERD financed from abroad is more than double the EU average and reflects the policy of attracting foreign direct investment (FDI) with a large R&D component. In order to reach its national target by 2020, R&D intensity in Ireland would have to grow at an average annual rate of 1.9 % over the period 2012-2020. This growth would depend on sustained incentives to attract and boost business R&D investment.

Structural Funds are an important source of funding for R&I activities. Of the EUR 751 million of Structural Funds allocated to Ireland over the 2007-2013 programming period, around €155 million (21% of the total) relate to RTDI[36]. Under the Seventh Framework Programme (FP7), beneficiaries from Ireland have received EUR 528 million. Overall, Irish applicants had a close-to-average success rate.

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

The graph below illustrates the strengths and weaknesses in the Irish R&I system. Reading clockwise, the graph 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.

[4] 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 shows in broad terms that Ireland's increasing investment in R&D has triggered stronger scientific production with increases in business R&D intensity, the number of new doctoral graduates, employment in knowledge-based activities, and scientific publications in the most highly cited journals. The number of researchers employed in business has also grown. The relative weaknesses of the Irish R&I system are the relatively low level of public-private co-publications, the low level of public expenditure on R&D financed by business enterprise, as well as a relatively low level of patent applications (PCT) per billion GDP. Recent policy is leading to the establishment of large research centres by Science Foundation Ireland (SFI) focusing on research and innovation aligned to the 14 research priority areas, and requiring the strong involvement and cash funding of industry. Establishment of the Industrial Development Authority/Enterprise Ireland Technology Centres is also being influenced by the 14 research priority areas.

In 2011, Ireland had a small net outflow of tertiary students to the United States. In 2011, 1145 students at undergraduate, masters or doctoral level left Ireland to study in the United States, while there was a corresponding inflow of 1013 students from the United States to Ireland. The country has engaged in the European Strategy Forum on Research Infrastructures (ESFRI) process from the beginning and supports 20 of the 44 areas identified in the original roadmap as well as participating in seven FP7-funded research infrastructure preparatory phase projects.

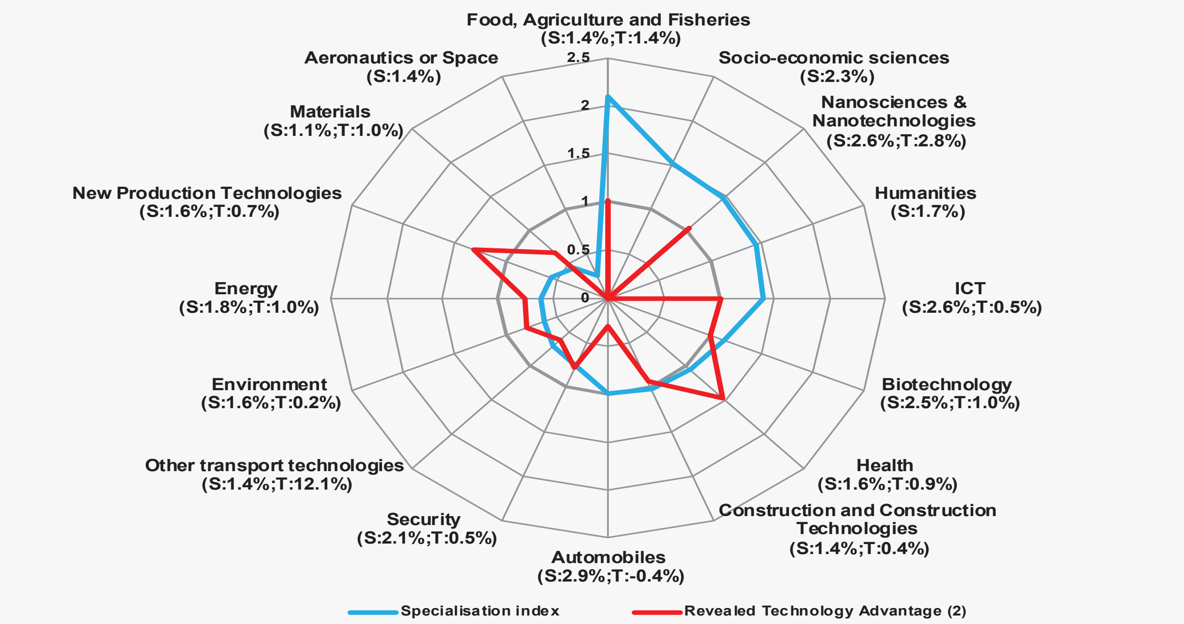
On knowledge transfer, Ireland's efficiency is relatively high with regard to the amount invested in generating each patent application, licence agreement and spin-off.

Ireland's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Ireland 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.

Ireland 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)

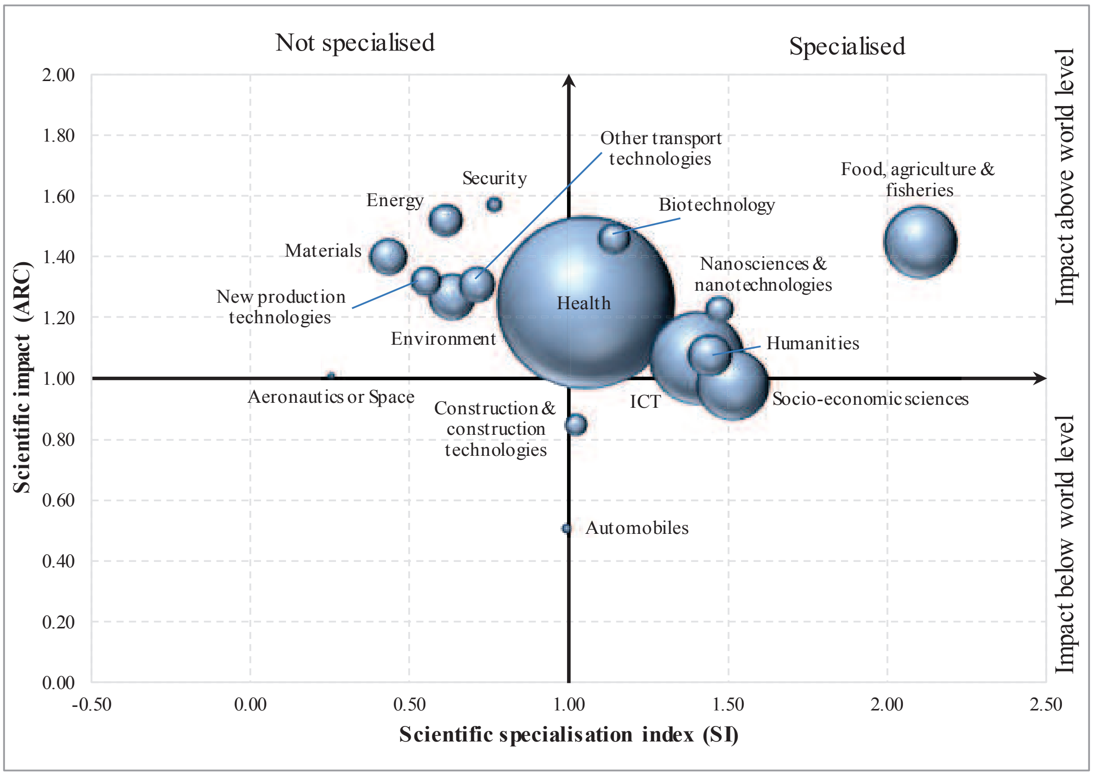


Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding 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 strong technological specialisation in the sectors of health, and new production technologies, whereas significant scientific specialisation exists in the sectors of food, agriculture and fisheries, nanosciences and nanotechnologies, ICT, socio-economic sciences, and humanities. There is obvious potential for stronger scientific and technological co-specialisations in the fields of health, biotechnology, construction, ICT, nanotechnologies, and food and agriculture.

The graph below illustrates the positional analysis of Irish 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 Ireland 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 graph above shows a positional analysis of scientific publications in Ireland. The country has a high specialisation in food, agriculture and fisheries with an impact well above the global average. Other specialised fields with impacts above the world level are biotechnology, nanosciences and nanotechnologies, ICT, and health. It is interesting to note that a number of non-specialised fields have high impacts at world level, including energy, materials, new production technologies, other transport technologies, and environment.

Policies and reforms for research and innovation

The Irish research system is centralised and whilst research policies are set nationally they address regional aspects and needs and take into account the effects of clustering which have led to regional specialisation. The significance of the Structural Funds for Ireland has been reduced, with funding for RTDI over the period 2007-2013 amounting to EUR 155 million which represents around 20 % of the annual government budget for R&D. Ireland comprises two NUTS II regions. The Border, Midland and Western region's key challenge is to develop its Institutes of Technology and to enhance the research, innovation and ICT infrastructure to promote enterprise development. The Southern and Eastern region has made a commitment to developing incubator spaces in close proximity to the institutes of Technology.

Policy before the economic crisis was based on a Strategy for Science, Technology and Innovation 2006-2013 which articulates the ambition to be a leading knowledge economy. Following the onset of the economic crisis, this policy is being implemented in the context of the Framework for Sustainable

Economic Renewal which, through an Action Plan for Jobs, involves actions to deliver reform and create economic growth and includes measures related to science, technology and innovation. The government's programme for national recovery places increased emphasis on delivering and accelerating value from the state's investment in research, the approach being to direct the majority of competitive funding towards 14 research priority areas. These are identified in the National Research Prioritisation exercise which forms the basis for Ireland's national R&I Smart Specialisation Strategy. In addition, a portion of funding will be retained for research into policy and research for knowledge.

In 2004, fiscal measures involving R&D tax credits were introduced and provided a 25 % tax credit for qualifying incremental expenditure covering all categories of research from basic to applied research and experimental development. According to OECD surveys on tax incentives, indirect support of business R&D in Ireland is almost three times higher than direct support. The fiscal incentives for carrying out R&D were complemented by an expansion of tax credits in 2010 to enhance investment in intellectual property (including software) by excluding royalties income from withholding tax.

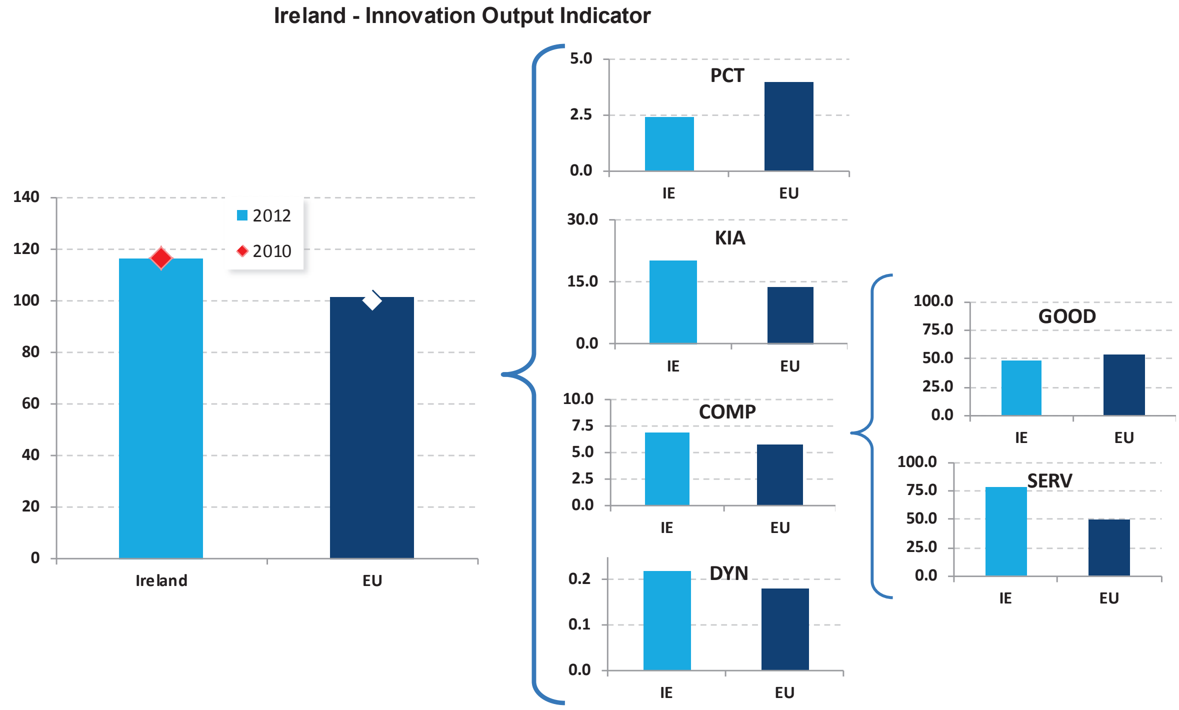
In 2012, the government adopted a proposal for the prioritisation of competitive research funding for activities related to areas of industrial strength. In addition, policy emphasis is being placed on increasing the innovation potential of indigenous firms and improving links between industry and higher education institutions, particularly in the establishment of SFI research centres and the Enterprise Ireland and IDA Ireland Technology Centres. Following the publication of the higher education strategy, the Department of Education and Skills and the Higher Education Authority are putting in place compact agreements with the higher education institutes which will set out performance indicators for the HEIs, including indicators relevant to R&I.

The existing national policies on IPR were reviewed by a task force and were found to be in line with international practice, including that emerging at EU level from the Commission Recommendation C(2008)1329 and the Responsible Partnering initiative from the key stakeholders. This has recently been updated with a new IP protocol (adopted in 2012) to clarify the rules on knowledge transfer in the context of collaboration between industry and HEIs. A key recommendation in the protocol is being implemented by setting up a central Technology Transfer Office due to be officially opened at the end of May 2014. This new office, branded 'Knowledge Transfer Ireland' (KTI), aims to make it easier for companies to access and use ideas developed through publicly funded research to develop new products and services and ultimately create jobs and exports. KTI will ensure that the IP protocol is responding to the needs of business and stakeholders, and its remit will include promoting, enabling and monitoring HEI/business engagement across the wide range of intellectual assets that occurring in the creation of and access to intellectual property, in all its forms.

In 2009, an innovation task force was established. Key areas recommended for action include a better matching between supply and demand for innovation, a financial framework fostering innovation, high-quality and extended human capital, and international projection. It also takes in promotion of public procurement for innovative products and services. However, due to the need for strong fiscal consolidation, the implementation of some of these recommendations has been limited.

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 medium/high-tech commodities); and future business opportunities (jobs in innovative fast-growing firms). The graph below enables a comprehensive comparison of Ireland'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 %).

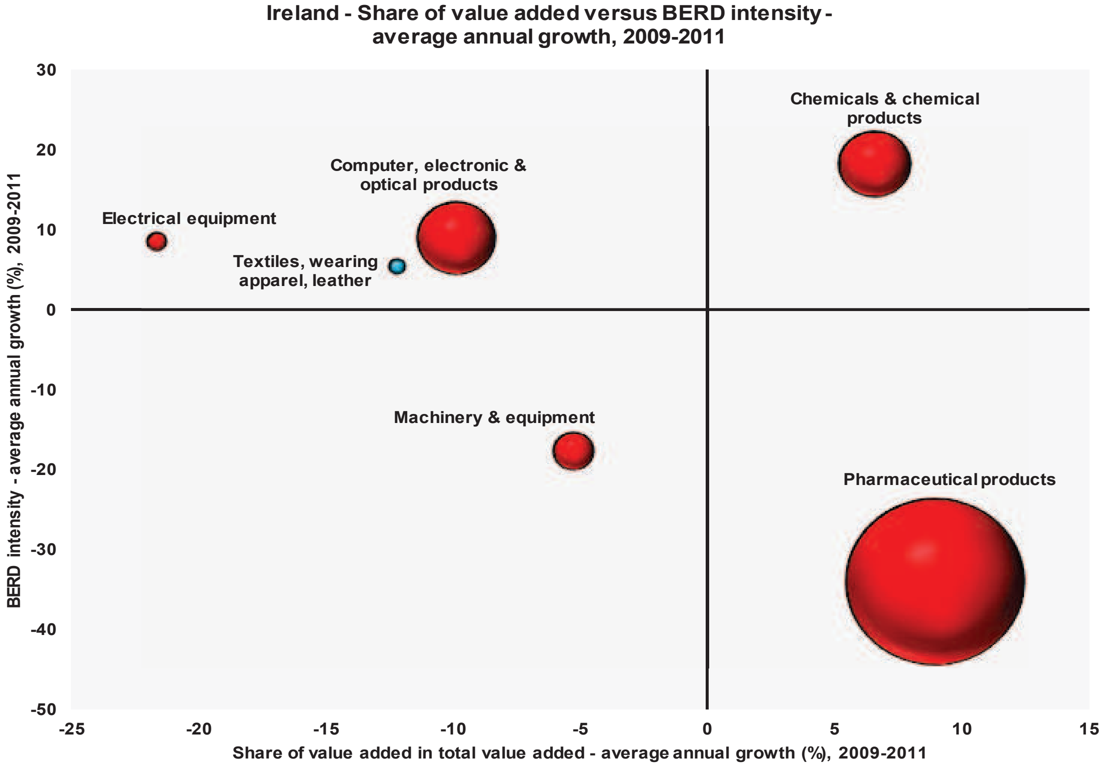
Ireland is one of the best performers in the EU in terms of the innovation output indicator. Only Germany and Sweden are ranked higher in the EU. Employment in knowledge-intensive activities in business industries and in high-growth innovative enterprises, as well as the share of knowledge-intensive services exports in total services exports is clearly above the EU average. Ireland is below the EU average in the indicators for PCT patent application per billion GDP and the share of medium-high and high-tech products in total goods exports. However, this should be seen in the context of the weight of ICT in the Irish economy and the fact that computer program patentability is limited.

Ireland is ranked second in the EU (after Luxembourg) in terms of share of total employment in knowledge-intensive activities (20.1 %) and first in the share of knowledge-intensive services in total exports (78.6 %).

Foreign multinational firms perform a large part of the activity in the knowledge-intensive sectors while foreign direct investments have continued to support the more technology-intensive sectors. In 2012, at 24.8 %, Ireland had by far the highest technology balance of payments receipts as % of GDP among those OECD countries for which data are available. The corresponding average annual growth rate for Ireland over the period 2007-2012 was 14.8 %.This can be largely attributed to the high level of foreign direct investment in Ireland and the resulting intra-group transfers of technology. In general, Ireland has favourable framework conditions for innovation, in particular in terms of time taken to start a business, barriers to entrepreneurship, and corporate taxation. In contrast, it is below average in terms of percentage of self-employed people, women entrepreneurs and entrepreneurs under 45 years of age. Barriers to entrepreneurship (including regulatory, administrative burdens and barriers to competition) are lower than in many other EU Member States. However, following the financial crisis, ease of access to capital in Ireland have fallen to a very low level, and in 2012, the country was ranked in 16th place in the EU in terms of venture capital investment as a % of GDP.

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 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
Note: (1) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

As recognised in Irish economic and industrial policy, the medium-term avenue for a more sustainable economy is to upgrade and move up on the value chain and internationalise its outreach. Compared to other countries, Ireland has scope to further increase both the R&D intensity in existing high-tech and medium-high-tech sectors and to boost knowledge intensity in the more traditional sectors of the economy.

The graph above illustrates recent structural change in the Irish economy. It shows that the economic expansion over the period 2009-2011 was mainly related to chemicals and pharmaceutical products, whereas the contribution of computer, electronic and optical products, and electrical equipment has fallen. The contribution from pharmaceutical products will also shrink as many of the medicines produced in Ireland have come off patent and thus their prices have fallen.

Key indicators for Ireland

IRELAND	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	0.89	1.20	1.38	1.38	1.41	1.56	1.59	1.90	1.95	7.2	*1.81*	11
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	501	:	:	487	:	:	501	0.0 [(3)]	495 [(4)]	8 [(4)]
Business enterprise expenditure on R&D (BERD) as % of GDP	0.80	0.82	0.83	0.85	0.94	1.15	*1.16*	1.14	*1.20*	*7.2*	1.31	11
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.32	0.43	0.42	0.44	0.51	0.53	0.53	*0.51*	*0.53*	*3.8*	*0.74*	18
Venture Capital as % of GDP	0.21	0.07	0.06	0.17	0.04	0.04	0.03	0.04	0.05	-20.2	0,29 [(5)]	16 [(5)]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	30.9	:	:	:	:	60.9	14.6	47.8	7
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	10.9	10.9	11.5	11.6	11.5	:	:	:	0.2	11.0	8
International scientific co-publications per million population	:	702	749	820	915	1003	1089	1133	1138	6.8	343	8
Public-private scientific co-publications per million population	:	:	:	29	26	22	29	34	:	4.6	53	12
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	2.3	2.4	2.4	2.7	2.9	2.8	2.3	:	:	-5.0	3.9	11
License and patent revenues from abroad as % of GDP	0.52	0.38	0.42	0.46	0.56	0.75	1.39	2.22	2.37	39.1	0.31	2
Community trademark (CTM) applications per million population	179	129	173	177	181	183	185	179	181	0.5	152	10
Community design (CD) applications per million population	:	15	14	13	14	14	18	15	16	4.3	29	20
Sales of new to market and new to firm innovations as % of turnover	:	:	12.6	:	11.0	:	9.3	:	:	-8.0	14.4	20
Knowledge-intensive services exports as % total service exports	:	:	:	:	:	71.3	72.7	71.4	:	0.0	45.3	2
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-5.37	-1.20	-0.92	-1.33	1.28	2.43	2.38	2.53	1.99	-	4,23 [(6)]	14
Growth of total factor productivity (total economy) - 2007 = 100	96	100	100	100	96	94	95	98	98	-2 [(7)]	97	7
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	57.5	:	:	:	:	68.2	3.5	51.2	1
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	18.2	19.1 [(8)]	19.5	19.7	20.2	1.7	13.9	2
SMEs introducing product or process innovations as % of SMEs	:	:	43.8	:	42.3	:	41.2	:	:	-1.3	33.8	7
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.10	0.05	0.08	0.09	0.23	0.17	:	:	:	35.8	0.44	12
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.53	0.55	0.39	0.62	0.60	0.75	:	:	:	10.0	0.53	6
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	70.4	72.6	73.4	73.8	72.3	66.9 [(8)]	64.6	63.8	63.7	-1.6	68.4	21
R&D Intensity (GERD as % of GDP)	1.11	1.25	1.25	1.28	1.45	*1.69*	*1.69*	*1.66*	*1.72*	*6.1*	*2.07*	12
Greenhouse gas emissions - 1990 = 100	124	128	128	127	125	114	113	106	:	-21 [(9)]	83	21 [(10)]
Share of renewable energy in gross final energy consumption (%)	:	2.8	3.1	3.6	4.0	5.2	5.6	6.7	:	16.8	13.0	22
Share of population aged 30-34 who have successfully completed tertiary education (%)	27.5	39.2	41.3	43.3	46.1	48.9	50.1	49.7	51.1	3.4	35.7	1
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	12.5	12.1	11.6	11.3	11.7	11.5	10.8	9.7	-3.5	12.7	13 [(10)]
Share of population at risk of poverty or social exclusion (%)	:	25.0	23.3	23.1	23.7	25.7	27.3	29.4	:	6.2	24.8	20 [(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) 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) Break in series between 2009 and the previous years. Average annual growth refers to 2009-2012.
(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.