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COMMISSION STAFF WORKING DOCUMENT

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

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Italy

The challenge of structural change for a more knowledge-intensive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation performance in Austria. 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: 1.27 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +1.5 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[1] 2012: 36.5 (EU: 47.8; US: 58.1) 2007-2012: -0.5% (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 84.3 (EU: 101.6)	*Knowledge-intensity of the economy*[2] 2012: 37.2 (EU:51.2; US: 59.9) 2007-2012: +0.9% (EU: +1.0%; US: +0.5%)
Areas of marked S&T specialisations: Automobiles, food and agriculture, ICT, biotechnology, and new production technologies	*HT + MT contribution to the trade balance* 2012: 4.8 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +2.5 % (EU: +4.8 %; US: -32.3 %)

Italy's share of GDP devoted to R&D activities has increased moderately over the last ten years, reaching 1.27 % in 2012. Nevertheless, both public and private R&D intensities remain a long way from those of its competitors at the technology frontier, thus undermining progress made towards a more efficient research system, and missing the opportunity for the country to move away from specialisation in low-technology-intensive products. Therefore, Italy should commit to increasing R&D intensity and improving business framework conditions for innovation and economic structural changes.

The Italian R&I system is still suffering from structural weaknesses, such as a low proportion of people with tertiary education and insufficient orientation of the education system towards technology-intensive specialisations. Recent budget cuts have made this situation worse: the number of university professors has fallen across all departments, while the Italian system is no longer able to retain national researchers or attract foreign ones. At the same time, Italy's business environment is stifled by complex bureaucratic procedures. This causes significant delays which have a very negative impact on innovation, in particular, when market advantages are considered. In addition, the low availability of venture capital, and the difficult commercialisation of results are further obstacles to innovation. For all of these reasons, Italy remains a moderate innovator.

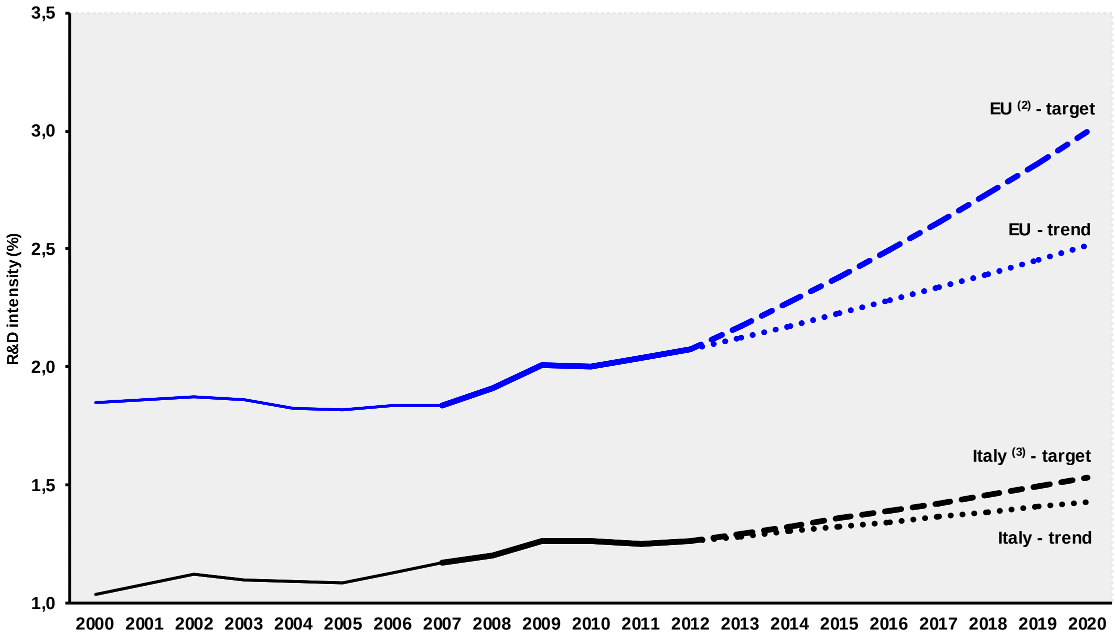
However, positive trends were registered between 2007 and 2012 in both the knowledge-intensity of the economy and the contribution of high-tech and medium-tech products to the trade balance.

[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.

Moreover, the innovativeness of small and medium-sized enterprises (SMEs) and the excellent quality of scientific outputs remain two important strengths within Italy's R&I system. This clearly indicates that the country has huge innovation potential which simply needs additional support to be fully exploited.

Investing in knowledge

Italy - 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) IT: The projection is based on a tentative R&D intensity target of 1.53% for 2020.

In 2012, Italy's R&D intensity was 1.27 %, which represents a very small improvement compared to 2011, when the share was 1.25 %. However, this slight growth is due in part to the fall in GDP registered in the same period (-1.9 %). Thus, the country's R&D intensity remains a long way from the 1.53 % share of GDP set as the national target for 2020. In order to reach this target, which is already lacking in ambition as regards the country's potential and challenges, Italy needs to invest more in R&D activities. Both public-sector and private-sector expenditure on R&D grew in the period 2000-2012, but at a modest rate and still below the EU average. The difference between Italy's R&D intensity and the EU average (2.07 %) is mainly due to a lower business R&D. Indeed, business R&D intensity in Italy was 0.69 % in 2012, as opposed to the EU average of 1.31 %. Nevertheless, public-sector R&D intensity also remains at a lower level than the EU average (0.54 % instead of 0.74 %).

The low level of business R&D intensity is mainly linked to the structural composition of the Italian economy, which has a modest share of high-tech industries in total manufacturing, and is dominated by small and micro firms. In Italy, around 4.1 million of the 4.5 million firms have between one and nine employees. Those companies, often characterised by a family ownership structure, do not usually carry out R&D because they are unable to attract financial resources or highly skilled human capital.

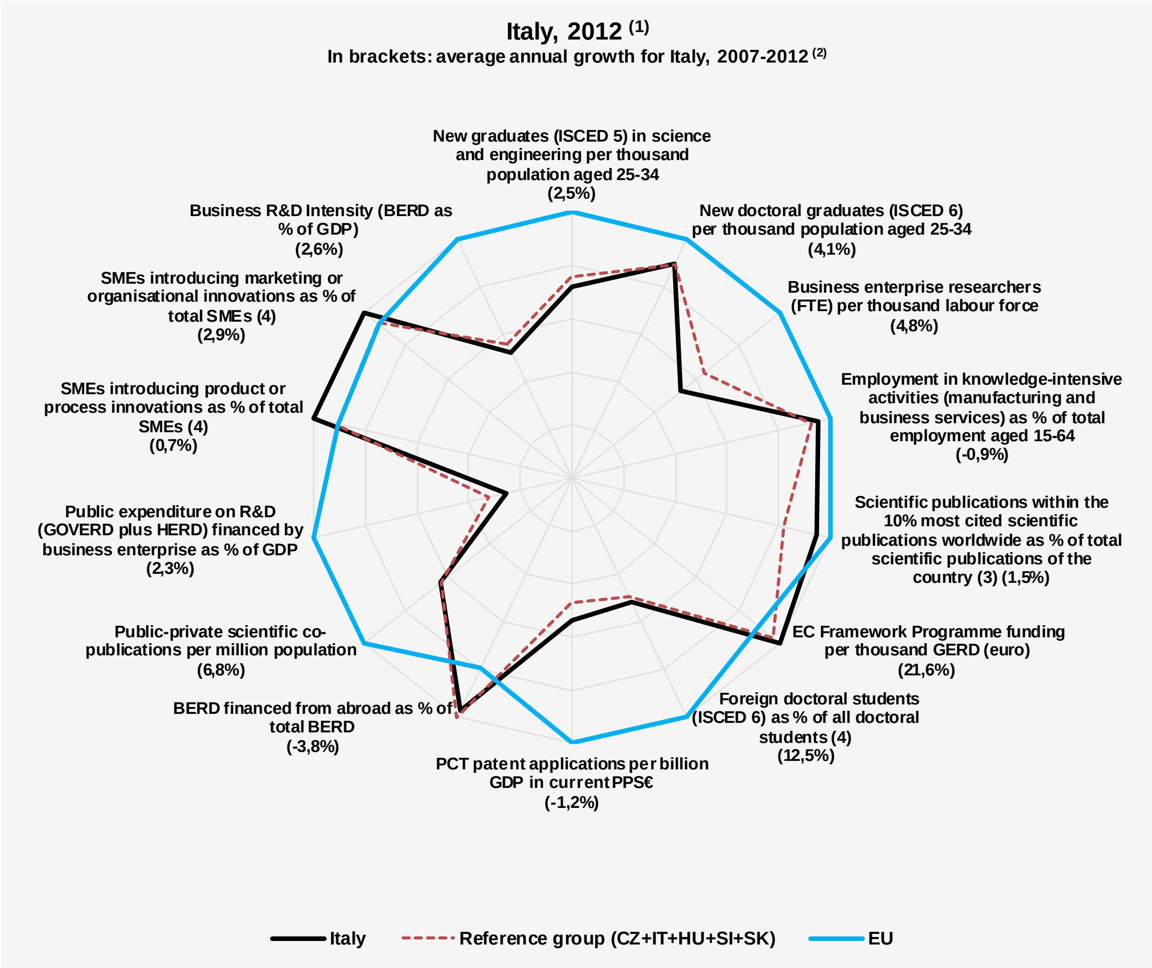
As regards public R&D investments, resources allocated to the higher education system appear inadequate. The 2013 budget for universities was about 20 % lower than in 2008, and the amount of resources for competitive funding has been reduced drastically in recent years. These budget cuts have also resulted in falling numbers of university staff: between 2006 and 2012 alone, the number of full and associate professors fell by 22 %.

On the other hand, Italy has been actively participating in the EU's Seventh Framework Programme. To date, Italian R&D institutions have received almost EUR 3.3 billion in EU contribution, making it the fourth most active country in FP7 projects. Structural Funds are another important source of funding for R&I activities. Of the EUR 27.9 billion of Structural Funds allocated to Italy over the 2007-2013 programming period, around EUR 6 billion (21.7 % of the total) relate to RTDI[3]. However, in spite of the crucial role these funds could play in the development and catching up of some regions, Italy has been unable to spend all those resources, preventing the country from taking full advantage of this important financial support.

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

The graph below illustrates the strengths and weaknesses of the Italian 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.

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 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 innovative attitude of its SMEs appears to be an emerging strength in the Italian R&I system. Italy scores above the EU average for both SMEs introducing marketing and organisational innovations, and those bringing in product and process innovations. Moreover, the overall quality of scientific publications is quite high, as is shown by the growing share of top publications. Nevertheless, the Italian system still suffers from a lack of skilled human capital and an unsatisfactory level of public-private collaboration.

Although the number of new graduates in science and engineering and new doctoral graduates increased between 2007 and 2012, Italy is still a long way from the EU average. This may also be related to the generally low share of citizens with higher education qualifications, which is a traditional weakness of the Italian system: in 2012, the proportion of people aged 30-34 years with tertiary education qualification was only 21.7 % (EU-28: 35.7 %). Furthermore, there is still a relatively high share of Italian researchers working in other EU countries and a relatively low share of non-national researchers in Italy. This alarming brain drain may become a further barrier to efforts to shift Italy's economy towards more knowledge-intensive and innovative activities.

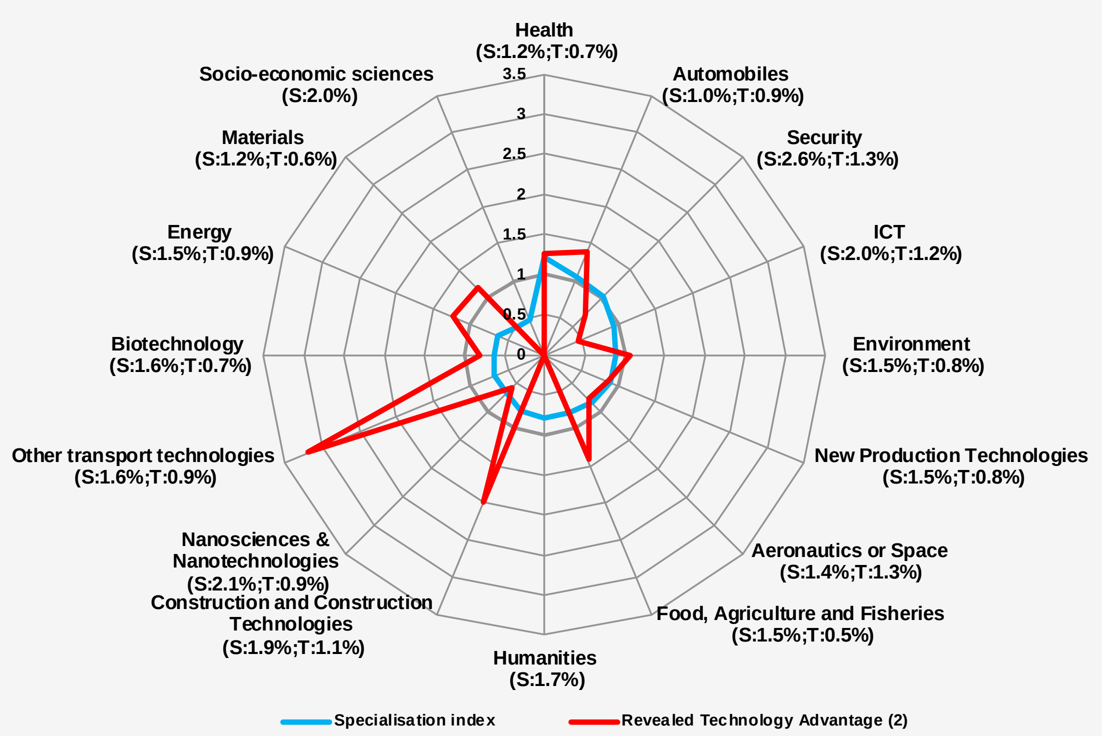
Public-private collaboration is also much lower than the EU average. Public expenditure on R&D financed by business enterprises represents only 0.013 % of GDP (EU: 0.052 %). Moreover, both the public-private scientific co-publications per million population and the number of business researchers per thousand of the labour force in Italy are well below EU average. Public-private cooperation often occurs on an ad-hoc basis in the absence of well-developed networks and formal structures (i.e. knowledge-transfer offices) which could act as intermediaries between the public research sector and businesses.

Italy's scientific and technological strengths

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

Italy 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)



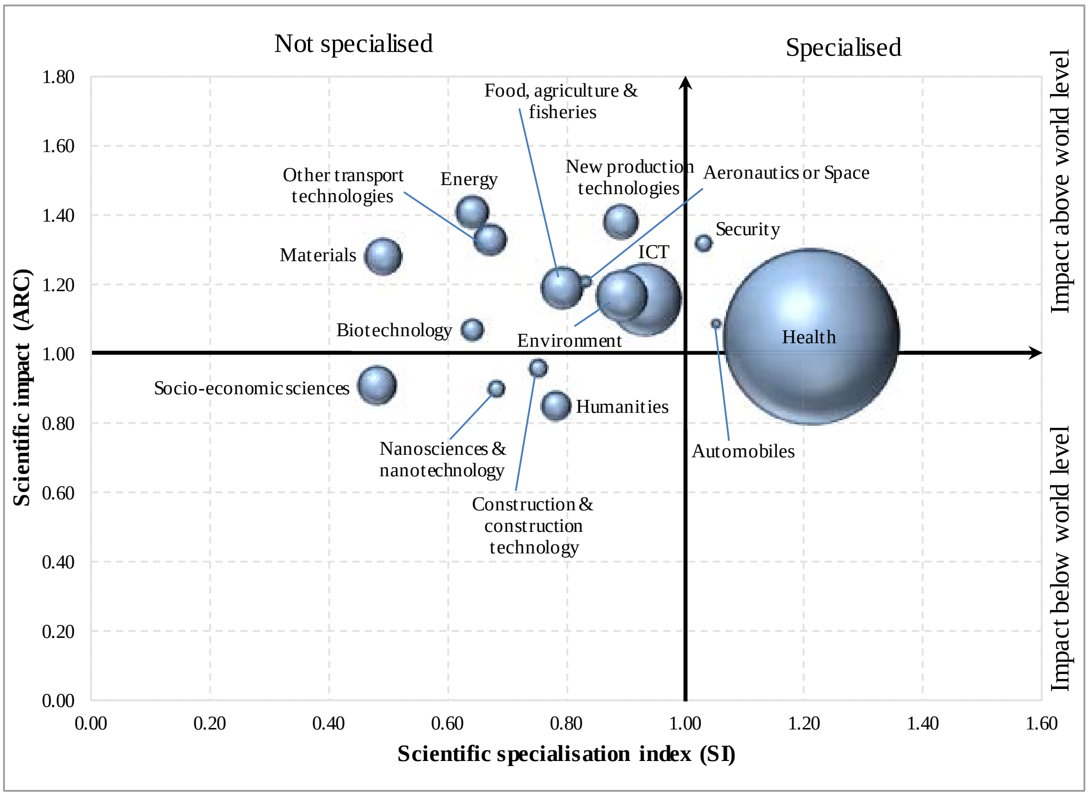
Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding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

In June 2013, the Italian National Agency for the Evaluation of University System and Research (ANVUR) published a report highlighting the fact that overall the share of Italian publications is growing faster than the EU average, and that the country's share of top publications (those receiving the top ten citations in each field) is above the world average. Thus, Italy's productivity output for both universities and public research organisations ranks among the best-performing countries.

However, scientific specialisation in Italy presents a large and diversified science base which only partially corresponds to the technological dynamics. S&T activities show substantial scientific specialisation in the health, automobile, and security sectors, although only the first two sectors reveal a technological advantage. On the other hand, Italy's technology production is strongly specialised in the field of other transport technologies, which attracts the highest share of patents, as well as in construction technologies, food, agriculture and fisheries, energy, and materials. These relative strengths in patenting reflect the weight of the traditional sectors and do not have a corresponding scientific specialisation.

There is room for improvement in matching Italy's science base to the needs of its industrial structure. However, translating the relative strengths in scientific publication into economic activities and revealed technology advantages requires stronger collaboration between public and private R&D actors, more investments and favourable market conditions. To foster this collaboration, the Ministry of Education, University and Research (MIUR) launched a competitive call for new technological clusters and carried out the first mapping of regional sectoral specialisation. Among the eight clusters selected, some follow Italian co-specialisations (aerospace, new production technologies, green chemistry, and life sciences), while others have been created in areas where there remains an important mismatch between science and technological development (food and agriculture, transport technologies, and smart communities). Those clusters may deploy their potential for structural change towards more knowledge-intensive activities by injecting knowledge into both existing and new industrial and services sectors.

Positional analysis of Italy 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 illustrates the positional analysis of Italian 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.

While the country is only specialised in the health, security, and automobiles sectors, the scientific impact of publications in all sectors (apart from socio-economic sciences and humanities, nanosciences and construction) is above the world level. This aspect is confirmation that the quality of science is an important strength in the Italian R&D system, although the commercialisation of scientific results and the collaboration between academia and industry remain difficult. In the ICT sector, for example, the quality of scientific publishing is extremely good and the sector is close to the scientific specialisation, but there is no revealed technology advantage in that field.

Policies and reforms for research and innovation

In March 2013, the MIUR launched Horizon 2020 Italia (HIT2020), a strategic document aimed at boosting the Italian R&I system by implementing the Europe 2020 strategy while, at the same time, focusing on specific national challenges. The new National Research Programme 2014-2020, which was presented to the Italian Council of Ministers in January 2014, is based on this strategy. For the first time, this programme will run for seven years (previously it was a three-year programme) in line with European policies. It acknowledges the obstacles that have made the development of a research policy in Italy difficult, and proposes an array of actions dedicated to removing those obstacles while making the best use of the positive characteristics within the existing production structure. In particular, it assigns strategic value to public-private partnerships and knowledge transfer to improve Italy's competitiveness, and focuses specifically on the importance of creating good working conditions to retain Italian researchers and attract foreign ones.

Important steps have already been taken in the direction of a more open and competitive research system, in line with the objectives of the European Research Area. In 2013, for the first time, 13.5 % of institutional funding was distributed on the basis of the results of the Quality Evaluation for Research carried out by ANVUR. This share of institutional funding, based on quality criteria, is expected to further increase to 16 % in 2014, 18 % in 2015 and 20 % in 2016. At the same time, international peer review for evaluating open calls for proposals has been introduced into the system, and its use is now widespread. Furthermore, a national system for the scientific certification of professorship candidature has been set up to guarantee transparent and merit-based recruitment, while the regulation introducing the reform of the Italian doctoral training system was adopted in February 2013. This regulation will be implemented in the academic year 2014-2015 with a view to creating attractive and competitive doctoral schools in Italy, especially for foreign students. However, the low level of institutional funding, along with a constant decline in competitive project funding, and the lack of career opportunities in universities could reduce the positive effects of those reforms significantly. Moreover, the Italian system is still suffering from high fragmentation which sometimes leads to duplications and inefficiencies.

Several measures have also been developed to foster Italy's innovation capacity and public-private collaboration. In addition to defining the eight technological clusters, the first mapping of regional sectoral specialisations, which will contribute to the design of smart specialisation strategies, was finalised in 2013. Furthermore, new legal frameworks have been devised for innovative start-ups and actions have been undertaken to simplify access to finance for SMEs. Nevertheless, implementation for some of these policy measures is still lacking and the administrative burden on businesses remains high. At the same time, fiscal credit or tax incentives remain inadequate.

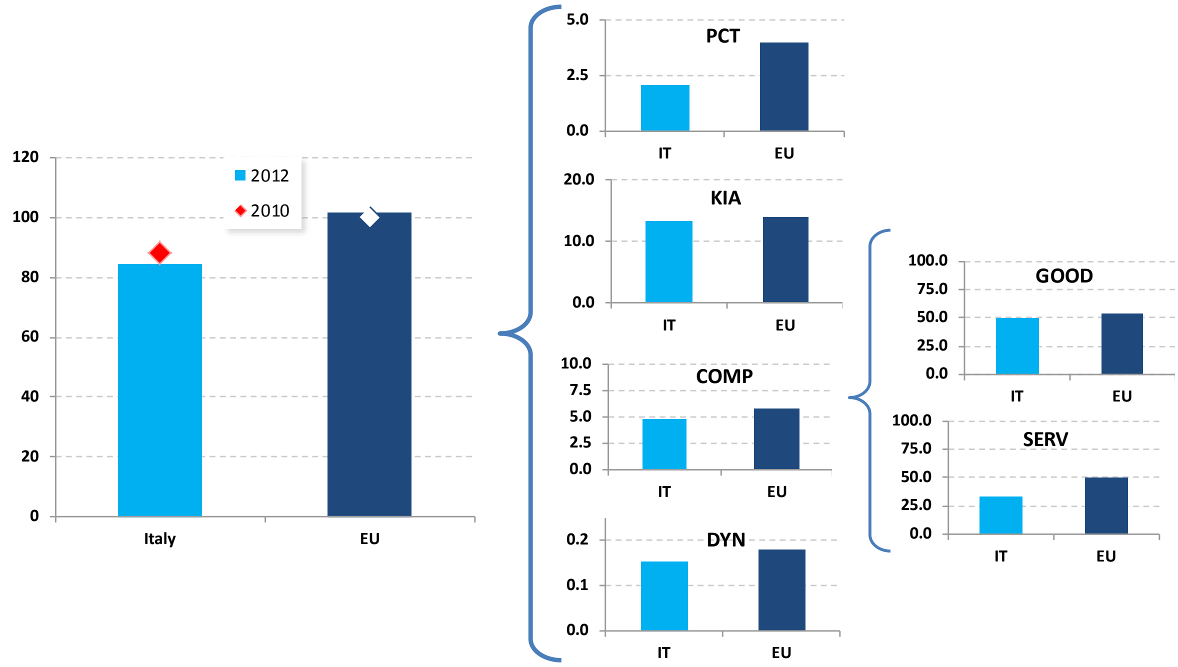
MIUR and MISE (the Ministry of Economic Development) are jointly responsible for the National Operational Programme for Research and Competitiveness 2007-2013 (PONREC), which is the main instrument for implementing R&I policies in the four convergence regions, namely Calabria, Campania, Puglia and Sicilia. This programme focuses on three main priorities: (i) supporting structural changes and scientific and technological improvement for a transition towards a knowledge economy; (ii) improving the innovative context for the development of competitiveness; and (iii) technical support and coaching. The PONREC has joined the Cohesion Action Plan, which was launched in November 2011 to overcome delays in using the Structural Funds, transferring part of its own funding there. In August 2013, the Italian authorities announced the creation of a public agency for territorial cohesion which is expected to become operational in autumn 2014. This agency should ensure the efficient management of Structural Funds – an objective which is still far from being reached – and support local governments running national and European projects.

Innovation Output Indicator

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

The graph below enables a comprehensive comparison of Italy's position regarding the indicator's different components.

Italy - Innovation Output Indicator



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

The Innovation Union Scoreboard 2014 considers Italy as a 'moderate innovator' since its innovation performance remains below the EU-27 average. This seems to be in line with the Innovation Output Indicator results in the graph above, where Italy is a medium-low performer with scores below the EU average in all components. The country comes closest to the EU average in employment in knowledge-intensive activities as a % of total employment. Overall, Italy's performance declined in the period 2010-2012.

Its low performance in patenting is partly explained by the country's economic structure, which comprises a high number of small and micro enterprises, in which patenting activities are more difficult because of economies of scale and scope and less capacity to attract venture capital. Moreover, despite Italy's specialisation in some technology-intensive sectors such as machinery, automotive and aerospace, the patent-intensive ICT sector is smaller than in other large economies, while sectors like textiles and footwear, which tend to have low patenting activities, are relatively more important than in other EU countries.

Italy also performs worse than the EU average in the innovativeness of fast-growing innovative firms. This is the result of a high share of low-tech manufacturing companies, transport, and administrative and support activities among the fast-growing enterprises.

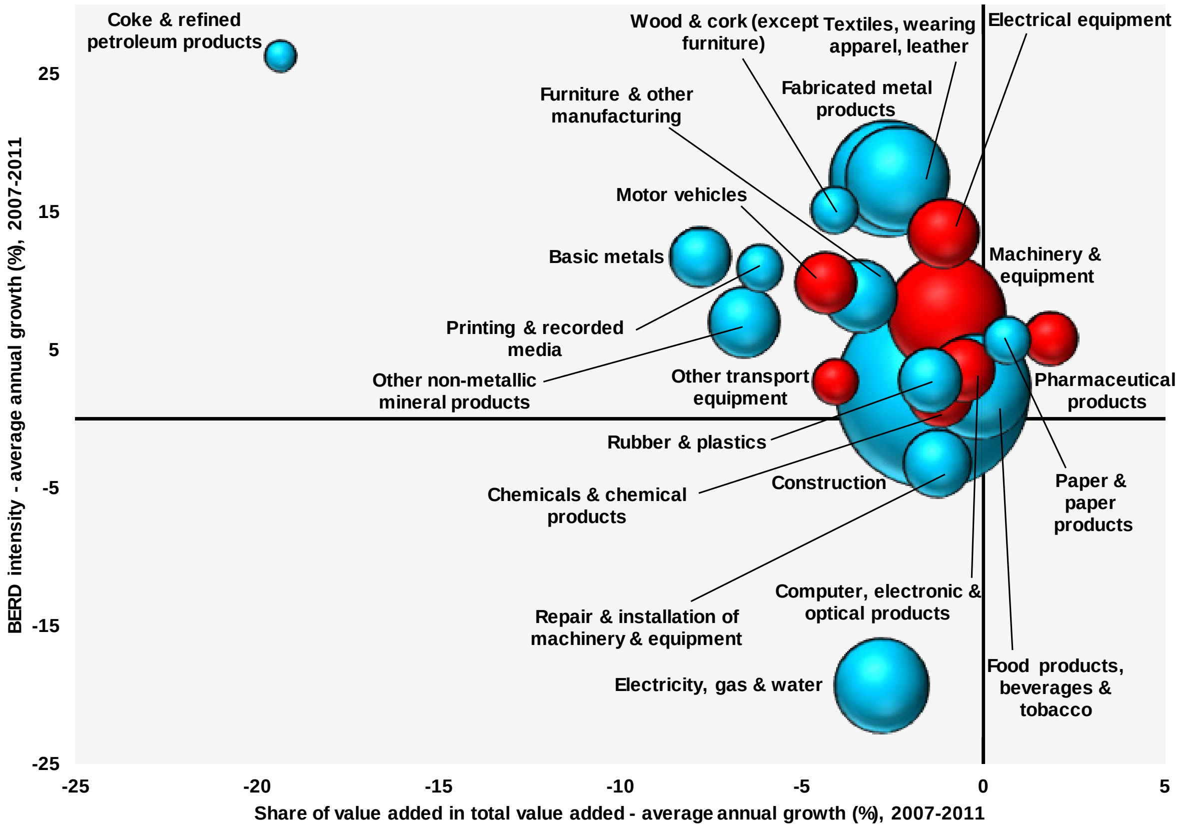
Italy is the second largest exporter of machinery in the EU, after Germany. However, it is also an important exporter of low-tech goods, such as textiles and shoes. As a result, it has a slightly below EU average share of medium/high-tech goods in total goods exports. The Italian economy is also characterised by a low share of knowledge-intensive services exports. This is partly explained by the huge weight of the tourism sector which, together with business travel, represents 40 % of all services exports in Italy, and is classified as non-KIS. In contrast, exports of software, classified as KIS, remain relatively low.

In addition to the above-mentioned aspects, the disparity between regions in terms of innovation performance remains an issue for the country. The most innovative Italian regions are Piemonte, Emilia Romagna, Friuli Venezia Giulia and Lombardia, which are all located in the northern part of the country. Unfortunately, the serious inefficiency registered in the use of Structural Funds, along with the negative effect of the economic crisis, are further widening these territorial imbalances.

Upgrading the manufacturing sector through research and technologies

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

Italy - Share of value added versus BERD intensity - average annual growth, 2007-2011



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

The shares in total Italian value added of nearly all manufacturing sectors declined between 2007 and 2011. This evolution reflects both the shift towards a more service-oriented economy, similar to that observed at EU level, and the higher competition of emerging economies in traditional sectors experienced by the country in recent years.

In spite of this de-industrialisation process, manufacturing still carries an important weight in the Italian economy and is mainly concentrated in low and medium-low technology sectors (i.e. construction, fabricated metal products, textiles, and clothes). However, Italy maintains a strategic position in some high-tech sectors, like machinery, automotive, and space. The graph shows the country's diversified industrial structure, where a wide range of industries account for a relatively small share of the Italian economy. This reflects a lack of specialisation in the Italian economy.

Between 2007 and 2011, the growth in business research intensity was moderate but concerned all manufacturing sectors except electricity, gas and water. The highest growth rate in BERD intensity was registered in traditional sectors like coke and refined petroleum products (which, on the other hand, saw a drastic reduction in their share of value added), fabricated metal products, textiles, and wood and cork. During the same period, all high-tech and medium-high-tech sectors also increased their business research intensity, in particular electrical equipment, machinery, and motor vehicles. In spite of those positive trends, the Italian economic system still suffers from insufficient R&D intensity in its knowledge-intensive industries.

Key indicators for Italy

ITALY	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	0,45	1,14	1,23	1,32	1,60	:	:	1,56	1,62	4,1	*1,81*	17
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	462	:	:	483	:	:	485	23.6 (3)	495 (4)	17 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0,52	0,55	0,55	0,61	0,65	0,67	0,68	0,68	*0,69*	*2,6*	1,31	17
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,52	0,52 (5)	0,54	0,52	0,52	0,55	0,54	0,53	*0,54*	*0,5*	*0,74*	17
Venture Capital as % of GDP	0,25	0,15	0,23	0,18	0,21	0,09	0,06	0,08	0,07	-16,6	0,29 (6)	15 (6)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	37,5	:	:	:	:	36,5	-0,5	47,8	11
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	9,6	9,8	10,1	10,3	10,4	:	:	:	1,5	11,0	13
International scientific co-publications per million population	:	347	372	412	431	457	483	511	532	5,2	343	19
Public-private scientific co-publications per million population	:	:	:	26	26	29	32	33	:	6,8	53	14
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	1,4	2,1	2,3	2,2	2,1	2,1	2,1	:	:	-1,2	3,9	13
License and patent revenues from abroad as % of GDP	0,05	0,06	0,06	0,05	0,17	0,18	0,18	0,18	0,20	33,4	0,59	14
Community trademark (CTM) applications per million population	75	89	107	122	122	122	133	133	133	1,7	152	15
Community design (CD) applications per million population	:	29	28	28	29	29	30	31	29	0,7	29	10
Sales of new to market and new to firm innovations as % of turnover	:	:	9,1	:	11,8	:	14,9	:	:	12,3	14,4	8
Knowledge-intensive services exports as % total service exports	:	21,6	23,7	23,9	27,3	24,7	28,4	27,5	:	3,6	45,3	19
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	2,10	3,31	4,49	4,36	5,04	4,14	4,02	4,82	:	-	4,23 (7)	5
Growth of total factor productivity (total economy) - 2007 = 100	100	99	100	100	99	95	97	97	95	-5 (8)	97	16
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	35,6	:	:	:	:	37,2	0,9	51,2	22
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	13,6	13,5	13,7	13,4	13,2	-0,9	13,9	15
SMEs introducing product or process innovations as % of SMEs	:	:	33,0	:	36,9	:	37,4	:	:	0,7	33,8	12
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,14	0,19	0,20	0,22	0,24	0,24	:	:	:	4,3	0,44	10
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,41	0,45	0,42	0,37	0,38	0,35	:	:	:	-1,9	0,53	12
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	57,4	61,6	62,5	62,8	63,0	61,7	61,1	61,2	61,0	-0,6	68,4	25
R&D Intensity (GERD as % of GDP)	1,04	1,09	1,13	1,17	1,21	1,26	1,26	1,25	*1,27*	*1,5*	*2,07*	18
Greenhouse gas emissions - 1990 = 100	107	112	110	108	105	96	97	95	:	-13 (9)	83	18 (10)
Share of renewable energy in gross final energy consumption (%)	:	5,1	5,5	5,5	6,9	8,6	9,8	11,5	:	20,2	13,0	17
Share of population aged 30-34 who have successfully completed tertiary education (%)	11,6	17,0	17,7	18,6	19,2	19,0	19,8	20,3	21,7	3,1	35,7	28
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	25,1	22,3	20,6	19,7	19,7	19,2	18,8	18,2	17,6	-2,2	12,7	25 (10)
Share of population at risk of poverty or social exclusion (%)	:	25,0	25,9	26,0	25,3	24,7	24,5	28,2	29,9	2,8	24,8	21 (10)

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

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

“Implement a growth-friendly fiscal adjustment […] preserving growth-enhancing spending like R&D, innovation, education and essential infrastructure projects. […] Ensure that public funding better rewards the quality of higher education and research.”

Latvia

A better R&I-business partnership as a step forward towards competitiveness

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Latvia. 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: 0.66 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +2.0% (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[4] 2012: 19.9 (EU: 47.8; US: 58.1) 2007-2012: +6.5 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 63.8 (EU: 101.6)	*Knowledge-intensity of the economy*[5] 2012: 37.6 (EU: 51.2; US: 59.9) 2007-2012: +3.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Materials, health, other transport technologies (other than automobiles and aeronautics), biotechnology, and food	*HT + MT contribution to the trade balance* 2012: -4.9 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

Over the last few years, Latvia's performance in research and innovation has not improved significantly. The several changes that were made in the governance of the R&I system aimed to improve the quality of the system and to strengthen the links between the research and industry sectors. Some of the measures have yet to prove their effectiveness since overall R&I performance is not showing any significant improvements. One particular aspect of this situation is that these measures are mainly dependent on Structural Funds since the national budget is contributing less and less. The main areas targeted by the measures included governance of the R&I system, modernisation of the scientific infrastructure and an improvement in human resources by attracting foreign academics, and industry's capacity to innovate, by developing better links between research and industry.

Latvia's poor innovation performance still impairs its competitiveness. The country has one of the lowest business R&D intensities in the EU (0.15 % in 2012). The national innovation system is overshadowed by low scientific performance, as measured by the share of scientific publications in the top 10 % most cited which at just 4 % is significantly below the EU average. There is little R&D investment by domestic companies or large foreign affiliates to support specialisation in knowledge-intensive and innovation-driven sectors.

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[4] 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.

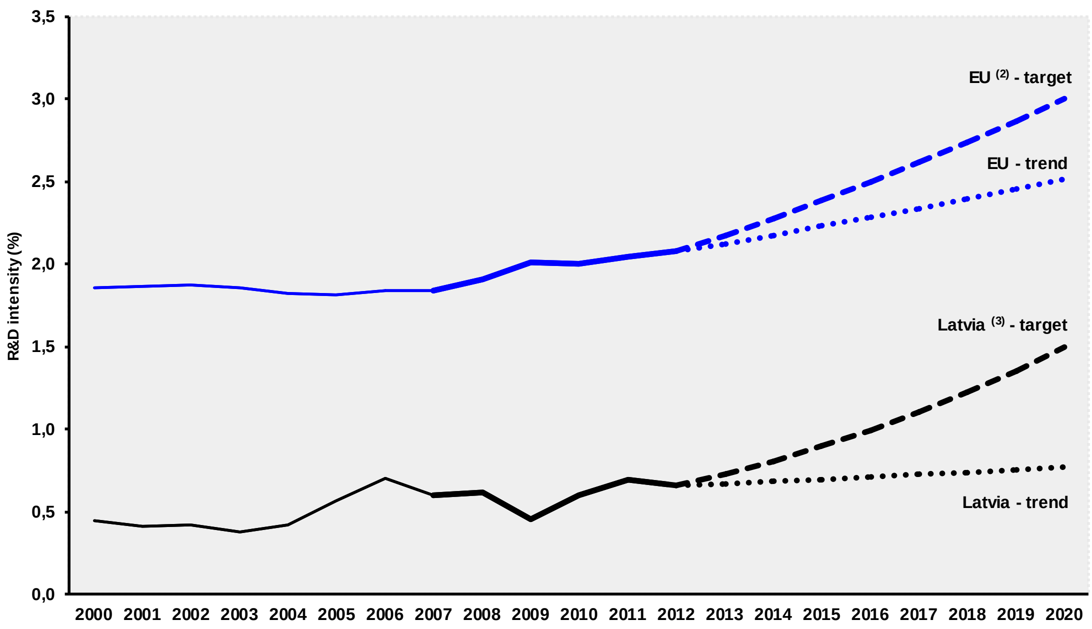
[5] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

As mentioned by one of the Country Specific Recommendations, Latvia needs to modernise its research institutions in order to improve the quality of the R&I system and increase its international competitiveness. Taking into account the thematic priorities and budgetary constraints, Latvia should improve the quality of the science base and rationalise the research and higher education institutions. There would be fewer results achieved but larger entities would be more able to build up critical mass in specialised areas of education and research, with a greater opportunity to innovate. Moreover, the use of resources would become more focused, enabling the country to be more efficient in the allocation of budgetary resources for R&I.

Latvia would also benefit from the R&I strategy for smart specialisation, which would facilitate a more efficient use of EU Structural Funds and improve the synergies between different EU and national policies, as well as increasing public and private investment in R&D.

Investing in knowledge

Latvia - 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) LV: The projection is based on a tentative R&D intensity target of 1.5% for 2020.

In Latvia, the effect of the crisis heavily influenced the R&D funds allocated in 2009. Compared to 2008, the total funds for R&D fell by 40 %, while the government budget for R&D was 49 % lower. Thanks to the country's rapid economic recovery, the public R&D budget partially recovered, reaching the same level in 2011 as it achieved in 2008, and continuing to rise in 2012 (by 10 %). As regards innovation policy, Latvia does not have plans in the field of innovation procurement which is mostly supply-led rather than demand-side led. To increase private investments in R&I, the government plans to adopt tax incentives as of 1 July 2014.

In strategic terms, Latvia has set a national R&D intensity target of 1.5 %. In 2012, it had an R&D intensity of 0.66 %, with public R&D intensity at 0.51 % and business R&D intensity at 0.15 %.

Latvia needs to increase R&D intensity in both the public and business sectors as a prerequisite to maintaining a performing R&I infrastructure and boosting innovation in firms. Over the period 2007-2012, Latvian R&D intensity grew at an average annual rate of 2.0 %, which is slightly below the EU average. The country needs to increase this rate significantly if the national 2020 R&D intensity target is to be achieved (in fact, an average annual growth rate of 10.8 % is required over the period 2012-2020 to reach the 1.5 % target). Public-sector R&D intensity had an average annual growth rate of 4.8 % over the period 2007-2012, where the 2012 value increased slightly compared to 2011 (a 1.3 % increase). On the other hand, private-sector R&D intensity recorded a fall of 5.3 % during 2007-2012, with a significant decline compared to 2011 (a 21 % decrease).

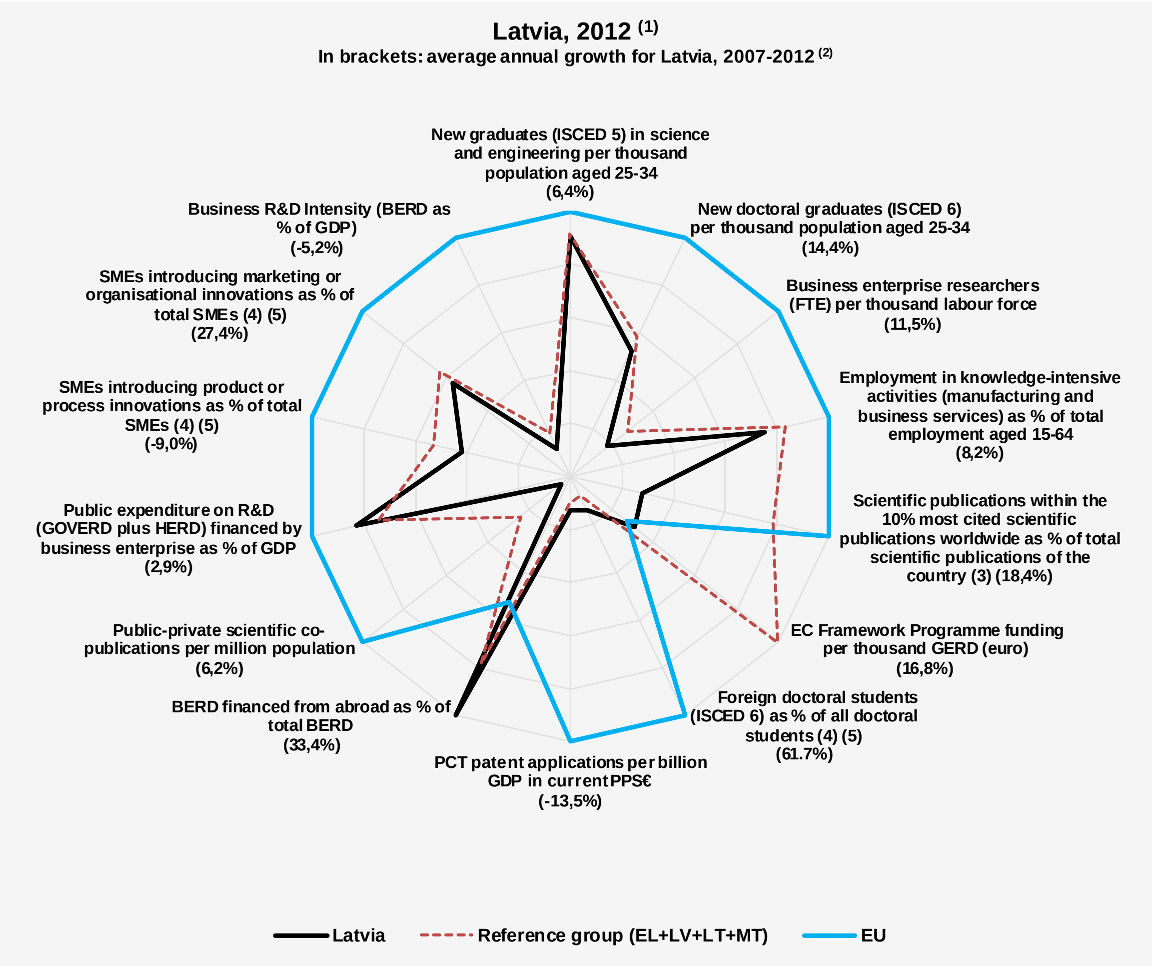
Latvia's success rate among participants in the EU's Seventh Framework Programme was 21.9 %. These participants received a total EC financial contribution of EUR 40.6 million. Structural Funds play a major role in the financing of R&I in Latvia – with 16 % of the total funds for the 2007-2013 period allocated to RTDI[6]. The R&I financing from the Structural Funds still exceeds national public funding for R&D, representing nearly half of the total R&D expenditure (2007-2012).

The low level of business expenditure on R&D is seen as a critical challenge for Latvia. Business expenditure on R&D increased by 14 % between 2008 and 2010, when it reached a value close to that of 2007. The downward trend continued with a fall of 19 % over the next two years. The initial increase was due to a large extent to the activities funded under Structural Fund programmes designed to improve industry's innovative capacity. The growing share of Structural Funds in R&D funding has also affected the previous balance between institutional and competitive funding which is now moving more towards project-based, competitive funding.

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

The graph below provides a synthetic picture of strengths and weaknesses in the Latvian 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.

[6] 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.



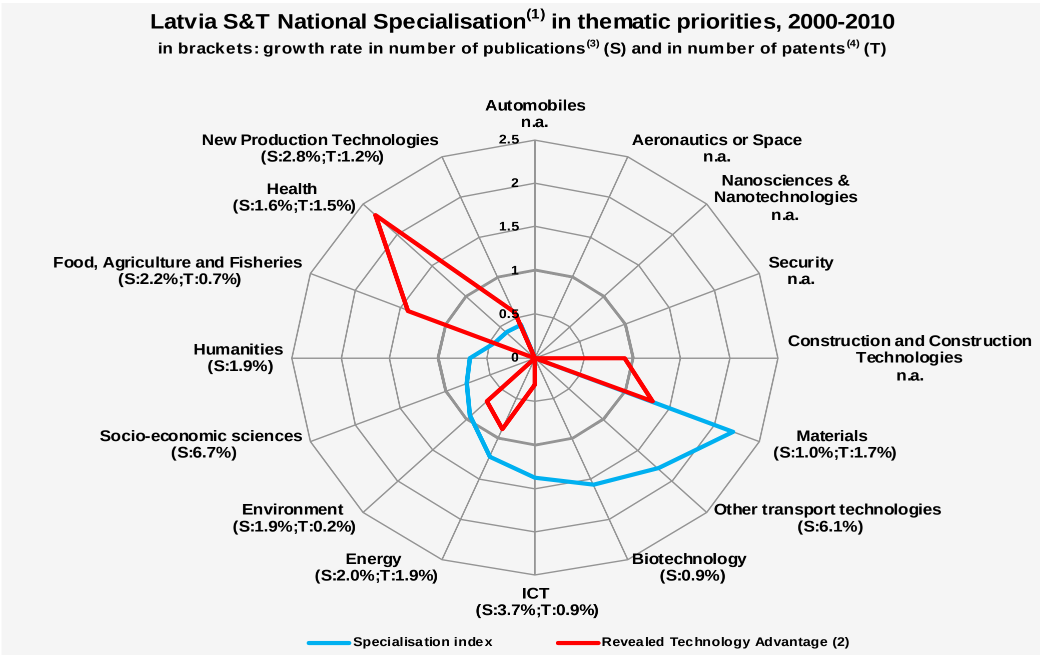
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates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

One important aspect of the Latvian R&I system remains the lack of highly qualified scientists and engineers, fairly correlated to the low numbers of new doctorates awarded and graduates in science and engineering. The share of researchers in business enterprise remains extremely low and although employment in knowledge-intensive activities is rising slowly, it is still below the EU average. In fact, Latvia suffers from a significant outflow of graduates and researchers to other countries, many scientists preferring to pursue their careers abroad. In addition, the country is failing to attract significant numbers of non-nationals in the field of R&I and the already low number of foreign doctoral students is falling even further.

The national innovation system is severely affected by low scientific performance (the share of scientific publications in the top 10 % of the most cited is 4 % and falling) and low licence and patent revenues. Moreover, the country needs to enhance the quality of the higher education system and to address the need to better attune Latvian research to the needs of local industry, while reinforcing the capacity of the latter to develop R&I activities. Public-private scientific cooperation is very low and investment in R&I by foreign affiliates in support of specialisation in knowledge-intensive and innovation-driven sectors has been declining. The results produced by the technology transfer contact points operating in several universities remain modest, although recent actions, such as the development of a Smart Specialisation Strategy and changes to the legal framework for protecting intellectual property rights, could improve their impact and increase the current low-level commercialisation of research results.

Latvia's scientific and technological strengths

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

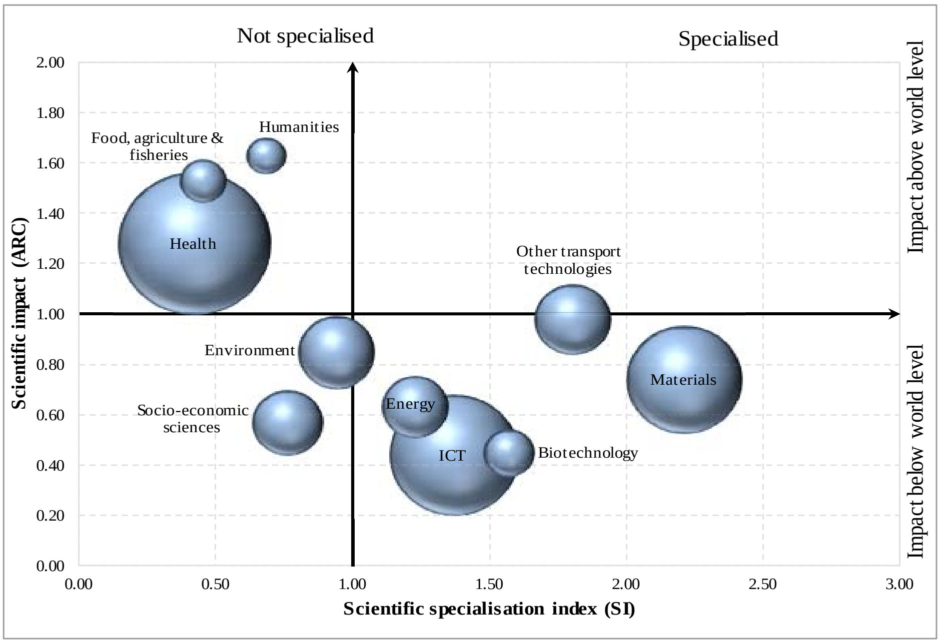
Latvia, together with Greece, Lithuania and Malta, is part of a group of countries characterised by medium-knowledge-capacity systems with a strong role in agriculture and low-knowledge-intensive services. As can be seen in the graph above, there is no sound correlation between the science and technology specialisation in general for Latvia. This could be a common characteristic among small-size countries, where in the debates regarding distribution of financial and human resources there is a continuing dilemma between a narrow specialisation with emphasis on niche areas versus a larger one which will not miss new emerging fields. Overall, the issue of critical mass remains vital for small countries in identifying priority areas.

However, there are some fields where Latvia is specialised and where it has some potential for specialisation. The country shows a good level of specialisation in materials (excluding nanotechnologies), in both science and technology, and has good potential in health, especially in the technological area. In addition, there are other areas where Latvia displays good potential for specialisation in science: environment, energy, ICT, biotechnology and other transport technologies.

In Latvia, a relative growth in technology fields have been recorded in construction, as well as good dynamics in science – measured by growth rates in publications – which can be seen in the fields of other transport technologies and ICT.

The graph below illustrates the positional analysis of Latvian 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 Latvia 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

In terms of the quality of science, Latvia portrays a slightly different picture. In the field of materials, where the country has shown specialisation in both science and technology, the quality of science does not have an impact at world level and thus it needs further improvement. On the other hand, the scientific production in health has a good quality with impact above the world level, even though the country has a low specialisation level.

A similar case is the food, agriculture and fisheries field, where Latvia has small but good scientific results while the specialisation index has a very low value. The science quality in the two fields mentioned above is apparently directly supported by good technological specialisation. Moreover, over the last period, the country has improved its scientific and technological performance both in food, agriculture and fisheries, and in health.

Other areas where Latvia could increase the level of its scientific performance are other transport technologies, and environment, where the scientific quality is good compared to the world level. There is also good potential for scientific development in ICT, biotechnology, and energy, but further steps are needed to improve the quality of the science in order to become competitive at an international level.

In fact, the new Guidelines for Science, Technologies and Innovations Development 2014-2020, approved in December 2013, include a component of the Smart Specialisation Strategy that has identified five specialisation fields offering potential for Latvia: knowledge based bio-economics, bio-medicine, medical technologies, bio-pharmacy and biotechnologies; advanced materials; technologies and engineering; smart energy; and ICT. When comparing these fields with the country's scientific potential it can be noted that they rely on specialised fields, such as ICT, materials, energy, and biotechnology, but also take into consideration the field with a good quality in scientific output (health).

Policies and reforms for research and innovation

The national R&I system faces a number of challenges:

- There is limited capacity to design, implement and coordinate R&I policy: Latvia has a complicated decision-making process for such a small country and the effectiveness of policy measures has been undermined by a lack of systematic evaluations.
- There is a lack of highly qualified scientists and engineers with pockets of excellence around few scientific areas; the number of new doctorates awarded remains low and many scientists pursue their careers abroad.
- The fragmented scientific and research infrastructure is underdeveloped and the limited R&I resources available are spread too thinly to be efficient.
- The level of commercialisation of research is low: the technology transfer contact points operating in several universities produce modest results, in part due to the incomplete legal framework for protecting intellectual property rights.
- Cooperation between businesses and academics continues to be poor: companies are barely using the research potential of universities or state research institutes and their participation in the ongoing competence centres programme is rather low.

In recent years, Latvia has taken several measures to tackle these weaknesses, the most significant of which include:

- Development of innovation financing tools to encourage innovation in the business sector, such as risk capital and seed/starting venture capital funds, mezzanine loans for risky projects;
- Development of business incubators to support new entrepreneurs across the country;
- Lowering administrative fees, simplifying administrative procedures, and reducing the time taken to register a business for entrepreneurs;
- Development of a long-term cooperation platform for enterprises and scientists – a framework for efficient cooperation between scientists and entrepreneurs in order to support joint research and to foster technology transfer.

The new Guidelines, mentioned above, have introduced a number of measures to improve the R&I system. These include the improvement of technology transfer possibilities, access to research infrastructure, development of competence centres, and introducing a new model for the management of the R&I system. Moreover, the Patent Law and the Copyright Law will ensure the protection of intellectual and industrial rights, whereas the Law on Scientific Activity will guarantee the annual increase of funding for R&I, thus strengthening the system's overall capacity.

The Guidelines also include the Smart Specialisation Strategy in part. The primary goal set in the strategy is to transform the economy towards higher-value-added products and technology-based growth. Five specialisation fields have been identified in the strategy:

1) Knowledge-based bio-economics;
2) Bio-medicine, medical technologies, bio-pharmacy and biotechnologies;

3) Advanced materials, technologies and engineering;
4) Smart energy;
5) ICT.

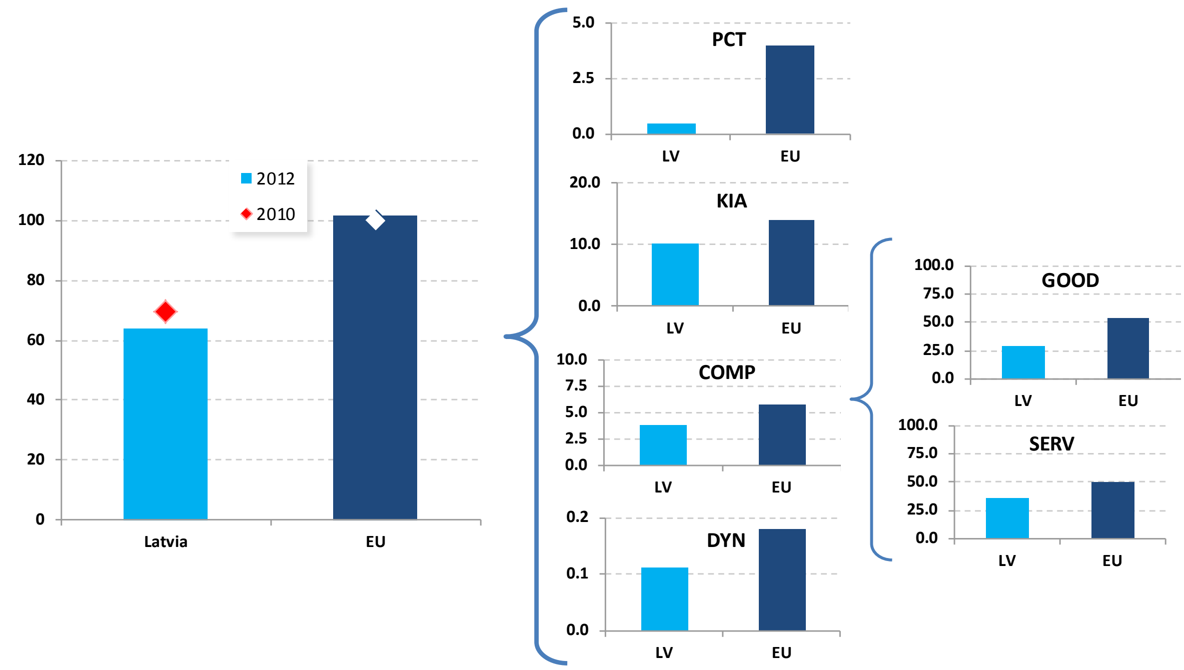
The strategy has mainly been used to focus on and plan the allocation of Structural Funds in the Partnership Agreement and Operational Programme, although the fields mentioned above are used to synchronise national budget allocations with other public resource allocations. The principles outlined in the strategy will serve as criteria for assessing the allocation of Structural Funds at the project level. The peer-review of the strategy has been scheduled for February 2014 in Latvia.

Moreover, in order to increase private investments in R&D, amendments were made in the Corporate Income Tax Law that will be applicable to costs incurred as from 1 July 2014.

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 Latvia's position regarding the different indicator components:

Latvia - 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 %).

Latvia is a low performer in the European innovation indicator. This is a result of low performance in all components – a performance which, furthermore, is declining.

The low performance in patents is linked to the country's economic structure, with a relatively small capital goods sector and the lack of large manufacturing companies, which often show high patenting activities if linked to a well-performing research system. This structure and the high export share of agricultural and wood products also explain the low export share of medium-high/high-tech goods.

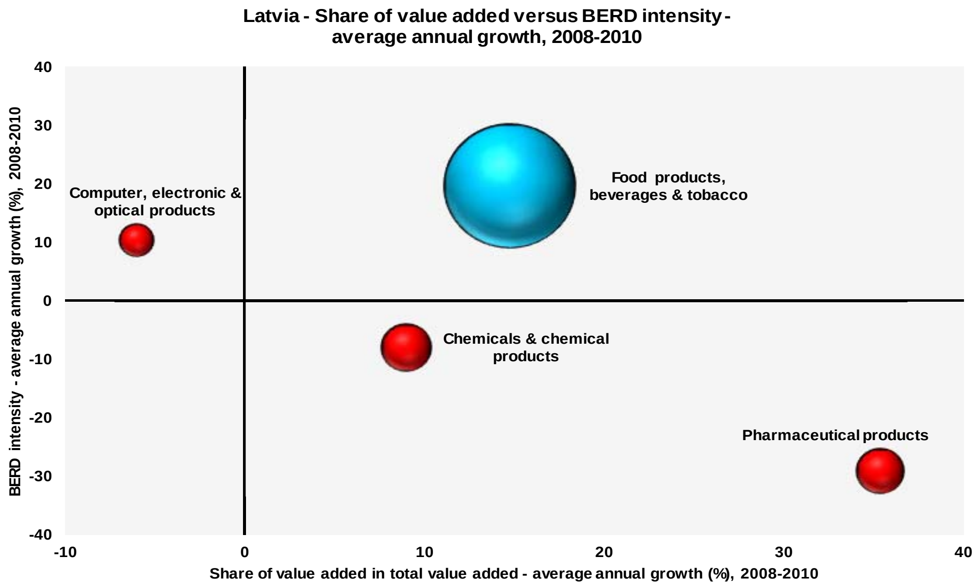
Agriculture, construction, and transport are relatively important sectors of the Latvian economy, contributing to a low share of employment in knowledge-intensive activities.

Freight transport services (transit traffic to/from Russia) such as pipeline, rail and road, and auxiliary transport services linked to sea transport – none of which are classified as KIS – play a key role in Latvian service exports. Combined with a lack of specialisation in KIS, this leads to a relatively low share of knowledge-intensive service exports.

Latvia performs at a low level as regards the innovativeness of fast-growing enterprises. This is the result of a high share of employment in low-tech manufacturing, construction, and transport companies among the fast-growing enterprises.

Upgrading knowledge and technologies in the manufacturing sector

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

The contribution of manufacturing to Latvia's total gross value added (14.5 % in 2012) has slightly increased compared to last year but is still lower than the EU average (15.2 % in 2012).

Based on the available data, in the period of 2008-2010, the food products, beverages & tobacco industry (a traditional industry) increased its contribution to Latvia's gross value added. At the same time, some more knowledge-intensive industries, such as pharmaceutical products and chemicals and chemical products, have also increased their contribution to Latvia's gross value added. Overall, the country remains specialised in sectors with low and medium-low research intensities, such as metal processing and machinery, wood and wood products, and food processing, but it is slowly moving towards more knowledge-intensive industry. Latvia's economic structure is highly biased towards small enterprises in traditional sectors, such as sawmilling and wood planing, as well as fish processing.

According to the results of the 2012 EU Industrial R&D Investment Scoreboard, there are no Latvian companies in the top 1000 EU companies listed by publication, highlighting the fact that there are no large R&D intensive firms in the Latvian economy, which is mainly characterised by SMEs and microenterprises.

Key indicators for Latvia

LATVIA	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	0,12	0,37	0,35	0,49	0,46	0,58	0,45	1,05	0,95	14,4	*1,81*	23
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	486	:	:	482	:	:	491	4.4 [3]	495 [4]	14 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	0,18	0,23	0,35	0,19	0,15	0,17	0,22	0,19	*0,15*	*-5,2*	1,31	27
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,27	0,33	0,35	0,40	0,46	0,29	0,38	0,50	*0,51*	*4,8*	*0,74*	19
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	14,6	:	:	:	:	19,9	6,5	47,8	25
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	4,7	3,2	2,2	3,7	3,0	:	:	:	18,4	11,0	28
International scientific co-publications per million population	:	128	116	125	147	142	141	196	196	9,4	343	27
Public-private scientific co-publications per million population	:	:	:	2	2	2	3	2	:	6,2	53	28
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,9	1,0	0,9	0,7	0,8	1,2	0,5	:	:	-13,5	3,9	21
License and patent revenues from abroad as % of GDP	0,02	0,07	0,05	0,04	0,04	0,03	0,05	0,04	0,04	-1,1	0,59	23
Community trademark (CTM) applications per million population	:	14	14	26	36	27	51	50	57	17,0	152	22
Community design (CD) applications per million population	:	5	10	8	5	13	17	15	9	2,2	29	23
Sales of new to market and new to firm innovations as % of turnover	:	:	3,3	:	5,9	:	3,1	:	:	-26,9	14,4	28
Knowledge-intensive services exports as % total service exports	:	35,3	35,3	34,6	34,9	35,8	35,1	32,8	:	-1,3	45,3	14
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-14,39	-10,47	-9,59	-8,87	-6,08	-2,83	-4,98	-5,42	-4,89	-	4,23 [5]	26
Growth of total factor productivity (total economy) - 2007 = 100	81	99	100	100	95	84	86	88	91	-9 [6]	97	26
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	31,7	:	:	:	:	37,6	3,5	51,2	21
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	8,2	9,1	9,6	8.9 [7]	10,4	8,2	13,9	21
SMEs introducing product or process innovations as % of SMEs	:	:	14,4	:	17,2	:	14,3	:	:	-9,0	33,8	26
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,03	0,00	0,07	0,02	0,00	0,04	:	:	:	32,0	0,44	24
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,34	0,41	0,16	0,18	0,11	0,32	:	:	:	34,2	0,53	13
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	63,5	70,3	73,5	75,2	75,8	67,1	65,0	66,3 [8]	68,1	-4,7	68,4	15
R&D Intensity (GERD as % of GDP)	0,45	0,56	0,70	0,60	0,62	0,46	0,60	0,70	*0,66*	*2,0*	*2,07*	25
Greenhouse gas emissions - 1990 = 100	38	42	44	46	45	42	47	45	:	-2 [9]	83	2 [10]
Share of renewable energy in gross final energy consumption (%)	:	32,3	31,1	29,6	29,8	34,3	32,5	33,1	:	2,8	13,0	2
Share of population aged 30-34 who have successfully completed tertiary education (%)	18,6	18,5	19,2	25,6	27,0	30,1	32,3	35,9 [8]	37,2	8,1	35,7	16
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	14,4	14,8	15,1	15,5	13,9	13,3	11,6 [8]	10,6	-4,1	12,7	16 [10]
Share of population at risk of poverty or social exclusion (%)	:	46,3	42,2	35,1	34,2 [11]	37,9	38,2	40,1	36,2	1,4	*24,8*	26 [10]

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

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

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

(2) EU average for the latest available year.

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

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

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

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

(7) Break in series between 2011 and the previous years. Average annual growth refers to 2008-2010.

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

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

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

(11) 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 for a more integrated and comprehensive research system also by concentrating financing towards internationally competitive research institutions."

Lithuania

Developing a stronger and thematically focused science base

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Lithuania. 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: 0.90 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +2.2 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[7] 2012: 14.1 (EU: 47.8; US: 58.1) 2007-2012: +1.2 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 57.9 (EU: 101.6)	*Knowledge-intensity of the economy*[8] 2012: 32.7 (EU: 51.2; US: 59.9) 2007-2012: +1.7 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Other transport technologies (other than automobiles and aeronautics), construction technologies, energy, and food	*HT + MT contribution to the trade balance* 2012: -0.8 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

The main strengths of Lithuania's research and innovation system remain the size of its public research sector and the good supply of new graduates. The weaknesses reveal scarce private and public R&D investments undertaken in a dispersed way and currently not linked to a smart specialisation strategy.

The country remains well below its 2020 R&D intensity target of 1.9 % of GDP, at least half of which is planned to come from private investments. R&D intensity is very limited in the business sector: almost three-quarters of all R&D expenditure in Lithuania is performed by the public sector. The low share of medium-tech and high-tech industries, low numbers of knowledge-intensive start-ups and the low rate of entrepreneurship have made it difficult for the private sector to reach the national commitment to the R&D target. Public R&D intensity has grown in recent years and, at 0.66 % in 2012, is no longer far from the EU average (0.74 %).

However, this is due to several major programmes funded by the Structural Funds, while the allocation to R&D from the national budget has declined significantly since 2007. Public R&D funding has become excessively dependent on the Structural Funds and it will not be possible to consolidate and further develop the public research system without increased national support for the basic functioning of the scientific institutions. Lithuania's science base is insufficiently competitive and is not well connected to European networks. There is an overall lack of knowledge transfer and the country's business environment is not geared towards facilitating innovation and entrepreneurship. Business

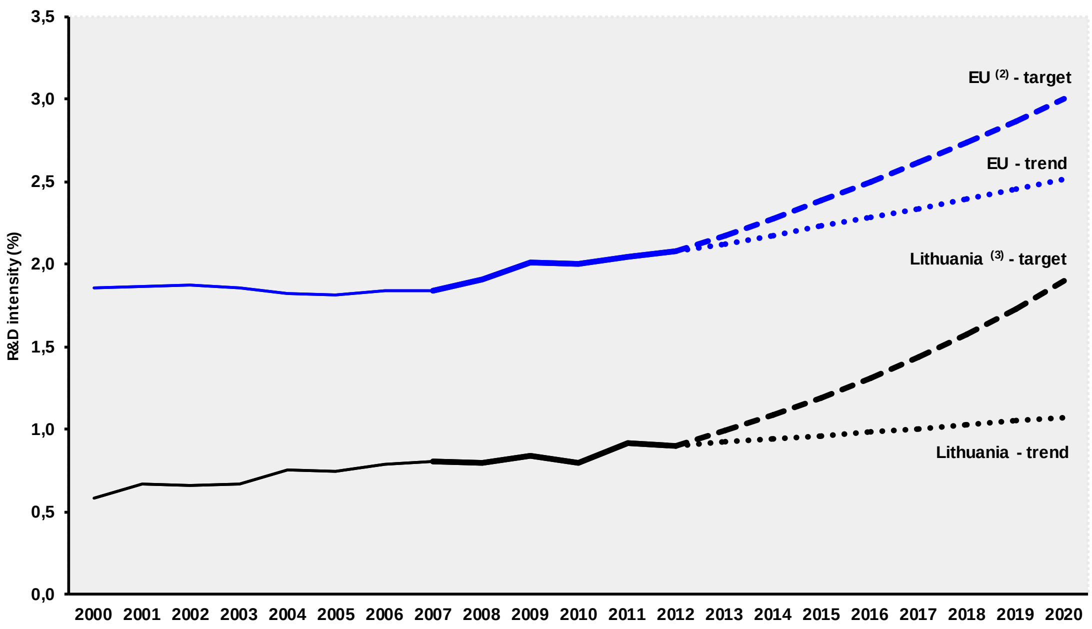
[7] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[8] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation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

investment in R&D will only improve if the quality, relevance and openness to the private sector of both the science base and higher education in Lithuania increase.

Reforms linked to the European Research Area agenda have been driven towards removing obstacles in relation to the transnational collaboration of R&D teams, fostering the competitive allocation of research funding based on peer review, a more open and merit-based market for hiring researchers, notably in the public sector, as well as ensuring support to those public research organisations putting gender equality strategies in place. Nonetheless, strong weaknesses remain to be addressed. Lithuania needs to ensure the effective use, management and financing of large research infrastructures and the relevance of focusing the country's science and technology strengths in those areas linked to the societal challenges where Lithuania has the greatest potential to increase its economic impact. Improving the country's capacity to exploit R&I results commercially will not just require developing a business environment prone to innovation but will also need a better skills base in higher education with the right incentives for researchers in the public sector to engage in knowledge transfer and commercialisation activities.

Investing in knowledge

Lithuania - 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) LT: The projection is based on a tentative R&D intensity target of 1.9% for 2020.

Following a substantial increase in Lithuania's R&D intensity in 2011, progress slowed in 2012 and the country remains well below its 2020 target. In 2012, R&D intensity reached 0.9 % of GDP, which is less than half of Lithuania's R&D intensity target of 1.9 % for 2020. Most of R&D intensity continued in the public sector and is due to progress in implementing R&D-related projects financed with EU Structural Funds. The business sector finances only about 26 % of total R&D expenditure, which is one of the lowest shares of business funding in the EU. The economic crisis hit the national R&D budget, which was cut by around 20 % between 2007 (LTL 503.1 million) and 2010 (LTL 407.5

million). It increased slightly in 2011 (LTL 435.6 million) and fell again in 2012 (LTL 412.6 million). Overall, the share of the R&D budget in total government expenditure fell back from 1.07 % in 2004 to 1.01 % in 2012. Lithuanian R&D intensity is planned to reach 1.9 % by 2020, at least half of which should be contributed by business investments.

Continuity in public funding of R&D has been ensured by Structural Funds and with a good absorption rate. Of the EUR 6.8 billion of Structural Funds allocated to Lithuania over the 2007-2013 programming period, around EUR 1 billion (14.6 % of the total) related to RTDI[9]. In 2011-2012, Lithuania simplified the use of Structural Funds in favour of RTDI. The forecast of R&D intensity for 2014-2020 is maintaining the same trend – i.e. to keep the EU Structural funds as the key funding source across a large set of schemes and instruments.

Lithuania also benefited by about EUR 55 million from the EU's Seventh Framework Programme (FP7). In the period 2007-2013, 410 participants received funding from FP7 which indicates a good success rate for Lithuanian applicants (20.19 % vs. 21.89 % for the EU average). This success rate places Lithuania 15th among the EU-28. In terms of requested EC financial contribution, the success rate is 14.75 %, putting Lithuania in 16th place. Additional government support for investment in R&D and in new technologies is being provided through R&D tax incentives, which have been in place since 2008.

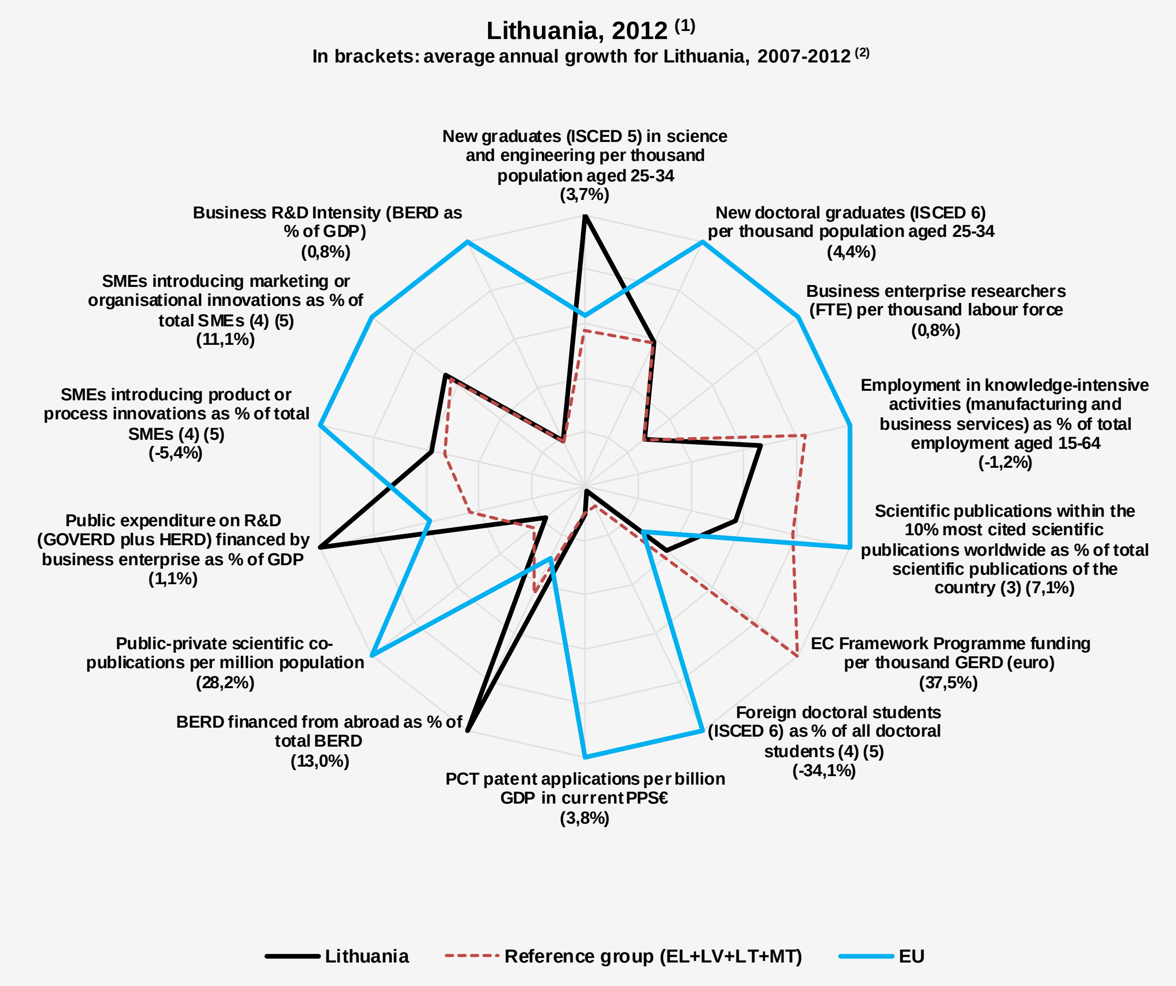
In 2012, business R&D as a percentage of total GDP amounted to only 18 % of the EU-28 average. Following some progress in the early 2000s, business R&D intensity hardly changed between 2006 (0.22 %) and 2012 (0.24 %). It was seriously affected by the economic crisis, hitting the lowest point of 0.19 % in 2008, but started to rise slowly in 2009 and is currently at 0.24 % for the second consecutive year. Business R&D intensity has been most affected in the services sector with a fall of 19 % in nominal terms between 2008 and 2009. On the other hand, it increased in the manufacturing sector by 13.5 % in the same period[10].

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

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

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

[10] Data from Eurostat, Business R&D expenditure (BERD) by economic activity based on the company's 'main activity'.



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 included in the reference group.
(5) EU does not include EL.

Lithuania's performance faces challenges in all four dimensions (human resources, scientific production, technology development, and innovation), for most of the main R&I indicators. Particular strengths are the number of new graduates in science and engineering (S&E) per population aged 25-34 years, public expenditure on R&D financed by business enterprises, and the financing of business R&D expenditure from abroad (mainly EU Structural Funds). The level of patenting activities and public-private collaboration are both very low and require improvement. Although business financing of university research appears to be relatively strong, the number of researchers employed by business remains low with only a small increase over the period 2007-2012.

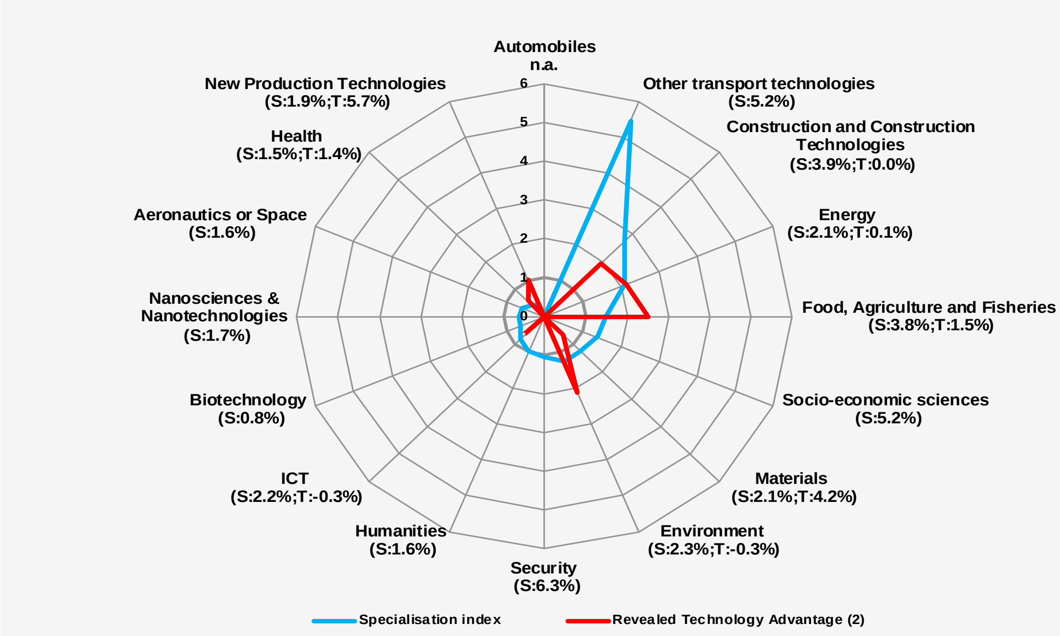
This leads to two observations: (i) Lithuania's R&D relies to a larger extent than the EU average on EU funds, be it Structural Funds or FP7 funding; (ii) a large share of the young population receives tertiary education in S&E in Lithuania, which is also reflected in the good share of total knowledge-intensive activities in total employment in the country. However, at the doctoral level, the number of new doctoral graduates per thousand population aged 25-34 years is considerably below the EU average, indicating that doctoral studies and Lithuania's research system are less attractive to students.

Lithuania's scientific and technological strengths

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

Lithuania 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.

Lithuania, together with Greece, Latvia and Malta, is classified as a medium-knowledge-capacity system with a strong role being played by agriculture and low knowledge-intensive services[11]. In general, there is no sound correlation between science and technology specialisation for Lithuania, and overall the issue of critical mass remains vital in identifying priority areas. Patenting activity in the country is generally extremely low and does not show any statistically significant technological specialisation.

Comparison of the scientific and technological specialisation in selected thematic priorities reveals a mixed situation with some co-specialisations as well as some mismatches. In terms of volume of scientific publications, Lithuania performs best in other transport technologies (i.e. transport other than automobiles and aeronautics), but the field is not supported by patenting activity. The scientific co-

[11] Innovation Union Competitiveness report, 2013

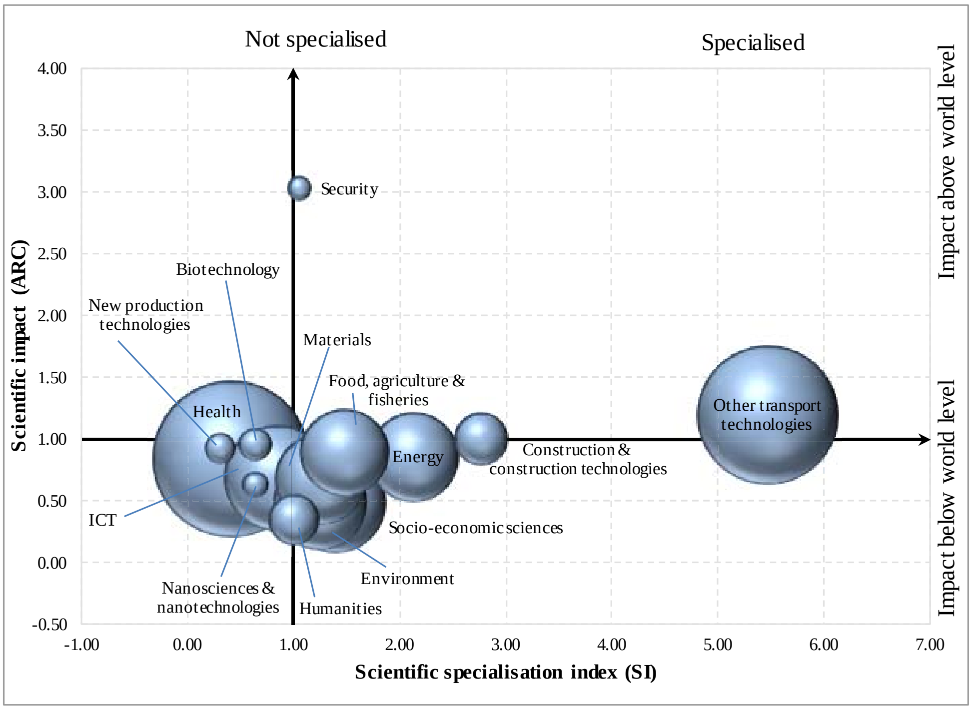
specialisation exists in some sectors, such as construction and construction technologies, energy, food, agriculture and fisheries, and the environment.

The recently defined Lithuanian R&I priorities for smart specialisation identify six broader priority areas, each with two to four specialisations – specific priorities, which include sectors with important innovation potential: energy and sustainable environment, health technologies and biotechnologies, agro-innovation and food technologies, new processes, materials and technologies, transport, logistics and ICT, and creative society.

Relative growth in technology fields has been recorded in new production technologies and materials. However, the figures should be considered carefully because of the small number of patent applications. Policy decisions at national level could consider further supporting science in these fields in order to match the technology developments. Overall, scientific activity shows a positive dynamic as measured by growing numbers of publications, with significant improvements in the fields of security and other transport technologies[12].

The graph below illustrates the positional analysis of Lithuanian 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 Lithuania 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

In terms of the quality of scientific results, Lithuania is below the world level in almost all specialisations related to the thematic priorities. Exceptions to this are the security and other transport

[12] Innovation Union Competitiveness report, 2013

technologies. The security field indicates scientific results of high quality with a low number of publications. In the case of other transport technologies, the quality of science is slightly above the world level but scientific production is much larger, being the second biggest in the country (after health). Therefore, there is room for improvement in the scientific quality of results in Lithuania. The food, agriculture and fisheries sectors lead the country's technological specialisation index list while, at the same time, occupying a modest position in scientific specialisation and scientific impact dimensions. Lithuania could probably benefit from fostering a scientific specialisation in the latter.

Policies and reforms for research and innovation

Lithuania has been carrying out reforms in its R&I system since the end of the last decade. These ongoing reforms are far-reaching and on the whole drive the research system towards what is accepted as international good practice. A number of reforms have been geared towards strengthening public-private R&D collaboration and commercialisation (e.g. setting up innovation vouchers and backing industrial PhDs). Furthermore, recent initiatives have been implemented to strengthen knowledge transfer (e.g. consultancy support for knowledge and technology transfer). These are boosting the exploitation of research results, and encouraging the use of new financial instruments, including debt and equity finance, with a series of business accelerators and seed and venture capital funds to support the creation and growth of innovative firms, although their contribution remains very modest. Measures have been taken to both facilitate and lower the costs of starting new businesses. These include, in particular, a very successful business voucher scheme and a legal entity called 'small partnership'.

Autonomy and a new mode of governance have been given to universities. The network of public research institutions has been reorganised and rationalised. The share of project-based funding has risen considerably and institutional funding is increasingly being allocated in relation to the performance of research institutions. Researchers' salaries have increased and dedicated schemes to attract local and international talent are now being implemented.

The creation and development of five clusters (called 'valleys') integrating higher-education institutions, research institutions and businesses around a number of scientific and technological areas is intended to strengthen links between higher education, science and businesses and improve knowledge transfer and the valorisation of research results in the country. However, these clusters have still to be used efficiently and with the necessary scale and scope to support scientists and business innovation activities.

Recently, three main programmes were adopted with the overall aim of enhancing the country's R&I potential:

- The Programme for the Development of Studies, Research and Experimental (social and cultural) Development for 2013–2020 aims to encourage the sustainable development of people and society, thereby improving the country's competitiveness and creating conditions for innovation by developing higher education and implementing studies, and R&D development;

- The Innovation Development Programme for 2014-2020 aims to promote the development and implementation of innovative products and technologies, the creation and internationalisation of value chains, and to foster public-sector innovation;

- The Programme for the Development of Priority Areas of Research and Experimental (social and cultural) Development and Innovation (smart specialisation) and Implementation of Priorities will develop the priority fields of R&D&I and implement their specialisations with the aim of achieving structural changes in the Lithuanian economy. This will determine the impact of the growth of high-value-added, knowledge and highly skilled labour-intensive economic activities on the country's GDP. During implementation of this programme, 20 action plans will be launched in close cooperation with adequate ministries and services.

Since public R&D funding has become excessively dependent on Structural Funds, it will not be possible to foster consolidation and further development of the public research system without increasing national support for the basic functioning of scientific institutions. The forecast for 2014-2020 relies on the same trend to maintain the EU Structural Funds as the key funding source through a large set of schemes and instruments. Such excessive dependency is not in line with the principles of the Structural Funds.

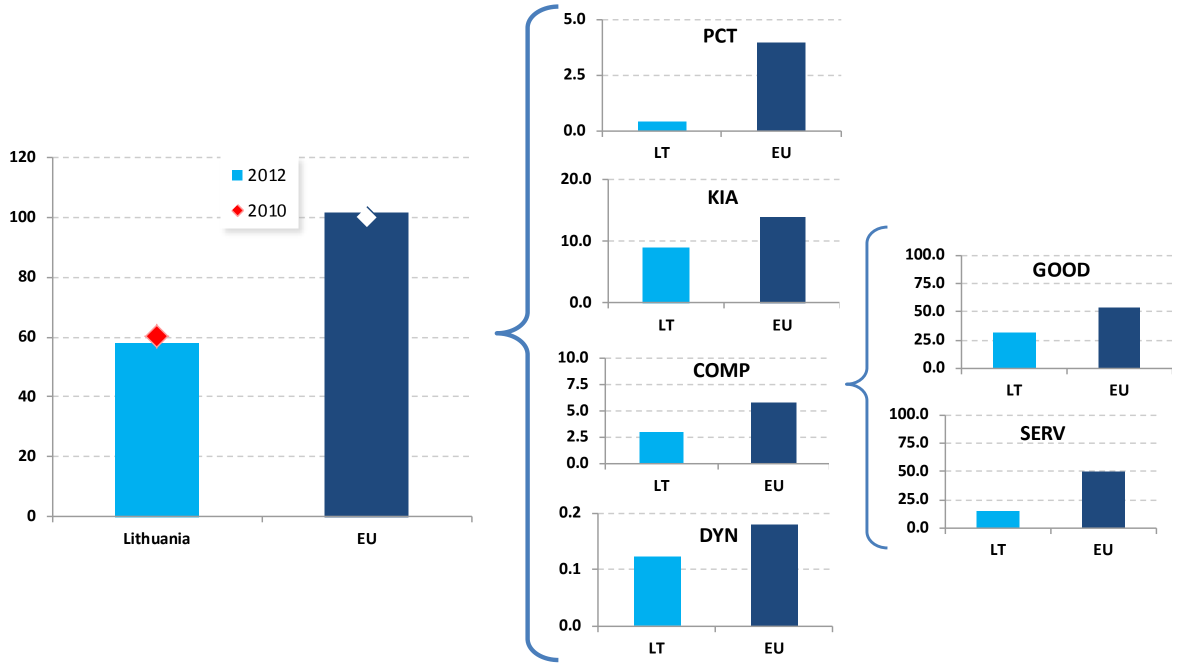
In addition to the existing innovative public procurement scheme, initial steps are being taken to facilitate the pre-commercial procurement of R&D. The plan is to develop a legal basis model towards the end of 2014 which should allow public authorities to use up to 5 % of their procurement budgets to purchase R&D-related products and services.

Government policy towards transnational collaboration, the internationalisation of science, and opening the national research system to researchers from other countries is still underdeveloped. The lack of strategic R&I internationalisation policy is impeding the internationalisation of quality Lithuanian research. The absence of policy relating to opening up the national research system stems from the need to first address the national problems related to unattractive career paths for researchers and limited research capacity. ERA priorities are only formally addressed and attention must be paid to the objectives of transnational collaboration, an open market for researchers, gender equality and mainstreaming.

Innovation Output Indicator

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

Lithuania - 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 %).

Lithuania is a low performer in the European innovation indicator, resulting from its low performance in all components. Furthermore, the country's performance is not improving.

The low performance in patents is linked to its economic structure with a lack of large manufacturing companies in technology-intensive sectors which, in certain fields, typically show high patenting activities. This structure, the lack of a sizeable car, pharmaceutical or machinery industry, and the high export share of agricultural products and food all explain the low score as regards the export share of medium-high/high-tech goods.

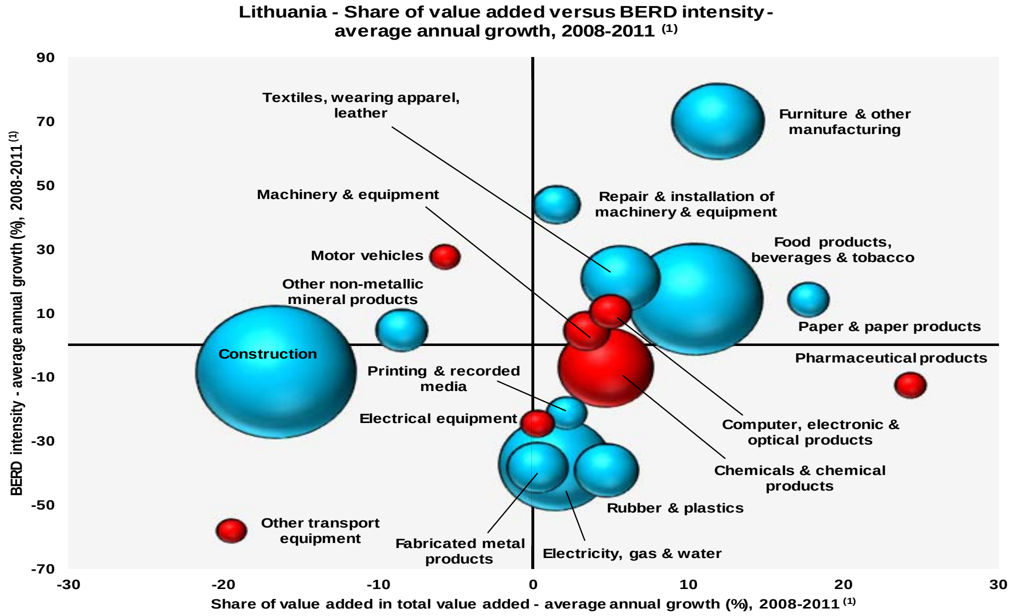
Relatively high employment in agriculture, construction, and transport is contributing to a low share of employment in knowledge-intensive activities.

Lithuania has one of the lowest shares of knowledge-intensive service exports among EU countries. This is explained both by the low volume of KIS exports and by the high level of non-KIS transport services exports (road transport, rail transport, and auxiliary transport services).

Lithuania performs at a low level regarding the innovativeness of fast-growing firms. This is the result of a high share of employment in low-tech manufacturing, transportation, and construction companies among fast-growing enterprises.

Upgrading the manufacturing sector through research and technologies

The graph below illustrates the upgrading of knowledge in different manufacturing industries for the period of 2008-2011. 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. The sectors above the x-axis are those where research intensity has increased over time. The size of the bubble represents the sector share (in value added) in manufacturing (for all sectors presented on the graph). The red sectors are high-tech or medium-high-tech sectors.



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Furniture and other manufacturing': 2009-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The graph above shows that Lithuania's manufacturing industry is dominated by low-tech and medium-low-tech sectors, which are intrinsically less research intensive than high-tech and medium-high-tech sectors (coloured in red). The only sizeable medium-high-tech sector is chemicals although in recent years it has received fewer business R&D investments and now accounts for less weight in the economy. All other high-tech and medium-high-tech sectors in Lithuania are small and import and re-export comprises a large part of the activity for some of them. As a result, the structure of this sector limits the overall level of business R&D intensity in the country. The graph includes data on the crisis in 2009-2010 which affected some sectors – notably, the construction sector has declined significantly since that period. Two sizeable sectors enjoyed positive growth trends during 2008-2011: food products, beverages and tobacco, and furniture and other manufacturing.

Structural change towards a more research-intensive economy is being driven mainly by high-tech and medium-high-tech manufacturing sectors. In Lithuania, no clear trend emerged for these sectors for the period 2000-2011: in the economy, the weight of some of these sectors increased (machinery and equipment, pharmaceutical products, and computer, electronic and optical products), while others decreased (motor vehicles). In the case of the other transport equipment sector, in the period 2008-2011, the share of both business investments and value added showed a significant declining trend. In the high-tech and medium-high-tech sectors, the research intensity has increased in the sectors of motor vehicles, computer, electronic and optical products, and machinery and equipment, but has fallen in the remaining sectors (chemicals and chemical products, pharmaceutical products, and electrical equipment).

The total effect of the evolution of the high-tech and medium-high-tech manufacturing sectors on overall business R&D intensity in Lithuania has been limited. The chemical sector is clearly the most important medium-high-tech/high-tech sector in Lithuania in terms of size, although in terms of evolution its importance has decreased (positive evolution in economic weight and fluctuating research intensity).

Key indicators for Lithuania

LITHUANIA	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	0,87	0,71	0,75	0,86	0,88	0,96	1,00	0,92	1,07	4,4	*1,81*	20
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	486	:	:	477	:	:	479	-7.6 [3]	495 [4]	20 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	0,13	0,15	0,22	0,23	0,19	0,20	0,23	0,24	*0,24*	*0,8*	1,31	24
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,46	0,60	0,57	0,58	0,61	0,63	0,56	0,67	*0,66*	*2,7*	*0,74*	12
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	13,3	:	:	:	:	14,1	1,2	47,8	27
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	3,3	4,9	5,4	6,1	6,2	:	:	:	7,1	11,0	19
International scientific co-publications per million population	:	168	181	202	228	238	236	290	304	8,5	343	24
Public-private scientific co-publications per million population	:	:	:	4	5	7	8	10	:	28,2	53	23
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,2	0,4	0,3	0,4	0,6	0,3	0,4	:	:	3,8	3,9	24
License and patent revenues from abroad as % of GDP	0,000	0,01	0,002	0,0004	0,002	0,001	0,002	0,002	0,009	83,1	0,59	26
Community trademark (CTM) applications per million population	0,3	11	21	21	34	35	31	46	69	27,4	152	20
Community design (CD) applications per million population	:	2	1	1	3	3	5	5	11	55,2	29	22
Sales of new to market and new to firm innovations as % of turnover	:	:	12,4	:	9,6	:	6,6	:	:	-16,8	14,4	27
Knowledge-intensive services exports as % total service exports	:	14,3	12,3	11,8	12,2	15,6	13,8	12,5	:	1,5	45,3	27
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-5,87	-5,79	-5,83	-5,11	-2,30	-1,62	-1,10	-1,27	-0,85	-	4,23 [5]	22
Growth of total factor productivity (total economy) - 2007 = 100	76	96	98	100	99	86	93	97	98	-2 [6]	97	9
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	30,1	:	:	:	:	32,7	1,7	51,2	25
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	7,5	8,1	9.4 [7]	8,9	9,2	-1,2	13,9	25
SMEs introducing product or process innovations as % of SMEs	:	:	19,7	:	21,9	:	19,6	:	:	-5,4	33,8	23
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,03	0,00	0,00	0,01	0,00	0,02	:	:	:	32,0	0,44	27
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,01	0,03	0,02	0,06	0,04	0,08	:	:	:	15,9	0,53	21
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	65,6	70,6	71,6	72,9	72,0	67,2	64,3 [7]	66,9	68,5	3,2	68,4	13
R&D Intensity (GERD as % of GDP)	0,59	0,75	0,79	0,81	0,80	0,84	0,79	0,91	*0,90*	*2,2*	*2,07*	19
Greenhouse gas emissions - 1990 = 100	40	48	49	54	51	42	43	44	:	-9 [8]	83	1 [9]
Share of renewable energy in gross final energy consumption (%)	:	17,0	17,0	16,7	18,0	20,0	19,8	20,3	:	5,0	13,0	9
Share of population aged 30-34 who have successfully completed tertiary education (%)	42,6	37,9	39,4	38,0	39,9	40,6	43,8	45,7	48,6	5,0	35,7	4
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	16,5	8,1	8,2	7,4	7,4	8,7	7,9	7,4	6,5	-2,6	12,7	6 [9]
Share of population at risk of poverty or social exclusion (%)	:	41,0	35,9	28,7	27,6	29,5	33,4	33,1	32,5	2,5	24,8	24 [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) EU is the weighted average of the values for the Member States.
(6) The value is the difference between 2012 and 2007.
(7) Break in series between 2010 and the previous years. Average annual growth refers to 2010-2012.
(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.

Luxembourg

The challenge of fostering the emergence of a genuine R&I ecosystem

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Luxembourg. 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: 1.46 % (EU: 2.07 %; US: 2.79 %) 2007-2012: -1.6 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[13] 2012: 23.5 (EU: 47.8; US: 58.1) 2007-2012: +1.6 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 116.4 (EU: 101.6)	*Knowledge-intensity of the economy*[14] 2012: 68.1 (EU: 51.2; US: 59.9) 2007-2012: +1.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Environment	*HT + MT contribution to the trade balance* 2012: -4.4 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

Luxembourg has rapidly built up its public research capacities from a situation where, 30 years ago, the public research system was non-existent: the oldest public research centres were set up in 1987 and the University of Luxembourg was established in 2003. Public sector R&D intensity steadily increased from 0.12 % of GDP in 2000 to 0.46 % of GDP in 2012 but still remains well below the EU average of 0.74 %. Luxembourg's scientific performance, as measured by the share of its scientific publications which are among the top 10 % most-cited publications worldwide (12.4 %, above the EU average of 11 %) is impressive considering that its public research system has only been in existence since the mid-1980s.

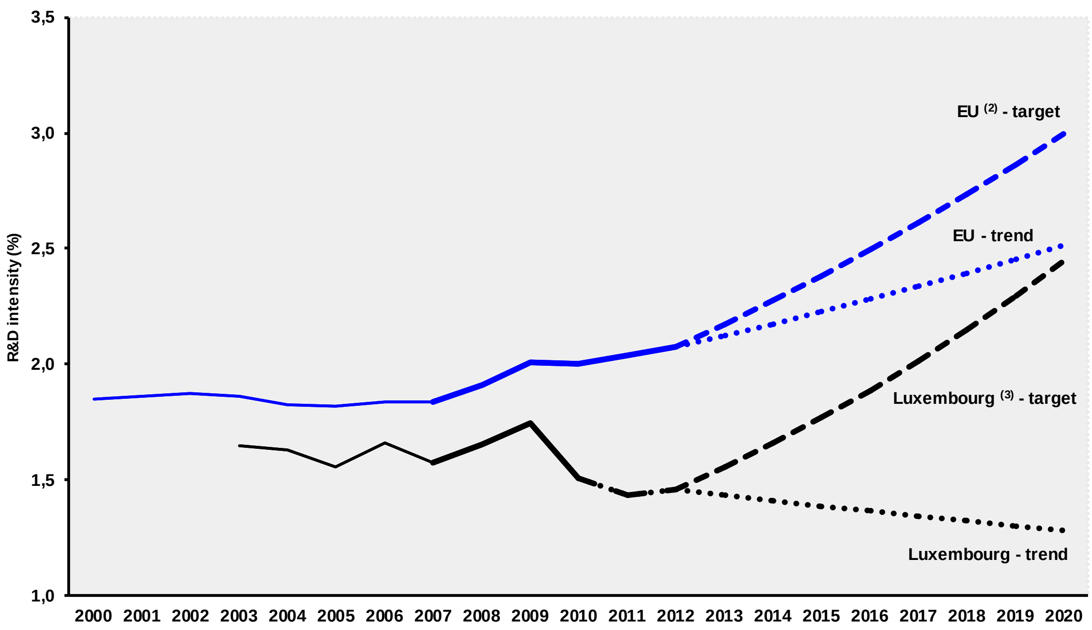
However, as reflected in the decline in business R&D intensity (from 1.53 % in 2000 to 1.00 % in 2012) and in the limited level of cooperation between public research institutions and firms, the Luxembourgish R&I ecosystem remains very weak. Its public components are not yet able to play a decisive role in fostering innovation-led growth. While the prosperity of the Luxembourgish economy in recent decades has been based on the expansion of the financial sector, its significant dependence on this sector creates a strong structural risk. In addition to its 'sovereignty niches', upon which the financial sector's expansion is based, crucially, the Grand Duchy needs to develop 'competence niches' as a springboard for innovation-led growth.

[13] 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.
[14] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

The government's resolve to make investment in RDI part of a long-term policy for Luxembourg's economic development and diversification has been translated into continued budgetary efforts. R&D project-funding targets thematic priorities selected through a Foresight exercise. Many actions are developed to foster public-private cooperation and more generally business R&D and innovation, including, for instance, a cluster programme, the setting up of business incubators, and the specification of IP/spin-off requirements in the performance contracts of public research organisations.

Investing in knowledge

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2007-2010 in the case of Luxembourg.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) LU: The projection is based on a tentative R&D intensity target of 2.45% for 2020.

Luxembourg is not at all on track to reach its R&D intensity target for 2020 of 2.3 % to 2.6 %, as its R&D intensity reveals a declining trend. This is explained by the sharp decrease in business R&D intensity (from 1.53 % of GDP in 2000 to 1.00 % in 2012). Conversely, public sector R&D intensity steadily increased from 0.12 % in 2000 to 0.46 % in 2012. This fourfold increase reflects the willingness of the Grand Duchy to build up its public research capacities from a situation where, 30 years ago, the public research system was non-existent. Public efforts to support R&D have continued in recent years but at a more moderate pace since 2009: between 2009 and 2012, the government budget for R&D increased in real terms by 16 %. In 2012, for the first time, the government budget for R&D caught up with the EU average in percentage of total government expenditure (1.4 %). However, if Luxembourg is to reach its 2020 R&D intensity target, the private sector's contribution should rise: 48 % of Luxembourgish private investment in R&D is made in the manufacturing sector, compared to 19 % in financial services and about 33 % in other services[15]. The level of R&D investment in financial services fell by 43 % between 2007 and 2012, which explains a major part of the negative trend in business R&D intensity, but not the totality.

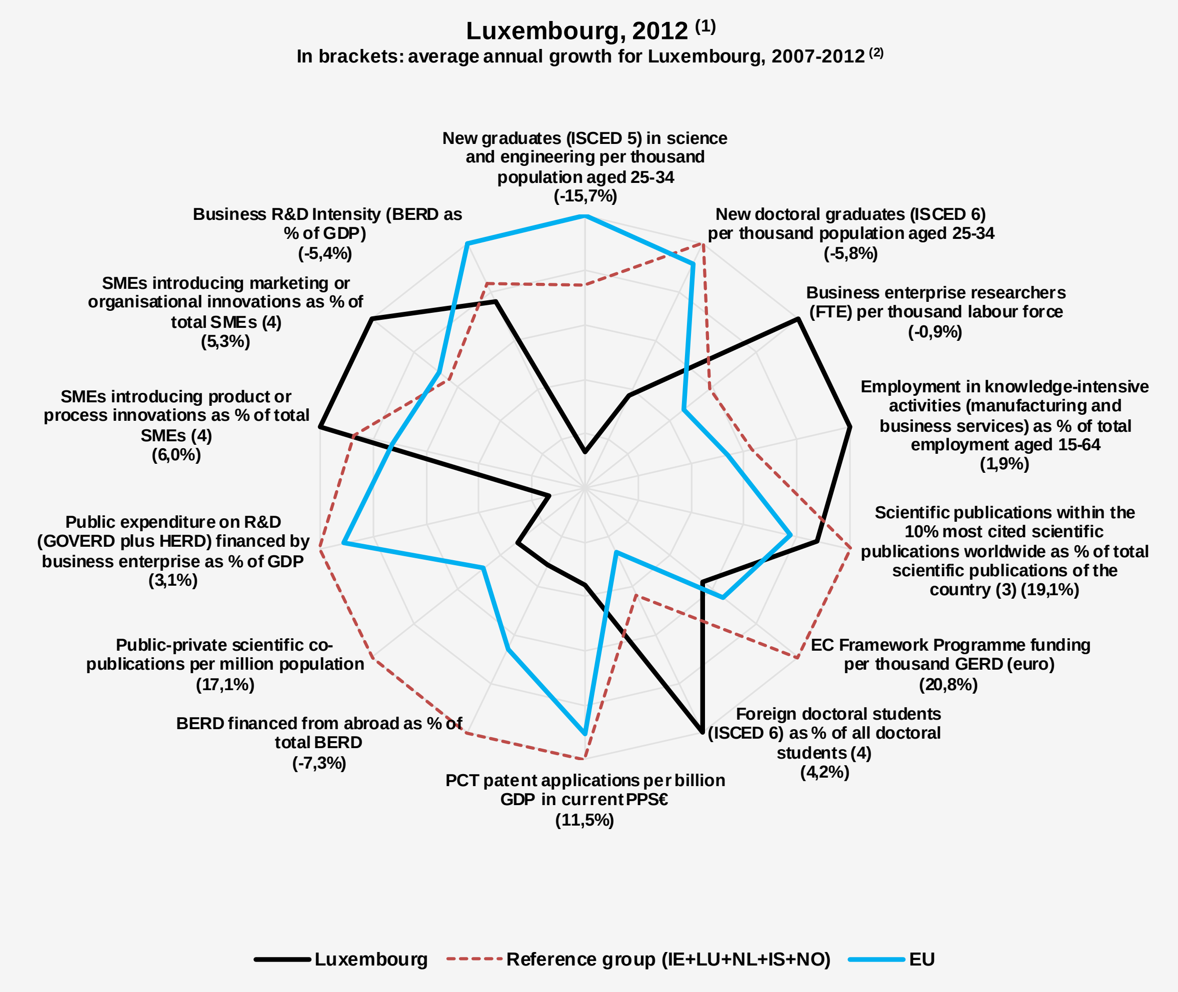
[15] However, it must be borne in mind that these other services include R&D services to the manufacturing sector.

Private and public R&D investment can also receive support via co-funding from the European budget, in particular through successful applications to the Seventh Framework Programme (FP7). A total of 191 Luxembourgish participants have been partners in a FP7 project, with a total EC financial contribution of almost EUR 40 million. The 19 % success rate of applicants is just below the EU average success rate of 22 %. As regards the Structural Funds – the other main source of EU funding for R&I – of the EUR 50 million of Structural Funds allocated to Luxembourg over the 2007-2013 programming period, around EUR 18 million (36 % of the total) related to RTDI[16].

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

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

[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 situation of Luxembourg's research system is marked by the contrast between public-sector R&D and private-sector R&D:

- The Luxembourgish public research system is very young, but is developing fast (see section Investing in knowledge above). Its scientific performance (as measured by the share of its scientific publications which are among the top 10 % most-cited scientific publications worldwide[17]) has progressed very rapidly and is now above the EU average. This is mainly due to a policy of attracting outstanding foreign researchers to work in Luxembourg.
- Despite its decline (see section Investing in knowledge above), the volume of business R&D is still quite high. This is reflected in a very high share of business enterprise researchers and a business R&D intensity which is also relatively high, taking into account the structure of the Luxembourgish economy (marked by the lowest share of manufacturing amongst all the EU Member States). This high volume is explained by the combination of significant R&D activities

[17] 12.4 % vs. an EU average of 11 %: on this indicator, Luxembourg ranks sixth among EU Member States.

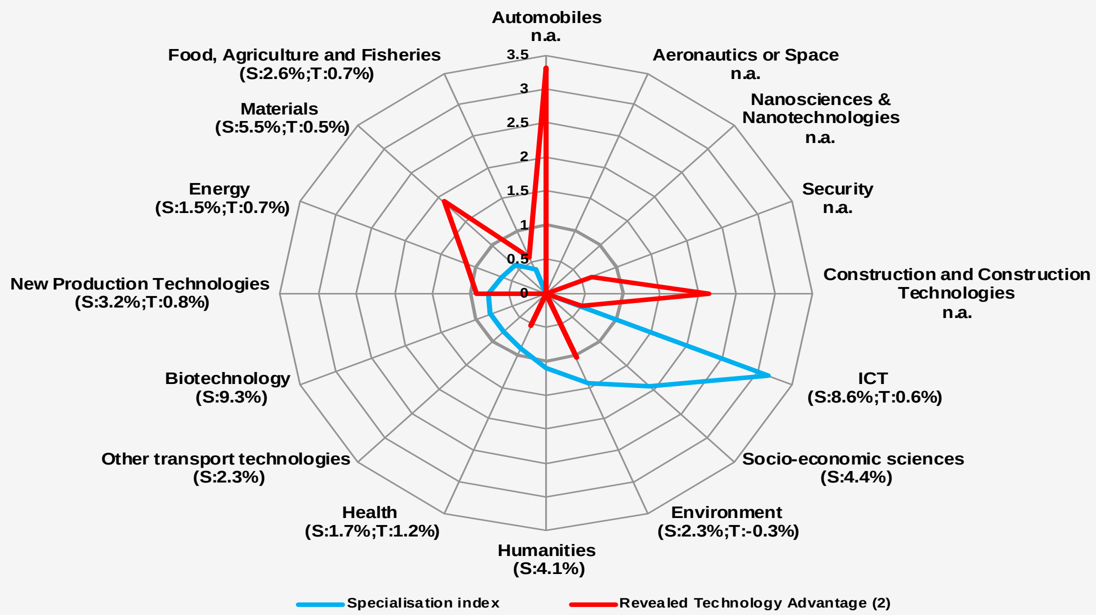
in the financial sector with the long-standing presence in the Grand Duchy of several R&D centres run by large multinational manufacturing companies (such as ArcelorMittal, Goodyear and DuPont de Nemours) and of smaller 'home-grown' technologically innovative companies (such as IEE, Paul Wurth and Rotarex).

Luxembourg's performance on the two indicators on cooperation between public research institutions and firms is well below the EU average, reflecting the current disconnect between private-sector R&D centres and the public research system.

Luxembourg's scientific and technological strengths

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

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



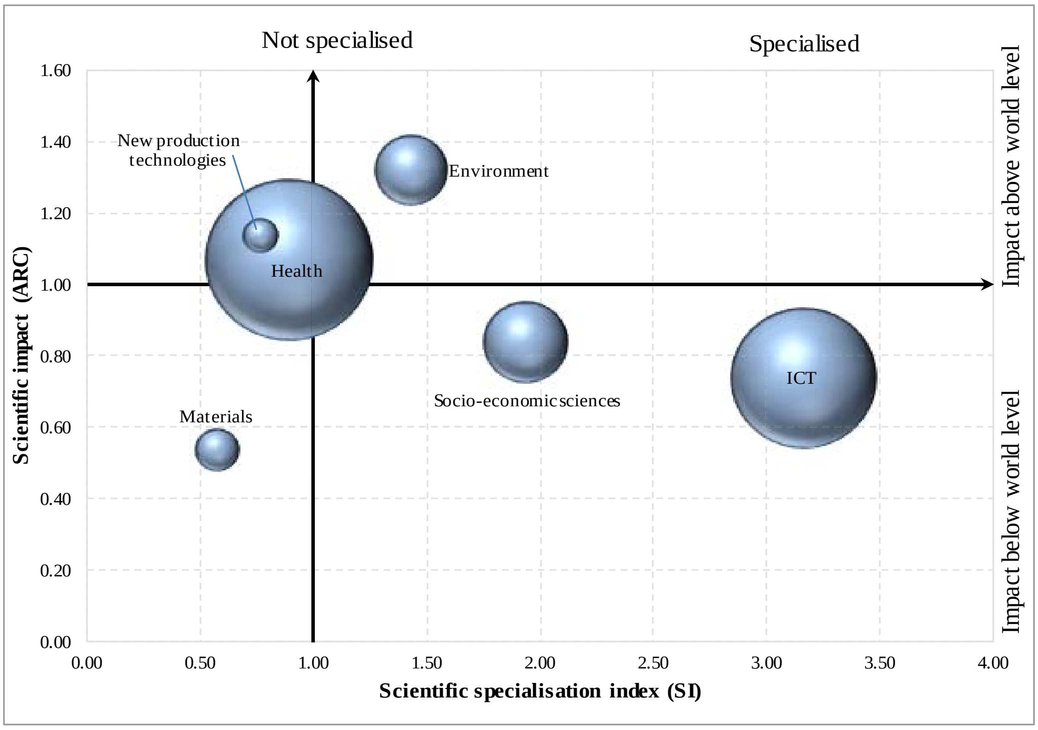
Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding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

The graph above shows a mismatch in Luxembourg between the science base (as measured through the number of publications) and the technological specialisations (as measured through the number of patents). Technological specialisation reflects business R&D activities, essentially: for instance, the very strong specialisation in automobiles reflects the presence of a very significant cluster of technologically innovative companies supplying the automotive industry (such as Delphi Automotive Systems and IEE). While Luxembourg has technological specialisations in automobiles, materials, construction, as well as to a lesser extent in energy, new production technologies, and the environment, only this last technological specialisation is supported by a corresponding specialisation in the science base. Besides environment, science base specialisations are ICT, socio-economic sciences, humanities, and health.

The mismatch between the specialisations of the public research system and those of private-sector R&D is probably a key factor behind the low level of public-private cooperation.

The graph below illustrates the positional analysis of Luxembourg's 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 Luxembourg 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

With reference to the quality of the science base, too (using as a proxy the scientific impact measured through citations), the graph above shows highly contrasting situations in various areas:

- Environment, the only sector where there is a scientific and technological co-specialisation, is also the area with the highest quality science base. This quality supports technological innovativeness, thus the situation in this theme looks very promising.

- Despite a strong science-base specialisation in ICT, its impact as measured through citations is rather low, placing a question mark over the situation in this area.

- Despite the fact that materials is a sector with major industrial R&D activities in Luxembourg, there is lack of corresponding specialisation within the science base and the quality attained so far seems low. To achieve a higher level of public-private cooperation, the strengthening of the science base in materials is probably required.

Policies and reforms for research and innovation

The steady increase in the public R&D budget between 2000 and 2009 reflects the government's resolve to make investment in RDI part of a long-term policy for Luxembourg's economic development and diversification. The country's national RDI strategy is founded on multi-annual planning and focuses on targeted priorities. Following the establishment of the public research centres (PRCs) and of the university between 1987 and 2003, key steps have included the OECD review of Luxembourg's national research system in 2006 and a Foresight Study in 2006-2007 that identified the thematic domains which now make up the CORE public research funding programme. A major outcome of the OECD review was the recommendation to implement performance contracts between the ministry and the National Research Fund (FNR), the university, the PRCs and Luxinnovation.

Two important draft laws are currently in the legislative process, with adoption expected in 2014:

- The first one aims to consolidate the public research organisations with, in particular, the merger of the Tudor and Lippmann Public Research Centres. This merger should allow for the building of critical mass in areas with major prospects for cooperation with Luxembourgish industry, such as materials and sustainable development, with some less-promising research subjects being discontinued.

- The second one aims to reform FNR, which allocates funds on a competitive basis. This reform targets better valorisation of research results, notably through enabling actions to support 'proof-of-concept'. In this context, a reform of the FNR's researchers training scheme (AFR) is foreseen. It will foster inter-sectoral (public/private) mobility.

Many initiatives have been developed to foster private R&D, public-private cooperation, innovation and entrepreneurship:

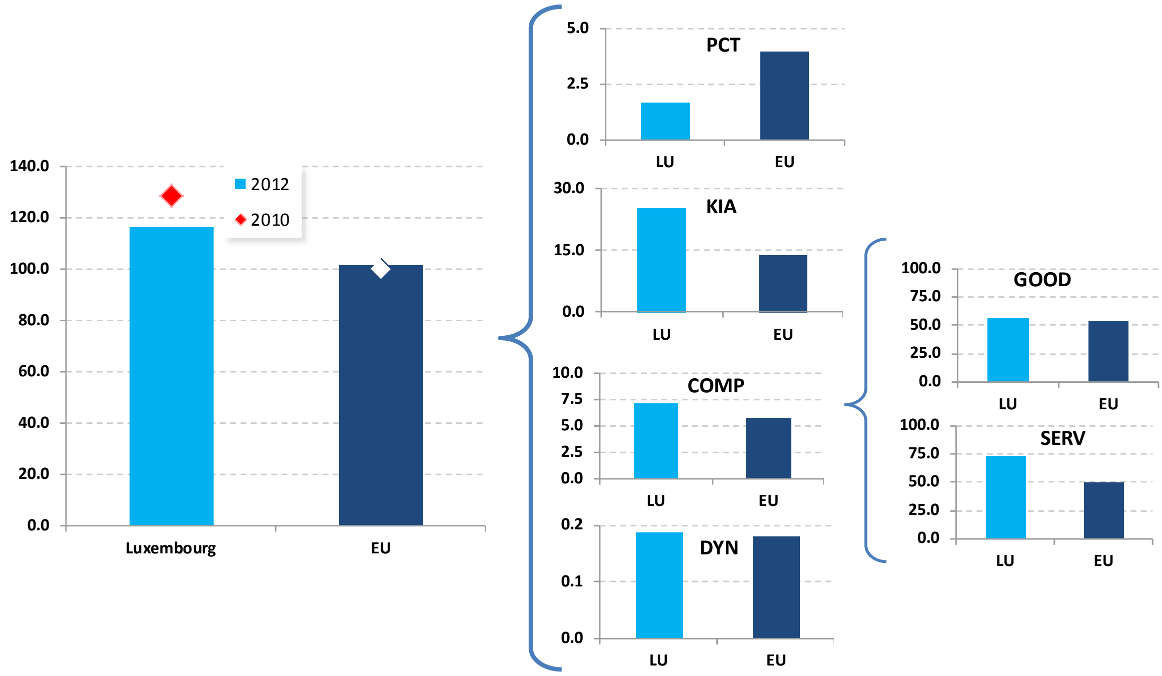
- The law of 5 June 2009 provides state aid for the private sector with a special focus on SMEs and services-sector innovation. The law of 18 February 2010 provides public aid to the private sector in the field of eco-innovation. The law on Intellectual Property (IP) tax incentives (21 December 2007) encourages companies to patent and licence the results of their R&D work, and also fosters spin-offs and start-ups based on IP.
- Measures to encourage the development of small innovative companies include: IP/spin-off requirements in PRCs' performance contracts, the creation of a Master's degree in Entrepreneurship and Innovation, the setting up of business incubators, a partnership with a business accelerator located in Silicon Valley (Plug and Play Tech Center) in order to help start-ups in Luxembourg to gain access to the United States market.
- The massive (EUR 565 million) infrastructure project Cité des Sciences aims at reinforcing relations between research, education and innovation, by hosting on one site all of Luxembourg's major public R&D institutes, as well as private and start-up companies, a new technical school, the university campus, the national archives and some cultural centres. It will provide facilities for public-private partnerships and a business incubator.
- Luxembourg has set up a cluster programme around five thematic clusters (in materials, ICT, space, bio-health, and eco-innovation). This policy was reinforced in 2013, with new missions given to clusters in relation to internationalisation and business developments as well as the setting up of a new cluster in the automotive field.

Moreover, the new government announced its intention to put in place a process to enable public research organisations and firms to develop common research agendas focused on middle- and long-term targets.

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

Luxembourg - Innovation Output Indicator



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

The country's high score on the European innovation indicator is mainly the result of its share of employment in knowledge-intensive activities which is the highest of all EU Member States (25.4 %, nearly twice the EU average) and its share of knowledge-intensive services in services exports, which is the second highest of all Member States. These situations are the result of a very strong specialisation in the financial services sector, which has been Luxembourg's main growth engine since the early 1980s. Its expansion has enabled the Luxembourgish economy to flourish despite the decline of its key manufacturing sectors, especially the steel industry. The country's good score on the DYN component is also linked to its economic structure oriented towards knowledge-intensive services, with a relatively high share of employment in fast-growing information services and financial and insurance activities.

The share of manufacturing in value added is now the lowest of all EU Member States and the limited role of high-tech and medium-tech manufacturing in the Luxembourgish economy explains the Grand Duchy's low scores on the indicator's PCT component. Nevertheless, the share of medium-high and high-tech goods in total goods exports is slightly above the EU average. This is explained by the country's role as an air-transport hub, with the high-tech goods transiting the country counted as Luxembourgish exports.

Although Luxembourg's financial sector is relatively healthy, the economy's significant dependence on this sector poses a strong structural risk. It is uncertain to what extent the financial sector will be able to continue to play such an important role in driving Luxembourgish prosperity in the future. Even if financial activities around the world remain as buoyant after the crisis as they were before it, the question arises as to whether Luxembourg will be able to preserve and continue to develop the competitive advantages, in terms of fiscal, legislative and regulatory environment, that have made it an attractive environment for this type of activity. It is therefore crucial for the Grand Duchy that, in addition to its 'sovereignty niches' upon which the financial sector expansion has been based, it also develops and strengthens 'competence niches' as a springboard for innovation-led growth.

Key indicators for Luxembourg

LUXEMBOURG	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	:	:	:	:	:	:	:	0,79	0,75	-5,8	*1,81*	25
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	490	:	:	489	:	:	490	-0.2 (3)	495 (4)	15 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	1,53	1,35	1,43	1,32	1,29	1,32	1,02	1,00	1,00	-5,4	1,31	14
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,12	0,21	0,23	*0,26*	0,37	0,42 (5)	0,49	0,44	0,46	2,8	*0,74*	21
Venture Capital as % of GDP	:	:	:	0,18	1,11	0,23	0,26	0,58	0,56	25,7	0,29 (6)	2 (6)
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	21,7	:	:	:	:	23,5	1,6	47,8	22
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	7,2	7,9	8,8	9,4	12,4	:	:	:	19,1	11,0	6
International scientific co-publications per million population	:	386	591	670	837	1106	1281	1467	1559	18,4	343	3
Public-private scientific co-publications per million population	:	:	:	19	25	30	33	36	:	17,1	53	11
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	2,8	1,4	1,7	1,1	1,7	1,8	1,6	:	:	11,5	3,9	15
License and patent revenues from abroad as % of GDP	0,66	0,78	0,92	0,77	0,62	0,76	0,92	0,80	1,31	11,1	0,59	4
Community trademark (CTM) applications per million population	803	891	1081	1525	1550	1710	1745	1932	1905	4,6	152	1
Community design (CD) applications per million population	:	52	100	107	103	111	112	121	141	5,7	29	1
Sales of new to market and new to firm innovations as % of turnover	:	:	12,4	:	8,9	:	8,3	:	:	-3,4	14,4	22
Knowledge-intensive services exports as % total service exports	:	78,4	81,3	81,8	78,9	76,7	77,4	75,3	:	-2,0	45,3	1
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-5,68	-5,11	-4,26	-5,16	-5,52	-3,61	-4,44	-3,89	-4,43	-	4,23 (7)	25
Growth of total factor productivity (total economy) - 2007 = 100	102	98	99	100	94	88	89	88	85	-15 (8)	97	28
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	63,1	:	:	:	:	68,1	1,5	51,2	2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	23,8	25,1	26,1	24,7	25,7	1,9	13,9	1
SMEs introducing product or process innovations as % of SMEs	:	:	44,7	:	41,5	:	46,6	:	:	6,0	33,8	3
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,72	0,55	0,52	0,23	0,36	0,16	:	:	:	-16,6	0,44	13
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,01	0,11	0,15	0,17	0,19	0,12	:	:	:	-15,3	0,53	19
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	67,4	69,0	69,1	69,6	68,8	70,4	70,7	70,1	71,4	0,5	68,4	10
R&D Intensity (GERD as % of GDP)	1,65	1,56	1,66	*1,58*	1,66	1,74	1,51	1,43	1,46	*-1,6*	*2,07*	15
Greenhouse gas emissions - 1990 = 100	81	108	107	103	102	97	102	100	:	-3 (9)	83	20 (10)
Share of renewable energy in gross final energy consumption (%)	:	1,4	1,5	1,7	1,8	1,9	2,9	2,9	:	14,3	13,0	27
Share of population aged 30-34 who have successfully completed tertiary education (%)	21,2	37,6	35,5	35,3	39,8	46,6 (11)	46,1	48,2	49,6	2,1	35,7	3
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	16,8	13,3	14,0	12,5	13,4	7,7 (11)	7,1	6,2	8,1	1,7	12,7	9 (10)
Share of population at risk of poverty or social exclusion (%)	:	17,3	16,5	15,9	15,5	17,8	17,1	16,8	18,4	3,0	*24,8*	5 (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 2009 and the previous years. Average annual growth refers to 2009-2012.
(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 2009 and the previous years. Average annual growth refers to 2009-2012.
(12) Values in italics are estimated or provisional.

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

"Pursue the diversification of the structure of the economy, including by fostering private investment in research and further developing cooperation between public research and firms."

Malta

Building up a knowledge-based economy in a specialisation strategy

Overall performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Malta. 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: 0.84 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +8.1 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[18] 2012: 23.3 (EU: 47.8; US: 58.1) 2007-2012: +5.6 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 84.8 (EU: 101.6)	*Knowledge-intensity of the economy*[19] 2012: 55.3 (EU: 51.2; US: 59.9) 2007-2012: +2.1 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Materials, new production technologies, ICT, health, and environment	*HT + MT contribution to the trade balance* 2012: 3.4 % (EU: 4.23 %; US: 1.02 %) 2007-2012: -18.4 % (EU: +4.8 %; US: -32.3 %)

In preparation for Malta's accession to the EU in 2004, research was given increased prominence. This is particularly evident through the availability of reporting and monitoring commitments, as well as via the continued upward trend in R&I spending from 2004 onwards. In recent years, the stated aim of the Maltese government has been to place research and innovation (R&I) at the heart of the country's economy in order to stimulate knowledge-driven and value-added growth and to sustain improvements in its citizens' overall quality of life. This can only be achieved in the long term and its success will depend on implementation of the policies outlined in the National Strategic Plan for Research and Innovation 2020 in support of an environment favourable to innovation. In spite of the fact that R&D intensity remained low at only 0.84 % of GDP in 2012, significant progress was made over the period 2007-2012. The business sector is the largest R&D performer, accounting for 60 % of GERD, followed by the higher education sector with 36 % in 2012. The lowest component in R&D expenditure remains from the government and public sector. Performance and economic output indicators show that Malta is a medium-low performer in the European innovation indicator, with a stagnating trend over the period 2007-2012. However, in 2012, high-tech & medium-tech contribution to the trade balance was positive, thanks to the structural changes introduced in the economy towards specialisation in knowledge-intensive sectors, products and services. High growth is also observed in excellence and quality of scientific production; a slight improvement is noted for PCT patent applications while licence and patent revenues from abroad remain an area of weak performance.

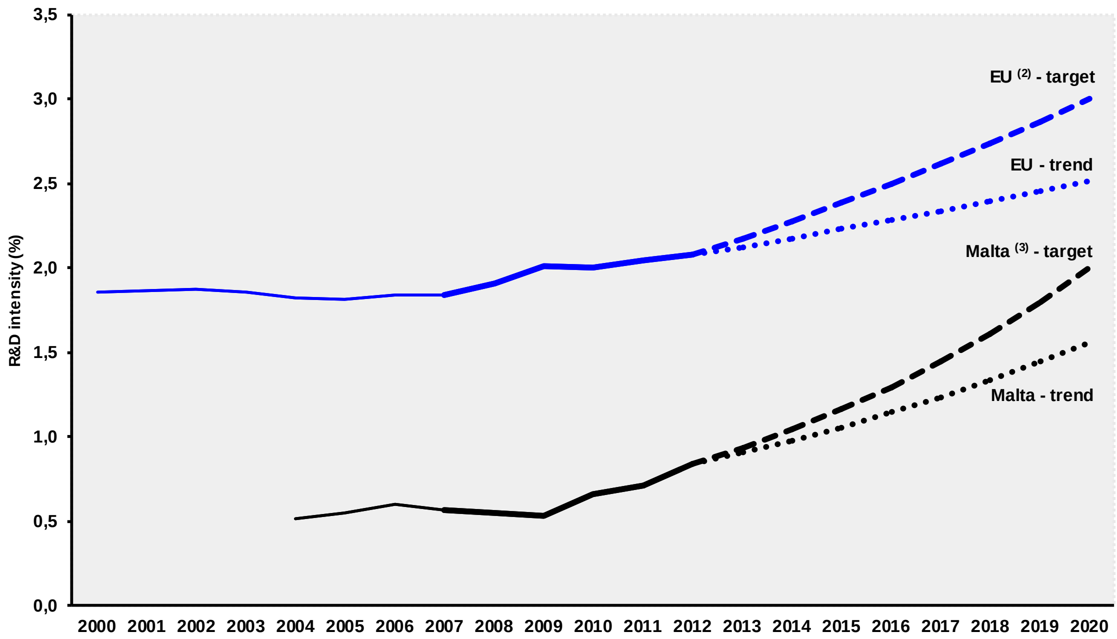
[18] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[19] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation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

It is important to highlight the problem of the volatility of indicators when these are reduced to Malta's micro-scale.

The country's key challenges include building up R&I capacity and to encourage increased investments in R&I, so that it moves closer to the newly fixed national R&D 2020 expenditure target. To meet this, Malta will need to improve its enabling environment considerably to allow for better research-to-market capacity. In this respect, innovation support and entrepreneurship, particularly for small and medium-sized enterprises (SMEs), remain key focal factors. A fundamental challenge for Malta is to stimulate indigenous private-sector R&I. The strategic principles adopted to address these challenges are outlined in Malta's National Strategic Plan for Research and Innovation 2020. This includes greater focus on priority areas, specialisation in a select number of areas of economic importance, coordinating public and private resources, expanding the science, technology, engineering and mathematics human capital base, and building strong links between knowledge institutions and business.

Investing in knowledge

Malta - 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) MT: The projection is based on an R&D intensity target of 2.0% for 2020.

Following a revision in 2013, Malta has set itself an ambitious target at 2 % of GDP by 2020, notably compared to its trend in the overall period of 2007-2012. In 2012, Malta's R&D intensity accounted for only 0.84 % of GDP, one of the lowest figures in the EU-27. However, significant increases in R&D expenditure in recent years may have motivated the country to take this bold step. Nevertheless, Malta has to come forward with details of how the increased R&D intensity will be achieved; its National Reform Programme (NRP) for 2014 will be important in this respect.

The central government allocation for the National R&I Funding Programme was boosted from 0.7 million Euros in 2010 to 1.1million in 2011 and again to 1.6 million in 2012. Government funding of R&D increased steadily between 2007 and 2012 at an average annual real growth rate of 8.2 %. The increased government spending on R&D resulted from greater expenditure on both higher education and business of 36.3 % and 0.50 % respectively.

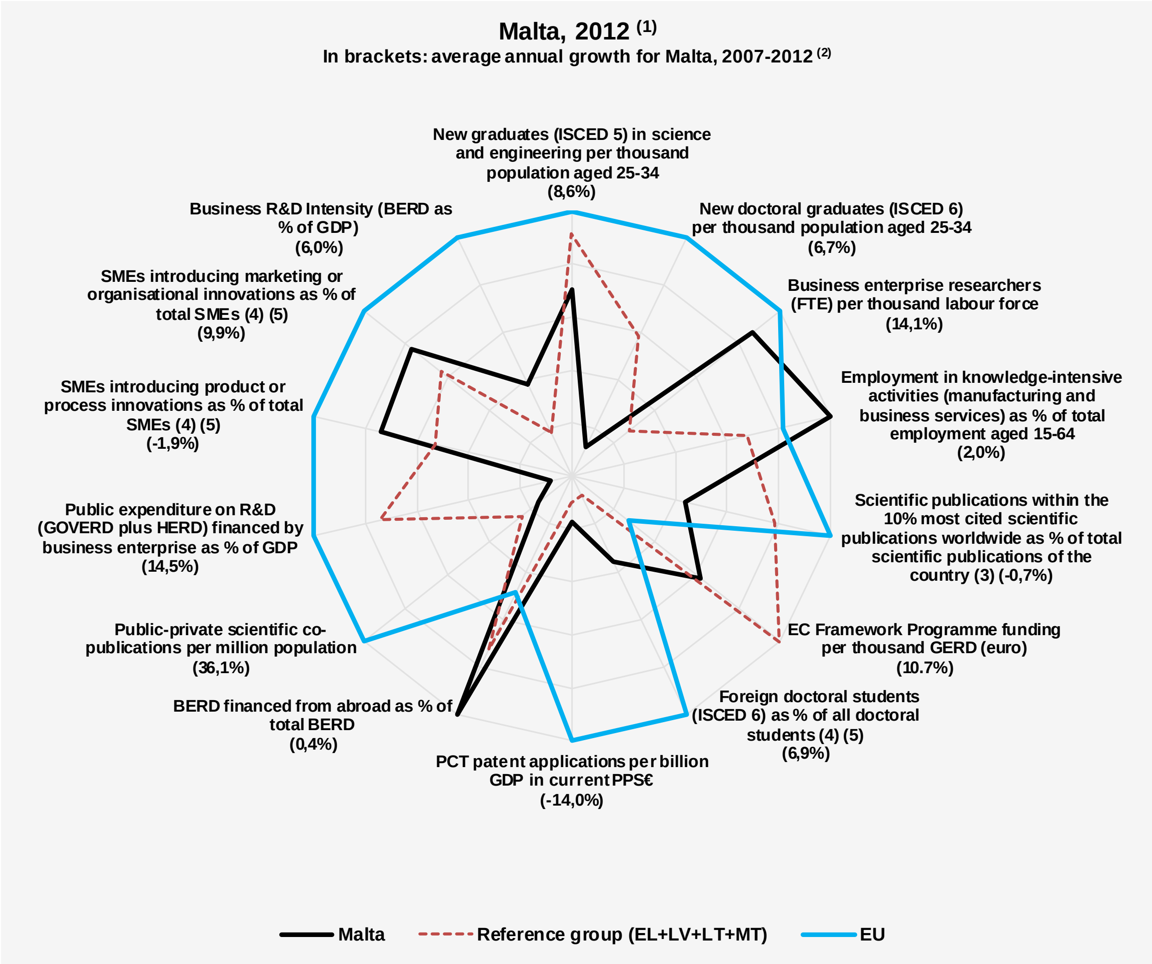
Malta is also ranked 19th in the EU in terms of business-enterprise expenditure on R&D as a % of GDP with a value of 0.50 % in 2012 compared to an EU average of 1.30 %. R&D financed by business enterprise increased in real terms between 2005 and 2012 at an average annual growth rate of 6.1 %. However, most of Malta's business R&D is carried out by a small cluster of foreign-owned companies. In view of this, continuous and firm commitment from the Maltese government during the upcoming period will be important to generate indigenous R&I, and to remain on the path towards meeting the new RDI intensity target by 2020.

The country relies heavily on support from the EU's Seventh Framework Programme (FP7) and Structural Funds for the achievement of its R&I objectives. In financial terms, up to February 2014, 155 FP7 projects had been approved and awarded around EUR 20 million (Source: E-CORDA). The success rate of Maltese applicants for FP7 funding is 19.1 % compared to the EU average of 22.0 %. Of the EUR 840 million of Structural Funds allocated to Malta over the 2007-2013 programming period, around EUR 72 million (8.5 % of the total) related to RTDI[20]. One of the objectives of the National Strategic Plan for R&I 2020 is to put in place a supporting framework to exploit opportunities for participation in EU R&I funding programmes.

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

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

[20] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in 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) EL is not included in the reference group.

(5) EU does not include EL.

Despite a clear strategy, Malta is still below the EU average for most of its indicators. Nevertheless, its share of employment in knowledge-intensive activities is higher than the EU average, reflecting the dominance of high-tech multinationals in the private sector. Innovation activities by SMEs are also above the reference-group average but below that of the EU. This factor complements the increase in BERD over the period 2007-2012, which also rose above that of both the reference group and the EU average, as the country's economy not only resisted during the financial crisis, but steadily continued to attract business from abroad.

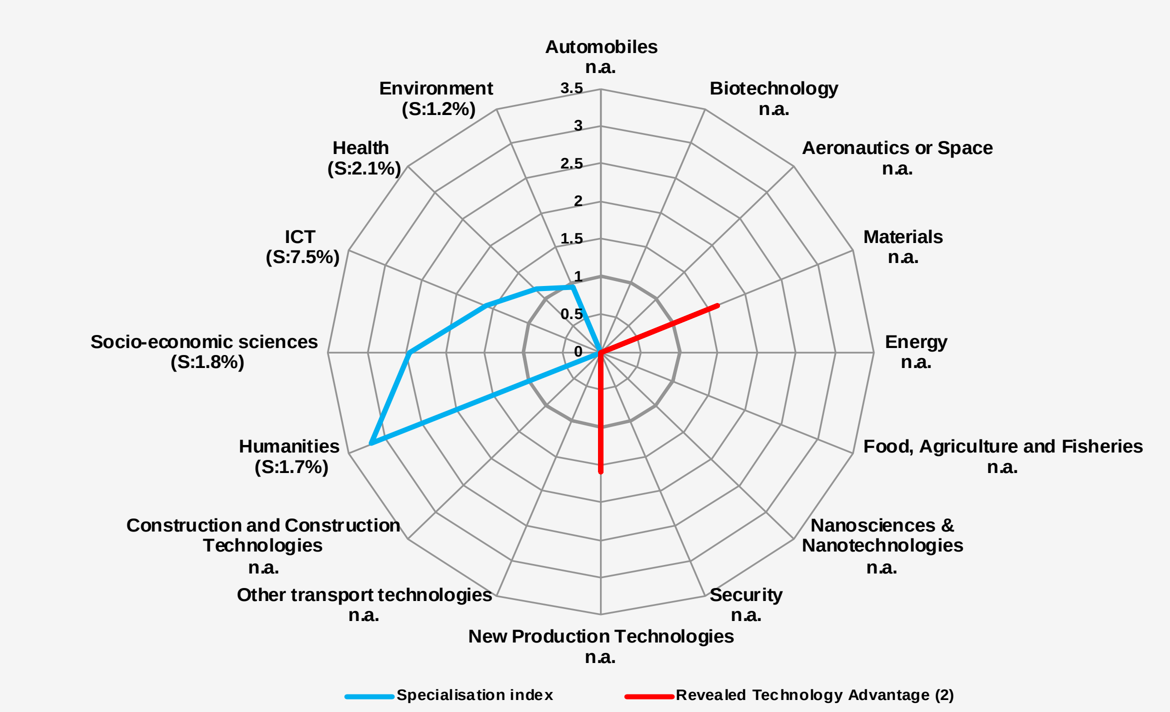
Knowledge creation as reflected in the production of highly cited scientific publications and public-private scientific co-publications remains weak, and the number of PCT patent applications is far below the EU average with a negative growth average, indicating a low scientific base. However, the establishment of the University of Malta Knowledge Transfer Office in 2009 is already contributing to reversing this trend. Malta's reliance on FP7 as a source of funding is shown in its above-average level of EC funding, although it is well below the reference group.

Malta's scientific and technological strengths

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

Malta 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.

There is very limited ground for comparing Malta's scientific and technological specialisation in selected thematic priorities because of the lack of specific data, which is probably due to the small size of the country and its market. A revealed technological advantage is apparent in only two sectors – materials and new production technologies – but data on trends is missing. No corresponding scientific specialisation seems to exist for these two fields. The materials sector has not been identified in the national strategic documents in the area of research, development and innovation, although the new National R&I Strategy 2020 does identify high-value-added manufacturing, with a focus on 'processes' as a specialisation area.

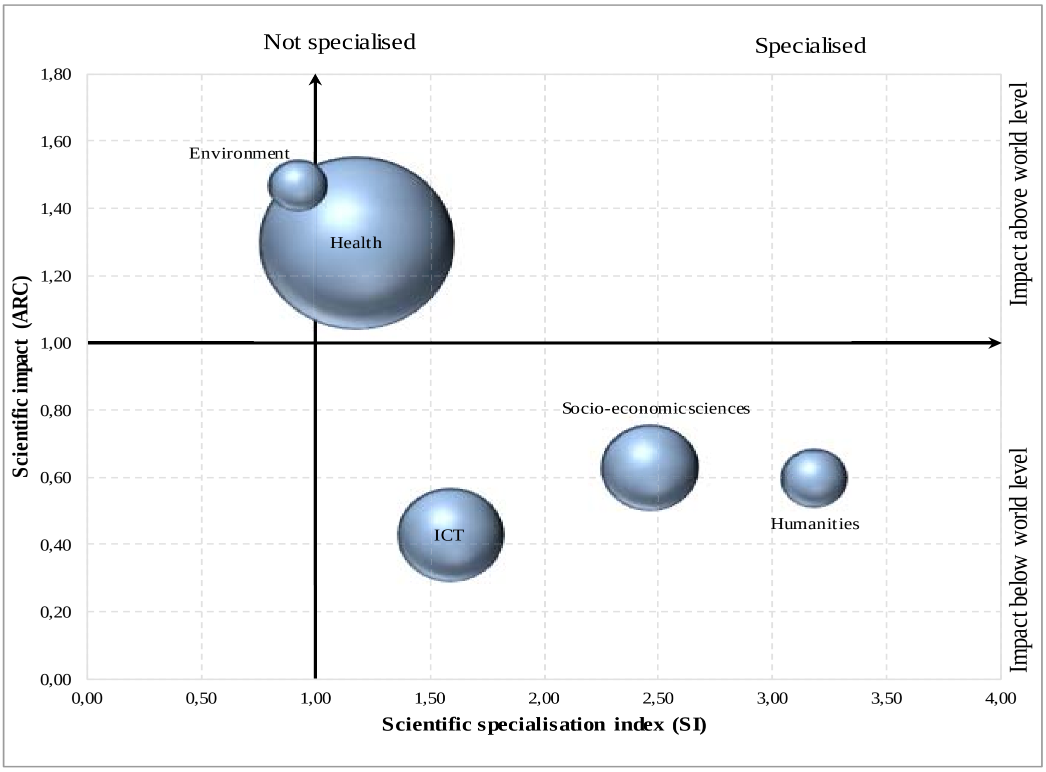
Malta's scientific specialisation indicator shows that the main scientific fields are ICT, health, environment, as well as humanities, and socio-economic sciences. Evidently, these sectors are mainly limited to scientific production, seemingly without corresponding technological production. This may be partly due to the fact that Malta is a small country with increasingly limited manufacturing and often with the research facilities of large multinationals based abroad. The increasing predominance of the services sector should also be considered in this respect.

In Malta, there is only one sector with a relatively high scientific impact, namely the environment, followed by health. An important task would probably be to foster technological specialisation in these two sectors. The three other specialised sectors identified are below average with regard to their impact.

Overall, as regards specialisation, Malta is ranked 25th in the EU-28 group. Because of this very low position, there is an apparent need to develop Malta's scientific and technological sectors in order to further enhance knowledge-based growth.

The graph below illustrates the positional analysis of Malta's 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 Malta 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

Malta's National R&I Strategy 2020 responds adequately to the challenges facing the country in R&I. It is strongly business oriented and aims to build up R&I capacity by concentrating efforts on areas of economic importance. Resource concentration and smart flexible specialisation in specific sectors is a key part of the Maltese R&I strategy. The plan proposes an improved tailoring of schemes for enterprises, as well as providing support for particular target groups such as SMEs and start-ups. A new commercialisation programme to help technology owners move their technologies closer to market was piloted in 2012, and was replaced by the Innovation Voucher Scheme in October 2013. Efforts are being made to use government expenditure on R&D to leverage an increase in business R&D expenditure, particularly through a varied set of incentives to promote R&D and innovation in the enterprise sector.

Malta's draft National R&I Strategy 2020 was published for public consultation in September 2013 and the final, updated version was endorsed by the cabinet in February 2014. This strategy is built on the previous strategic plan, but introduces a number of new elements, whilst retaining the same key vision. The strategy articulates three main goals: building a comprehensive R&I ecosystem; developing a stronger knowledge base; and smart, flexible specialisation.

The Strategy proposes to address the serious shortfall in human capital for R&I by investing in human-resource development at all levels of education. Scholarship schemes supporting postgraduate studies in Malta and abroad are in place and are being synchronised with areas of national priority. Malta is also investing in the construction of a new National Interactive Science Centre in order to instil an active interest in science, research and innovation among the country's youth and to encourage them to pursue a career in science and technology, as well as helping to expand the science, engineering and technology human capital base. The Centre will open in 2015.

The European Research Area (ERA) dimension in Malta's national R&I system is limited in the extent of the policies and measures specifically addressing this aspect. This probably arises from the fact that the country's research-relevant policies are still in their infancy, but fuller participation is on track and some success has been achieved by putting in place a legal framework for the inward mobility of third-country researchers, and the very good participation rates in FP6 and FP7. International cooperation is an important cross-cutting element of the National Strategy for R&I, and a number of priority measures have been identified for implementation in the short term. Generally speaking, efforts for the immediate future are mainly focused on building and strengthening internal capacity, hopefully leading to improvements in order to shift the focus to fuller integration in the near future.

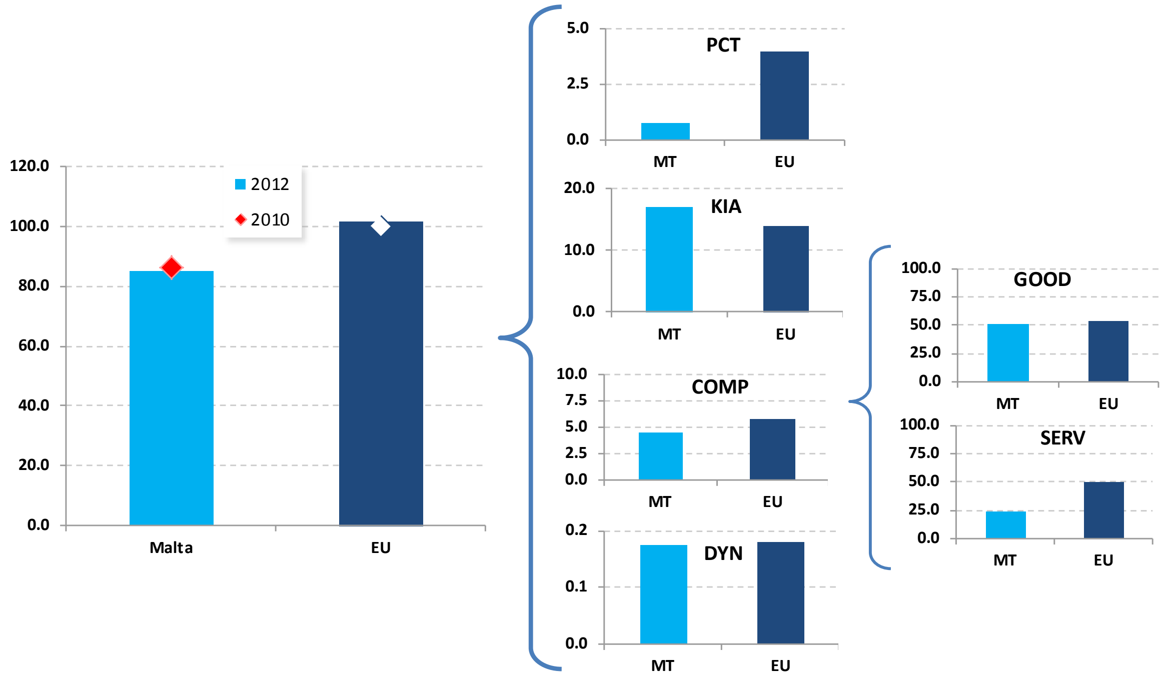
The National R&I Strategy 2020 places increased emphasis on the importance of innovation in all its forms. Indeed, Malta aims to support both research-based and non-research-based innovation by identifying key issues and opportunities and providing an appropriate enabling and support framework for potential innovators.

Malta's Smart Specialisation Strategy has been finalised and incorporated into the National R&I Strategy. It identifies seven national smart specialisations which have important innovation potential: tourism product development, maritime services, aviation and aerospace, health (with a focus on e-health as well as active living and healthy ageing), resource-efficient buildings, high-value-added manufacturing (with a focus on processes and design), and aquaculture. ICT was identified as a horizontal enabling technology as well as a source of innovation in itself (especially in health, digital gaming, financial services, and tourism product development). Malta's Smart Specialisation Strategy will be key in guiding R&I investments foreseen to be implemented through the European Structural and Investment Funds (ESIF) towards strategic areas considered to have high potential economic impact.

Innovation Output Indicator

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

Malta - 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 %).

Malta is a medium-low performer in the EU innovation indicator, scoring below the EU average and unable to improve its performance over the period 2010-2012. According to Eurostat data, Malta is positioned at the lowest European ranking in terms of number of patents filed to the European Patent Office at national level. However, other data sourced from the EPO website[21] for 2012 and 2013 indicate that applications filed with the EPO on the basis of per country of residence of the first named applicant increased significantly for Malta (from 23 in 2012 to 43 in 2013). Malta is also a low performer as regards PCT patents. Low performance in patents is seen as being linked to the economic structure of a country with a very small capital goods sector, and a lack of large manufacturing companies, which typically show high patenting activities.

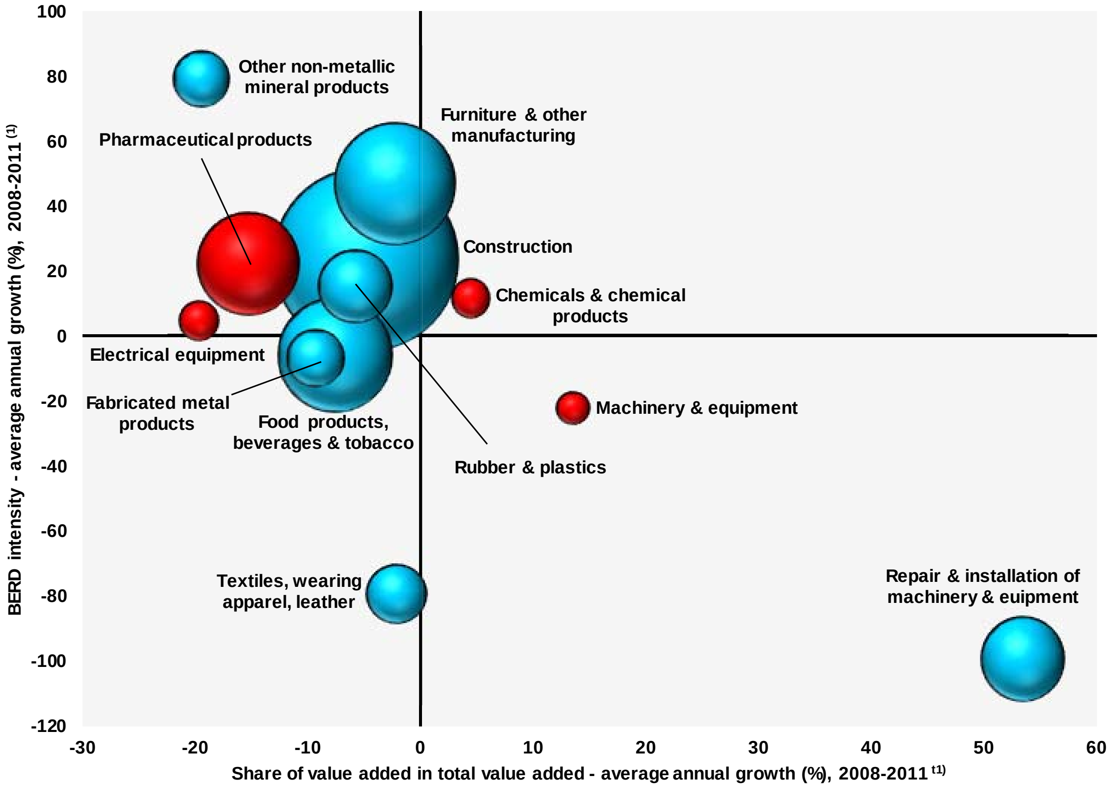
[21] http://www.epo.org/law-practice/legal-texts/official-journal/2014/03/a34.html

Most of the country's RDI expenditure comes from the business sector, notably from foreign companies with manufacturing plants in Malta; R&D activities, including patenting, tend to be carried out in the headquarter country rather than in Malta. Also, the exportation of knowledge-intensive services is far below the EU average, probably due to the high share of tourism in the Maltese economy. However, on a positive note, MT ranks fifth within the EU for employment in knowledge-intensive activities. Average rankings could also be observed for the other two components: the export share of medium-high and high-tech products (11th within the EU) and the innovativeness of high-growth enterprises (12th within the EU), thanks to a relatively strong financial and insurance sector.

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.

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



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Chemicals and chemical products'; 'Construction', 'Fabricated metal products', 'Machinery and equipment', 'Other non-metallic mineral products'; 'Repair and installation of machinery and equipment': 'Textiles, wearing apparel, leather': 2010-2011.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

In Malta, the services sector has been gaining in importance, mainly thanks to the emergence of new activities such as remote gaming, financial intermediation, and IT, legal and accounting services, which, in addition to more traditional services such as tourism, account for around 80% of total value added. Professional, scientific and technical activities, administrative and support service activities as well as information and communication and financial and insurance activities exhibited an increase in share of value added over the period 2010-2013. The contribution of manufacturing to the total value added has been in regular decline over the last decade. R&D activity is clustered around a few sectors. Since 2008, the pharmaceutical products and preparations (NACE Code Rev. 2.21) sector has undertaken around 20-22 % of R&D in the enterprise sector. This indicates that overall, and in spite of the progress noted in some of the sectors, as mentioned above, no clear interaction has been observed between R&D and business value added.

Key indicators for Malta

MALTA	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	0,13	0,09	0,07	0,16	0,19	0,31	0,20	0,31	0,21	6,7	*1,81*	28
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	:	:	:	463	:	:	:	:	495 [3]	:
Business enterprise expenditure on R&D (BERD) as % of GDP	:	0,37	0,40	0,37	0,36	0,34	0,41	0,47	*0,50*	*6,0*	1,31	19
Public expenditure on R&D (GOVERD + HERD) as % of GDP	:	0,19	0,20	0,19	0,19	0,20	0,25	0,24	*0,33*	*11,8*	*0,74*	26
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	17,7	:	:	:	:	23,3	5,6	47,8	23
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	6,0	7,4	4,8	7,7	4,8	:	:	:	-0,7	11,0	22
International scientific co-publications per million population	:	219	200	180	245	219	302	335	400	17,3	343	22
Public-private scientific co-publications per million population	:	:	:	2	1	2	6	8	:	36,1	53	24
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,4	0,7	0,6	1,1	1,0	0,3	0,7	:	:	-14,0	3,9	19
License and patent revenues from abroad as % of GDP	0,04	0,78	2,19	0,68	0,51	0,56	0,36	0,27	0,21	-20,9	0,59	12
Community trademark (CTM) applications per million population	66	114	183	152	278	297	343	399	565	30,0	152	2
Community design (CD) applications per million population	:	2	7	7	5	10	5	14	19	21,1	29	16
Sales of new to market and new to firm innovations as % of turnover	:	:	28,6	:	15,2	:	7,4	:	:	-30,2	14,4	25
Knowledge-intensive services exports as % total service exports	:	12,0	15,4	17,8	14,5	13,4	13,7	11,2	:	-11,0	45,3	28
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	5,07	7,72	7,52	9,46	10,73	9,61	3,21	0,92	3,42	-	4,23 [4]	10
Growth of total factor productivity (total economy) - 2007 = 100	100	99	99	100	101	98	99	99	98	-2 [5]	97	8
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	49,7	:	:	:	:	55,3	2,1	51,2	10
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	15,7	15,7	16,0	16,2	17,0	2,0	13,9	5
SMEs introducing product or process innovations as % of SMEs	:	:	:	:	25,9	:	25,0	:	:	-1,9	33,8	22
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,00	0,10	0,13	0,19	0,00	0,12	:	:	:	-19,5	0,44	16
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,00	0,00	0,00	0,06	0,00	0,12	:	:	:	39,5	0,53	20
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	57,2	57,9	57,6	58,5	59,2	58,8	60,1	61,5	63,1	1,5	68,4	22
R&D Intensity (GERD as % of GDP)	:	0,55	0,60	0,57	0,55	0,53	0,66	0,71	*0,84*	*8,1*	*2,07*	21
Greenhouse gas emissions - 1990 = 100	130	147	148	154	152	147	150	151	:	-2 [6]	83	28 [7]
Share of renewable energy in gross final energy consumption (%)	:	0,0	0,0	0,0	0,0	0,0	0,2	0,4	:	100,0	35,7	28
Share of population aged 30-34 who have successfully completed tertiary education (%)	7,4	18,3	21,6	21,5	21,1	21,3	21,5	21,4	22,4	0,8	35,7	26
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	*54,2*	33 [8]	33,1	32,7	29,3	28,0	25,9	23,6	22,6	-7,1	12,7	27 [7]
Share of population at risk of poverty or social exclusion (%)	:	20,2	19,1	19,4	19,6	20,2	20,3	21,4	22,2	2,7	24,8	13 [7]

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.
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(7) The values for this indicator were ranked from lowest to highest.
(8) Break in series between 2005 and the previous years.
(9) Values in italics are estimated or provisional.

The Netherlands

Towards enhanced cooperation between research institutions, businesses and public authorities

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in the Netherlands. 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: 2.16 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.9 % (EU: +2.3 %; US: +1.2 %)	*Excellence in S&T*[22] 2012: 79.7 (EU:47.8; US: 58.1) 2007-2012: +2.9 % (EU: +2.9 %; US: -0.2)
Innovation Output Indicator 2012: 95.5 (EU: 101.6)	*Knowledge-intensity of the economy*[23] 2012: 61.0 (EU:51.2; US: 59.9) 2007-2012: +0.1 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food, agriculture and fisheries, ICT, and to a lesser extent, biotechnology, other transport technologies, nanosciences & nanotechnologies, and environment	*HT + MT contribution to the trade balance* 2012: 0.9 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +24.0 % (EU: +4.8 %; US: -32.3 %)

In terms of GERD (Gross Domestic Expenditure on R&D), the Netherlands is performing above the EU-28 average (2.16 % of GDP in 2012 of which 1.22 % came from the private sector) including the GBAORD (Government Budget Appropriations or Outlays on R&D) with 0.78 % of GDP. The R&D intensity in the business sector (BERD) is relatively low (1.22 % in 2012), but increasing.

According to the Innovation Union Scoreboard 2014, the Netherlands ranks second amongst the 'innovation followers'. However, the Netherlands is a 'moderate grower' maintaining its level of the 2011 Innovation Union Scoreboard with relative strengths in 'Open, excellent and attractive research systems' and for 'Linkages and entrepreneurship' and relative weaknesses in 'Firm investments' and 'Innovators'.

Further to the main policy response ('To the Top') to the national challenges launched in 2011, the next target for the Netherlands is to restore confidence and harness growth while simultaneously stabilising public finances and supporting the continued balance sheet adjustment at a measured pace. These challenges concern fiscal policy, the pension system, labour market regulation and the housing market. Efforts within fiscal constraints to promote innovation and safeguard growth-enhancing expenditure are key to achieving a balanced adjustment. Gradually improving the housing market at a sustainable pace is a defining element of the strategy. Moreover, additional efforts to reduce regulatory

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

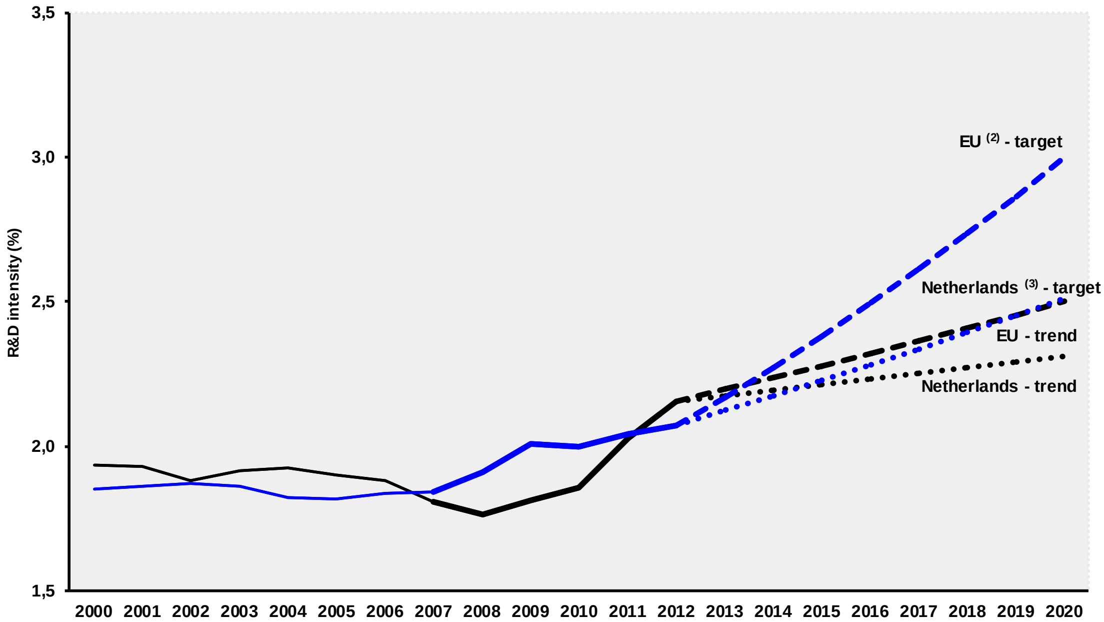
disincentives on labour would make work more attractive. Despite the overall good performance of the Dutch school system, there is a need to address quality and excellence across educational levels, in particular, engineering and technology-related professions that should be addressed.

The current government is continuing with its enterprise policy, including its ‘top-sector’ approach, and Strategic Agenda for Higher Education and Research (including joint roadmaps, Human Capital Agenda and the Technology Pact). R&I investments in the private sector are being promoted through generic instruments such as tax incentives and financing innovative entrepreneurship through risk capital.

The Dutch R&I system has succeeded in maintaining its innovative capacity during the financial crisis, with high efficiency and effectiveness of public R&D investment, improved S&T excellence from an already high level and the development of hot spots in key technologies, and greater R&D intensity. These efforts are reflected in the competitiveness of the Dutch economy, which is benefiting from a positive contribution by high-tech and medium-tech products to the trade balance. The Dutch economy is very knowledge-intensive and Dutch enterprises – small and medium-sized enterprises (SMEs) in particular – are more innovative in product or process innovation than the EU average.

Investing in knowledge

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, Member State
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2007-2010 in the case of the Netherlands.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) NL: The projection is based on a tentative R&D intensity target of 2.5% for 2020.
(4) NL: There is a break in series between 2011 and the previous years.

Over the period 2000-2008, Dutch R&D intensity fell from 1.94 % to 1.77 %, largely reflecting a parallel drop in business expenditure on R&D. In contrast, since 2008, the R&D intensity rapidly increased to reach 2.16 % in 2012, initially driven by public expenditure and, since 2011, by business expenditure, too. In spite of this rebound, the Dutch R&I system is still characterised by a relatively low R&D intensity in the business sector against a relatively high R&D intensity within the public sector. In 2012, business R&D intensity (1.22 %) was below the EU average (1.31 %) while public R&D intensity (0.93 %) was higher than the EU average of 0.74 %.

Tax incentives comprise WBSO[24], tax credit for private R&D wage costs, RDA[25] tax allowance for private non-wage R&D investment, and the Innovation Box offering a low tax rate for R&D-related profits. To address capital market shortcomings related to innovative projects and enterprises, the Netherlands has expanded those instruments to increase the availability of risk capital, especially through the Innovation Fund SME+ (innovation credit, seed capital and Fund of Funds) together with the European Investment Fund.

The Netherlands' participation in the EU's Seventh Framework Programme has been successful with an EC contribution of EUR 3.145 billion up to the end of 2013, representing 7.3 % of total EC funding, ranking fifth among the Member States. The success rate was 22.56 %, which is the second highest among participating countries.

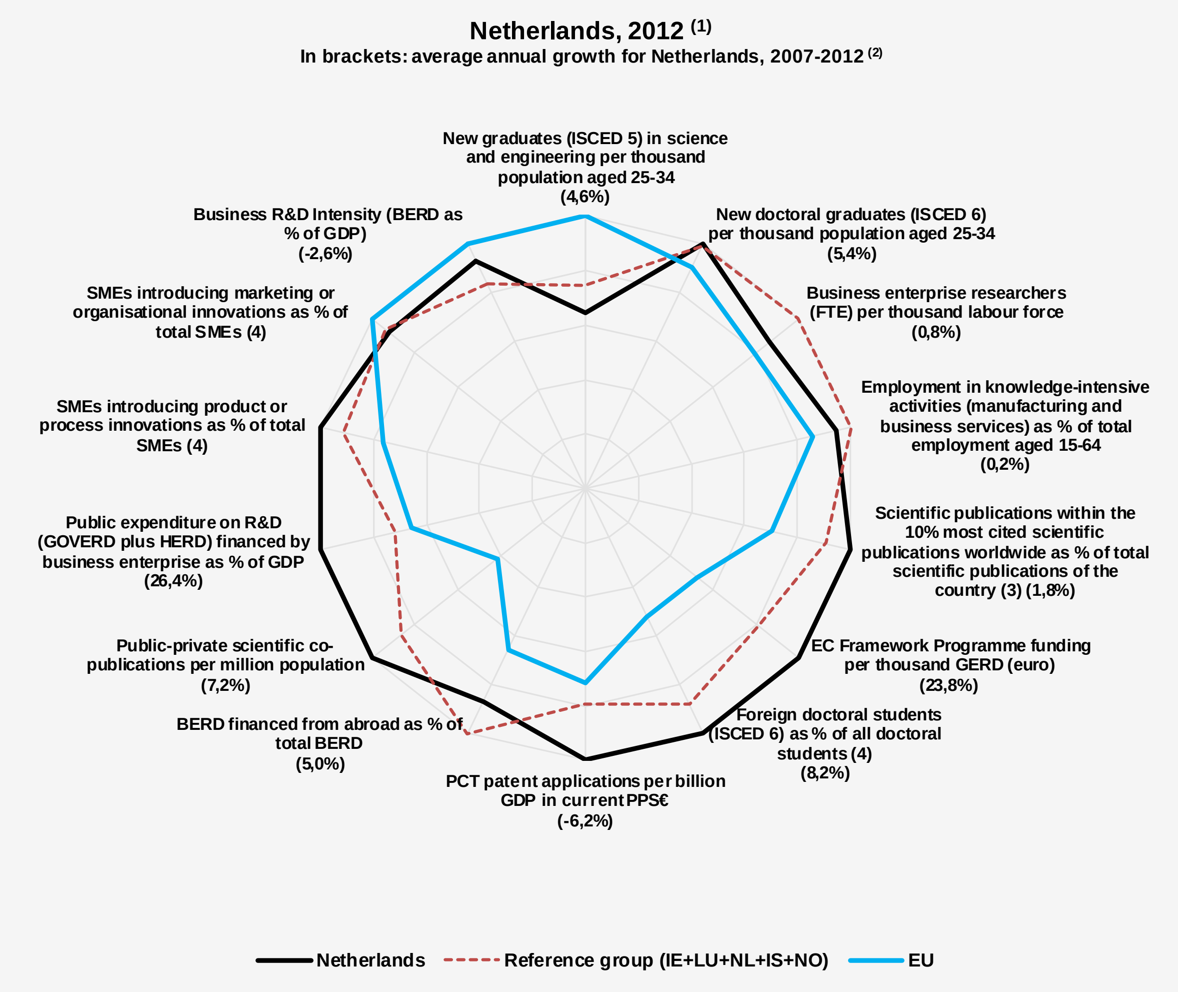
Structural Funds are also an important source of funding for R&I in the Netherlands. Of the EUR 1.6 billion of Structural Funds allocated to the country over the 2007-2013 programming period, around EUR 300 million (18 % of the total) related to RTDI[26].

In addition to these challenges, the government announced its National Technology Pact 2020 which involves commitments from both public and private stakeholders. Their representatives from various horizons will ensure this strategy's implementation and foster the innovative capacity of Dutch companies.

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

The figure below illustrates the strengths and weaknesses of the Netherlands' R&I system providing information on human resources, scientific production, technology valorisation and innovation as well as the average annual growth (manufacturing and business services only) rates in the period 2007-2012.

[24] WBSO – Wet Bevordering Speur- en Ontwikkelingswerk – R&D Promotional Law
[25] RDA – Research & Development Aftrek – R&D Deduction
[26] RTDI includes the following sectors: (01) RTD activities in research centres, (02) RTD infrastructures and centres of competence, (03) Technology transfer and improvement of cooperation of networks, (04) Assistance to RTD, particularly in SMEs (and RTD services in research centres), (06) Assistance to SMEs for the promotion of environmentally friendly products and processes, (07) Investment in firms directly linked to research and innovation, (09) Other methods to stimulate research and innovation and entrepreneurship in SMEs, and (74) Developing human potential in the field of research and innovation.



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

The Netherlands is performing better than the EU average on most S&T indicators and currently ranks first for the number of scientific publications within the 10 % most-cited scientific publications worldwide, a clear sign of the quality of its scientific output. Other areas of marked performance include public-private cooperation, intellectual property, attractiveness for foreign doctoral students, and international cooperation. Furthermore, strong dynamics are visible in the business funding of public research, business innovation expenditure (non-R&D), innovating SMEs, new doctorate holders, and international scientific co-publications.

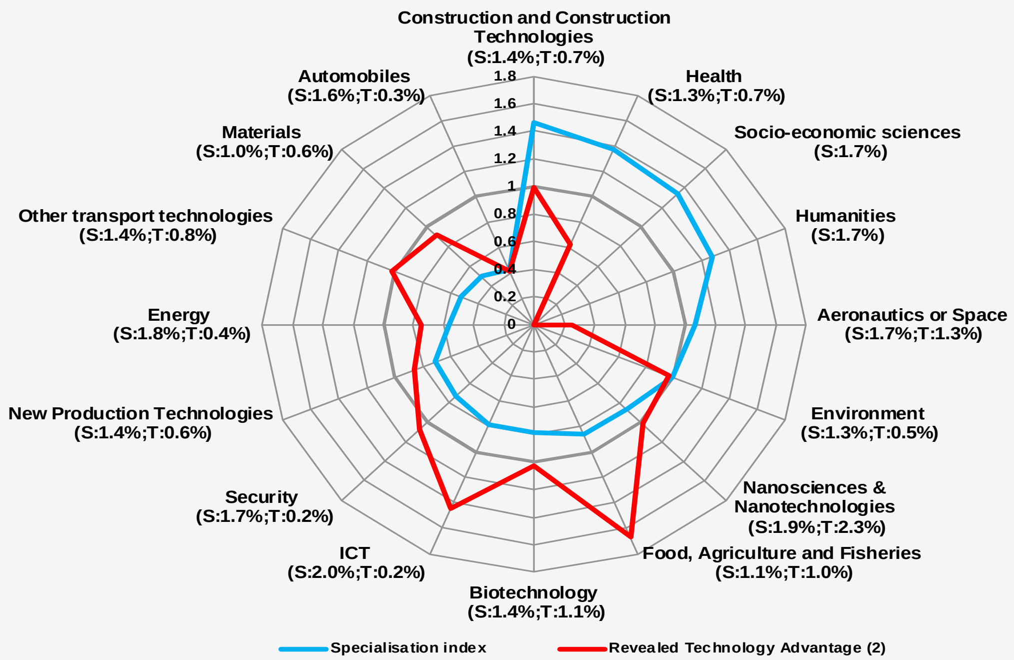
In contrast, the two main weaknesses of the Dutch innovation system are the relatively weak business R&D intensity and a low level of science and engineering graduates amongst 25-34-year-olds. However, the latest European Patent Organisation (EPO) figures show an increase in patenting activities of 17.2 % in 2013, placing the Netherlands in eighth position worldwide. For the country's future innovation capacity, the government recognises that increasing the number of S&T graduates is an important goal, for which the 'Techniekpact' is instrumental.

The Netherlands' scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where the Netherlands 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. Each specialisation field provides information on the growth rate in the number of publications and patents.

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

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



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

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

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

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

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

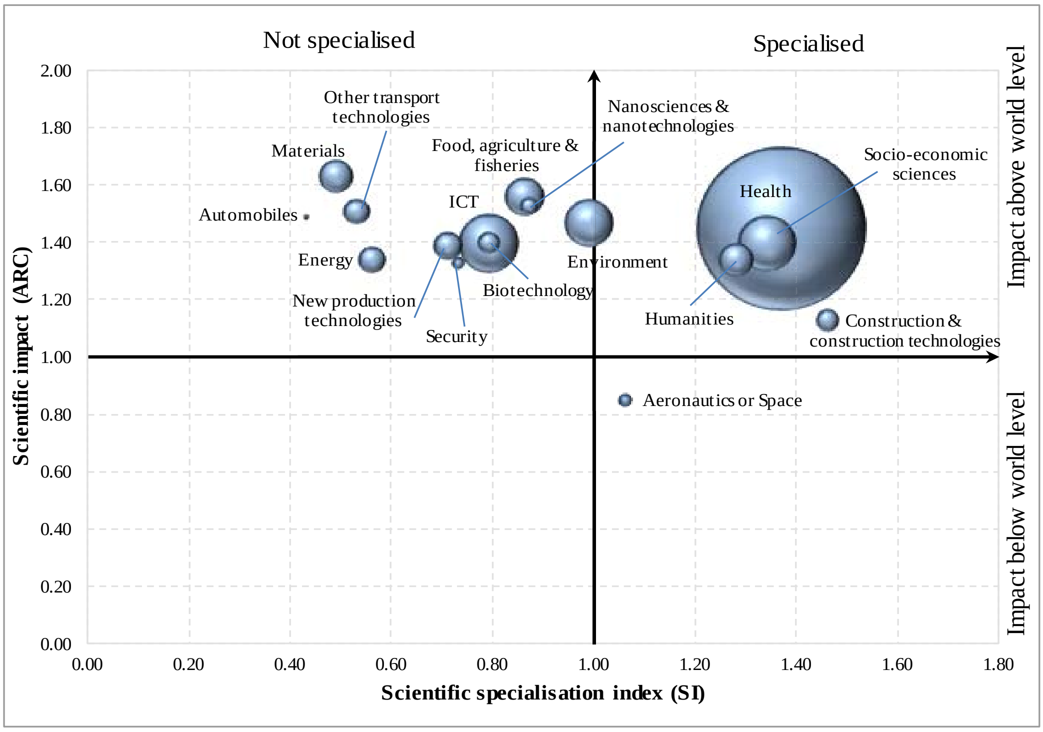
(4) The growth rate in number of patents (T) refers to the periods 2000-2002 and 2003-2006.

The Netherlands has a relative specialisation – either scientific or technological – in most of the selected thematic priorities shown above, in particular in health, socio-economics sciences, food, agriculture and fisheries, ICT, and construction and construction technologies, some of which coincide with the top sectors in the Dutch enterprise policy 'To-the-Top'. The only exceptions are automobiles, energy, and new production technologies.

However, a comparison of the Dutch scientific and technological specialisations in these priorities shows a mixed situation with some co-specialisations as well as some mismatches. Technology production is strongly specialised in food, agriculture and fisheries, and ICT, but also holds strong positions in the environment, nanosciences and nanotechnologies, biotechnology, security, and other transport technologies. In contrast, the main fields of scientific specialisation are construction and construction technologies, health, socio-economic sciences, and humanities and, to a lesser extent, in aeronautics and the environment. The best matches between science and technology specialisations are in environment, and construction and construction technologies, while partial matching can also be seen in nanosciences and nanotechnologies, food, agriculture and fisheries, biotechnology, ICT, and security.

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

Positional analysis of The Netherlands 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 Netherlands has a very high level of scientific excellence, as evidenced by the impact of Dutch scientific publications which is clearly above both the EU and world average in all fields except aeronautics. Scientific excellence, in particular, supports the areas of S&T co-specialisation, which include the environment, and construction and construction technologies.

Policies and reforms for research and innovation

In 2013, the Netherlands faced the challenge of widening its innovation capacity and maintaining levels of funding for fundamental research, by providing suitable incentives through its enterprise policies, high-added-value production and services, and an increase in private investments in the R&I system.

Despite a slight growth in business R&D intensity, the numbers of new graduates in science and engineering and doctorates have declined in recent years. The reform undertaken in education should be closely linked to the top-sector strategy and should align the education system to the needs identified by businesses. Several programmes – 'Training for Teachers', Science Acquisition, Technology Pact and Human Capital Agendas, etc. – were set up to meet the needs, but it is too early to assess their results.

In 2014, the government adapted its fiscal innovation instruments to support R&D in order to encourage SMEs and offer more opportunities for growth among the innovative ones. The first of these lies with the WBSO (R&D salary costs) where the ceiling of the top layer is extended from EUR 200 000 to EUR 250 000 (with 50 % off for start-ups) and its tariff reduced from 38 % to 35 %. The other instrument relates to an increase in the percentage of RDA (reduction in R&D costs and investments) to 60 % (compared to 54 % in 2013 and 40 % in 2012). Together with the Innovation Funds (MKB) and other measures (WBSO, Innovation Box), the budget outlays for generic measures will reach more than EUR 2 billion in 2015.

So far, approximately 1800 enterprises have signed up for one or more knowledge and innovation (TKI[27] programmes, of which 70 % are SMEs. The enterprise policy will shift significantly from direct funding by the government to fiscal incentives for R&D. Total R&D funds allocated by the central government will reach EUR 6.400 billion in 2016, of which 52.62 % (as against 48.29 % in 2013) has been allocated to fundamental research and 26 % to fiscal R&D measures. The reduced budget for applied research to 10.72 % reflects the government's choice to provide better incentives to applied research institutes to earn more private funding through public private partnerships.

In addition to the generic instruments, the enterprise policy also uses specific policies delivered through the nine top sectors: chemicals, creative industry, logistics, health, high-tech, agro-food, water, energy, and horticulture. Primarily, these sectors serve as a coordination mechanism for public private partnerships (PPPs), linking knowledge, industry and government. These PPPs are served through 19 top consortia for TKI aimed at societal and business needs. To stimulate private contributions, the government grants TKI allowances (25 % of private contributions), and to encourage involvement from SMEs, the MIT[28] scheme provides several instruments, such as innovation vouchers, targetting SMEs' needs.

Through the signed 'innovation contracts' for 2014/2015, top sector stakeholders promised an annual research investment of almost EUR 2 billion (of which about EUR 970 million is provided by the private partners (enterprises) and EUR 1.06 billion by public investments). These innovation contracts – a mixed balance between fundamental research, applied research and valorisation – were tailored to the market needs and aligned to most thematic topics in the EU's Framework Programmes and Horizon 2020. For the period 2014-2017, an annual budget of EUR 50 million (JTI, Eurostars) and EUR 36 million for other programmes (e.g. ERA-net) has been agreed.

The TKIs have a goal of EUR 500 million in public-private research in 2015 with at least 40 % financed by private partners. This means a significant increase compared to the 10 to 35 % of private contributions to PPP programmes before 2012. From 2013 onwards, the cabinet will raise the TKI-allowance budget from EUR 56 million to EUR 130 million in 2017. The limited cooperation between enterprises and research institutions is addressed by part of the programmes for fundamental research in line with top-sector topics, while maintaining research excellence. To this end, NWO (The Netherlands Organisation for Scientific Research) will allocate an increasing amount (up to EUR 275 million in 2015) to those topics from various NWO instruments, while the Dutch ministries will contribute EUR 59.1 million to relevant TKI programmes to provide solutions to societal challenges.

Emerging skill shortages and mismatches, especially in engineering and technology, have been identified and represent a bottleneck for growth. Therefore, and in view of the European 2020

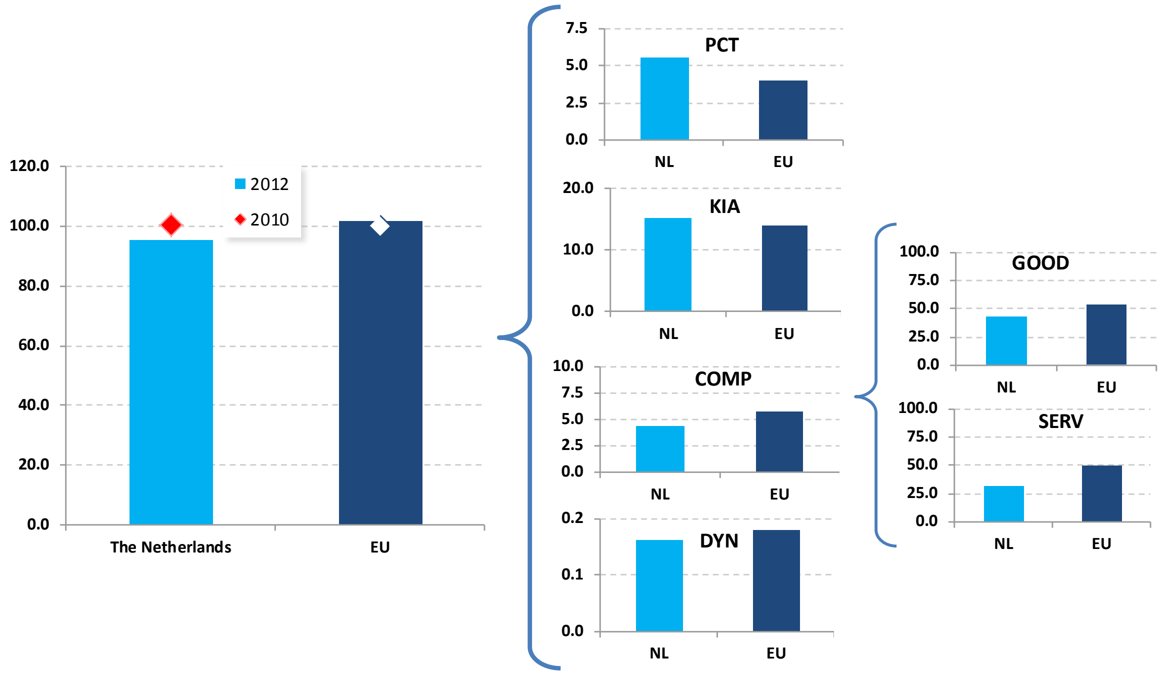
[27] TKI – Topconsortia voor Kennis en Innovatie
[28] MIT – MKB-Innovatiestimulering Topsectoren

objectives, a ‘Technology Pact’ was signed in 2013 to complement the top sector’s ‘Human Capital Agendas’. For education and academic quality achievements, the budget will be raised to EUR 245 million in 2016, in addition to EUR 100 million to reward best universities’ and colleges’ performances. The ‘Policy on Science’ and the ‘Science in Transition’ programmes were also set up to leverage the shortage of skilled workers, but it would be premature to monitor their impacts at present.

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 fast-growing firms in innovative sectors). The graph below enables a comparison of the Dutch position regarding the indicator’s different components.

The Netherlands - Innovation Output Indicator



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

The Netherlands is a medium performer in the European innovation indicator although its performance declined in the period 2010-2012. The relatively good performance in patents is partially explained by the strong electric products and electronics sector, with the Dutch companies Philips, NXP and ASML ranking among the largest patent producers in Europe[29].

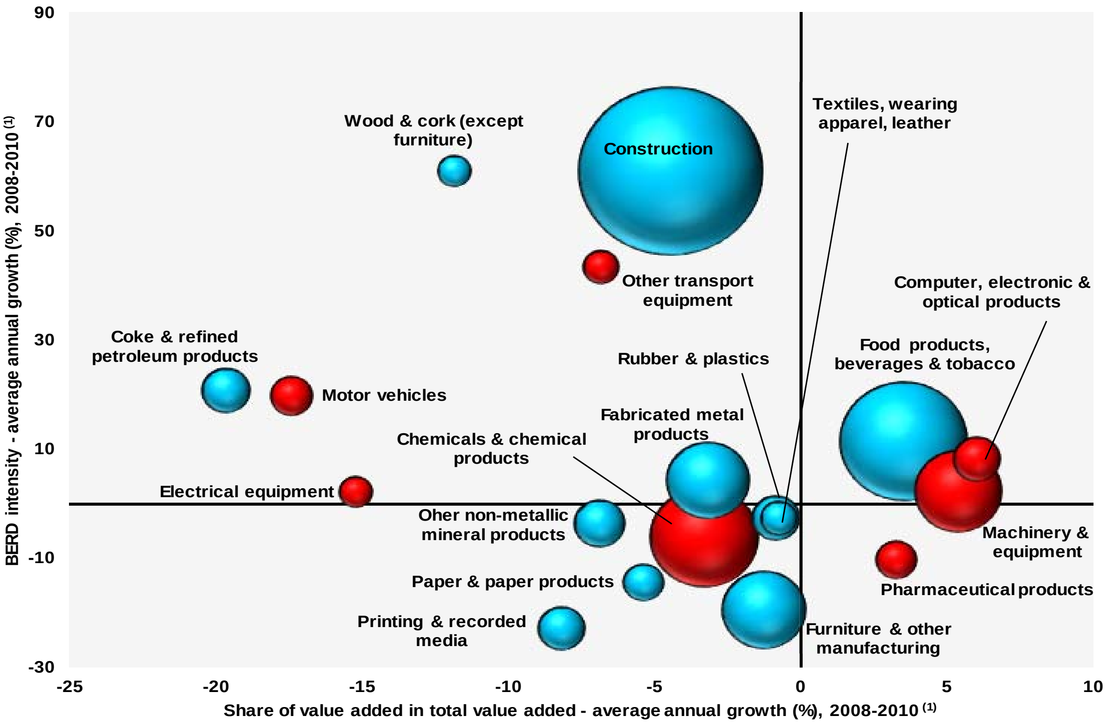
The share of medium-high and high-tech goods in total goods exports is below the EU average, partly due to the relatively high exports of agricultural products and of natural gas, not listed as high- and medium-tech products. The relatively low performance in knowledge-intensive service exports can be explained by the very high level of licence fees and royalties, which are not classified as KIS, although they employ highly skilled labour.

The Netherlands performs below the EU average in terms of the innovativeness of its fast-growing companies, which results from a high share of wholesale and retail trades, and administrative and support service activities among 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 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 (HT) or medium-high-tech (MHT) sectors.

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



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

[29] The Netherlands also performs well in Community trademarks and designs.

Most manufacturing sectors contracted during the initial phase of the crisis (2008-2010), with the exception of food products, beverages and tobacco and of three HT and MHT sectors (pharmaceuticals; machinery and equipment, and computer, electronic and optical products). In comparison with the 1995-2007 period, during which all HT and MHT sectors had become more R&D intensive, the BERD intensity of pharmaceuticals and of chemicals and chemical products decreased between 2008 and 2010. Conversely, other sectors, in particular construction, substantially increased their R&D intensity. Overall, total BERD over GDP remained constant during 2008-2010 but the manufacturing sector as a whole became slightly more R&D intensive.

Key indicators for the Netherlands

NETHERLANDS	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	1,00	1,32	1,41	1,54	1,60	1,65	1,87	1,85	2,00	5,4	*1,81*	10
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	531	:	:	526	:	:	523	-7.7 [3]	495 [4]	1 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	1,07	1,01	1,01	0,96	0,89	0,85	0,89	1,14 [5]	*1,22*	*-2,6*	1,31	10
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,85	0,90	0,87	0,85	0,88	0,96	0,97	0,89	*0,94*	2,0	*0,74*	5
Venture Capital as % of GDP	0,46	0,46	0,44	0,49	0,29	0,13	0,22	0,35	0,21	-15,4	0,29 [6]	7 [6]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	69,1	:	:	:	:	79,7	2,9	47,8	3
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	14,5	14,6	15,1	15,2	15,6	:	:	:	1,8	11,0	1
International scientific co-publications per million population	:	898	979	1044	1100	1203	1288	1359	1457	6,9	343	4
Public-private scientific co-publications per million population	:	:	:	97	101	106	117	128	:	7,2	53	3
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	7,4	7,1	7,0	6,6	6,5	6,3	5,4	:	:	-6,2	3,9	5
License and patent revenues from abroad as % of GDP	0,56	1,60	1,52	1,75	2,25	2,61	3,16	3,70	4,01	18,0	0,59	1
Community trademark (CTM) applications per million population	92	139	172	192	196	238	229	234	237	4,3	152	8
Community design (CD) applications per million population	:	47	45	45	52	54	48	49	54	3,7	29	5
Sales of new to market and new to firm innovations as % of turnover	:	:	10,9	:	8,9	:	10,4	:	:	8,6	14,4	19
Knowledge-intensive services exports as % total service exports	:	37,3	35,2	33,9	32,4	30,7	26,3	28,8	:	-4,0	45,3	17
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-1,48	-0,04	-0,13	0,30	0,01	0,25	0,49	1,68	0,88	-	4,23 [7]	18
Growth of total factor productivity (total economy) - 2007 = 100	93	97	98	100	100	96	98	98	97	-3 [8]	97	14
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	60,8	:	:	:	:	61,0	0,1	51,2	4
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	16,5	15,4	15,2 [9]	14,9	15,2	0,2	13,9	10
SMEs introducing product or process innovations as % of SMEs	:	:	32,9	:	31,6	:	44.5 [10]	:	:	-	33,8	4
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,41	0,33	0,48	0,47	0,50	0,54	:	:	:	6,9	0,44	6
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,97	0,90	1,11	0,85	0,89	0,93	:	:	:	4,3	0,53	4
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	74,3	75,1	76,3	77,8	78,9	78,8	76,8 [9]	77,0	77,2	0,3	68,4	2
R&D Intensity (GERD as % of GDP)	1,94	1,90	1,88	1,81	1,77	1,82	1,86	2.03 [5]	*2,16*	*0,9*	*2,07*	10
Greenhouse gas emissions - 1990 = 100	103	102	100	99	99	96	101	95	:	-5 [11]	83	17 [12]
Share of renewable energy in gross final energy consumption (%)	:	2,1	2,3	3,0	3,2	4,0	3,7	4,3	:	9,4	13,0	24
Share of population aged 30-34 who have successfully completed tertiary education (%)	26,5	34,9	35,8	36,4	40,2	40,5	41,4 [10]	41,1	42,2	1,0	35,7	11
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	15,4	13,5	12,6	11,7	11,4	10,9	10,0 [10]	9,1	8,8	-6,2	12,7	10 [12]
Share of population at risk of poverty or social exclusion (%)	:	16,7	16,0	15,7	14,9	15,1	15,1	15,7	15,0	-0,9	24,8	1 [12]

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

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

"Protect expenditure in areas directly relevant for growth, such as education, innovation and research."

Poland

Improving the quality of the science base 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 Poland. 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 statistics of research and innovation performance	
R&D intensity 2012: 0.90 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +9.7 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[30] 2012: 20.0 (EU: 47.8; US: 58.1) 2007-2012: +9.8 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 81.4 (EU: 101.6)	*Knowledge-intensity of the economy*[31] 2012: 34.8 (EU: 51.2; US: 59.9) 2007-2012: +1.5 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Food, agriculture and fisheries, construction, transport, environment, and materials	*HT + MT contribution to the trade balance* 2012: 0.6 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +14.7 % (EU: +4.8 %; US: -32.3%)

Since 2007, Poland has increased its investment in R&D and improved its excellence in science and technology, while focusing on key technologies relevant to industry. The economy has been undergoing structural change towards higher knowledge intensity (an average growth of 1.5 % in 2007-2012) and Poland's global competitiveness is improving at a higher rate than the EU average. Poland scores below average in the Innovation Output Indicator although Polish innovation performance has improved over the last decade. Moreover, the country is still lagging behind the EU average in terms of investment, scientific excellence and knowledge-intensity in the economy, thus leaving room for further progress, illustrated by the ambitious Polish R&D intensity target for the Europe 2020 strategy (1.7 % of GDP by 2020).

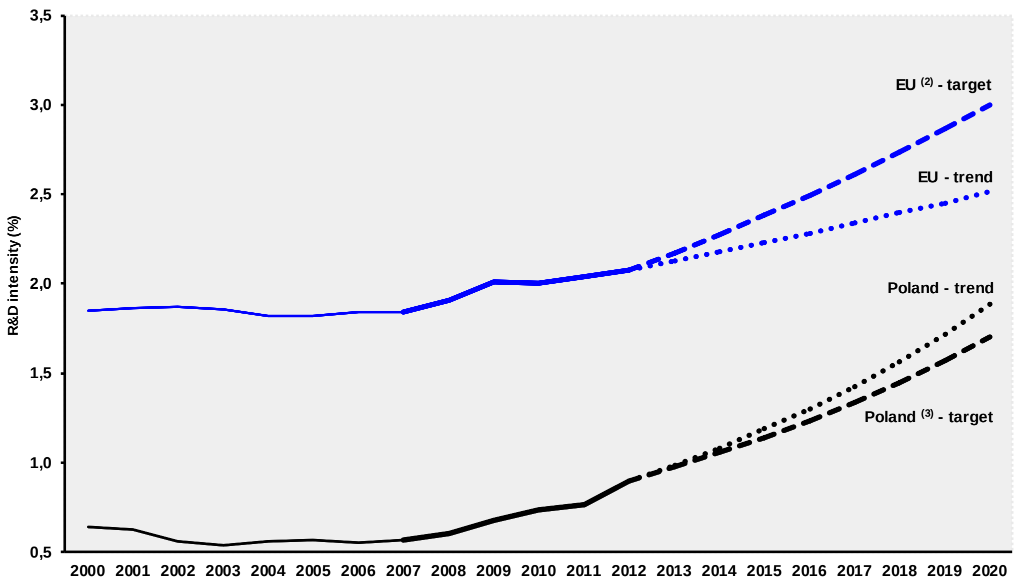
Persistently low R&D spending, in particular severe under-investment in R&I in the private sector, and limited in-house technological innovation call for giving way to a new approach targeting different stages of the innovation cycle with well-designed incentives and effective support through public funding, including increased public-private cooperation. Poland has acknowledged the need for this new approach and over the last few years the Polish R&D system has undergone major restructuring. Reforms in the science and higher education systems (2010-2011) introduced significant changes, including the move towards more competitive funding and increased cooperation between science and industry. A major policy document – the Strategy for Innovation and Effectiveness of the

[30] 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.
[31] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation sub-indicators.

Economy 2020 (SIEG) – was adopted in 2013 and focused on stimulating innovativeness and addressing key challenges in the R&D&I system, including stimulation of private expenditure on R&D, internationalisation and genuine innovation. Together with other documents, such as its executive programme PRP (Enterprise Development Programme), the National Smart Specialisation Strategy, the Operational Programmes 'Smart Growth' and 'Knowledge, Education, Development'), those policy developments form a coherent approach towards building a more effective R&I ecosystem. It remains to be seen if Poland will successfully move from the strategic level to the systemic and coordinated implementation of measures, which is required to ensure a visible improvement in the innovativeness of Polish companies as well as to maintain sustainable high growth of the economy.

Investing in knowledge

Poland - 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) PL: The projection is based on a tentative R&D intensity target of 1.7% for 2020.

Poland's R&D intensity experienced an average annual growth of 9.7 % between 2007 and 2012, reaching 0.9 % of GDP in 2012 (20th position in the EU). The average annual increase required to hit the ambitious Polish target of 1.7 % by 2020 is slightly lower but is still challenging at 8.3 %. The main weakness remains under investment by the private sector with business R&D expenditure accounting for only 0.33 % of GDP (23rd place within the EU). However, actual R&D expenditure by Polish firms may be underestimated due to the lack of appropriate incentives for businesses to report them. Since the existing tax incentives for R&D, only used by a limited number of big companies, are ineffective in inducing genuine innovations by Polish companies, a reassessment of these tax incentives is needed in view of increasing their effectiveness.

The breakdown of total R&D expenditure by funding source and performance sector illustrates the opposite picture when compared to the EU average. The government remains the main source of R&D

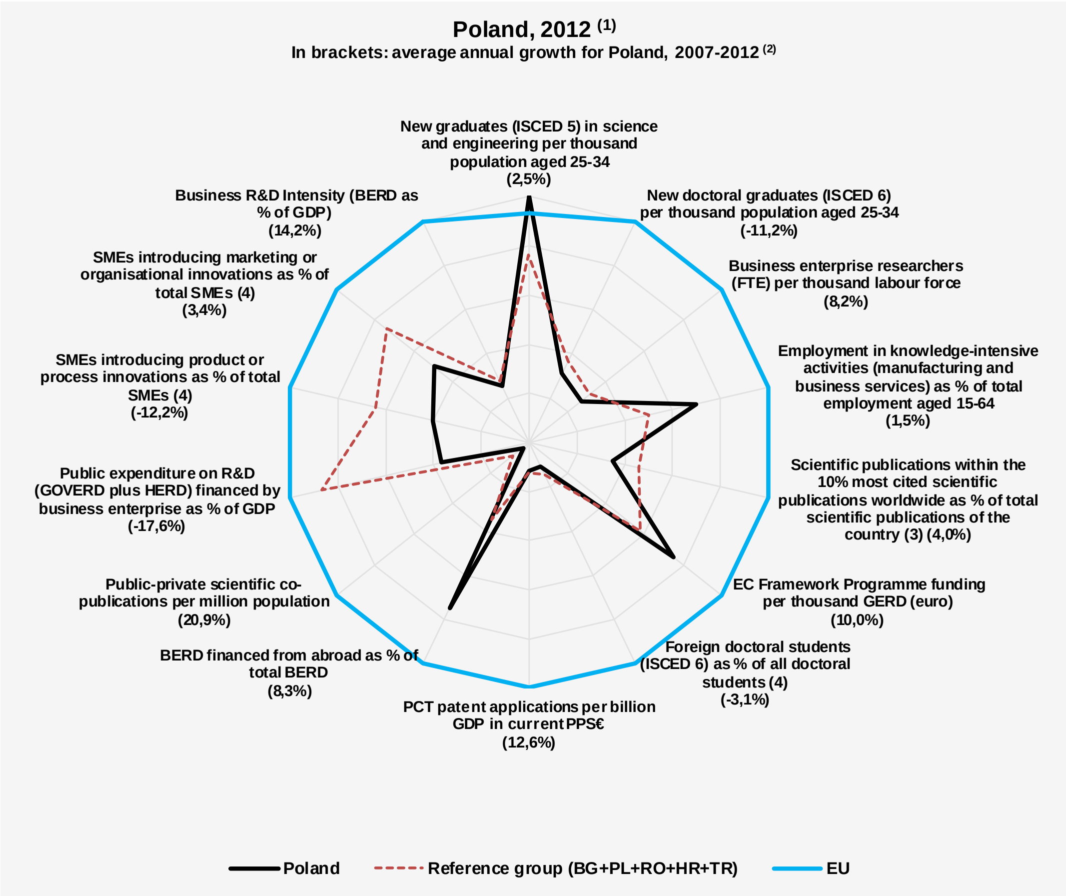
funding, contributing 51.3 % of GERD, well above the EU average of 33.4 %. The share of R&D financed and performed by business enterprises declined slightly over the 2000-2010 period before starting to rise again since 2011. In 2012, private businesses performed 37.2 % of total R&D (compared to the significantly higher EU average of 63 %) while the government performed 27.96 % of total R&D (compared to the EU average of 12 %). These indicators do not reflect efforts recently undertaken to increase public R&D spending and trigger private-sector investment in R&D.

Structural Funds are an important source of funding for R&I activities. Of the EUR 67 billion of Structural Funds allocated to Poland over the 2007-2013 programming period, around EUR 9.4 billion (14 % of the total) related to RTDI[32]. As regards the EU's Seventh Framework Programme (FP7) signed grant agreements, Poland ranks 13th in number of applicants and 15th in terms of requested EC contributions. Almost 2150 partners from Poland have participated in FP7, receiving EC financial contributions of over EUR 392 million. Given Poland's low level of participation in FP7 (19th in terms of applicants' success rate and 21st in terms of the success rate in financial contributions), clearly there are new opportunities available for Poland to engage in partnership with established centres of R&I excellence.

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

The graph below illustrates the strengths and weaknesses of the Polish 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.

[32] 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.

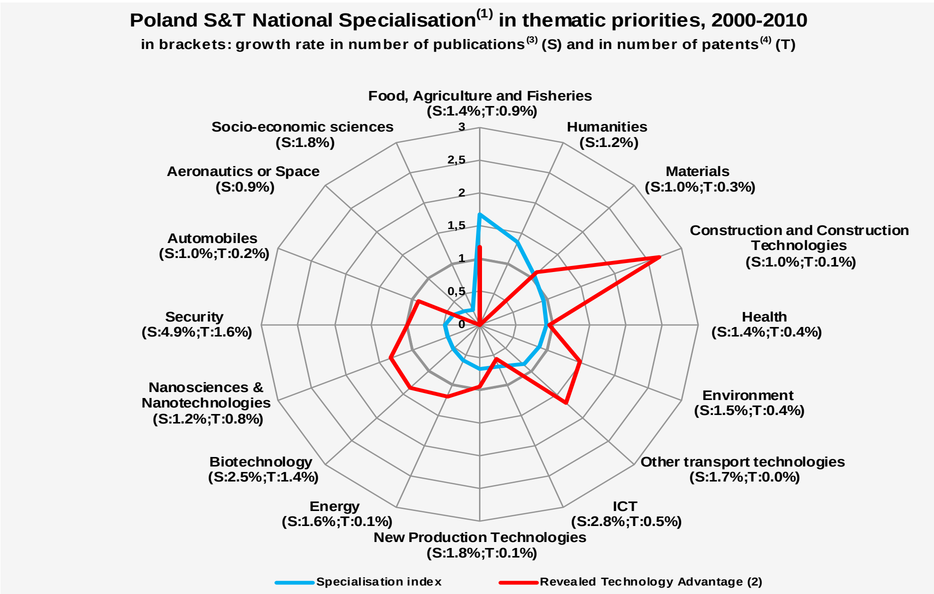
The Polish R&I system is primarily public-based with only 37.2 % of research being performed by the business sector (the EU average is 63 %). Poland's relative weaknesses are mainly on the output side and relate to the private sector's innovation performance. Its relative strengths are pronounced in human resources, where the average annual growth of new graduates in science and engineering exceeds the EU average. However, the number of new doctoral graduates and foreign doctoral students shows a significant decline (-11.2 % over the 2007-2012 period for new doctoral graduates). Poland has a low intensity of business researchers which reflects the minor role the business sector plays in the national R&I system. On a more positive note, the number of business researchers increased in 2012, showing a positive average annual growth over the 2007-2012 period.

Poland relies on foreign technology transfers to upgrade its economy. Domestic knowledge production is limited, and it has low scores in terms of both high-impact scientific publications and patent applications, where the difference from the EU average is particularly large. Only around 4 % of Polish scientific publications qualify for the top 10 % of most-cited scientific publications worldwide. This is the third lowest ranking among EU countries. The level of public-private co-publications is equally very low, highlighting weak linkages and a lack of cooperation culture between science and industry. While Poland performs better than other countries in the reference group in relation to the level of employment in knowledge-intensive activities, this indicator remains one of the lowest in the EU. High growth is observed for business R&D intensity, PCT patent applications and BERD financed from abroad. An alarming decline can be seen in all the innovation activities performed by small and medium-sized enterprises (SMEs): the percentage of SMEs introducing a new product or process is falling significantly. The same trend is observed for public expenditure on R&D financed by businesses.

Overall, business enterprises' low level of R&D expenditure and low R&D and innovation activity, coupled with insufficiently favourable framework conditions, has resulted in a poor scientific and technological performance.

Poland's scientific and technological strengths

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



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

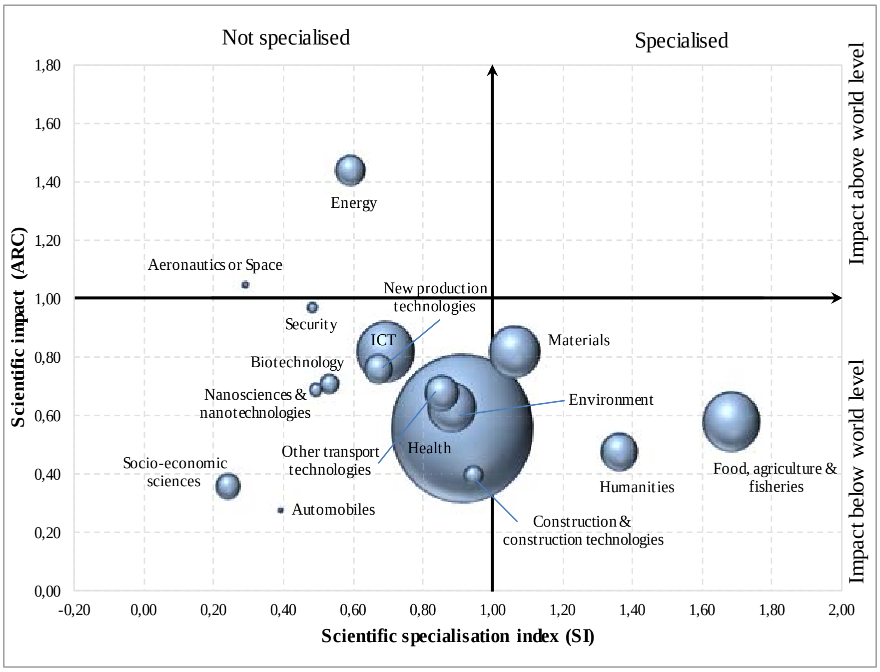
Comparison of the scientific and technological specialisation in selected thematic priorities shows a mixed situation with some co-specialisations as well as some mismatches. The technology production is strongly specialised in construction and construction technologies, transport, environment, biotechnology, nanosciences/nanotechnologies, and energy. However, no corresponding scientific specialisation can be found for those fields, with the exception of the science base in construction. These sectors mainly correspond to the scientific and economic fields identified in two national strategic documents in the area of research, development and innovation: the National Research Programme (KPB) and InSight2030 which formed the starting point for determining smart specialisation strategies at the national level.

Poland's scientific specialisation index shows that the main scientific fields are food, agriculture and fisheries, as well as humanities, and materials. In food, agriculture and fisheries, materials, and health, Polish technology production is quite important – these are the sectors with the corresponding matching between science and technology specialisations. The recently drafted Polish Smart Specialisation Strategy identifies 18 national smart specialisations in five thematic areas, which include sectors with important innovation potential: healthy society, bio-economy in the agri-food processing and environment, sustainable energy, natural resources and waste management, and innovative technologies and industrial processes.

Poland, together with Bulgaria, Romania, Turkey and Croatia, is classified as a low-knowledge-capacity system with a specialisation in low-knowledge intensity[33].

The graph below illustrates the positional analysis of Polish 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 Poland 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

There is a room for scientific impact improvement in some of the sectors ranking high on the science specialisation index, i.e. food, agriculture and fisheries, materials, construction, and humanities (for which a strong level of co-specialisation in S&T has also been identified). It is interesting to note the high level of scientific excellence attained in energy, while this sector has a low scientific specialisation indicator. Taking into account Polish technological specialisation in this field, the country would probably benefit from fostering scientific specialisation in energy.

The excellence in research correlates to more cooperation with researchers from other European countries and beyond. Therefore, in order to increase its research excellence, Poland would benefit

[33] Source: Innovation Union Competitiveness report

from actively supporting and providing incentives for its researchers to connect to Horizon 2020 networks. Considering its share of grants by FP7 fields, there is room for improvement, for instance, in the ICT sector. The availability of significant Structural Funds during the 2007-2013 period tended to reduce the attractiveness of participation in highly competitive European research programmes. Through the new financial perspective (2014-2020), more support instruments will enhance the participation of Polish applicants in international projects. The Operational Programme 'Smart Growth' includes instruments ensuring the complementarity of Polish R&D funding with Horizon 2020 and plans to support the preparation of applications in the Horizon 2020 and COSME programmes.

Policies and reforms for research and innovation

The challenges of increasing the quality and effectiveness of the Polish R&I system and linking science and industry have been addressed by reforms in higher education and science (2010-2011) which spurred significant changes, including a move towards more competitive funding schemes. In 2013, the Committee for Evaluation of Scientific Institutions (KEJN), an advisory body set up in 2010, conducted its first nationwide evaluation of scientific institutes by defining the levels of institutional funding on the basis of several criteria, including technology transfers to industry and collaborative projects. The Polish government has declared that by 2020 it will distribute 50 % of its entire science budget through competitive mechanisms. However, already in 2013, 44.1 % of all science funds were allocated through competitions (as against 30.9 % in 2007), which was largely due to the performance-based funding allocated by NCN[34] (a basic research executive agency established in 2010) and NCBiR[35] (an applied research executive agency established in 2007 and reinforced by the above-mentioned reforms).

Projects run by the NCBiR are successful in inducing substantial new investment in private R&D by focusing on the stimulation of science-industry cooperation and supporting the commercialisation of R&D. Recent initiatives, such as BRIdge VC, Bridge Alfa or DEMONSTRATOR+, the so-called 'fast-track support scheme', induce the use of financial instruments, venture capital funds, and enhance the transfer of research results to the economy. The sectoral programmes (INNOLOT, INNOMED) have been very successful in fostering cooperation within industry and between industry and academia. Further measures to encourage innovation, such as increasing the role of scientists in the process of knowledge commercialisation, and better matching the higher education system to business needs are foreseen in recently proposed amendments to the Acts on Higher Education and on the Principles of Financing Science. In addition, already adopted amendments to the Act on public procurement have relaxed the binding restrictions on R&D services, and the first project supporting the use of pre-commercial procurement by the Polish public administration was launched by NCBR in July 2013. Thirty 'brokers of innovation' selected during the first competition launched by the Ministry of Science and Higher Education (September 2013) will deal with the commercialisation of research, the creation of spin-off companies and the conclusion of licence agreements. The second edition of the competition for the Polish KNOW (National Leading Scientific Centres) is ongoing in parallel with the Top 500 innovators initiative which aims to improve the technology transfer skills of researchers and professionals. To strengthen the technology transfer of universities and public research organisations, in 2013, the ministry launched the 'Innovation Incubators' programme and the NCBiR launched the SPIN-TECH programme.

New policy documents are directed at boosting indigenous local innovation by Polish companies. In January 2013, the 'Strategy for the Innovation and Effectiveness of the Economy' (SIEG), the country's main document setting out its R&I policy priorities, was adopted. By addressing significant

[34] The National Science Centre
[35] The National Centre for Research and Development

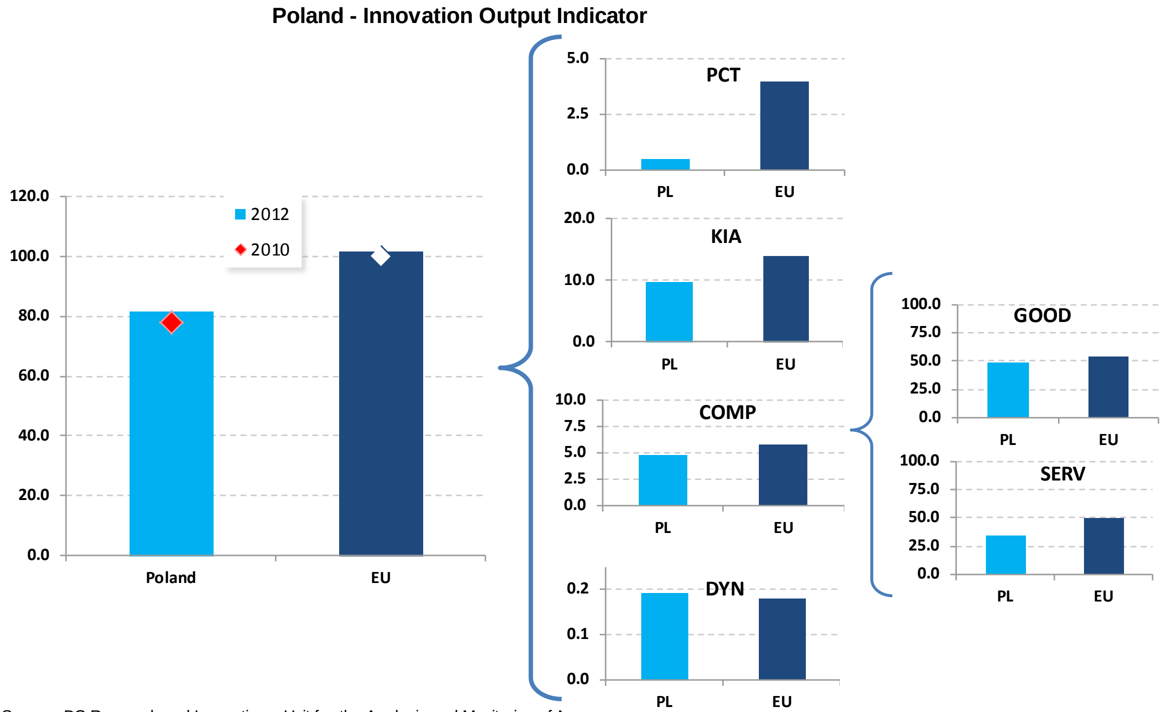
weaknesses within the Polish R&I system, the most important being the innovative output, the new innovation strategy foresees greater emphasis on financial engineering and demand-side measures. Its executive programme PRP introduces the proposition of tax incentives for innovative companies[36] and proposes adequate instruments for different phases of the innovation cycle, i.e. grants for projects with a higher risk level and financial instruments to help with implementation and internationalisation stages. The Smart Growth OP, adopted by the government in January 2014, will implement the PRP. With the proposed budget of EUR 8.6 million for R&D, it will focus on the development of in-house innovations "from idea to market", covering the entire innovation cycle, and on the business funding of R&D via financial instruments, such as loans, public guarantees and PPPs with venture capital funds. Until now, risk aversion remains a significant problem for participants in the Polish R&I system with only 30 % of entrepreneurs using outside funding, with conservative selection panels, and grants remaining the predominant source of funding even for less-risky projects. Together with the National Strategy for Smart Specialisation (KIS), which forms an integral part of the PRP, new policy documents aim at streamlining and prioritising the support measures and enhancing innovation, and will be used as the basis for supporting R&I in the period 2014-2020.

Raising the innovativeness of Polish companies and strengthening science-industry cooperation has been a long-standing challenge for which different policy responses have been proposed in recent years. Strategically, Poland is addressing those challenges well. The way forward would be to fully implement these innovation-oriented reforms and conduct the systematic evaluation of policies to determine whether and how policy interventions can achieve the desired change.

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

[36] The introduction of tax relief for R&I is foreseen following the removal of Poland's excessive deficit procedure.



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 %).

Improving the economic impact of innovation remains one of the main challenges for the Polish R&I system. Poland is a below average performer in the Innovation Output Indicator, even though its performance has clearly been improving since 2010. A very low performance in patents (PCT) is linked to the still overall limited research capacity, the low level of internationalisation of the science sector as well as to the Polish economic structure, which is characterised by businesses' limited investment and innovativeness. There is a lack of large Polish multinational manufacturing companies, and the international companies, including motor-vehicle producers, which have production facilities in Poland tend to do their research and patenting in the headquarter country.

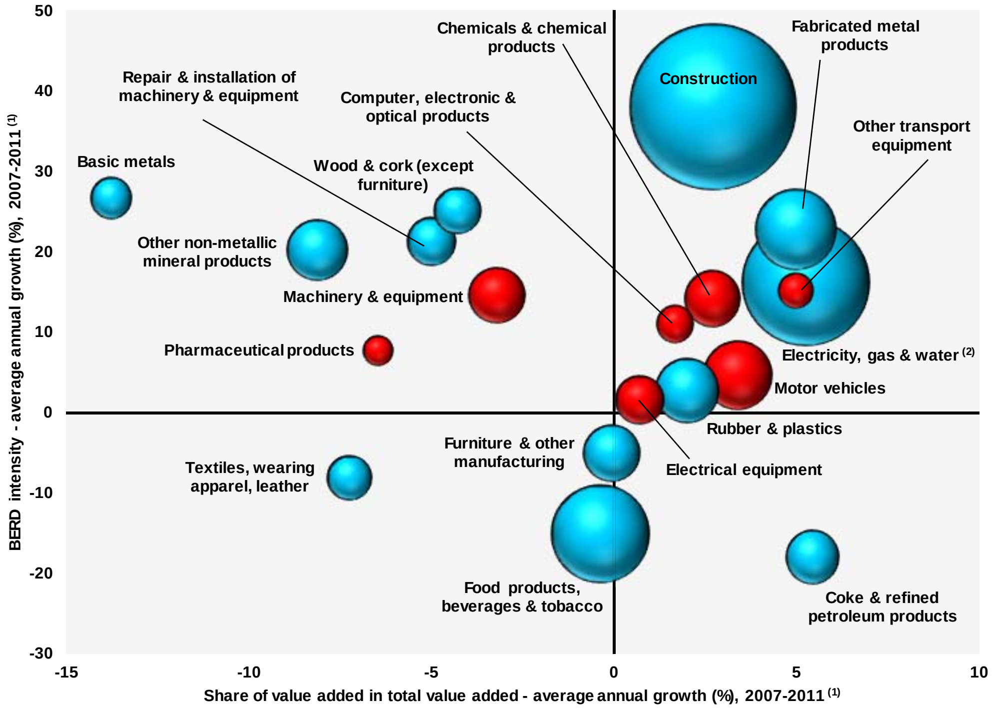
The importance of employment in agriculture and construction to the Polish economy contributes a low share of employment in knowledge-intensive activities (KIA). In addition, the low share of knowledge-intensive service exports (SERV) is explained by relatively high exports of non-KIS transport services (mainly road freight transport, but also pipelines) and construction services, not compensated by any strongholds in KIS exports. Poland performs above the EU average in the innovativeness of fast-growing innovative firms (DYN). This is the result of a high share of the financial services sector among fast-growing firms.

There is strong awareness of those challenges at national level and support mechanisms have been launched to encourage science-industry cooperation and foster the innovativeness of Polish companies. The new Strategy for the Innovation and Effectiveness of the Economy is aiming for an integrated approach to R&I embedded in a wider economic context.

__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 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.

Poland - 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', 'Wood and products of wood and cork': 2007-2010; 'Coke and refined petroleum products', 'Furniture and other manufacturing': 2008-2011.
(2) 'Electricity, gas and water' includes 'sewerage, waste management and remediation activities'.
(3) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

Comparison of the positioning of the high-tech or medium-tech sectors for 2007-2011, with their previous positioning illustrated in the 2013 country profile for the years 1995-2007, shows a clear increase in the R&D intensities in all the research-intensive sectors: machinery and equipment, chemicals and chemical products, motor vehicles, electrical machinery and apparatus, medical precision and optical instruments. For numerous sectors (with the exception of machinery and equipment and pharmaceutical products) this shift was accompanied by an increasing share of value added in the overall economy. This finding suggests that Poland is moving towards more research-intensive, higher-value-added products in high-tech and medium-tech industries. However, with the exception of motor vehicles, the share of those sectors (in value added) in manufacturing is not gaining any special importance.

Poland's economic structure is still dominated by less research-intensive sectors, mainly construction, fabricated metal products, and electricity, gas and water. The visible increase in Polish business R&D intensity, especially for construction, basic metals, wood and cork, fabricated metal products, repair and installation of machinery and equipment, furniture and other manufacturing, reflects the economy's continuous reliance on the country's traditional sectors.

The above economic structure is reflected in the sectors of activity of the top Polish corporate R&D investors. Poland has four out of 1000 companies analysed in the 2013 EU Industrial R&D Investment Scoreboard, coming from the fields of telecommunications, banking, software and computers. Overall, the relatively stable sectoral composition of Polish industry around low research-intensive sectors reflects the country's comparative weaknesses in terms of R&I performance.

Key indicators for Poland

POLAND	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]	Rank within EU
ENABLERS												
Investment in knowledge												
New doctoral graduates (ISCED 6) per thousand population aged 25-34	:	1,00	1,01	1,02	0,92	0,82	0,53	0,48	0,56	-11,2	*1,81*	26
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	495	:	:	495	:	:	518	22.1 [3]	495 [4]	4 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	0,23	0,18	0,18	0,17	0,19	0,19	0,20	0,23	0,33	14,2	1,31	23
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0,41	0,39	0,38	0,39	0,42	0,48	0,54	0,53	0,56	7,4	*0,74*	16
Venture Capital as % of GDP	0,11	0,06	0,11	0,14	0,20	0,15	0,14	0,19	0,14	0,3	0,29 [5]	11 [5]
S&T excellence and cooperation												
Composite indicator on research excellence	:	:	:	12,5	:	:	:	:	20,0	9,8	47,8	24
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	3,5	3,5	3,5	3,4	3,8	:	:	:	4,0	11,0	24
International scientific co-publications per million population	:	178	189	192	194	206	205	215	226	3,3	343	25
Public-private scientific co-publications per million population	:	:	:	2	3	3	4	5	:	20,9	53	26
FIRM ACTIVITIES AND IMPACT												
Innovation contributing to international competitiveness												
PCT patent applications per billion GDP in current PPS€	0,3	0,2	0,3	0,3	0,4	0,5	0,5	:	:	12,6	3,9	22
License and patent revenues from abroad as % of GDP	0,02	0,02	0,01	0,02	0,04	0,02	0,05	0,05	0,05	14,9	0,59	21
Community trademark (CTM) applications per million population	0,8	20	25	33	42	41	46	51	56	10,9	152	23
Community design (CD) applications per million population	:	7	10	14	17	23	21	25	27	14,3	29	13
Sales of new to market and new to firm innovations as % of turnover	:	:	10,1	:	9,8	:	8,0	:	:	-9,8	14,4	23
Knowledge-intensive services exports as % total service exports	:	22,6	23,2	22,2	24,5	26,1	26,1	28,3	:	6,2	45,3	18
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-5,74	-1,99	-0,93	-0,39	0,34	0,45	0,37	0,88	0,58	-	4,23 [6]	19
Growth of total factor productivity (total economy) - 2007 = 100	86	96	98	100	100	99	100	101	101	1 [7]	97	3
Factors for structural change and addressing societal challenges												
Composite indicator on structural change	:	:	:	32,2	:	:	:	:	34,8	1,5	51,2	23
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	8,2	8,9	9.4 [8]	9,6	9,7	1,5	13,9	24
SMEs introducing product or process innovations as % of SMEs	:	:	20,4	:	17,5	:	13,5	:	:	-12,2	33,8	27
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,00	0,03	0,01	0,03	0,06	0,06	:	:	:	29,3	0,44	19
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0,03	0,05	0,04	0,06	0,06	0,06	:	:	:	-1,2	0,53	24
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES												
Employment rate of the population aged 20-64 (%)	61,0	58,3	60,1	62,7	65,0	64,9	64.3 [8]	64,5	64,7	0,3	68,4	19
R&D Intensity (GERD as % of GDP)	0,64	0,57	0,56	0,57	0,60	0,67	0,74	0,76	0,90	9,7	*2,07*	20
Greenhouse gas emissions - 1990 = 100	84	85	89	89	88	83	88	88	:	-2 [9]	83	14 [10]
Share of renewable energy in gross final energy consumption (%)	:	7,0	7,0	7,0	7,9	8,8	9,3	10,4	:	10,4	13,0	18
Share of population aged 30-34 who have successfully completed tertiary education (%)	12,5	22,7	24,7	27,0	29,7	32,8	34,8	36,5	39,1	7,7	35,7	15
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	5,3	5,4	5,0	5,0	5,3	5,4	5,6	5,7	2,7	12,7	5 [10]
Share of population at risk of poverty or social exclusion (%)	:	45,3	39,5	34,4	30,5 [11]	27,8	27,8	27,2	26,7	-3,3	24,8	17 [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 2010 and the previous years. Average annual growth refers to 2010-2012.
(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) 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:

"Improve the effectiveness of tax incentives in promoting R&D in the private sector as part of the efforts to strengthen the links between research, innovation and industrial policy, and better target existing instruments at the different stages of the innovation cycle."