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

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The challenge of structural change towards a more diversified economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Norway. 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: 1.65 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.7 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[1] 2012: 67.6 (EU: 47.8; US: 58.1) 2007-2012: +15.7 % (EU: +2.9 %;US: -0.2 %)
Innovation Output Indicator 2012: 83.9 (EU: 101.6)	*Knowledge-intensity of the economy*[2] 2012: 40.0 (EU:51.2; US: 59.9) 2007-2012: +2.4 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Energy, environment, food, agriculture and fisheries, and other transport technologies	*HT + MT contribution to the trade balance* 2012: -17.4 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US:-32.3 %)

Norway has the second highest GDP per capita in Europe. This partly explains the low R&D intensity level, which was only 1.65 % in 2012, well below the EU average (2.07 %). Nevertheless, Norway maintains one of the highest spending levels on R&D per capita. The country's R&D intensity fluctuated slightly over the period 2007-2012, reaching a high of 1.76 % in 2009 but remaining almost stable between 2010 and 2012, with an average annual growth rate of 0.7 %.

To a large extent the Norwegian economy is based on traditional industrial activities related to the extraction of raw materials and natural resources (i.e. oil and natural gas, fish, minerals) and to their industrial processing into bulk products and semi-finished goods. High shares of public R&D financing have been allocated to these activities to improve their efficiency. However, a forward-looking distribution of R&D investments should be considered in order to reduce Norway's dependence on raw materials and facilitate a gradual change towards a more diversified economy.

The knowledge-intensity of the Norwegian economy remains below the EU average although it has been growing at a faster rate in recent years (+2.4 % instead of +1.0 % at the European level). Internationalisation has become an overall priority of the government's R&I policy in recent years in order to improve the quality of research. The new White Paper on research entitled 'Long-term perspectives – Knowledge provides opportunity', which was presented in March 2013, states that Norway should commit to strengthening the internationalisation of its research system. Following this line, it has been requested that all activities of the Research Council of Norway (RCN) include clearly defined objectives and plans for international cooperation. Moreover, in terms of funding, there has

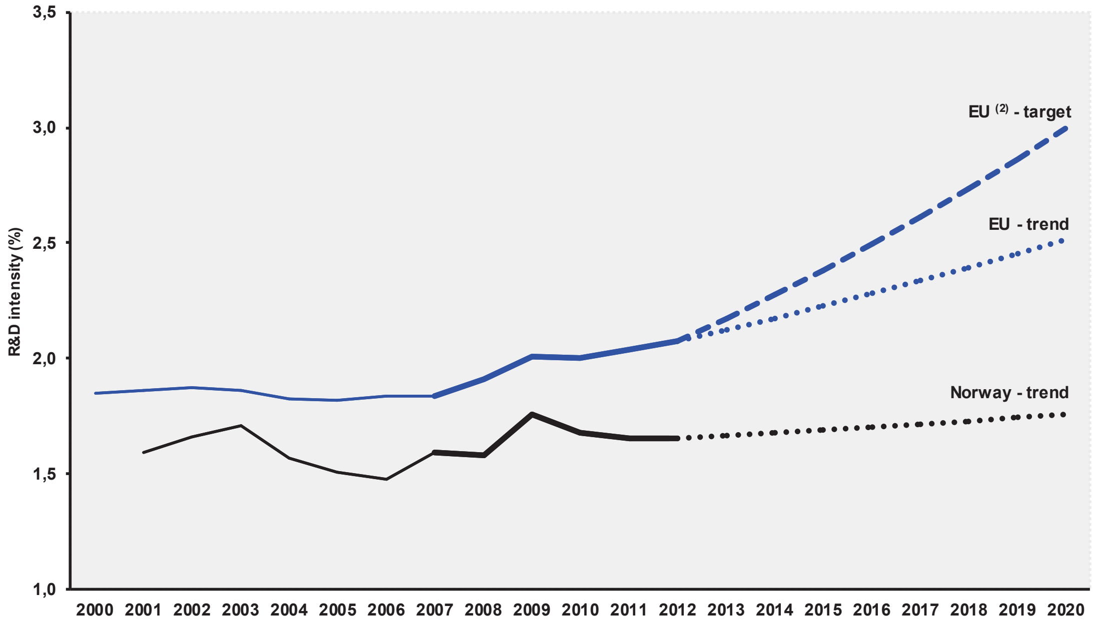
[1] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.
[2] Composite indicator that includes R&D, skills, sectoral specialisation, international specialisation and internationalisation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

been a shift from instruments dedicated to internationalisation towards including the internationalisation dimension in all activities.

The Norwegian system also shows a high level of S&T excellence (67.6 in 2012 compared to an EU average of 47.8), which is expected to increase further in the following years, thanks to its significant growth rate (+15.7 % between 2007 and 2012).

Investing in knowledge

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) NO: An R&D intensity target for 2020 is not available.

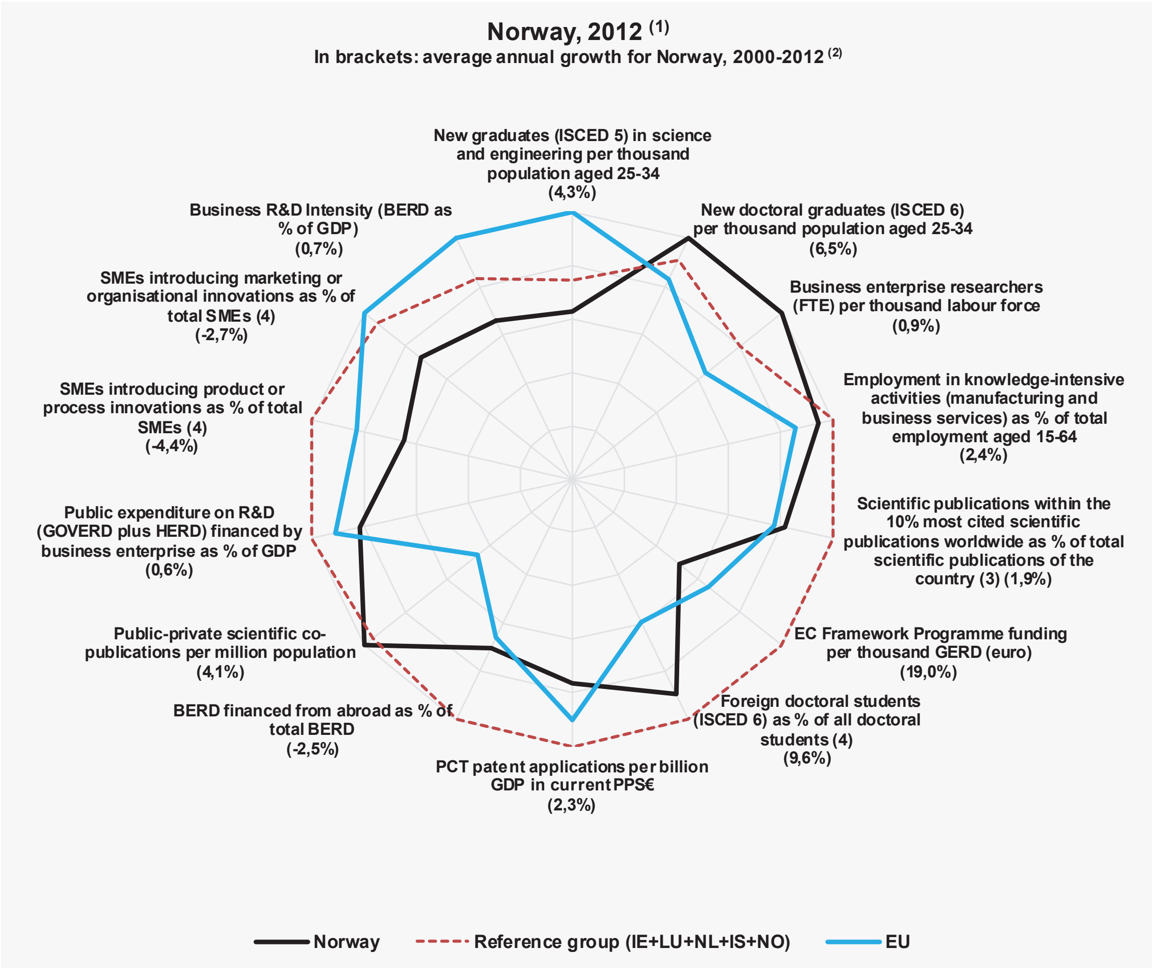
Norway's R&D intensity was 1.65 % in 2012, which is still a long way from the EU average. This is partly due to the particular nature of the Norwegian economy – which is characterised by traditional industrial activities related to the extraction and processing of natural resources – and partly to its high level of GDP. Nevertheless, following its election in October 2013, the new government has committed to achieving a 3 % target by 2030.

While in 2012 Norway's public R&D intensity was slightly higher than the EU average (0.79 % vs. 0.74 %), the 0.87 % business R&D intensity was much lower than the EU value of 1.31 %, and a long way below the level of the other Nordic countries. However, it is important to mention that the BERD value does not include any form of indirect support, such as tax credits, which is still the largest R&D support scheme for business in Norway. In recent years, Norwegian policy-makers have increasingly recognised that the low level of industrial R&D should be seen against the backdrop of the country's industrial structure, and the new government has already declared its intention to put more emphasis on stimulating R&D investments in the private sector.

The EU's Seventh Framework Programme is the most important international research programme in which Norway participates. Norwegian institutions and researchers have been participating in EU FPs since 1987. The success rate of Norwegian participants in FP7 is 24.49 %, which means that one in four applicants eventually receives funding. To date, the successful participants have received a total EU financial contribution of EUR 675 million.

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

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



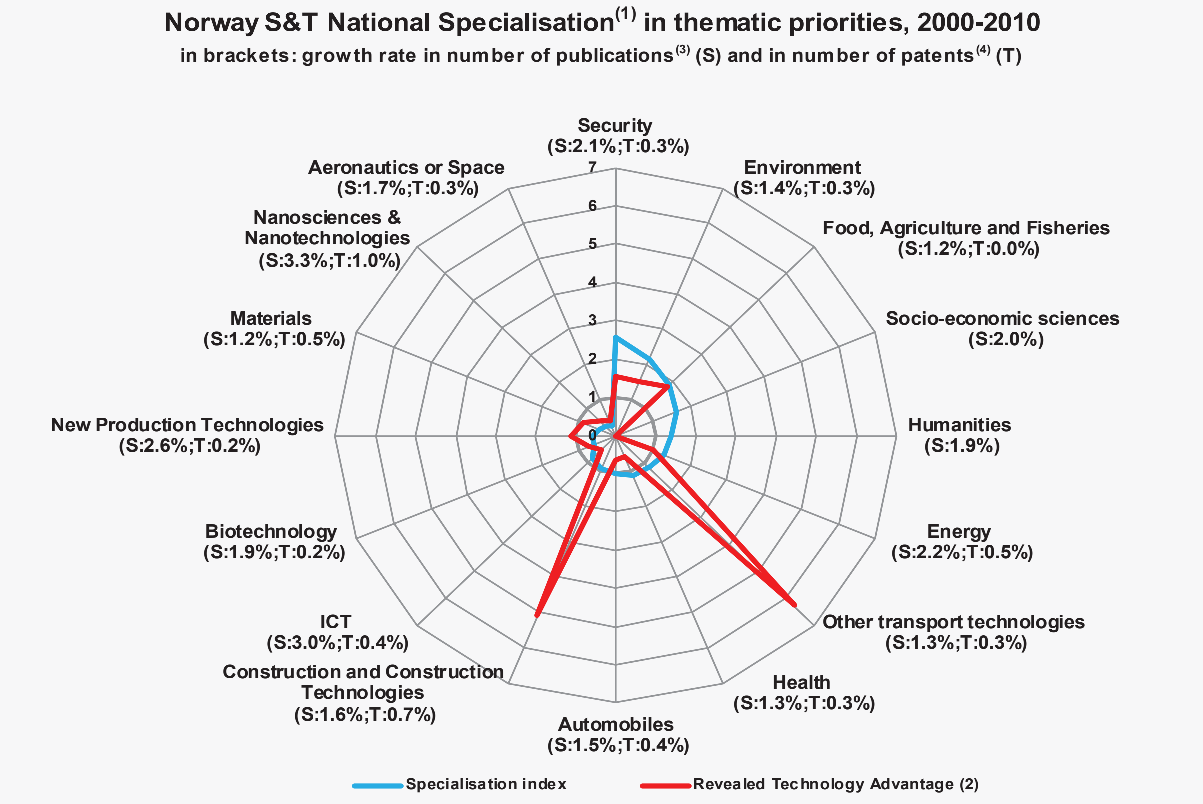
Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) The values refer to 2012 or to the latest available year.
(2) Growth rates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

Norway's main strengths are its human resources, public-private cooperation, and the attractiveness of its research system. Although the share of new graduates in science and engineering is lower than the EU average, Norway has a very high number of full-time researchers in the labour force and a strong dynamic of new doctoral graduates. At the same time, it is among the OECD countries with the highest education level, revealing a wide range of employees with higher-education qualifications in both the public and private sectors. Furthermore, the Norwegian higher education system is considered attractive by foreign doctoral students, with numbers continuing to rise since 2000 (+9.6 % annual growth). As regards public-private collaboration, the number of co-publications is much higher in Norway than in other European countries.

Areas of relative weakness are private investments in R&D, the low levels of patenting, and the modest level of business innovation among small and medium-sized enterprises (SMEs). While both the BERD intensity and the number of PCT patent applications have increased slightly in recent years, the share of SMEs introducing marketing/organisational or product/process innovation has decreased even further. A variety of measures targetting SMEs exist in Norway, such as the Skattefunn and the BIA schemes. The first is a tax-credit scheme aiming to leverage R&D activities in businesses, whereas the second one is a funding scheme for business innovative projects without any thematic restriction. Norwegian authorities have also tried to simplify rules and reduce the administrative burden on SMEs in a wide range of fields, such as competition, tax and auditing.

Norway's scientific and technological strengths

The graph below illustrates the areas, based on the Framework Programme thematic priorities, where Norway shows scientific and technological specialisations[3]. 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 the one existing at the world level. For each specialisation field it provides information on the growth rate in the number of publications and patents.



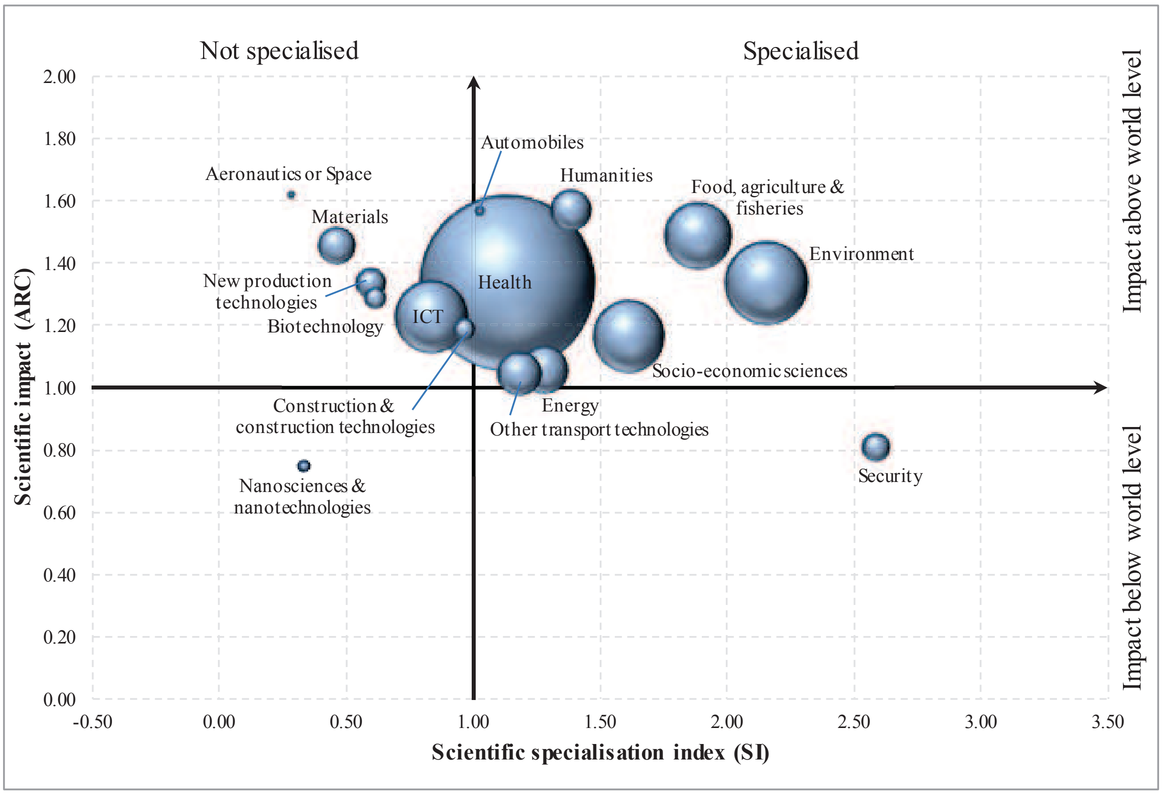
Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix - Canada, Univ. Bocconi - Italy
Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
(2) The Revealed Technology Advantage is calculated based on the data corresponding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

[3] Please note that Norway only became an EPO member state in 2008.

The annual report on the condition and evolution of Norway's higher-education sector published in May 2013 shows that the number of scientific publications has registered a 60 % increase since 2003. Norwegian S&T activities present substantial scientific specialisations in almost all FP7 thematic priorities, the only exceptions being aeronautics, nanotechnologies, materials, new product technologies, and biotechnologies. This scientific activity follows the country's R&D policy priorities closely.

At the same time, Norway's technology production is quite well in line with the scientific specialisation patterns, showing relative strengths in patenting in many sectors, such as other transport technologies, construction technologies, energy, food, agriculture and fisheries, and environment. This alignment between scientific publications and revealed technology advantages reflects smooth knowledge transfer between academia and private companies, although the level of Norwegian patenting remains below the EU average for both PCT and European Patent Office applications.

Positional analysis of Norway 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

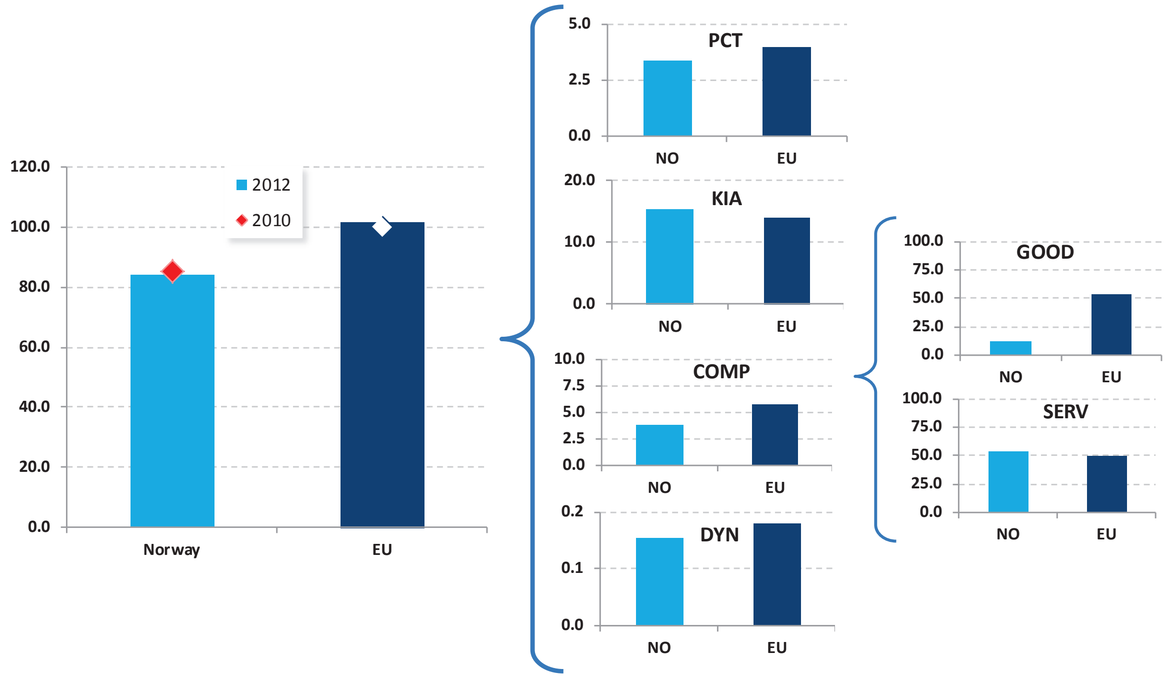
The graph above illustrates the positional analysis of Norwegian publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share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

The country is mainly specialised in security, environment, food, agriculture and fisheries, and socio-economic sciences and humanities. In almost all sectors, the scientific impact of publications is above the world level, with the exception of nanotechnology and security. As in almost all countries, the health bubble dominates strongly. Since the mid-1990s, Norway has seen the most significant rise in scientific impact, and today the proportion of highly cited Norwegian scientific publications is greater than the EU average.

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

Norway - Innovation Output Indicator



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

Norway is a medium-low performer in the European innovation indicator. This is mainly due to a very low performance in the export share of medium-/high-tech goods. All other areas are almost in line with or above the EU average, and Norway's performance is improving slightly.

With mineral fuels (oil, natural gas) representing two-thirds of exports, and fish representing another 6 %, the share of medium-/high-tech goods in total good exports is relatively low in Norway (at the lowest position in Europe). Norway performs better (i.e. slightly above the EU average) in knowledge-intensive services exports, mainly as a result of its maritime freight transport sector.

The country performs below EU average in the innovativeness of fast-growing firms because of high shares of employment in the mining and quarrying, and construction sectors. However, the share of employment in knowledge-intensive activities is well above the EU average, showing that the quality of Norway's human capital remains one of its greatest strengths.

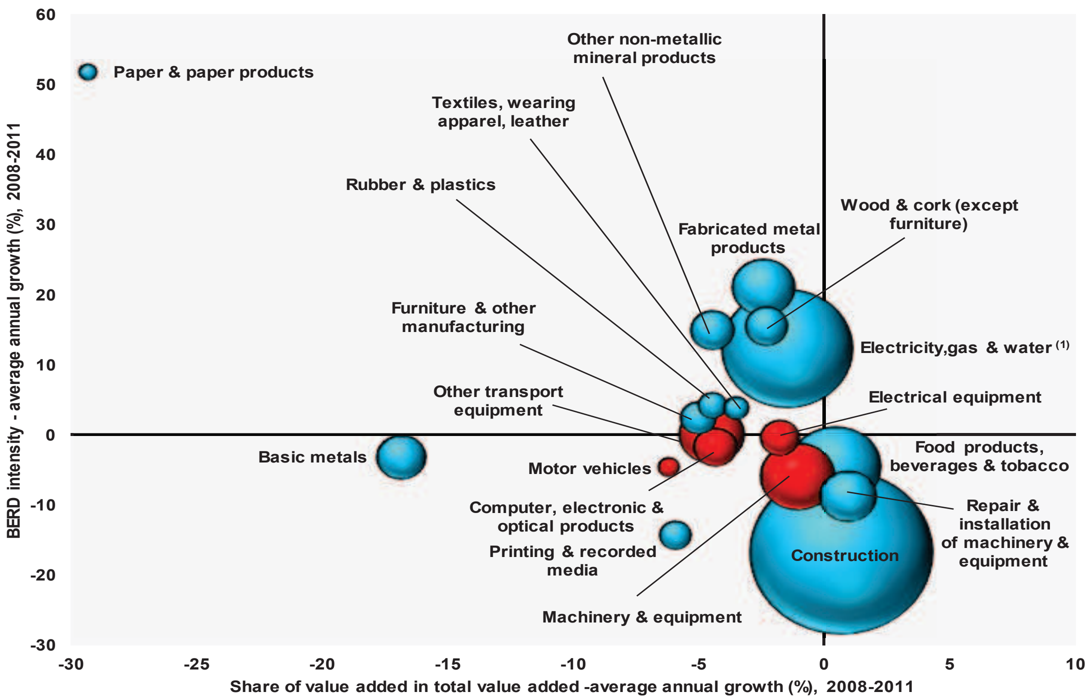
The production in services accounts for around 76 % of employment (man hours) and 52 % of value added in the Norwegian economy (2010). The construction sector is not included in the figures. The share of services in total value added is lower in Norway compared to many other advanced economies, mainly as the result of a dominant oil sector in the country. In its Review of Innovation Policy in Norway (OECD, 2008) the OECD notes that "Non-R&D based innovation, for instance in the service sector, seems to underlie the exceptional productivity performance of the private service sector".

Innovation Norway and the Research Council of Norway manage several schemes and instruments promoting innovation. Policies aiming to strengthen the framework conditions for innovation and targeted programmes aiming to enhance innovation in enterprises are open to all industry sectors, but there are no schemes exclusively for service innovation.

Upgrading the manufacturing sector through research and technologies

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

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



Source: DG Research and Innovation - Analysis and monitoring of national research policies unit
Data: Eurostat
Notes: (1) 'Electricity, gas and water' includes 'sewerage, waste management and remediation activities'.
(2) High-Tech and Medium-High-Tech sectors (NACE Rev. 2 - 2 digit level) are shown in red.

The above graph shows that there were only small changes in R&D investments in the manufacturing sectors over the period 2008-2011. Very few sectors have significantly increased their R&D intensities (i.e. paper and paper products, fabricated metal products, other non-metallic mineral products, wood and cork, electricity, gas and water), and manufacturing in general has continued to lose its weight in the overall economy. Most of the sectors are grouped near the intersection point of the axes, meaning that small variations in levels of R&D intensity are usually accompanied by small or no variations in shares of value added. In this context, the paper and paper products sector represents a negative exception as its business R&D intensity registered a significant increase (+51.8 %) while the share of value added decreased drastically (- 29.3 %).

In recent years, R&D policies and innovation strategies have focused on specific and representative areas of Norway's economy. These include the strategies for oil and gas, energy, climate, green growth, biotechnologies, nanotechnologies, and the maritime sector. At the national level, there is also a broad political consensus on the need to foster R&D-intensive and knowledge-intensive manufacturing industries and services by exploiting both renewable and non-renewable energy technologies.

Key indicators for Norway

NORWAY	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 [1] (%)	EU average [2]
ENABLERS											
Investment in knowledge											
New doctoral graduates (ISCED 6) per thousand population aged 25-34	0.96	1.33	1.41	1.59	1.99	1.74	1.92	2.05	2.17	6.5	*1.81*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	490	:	:	498	:	:	489	-0.5 [3]	495 [4]
Business enterprise expenditure on R&D (BERD) as % of GDP	:	0.81	0.79	0.84	0.84	0.91	0.86	0.86	0.87	0.7	1.31
Public expenditure on R&D (GOVERD + HERD) as % of GDP	:	0.70	0.69	0,76 [5]	0.74	0.85	0.82	0.79	0.79	*0.8*	*0.74*
Venture Capital as % of GDP	0.16	0.17	0.17	0.24	0.25	0.23	0.29	0.20	0.22	-2.1	0,29 [6]
S&T excellence and cooperation											
Composite indicator on research excellence	:	:	:	32.6	:	:	:	:	67.6	15.7	47.8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	11.3	11.7	11.1	12.1	11.5	:	:	:	1.9	11.0
International scientific co-publications per million population	:	938	1078	1191	1293	1440	1539	1638	1767	8.2	343
Public-private scientific co-publications per million population	:	:	:	98	102	114	119	116	:	4.1	53
FIRM ACTIVITIES AND IMPACT											
Innovation contributing to international competitiveness											
PCT patent applications per billion GDP in current PPS€	4.3	3.5	3.2	3.1	2.9	3.7	3.3	:	:	2.3	3.9
License and patent revenues from abroad as % of GDP	0.10	0.17	0.20	0.18	0.15	0.17	:	:	:	-3.3	0.59
Community trademark (CTM) applications per million population	28	35	44	48	59	70	68	70	72	8.3	152
Community design (CD) applications per million population	:	15	16	18	14	16	13	9	10	-10.8	29
Sales of new to market and new to firm innovations as % of turnover	:	:	4.8	:	3.3	:	6.1	:	:	35.2	14.4
Knowledge-intensive services exports as % total service exports	:	47.7	50.1	46.9	48.9	49.4	:	:	:	2.6	45.3
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-19.77	-18.39	-18.26	-17.52	-17.73	-16.74	-16.46	-17.38	-17.42	-	4,23 [7]
Growth of total factor productivity (total economy) - 2007 = 100	96	102	101	100	97	94	94	94	94	-6 [8]	97
Factors for structural change and addressing societal challenges											
Composite indicator on structural change	:	:	:	35.4	:	:	:	:	40.0	2.4	51.2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	13.8	14.9	14.2	15.1	15.2	2.4	13.9
SMEs introducing product or process innovations as % of SMEs	:	:	29.8	:	28.9	:	26.4	:	:	-4.4	33.8
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.22	0.24	0.22	0.30	0.24	0.39	:	:	:	14.0	0.44
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.55	0.29	0.34	0.29	0.24	0.31	:	:	:	3.3	0.53
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES											
Employment rate of the population aged 20-64 (%)	80.3	78.2	79.5	80.9	81.8	80.6	79.6	79.6	79.9	-0.2	68.4
R&D Intensity (GERD as % of GDP)	:	1.51	1.48	1.59	1.58	1.76	1.68	1.65	1.65	0.7	2.07
Greenhouse gas emissions - 1990 = 100	107	108	108	111	108	103	108	:	:	-3 [9]	83
Share of renewable energy in gross final energy consumption (%)	:	60.2	60.7	60.5	62.1	65.2	61.4	65.0	:	1.8	13.0
Share of population aged 30-34 who have successfully completed tertiary education (%)	37.3	39.4	41,9 [10]	43.7	46.2	47.0	47.3	48.8	47.6	1.7	35.7
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	12.9	4.6	17.8 [10]	18.4	17.0	17.6	17.4	16.6	14.8	-4.3	12.7
Share of population at risk of poverty or social exclusion (%)	:	16.2	16.9	16.5	15.0	15.2	14.9	14.5	13.8	-3.5	24.8

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

Switzerland

The challenge of structural change maintaining a leading competitive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Switzerland. 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 2008: 2.87 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +0.5 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[4] 2012: 97.7 (EU:47.8; US: 58.1) 2007-2012: +2.6 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 117.8 (EU: 111.6)	*Knowledge-intensity of the economy*[5] 2012: 73.4 (EU: 51.2; US: 59.9) 2007-2012: +0.8 % (EU: +1.0 %; US: +0.5 %)
Areas of marked S&T specialisations: Energy, environment, biotechnology, ICT, nanoscience and nanotechnology	*HT + MT contribution to the trade balance* 2012: 8.1 % (EU: 4.23 %; US: 1.02 %) 2007-2012: +1.3 % (EU: +4.8 %; US: -32.3 %)

Switzerland's level of economic development is amongst the highest in Europe. Swiss research policy is characterised by continuity and stability and the country performs better in R&D than both the EU (average) and the United States. Switzerland had an R&D intensity of 2.87 % in 2008 (the latest available year) with an R&D intensity average annual growth rate of 1.9 % in the period 2000-2008, both of which are higher than the corresponding values for the EU (2.03 % and 0.8 %) and the US (2.75 % and 0.2 %).

The high level of R&D performance is accompanied by a high level of S&T excellence with Switzerland performing at a level twice the EU average. It is one of the most advanced countries in terms of the knowledge-intensity of its economy, and made even further progress over the years 2007-2012. The country performs well in all indicators relating to the size of the knowledge economy. There is also a high performance on the cumulative inward and outward FDI stock as a share of GDP, relative specialisation in the exports of medium-high-tech and high-tech products (Revealed Competitive Advantage) and the share of value added in knowledge-intensive activities within the country's total value added.

The contribution of high-tech (HT) and medium-high-tech (MT) products to the country's trade balance is much higher than the corresponding contributions in the EU as a whole and the US. It is based on a very good performance by the knowledge-intensive sectors of the economy and includes sectors such as medicaments and vaccines, watches, and orthopaedic appliances.

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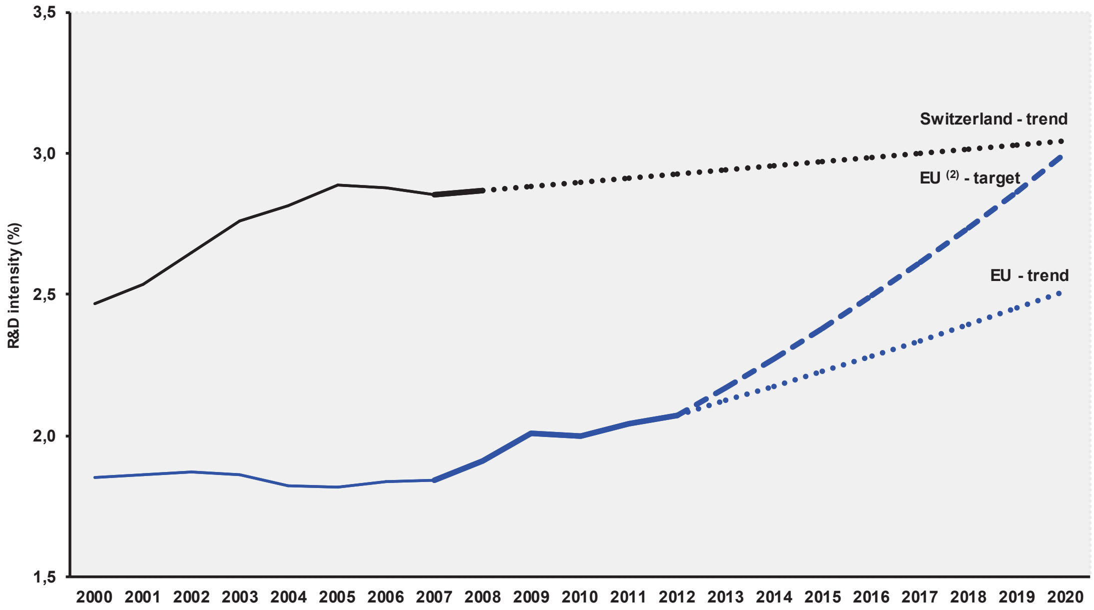
[4] Composite indicator that includes PCT per population, ERC grants per public R&D, top universities and research institutes per GERD and highly cited publications per total publications.

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

Investing in knowledge

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2004-2008 in the case of Switzerland.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) CH: An R&D intensity target for 2020 is not available.
(4) CH: The values for 2001, 2002, 2003, 2005, 2006 and 2007 were interpolated by DG Research and Innovation.

The Swiss research system is of high quality and based on a clear-cut separation between the public sector, which is centred on very-research-intensive universities, and the private sector, which is focused on the large research units within multinational companies. The main priority for Swiss national R&I policies is to provide excellent framework conditions by fostering basic as well as applied research and technology transfer.

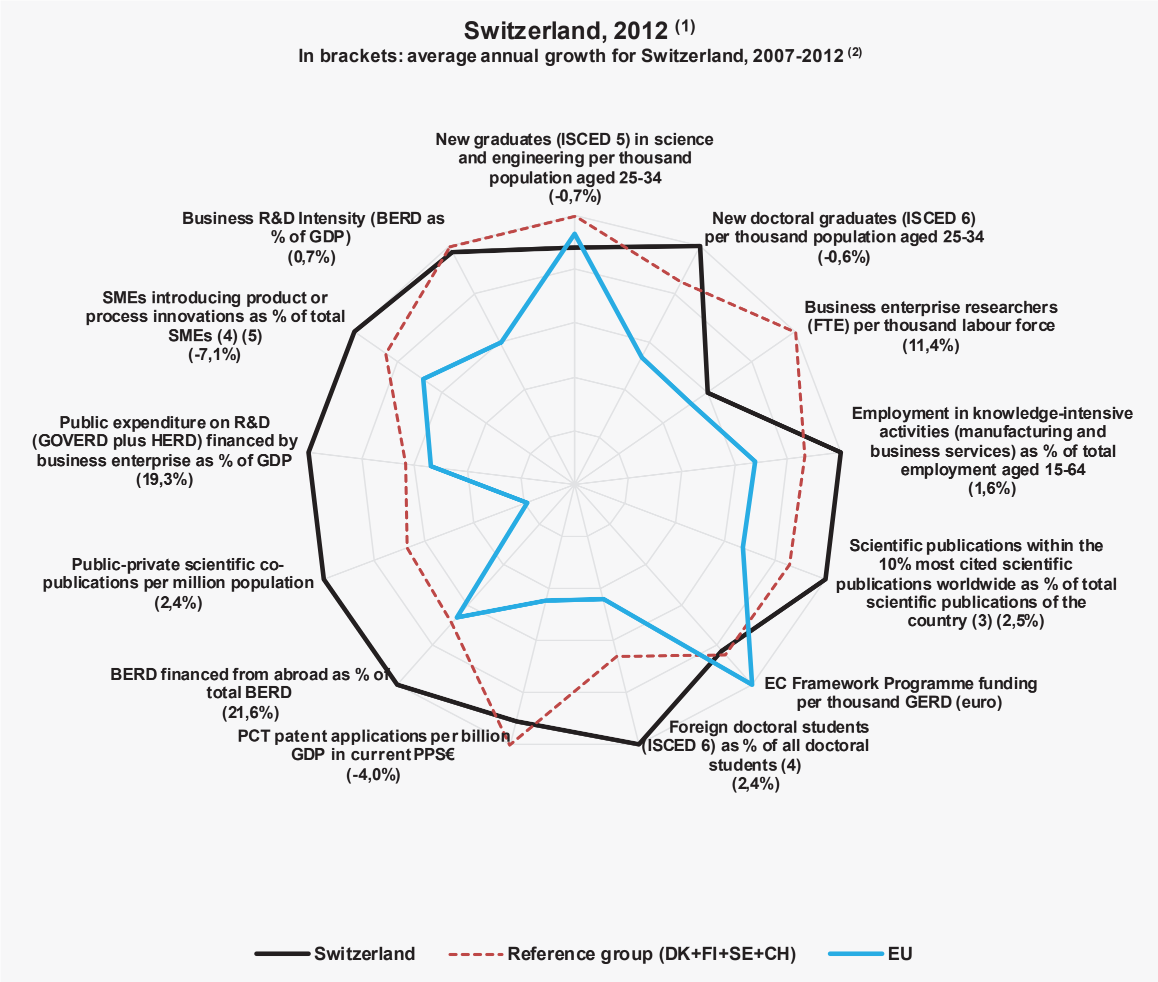
Switzerland has one of the highest R&D intensities both in Europe and in the world, with a value of 2.87 % in 2008. Over the last decade, R&D intensity grew at an average annual rate of 1.9 %, well above the EU rate of 0.8 % and, if this trend continues, will reach 3.60 % in 2020. Almost 74 % of R&D is performed by the private sector. This is due to the specific structure of the Swiss economy which is dominated by large multinational companies with their own global strategies. Swiss research policy focuses mainly on the quality of the public research sector and on the training of skilled researchers. An important trend in public R&D expenditure is the increasing R&D expenditure for universities. As a result, over the period 2000-2010, total higher education expenditure on R&D increased in real terms at an average annual rate of 5 %. In 2008, higher education expenditure on R&D as a percentage of total expenditure on R&D in Switzerland was approximately the same as the EU average (CH: 24.2 % vs. EU: 23.0 %).

The share of new doctoral graduates per thousand population aged 25-34 years increased from 2.7 % in 2002 to 3.5 % in 2011, a value which is more than twice the EU average. Switzerland's competitive R&I system is maintained by intensive and successful scientific activity, as shown by a high share of scientific publications within the 10 % most-cited scientific publication worldwide (16.4 % in 2009), a high number of international scientific co-publications per million population (2894 in 2012), a high level of PCT patent applications per billion GDP (7.9 in 2010) and a high level of licensing and patent revenues from abroad as a % of GDP (3.24 % in 2012).

Switzerland has a good tradition of participating in international research programmes at the European level. Its success rate for participants in the EU's Seventh Framework Programme (FP7) was 25 %. The successful participants received a total financial contribution from the EU of EUR 1.7 billion.

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

The graph below illustrates the strengths and weaknesses of Switzerland'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 (2012) are given in brackets.



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

The Swiss R&I system is characterised by very strong scientific and technological production that outperforms the EU on almost all the indicators analysed in the graph above, making Switzerland an innovation leader.

One weakness in Switzerland's R&I system, compared to the group of reference countries, is in the field of researchers employed by business enterprises. However, this number has increased significantly in recent years. However, the number of graduates in the fields of science and engineering per thousand population aged 25-34 years has declined over the period 2007-2012, creating a growing gap in the supply of graduates in these fields. Another challenge facing the Swiss R&I system is improving the curricula for education and training in relation to entrepreneurial education and the teaching of intercultural and communication skills.

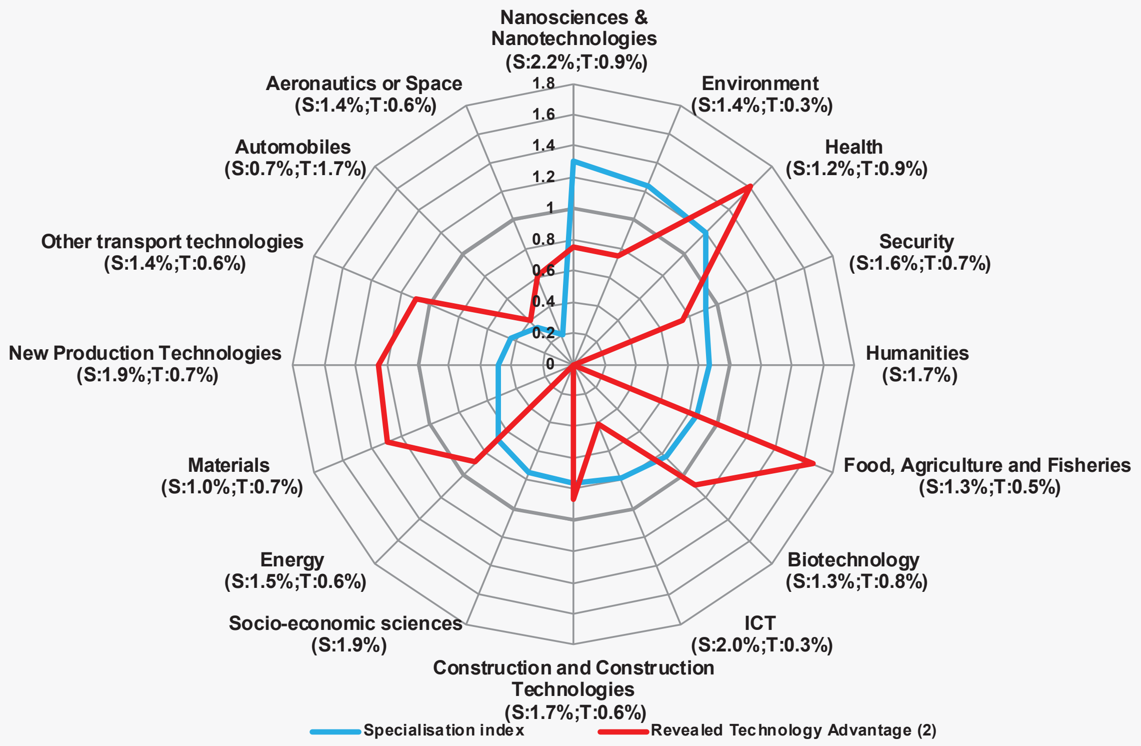
Although business expenditure on R&D (BERD) as a percentage of total expenditure on R&D is very high in Switzerland (73.5 %), the share of business expenditure financed from abroad is lower than both the EU average and Switzerland's reference group of countries, probably as a result of the abundance of financial resources within the country. Switzerland outperforms both the EU and its reference group of countries in terms of production of scientific publications, public-private scientific co-publications, share of foreign doctoral students among all doctoral students, and its share of employment in knowledge-intensive activities in total employment aged 15-64 years.

Switzerland's scientific and technological strengths

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

Switzerland 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.

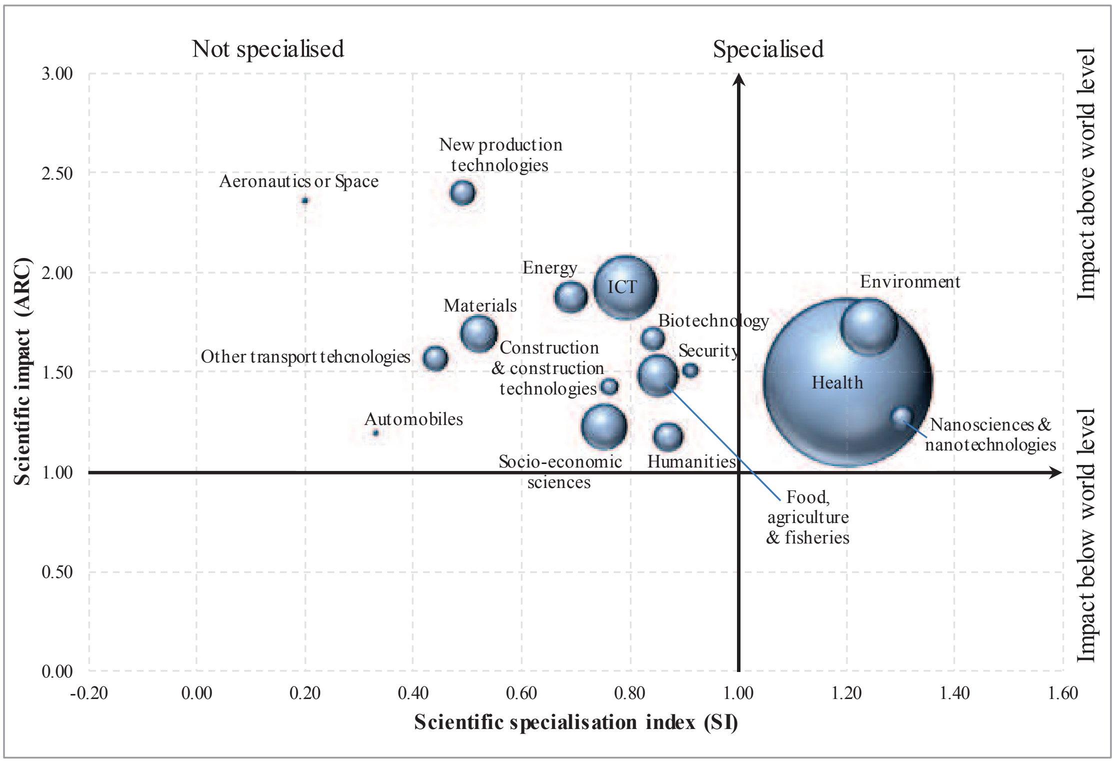
(2) The Revealed Technology Advantage is calculated based on the data corresponding to the number of patent applications by country of inventors. For the thematic priorities with less than 5 patent applications over 2000-2010, the Revealed Technological Advantage (RTA) is not taken into account. Patent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

As illustrated in the graph above, there is a notable difference in performance between scientific production (publications) and technological production (patents) in Switzerland. As regards publications, the country shows specialisation in the fields of nanoscience and nanotechnologies, environment, and health. With reference to revealed technological advantage as measured by patents (technological output), Switzerland has obvious strengths in health and food and, to a lesser extent, biotechnology, materials, new production technologies, and other transport technologies.

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



Source: DG Research and Innovation - Economic Analysis Unit

Data: Science Metrix - Canada, based on Scopus

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

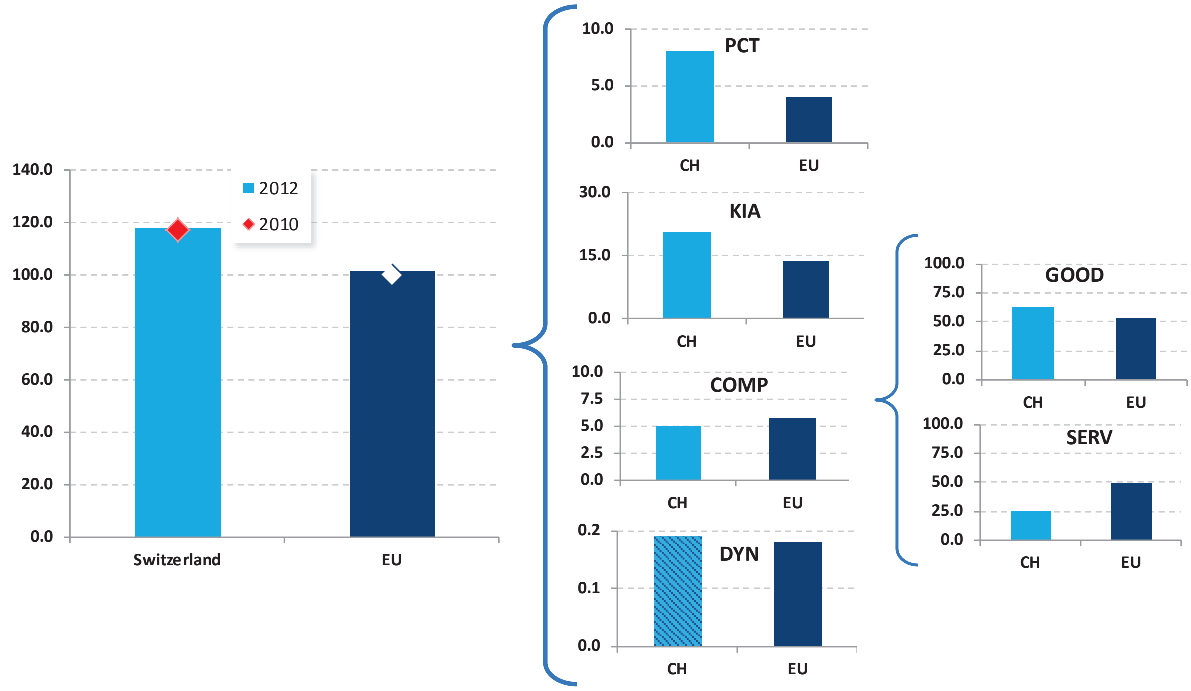
The graph above illustrates the positional analysis of Swiss publications showing the country's situation in terms of scientific specialisation and scientific impact over the period 2000-2010. The scientific production of the country is reflected by the size of bubbles, which corresponds to the share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

The country shows a high specialisation in publications in the field of health, environment, and nanoscience and nanotechnologies. In these areas, as well as in all the other areas, scientific impact is above the world average

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

Switzerland - Innovation Output Indicator



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

Switzerland is a very good performer in the European innovation indicator. This is the result of a good performance in all components except knowledge-intensive service exports. However, recently its performance has not improved further.

Good performance in patents is explained by the above-average share of patent-intensive industries (pharmaceuticals, medical technology, biotechnology, ICT) and the relatively high number of large manufacturing companies headquartered in Switzerland and carrying out research and patenting in the country as a result of a well-performing research system.

Switzerland's good performance in knowledge-intensive activities is explained by the importance of its financial, insurance, and legal and accounting services, as well as activities performed by head offices, consultancies and other professional, scientific and technical activities in its economy.

As a result of strong exports of pharmaceutical products, watches and machinery, Switzerland performs above the EU average as regards the share of medium-high and/high-tech goods in total goods exports. Figures for services exports are incomplete and the Swiss performance in this area must be analysed carefully. Switzerland has high financial and insurance services exports, but also has a high share of trade-related services, royalties and licence fees, which are classified as non-KIS.

Key indicators for Switzerland

SWITZERLAND	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)
ENABLERS											
Investment in knowledge											
New doctoral graduates (ISCED 6) per thousand population aged 25-34	:	3.31	3.42	3.49	3.44	3.58	3.68	3.51	3.39	-0.6	*1.81*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	530	:	:	534	:	:	531	1.3 (3)	495 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	1.82	:	:	:	2.11	:	:	:	2.17	0.7	1.31
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.60	:	0.66	:	0.71	:	0.80	:	0.90	6.0	*0.74*
Venture Capital as % of GDP	0.23	0.12	0.26	0.29	0.30	0.18	0.37	0.13	0.13	-14.6	0,29 (5)
S&T excellence and cooperation											
Composite indicator on research excellence	:	:	:	85.9	:	:	:	:	97.7	2.6	47.8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	15.6	15.9	15.6	15.8	16.4	:	:	:	2.5	11.0
International scientific co-publications per million population	:	1763	1919	2132	2225	2376	2532	2738	2894	6.3	343
Public-private scientific co-publications per million population	:	:	:	253	254	269	281	278	:	2.4	53
FIRM ACTIVITIES AND IMPACT											
Innovation contributing to international competitiveness											
PCT patent applications per billion GDP in current PPS€	7.4	9.0	8.6	8.9	7.9	8.1	7.9	:	:	-4.0	3.9
License and patent revenues from abroad as % of GDP	:	2.24	1.97	2.07	2.17	2.93	3.01	2.98	3.24	9.4	0.59
Community trademark (CTM) applications per million population	165	273	338	376	388	371	462	482	428	2.6	152
Community design (CD) applications per million population	:	55	57	76	51	38	37	43	34	-15.0	29
Sales of new to market and new to firm innovations as % of turnover	:	:	:	:	24.9	:	16.1	:	:	-19.6	14.4
Knowledge-intensive services exports as % total service exports	:	37.4	37.3	38.4	34.2	30.5	26.6	25.1	:	-10.0	45.3
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	6.30	6.98	7.56	7.58	8.28	8.17	8.02	8.44	8.08	-	4,23 (6)
Growth of total factor productivity (total economy) - 2007 = 100	93	97	98	100	100	98	100	100	100	0 (7)	97
Factors for structural change and addressing societal challenges											
Composite indicator on structural change	:	:	:	70.4	:	:	:	:	73.4	0.8	51.2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	19.5	19.9	19,8 (8)	19.9	20.5	1.6	13.9
SMEs introducing product or process innovations as % of SMEs	:	:	:	:	57.0	:	49.2	:	:	-7.1	33.8
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.42	0.54	0.48	0.68	0.55	0.76	:	:	:	5.7	0.44
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	2.30	2.79	2.63	2.52	2.23	2.25	:	:	:	-5.5	0.53
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES											
Employment rate of the population aged 20-64 (%)	80.9	79.9	80.5	81.3	82.3	81.7	81,1 (8)	81.8	82.0	0.6	68.4
R&D Intensity (GERD as % of GDP)	2.47	:	:	:	2.87	:	:	:	:	0.5 (9)	*2.07*
Greenhouse gas emissions - 1990 = 100	98	103	102	98	101	99	102	:	:	4 (10)	83
Share of renewable energy in gross final energy consumption (%)	:	:	:	:	:	:	:	:	:	:	:
Share of population aged 30-34 who have successfully completed tertiary education (%)	27.3	33.4	35.0	36.5	41.3	43.4	44.2	43.8	43.8	3.7	35.7
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	7.3	9.7	9.6	7.6	7.7	9.1	6.6	6.3	5.5	-6.3	12.7
Share of population at risk of poverty or social exclusion (%)	:	:	:	17.9	18.6	17.2	17.2	17.2	17.5	-0.5	24.8

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT.
(5) Venture Capital: EU does not include EE, HR, CY, LV, LT, MT, SI, SK.
(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) Average annual growth refers to 2004-2008.
(10) The value is the difference between 2010 and 2007. A negative value means lower emissions.
(11) Values in italics are estimated or provisional.

Turkey

The challenge of structural change for a more competitive economy

Summary: Performance in research and innovation

The indicators in the table below present a synthesis of research and innovation (R&I) performance in Turkey. 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 2011: 0.86 % (EU: 2.07 %; US: 2.79 %) 2007-2012: +4.4 % (EU: 2.4 %; US: 1.2 %)	*Excellence in S&T*[6] 2012: 17.6 (EU:47.8; US: 58.1) 2007-2012: +6.7 % (EU: +2.9 %; US: -0.2 %)
Innovation Output Indicator 2012: 59.2 (EU: 101.6)	*Knowledge-intensity of the economy*[7] 2012: 19.5 (EU:51.2; US: 59.9) 2007-2012: +5.3% (EU: +1.0%; US: +0.5%)
Areas of marked S&T specialisations: Energy, construction and construction technologies, and automobiles	*HT + MT contribution to the trade balance* 2012: -3.1 % (EU: 4.23 %; US: 1.02 %) 2007-2012: n.a. (EU: +4.8 %; US: -32.3 %)

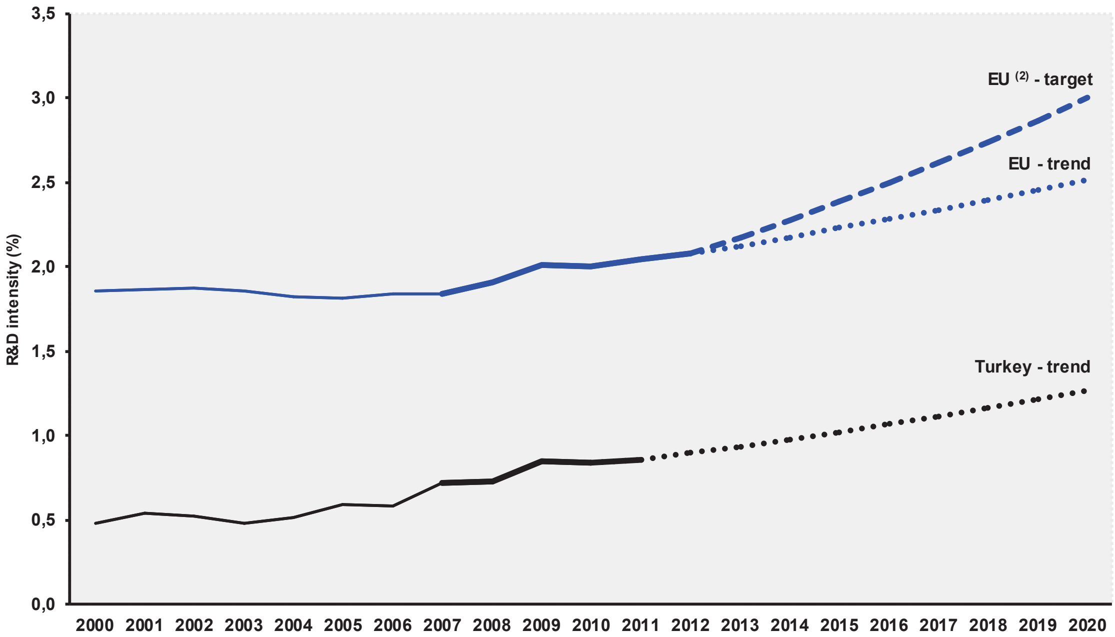
Since the early 2000s, Turkey has devoted increasing importance to investment in science, technology and innovation, as shown by the continuing rise in government funding for R&D and innovation activities. The growing political commitment to science, technology and innovation is also reflected in the Tenth Development Plan (2014-2018) adopted by the Parliamentary General Assembly on 2 July 2013. It establishes a long-term perspective and identifies improving science, technology and innovation as one of the building blocks for innovative production and steady growth.

The new science, technology and innovation strategy document, National Science, Technology and Innovation Strategy (UBTYS), covering the period 2011-2016, was approved by the Supreme Council for Science and Technology (BTYK) in December 2010. It aims to create more output from existing research capacity, to enhance needs-oriented research capacity, and defines strategic focus areas for increased science, technology and innovation performance. Target-oriented approaches are identified in the areas where Turkey has R&D and innovation capacities, demand-oriented approaches where further R&D and innovation efforts are needed, while bottom-up approaches (including basic, applied and frontier research) are also an option.

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

Investing in knowledge

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



Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: DG Research and Innovation, Eurostat
Notes: (1) The R&D intensity projections based on trends are derived from the average annual growth in R&D intensity for 2007-2012 in the case of the EU and for 2007-2011 in the case of Turkey.
(2) EU: The projection is based on the R&D intensity target of 3.0% for 2020.
(3) TR: An R&D intensity target for 2020 is not available.

R&D intensity in Turkey increased progressively from 0.48 % in 2000 to 0.86 % in 2011, experiencing an average annual growth rate of 4.4 % during this period. If this trend continues, Turkey will have an R&D intensity of 1.27 % in 2020, which would be a very good achievement although still below the projected EU average for 2020.

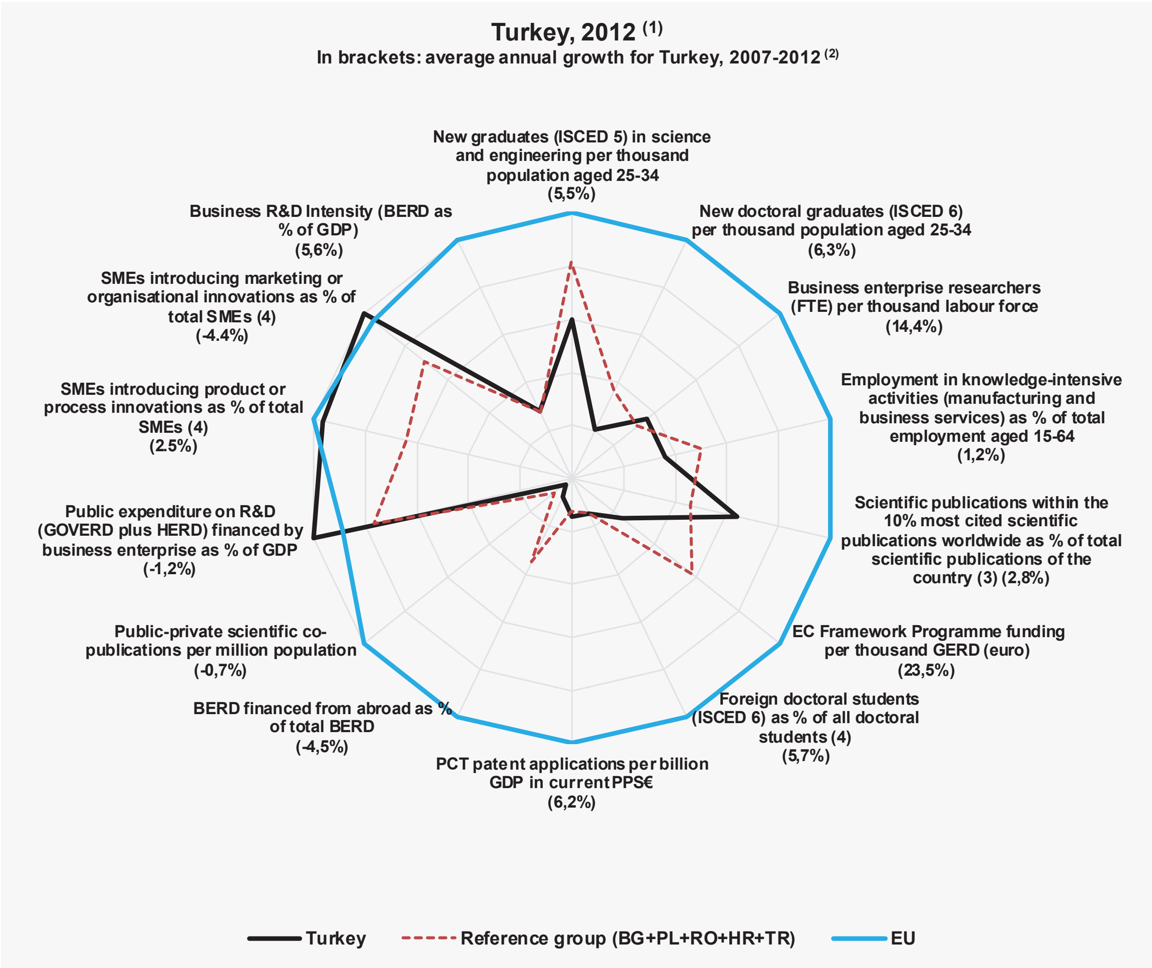
Turkey's R&D intensity decreased slightly from 0.85 % in 2009 to 0.84 % in 2010 due to a corresponding decrease in public R&D intensity from 0.51 % to 0.48 %. Despite the decline in public R&D intensity and the economic crisis, R&D expenditure has increased across all sectors while business R&D intensity grew from 0.34 % in 2009 to 0.37 % in 2011. Although Turkey's business R&D intensity is still well below the EU average of 1.30 %, it is involved in a positive catching-up process with an average annual growth rate of 2.0 %[8].

Turkish R&I also benefit from support from the EU budget, the main funding instrument being the EU's Framework Programmes for research and development. The total number of participants in the Seventh Framework Programme (FP7) in Turkey is 1201 (out of 7844 applicants), who are receiving more than EUR 200 million. Although the success rate among the participants rose to 16.56 %, it remains below the EU average success rate of 23.72 %.

[8] 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.

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

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



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(3) Fractional counting method.
(4) EU does not include EL.

The graph above shows that the Turkish R&I system is still weaker than the EU average in all areas except innovation in small and medium-sized enterprises (SMEs) and public expenditure on R&D financed by business enterprise as a % of GDP. On the other hand, the average annual growth rates for most of the indicators are increasing progressively.

The most vulnerable areas include human resources, patents and public-private scientific co-publications. In particular, Turkey is behind countries with similar knowledge capacity and economic structure in human resources, with new graduates in science and engineering and new doctoral graduates showing especially low averages. The relative strength of Turkey's R&I system has declined in the quality of its scientific production, lowering its average annual growth to 2.8 % in the share of its scientific publications among the top 10 % most cited worldwide.

A new policy tool has been designed to improve the quality and impact of scientific publications; it is based on arranging the incentives for scientific publications according to their impact factors. In view of Turkey's commitment to achieve 2023 targets, it shows great potential for catching up.

The decrees adopted at the 24th meeting of the Supreme Council for Science and Technology (BTYK), which focus on furthering the development of human resources for STI, can be considered as complementary initiatives to the National Science and Technology Human Resources Strategy and Action Plan (2011-2016). These decrees strengthen the linkage between the Action Plan and education policies, their main purpose being to improve the quality of Turkey's education system.

Turkey's scientific and technological strengths

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

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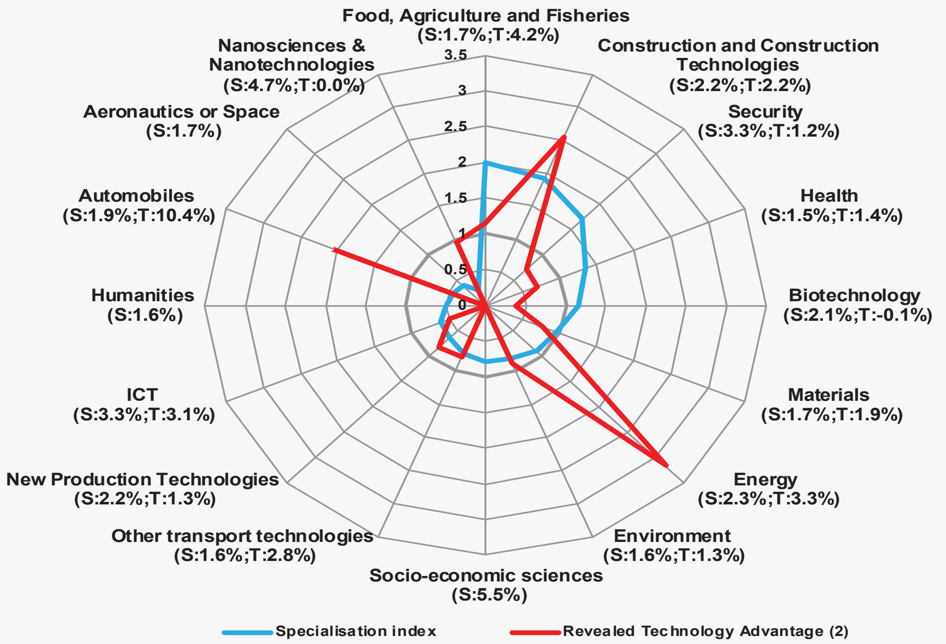

Source: DG Research and Innovation - Analysis and monitoring of national research policies
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Notes: (1) Values over 1 show specialisation, under 1 lack of specialisation.
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(3) The growth rate index 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.

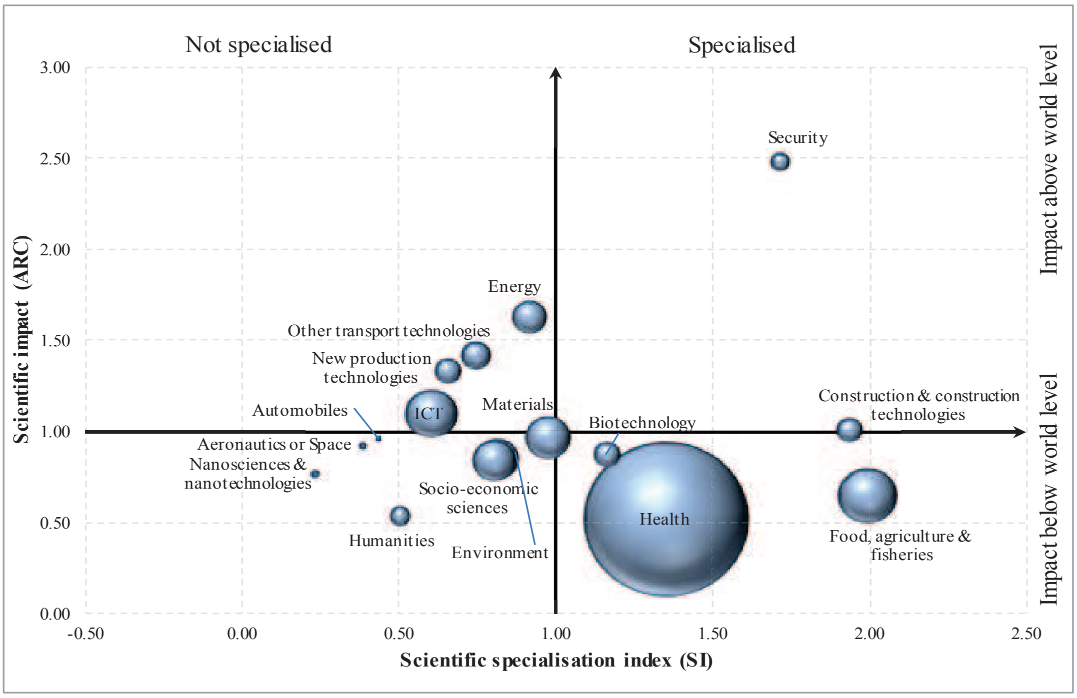
The graph above shows Turkey's strong technological specialisations (measured by the number of patents) in energy, construction and construction technologies, and automobiles, as well as scientific specialisation in food, agriculture and fisheries, construction, security, health and biotechnology. Co-specialisation in science and technology can be noted for food, agriculture and fisheries, construction and, to some extent, energy.

The relatively limited correlation between specialisation in science and specialisation in technologies suggests that the knowledge transfer towards industry through technologies is limited while, at the same time, the country has yet to benefit from sufficient inflows of foreign direct investment for technological activities, which would help shape a more coherent industrial specialisation.

Like Bulgaria, Romania, Poland and Croatia, Turkey has a low knowledge-intensive economy and a rather modest participation in FP7. Turkish participation in FP7 is highest in food, agriculture and biotechnologies.

The graph below illustrates the positional analysis of Turkish publications showing the country's situation in terms of scientific specialization 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 Turkey publications in Scopus (specialisation versus impact), 2000-2010



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

The graph above shows the results of a positional analysis of scientific publications in Turkey. The highest numbers of scientific articles are produced in the field of health, followed by food, agriculture and fisheries, ICT, materials and socio-economic sciences. Scientific excellence can be found in particular in the field of security, energy, other transport technologies, new production technologies, ICT, and construction and materials. However, those areas of greatest impact are still underdeveloped in terms of the number of publications.

Policies and reforms for research and innovation

Since 2013, Turkey has adopted an even more bottom-up strategic approach to formulating and implementing STI policy, which enables the wide and active participation of non-state actors. Through this process, both the private sector and academia have identified their R&D needs in a detailed and more efficient way, and support mechanisms have acquired a more targetted structure.

In addition, in 2013 the Scientific and Technological Research Council of Turkey (TÜBİTAK) developed call-based measures to improve R&D performance in the priority research areas. 'The Support Programme for Research, Technological Development and Innovation Projects in Priority Areas (TÜBİTAK-1511)' targetted private-sector companies whereas 'The Support Programme for Research, Technological Development and Innovation Projects in Priority Areas (TÜBİTAK-1003)' was directed towards researchers from both academia and private/public research centres. Within the last two years, around 60 calls have been opened within the scope of TÜBİTAK-1511 and TÜBİTAK-1003 covering all the priority fields, and new calls will be opened in the near future.

The most recent STI priorities include the decisions adopted in meetings of the Supreme Council for Science and Technology (BTYK) which set new targets for Turkey's national innovation and entrepreneurship system. The BTYK's 26th meeting was held on 11 June 2013. The resulting seven new decisions, directly or indirectly related to the energy sector

The national innovation and entrepreneurship system targets have been renewed and new ones set for 2023, the aim being for Turkey to become of the top 10 economies in the world by 2023. The targets are: to increase R&D intensity to 3 %; to increase business R&D intensity to 2 %; to raise the number of full-time equivalent (FTE) researchers to 300 000; to raise the number of FTE researchers in business to 180 000.

On the other hand, The Support Programme for National New Opinions and Products (TÜBİTAK 1005) aims to support much-needed projects in Turkey in order to reduce foreign technology dependency and/or increase the country's competitiveness. The development of applied research or experimental research projects at the national/international level for new products, processes, methods and modelling is also supported.

Another example is the decree which aims to develop policy tools to trigger innovation and entrepreneurship in the universities.

In line with this decree, a university index was developed in 2012 to evaluate universities' entrepreneurship and innovativeness performance, based on such criteria as R&D projects, university-industry collaborations, international collaborations, articles, licences and spin-offs. The 50 most entrepreneurial universities in Turkey were listed for the first time, and this list will be renewed and published annually.

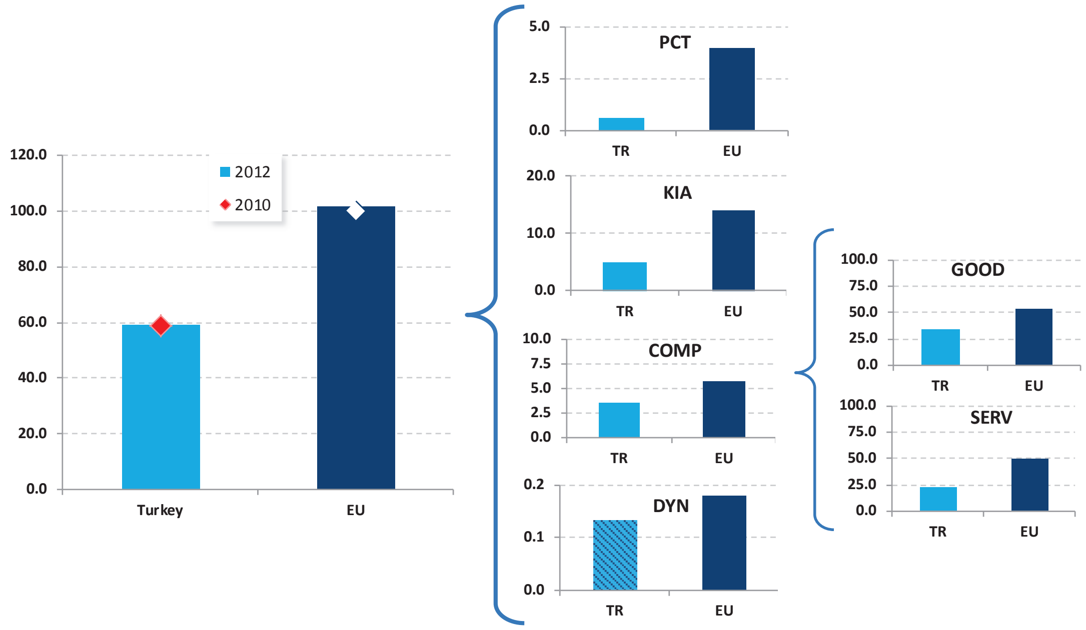
The Ministry of Science, Industry and Technology (MoSIT) has also adopted the evaluation-based approach by conducting a performance index work and impact assessment. The first task was preparation of the index for the Technology Development Zones operating in Turkey. The results were announced at a summit held by the ministry in March 2013. The new index is under preparation and indicators are being reviewed for better results.

To coordinate the R&I policies and supporting tools, a temporary interministerial coordination board has been set up, including participation of the relevant governmental bodies, to review all R&D, innovation and entrepreneurship support mechanisms in Turkey with a view to ensuring a target-oriented approach.

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

Turkey - Innovation Output Indicator



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

Turkey is a low performer in the European innovation indicator. This is the result of low performance in most components of the innovation indicator, whilst the country has no areas of strong performance. Furthermore, its performance is stagnating.

The relatively low performance in patents is linked to Turkey's economic structure, with a relatively large agricultural and low-tech sector (textiles), a limited number of large Turkish multinational manufacturing companies, and the division of work within international companies, including motor vehicle producers, which have production facilities in Turkey but tend to do research and patenting in the headquarter country[9].

Turkey has a very low share in knowledge-intensive activities, partly explained by the importance of employment in the agriculture, construction and tourism sectors.

As regards the exports of goods, low- and medium-low-tech sectors, such as food and textiles, are over-represented, which explains the low performance in the share of medium-high/high-tech exports.

The low share of knowledge-intensive service exports is explained by the importance of tourism (personal and business travel represent nearly 60 % of service exports) and of transport services (road freight transport) which are not classified as knowledge intensive.

However, Turkey is committed to improving its innovative capacity through smart policies and more investment in RDI activities.

[9] Turkey also performs at a low level in Community designs and trademarks.

Key indicators for Turkey[10]

TURKEY	2000	2005	2006	2007	2008	2009	2010	2011	2012	Average annual growth 2007-2012 (1) (%)	EU average (2)
ENABLERS											
Investment in knowledge											
New doctoral graduates (ISCED 6) per thousand population aged 25-34	0.19	0.22	0.20	:	0.31	0.34	0.38	0.37	:	6.3	*1.81*
Performance in mathematics of 15 year old students - mean score (PISA study)	:	:	424	:	:	445	:	:	448	24.0 (3)	495 (4)
Business enterprise expenditure on R&D (BERD) as % of GDP	0.16	0.20	0.21	0.30	0.32	0.34	0.36	0.37	:	5.6	*1.31*
Public expenditure on R&D (GOVERD + HERD) as % of GDP	0.32	0.39	0.37	0.42	0.40	0.51	0.48	0.49	:	3.6	*0.74*
Venture Capital as % of GDP	:	:	:	:	:	:	:	:	:	:	:
S&T excellence and cooperation											
Composite indicator on research excellence	:	:	:	12.7	:	:	:	:	17.6	6.7	47.8
Scientific publications within the 10% most cited scientific publications worldwide as % of total scientific publications of the country	:	5.1	5.5	6.6	6.8	7.0	:	:	:	2.8	11.0
International scientific co-publications per million population	:	43	48	53	58	66	70	76	85	9.8	343
Public-private scientific co-publications per million population	:	:	:	2	2	2	2	2	:	-0.7	53
FIRM ACTIVITIES AND IMPACT											
Innovation contributing to international competitiveness											
PCT patent applications per billion GDP in current PPS€	0.2	0.4	0.4	0.5	0.5	0.6	0.6	:	:	6.2	3.9
License and patent revenues from abroad as % of GDP	0.00	:	:	0.00	0.00	0.00	0.00	0.00	:	:	0.59
Community trademark (CTM) applications per million population	0.7	1.5	2.1	2.0	2.2	2.1	3.0	4.7	5.5	22.4	152
Community design (CD) applications per million population	:	0.8	0.7	1.2	1.4	0.8	0.7	1.0	0.9	-5.3	29
Sales of new to market and new to firm innovations as % of turnover	:	:	15.8	:	:	:	:	:	:	:	14.4
Knowledge-intensive services exports as % total service exports	:	:	:	16.6	18.7	18.5	21.0	21.9	:	7.1	45.3
Contribution of high-tech and medium-tech products to the trade balance as % of total exports plus imports of products	-10.66	-4.79	-2.94	-1.95	-0.82	-3.88	-2.83	-2.22	-3.13	-	4,23 (5)
Growth of total factor productivity (total economy) - 2005 = 100	100	117	120	:	:	:	:	:	:	3 (6)	103
Factors for structural change and addressing societal challenges											
Composite indicator on structural change	:	:	:	15.1	:	:	:	:	19.5	5.3	51.2
Employment in knowledge-intensive activities (manufacturing and business services) as % of total employment aged 15-64	:	:	:	:	:	4.8	4.8	4.7	5.0	1.2	13.9
SMEs introducing product or process innovations as % of SMEs	:	:	29.5	:	:	:	32.5	:	:	2.5	33.8
Environment-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.004	0.01	0.01	0.01	0.01	0.01	:	:	:	-2.6	0.44
Health-related technologies - patent applications to the EPO per billion GDP in current PPS€	0.01	0.01	0.01	0.01	0.02	0.10	:	:	:	158.1	0.53
EUROPE 2020 OBJECTIVES FOR GROWTH, JOBS AND SOCIETAL CHALLENGES											
Employment rate of the population aged 20-64 (%)	:	:	48.2	48.2	48.4	47.8	50.0	52.2	52.8	1.8	68.4
R&D Intensity (GERD as % of GDP)	0.48	0.59	0.58	0.72	0.73	0.85	0.84	0.86	:	4.4	*2.07*
Greenhouse gas emissions - 1990 = 100	159	176	187	203	196	198	:	:	:	-6 (7)	83
Share of renewable energy in gross final energy consumption (%)	:	:	:	:	:	:	:	:	:	:	:
Share of population aged 30-34 who have successfully completed tertiary education (%)	:	:	11.9	12.3	13.0	14.7	15.5	16.3	18.0	7.9	35.7
Share of population aged 18-24 with at most lower secondary education and not in further education or trainng (%)	:	:	48.8	46.9	45.5	44.3	43.1	41.9	39.6	-3.3	12.7
Share of population at risk of poverty or social exclusion (%)	:	:	72.4	:	:	:	:	:	:		24.8

Source: DG Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies
Data: Eurostat, DG JRC - Ispra, DG ECFIN, OECD, Science Metrix / Scopus (Elsevier), Innovation Union Scoreboard
Notes: (1) Average annual growth refers to growth between the earliest available year and the latest available year for which compatible data are available over the period 2007-2012.
(2) EU average for the latest available year.
(3) The value is the difference between 2012 and 2006.
(4) PISA (Programme for Internatonal Student Assessment) score for EU does not include CY and MT.
(5) EU is the weighted average of the values for the Member States.
(6) The value is the difference between 2006 and 2005.
(7) The value is the difference between 2009 and 2007. A negative value means lower emissions.
(8) Values in italics are estimated or provisional.

[10] According to data provide by the Turkish government, values for some indicators are as follows:

- BERD as % of GDP increased from 0.16 in 2000 to 0.36 in 2010 with an average annual growth rate of 10.7.
- GERD as % of GDP increased from 0.48 in 2000 to 0.84 in 2010 with an average annual growth rate of 6.2.
- In 2010, the average number of SMEs introducing products or process innovations was 32.6 %.

Methodological Annex

Symbols and abbreviations

Country codes

AT	Austria
BE	Belgium
BG	Bulgaria
HR	Croatia
CY	Cyprus
CZ	Czech Republic
DK	Denmark
EE	Estonia
FI	Finland
FR	France
DE	Germany
EL	Greece
HU	Hungary
IE	Ireland
IT	Italy
LV	Latvia
LT	Lithuania
LU	Luxembourg
MT	Malta
NL	Netherlands
PL	Poland
PT	Portugal
RO	Romania
SK	Slovakia
SI	Slovenia
ES	Spain
SW	Sweden
UK	United Kingdom
EU	European Union
CN	China
IS	Iceland
IL	Israel
JP	Japan
NO	Norway
KR	South Korea
CH	Switzerland
TR	Turkey
US	United States

Other abbreviations

: 'not available'

- 'not applicable' or 'real zero' or 'zero by default'

Overall performance in research and innovation

R&D intensity
Definition: Gross Domestic Expenditure on R&D (GERD) as % of Gross Domestic Product (GDP)
Sources: Eurostat, OECD

Gross Domestic Product (GDP)
Definition: Gross Domestic Product (GDP) data have been compiled in accordance with the European System of Accounts (ESA 1995). Since 2005, GDP has been revised upwards for the majority of EU Member States following the allocation of FISIM (Financial Intermediation Services Indirectly Measured) to user sectors. This has resulted in a downward revision of R&D intensity for individual Member States and for the EU.
Source: Eurostat

Gross Domestic Expenditure on R&D
Definition: Gross domestic expenditure on R&D (GERD) is defined according to the OECD Frascati Manual definition. GERD can be broken down by four sectors of performance:
(i) Business Enterprise expenditure on R&D (BERD);
(ii) Government intramural expenditure on R&D (GOVERD);
(iii) Higher Education expenditure on R&D (HERD);
(iv) Private Non-Profit expenditure on R&D (PNPRD).
GERD can also be broken down by four sources of funding:
(i) Business enterprise;
(ii) Government;
(iii) Other national sources (higher education and private non-profit);
(iv) Abroad.
Sources: Eurostat, OECD

Innovation Output Indicator

$$I = w_1 \times PCT + w_2 \times KIA + w_3 \times COMP + w_4 \times DYN$$

where

PCT	=	Number of patent applications filed under the Patent Cooperation Treaty per billion GDP Patent counts are based on the priority date, the inventor's country of residence and fractional counts (Eurostat/OECD)
KIA	=	Employment in knowledge-intensive activities in business industries (including financial services) as % of total employment. Knowledge-intensive activities are defined, based on EU Labour Force Survey data, as all NACE Rev.2 industries at 2-digit level where at least 33 % of employment has a higher education degree (ISCED5 or ISCED6) (Eurostat).
COMP	=	$0.5 \times GOOD + 0.5 \times SERV$
GOOD	=	High-tech and medium-high-tech products exports as % of total goods exports (Eurostat (COMEXP)/UN (Comtrade)).
SERV	=	Knowledge-intensive services exports as % of total service exports (exports of knowledge-intensive services are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208, 211, 212, 218, 228, 229, 245, 253, 260, 263, 272, 274, 278, 279, 280 and 284 (UN/Eurostat)).

DYN = Employment in fast-growing firms in innovative business industries, including financial services

$$\sum_{s}(CIS^{score} \times KIA^{score})_s \frac{E^{HG}_{sC}}{E^{HG}_{C}}$$

where

$(CIS^{score} \times KIA^{score})_s$	=	Innovation coefficient of sector *s,* resulting from the product of Community Innovation Survey and Labour Force Survey scores for each sector at EU level.
E^{HG}_{sC}	=	The employment in fast-growing firms in sector *s* and country *C*.
E^{HG}_{C}	=	The employment in fast-growing firms in country *C*.
w_1, w_2, w_3, w_4	=	The weights of the component indicators, fixed over time, and statistically computed in such a way that the component indicators are equally balanced. The current values are (34, 15, 37, 14).

Source: DG Research and Innovation (*Commission Staff Working Document - Developing an indicator of innovation output*) – Unit for the Analysis and Monitoring of National Research Policies

Excellence in research (S&T)

Definition: This composite indicator was developed to measure research excellence in Europe – i.e. the effects of European and national policies on the modernisation of research institutions, the vitality of the research environment, and the quality of research outputs in both basic and applied research. This core indicator is a composite of four variables:

- The share of highly cited publications in all publications where at least one of the authors has an affiliation in a given country (10 % of the most highly cited publications considered, full counting method; source: Science-Metrix calculations using Scopus data).
- Number of top scientific universities and public research organisations in a country divided by million population (world top 250 scientific universities and top 50 public research organisations considered; source: Leiden Ranking and SCImago Institutions Ranking).
- Patent applications per million population (PCT patent applications by country of inventor, three-year moving average; source: OECD, Eurostat).
- Total value of ERC grants received divided by public R&D performed by higher education and government sectors (transformed by using the natural logarithm, multi-year projects divided equally over time; source: DG-RTD, ERC).

The value of the composite indicator (a country score) is a geometric average of the four variables normalised between 10 and 100 using the min-max method and taking into consideration the two time points simultaneously.

Source: Group of Research and Innovation Union Impact, RTD-JRC (Ispra): Composite Indicator of Research Excellence, 2012.

Knowledge-intensity of the economy (structural change of economy)

Definition: Compositional structural change indicators measure changes in the actual sectoral composition of the economy in terms of production and employment, business research and development (R&D), high-tech exports and technological specialisation, and foreign direct investments. Changes may affect the linkages among sectors and technologies, and influence the changes to countries' international advantages.

Eight compositional structural change indicators have been identified and organised into five dimensions:

- The R&D dimension measures the size of business R&D (as a % of GDP) and the size of the R&D services sector in the economy (in terms of total value added; source: wiiw calculations using OECD, Eurostat, WIOD and national sources).

- The skills dimension measures changing skills and occupations in terms of the share of people employed in knowledge-intensive activities (both manufacturing and service sectors considered where on average at least a third of the employees are tertiary graduates; source: Eurostat).
- The sectoral specialisation dimension captures the relative share of knowledge-intensive activities (in terms of value added; source wiiw calculations using OECD, Eurostat, WIOD and national sources).
- The international specialisation dimension captures the share of the knowledge economy through technological (patents) and export specialisation (revealed technological and competitive advantage).
- The internationalisation dimension refers to the changing international competitiveness of a country in terms of attracting and diffusing foreign direct investment (inward and outward foreign direct investments).

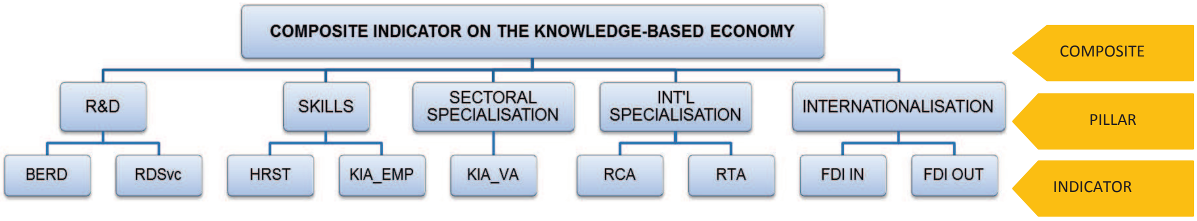
The eight indicators in the five pillars have been normalised between 10 and 100 using the min-max method and taking into consideration three time points simultaneously. The five pillars have also been aggregated into a single composite indicator of structural change using the geometric average to provide an overall measure of country progress in this area.

Source: Group of Research on the impact of the Innovation Union (GRIU), RTD-JRC/IPSC Ispra): Composite indicators measuring structural change, monitoring the progress towards a more knowledge-intensive economy in Europe, 2011.

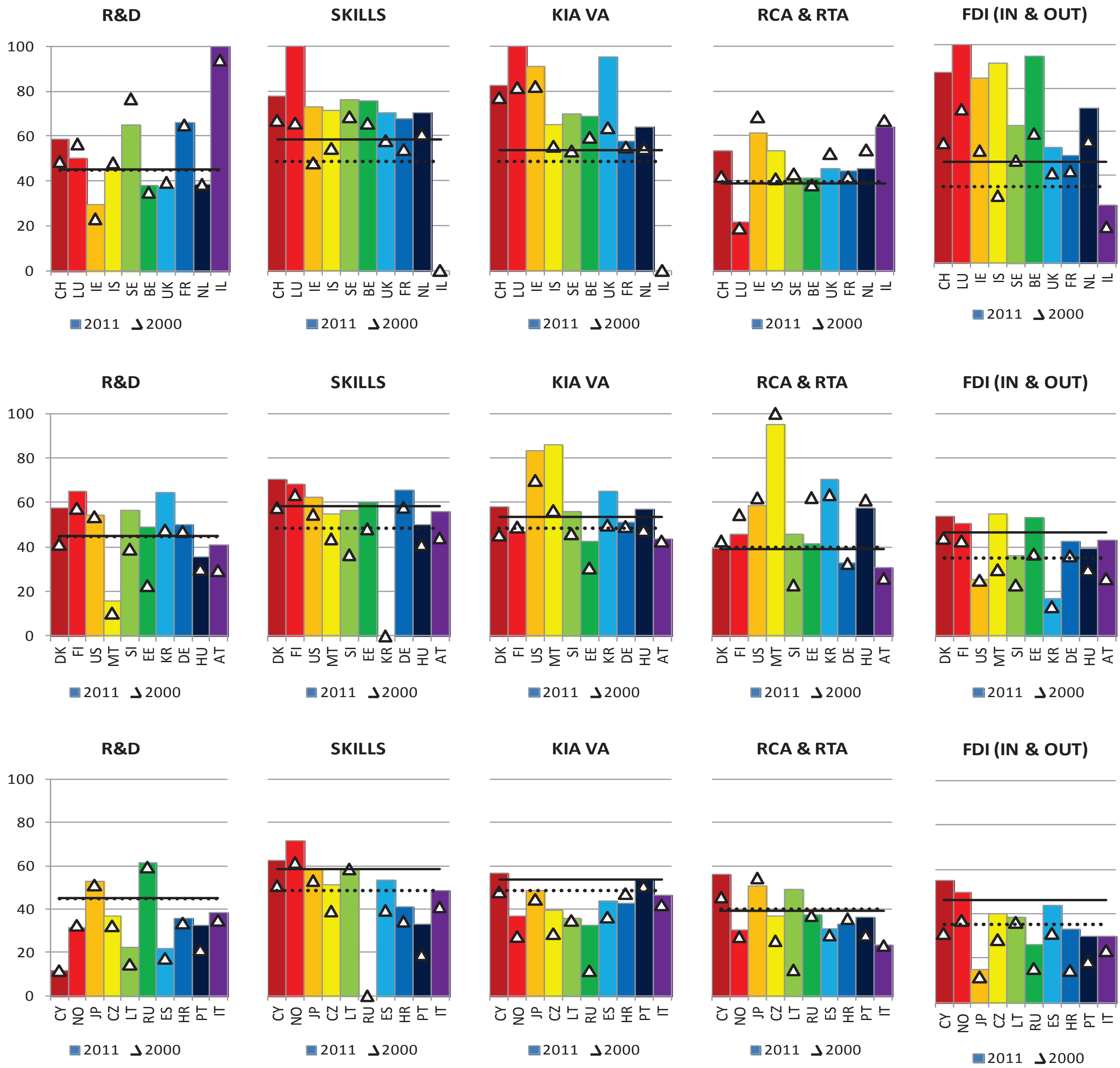
Indicators on the size of the knowledge economy

Indicator	Definition	Source
R&D indicators		
BERD	Total R&D expenditure as a share of GDP (%)	Eurostat/OECD
RDSvc	The share of R&D services in the economy (the value added share of sector NACE Rev 2 code K72 in the total economy)	Eurostat/OECD EUKLEMS/WIOD (wiiw)
Skills indicators		
HRST	Share of human resources in science and technology (HRST) as a share of the active population (15-74 years old) (%)	Eurostat
KIA_EMP	Share of people employed in knowledge-intensive activities (KIAs) as a percentage of total employment	Eurostat
Sectoral specialisation indicator		
KIA_VA	The share of value added in knowledge-intensive activities within the total value added in a country	Eurostat/OECD EUKLEMS/WIOD (wiiw)
International specialisation indicators		
RTA	Relative specialisation in holding PCT patents in selected technology classes (Revealed Technological Advantage – RTA)	OECD
RCA	Relative specialisation in the export of medium-high-tech and high-tech products (Revealed Competitive Advantage – RCA)	Eurostat
Internationalisation indicators		
FDI_IN	Cumulative inward FDI stock as a share of GDP	UNCTAD
FDI_OUT	Cumulative outward FDI stock as a share of GDP	UNCTAD

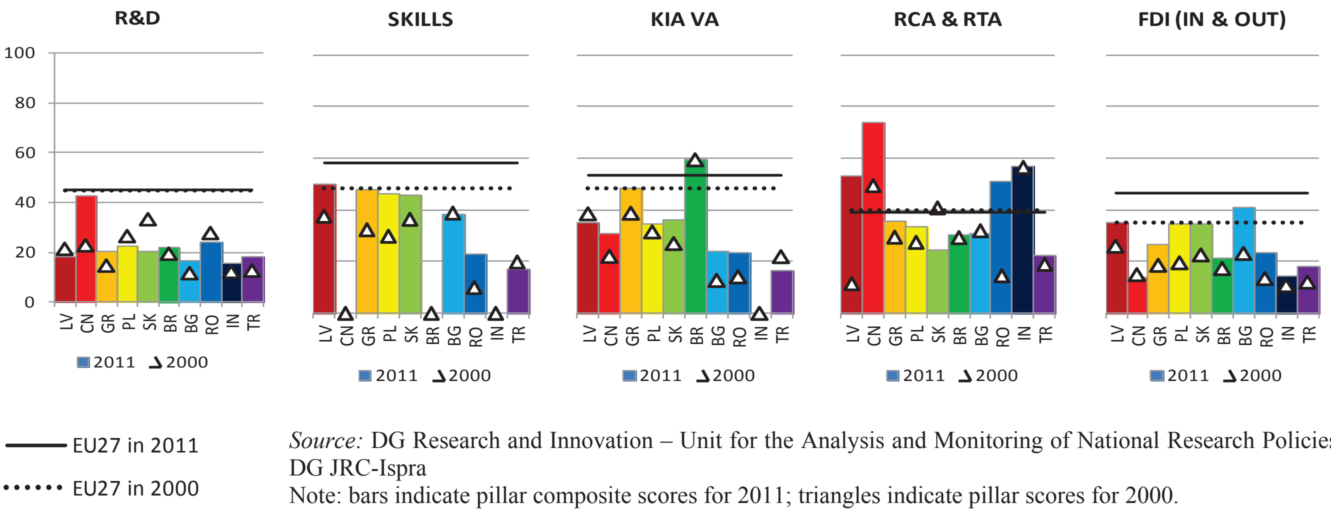
The architecture of the composite indicator on the knowledge-based economy



Comparison of pillar-level structural dynamics for 40 countries, at 2000 and 2011



Comparison of pillar-level structural dynamics for 40 countries, at 2000 and 2011



Source: DG Research and Innovation – Unit for the Analysis and Monitoring of National Research Policies; DG JRC-Ispra
Note: bars indicate pillar composite scores for 2011; triangles indicate pillar scores for 2000.
For reference, EU-27 scores are shown with a continuous line in 2011 and a dotted line in 2000.

Contribution of high-tech and medium-high-tech manufacturing to trade balance
Definition: The "contribution to the trade balance" is the difference between the observed industry trade balance and the theoretical trade balance.
Trade balance means the difference between the level of exports and the level of imports in a particular industry/sector.
The contribution to the trade balance is calculated by the formula:

$$\left[(X_i - M_i) - (X - M)\frac{(X_i + M_i)}{(X + M)}\right] / (X + M) * 100$$

where

$(X_i - M_i)$	=	observed industry trade balance
$(X - M)\frac{(X_i + M_i)}{(X + M)}$	=	theoretical trade balance

If there is no comparative advantage or disadvantage for any industry, a country's total trade balance (surplus or deficit) should be distributed across industries according to their share in total trade. A positive value for an industry indicates structural surplus and a negative value a structural deficit.

The HT & MHT trade balance include the following SITC Rev.3 products: 266, 267, 512, 513, 525, 533, 54, 553, 554, 562, 57, 58, 591, 593, 597, 598, 629, 653, 671, 672, 679, 71, 72, 731, 733, 737, 74, 751, 752, 759, 76, 77, 78, 79, 812, 87, 88, 891.
Sources: OECD (*Moving Up the Value Chain: Staying Competitive in the Global Economy*, 2007), UN (Comtrade), RTD - Unit for the Analysis and Monitoring of National Research Policies

High-tech trade
Definition: High-tech trade covers exports and imports of products the manufacture of which involved a high intensity of R&D. They are defined in accordance with the OECD's high-tech product list (see OECD (1997) - Revision of the High-Technology Sector and Product Classification (1997), *STI Working Papers* 2/1997, OECD, Paris. The indicators used in this report use the so-called 'product approach', i.e. they measure the world market share of exports of high-tech products.
Sources: Eurostat (Comext), UN (Comtrade)

Investing in knowledge

Public expenditure on R&D
Definition: For the purposes of this publication, public expenditure on R&D is defined as Government intramural expenditure on R&D (GOVERD) plus Higher Education expenditure on R&D (HERD).
Sources: Eurostat, OECD

BERD intensity
Definition: Business Enterprise expenditure on R&D (BERD) as % of Gross Domestic Product (GDP).
Sources: Eurostat, OECD

Public sector R&D intensity
Definition: Public expenditure on R&D (GOVERD plus HERD) as % of GDP.
Sources: Eurostat, OECD

Government budget for R&D
Definition: The government budget for R&D is defined as government budget appropriations or outlays for R&D (GBAORD), according to the OECD Frascati Manual definition. The data are broken down by socio-economic objectives in accordance with the nomenclature for the analysis and comparison of scientific programmes and budgets (NABS).
Source: Eurostat

Structural Funds
Definition: Structural Funds are funds intended to facilitate the structural adjustment of specific sectors or regions, or combinations of both, in the European Union. Structural Funds for RTDI include data from sectors involving research and development, technological innovation, entrepreneurship, innovative ICT and human capital.
Source: DG REGIO

Purchasing Power Standards (PPS)
Definition: Financial aggregates are sometimes expressed in Purchasing Power Standards (PPS), rather than in euro based on exchange rates. PPS are based on a comparison of the prices of representative and comparable goods or services in different countries in different currencies on a specific date. The calculations of R&D investments in real terms are based on constant 2000 PPS.
Source: Eurostat

Value added
Definition: Value added is current gross value added measured at producer prices or at basic prices, depending on the valuation used in the national accounts. It represents each industry's contribution to GDP.
Sources: Eurostat, OECD

Venture capital
Definition: Venture capital investment is defined as private equity being raised for investment in companies. Management buyouts, management buy-ins, and venture purchase of quoted shares are excluded. Venture capital includes early stage (seed + start-up), expansion and replacement capital.
Source: Eurostat

Average Annual Growth Rate
Definition: Average annual growth rate (AAGR) refers to the compound annual growth rate (CAGR) and is the geometric progression ratio that provides a constant rate of return over the time period.

$$AAGR = CAGR = \left[\left(\frac{v_f}{v_i}\right)^{\frac{1}{(y_f - y_i)}} - 1\right] * 100$$

where

v_f	=	final value
v_i	=	initial value
$y_f - y_i$	=	number of years

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

Framework Programme
Definition: The Framework Programmes for Research and Technological Development are the EU's main instruments for supporting collaborative research, development and innovation in science, engineering and technology. Participation is on an internationally collaborative basis and must involve European partners. The First Framework Programme was launched in 1984. The Seventh Framework Programme (FP7) covers the period 2007-2013.
Source: DG Research and Innovation

Higher education
ISCED (International Standard Classification of Education);
ISCED 5: Tertiary education (first stage) not leading directly to an advanced research qualification;
ISCED 5A: Tertiary education programmes with academic orientation;
ISCED 5B: Tertiary education programmes with occupation orientation;
ISCED 6: Tertiary education (second stage) leading to an advanced research qualification (PhD or doctorate).

Human Resources for Science and Technology (HRST), R&D personnel and researchers
The Canberra Manual proposes a definition of HRST as people who either have higher education or are employed in positions that normally require such education. HRST applies to people who fulfil one or other of the following conditions:

a) Have successfully completed education at the tertiary level in an S&T field of study (HRSTE - Education);
b) Not formally qualified as above, but employed in an S&T occupation where the above qualifications are normally required (HRSTO - Occupation).

HRST Core (HRSTC) refers to people with both tertiary-level education and an S&T occupation. Scientists and engineers are defined as ISCO (International Standard Classification of Occupations) categories 21 (physical, mathematical and engineering science professionals) and 22 (life science and health professionals).

The Frascati Manual proposes the following definitions of R&D personnel and researchers:

- R&D personnel: "All persons employed directly on R&D should be counted, as well as those providing direct services such as R&D managers, administrators, and clerical staff." (p.92);
- Researchers: "Researchers are professionals engaged in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned." (p.93). R&D may be either the primary function or a secondary function. It may also be a significant part-time activity.

Therefore, the measurement of personnel employed in R&D involves two exercises:

- Measuring their number in headcounts (HC) whereby the total number of people who are mainly or partially employed in R&D are counted;

- Measuring their R&D activities in full-time equivalence (FTE): the number of people engaged in R&D is expressed in full-time equivalents on R&D activities (= person-years).

Source: Eurostat

Public- and private-sector researchers
Definition: For the purposes of this publication, public-sector researchers are researchers in the government and higher-education sectors. Private-sector researchers are researchers in the business-enterprise and private non-profit sectors.
Sources: Eurostat, OECD

Small and medium-sized enterprises (SMEs)
Definition: Small and medium-sized enterprises (SMEs) are defined as enterprises having fewer than 250 employees.
Sources: Eurostat, OECD

Licence and patent revenues from abroad
Definition: This refers to the export part of international transactions in royalties and licence fees.
Source: Eurostat

Patent Cooperation Treaty (PCT) patents
Definitions: The Patent Cooperation Treaty (PCT) is an international treaty administered by the World Intellectual Property Organization (WIPO) and signed by 133 Paris Convention countries. The PCT makes it possible to seek patent protection for an invention simultaneously in each of a large number of countries by filing a single 'international' patent application instead of filing several separate national or regional applications. Indicators based on PCT applications are relatively free from the 'home advantage' bias (proportionate to their inventive activity, domestic applicants tend to file more patents in their home country than non-resident applicants). The granting of patents remains under the control of the national or regional patent offices. The PCT patents considered are 'PCT patents, at international phase, designating the European Patent Office'. The country of origin is defined as the country of the inventor.

The timeliness (at the international phase of the PCT procedure) is much better than for Triadic patents. However, the relatively low cost of a patent application on an international basis prevents the PCT procedure from being very selective. Many PCT applications will cover inventions whose value is known *a posteriori* to be low, while few will cover inventions of very high value. A high share of patent applications invented in a given country might result in a limited impact on its economy if they all turn out to be of little or no use.
Patents dealing with societal challenges comprise climate-change-mitigation patents and health-technology patents. Climate-change-mitigation patents comprise patents for renewable energy, electric and hybrid vehicles, and energy efficiency in buildings and lighting. Health-technology patents comprise patents for medical technologies and pharmaceuticals.

Environment-related technologies
Definition: Patent applications to EPO per billion GDP in current EUR PPS.
Environment-related technologies refer to the following thematic areas:

A. General environmental management;
B. Energy generation from renewable and non-fossil sources;
C. Combustion technologies with mitigation potential;
D. Technologies specific to climate-change mitigation;
E. Technologies with potential or indirect contribution to emissions mitigation;
F. Emissions abatement and fuel efficiency in transportation;
G. Energy efficiency in buildings and lighting.

Source: OECD

Health-related technologies
Definition: Patent applications to the EPO per billion GDP in current EUR PPS.
Health-related technologies refer to medical technologies and pharmaceuticals: surgery, dentistry, prostheses, transport/accommodation for patients, physical therapy devices, containers, medical preparations, sterilisation, media devices, electrotherapy, and chemical compounds.
Source: OECD

Community trademark
Definition: A Community trademark is any trademark which is pending registration or has been registered in the EU as a whole (rather than on a national level within the EU).
Sources: OHIM, Eurostat

Country groupings – methodology
In order to create homogeneous groups of similar research and innovation systems in the European Research Area, a Principal Component Analysis (PCA) was carried out on 19 variables characterising research and innovation systems. The values of the variables were obtained for 2008 or the latest available year from Eurostat and the OECD and included data for the then 27 EU Member States as well as for Norway, Switzerland, Croatia, Turkey and Israel. Table 1 presents the main values of the different factors accruing from the PCA. The first principal component explains 49.7 % of the variance. The second principal component explains 12.4 % of the variance, and together the two principal components are able to explain over 62 % of the total variance.

Table 1: Results of the PCA

	Eigenvalue	Proportion	Cumulative
Factor 1	9.44203858	0.4969	0.4969
Factor 2	2.35266703	0.1238	0.6208
Factor 3	1.96210394	0.1033	0.724
Factor 4	1.23153877	0.0648	0.7889
Factor 5	1.01292575	0.0533	0.8422

Table 2 presents the correlation matrix between the main components and the individual variables that can help in interpreting the nature of these factors. To a large extent, the first component corresponds to a country's economic and technological development. As shown by the correlation matrix, this factor is closely related to per capita GDP, investments in R&D, HRST, research excellence, patents and levels of skills and employment. The second component represents the sectoral specialisation, as shown by the coordinates of industrial employment and employment in medium-high and high-tech manufacturing.

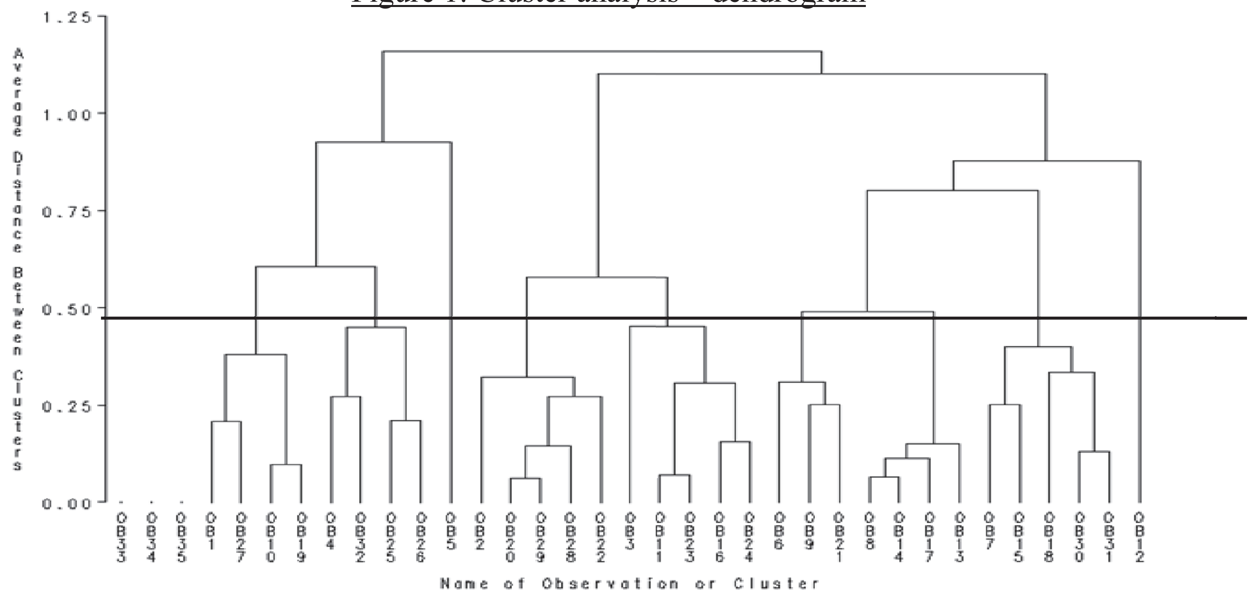
Table 2: Correlation matrix between the principal components and the individual variables

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
GERD as % GDP	**0.88045**	0.34761	0.1694	0.09631	-0.06329
BERD as % GDP	**0.86653**	0.37803	0.0769	0.10575	-0.03081
GOVERD as % GDP	0.07583	0.26135	0.55564	-0.44498	0.49791
HERD as % GDP	**0.77148**	0.08173	0.20893	0.25351	-0.41071
HRST as % total population	**0.84051**	-0.32415	0.24602	-0.09118	0.16476
EPO patent applications per million population	**0.85114**	0.24681	-0.1413	0.04174	-0.02927
EPO high-tech patents per million population	**0.82359**	0.28775	-0.08296	0.01004	-0.02086
Population aged 25-64 having completed tertiary education	**0.76955**	-0.39397	0.23008	-0.10595	0.04449

	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
Participation in lifelong learning	**0.8845**	-0.00273	0.21098	0.24563	-0.03637
Employment in primary sectors	-0.63319	0.01507	0.40398	-0.07697	-0.32419
Employment in industrial sectors	-0.5726	**0.60788**	0.22957	0.32484	0.2158
Employment in business and financial sectors	0.59243	0.03313	-0.52275	-0.38809	0.16055
Employment in high-tech and medium-high-tech manufacturing	-0.07533	**0.88354**	0.0989	0.10371	0.24159
Employment in knowledge-intensive services (KIS)	**0.90799**	-0.08451	-0.00034	0.15404	0.08702
Population density	-0.05817	-0.08058	**-0.69541**	0.49535	0.29596
Employment rate	**0.70931**	-0.29551	**0.44466**	0.10663	0.07883
GDP per capita	**0.75882**	-0.09803	-0.28462	-0.27672	0.20282
GDP natural logarithm	0.17245	0.584	-0.29413	-0.48494	-0.41219
Research excellence (highly cited scientific publications)	**0.89965**	0.08266	-0.2061	0.04531	-0.10682

Based on the findings of the PCA, a hierarchical cluster analysis has been carried out to gather the regions into homogeneous groups. Figure 1 presents the dendrogram showing the different groups as well as a bar separating the different country groups.

Figure 1: Cluster analysis – dendrogram



Source: DG Research and Innovation

Scientific and technological strengths

The NUTS classification
Definition: The Nomenclature of Statistical Territorial Units (NUTS) is a single coherent for dividing up the European Union's territory in order to produce regional statistics for the Community. NUTS subdivides each Member State into a whole number of regions at NUTS level 1. Each of these is then subdivided again into regions at NUTS level 2 and, in turn, subdivided into regions at NUTS level 3.
Source: Eurostat

Scientific publications
Definition: Publications refer to research articles, reviews, notes and letters published in referenced journals which are included in the Elsevier Scopus database. The counting method used at the country level for publications was the full-counting method. However, for the EU aggregate, double counts of multiple occurrences of EU Member States in the same record were excluded.
Source: Scopus (Elsevier); treatments and calculations: Science-Metrix

Average of Relative Citations (ARC)
The ARC is an indicator of the scientific impact of papers produced by a given entity (e.g. the world, a country, a NUTS 2 region, an institution) relative to the world average (i.e. the expected number of citations). The number of citations received by each publication is counted for the year in which it was published and for the three subsequent years. For papers published in 2000, for example, citations received in 2000, 2001, 2002 and 2003 are counted.
To account for different citation patterns across scientific fields and sub-fields (e.g. there are more citations in biomedical research than in mathematics), each publication's citation count is divided by the average citation count of all publications of the corresponding document type (i.e. a review would be compared to other reviews, whereas an article would be compared to other articles) that were published the same year in the same sub-field to obtain a Relative Citation count (RC). The ARC of a given entity is the average of the RCs of the papers belonging to it. An ARC value above one means that a given entity is cited more frequently than the world average, while a value below one means the opposite. The ARC is computed for the 2000-2006 period only, since publications in 2007, 2008 and 2009 have incomplete citation windows.

Methodology of co-publication analysis
The methodology used for co-publication analysis involved three types of analysis:
a) Single country publications cover co-publications that involve domestic partners only; this is the sum of all papers written by one or more authors from a given country (and non-nationals resident in that country). Although the literature usually distinguishes between domestic single publications (including one or more authors belonging to the same institution) and domestic co-publications (i.e. authors within the same country but from different main organisations), for the purpose of the current analysis the sum of the two categories has been used under the heading "single country publications".
b) EU transnational co-publications refer to international co-publications which involve at least one author from an EU country. This category includes both co-publications by authors from at least two different EU Member States (as defined by research papers containing the addresses of at least two authors in different countries) and co-publications by one or several authors from the EU together with at least one author from a country outside the EU.
c) Extra-EU co-publications is a subcategory of the broader EU transnational co-publications. It refers exclusively to international co-publications involving at least one EU author and at least one non-EU author, as defined by the authors' addresses in different countries.
Another important methodological issue concerns the way in which a co-publication is quantified. The full counting method has been used in this report, meaning that a single international co-published paper is assigned to more than one country of scientific origin. If, for example, the authors' addresses indicate three different countries in the EU, the publication is counted three times – once for each country mentioned. Therefore, in a matrix of co-publications between countries, the number of publications mentioned is not a completely accurate indicator of the number of publications being co-authored, but rather how often a country or region is involved in co-publications.

Public-private co-publications
Definition: The number of public-private co-authored research publications. The private sector excludes the private medical and health sector.
Sources: Scopus (Elsevier); Science-Metrix

Specialisation Index (SI)

Definition: This is an indicator of the research intensity for a given economic sector, as defined by a sample of representative companies, in a given research area (sub-field) relative to the intensity of the reference entity (world, entire output as measured by the database) in the same research area. In other words, when a sector is specialised in a sub-field, it places more emphasis on that field at the expense of other research areas. The SI formula is the following:

$$SI = \frac{\left(X_s / X_T\right)}{\left(N_s / N_T\right)}$$

where

X_s	=	Papers from sector X in a given research area s (e.g. NACE 15&29.53 in food sciences)
X_T	=	Papers from entity X in a reference set of papers T (e.g. NACE 15&29.53 in Scopus)
N_s	=	Papers from the reference entity N in a given research area s (e.g. world in food sciences)
N_T	=	Papers from the reference entity N in a reference set of papers (e.g. world in Scopus)

A given sector is specialised relative to the reference entity if the index value is above one, and the reverse if the index value is below one. This indicator's value is directly related to the relevance of the sub-field for the sector (the higher the value of the indicator, the greater relevance of the sub-field for the sector).

Source: Science-Metrix/Scopus (Elsevier)

Revealed Technological Advantage index (RTA)

Definition: The Revealed Technological Advantage (RTA) index provides information about the technological specialisation of areas and countries. The formula used to calculate the RTA index is the following:

$$RTA_{ij} = \left(\frac{X_{ij}}{\sum_j X_{ij}}\right) / \left(\frac{\sum_i X_{ij}}{\sum_i \sum_j X_{ij}}\right)$$

where

X_{ij}	=	The number of patents for an area (or country) i in technology j
$\sum_j X_{ij}$	=	Total number of patents for the area (or country) i
$\sum_i X_{ij}$	=	Total number of patents for the technology j
$\sum_i \sum_j X_{ij}$	=	Total number of patents worldwide

The expression's numerator represents the share of technology j among all patents in an area (or country) i. In other words, it represents the relative importance of technology j in the patenting activity of the area (or country) i.

The denominator represents the share of all patents in all areas (countries) accounted for by technology j – i.e. it represents the relative importance of technology j in patenting activities worldwide.

A zero value for the RTA indicates that area i has not patented in technology j and thus it is fully de-specialised in that technology. The RTA takes value one when the weight of technology j in the patenting activities of area i is exactly equal to the weight that this technology has in patenting at the world level. This implies that an RTA value greater than one indicates that area i is relatively

specialised in technology *j*. On the contrary, an RTA value lower than one indicates that area *i* is relatively de-specialised in that technology. Comparison of the different specialisation levels across the various technological and economic fields enables conclusions to be drawn about the relative strengths and weaknesses of different areas and countries (although the RTA index must be interpreted with caution for those areas and countries which have registered a relatively small number of patents).
Source: University Bocconi (Italy)

Innovation and growth in firms

Innovative enterprises
Definition: Enterprises that introduce new or significantly improved products (goods or services) to the market, or enterprises that implement new or significantly improved processes or a new organisational or marketing method, which has not been used before. Innovations are based on the results of new technological developments, new combinations of existing technology or the utilisation of other knowledge acquired by the enterprise.
Source: Eurostat

Fast-growing enterprises/ High-Growth Enterprises
Definition: High-Growth Enterprises (HGEs) are defined as enterprises with an average annual growth in employees greater than 10 % a year, over a three-year period, and with 10 or more employees at the beginning of the observation period.
Source: Eurostat

EU Industrial R&D Investment Scoreboard
Definition: The EU Industrial R&D Investment Scoreboard presents information on the top 1000 EU companies and 1000 non-EU companies. The Scoreboard includes data on R&D investment along with other economic and financial data. It is the source for the ICT Scoreboard which provides data on the ICT companies with the largest R&D budgets globally.
Source: DG JRC

Upgrading the manufacturing sector through research and technologies

Knowledge-Intensive Activities (KIAs)
Definition: Knowledge-Intensive Activities (KIAs) are defined as economic sectors in which more than 33 % of the employed labour force has completed academic-oriented tertiary education (i.e. at ISCED 5 and 6 levels). They cover all sectors in the economy, including manufacturing and services, and can be defined at two- and three-digit levels in the statistical classification of economic activities.
Source: Eurostat

Knowledge-Intensive Services (KIS)
Definition: Knowledge-Intensive Services (KIS) include the following sectors (NACE Rev.2 codes are given in brackets): water transport (50), air transport (51), publishing activities (58), motion picture, video and television programme production, sound recording and music publishing activities (59), programming and broadcasting activities (60), telecommunications (61), computer programming, consultancy and related activities (62), information service activities (63), financial service activities, except insurance and pension funding (64), insurance, reinsurance and pension funding, except compulsory social security (65), activities auxiliary to financial services and insurance activities (66), legal and accounting activities (69), activities of head offices; management consultancy activities (70), architectural and engineering activities; technical testing and analysis (71), scientific research and development (72), advertising and market research (73), other professional, scientific and technical activities (74), veterinary activities (75), security and investigation activities (80), public

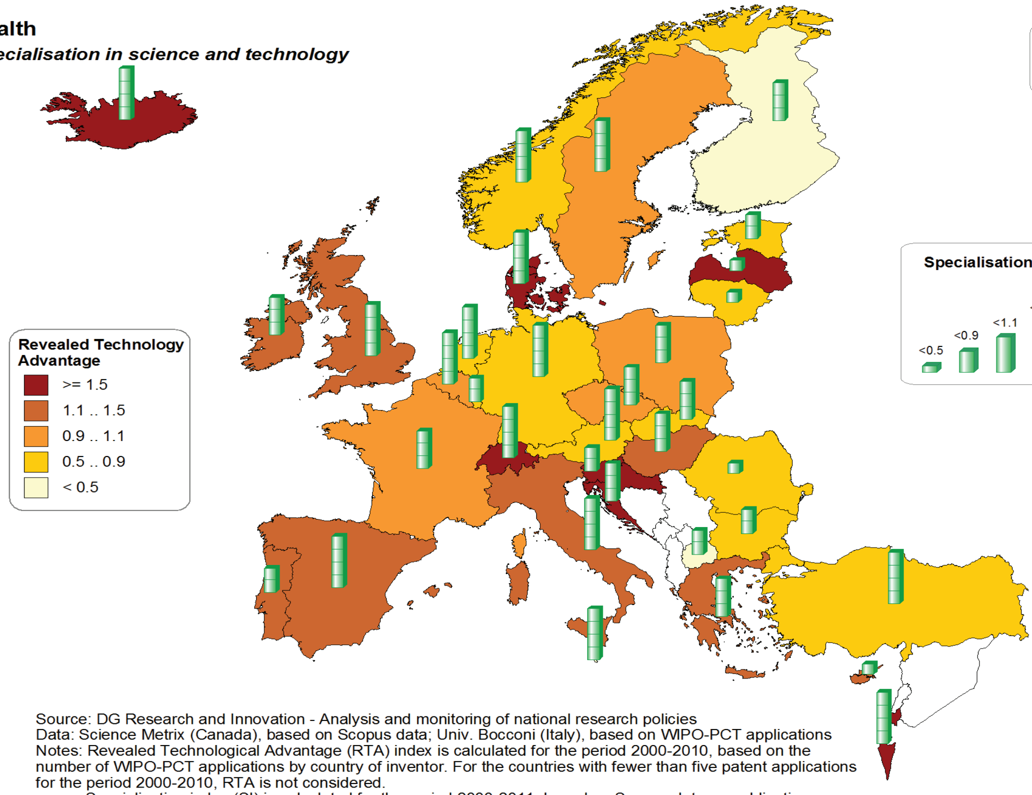
administration and defence; compulsory social security (84), education (85), human health and social work activities (86 to 88), arts, entertainment and recreation (90 to 93).
Source: Eurostat

Knowledge-Intensive Services exports
Definition: KIS exports are measured by the sum of credits in EBOPS (Extended Balance of Payments Services Classification) 207, 208, 211, 212, 218, 228, 229, 245, 253, 260, 263, 272, 274, 278, 279, 280, 284.
Sources: UN, Eurostat

Maps on Science and Technology specialisation in Framework programme thematic priorities

Health

Specialisation in science and technology



Source: DG Research and Innovation - Analysis and monitoring of national research policies
Data: Science Metrix (Canada), based on Scopus data; Univ. Bocconi (Italy), based on WIPO-PCT applications
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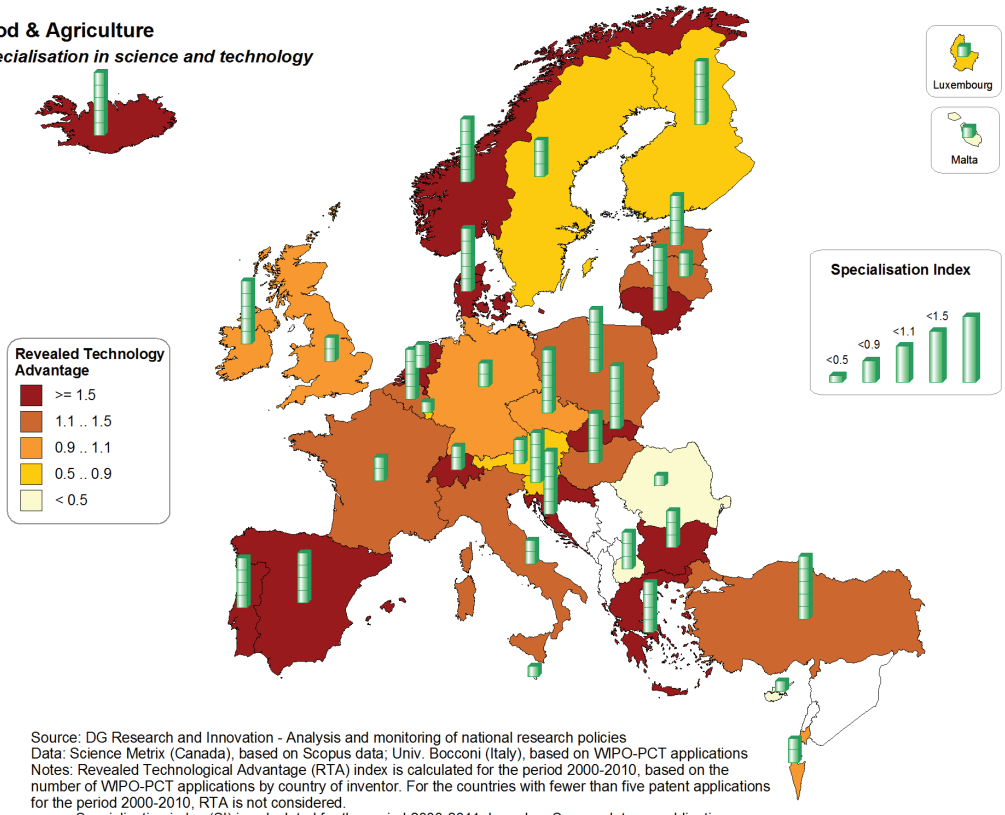
Food & Agriculture

Specialisation in science and technology



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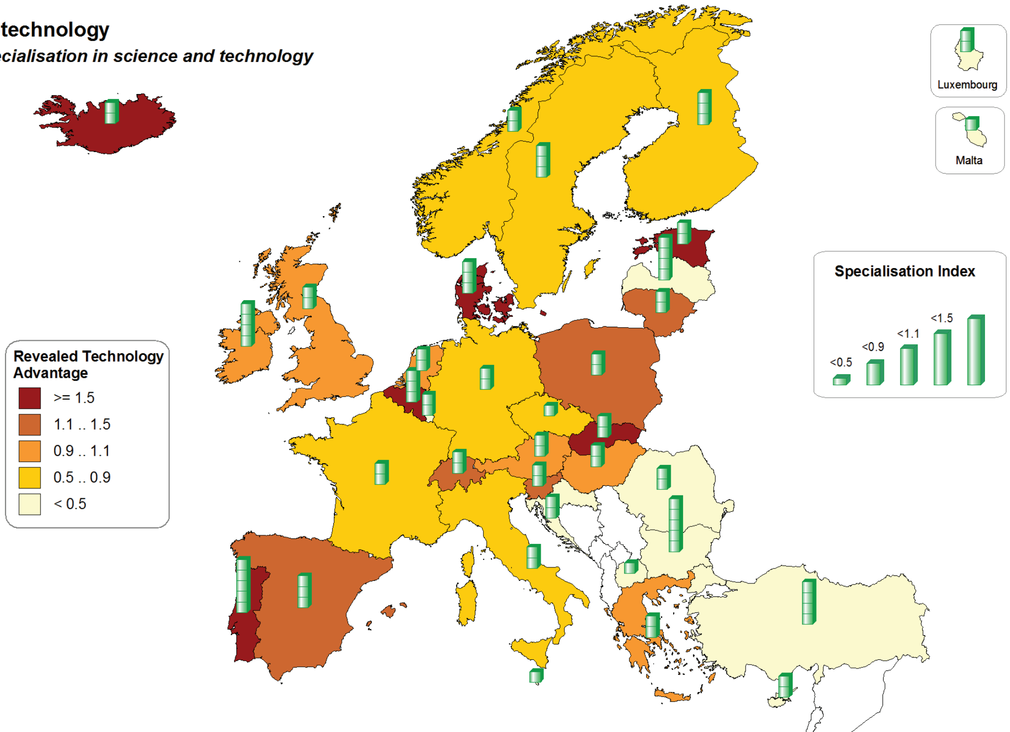
Biotechnology

Specialisation in science and technology



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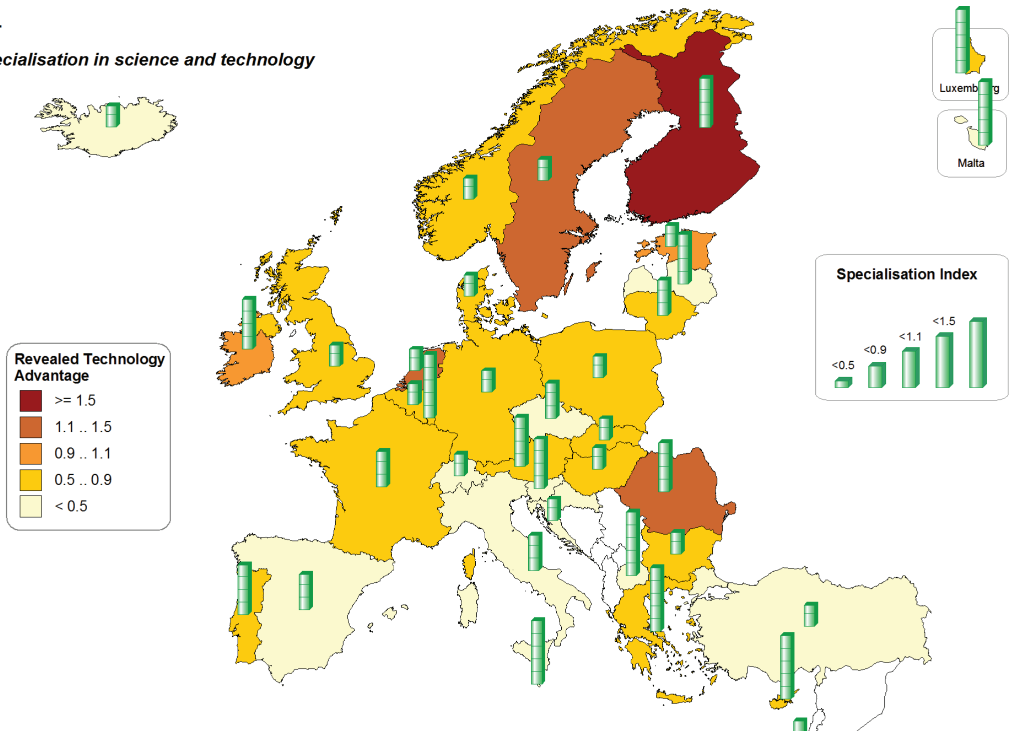
ICT

Specialisation in science and technology



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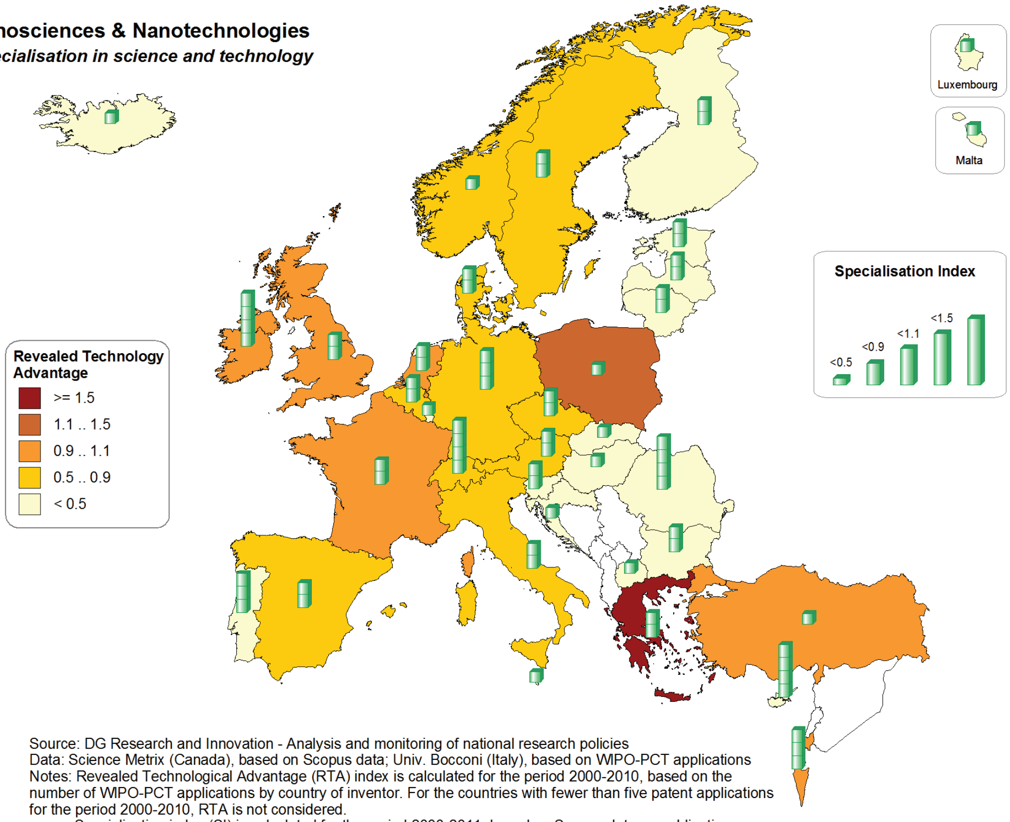
Nanosciences & Nanotechnologies

Specialisation in science and technology



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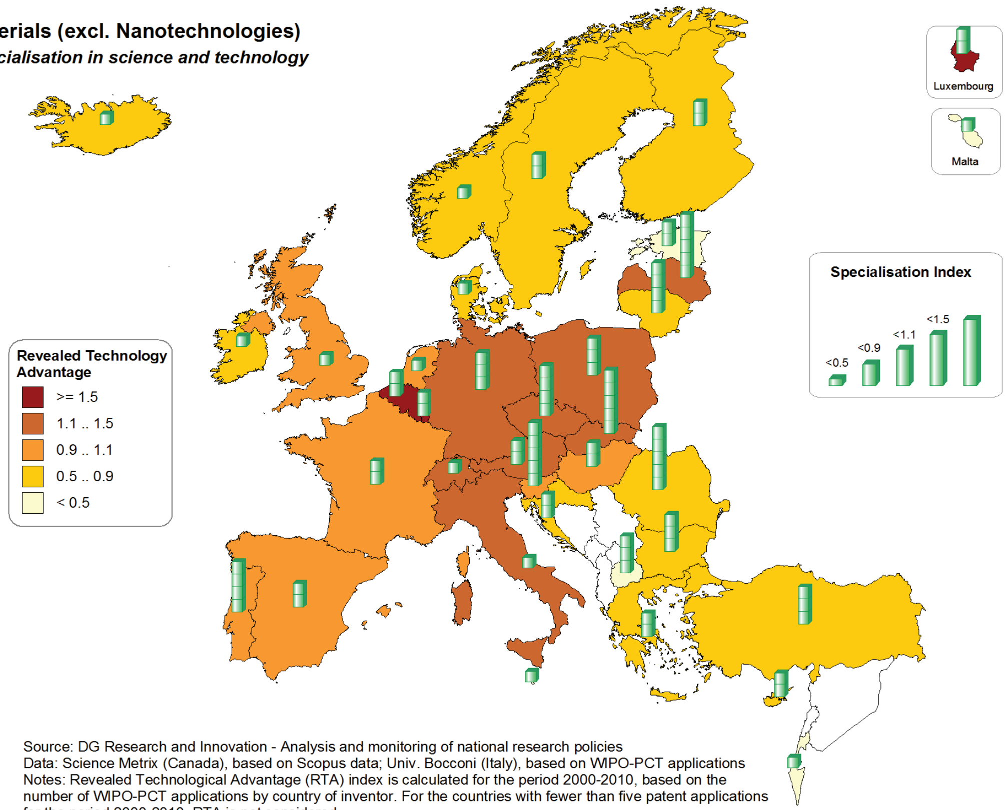
Materials (excl. Nanotechnologies)

Specialisation in science and technology



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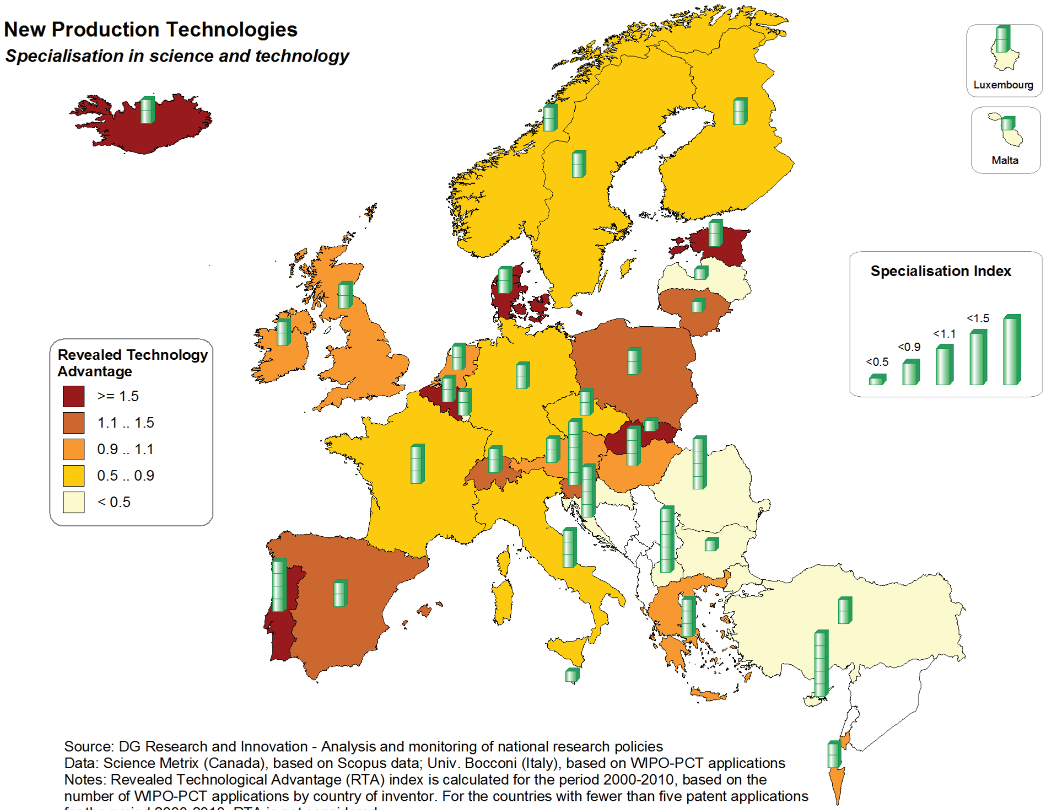

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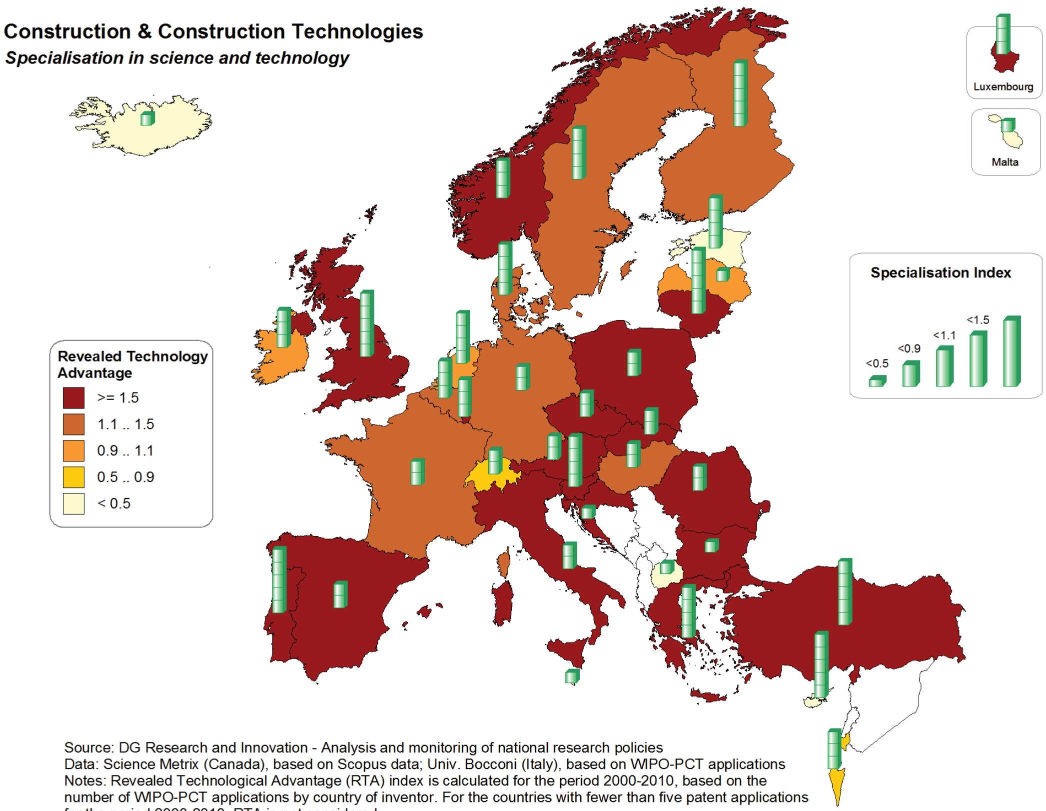

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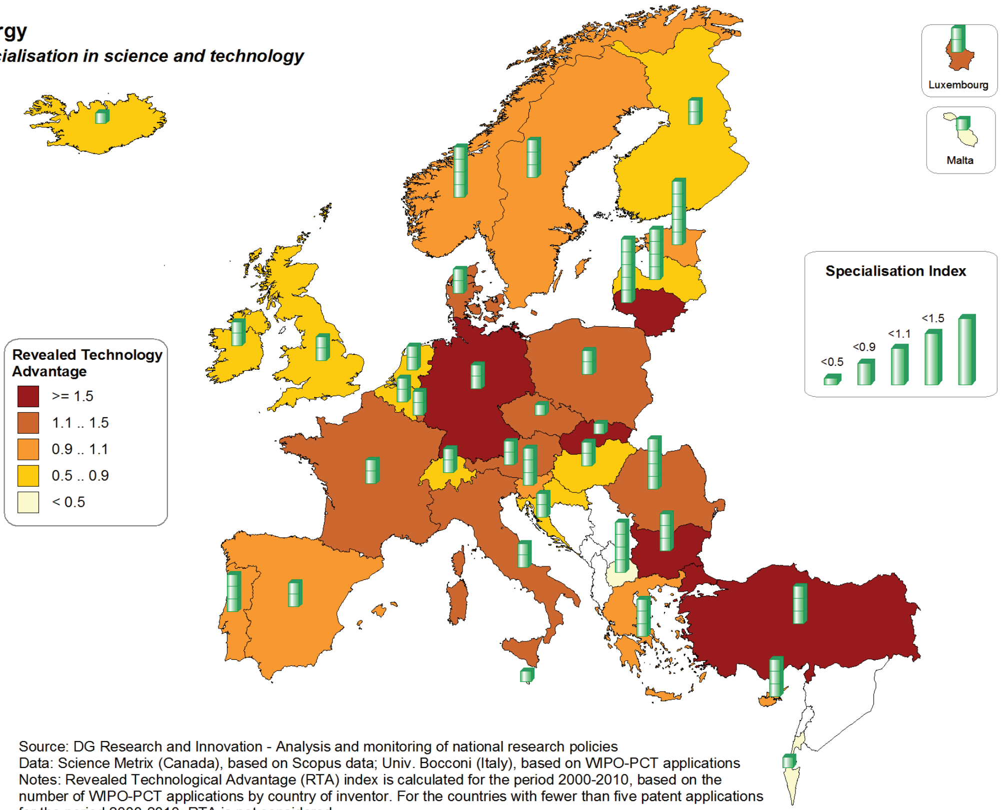
Energy

Specialisation in science and technology



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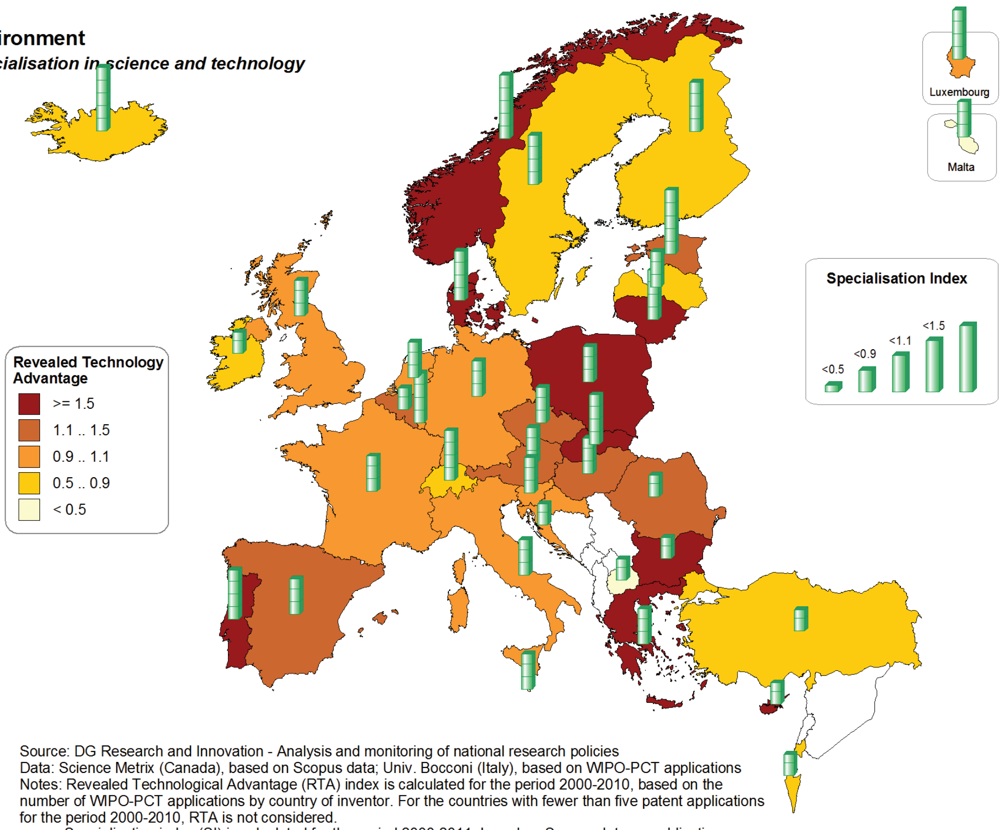
Environment

Specialisation in science and technology



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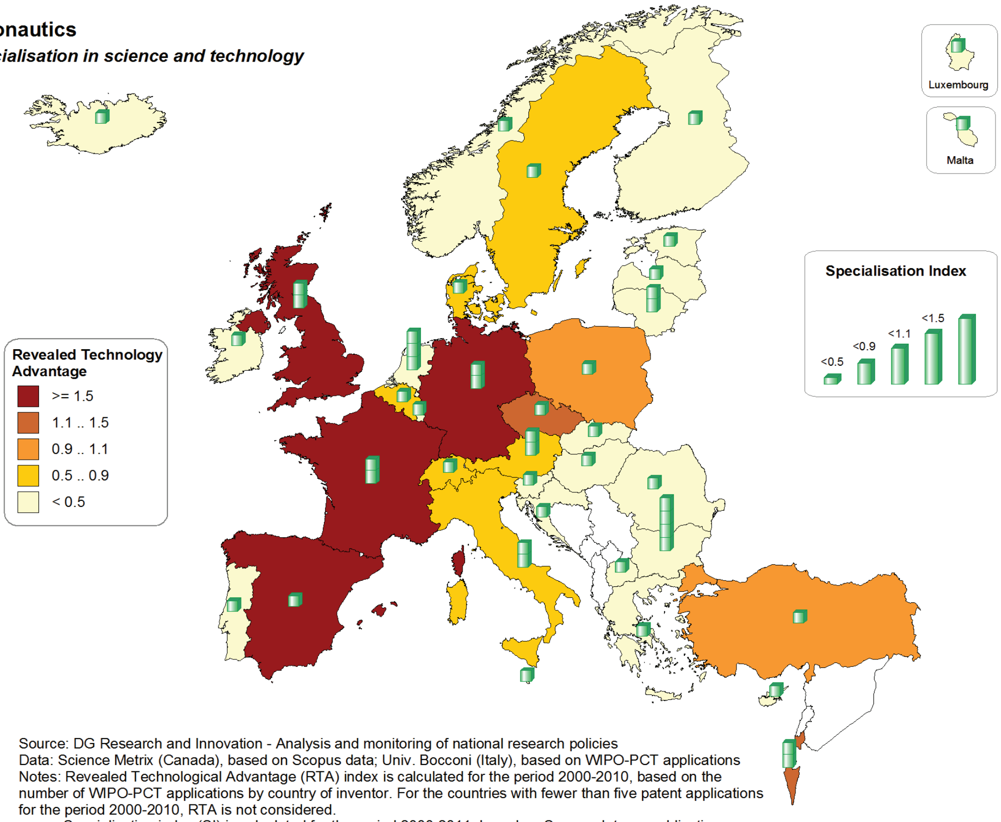
Aeronautics

Specialisation in science and technology



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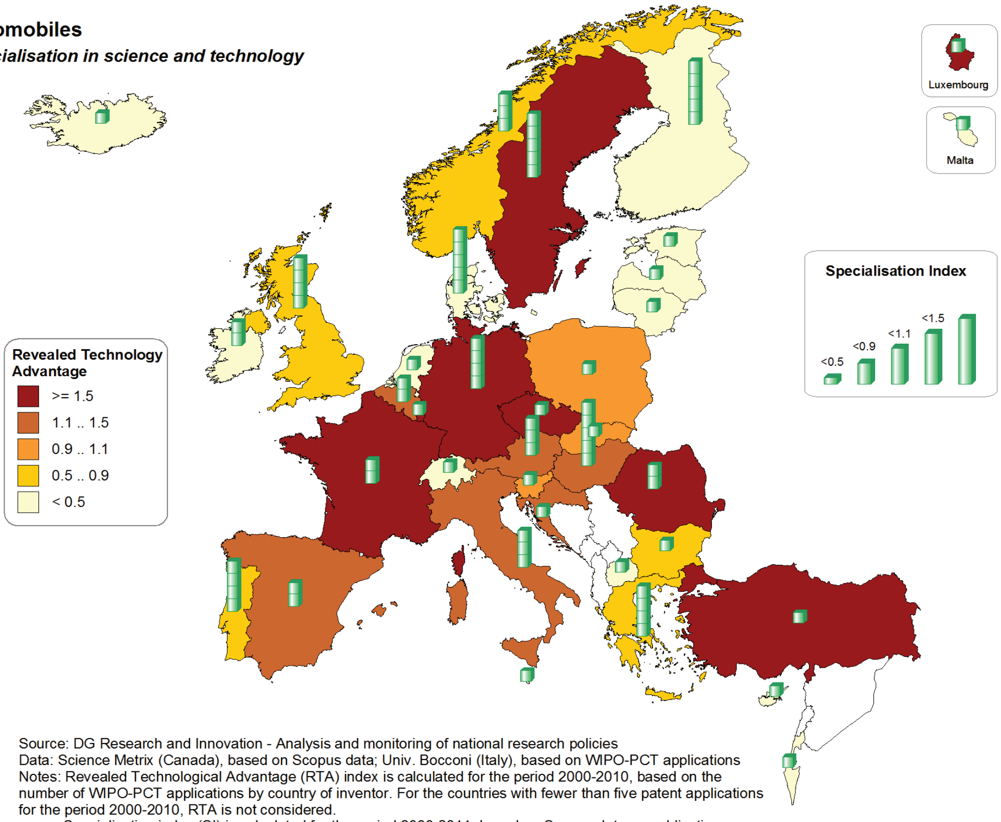
Automobiles

Specialisation in science and technology



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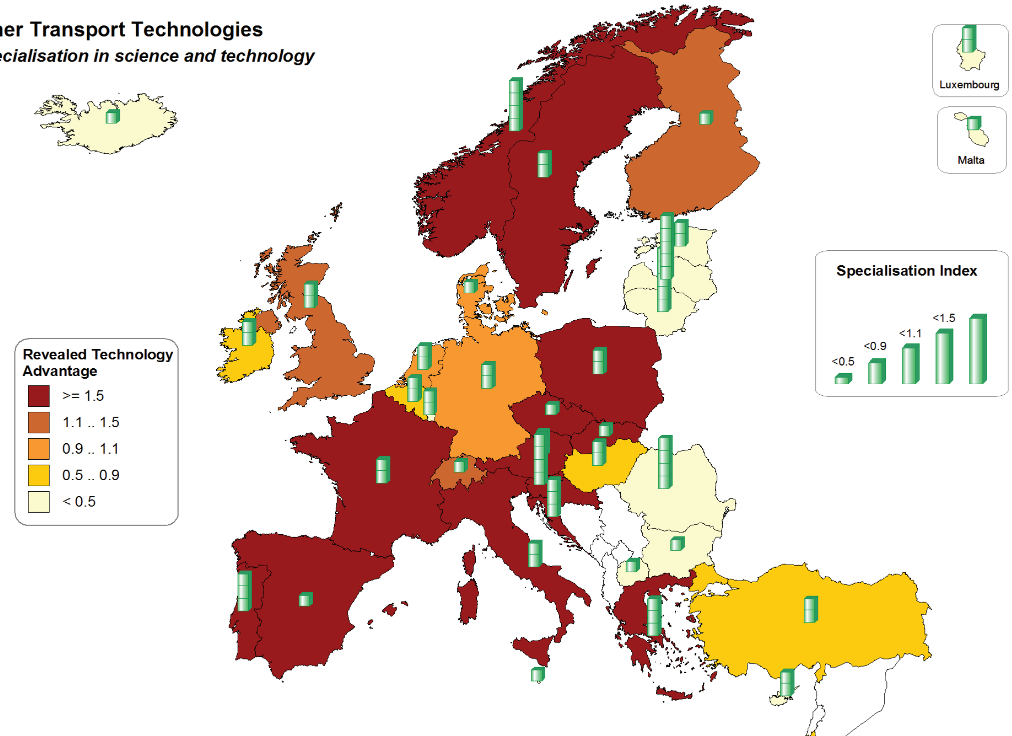
Other Transport Technologies

Specialisation in science and technology



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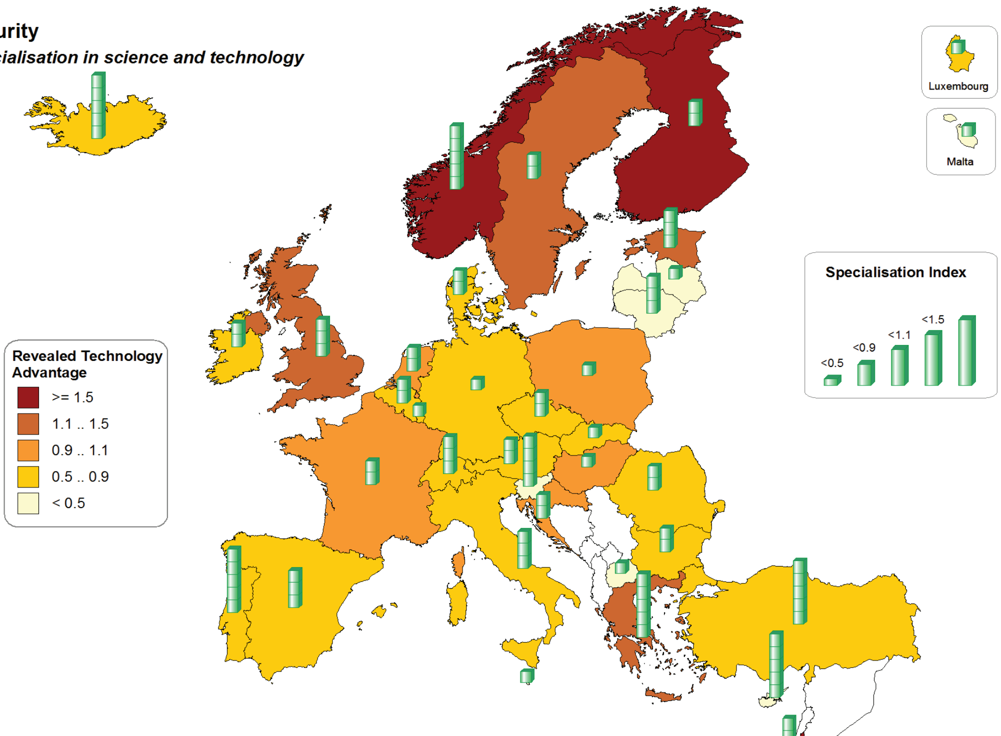
Security

Specialisation in science and technology



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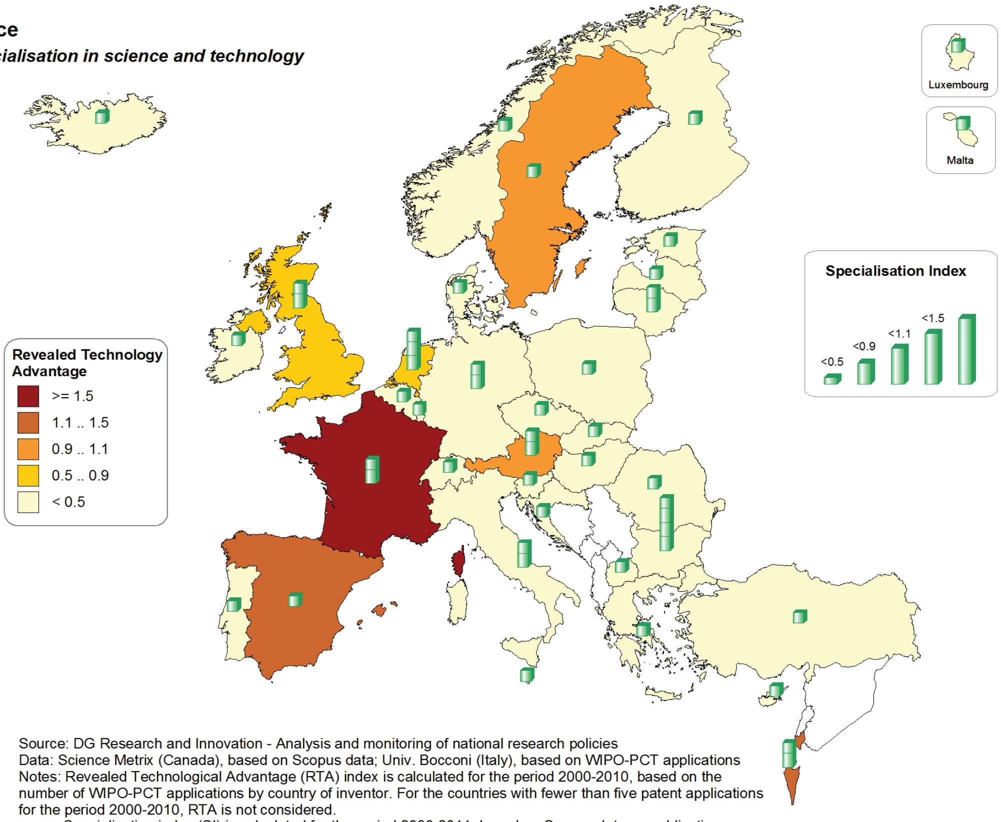
Space

Specialisation in science and technology



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List of acronyms/abbreviations

AdI – Innovation Agency, Portugal

AEI – National Research Agency, Spain

ANVUR - National Agency for the Evaluation of University System and Research, Italy

ARC – Average of relative citations

BERD – Total R&D expenditure as a share of GDP (%)

BICRO – Business Innovation Centre of Croatia

BIF – Baltic Innovation Fund

BIS – Department for Business, Innovation and Skills, UK

BMBF – Federal Ministry for Education and Research, Germany

BMWi – Federal Ministry for Economic Affairs, Germany

BRIC – Brazil, Russia, India and China

BTYK – Supreme Council for Science and Technology, Turkey

CD – Community design

CDTI – Centre for Industrial Technological Development, Spain

CIR – Research tax credit, France

COSME – Competitiveness of Enterprises and Small and Medium-sized Enterprises

COTEC – Foundation for Technological Innovation, Spain

CUE - Communities of Universities and Institutions, France

CTM – Community trademark

EBOPS – Extended Balance of Payments Services classification

ECB – European Central Bank

E-CORDA – External Common Research Data Warehouse

EEA – European Economic Area

ENA – National School of Administration, France

EPO – European Patent Office

ERA – European Research Area

ERAC – European Research Area and Innovation Committee

ERA-NET – Strengthening coordination of national and regional research programmes under FP7

ERC – European Research Council

ERDF – European Regional Development Fund

ESF – European Social Fund

ESIF – European Structural and Investment Fund

ESFRI – European Strategy Forum on Research Infrastructures

EU – EU-28 – European Union

EUR – Euro

FCT – Foundation for Science and Technology, Portugal

FDI – Foreign direct investment

FiDiPro – Finland Distinguished Professor Programme

FISIM – Financial intermediation services indirectly measured

FNR – National Research Fund, Luxembourg

FP7 – Seventh Framework Programme for Research

FTE – Full-time equivalent

GBAORD – Government budget appropriations or outlays for R&D

GCI – Global competitiveness index

GDP – Gross domestic product

GERD – Gross domestic expenditure on R&D

GOVERD – Government intramural expenditure on R&D

GSRT – General Secretariat for Research and Technology, Greece

HEFCE - Higher Education Funding Council for England

HERD – Higher Education expenditure on R&D

HEI – Higher education institutes

HGE – High-growth enterprise

HRST – Human resources in science and technology

HT – High-tech

ICI – Innovation Centre Iceland

ICT – Information and communication technologies

IMF – International Monetary Fund

INNO+ - Platform for strategic investments in innovation, Denmark

IP – Intellectual property

IPA – Pre-Accession Instrument

ISCED – International Standard Classification of Education

JRC – Joint Research Centre (of the European Commission)

KEJN – Committee for Evaluation of Scientific Institutions, Poland

KETs – Key enabling technologies

KIA – Knowledge-intensive activities

KIS - Knowledge-intensive services

KNOW – National Leading Scientific Centres, Poland

KTI – Knowledge Transfer Ireland

ME – Ministry of Economy, Slovakia

MESRS - Ministry of Education, Science, Research and Sport, Slovakia

MNCs –Multinational companies

MIUR – Ministry for Education, University and Research, Italy

MISE – Ministry for Economic Development, Italy

MIT-MKB – Encouraging SME innovation top sectors, the Netherlands

MoSIT – Ministry of Science, Industry and Technology, Turkey

MTA – Hungarian Academy of Sciences

MT/MHT – Medium high-technology/Medium high-technology and high technology

n.a. – not available

NACE – Statistical Classification of Economic Activities

NCBiR – National Centre for Research and Development, Poland

NCN – National Science Centre, Poland

NCRITD – National Committee on Research, Innovation and Technological Development, Cyprus

NIH - National Innovation Office, Hungary

NIS – National Innovation Strategy, Czech Republic

NRP – National Reform Programme

NSRF – National Strategy for Research, Technological Development and Innovation, Greece

NTIT – National Science Policy and Innovation Board, Hungary

NUTS – Nomenclature of Statistical Territorial Units

OECD – Organisation for Economic Co-operation and Development

OHIM – Office for Harmonization in the Internal Market

OP – Operational Programme

PCT – Patent Cooperation Treaty

PISA – Programme for International Student Assessment

PONREC – National Operational Programme for Research and Competitiveness, Italy

PPS – Purchasing Power Standards

PRC – Public Research Centre, Luxembourg

PRES – Higher education research institutions clusters, France

PRP – Enterprise Development Programme, Poland

RANNIS – Icelandic Centre for Research

R&D – Research and development

R&I – Research and innovation

RCA – Revealed comparative advantage

RIS3 – Research and Innovation Strategies for Smart Specialisation

RISS – Research and Innovation Strategy 2011-2020, Slovenia

RPF – Framework Programme for R&I, Cyprus

RTA – Revealed technological advantage Index

RTDI – Research, technological development and innovation

S&E – Science and engineering

S&T – Science and technology

SGCSTI - Slovak Government's Council for Science, Technology and Innovation

SERV – Knowledge-intensive service exports

SFI – Science Foundation Ireland

SHOK – Strategic Centre for Science, Technology and innovation

SI – Specialisation Index

SIEG – Strategy for Innovation and Effectiveness of the Economy 2020, Poland

SIFIDE – System of tax investments for companies investment in R&D, Portugal

SME – Small and medium-sized enterprise

S3 – Smart Specialisation Strategy

STI – Science, technology and industry

STPC – Science and Technology Policy Council, Iceland

TFP – Total factor productivity

TSB – Technology Strategy Board, UK

TKI – Top Consortia for Knowledge and Innovation, the Netherlands

TÜBİTAK - Scientific and Technological Research Council of Turkey

UBTYS – National Science, Technology and Innovation Strategy, Turkey

VC – Venture capital

VTT – Technical Research Centre of Finland

WEF – World Economic Forum

WBSO – R&D promotional law, the Netherlands

WIPO – World Intellectual Property Organization