Sehr geehrte Damen und Herren,

Das Bundesministerium für Wissenschaft, Forschung und Wirtschaft lädt Sie zu einem strategischen Dialog mit der Europäischen Kommission ein. Im Mittelpunkt des Gesprächs steht die Leistungsfähigkeit des österreichischen Innovationssystems im Lichte der Europa-2020 Strategie sowie der Ziele des Europäischen Forschungsraums.

Die Veranstaltung findet am **29. Juni 2017, von 14:00 - 16:00 Uhr**, im BMWFW, 1010 Wien, Freyung 3, 2. Stock (Veranstaltungsräume) statt. Ich ersuche Sie, mir bis spätestens 12. Juni 2017 Ihre Teilnahme zu bestätigen.

Im Rahmen dieses strategischen Dialogs wird die Europäische Kommission ihre Sicht auf die österreichische FTI-Performance zur Diskussion stellen. Dieser Blick von außen ist wichtig, er ist aber nur so wertvoll, wie er mit der Innensicht der österreichischen FTI-Community in Einklang gebracht werden kann. So geht es insbesondere um die Frage, welche Schlussfolgerungen Österreich aus den Analysen der Europäischen Kommission zieht. Es wird auf die beiliegenden Dokumente zur Einstimmung verwiesen.

Im Rahmen des strategischen Dialogs wird Österreich den 1. Fortschrittsbericht zur Umsetzung der "Österreichischen ERA Roadmap" vorstellen.

Mit freundlichen Grüßen

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EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION

Directorate A - Policy Development and Coordination
A.4 - Analysis and monitoring of national research & innovation policies

Research and Innovation analysis in the European Semester Country Reports 2017

This document, compiled by DG Research & Innovation, collects all the research and innovation (R&I) aspects covered by the 2017 European Semester Country Reports. In particular, for each Member State the document shows: (i) the R&I relevant findings and related policy challenges from the Executive Summary of the Report; (ii) the R&I specific section of the Report; (ii) any additional references to R&I issues in other sections of the Report. Greece is not covered by this document, as a Programme country not included in the European Semester process.

Contents

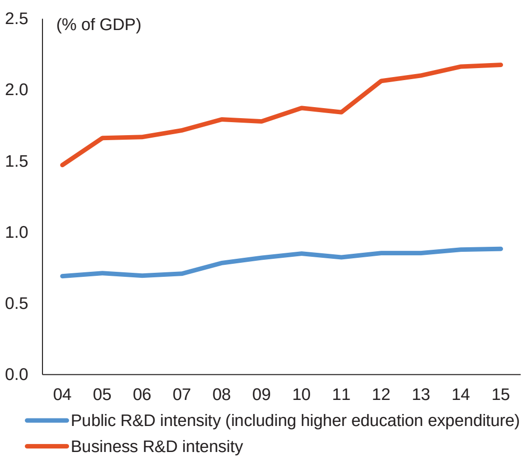
1. Austria

1.1. Research and Innovation

Austria ranks second among Member States on public and private R&D spending but has not yet achieved a matching performance in innovation. In Austria R&D spending as a percentage of GDP amounted to 3.07 % in 2015 (Eurostat), the second-highest level in the EU. Austria is also among the EU countries with the strongest increase in R&D intensity since 2000, as a result of increases in both public and business R&D expenditure. However, like in other comparable Member States, progress on R&D intensity has slowed in recent years, especially for public expenditure. Despite the high overall spending levels, funding of basic research remains low and there is scope to increase excellence in research, a field where Austria scores only near the EU average (11.7 % of publications are highly cited, compared to an EU average of 10.5 % in 2013). The increase in the budget for universities by EUR 615 million for the period 2016-2018 is an important step. Public spending on R&D co-financed by private companies, an indicator of the level of public-private cooperation in R&D, accounted for 0.042 % of Austria's GDP in 2013, compared with an EU average of 0.052 %. Austria's performance on innovation outputs leaves room for improvement in some areas. These include: the sales shares of new product innovations (9.8 % in 2012, below the EU average of 12.4 %); licence and patent revenues from abroad (0.25 % of GDP in 2014, below the EU average of 0.54 %); and medium- and high-tech product exports (57.4 % in 2015, only slightly above the EU average of 56.1 %).

Since formulating its innovation leadership ambition in 2011, Austria has tabled a multitude of initiatives and programmes but has not yet evaluated their overall effectiveness. In 2011 Austria formulated a comprehensive national strategy to boost the performance of its research and innovation system (Der Weg zum Innovation Leader). Among the more recent follow-up measures are the research action plan published in 2015 and new guidelines for research, technology and innovation funding which entered into force on 1 January 2015. In line with a shift from direct to indirect support such as tax incentives, the research premium was increased from 10 % to 12 % in January 2016. In early 2017 Austria announced a further increase to 14 % effective as of January 2018. There has also been a growing number of initiatives in recent years focusing on improving knowledge transfer and cooperation between public research (including research at universities) and business. The ongoing evaluation of the effectiveness of the research premium could help to further optimise its impact.

Graph 3.5.1: **Evolution of business and public R&D intensity**



Source: European Commission

1.2. Additional references

[3.3.3 Education, p. 27]

Austria faces challenges in meeting the growing demand of ICT specialists, digital skills among the general workforce and e-entrepreneurs. The share of ICT specialists in the Austrian workforce of around 4 % is only around the EU average. Students' motivation to engage in science has further deteriorated since 2006 and is now at one of the lowest levels in the EU. Even if interest in science topics has risen back to the OECD average again (Bifie, 2016), this comparative lack of motivation does not help achieve the increase in human resources devoted to science, technology, engineering and mathematics that is needed for Austria to become an innovation leader.

Funding remains an issue in the higher education system and is preventing Austria from improving education outcomes. Austria's tertiary attainment rate was 38.7 % in 2015, the same as the EU average. Austria reached its Europe 2020 national target of 38 %. Austria has a comparatively larger share of studies on ISCED 5 level (OECD 2016b). In 2014, per 1 000 population in the age group 20-29 Austria had 22.5 graduates in science, mathematics, computing, engineering, manufacturing & construction, above the EU average of 18.7 graduates. However, it has a lower proportion of graduates at higher qualification levels (i.e. master's degrees and PhDs) than those countries it aims to join in its ambition to become an innovation leader.

2. Belgium

2.1. Executive summary

A number of bottlenecks weigh on Belgium's growth potential. Despite fiscal incentives for research activities, patent registrations and notwithstanding the presence of a highly skilled work force, the technological content of Belgium’s exports is behind that of its peers. Its high-quality public research system has not brought about an abundance of fast-growing firms in innovative sectors. Stimulating the adoption of digital technologies and higher human capital accumulation could further underpin productivity growth. Moreover, new sectors capable of creating domestic value added are not sufficiently involved, thereby missing out on multiplier effects, also in relation to employment, especially in services. Apart from downstream services such as distribution, this is a lost opportunity for an upward shift in the production chain, to where margins are bigger and finished products are more differentiated, notably through services such as R&I, design and branding.

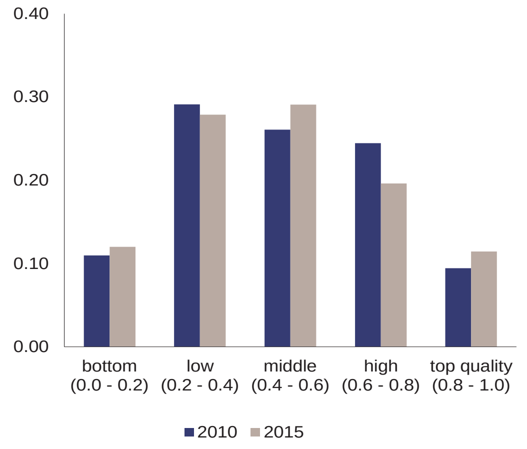
2.2. Research and Innovation

Upscaling the product range, enlarging the accumulation of knowledge-based capital across a wider spectrum of the economy, and improving market functioning will be crucial to safeguarding potential growth over the long-term. This depends on a broad range of conditions, linked to innovation and technology content, company creation and growth, product and process development, trade participation and factors conducive to a supportive business environment. These various factors contributing to non-cost competitiveness are discussed in more detail below.

Quality of exports

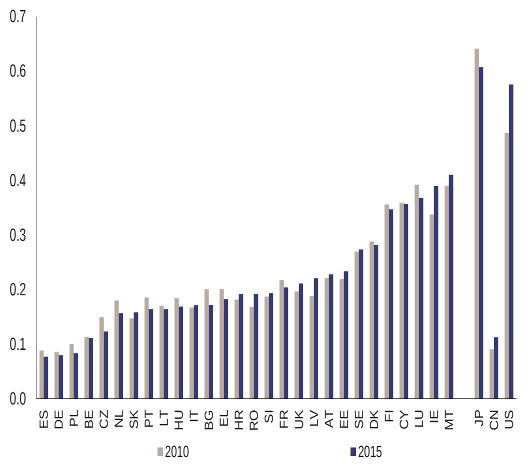
Belgium exports mainly and increasingly medium-quality goods. On average product quality, peer countries are generally found to perform better, as do most EU-15 countries: Germany and the Netherlands are situated in the middle range, while French exports are concentrated more at the upper end of the quality spectrum. Graph 3.4.6 shows the share of value that Belgium was exporting in each quality category in 2010 and in 2015. This shows that the share of the ‘bottom’, ‘middle’ and ‘top’ categories increased between 2010 and 2015. However, the ‘high’ category’s share fell. Nevertheless, Belgium lags behind its neighbours in terms of the number of different top-quality products exported (Graph 3.4.7).

Graph 3.4.6: Share of export value by quality rank, Belgium



Source: COMEXT (Eurostat) and ORBIS

Graph 3.4.7: Share of number of different products exported in the top-quality category, EU-28 countries plus Japan, U.S. and China



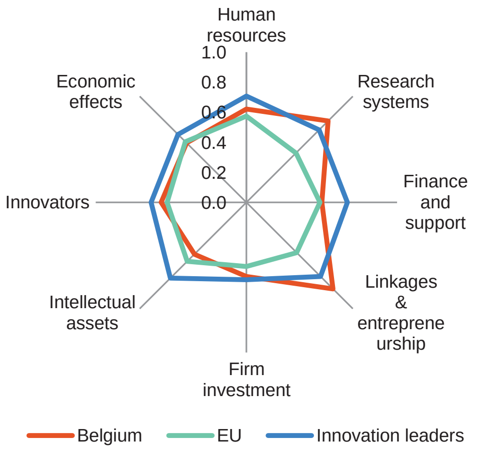
Source: COMEXT (Eurostat) and ORBIS

Generally upscaling the product range or mix would help to compensate for high labour costs and to allow future export growth. Belgium's product specialisation in the middle-quality product segments seems to be misaligned with its high labour costs. This is particularly relevant to manufacturing industries exposed to fierce global competition and facing a fall in relative prices: rubber and plastic products, transport equipment and, to a lesser extent, textiles, metallurgy, chemicals, wood, paper and printing, and electrical equipment. Producers cannot easily pass on higher input costs in the price of their products, most of which are standardised, can be easily copied and are abundantly available. Price demand for these products is also highly elastic, as they are easy to substitute. Furthermore, the value added in these industries has also evolved much less favourably than that of neighbours.

Innovation capacity

Belgium is a strong innovator with an above-EU-average performance, although it declined slightly in 2015 and remains below the group of EU innovation leaders (Graph 3.4.8). ([1]) Its good performance can be explained by the openness and quality of its science base, which is reflected in strong public-private collaborations, a high proportion of public R&D financed by the business sector and the its attractiveness to foreign doctoral students. However, the high quality of the science base is not sufficient by itself to translate into innovation output. The proportion of high-growth, innovative enterprise in the total economy remains low (0.10 %, against an EU-28 average of 0.16 %), especially compared to EU innovation leaders (which have an average of 0.24 %) (Costa *et al.*, 2016).

Graph 3.4.8: European Innovation Scoreboard — distance to EU innovation leaders and to EU average



(1) A score of 0 indicates the lowest performance among all countries in the sample, whereas 1 indicates the frontier of best practice.
Source: European Innovation Scoreboard (2016)

Regional innovation strategies, coupled to fiscal incentives at the federal level, have aimed at fostering innovation-led business competitiveness. Following overall evaluations, regional development strategies have expanded their initial science/technology focus to encompass innovation more broadly. Wallonia and Flanders, in their efforts to streamline and simplify research and

([1]) Sweden, Denmark, Finland, Germany and the Netherlands ranked as 'innovation leaders' in 2015 - European Innovation Scoreboard (European Commission, 2016).

innovation support, recently merged the agencies responsible in their regions. ([2]) The focus on boosting innovation in SMEs and start-ups has increased. ([3]) The federal government also recently aimed to increase the availability of equity financing, with the introduction of a 'tax shelter' for investment in start-ups. Federal fiscal support for business R&D has also increased to over EUR 1.2 billion, accounting for over two thirds of total public support for business R&D, in particular due to increased use of the partial salary withholding tax exemption for researchers (OECD (2015b; Belgium National Reform Programme 2016).

Total R&D intensity in Belgium reached 2.45 % of GDP in 2015, narrowing the gap both with the Europe 2020 target (3 % of GDP), and with the average of innovation leaders (3.05 %). However, public R&D intensity ([4]), at 0.68 %, remains low compared to the EU average and innovation leaders ([5]), whereas the business sector remains the largest and an expanding source of R&D investment, with spending of 1.77 % of GDP in 2015 (Belgian Court of Auditors, 2013; Dumont, M., 2012; Dumont, M., 2015).

Ensuring the efficiency and coherence of public support for research and innovation remains a challenge, especially to foster high-growth innovative enterprises (Graph 3.4.9). Total public support for private R&D has become the highest in the OECD, reaching 0.41 % of GDP (OECD, 2016c). However, reflecting its generic nature and the concentration of R&D, more than 90 % of this fiscal support goes to large companies, mostly those active in high-tech sectors (Belgian Court of Auditors, 2013; Dumont, M., 2012). The lack of evaluation of potential overlaps between the many support instruments across the regions and communities is an issue. The scope for increasing the efficiency, effectiveness and coherence of public support for R&I in Belgium is likely to be significant.

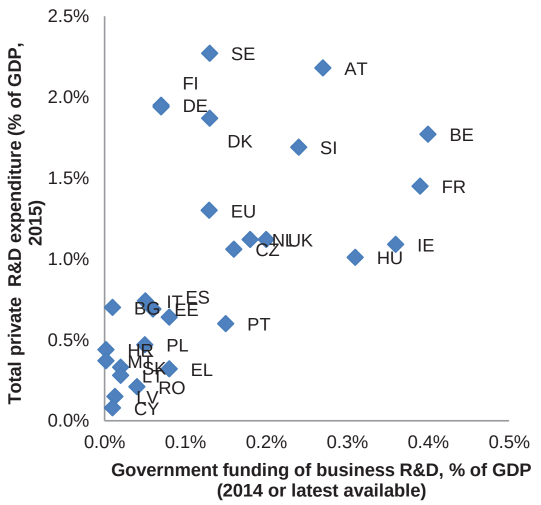
([2]) In Flanders, as from January 2016, Enterprise Flanders (AO) and the Agency for Innovation by Science and Technology (IWT) merged into the Innovation and Entrepreneurship agency (VLAIO). In Wallonia, l'agence de stimulation technologique and the agence de stimulation économique were merged into the l'Agence pour l'entreprise et l'innovation (AEI) in March 2015.

([3]) Notably, initiatives in Wallonia under the 'Walloon Small Business Act', 'Creative Wallonia' and 'Digital Wallonia'; the 'Small Business Act' and the 'regional innovation plan' in Brussels; the 'Digital Belgium' action plan at the federal level; in 2016, the Flemish Government also launched the SME growth subsidy programme, managed by VLAIO.

([4]) R&D expenditure as a percentage of GDP is used as an indicator of an economy's relative degree of investment in generating new knowledge.

([5]) Sweden, Denmark, Finland, Germany, the Netherlands; see European Innovation Scoreboard 2016.

Graph 3.4.9: Efficiency of public funding of private R&D



Source: OECD

Furthermore, a wider base of businesses investing in knowledge-based capital (KBC) ([6]) could help boost innovation and productivity growth. Belgium has a relatively high percentage of knowledge-based capital (OECD, 2015b), of which R&D constitutes more than half. However, most business R&D spending is concentrated in a few industries ([7]) featuring a few large multinational companies. ([8]) This high concentration of business R&D suggests that much knowledge-based capital is also highly concentrated in a small number of firms, since R&D investment is one of the main assets of this kind (Biatur and Kegels, 2015), and that strong R&D performers tend to also invest more in other forms of intangibles (ICT and skills notably). Furthermore, while the stock of knowledge-based capital is high, investment mostly occurs in highly-productive innovative firms, while a large pool of firms underinvests (OECD, 2015). This decline can in future lead to a slowdown in innovation performance of certain sectors and partly explain the slowdown in total factor productivity growth. Investment in knowledge-based capital is a major driver of productivity and growth as it usually underpins innovations and their subsequent adoption (Corrado *et al.*, 2012, Corrado *et al.*, 2013, and Andrews and Criscuolo, 2013). ([9])

A skilled workforce to develop and use technology for new ideas and products is also essential to boost innovation. The comparably low percentage of students and graduates in STEM (science,

([6]) According to the OECD, knowledge-based capital encompasses all assets that lack physical substance but, like physical capital, generate economic benefits that can be retained by firms, at least to some extent, for a period that exceeds one year. Three main categories of intangible assets are usually measured: computerised information (which includes software and databases), innovative property (covering R&D, design, mineral exploration, financial innovation and artistic originals) and economic competencies (including advertising, marketing research, own-account organisational capital and training).

([7]) In particular: pharmaceuticals (28.8 % of total business R&D expenditure in 2013), manufacturing of computer, electronic and optical products (7.1 %) and IT & information services (6.3 %) (RIO Country Report Belgium 2016 - publication pending).

([8]) For instance, around 30 % of R&D expenditure in the pharmaceutical industry in 2014 was carried out by a single large multinational.

([9]) Investments in intangibles, innovation activities and productivity all appear to be intrinsically linked. It has been estimated that investment in knowledge-based capital has accounted for one fifth to one third of labour productivity growth.

technology, engineering and mathematics) might become a concern for future innovation capacity. By international comparison**,** the proportion of tertiary education graduates in STEM fields (17.8 % in 2014) has increased slightly in recent years, but is still one of the lowest in Europe. This is partly caused by the relatively low rate of new entrants. ([10]) Flemish students perform relatively well in engineering and sciences (Lambert, 2015). However, only 5 % of their 15 year-old French community peers are among the top achievers. The communities and regions are taking action to make STEM more attractive at different levels of education and training (EC, 2015b, 2016c). Monitoring of the Flemish STEM action plan ([11]) points to positive results in higher education but mixed results in secondary education. The proportion of people with high computer skills (24 %) is below the EU average (29 %), and well below the highest percentage observed in innovation leaders. ([12]) The shortage of qualified experts in ICT is expected to rise from about 8,000 in 2012 to 30,000 in 2020 (EC, 2016b).

2.3. Additional references to R&I

[Productivity, p. 34]

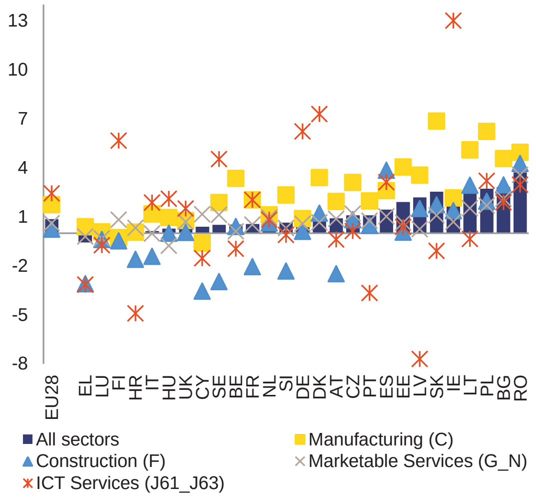
Within the broad group of manufacturing industries, productivity growth trends vary considerably between individual sectors. The most productive firms, the so-called global frontier firms, have not been so affected by the slowdown in productivity growth. They display more robust productivity growth rates than other businesses. Productivity growth has been very strong in the food and basic metals industries, with Belgium being a leader in the food industry, which accounts for 15 % of manufacturing gross value added. Meanwhile, productivity growth has been less good in two other leading industries: pharmaceuticals and chemicals. This partly reflects their already high productivity level, and, without considering innovation aspects, it testifies to the limits and risks of a strategy based mainly on deepening capital. Given their size in the manufacturing sector, with close to 28 % of value added and 55 % of business R&D expenditure in manufacturing, regaining productivity growth in these two sectors is crucial. In addition, Belgium has low labour productivity growth in some manufacturing industries that have the highest EU growth rates, such as motor vehicles, computers, electronics and optical products.

([10]) In comparison with the EU-21 and OECD averages, the 2012 Belgian enrolment rates for new entrants was lower in sciences (5 % against 11 % in EU-21) and engineering (10 % against 15 % in EU-21).

([11]) STEM action plan and STEM monitor 2016.

([12]) Finland (46 %), Denmark (39 %) and Germany (30 %).

Graph 3.4.5: Labour productivity in EU-28 (2006-2015) — average % annual change



Note: Labour productivity is defined as the ratio between value added in constant prices and the labour input, the latter given by hours worked by people employed (incl. self-employed) or, in case this data is not available, by total employment in persons. Primary data on value added and labour input –both hours worked and total employment- was retrieved from Eurostat for the EU-28 aggregate and country members (data on 'value added, gross' in constant prices (chain-linked volumes) and for labour input data in terms of 'hours worked' or 'persons'). 2006-2014 average for all industries in CZ and IE, 'C', 'G_N' and 'J61_J63' in EU28, 'J61_J63' in CY, DE, ES, FR, LT, LV, PL, PT, RO, SE; 2008-2014 average in HR; 2009-2010 change excluded in HU due to methodological change; no available data for MT.
Source: Eurostat

The recent flattening of overall labour productivity growth points to a number of major challenges. First, the already high degree of capital intensity reduces the scope for future productivity gains through additional capital deepening in various sectors, except by means of radical breakthroughs in organisational or technological change. In this respect, manufacturing and, to a lesser extent, the services sector in Belgium seem to have benefited less from growth returns from ICT than in most neighbouring countries (FPB, 2015). This may have had the effect of hampering potential growth. More in general, investment in research and knowledge-based capital accumulation remains to a large extent concentrated in a handful of sectors. A better diffusion of innovation across industries might help to upscale the product and services mix with which Belgium competes in global markets (see Section 3.4.2). Second, future productivity growth in many sectors is constrained by persistent skills gaps and labour shortages in certain occupations. In a context of rapid technological change since the beginning of the century, labour demand in Belgium has rapidly shifted towards high-skilled occupations since the beginning of the century (close to +25 % between 2000 and 2010) (Maselli, 2012) and maintained low-skilled functions, mostly at the expense of middle-skilled functions (De Mulder & Duprez, 2015). Labour supply, however, has not adapted as swiftly. This is shown, for instance, by the low proportion of tertiary education graduates in science, technology, engineering and mathematics (see Section 3.3).

More efficient allocation of resources, especially across market services, could imply large gains in productivity (European Commission, 2015a; European Commission, 2016e). The allocative efficiency indicator uses information on employment and value added distribution across firm-size classes. It captures the extent to which productive resources are allocated to their most productive uses. Allocative inefficiencies have increased in professional, scientific and technical services ([13]) and ICT services, as well as transportation and storage (European Commission, 2015a). It suggests that regulatory restrictions and a lack of market dynamism are inhibiting further efficiency increases and that reducing barriers to innovation and entrepreneurship and improving the overall business and investment environment could positively contribute to the overall growth capacity of the Belgian economy.

Finally, the widespread practice of wage indexation in most sectors makes full adjustment of wages to differences in productivity across firms within the same sector more difficult. Automatic indexation makes real wages more rigid and consequently works against adjustment in the labour market, thereby increasing the risk of misallocation of labour, with high wages (and low employment and value added) in low-productivity firms. Although firm-level derogations from sector-level agreements (opt-outs) are possible under specific conditions, they are rarely used.

[Education and skills, p. 27]

Nurturing excellence is essential in order to counter the declining share of top performers among the 15-year-olds students. According to Pisa 2015 results, Belgium's share of top performers is still above the OECD average in all three areas tested, at 15.9 % in mathematics (against an OECD average of 10.7 %), 9 % in science (OECD average 7.7 %) and 9.3 % in reading (OECD average 8.4 %). However, since 2003, there has been a rapidly down turning trend of top performers in mathematics even when adjusted for the demographic changes. The decrease is especially pronounced in the Flemish community. The proportion of top performers in the French and German community is below the national average in all three areas and is little more than 5 % in science. Moreover, the low proportion of students and graduates in science and technology might hamper future innovation as discussed in the 2016 country report**.** For further details on science, technology, engineering and mathematics (STEM) students and graduates, see Section 3.4.2. on innovation.

([13]) This category includes: scientific research and development; legal and accounting activities; architecture and engineering; technical testing and analysis; head offices; management consultancies; advertising and market research; veterinary activities; and other professional, scientific and technical activities.

3. Bulgaria

3.1. Research and Innovation

Low technological progress and innovation performance limit Bulgaria's growth potential. Bulgaria is a modest innovator with an innovation performance at only 46 % of the EU average (European Commission, 2016g). The main weaknesses are in the areas of 'linkages and entrepreneurship', 'open, excellent and attractive research systems' and 'finance and support'. Despite stronger results in community trademarks and designs, patent applications are low, which could be partly explained with the insufficient cooperation between businesses and academia (see below).

The research and innovation (R&I) system remains ineffective. The R&I system suffers from weak long-term financial commitment, inefficient governance structures, inadequate incentives for high-quality research, a lack of effective policies to strengthen research-business cooperation, and a weak human resources base. As a result, it does not create the necessary framework conditions to stimulate investments in business R&D and innovation.

There are still a number of shortcomings in the financing of R&I. Identified inefficiencies ([14]) include the need to establish a long-lasting support for R&I investments and to ensure the independent, robust and coordinated management of national and European R&I funding ([15]). A rapid alignment with international peer review standards to guarantee an adequate evaluation of R&I projects and performance-based institutional funding would also help improve the efficiency and impact of public R&I funding. Support for firms that perform R&D&I through a wider and adequately funded portfolio of instruments ([16]) and the deployment of ESIF funds are indispensable for improving the innovation landscape.

The low level of R&D investment hampers competitiveness. Investment in R&D increased by more than 21.5 % in 2015 to 0.96 % of GDP. However, it is still well below the national target of 1.5 % of GDP. Higher business R&D (representing 73 % of total R&D expenditure) explains most of the growth based on preliminary data from the National Statistical Institute (NSI). Foreign companies are the largest sources of funds for business R&D (Graph 4.5.1) ([17]).

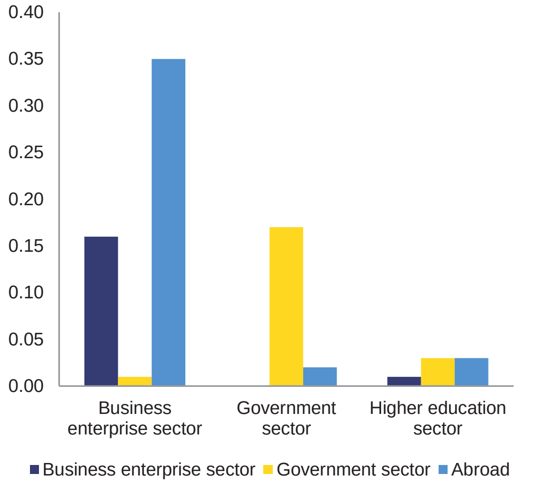
([14]) The authorities requested an evaluation of the R&I system using the Horizon 2020 Policy Support Facility (PSF). A report with policy messages and operational recommendations was published in October 2015 (European Commission, 2015d).

([15]) An effective governance mechanism between the Ministries and R&I stakeholders through the activation of the Smart Growth Council would support this goal.

([16]) Including innovation vouchers, "proof of concept" funds and science-business mobility schemes.

([17]) The sectors with the largest business R&D investments are the professional, scientific and technical activities, reflecting investments in clinical trials by foreign companies, and manufacturing. However, R&D investment in manufacturing is lower than in any other EU country.

Graph 4.5.1: R&D expenditure (GERD) by sector of performance and source of funds, 2014



Source: European Commission

Universities' R&D funding is the lowest in the EU. Preliminary data from the NSI points to a further decline of 0.02 pp. in 2015, to 0.05 % of GDP. Business investment in the higher education R&D sector is low, which suggests insufficient interest for cooperation ([18]).

The impact of ESIF and the development of the science base are limited by structural weaknesses in the R&I system. Policy initiatives such as the updated National Strategy for the Development of Scientific Research and changes to the Law on the Promotion of Scientific Research do not sufficiently address the systemic shortcomings of R&I. Key bottlenecks remain: (i) poor administrative capacity and insufficient reliance on performance-based funding allocation; (ii) the fragmentation of the R&I system and lack of systematic dialogue and incentives for stronger cooperation between academia, research and business; (iii) the lack of a comprehensive update of the research infrastructure mapping with a systematic prioritisation; and (iv) the lack of synergies with the smart specialisation process.

3.2. Additional references

[4.4.3. Investment challenges, p. 39]

In the Global competitiveness ranking (World Economic Forum, 2016a), innovation and business sophistication are also highlighted as persistently hampering the business environment.

The business environment continues to be less supportive of SMEs than in the EU ([19]). Little progress was made in 2016 in implementing relevant measures or improving key policy indicators, especially in the areas of entrepreneurship, skills and innovation, internationalisation, responsive administration, and public procurement. This is a crucial source of concern especially given the high contribution of SMEs to employment and value added.

([18]) The Global Competitiveness Report 2016-2017 ranks Bulgaria 74th out of 138 countries in university-industry collaboration in R&D (World Economic Forum, 2016a).

([19]) 2016 SBA Fact-sheet, Bulgaria.

[4.6.2. Public procurement, p.45]

Despite some improvements, there are still deficiencies in the public procurement system. The procurement publication rate is higher than the EU average. However, the fact that the lowest price is often the only selection criteria (in around 64 % of the awarded tenders in 2016) might give less room for fostering quality and innovation in the selected projects.

4. Croatia

4.1. Research and Innovation

Croatia has the fifth lowest R&D intensity level in the EU and, as a moderate innovator, performs below average in nearly all innovation dimensions. R&D intensity amounts to only 0.85 % of GDP, significantly below both the 2 % EU average and the national R&D intensity target of 1.4 %. Public R&D intensity stagnated in the last 5 years at around 0.4 % of GDP. Business R&D intensity has increased between 2009 and 2015 from 0.34 % to 0.44 %, but remains far below the EU average of about 1.3 %. In innovation, Croatia performs above the EU average only in human resources, a result of having an above-average proportion of young people with upper secondary education. Notwithstanding the high number of graduates, the education system faces challenged (see section 4.3.2).

The low level of R&D spending is one of the reasons for the low quality and efficiency of the R&I system. The quality and efficiency of the R&I system as measured by the quality and impact of scientific publications is low ([20]). Several factors continue to hinder the development of a strong science base in Croatia with improved connections to the economy. They include sub-critical scale, fragmentation, lack of international integration and a below EU average rate of new graduates in science and engineering ([21]). Public-private cooperation in R&I remains at a relatively low level, as shown by the level and decline in public-private co-publications ([22]) and the share of public research financed by business ([23]).

Croatia has recently introduced some policy responses to foster innovation. Several national-level strategies to support R&I have recently been developed to complement the 2014 strategies for education, science and technology and for fostering innovation. In particular, the 'smart specialisation' strategy adopted in March 2016 is an important framework for implementing ESIF funding effectively and ensuring that R&I activities are fostered in five key thematic priorities (health and quality of life; energy and sustainable environment; transport and mobility; security; food and bio-economy). There was progress in improving governance by merging existing R&I institutions — the National Science Council and the National Council for Higher Education; the Business and innovation agency BICRO and the Agency for Small Business and Investments, HAMAG. In November 2015 six new centres of research excellence were established and additional resources for them are planned from ESIF funding.

Changes have been made with the aim of introducing competitive funding of R&D, but with low impact. These changes include funding research and higher education, and awarding project-based R&D, on the basis of performance; allocating new institutional responsibilities; and a more rigorous

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([20]) Only 4.5 % of Croatian publications were within the top 10 % most cited publications in 2013, compared to an EU average of 10.5 %

([21]) New graduates in science and engineering per thousand population aged 25-34 in Croatia represent 14.4 (EU average 17.6).

([22]) Croatia in 2014 had 11 public private co-publications per million population, compared to an EU average of 34.

([23]) In Croatia public expenditure on R&D financed by business enterprise amounted to 0.034 % of GDP in 2015 compared to 0.052 % in the EU evaluation process. Although these reforms can help to strengthen the accountability of public research organisations, the percentage of public funding allocated on this basis remains low. Public spending on R&D as a share of GDP in 2015 reached only 59 % of the EU average.

The 'smart specialisation' strategy addresses the need to strengthen the private sector's R&I capacity. The strategy aims to create an innovation-friendly environment for SMEs, strengthen the links between science and business and develop smart skills to meet business needs. This initiative follows the National Innovation Strategy (of December 2014) and a programme for technology transfer at universities launched in February 2015. Additional grant schemes for SMEs were launched in 2016 to complement the R&D investment schemes and to ensure sequencing of innovation policy instruments aimed supporting the commercialization phase of innovation projects. The new tax reform maintains the existing tax incentives for R&D. The National Information System in Science, launched in 2014 to improve programme evaluation, has yet to be completed.

Croatia can build on the use of EU funds to meet its challenge of increasing investment in R&D&I. Croatia is eligible for a substantial amount of funding for R&D from EU funds over 2014-2020, including a contribution of around EUR 665 million from the European Regional Development Fund. These resources have a key role in stimulating the transition towards a knowledge-intensive economy through targeted capacity building and by bringing together areas of scientific excellence and industry clusters under the smart specialisation strategy.

5. Cyprus

5.1. Executive Summary

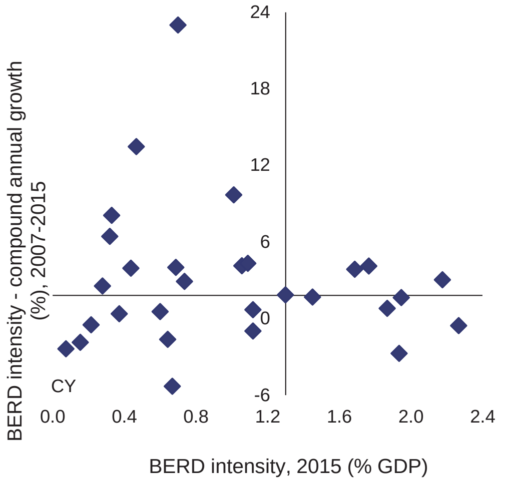
Potential growth remains weak, constrained by limited implementation of structural reforms to support investment. Growth-enhancing initiatives are being implemented, albeit rather slowly. This includes measures presented in the action plan for growth to stimulate investment, promote entrepreneurship and innovation, and facilitate access to finance. The latter remains challenging for many companies, in particular small and medium sized enterprises. Shortcomings in the business environment and banking sector discourage productivity-enhancing investment, as reflected by the low rate of private investment, notably in innovation. Inefficiencies in the justice system hamper the swift resolution of civil and commercial cases, in particular regarding contract enforcement, insolvency and foreclosure. Administrative burden remains high, notably for licensing and export procedures.

5.2. Research and Innovation

R&D investment remains modest in Cyprus. In 2015, total R&D intensity stood at 0.46 % of GDP, with public R&D intensity accounting for 0.31 % of GDP. Investment in R&D carried out by the private sector was 0.08 % of GDP, which is the lowest across all Member States (see Graph 4.5.1). These very low values illustrate the nascent and significantly underdeveloped nature of the R&D system in Cyprus. This can notably be explained by structural limitations such as Cyprus' remote location, small market size, and service-oriented economy. The low levels of R&D hinder Cyprus' ability to diversify its economic structure and boost productivity.

Although some measures have been adopted to redirect scarce public funding towards priority areas, there are still some shortcomings in R&D governance and evaluation of funding. Cyprus has adopted a series of policy instruments to promote R&D. For example, a scheme to support private R&D investment has been introduced and the government plans to set up a national knowledge transfer office. However, there is still limited monitoring and evaluation of how public research is structured and strategically steered. Sustained monitoring is necessary to boost science-business linkages and ensure the relevance of public research. Overall, reforms undertaken by Cyprus go in the direction of building a more robust R&D policy system.

Graph 4.5.1: Business enterprise expenditure on R&D (BERD) Intensity



Source: European Commission

5.3. Additional references to R&I

[4.1.1.Public expenditure, p.21]

Low public investment, in particular in R&D and infrastructure, continues to weigh on potential growth. Public investment in Cyprus was among the lowest in the EU in 2016, a clear deterioration compared to past performance (European Commission, 2014a). Public spending on R&D (0.4 % of GDP) remains one of the lowest in the EU. Low investment has limited progress in terms of the quality and sustainability of basic public services, such as waste and water management or public transport (see Section 4.5). Similarly, the low level of public spending on healthcare may have contributed to lower than EU average health system performance outcomes (see Section 4.3).

[4.1.4 Taxation, p.24]

Cyprus has taken steps to adjust some of its tax rules facilitating aggressive tax planning. The patent box regime (see European Commission, 2016b) has been amended in order to bring it in line with Action 5 of the Base Erosion and Profit Shifting project (see OECD, 2015), as endorsed by the Code of Conduct for Business Taxation. This means that a stronger link between profits registered in Cyprus and the underlying R&D will have to be proven in order for profits to qualify for the reduced patent box rate.

[4.2.2 Productivity and investment, p.42]

The deterioration in productivity growth was accompanied by weak productivity-enhancing investments. Overall, low private and public investment levels, particularly in research and development, and a subpar quality of infrastructure help explain low productivity growth in Cyprus. From 2008 to 2015, investment in Cyprus contracted by almost 15 pps. of GDP, which was among the largest declines in the EU. This was partially due to the current tight credit conditions. Alternative financing, through venture and seed capital, is only marginally benefiting young and innovative firms (European Central Bank, 2015). Business sector involvement in research and innovation activities and investment in intangible assets is among the lowest in the EU (see Section 4.5). This limits productivity and economic growth, which stems in good part from investments in knowledge creation.

[4.3.2 Education and Skills, p. 35-36]

Cyprus has a very high tertiary education attainment rate, but a relatively low proportion of graduates in the fields most strongly linked to innovation. The tertiary attainment rate reached 52.5 % in 2014 and 54.6 % in 2015, well above the EU average. However, a widening gender gap persists, with women outperforming men by 12.2 pps. in 2014 and 14.9 pps. in 2015. In 2014, as many as 44 % of students were in the fields of social science, business and law, one of the largest proportion in the EU. On the other hand, there is a low proportion of science, technology, engineering and maths graduates, 9.2 per 1000 individuals (age 20-29), below EU average of 19 per 1000 individuals (age 20-29), which may hamper the development of the digital economy. However, this seems to be a legacy of the previous growth model of the country (based on financial and legal services). It does not necessarily correspond to future developments based on smart specialisation.

Cyprus is among the countries with the highest proportion of tertiary graduates working in occupations sometimes considered as not requiring a university education. Notably, 35 % of tertiary graduates were in jobs classified under International Standard Classification of Occupations (ISCO) categories ([24]) 4-9 (EU average: 23 %), considered by the International Labour Organisation (2007) as not requiring a tertiary degree. In practice this means that a large proportion of tertiary graduates are working as clerical support workers or as service and sales workers. Here the potential of university education to contribute to productivity, technological innovation and growth may be weaker than if the graduates were working as managers, (associate) professionals or technicians.

([24]) The ISCO one-digit classification is as follows: 1: Managers; 2: Professionals; 3: Technicians and associate professionals; 4: Clerical support workers; 5: Service and sales workers; 6: Skilled agricultural, forestry and fishery workers; 7: Craft and related trades workers; 8: Plant and machine operators and assemblers; 9: Elementary occupations; 10: Armed forces occupations.

6. Czech Republic

6.1. Executive Summary

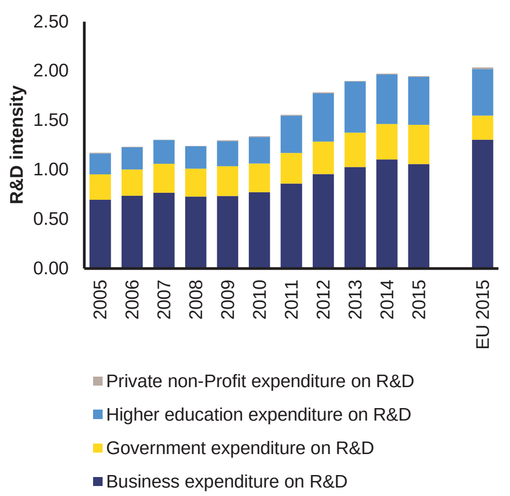
While R&D investment has increased, governance reforms are not being fully implemented yet. The level of total investment in R&D has come close to the EU average and the corresponding Europe 2020 target of public R&D expenditure is likely to be achieved if recent trends are maintained. The Czech Republic still faces challenges in a number of areas, particularly in relation to cooperation between businesses and research institutes.

6.2. Research and Innovation

[3.4 Secoral policies, p. 29]

R&D intensity has increased significantly in recent years, reaching 1.95 % of GDP in 2015, nearly at par with the EU average of 2 %. Reaching an R&D intensity of 2.5 % of GDP in 2020 will only be possible if the overall trend observed over the 2007-2015 period is maintained. Yet the national target for public R&D expenditure (1 % of GDP in 2020) will be attained (Office of the Government of the Czech Republic, 2015a). As discussed in the *2016 country report*, the increase in R&D intensity since 2010 has largely been financed by ESI funds and foreign-owned firms, indicating a lack of dynamism in R&D expenditure of the domestic sector. Sustaining the current level of R&D intensity after the end of the programming period for ESI funds by 2020 would require a compensating increase in business R&D (OECD, 2016d). In particular due to ESI funds, the government sector accounts for a relatively high proportion of total R&D intensity compared to the EU average (20.5 % of total R&D expenditure in 2015 vs an EU average of 11.8 %, see Graph 3.4.1).

Graph 3.4.1: **R&D intensity by sector, Czech Republic**



Source: Eurostat

The strong increase in R&D intensity since 2005 is not being matched by corresponding improvements in the quality of outcomes. While progress has been made, the Czech Republic still fares significantly below the average EU performance in terms of openness and excellence of its research system and intellectual assets according to the 2016 European Innovation Scoreboard (European Commission, 2016e). The Czech Republic also faces challenges in venture capital investment (see Section 3.3), patent applications, attracting non-EU doctorate students and undertaking public-private co-publications. Moreover, the innovation output indicators of the scoreboard that capture SME's product and process innovations, as well as marketing and organisational innovation, are below or close to the EU averages and have declined over time. In contrast, there has been an improvement in the human resources available to the R&D sector, with the Eurostat indicator for new graduates in science and engineering improving in recent years (from 10.7 per thousand of population aged 25-34 in 2007 to 15.1 in 2014 vs the EU average of 17.6 in 2014).

The Czech authorities have set out a list of priorities for the R&D sector, in line with the recently-adopted European Research Area Roadmap (2016-2020). The priorities of the domestic R&D agenda are the streamlining of governance, the implementation of the new evaluation framework, the development of a base for applied research and an improvement in the research and innovation capabilities of the business sector. In September 2016 the updated National Research and Innovation Strategy for Smart Specialisation was approved by the Commission. Furthermore, a number of operational programmes are being also put into place to support R&D, innovation and competitiveness.

Proposed reforms to the governance of the R&D system are being pursued. The new evaluation methodology (Metodika 17+), which intends to strengthen the steering and structure of responsibilities related to the evaluation and allocation of research funding was approved by the government in February 2017. To create a bridge for the performance–based funding system that existed until 2010 (Good, B. et al., 2015), an interim system was introduced to stabilise funding flows and to allow for a transition to the new methodology in 2017. During the gradual phasing in of Metodika 17+, the information system for R&D will be further developed to improve the contribution of qualitative aspects to the methodology. These include research excellence, international research cooperation and the relevance and impact of research with regards to society.

A series of measures are being taken to improve cooperation between businesses and research institutes, and the Czech authorities intend to introduce clear rules for this collaboration. The Technological Agency currently runs a number of programmes aimed at enhancing cooperation between businesses and public research institutes. These include the establishment of competence centres, which aim to support research, development and innovation in advanced fields with an emphasis on the commercial application of outputs. However, these programmes have not yet undergone a thorough international and peer-reviewed evaluation process. Two new measures to support research for industry are in the process of being launched, namely the EPSILON and TRIO programmes. The former aims to support applied research, while the latter targets projects in industrial research. Finally, the tax credit system was recently extended to include the purchase of R&D services from research organisations (Srholec, M. et al, 2017 f.). Whilst predominately used by large firms ([25]), no specific support instruments for SMEs are currently in place.

6.3. Additional references to R&I

[3.2 Education and skills, p.22]

The tertiary education attainment rate continued its rapid rise, reaching 30.1 % in 2015 compared with an EU average of 38.7 %. It is likely that the 32 % national target will be attained by

([25]) In 2013, around 70 % of the total allocation was used by large firms (Office of the Government of the Czech Republic, 2015a).

2020. Czech adults with tertiary education qualifications earn 92 % more than those who did not continue beyond upper secondary education. The Czech Republic is currently implementing the higher education reform adopted in 2016. The aim of the reform is to raise the standards of accreditation and internal quality assurance and to give institutions more autonomy. A new independent National Accreditation Authority has been set up and the government has adopted new standards for accreditation. Another objective is to support the diversification of programmes offered, with a view to increasing profession-oriented programmes. Grants to students in need will be increased, which is likely to help increase the social diversity of tertiary education graduates. The reform is also likely to increase the number of programmes that are professionally accredited and employers' representatives are positive about closer links between academia and employers.

[3.3 Investment, Investment trends, p.28]

While access to finance does not appear to pose a problem for Czech firms, markets for non-bank sources of finance remain underdeveloped. According to the ECB's most recent survey on the enterprises' access to finance (European Central Bank, 2016), the success rate of applications for credit lines or overdrafts in the country is the highest of all Member States. Czech SMEs also reported the smallest net increase in collateral requirements since the previous survey. However, based on the OECD Finance Policy Brief (OECD, 2016c), equity financing is less relevant in the Czech Republic compared to the EU average (2 % vs 9 %). Furthermore, private equity investment remains weak, even compared to other central and eastern European countries, with venture capital playing a negligible role in firms' total funding. Total venture capital stood at only 0.001 % of GDP in 2015, significantly less than the EU average of 0.024 % (Invest Europe, 2016). Plans to boost the access to venture capital through public-private seed funds have so far failed. However, the government has established a National Innovation Fund, with funding from the Operational Programme for Enterprises and Innovation for Competitiveness, although it remains to be seen how quickly the initiative will become operational. This consists of a EUR 45 million investment platform dedicated to SMEs, seed project financing and mobilising private-sector participation in equity financing.

The large number of small firms and their relatively low level of productivity point to weaknesses in allocative efficiency in the Czech Republic. Indicators of firm dynamics are largely in line with EU averages. However, there is a higher proportion of micro-enterprises (i.e. those with up to nine employees) than in the EU (96.1 % vs 92.8 % in 2013). Furthermore, there is a considerable gap between the productivity of micro-enterprises and large firms (firms with 250+ employees), with productivity of the former standing at around 34 % of the latter in the industrial sector and 59 % in the services sector. Such a productivity gap points to weaknesses in allocative efficiency in the Czech Republic. OECD (2016d) attributes this phenomenon to the low mobility of workers, cumbersome bankruptcy rules and difficulties faced by seed and start-up enterprises in accessing finance.

[Box 3.3.1: Investment challenges and reforms in the Czech Republic, p.27]

Main barriers to investment and priorit actions underway:(…) While total investment in R&D is at the EU average, this is largely driven by the public sector, EU funds and large, foreign-owned enterprises (see Section 3.4). Proposed reforms of the governance system remain unimplemented and efforts to boost cooperation between research centres and enterprises have not been sufficiently enforced.

7. Denmark

7.1. Executive Summary

While the Danish economy's productivity level is among the highest in the EU, productivity growth has been on a downward trajectory. In 2014, the Productivity Commission pointed to a broad range of possible impediments to productivity growth, including, in particular, weak competition in the domestically oriented services sector, weaknesses in the Danish education system, weak productivity growth in the public sector and unexploited potential to foster the commercialisation of university research outputs due to certain regulatory barriers in the relation with businesses. Even though R&D spending relative to GDP is high in Denmark, it is not translated adequately to economic growth, productivity and investment. Investment needs in the transport infrastructure persist, stemming from projected faster growth of freight and passenger transports than of the overall economy and from a need to meet higher climate, security and performance requirements.

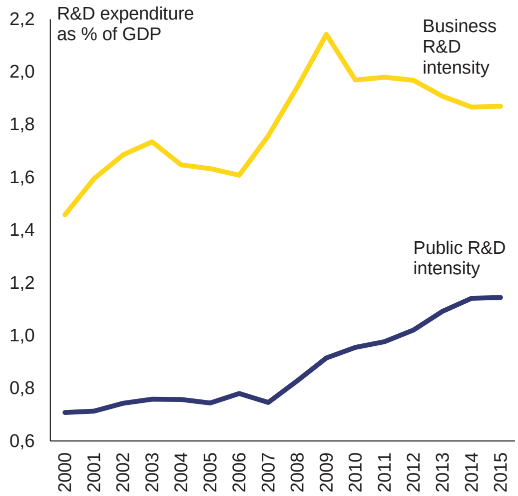
Danish start-ups are characterised by low start-up size, low start-up ratios and low net job creation. Denmark has one of the smallest average company sizes at entry, and significantly lower than in many other Member States. Start-up ratios and net job creation in Denmark continue to be low. For instance, the net job creation by entrants that survive at least three years represents around 2.5 % of overall employment, lower than in other Member States. Scaling-up is a challenge, because new businesses do not have the capacity or the incentives to grow.

7.2. Research and Innovation

Denmark has already reached the national 2020 R&D intensity target of 3 % of GDP[26]. However, resources for public research were reduced in 2016. Denmark's R&D intensity has developed positively from 2.51 % of GDP in 2007 to 3.03 % of GDP in 2015. Despite the reduction of investment in public research in 2016, Denmark´s public R&D intensity is expected to remain above 1 % of GDP according to the Danish Agency for Science, Technology and Innovation (DASTI), after having reached 1.14 % of GDP in 2015.

([26]) Current Eurostat data are expected to be revised following Statistics Denmark's revision of the National Accounts on 15 November 2016.

Graph 3.5.1: **Denmark - development of business R&D intensity and public R&D intensity, 2000-2015**



(1) Business R&D intensity: Business enterprise expenditure on R&D (BERD) as % of GDP.
(2) Public R&D intensity: Government intramural expenditure on R&D (GOVERD) plus higher education expenditure on R&D (HERD) as % of GDP.
(3) Business R&D intensity: Break in series between 2007 and the previous years.
(4) Public R&D intensity: Breaks in series between 2002 and the previous years and between 2007 and the previous years.
Source: Eurostat

Private R&D investment as a percentage of GDP was still one of the highest in the EU in 2015. There has been a significant increase in the intensity of Business Enterprise R&D Expenditures (BERD) between 2007 and 2009 from 1.76 % to 2.14 % of GDP, but since then there has been a downward trend towards 1.87 % of GDP in 2015.

The human resources base in science and technology has successfully expanded but the availability of appropriate skills and competences to meet current needs of the labour market is a challenge. Eurostat reports an increase in new graduates in science and engineering per thousand population aged 25-34 between 2007 and 2014 with Denmark ranking third in the EU. The number of researchers per thousand of employment also showed a positive trend. Additionally, researchers (FTE) have been absorbed by the business sector to a remarkable extent with Denmark ranking one of the best in the EU in this respect in 2015. Despite the significant progress already achieved, industry has expressed a concern that in some sectors the right skills and qualifications are missing such as ICT and engineering capabilities. Faced with these challenges, the Government strategy launched in 2015 is designed to promote *"Growth and development in the whole of Denmark*"

The growing shortage of ICT professionals reported in Europe is also an issue for Denmark. In particular, the study "e-skills for jobs in Europe: measuring progress and moving ahead" estimated that by 2017 there will be 14 000 unfilled vacancies for ICT professionals, a number which is expected to rise towards 19 000 vacancies by 2020 (Hüsing et al., 2015). In the spring of 2016 the national authorities launched a national mapping exercise of companies' need for digital skills. A similar mapping exercise but at the regional level was performed by the Danish Growth Council in December 2016. So far, the mapping has shown variations across the five regions in regards to the demand for digital skills which is linked to the business structure of the region. Also, two previous mapping activities targeted business needs and research and education in the field of cybersecurity[27], and future needs for digital skills. Moreover, the Danish government launched two partnerships promoting digitisation in SMEs in specific industries involving the Danish Business Authority, industry associations and different stakeholders.

Denmark is an Innovation Leader according to the European Innovation Scoreboard 2016 but Community Innovation Survey (CIS) data show that some indicators have worsened. Though performance relative to the EU has increased from 26 % above the EU average in 2008 to 34 % in 2015, CIS 2014 data recently released in 2017 by Eurostat points to fall in performance for some indicators relative to CIS 2012 results. Notably this concerns a decrease in the share of SMEs that are product/process innovators, those that are organisational/marketing innovators, and the share of innovative SMEs collaborating. Additionally, the share of innovative enterprises is only slightly above the EU-average.

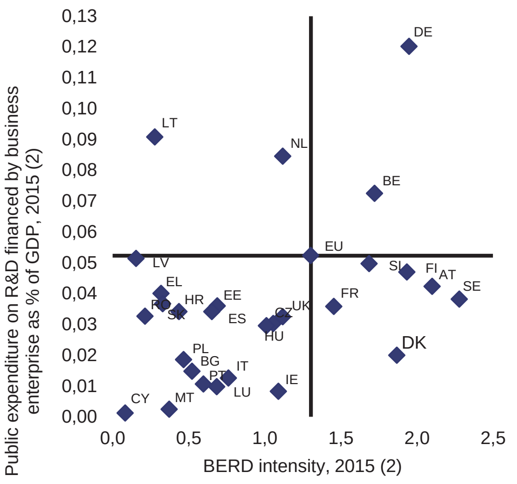
There is a need for stronger links between the players in the R&I system to foster knowledge transfer and firms' performance. An analysis conducted by the Ministry of Science and Higher Education showed that on average productivity is 15 per cent higher among Danish R&D-performing firms that cooperate with universities and public research institutions than for R&D-performing firms that do not engage in such cooperation[28]. Public expenditure on R&D financed by business as a percentage of GDP has notably decreased from 0.031 % of GDP in 2009 to 0.020 % of GDP in 2015, with Denmark ranking only 20th within the EU (see Graph 3.5.2). Moreover, as discussed in the European Commission's Country Report on Denmark (2016), obstacles to the utilisation of university research include complexities in the regulatory system especially concerning collaboration efforts between universities and businesses, and sometimes different views regarding the pricing of intellectual property rights.

The challenge of incentivising academia-business collaboration has also been addressed by the European Commission's Country Report on Denmark (2016). In order to act on this development, the Danish Government intends to regard innovation and business collaboration as an integral part of research activities which has led to a reorganization of the Ministry of Higher Education and Science in 2017. Importantly, DASTI and Universities Denmark will jointly form a working group to create a guideline advising universities on how to legally engage in strategic partnerships with industry which involve state aid. In parallel, the role of the Research and Technology Organisations (RTOs) will be strengthened. The Innovation Fund Denmark launched in 2014 will also support investments and long-term projects/partnerships that involve research, technology, demonstration and market development activities, and also SMEs and entrepreneurship through the InnoBooster program.

([27]) Survey of knowledge and training in cyber and information security at Danish educational and research institutions (2015)

([28]) Economic effects of business collaborative research with public knowledge institutions (2011).

Graph 3.5.2: **Public expenditure on R&D financed by business enterprise as % of GDP (1) versus BERD intensity (business enterprise expenditure on R&D as % of GDP)**



(1)Public expenditure on R&D financed by business enterprise does not include financing from abroad.
(2)BE, LU, AT, SE: 2013; BG, DE, IE, ES, FR, IT, CY, PT, EU: 2014.
Source: Eurostat

Relatively low survival rates also affect innovative companies. On average, the survival rate of the companies in the portfolio of the Danish Innovation Incubators is 49 % after 5 years which may reflect the fact that the Danish Innovation Incubators generally take on high risk (DASTI). Hence, despite being the top performer in the EU according to the World Bank's 2016 'Ease of Doing Business' Rank, Danish companies seem to face some challenges in the post-entry phase to the markets. According to the Global Competitiveness Index 2016-2017, the 'most problematic issues for doing business' were related to tax rates and regulations, to restrictive labour regulations, access to financing and inefficient government bureaucracy (see also Section 3.4.2 on business environment).

7.3. Additional references to R&I

[Box 3.4.1: Investment challenges, p.35]

Main barriers to investment and priority actions underway : (…)

2. Collaboration between public research and businesses could be further improved. Even though R&D spending relative to GDP is high in Denmark, it is not translated adequately to economic growth, productivity and investment. There are barriers to the utilisation of university research, such as complexity in the regulatory system that regulates cooperation between the universities and the business sector. The government has taken several initiatives in this area, including setting up a working group between universities and the business sector and launched an Innovation Fund that will also support investments and long-term partnerships.

[3.4.2. Business Environment, p.31]

There is significant business dynamism in Denmark which can be identified from the churn rates (the sum of the birth and death rates of enterprises). Even though enterprise birth rates have been in line with the EU average (and actually exceeded it in 2014)[29], enterprise death rates are higher[30]. This results in survival rates that are below the EU average after one and three years of the creation of the firm[31], although five-year survival rates in 2014 were above the EU average (DK: 45.7 %; EU average: 44.5 %). Denmark is still below countries such as Austria (53.8 %), the Netherlands (51.5 %) and Sweden (56.7 %).

Danish start-ups are characterised by low start-up size, low start-up ratios and low net job creation (Calvino et al., 2015). Denmark is a small country, so it is not unusual that Denmark has one of the smallest average sizes at entry, and much lower than in many other Member States. Start-up ratios in Denmark are significantly lower than in other Member States such as Spain, Sweden, the Netherlands and Italy[32]. In Denmark, the net job creation by entrants that survive at least three years represents around 2.5 % of overall employment, lower than in other Member States such as Spain, Italy, Hungary and Sweden[33].

Scaling-up in Denmark is identified as a challenge for SMEs. Denmark has many successful companies, but all of the 20 largest companies are over 30 years old, while smaller successful companies have not been incentivised or able to expand. Previous programmes were in place to support start-ups, but did not address growth. The Government started an initiative on scale-ups in order to address the problem of slow growth. 'Scale-Up Denmark' works through private organisations but is financed by public funds (EUR 22 million), half of which come from the five Danish regions and half from the EU (ERDF). It works together with established businesses and makes use of their expertise to guide new firms looking to expand through training, mentoring and help to access finance. Their work is carried out through hubs based on field of business rather than region, which allows for more specialised support. Scale-up Denmark is currently the largest Scandinavian accelerator programme. The objectives of this programme are (1) to increase the number of high-growth start-ups; (2) to provide established companies with innovation opportunities; (3) to build next-generation serial innovators; and (4) to develop self-sustaining ecosystems that persist without public funding.

[3.3.4. Education, p.26]

Recent reforms aim at improving school outcomes and raising academic standards. In April 2016, the government proposed a reform of general upper secondary education with the aim of raising academic standards and providing a solid preparation for higher education. One objective is to boost the learning of mathematics and natural sciences to reverse the trend of decreasing numbers of students choosing natural science subjects, and the increasing number of general upper secondary

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([29]) 2014: DK (11.1 %), EU (10.7 %). Data: Eurostat

([30]) 2013: DK (11.0 %), EU (9.8 %). Data: Eurostat

([31]) 2014: Survival rates after 1 year (DK: 73.6 %; EU except Greece and Ireland: 83.1 %); Survival rates after 3 years (DK: 52.3 %; EU: 60.1 %).

([32]) Start-up ratio: measured as the number of entrants relative to the country's total employment

([33]) For every existing 100 jobs in the economy in any given year, the start-ups which are born in that year will add 2.5 new jobs within the following three year graduates needing to take supplementary courses in mathematics and natural sciences to meet entry requirements for tertiary education studies (Leffland, 2014; Productivity Commission, 2014). The higher preparatory examination (the HF programme) will specifically target students that prefer Professional Bachelor's programmes and Academy Profession programmes. A political agreement was reached on 3 June 2016 between the government and a broad group of political parties and the proposal for the legislative change was passed in the Parliament in December 2016. The reform will be implemented as from the 2017/2018 school year. As part of the reform DKK 400 million (EUR 53.8 million) is being allocated in the period 2017-2024, for the continuing professional development of teachers and high school principals.

8. Estonia

8.1. Executive Summary

Still-low business investment in technological development and weak commercialisation of research achievements remain challenges for productivity growth, for increasing the value-added of exports of goods and for strengthening potential output. The volume of contract research between academia and businesses increased in 2015, but the cooperation between the two sectors remains limited. This also resulted in a still-low level of patent applications. An entrepreneurial discovery process has not yet been re-launched. The low attractiveness of research careers and the relatively low level of scientific excellence are interlinked challenges.

8.2. Research and Innovation

Despite progress in implementing R&D and enterprise growth strategies, Estonia's research and innovation ecosystem remains fragile. Estonia has in place strategies to strengthen its productivity, supported by the 'implementation plan' for 2016-2019. Nevertheless, key challenges remain: low private investment in R&D, insufficient cooperation between businesses and academia, low efficiency of public R&D spending, shortage of skills, insufficient prioritisation of research and innovation investment and lack of entrepreneurial discovery process. Besides this, rapidly rising wages require further improvement in non-cost competitiveness. To face these challenges, during the years 2015-2020 more than 600 million euros will be invested in R&D, innovation and business development.

Investment in R&D

Business investment in R&D remains low, mainly due to a low share of high technology and knowledge-intensive companies([34]). In 2015, R&D intensity increased marginally to 1.50 % of GDP (from 1.45 % in 2014) and business enterprise expenditure in R&D reached 0.69 % (from 0.63 in 2014). The Estonian economy remains dominated by SMEs in traditional sectors with limited needs for R&D. Investment is concentrated in a few large companies. Many firms are involved in contract manufacturing as a prevalent business model and foreign investment in business R&D in Estonia remains low (0.06 % of GDP in 2015).

Investment in intangible assets in Estonia is low. It accounts for 9.5 % of total investment compared to an EU average of 19.6 %. According to the 2016 Innobarometer ([35]), Estonian companies are less likely to invest in research and development. However, the share of companies investing in software development is increasing. Only half of companies reported that they had introduced some innovation since 2013, up by 6 pp. on the previous survey.

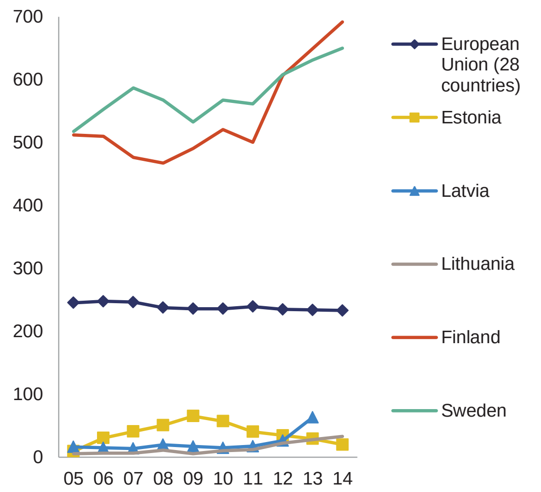
To support R&D, the government launched several measures in 2016: (i) the high-growth business development programme for firms with strong potential; (ii) support for public procurement

([34]) The value added in medium high-tech manufacturing stands at 2.8 % of total value added in 2014, well below the EU average of 5.5 %.

([35]) Flash Eurobarometer 433 — Innobarometer 2016 — EU business innovation trends: the Innobarometer is a survey on activities and attitudes related to innovation. Each year, it gathers opinions and feedback from the general public and European businesses and provides a unique source of direct information on innovation for policymakers.

of innovation; (iii) measures to boost the use of financial instruments. In addition, an 'Industrial Policy Green Book' is being developed by the Ministry of Economic Affairs. The Book includes proposals for R&D, with the aim of raising Estonia's R&D investment and position in the value chain

Graph 3.5.1: **Patent application to the European Patent Office (by priority year and per million people of active population)**



Source: Eurostat

Cooperation between business and academia

The cooperation between public R&D institutions and private companies increased in 2015, but its volume remains limited. Research contract between public R&D institutions and the private sector increased by 24 %. However the share of R&D funded by business and performed by public research organisations (as a percentage of total R&D expenditure) was 2.4 % in 2015, well below the EU-28 average. Patent application from Estonia was low and continued its downward trend (Graph 3.5.1). Also, the royalties and licence fees paid abroad by Estonian companies were far below those of Nordic countries and declining (see Graph 3.5.2). Finally, the number of public-private scientific co-publications per million population is one of the lowest in the EU([36]).

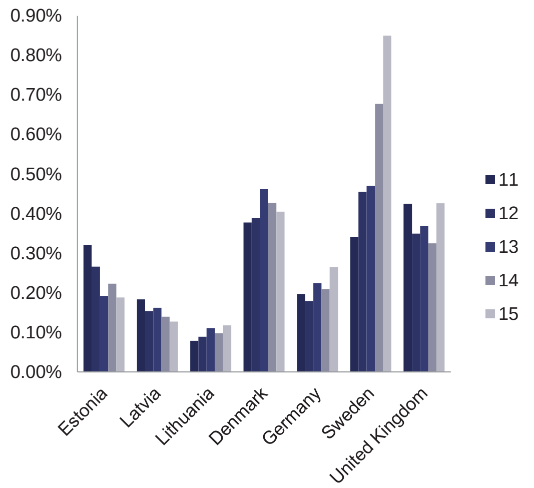
The Estonian Government has launched measures to improve science-business cooperation. These include support to public research organisations for applied research and development of products in cooperation with business in areas addressed by the smart specialisation strategy ('NUTIKAS'). Additionally, from 2017 the government is changing the baseline funding formula of research institutions to provide incentives for public- and private-sector contract research. A specialised ad hoc expert group formed by the Estonian Research Council has recommended increasing the baseline funding to 50 % (from the current 20 % in 2015). In 2016, the share of baseline funding constituted 27 % and it is gradually increasing. In addition, the 'ADAPTER' platform was launched in April 2016 as a one-stop shop for companies willing to engage in research with Estonian universities. Finally, doctoral studies in cooperation with enterprises and support for business to participate in technology development centers and clusters are being implemented.

([36]) Estonia ranks 22nd and was on a downward trend of 17.9 % during 2007-2015.

Higher education and research

The ageing population and the low attractiveness of research careers in Estonia remain key bottlenecks. Estonia has a comparatively low number of PhD graduates([37]). The number of new graduates in science and engineering (per 1000 population aged 25-34) is also low. Estonia has launched initiatives in recent years to address the scarcity of highly qualified employees and improve researchers' mobility between the public and private sectors. The ruling coalition agreement includes provision for more scholarships for doctoral students and the aim is also to double the monthly sum of scholarship. However, the national target of 300 PhD graduates per year by 2020 remains ambitious.

Graph 3.5.2: **Charge for the use of intellectual property from abroad as % of GDP**



Source: Eurostat

Internationalisation and excellence

The relatively low efficiency of public R&D spending is linked to a lack of economies of scale and of critical mass in research areas. Estonia has to some extent improved the quality of its scientific production since 2000. However the low level of scientific excellence remains a challenge as highly cited publications([38]) remain below EU average (compared to the level of public R&D intensity that is above EU average). Estonia also showed progress in the internationalisation of its research system. Despite the close economic integration of Estonia's manufacturing industry with the Nordic economies there is insufficient cooperation in R&D and innovation.

The smart specialisation framework

Estonia is working to improve implementation of smart specialisation. The task of running the entrepreneurial discovery process was transferred from the Estonian Development Fund to the Ministry of Economic Affairs in June 2016. Subsequently, Estonia developed an action plan for

([37]) Estonia ranked 20th in the EU-28 for new doctoral graduates in 2014.

([38]) The share of Estonian scientific publications among the top 10 % most cited worldwide was only 7.3 % in 2013 vs an EU average of 10.5 %.

securing a continuous entrepreneurial discovery process. The plan for 2017 is to enhance monitoring of growth areas, update the growth area reports from 2014 and strengthen links with other regions. **Estonia is also planning to launch value chain research.** Successfully implementing these plans is likely to help prioritise investments in R&D and innovation in domains with potential for growth. Under the 2016 'RITA' programme, specialised R&D civil servant profiles have been created in line ministries to help deliver R&D priorities closer to business needs in smart specialisation areas. It should also contribute to less fragmented R&D governance, although success will depend on the availability of R&D funds in line ministries.

R&D funding streams after 2020

From 2007 to 2013, Structural Funds accounted for 50 to 60 % of all public R&D spending and continue being a major share of it during the 2014-2020 programming period. This raises questions as to the medium-term to longer-term sustainability of public R&D investments. The government launched in June 2016 a task force on research funding and management, which is expected to make proposals in 2017 on the long-term financing and management of Estonia's research and higher education system.

9. Finland

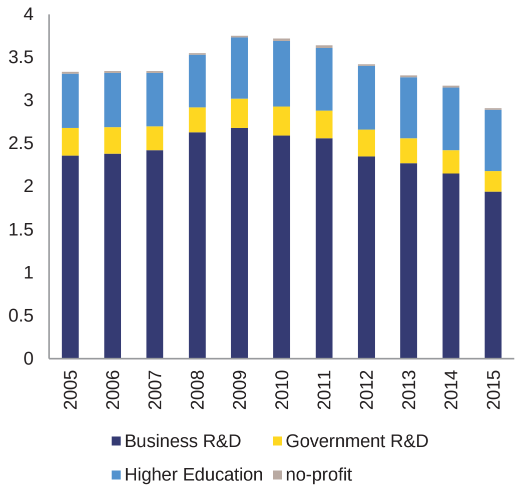
9.1. Executive Summary

Structural change is unfolding, but the reorientation of the economy seems to have slowed down recently. After a decline in IT manufacturing, information and communications technology services have become a more important exporting sector. The recent rapid increase in start-ups is expected to contribute to the gradual diversification of production structures. Policies to support start-ups and the internationalisation of small and medium sized enterprises are in place, and the government has outlined plans to enable and promote entrepreneurship further, including by reducing the administrative and regulatory burden.

9.2. Research and Innovation

Since cost competitiveness is improving thanks to the recent wage agreements, non-cost competitiveness issues become even more important. Retaking the path towards sustainable growth and renewed competitiveness will require a clear focus on research and innovation which should increase business dynamism and help to renew the structure of the economy. While Finland's total R&D budget (2.9 % GDP in 2015, projected to marginally decline in 2016) is still among the highest in the world, it has decreased by 15 % in 2009- 2014. The decline was mainly caused by lower investments in the private sector which can be linked to economic restructuring. The share of manufacturing in total value-added has decreased from 25.3 % in 2007 to 17.0 % in 2015. The share of high-tech manufacturing has decreased from 7.3 % in 2007 to 3.0 % in 2015.

Graph 4.5.1: **Total intramural R&D expenditure (GERD) by sectors of performance in Finland between 2005 and 2014**



Source: European Commission

Public R&D intensity remained almost stable over the period 2007-2014 with a counter-cyclical expansion in expenditure during the crisis years. In 2015 public R&D intensity dropped below 1%, bringing it back to the pre-crisis levels due to the government's fiscal consolidation programme. Based on the 2016 budget, research and innovation expenditure decreased 9.4 % in comparison to 2015. Among the areas most concerned by the cuts are the R&D subsidies to businesses-driven research, mainly those distributed by the Tekes agency. No evaluations that would demonstrate the impact and appropriateness of cuts in the programmes and other Tekes activities have been made.

In international comparison, subsidies towards R&D have been moderate. Direct government funding of business R&D as a percentage of GDP amounted to only 0.06 % in 2014 (OECDd). Subsidies are replaced by soft loans to businesses, so that these could become commercially successful on a global level. The government is also experimenting with new programmes in growth areas such as clean technology, biotechnology and digitalisation, but these are on a relatively small-scale.

In the 2016 European Innovation Scoreboard, Finland remains an innovation leader. Its innovation performance has, however, decreased since 2010. Its performance has deteriorated based on a number of indicators, notably innovative SMEs collaborating with others, non-R&D innovation expenditures and venture capital. Nevertheless, Finland still has clear strengths in international scientific co-publications, licence and patent revenues from abroad, patent applications and public-private co-publications.

Some of the resources put into public research do not lead to high quality results. In terms of highly cited publications (share of these in total publications of the country), Finland only ranked 11th in the EU. Public-private cooperation also shows a worrying declining trend, with the amount of public R&D expenditure financed by business declining from 0.08 % of GDP in 2007 to 0.05 % GDP in 2014.

The choices made by the government in the fiscal consolidation process have led to relatively higher funding of fundamental research. Encouraging the commercialisation of research output also features prominently on the policy agenda. The streamlining of profiles and the division of labour between higher education and research institutes is also a policy priority. In 2017 further changes are planned to the funding model for universities. Part of the institutional funding of universities has already been re-allocated to the Academy of Finland to facilitate strategic choices.

Universities have been pursuing the commercialisation of research output. This has been achieved through the creation of spin-offs and by significant investment into the innovation capacity of the start-up ecosystem. However, the share of high-growth enterprises categorised as innovative is slightly lower than the EU average. Also in terms of the average size of high-growth businesses measured in employment, Finland falls behind the EU average (Costa et al 2016).

The government's programme for 2015-19 focuses research and innovation policy strongly on university-business collaboration and the creation of an efficient national research system. While the budgetary restrictions have a distortionary impact on the research and innovation ecosystem which needs to be thoroughly assessed, the risk taking by the government on policy experimentation is remarkably progressive and forward-looking. Yet, the lack of justification for budgetary cuts and limited cooperation with the main stakeholders can be assessed as posing a threat to the success of reforms.

9.3. Additional references to R&I

[4.3.3. Education and skills, p.29]

The universities aim at increasing the transfer of research output to the business sector. Current government reforms seek to encourage higher education institutions to develop a sharper strategic focus and clearer profiles in their fields of study. The government objectives are to shorten the time it takes to enter higher education and to move from graduation to work. Since the institutions are autonomous only limited public influence can be exerted via university financing agreements, legislation and informal steering. These actions fit the trend in other European countries. For further discussion, see section 4.5.1.

[4.4.3. Business environment, p.34]

The business environment is an important enabler of company growth. The growth orientation of SMEs has increased: 11 % of small and medium-sized enterprises now declare that they are strongly growth-oriented, and 39 % plan to grow as far as possible (Yrittäjät, 2016a). Their main challenges are weak demand in the domestic market and increased competition. To promote the internationalisation of Finnish firms, a government initiative known as Team Finland provides services such as market research, networking, training and business development support and financing.

[box 4.4.1 Investment challenges, p.35]

Overall, the business environment could be more favourable for foreign and domestic investment. The government has pledged to reduce regulatory burden, also in services such as retail, to make the economy more flexible and the business environment more attractive (see Section 4.4.3). The government programme Team Finland on one hand supports growth of innovative start-ups and helps them to internationalise and on the other hand promotes Finland as location for foreign investment.

10. France

10.1. Executive Summary

The French national innovation system does not match the performance of Europe's innovation leaders. A high degree of complexity remains and overall coordination is a challenge. The discrepancy between the amount of public support granted and France's middling innovation performance raises questions about the efficiency of public support schemes.

10.2. Research and Innovation

The French national innovation system does not perform as well as Europe's innovation leaders. According to the 2016 European Innovation Scoreboard (EIS), France ranks 11th in the EU, and its performance has remained stable over time compared to the best performers: its combined performance in the scoreboard stood at 86 % of that of the innovation leaders ([39]) in 2015, against 85 % in 2008. France's strengths are in some enabling factors of innovation, such as the quality and openness of research systems ([40]) and skilled human resources ([41]). Factors linked to company activities and outputs show a contrasting picture. SMEs are rather good at introducing innovations. However, France ranks below the EU average for intellectual assets, especially trademarks and designs, despite high investment in this area (Subsection investment, Section 4.4). Finally, the performance is just above EU average for linkages (i.e. cooperation between actors in the innovation system) (Graph 4.5.1).

Private investment in R&D is just above EU average. At 1.5 % of GDP in 2015, France ranked 8th in the EU as regards private R&D spending, an intermediate position between the EU average (1.3 %), and the innovation leaders (1.8%). Furthermore, private R&D is concentrated in sectors of declining economic importance as measured by their value added (European Commission, 2016c).

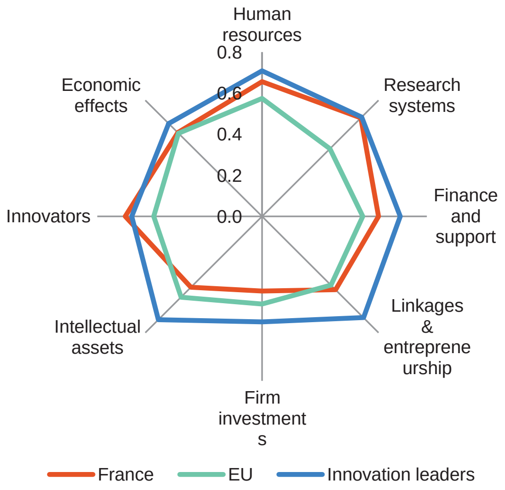
In addition, private R&D comes at a high cost to public finances. France ranked 2nd in the EU in 2015 in terms of public funding of business R&D (Graph 4.5.2). The discrepancy between the amount of public support, the output in terms of private investment and its intermediate innovation performance raises questions about the efficiency of public support schemes. In particular, the research and innovation tax credit (CIR), which amounted to EUR 5.1 billion of foregone revenue in 2015 (0.3 % of GDP, and roughly three quarters of public support for private R&D) has a positive impact on corporate R&D, but its impact in terms of innovation output has yet to be proven. Its real impact may be to help firms that invest in R&D survive better than those that do not (OECD, 2014b).

([39]) Sweden, Denmark, Finland, Germany and the Netherlands make up the group of innovation leaders in the European Innovation Scoreboard.

([40]) Measured by a high level of non-EU doctorate students, or a high number of international scientific co-publications

([41]) Measured by the high share of the population with upper secondary level education or completed tertiary education

Graph 4.5.1: Performance of France's innovation system - distance to EU innovation leaders and to EU average



(1) a score of 0 indicates the lowest performance among all countries in the sample, whereas 1 indicates the frontier of best practice.
Source: European Innovation Scoreboard (2016)

There is an increasing dispersion of public resources supporting innovation. Overall public support for innovation doubled over 15 years to 0.5 % of GDP in 2014, and the number of public schemes supporting innovation has followed a similar trend, increasing from 30 in 2000 to 62 in 2015 (Pisani-Ferry, J. *et al.*, 2016). Over the same period, the CIR was multiplied by more than 9, suggesting an important dispersion of remaining resources for other public support schemes. Regions also promote their own initiatives, coming on top of the state-supported ones.

The rising number of publicly-supported structures are challenging for overall consistency and coordination. Many structures to support innovation policy have been created in recent years. To the pre-existing competitiveness clusters (*pôles de compétitivité*), and Carnot Institutes, the Investment for the Future programme (*Programme d'Investissements d'Avenir*) has added the societies for technological transfers (SATT) and institutes for technological research (IRT). While these different structures each have their own specificities, they contribute to blurring the readability of the system for firms and overall coordination is a challenge (Ekeland M., Landier and Tirole, 2016). Public support schemes and structures are regularly evaluated but it is not clear how those evaluations are used to improve policies, at systemic level in particular.

Cooperation and transfers of competences and results between public research and companies is suboptimal, and weighs on the economic output of the innovation system. France lags behind innovation leaders in terms of public-private scientific co-publications – around 40 per million inhabitants against over 50 in Germany and above 60 in the Nordic countries (European Commission, 2016d). On the other hand, private funding of public R&D is also low by international comparison (Coordination interministérielle de l'innovation et du transfert, 2016). Generally speaking, universities and other public research organisations are weakly involved in the innovation ecosystem.

Many innovative small firms are created in France, but they have difficulties growing. The innovative landscape is dynamic, as attested by the high employment in fast-growing firms in the innovative sectors (22 %, third highest rate in the EU). However, it might be too scattered in small entities to have a huge economic impact: although Paris counted more start-ups than London or Berlin in 2015 (Vilard, 2015), France only had 3 'unicorns', valued at EUR 6.7 bn, whereas Germany had 4 and the UK 17, valued at EUR 18 and EUR 40.4 bn respectively (GP Bullhound, 2015). While France has put in place many measures targeted at small innovative businesses (such as the tax credit for innovation), sometimes focussed on young innovative ones (such as the Young Innovative Enterprises tax scheme), the growth of small firms may still be hampered by the general business environment (section 5.4). Finally, financial capital resources to support scaling-up may not be available in sufficient quantity: venture capital as a share of GDP is twice lower than in the UK or Sweden (Ausilloux V.; Gouardo C., 2017).

10.3. Additional references to R&I

[Competitiveness, p.39]

Investment in research and development in manufacturing is concentrated in subsectors of declining economic importance as measured by their value added, which has implications for the long-term growth potential of the whole economy. This is the case in particular for the R&D intensive sectors of motor vehicles, computer, electronic and optical products, and pharmaceuticals whose share in the total value added of the economy shows a declining trend (European Commission, 2016c).

[Competition in service markets, p.50]

France is engaged in establishing the regulatory framework for collaborative economy activities introducing new requirements for collaborative platforms and related service providers. French consumers are particularly keen to use collaborative economy services. These activities may have a significant potential for growth and innovation. France is a leader as regards start-up creation with more than 50 collaborative economy organisations currently founded in France. At the same time, France is engaged in establishing a specific regulatory framework for collaborative platforms and related service providers. The rules proposed often increase the obligations and liability of collaborative economy actors, in particular collaborative platforms, with regard to the services offered by related providers.

11. Germany

11.1. Executive Summary

Private investment appears particularly restrained in certain sectors, pointing to specific investment barriers. While large technology-intensive corporations are investing strongly in equipment and knowledge, the services sector and small and-medium-sized enterprises (SMEs) are lagging behind compared to other advanced economies. There is also evidence that the share of SMEs investing in R&D has been gradually declining in recent years. A high level of regulatory restrictiveness in the services sector, notably in business services, affects business dynamics and investment in this sector, but also has repercussions on the manufacturing industry.

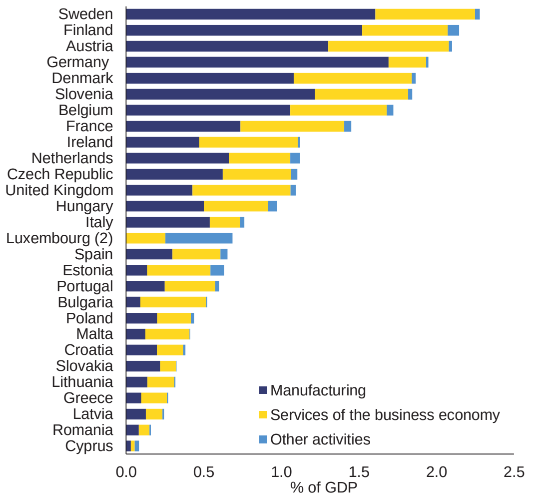
11.2. Research and Innovation

While investment in knowledge-based capital is crucial for long-term productivity growth, it is currently lower than in other high-income economies. In countries close to the technology frontier, such as Germany, the contribution of knowledge-based capital ([42]) to productivity growth is expected to be particularly strong. Business expenditure on R&D (a sub-component of knowledge-based capital) is high in Germany by international standards. Overall, however, investment in knowledge-based capital relative to GDP is lower than in some other high-income economies such as Denmark, Sweden or the US and has grown little over time. It is particularly low in the services sector (OECD, 2016b).

Strong R&D investment by the manufacturing sector contributes to a high level of intellectual property rights, while R&D investment in the services sector is relatively low. In 2014, Germany recorded the fourth highest business expenditure on R&D in relation to GDP in the EU (Graph 4.5.1). German manufacturers contributed 86 % to total business expenditure on R&D and were the top investors in innovation (1.7 % of GDP) across the EU. Yet the relative share of the manufacturing sector was even higher in the more R&D-intensive countries, Japan and South Korea (both 89 %). By contrast, expenditure on R&D in the services sector accounted for only 0.24 % of GDP. As a result, the services share of German business expenditure on R&D was by far the lowest in the EU. In 2013, Germany filed in relation to GDP the third highest number of international patent applications under the Patent Cooperation Treaty (PCT) in the EU. The country is the world's largest applicant for design rights in the transport sector (OECD, 2013).

([42]) Knowledge-based capital includes computerised information (software and databases), innovative property (R&D, mineral explorations, copyright and creative assets, new product development in financial services, and new architectural and engineering designs) and economic competences (brand-building advertisement, market research, training of staff, management consulting, and own organisational investment).

Graph 4.5.1: Business enterprise expenditure on R&D by economic activity (2014)



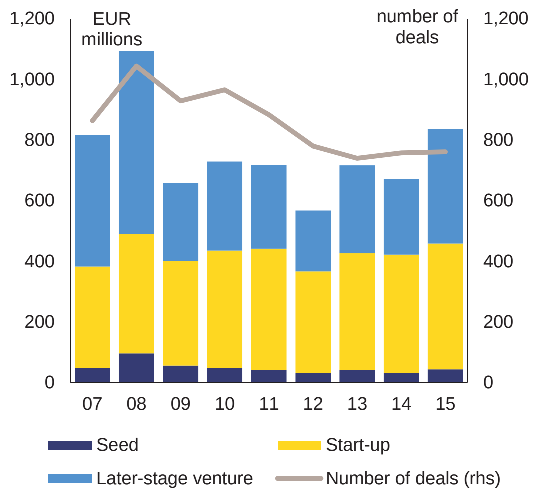
(1) BE, IE, EL, FR, LU, AT, SE: 2013
(2) LU: Other activities includes manufacturing
Source: European Commission

Business R&D investment is increasingly concentrated in large firms. While overall business R&D investment is growing, it is increasingly concentrated in big companies, in particular in medium-high technology manufacturing sectors. At the same time, the contribution of SMEs is declining. In particular, smaller companies and those with only occasional research needs seem to have reduced their innovation activities. Most of the obstacles to innovation for SMEs stem from shortages of financial and human resources.

Public support for business R&D in Germany is relatively low by international comparison and does not include tax incentives. While investment in public R&D has increased in recent years in Germany, government support for business R&D (0.08 % of GDP in 2014) is significantly lower than for example in Belgium (0.44 %), France (0.42 %) and Austria (0.40 %) and some OECD countries like South Korea (0.36 %), Russia (0.41 %) and the US (0.26 %) (OECD, 2016c). Unlike the majority of EU and OECD countries, Germany relies entirely on direct government funding, e.g. through grants or contracts, and does not offer preferential tax treatment for business R&D expenditure.

Venture capital investment has increased in Germany, but the market still remains underdeveloped by international standards. Venture capital investment in Germany increased to about EUR 837 million in 2015, which is still below the level in 2008 (Graph 4.5.2). In 2015, venture capital investment accounted for about 0.03 % of GDP, which is slightly above the EU average but still below countries such as Finland, the UK, Sweden, Ireland or France and much below non-EU countries such as Israel and the US. The venture capital market in Germany appears to be failing to provide in particular bigger later-stage investments (KfW *et al.*, 2016). While the public funding of start-ups has developed well as a result of specific funding instruments *(EXIST and High-Tech Gründerfonds)*, the framework conditions for private investors during the growth phase remain poor (Commission of Experts for Research and Innovation 2016). Despite some encouraging developments, including the dynamic start-up ecosystems in Berlin and Munich, Germany and Europe as a whole continue to lag behind the US in terms of venture capital investment in important areas of the digital economy, such as computer and consumer electronics (OECD, 2015c).

Graph 4.5.2: Venture capital investments in German companies



Source: Invest Europe, PEREP_Analytics

Some steps have been taken to support venture capital investment. The Federal Government has simplified the taxation of investment funds and has improved loss carry-forwards under the corporate income taxation system to make it easier for young and innovative companies to access equity. Moreover, *Kreditanstalt für Wiederaufbau* (KfW) is again operating as an anchor investor ([43]) and the INVEST programme for business angels has been expanded. Further measures are being considered, including a dedicated technology growth fund to support the venture debt market. The absence of a dedicated stock market segment for SMEs may be a disadvantage. However, the *Deutsche Börse* Venture Network launched in 2015 aims to bring young, fast-growing companies together with potential investors and a new SME stock market segment is planned for March 2017. Nevertheless, some elements of corporate taxation might still hamper private investment (see Section 4.4).

Despite some encouraging developments, trends in entrepreneurial activity are overall rather negative, including in knowledge-intensive sectors. The dynamic start-up ecosystem in Berlin and the large increase in entrepreneurs with a migrant background – who currently account for nearly 45 % of new businesses compared to 13 % in 2003 – are two examples of increasing entrepreneurial activity.([44]) However, the number of high-growth innovative firms and employment in such firms has decreased. There are a range of challenges in this area, including limited venture capital markets, tax and regulatory obstacles, a lack of exit prospects for venture capital providers and demographic trends. An ageing population may also have an impact on entrepreneurial activity in the coming years, including on the transfer of existing businesses. Up to 17 % of entrepreneurs are planning to transfer or sell their businesses by 2018, while there are currently around three times as many entrepreneurs willing to hand over their business as there are potential investors.

([43]) Anchor investors are usually investors that take a large share in the investment and provide confidence to potential other investors.

([44]) As part of the project '*Die Neue Gründerzeit*', the German government launched a pilot scheme called '*Gründerpaten'* to support the entrepreneurial potential of refugees. See Federal Ministry for Economic Affairs and Energy (2016a).

11.3. Additional references to R&I

[4.4.3. Public investment, p. 43]

Education and research expenditure as a proportion of GDP has remained largely stable in recent years. Total consolidated public and private expenditure on education and research amounted to 9.1 % of GDP in 2013 and 2014. (Federal Statistical Office, 2016b) It therefore fell short of the national target of 10 % of GDP that the Federal Government and the federal states agreed to meet by 2015. General government expenditure on education as a proportion of GDP has remained stable at around 4.3 % of GDP since 2009 and therefore well below the EU average (4.9 % in 2014). Public expenditure on research and development (R&D) has remained stable at around 0.9 % of GDP in recent years. Total gross domestic public and private expenditure on R&D accounted for around 2.9 % of GDP in 2014 and 2015, thus Germany almost met its Europe 2020 target of 3 % R&D spending, However, Germany's R&D intensity in 2015 was lower than in Sweden (3.3 %), Austria (3.1 %), Denmark (3.0 %) and Finland (2.9 % of GDP) and also remained behind that of South Korea (4.3 % in 2014) and Japan (3.6 % in 2014).

[4.6.1. E-government and public procurement, p. 51]

Aggregated purchasing is hardly used. In 2015 public procurement expenditure on works, goods and services amounted to EUR 461.7 billion, or 15.2 % of GDP. According to data extracted from TED, individual authorities in Germany rarely buy together (only in 5 % of procedures, compared with an EU average of 8 %). ([45]) Buying in bulk can lead to better prices and better quality. Although not all types of purchase are suitable for aggregation, excessively low aggregation rates imply lost opportunities. Moreover, the smarter use of public procurement could also encourage innovation. Despite the introduction of a centre of excellence for innovative public procurement in 2013, the progress made at federal and regional level in stimulating innovation through public procurement seems limited.

([45]) Information system for public procurement (SIMAP), standard forms for public procurement, question I.4: 'Contract award on behalf of other contracting authorities'.

12. Hungary

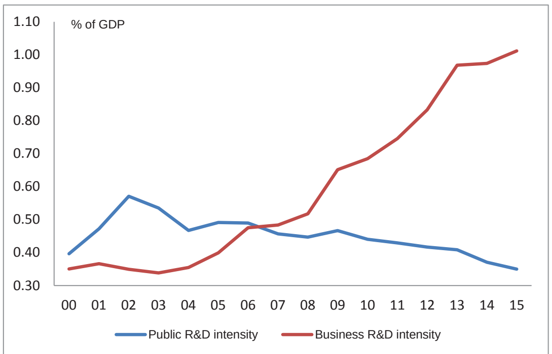
12.1. Executive Summary

Low corporate investment is however holding back productivity growth and thereby competitiveness and potential growth. Productivity is comparatively low. Without productivity gains, there is a risk of Hungary becoming less competitive in the medium term. The recent increases in minimum wages are intended to trigger a shift towards higher productivity jobs. Innovation is not yet embedded in the economy reflected in wide productivity gaps between foreign-owned and domestic companies. Regulatory barriers in services, including retail, tend to limit market dynamics and hamper investment.

12.2. Research and Innovation

Total spending on R&D increased in recent years, but public R&D intensity is falling. Although R&D spending in the business sector is still below the EU average, it has doubled as a percentage of GDP over the past ten years (*Graph 3.5.1*). However, business innovation is highly concentrated in a handful of large foreign-owned companies. At the same time, public R&D has been decreasing, leaving Hungary in the bottom group of EU Member States on this account. This weakens the science base which provides the knowledge and human resources for business development. The low quality of the public research and innovation system contributes to insufficient cooperation between higher education institutions, public research organisations and businesses.

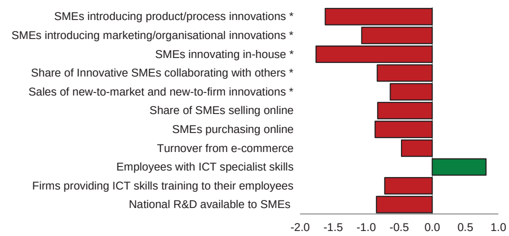
Graph 3.5.1: **The evolution of R&D intensity by sectors**



Source: Eurostat

Overall, innovation is not sufficiently embedded in the Hungarian economy. Hungary has been a major beneficiary of foreign direct investments over the past 25 years. This brought in high-technology production, which represents a significant proportion of manufacturing. However, domestically-owned firms have not been able to benefit from technological spill-overs from foreign owned enterprises, and their productivity has remained weaker. The limited knowledge transfer can be partly linked to the orientation of foreign companies towards their global production networks, while relying on low labour costs locally. The very low innovation propensity of small- and medium-size enterprises (SMEs) in terms of adopting new technologies and processes also reduces the scope for technological spill-overs. Similarly, only a small fraction of Hungarian SMEs are involved in in-house innovation activities (*Graph 3.5.2*). Human resource constraints, including weak entrepreneurship, play a major role in hampering innovation. The lack of highly-skilled professionals is a major obstacle that puts at risk investments in knowledge-intensive activities. ([46]) Based on the European Innovation Scoreboard, which reflects the above factors, Hungary ranks 21st of the 28 EU countries in innovation performance (*European Commission, 2016d*).

Graph 3.5.2: **Performance of Hungarian SMEs in selected innovation indicators – measured in standard deviations (EU average=0)**



(*) Data bars pointing left show weaker performance than the EU average. Data refer to 2015 or 2012.
Source: European Commission

The government's economic strategy puts emphasis on promoting innovation, but weaknesses in policy coordination tend to limit results.([47])The National Research and Development and Innovation Strategy (2013-2020) laid down policies explicitly targeting innovation in SMEs. However, there are mismatches between the planned measures and the actual situation of SMEs. Hungarian R&D, especially in the small busines sector, is heavily dependent on EU Structural Funds and other external sources. Yet, R&D grants do not appear to have the desired broad effect in stimulating innovation across the economy. Considerable funds are available to support business R&D during the 2014-2020 programming period. Yet, appropriate evaluation and monitoring mechanisms to safeguard the effective utilisation of these resources are missing. There is only limited policy coordination to ensure the complementarity and continuity of different programmes.

12.3. Additional references to R&I

[3.2 Education and skills, p.25]

The growing demand for highly-skilled workforce is not matched by a sufficiently large pool of applicants to tertiary education and adequate completion rates. Hungary’s tertiary educational attainment rate for 30 to 34 year-olds stood at 34.3% in 2015. The rate was thus in line with the EU2020 national target of 34%, but below the EU average (38.7%). There has been a decline in applications and enrolment rates for tertiary programmes since 2011 but the drop-out rate from higher education is higher ([48]). This may negatively affect tertiary attainment rates in Hungary over the next

([46]) The number of new graduates in science and engineering per thousand of population aged 25-34 was at 10.8 % in 2014, 7 pps. below the EU average – placing Hungary 25th in the EU.

([47]) At the request of the Hungarian authorities, a peer review was conducted on the country's research and innovation system under the Horizon 2020 Policy Support Facility, which concluded in drawing up several recommendations (*European Commission, 2016e*).

([48]) National data from 2015 indicates drop-out rates of 36.4 % in the first cycle, 17.8 % in the second cycle and 38.7 % in undivided programmes.

decade. The low relative number of researchers and tertiary graduates is considered to be one of the main challenges of the Hungarian research and innovation system (*European Commission, 2016d*).

[3.3 Investment, Investment trends, p.27]

Low investment has a dampening impact on Hungary's potential growth (*Graph 1.10*). The low rate of potential growth was discussed in Section 1. It mainly reflects low total factor productivity growth, which in turn is linked to the low level of innovation in the economy. Without sustained growth in market-driven private sector investment, the contribution of capital accumulation to potential growth and productivity growth will remain moderate. Private investment is particularly important as EU-funded investment gradually subsides.

[Box 3.4.1 Hungary's weak post-crisis productivity growth hinders competitiveness, p.27]

Existing structutal problems in the innovation system, the labour market, education and health care also weigh on productivity growth.

[3.5 Sectoral policies, Regulation in the service sector, p. 32]

Although product market regulation is not particularly strict in general, access to several service sectors continues to be constrained. Over the past years, several segments of the service sector saw the introduction of new regulatory barriers in previously open markets. The affected areas include retail outlets, tobacco retail, pharmacies, waste management public service, textbook publishing and distribution or mobile payment systems. During 2016, no substantial steps were taken to ease the recently erected entry barriers in service sectors. On the contrary, the government adopted new, tighter requirements for passenger transport services operated by independent dispatching centres. Increasing restrictions to entry in certain service sectors hinder the efficient allocation of resources and innovation-enhancing business dynamics, while also generating uncertainty for investors.

13. Ireland

13.1. Executive Summary

Linkages between multinationals and indigenous firms remain limited. Their export performances and profiles are significantly different, while the productivity gap between them is growing wider.

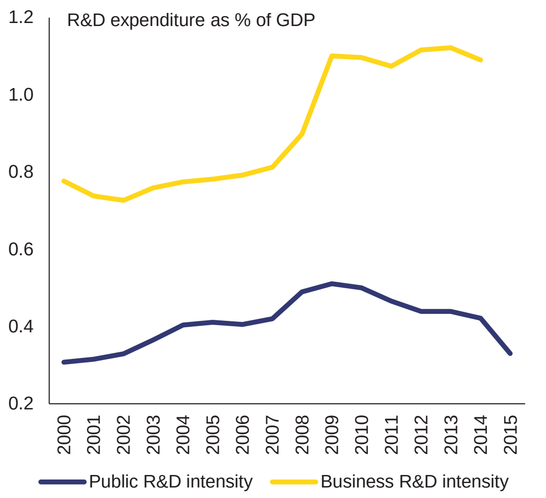
Public R&D expenditure remains low. Public R&D intensity has declined since 2009 and continues to cause concern. Fully implementing measures to improve R&D, in particular those to support the innovation capacity of indigenous SMEs, depends on the return to a trend of sustained investment.

13.2. Research and Innovation

Ireland is a strong innovator moving up the international rankings ([49]). Ireland has the vision to become a global innovation leader, which largely depends on the economy maintaining its recent recovery.

Low public expenditure on R&D continues to cause concern as Ireland ranks 25th in the EU. Even though public expenditure on R&D marginally grew from EUR 814 million in 2014 to EUR 843 million in 2015, public R&D intensity has declined since 2009, reaching 0.33 % GDP in 2015 (Graph 4.5.3, Graph 4.5.4). The share of capital expenditure in public R&D also decreased from 15 % in 2008 to 10 % in 2014.

Graph 4.5.3: **Trends in business R&D intensity and public R&D intensity, 2000-2015**



Source: European Commission, Directorate General for Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies. Data: Eurostat

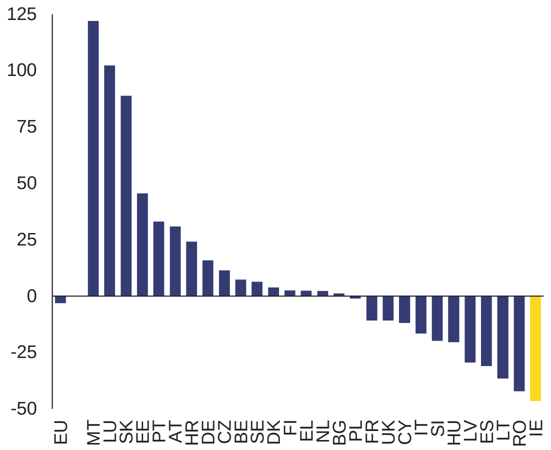
In reaction to the decline, R&D public funding has been redesigned to improve its impact through Ireland's strategy for research, development, science and technology (Innovation 2020). A first

([49]) European Commission, European Innovation Scoreboard (6th place in 2016) and Innovation Output Indicator (3rd place in 2016).

progress report was published in July 2016 showing progress in implementing the strategy (Department of Jobs, Enterprise and Innovation, 2016). Specific R&D programmes have been implemented. Of key importance is the planning of a new cycle of funding for the Programme for Research in Third Level Institutions. Also twelve world class Research Centres and fifteen industry-led technology Centres are being supported.

Full implementation of measures undertaken depends however on the return to a trend of sustained investment. Declining R&D intensity may have a negative impact on the high standing of the Irish public research base (50). Irish universities have started to fall in the international rankings, and the falling number of enrolled PhD students may become a barrier to sustaining the economic growth.

Graph 4.5.4: **Difference between real growth in government budget appropriations for R&D (GBOARD) and real growth in GDP, 2007-2015**



(1) Real growth was calculated from values in PPS€ at constant 2010 prices and exchange rates
(2) Foregone tax revenues resulting from R&D tax revenues are not included
(3)Poland: 2007-2011; Romania: 2007-2012; Luxembourg: 2007-2014; Greece, Croatia: 2008-2015; Denmark: 2010-2015
(4) Austria: GBAORD refers to federal or central government only
Source: European Commission, Directorate General for Research and Innovation - Unit for the Analysis and Monitoring of National Research Policies. Data: Eurostat

Further public expenditure in R&D is needed to make indigenous Irish-owned firms more dynamic and innovative, while maintaining the country's attractiveness to foreign investment. Business expenditure on R&D (1.14 % of GDP) accounted for 73.5 % of the overall research carried out in 2014. This was however dominated by a small number of mainly foreign-owned multinational companies with limited spillovers to Irish SMEs. Furthermore, 54 % of R&D active companies with headquarters in Ireland do not perform their R&D in the country (Research and Innovation Observatory, 2016). Despite the increase of SMEs engaging in R&D, Irish patenting remains low and is concentrated in a small number of companies.

([50]) 2015 Eurostat: International scientific co-publications (Ireland ranks 8th in the EU), highly-cited publications

To stimulate innovation by indigenous SMEs, innovation policies could be rebalanced towards more direct forms of funding. Support from the government for business R&D has increasingly relied on R&D tax credits. A Knowledge Development Box was introduced in 2016. More targeted policy mixes and direct funding measures may better address the needs of Irish young innovative firms and exploit opportunities from the strong investing power of MNEs. This would serve to facilitate access to global value chains and accelerate knowledge spillovers. In this regard, the government's first steps in reviewing the R&D support to businesses ([51]), are welcomed, as is the scaling up of the National Healthcare Innovation Hub in 2016. The Global Sourcing Initiative helps to deepen Irish company and MNE relationships through supplier opportunities, technology partnerships, investment and other collaborative engagements.

More business-academia cooperation could help Irish–owned firms become more competitive and leverage additional private R&D investments. The level of business enterprise funding of public R&D is one of the lowest in the EU and the public-private scientific co-publications per million inhabitants remains relatively low. To address this challenge, Ireland has introduced more industry leadership — including by MNEs — onto the agendas of Higher Education Institutions and Public Research Organisations (Research Centres programme and the Technology Centres Programme). The Knowledge Transfer Ireland office acts as an interface between public research and industry. 748 new collaborative research agreements were signed in 2015 between research performing organisations and industry. In January 2016, an updated national intellectual property protocol to assist firms access knowledge in the public research sector was introduced. ERDF is currently co-investing 35 % in RTDI, its largest share of allocation from its total 2014-2020 co-investment to Ireland (Box 2.1)..

13.3. Additional references to R&I

[4.4.2, Competitiveness and business environment, p.47]

The Irish government adopted last year the Enterprise Policy 2025 plan to help increase the export intensity of the indigenous firms and support geographic market diversification. The Global Sourcing initiative undertaken in 2012 to deepen Irish company and MNEs relationships through supplier opportunities, technology partnerships, investment and other collaborative engagements has made progress but its continuity is important. The Enterprise Ireland Agency has also strengthened its information and support tools recently. At the same time, innovation among Irish indigenous firms could be improved. More strategic cooperation with public research centres, universities and foreign multinationals could help improve those results (National Competitiveness Council, 2016). A National Support Network has been created to scan and exploit innovation opportunities for firms and researchers in Horizon 2020. The Health Innovation Hub Ireland fosters cooperation between the public health system and companies for products and services innovation. The European Regional Development Fund programmes 2014-2020 and Science Foundation Ireland Spokes Programme 2015 are already involved in helping Irish firms in this area. Limited managerial skills and lack of resources remain key barriers to SME internationalisation. Skills shortages are also becoming relevant in some areas (Section 4.3.3).

([51]) Request for tenders for the provision of research and consultancy services to undertake a review of RD&I support to business in Ireland to maximise business expenditure on research and expenditure, 19 April 2016.

14. Italy

14.1. Executive Summary

Italy's R&D and innovation performance is below EU average. R&D investment in Italy, in particular by the private sector, continues to be considerably lower than the EU average. It is held back by a range of structural factors like the lack of high-skilled people, limited cooperation between academia and business and unfavourable framework conditions. Some new measures were introduced to strengthen Italy's innovation track record, notably the 'Industry 4.0' strategy.

14.2. Research and Innovation

Italy's R&D investment still lags behind that of other EU countries. In 2015, Italy's overall R&D intensity (i.e. total R&D expenditure as a proportion of GDP) was 1.33 %, slightly lower than in 2014 and still significantly below the EU average of 2.03 %. The gap with the EU average for R&D expenditure by the private sector (0.74 % of GDP in Italy – 14th in the EU – as against the EU average of 1.30 %) remained significantly larger than for public R&D expenditure (0.56 % of GDP in Italy – 17th in the EU – as against the EU average of 0.71 %). Between 2007 and 2015, the Italian government's budget allocated to R&D activities fell from EUR 9.9 billion to EUR 8.3 billion.

The lack of highly-skilled people holds back Italy's innovation performance. Italy still has an insufficient number of highly-skilled people, in particular in science, engineering and computing. This is driven by the country's low tertiary education attainment rate (see Section 4.3.3) and the low number of new graduates in relevant study domains: in 2014, Italy counted 12.5 new graduates in science and engineering and 0.5 new graduates in computing per thousand inhabitants aged 25-34 (as against the EU average of 17.6 and 2.3, respectively). In addition, a significant number of Italian researchers left the country owing to lack of career prospects or more attractive salaries, and this brain drain has so far not been offset by the arrival of foreign researchers.

Other factors also explain Italy's innovation performance lag. Cooperation between academia and business in Italy remains limited, thereby hampering an efficient transfer of knowledge or leverage effect on firms' R&D investment. In 2014, public-private scientific co-publications per million inhabitants in Italy numbered 18 (as against the EU average of 34). Furthermore, in 2014, the volume of research performed by the public research and innovation system funded by businesses amounted to just 0.013 % of GDP (well below the EU average of 0.052 % of GDP), although Italy performs relatively well in terms of the quality of its scientific publications base. In addition, framework conditions for innovation in Italy are unfavourable to the creation and growth of R&D intensive firms. Italy ranks 21st in the EU on the proportion of employment in high-growth enterprises (9.5 % as against the EU average of 13 %), and most of those firms do not operate in knowledge-intensive innovative sectors. Moreover, conservative bank lending policies and the underdevelopment of capital markets hampers innovative start-ups' access to external funding. For instance, in 2015, private venture capitalists' investments in Italy represented only 0.003 % of GDP (as against the EU average of 0.024 %).

Box 4.5.1: **Selected highlights: Italy's Start-up Act & Industry 4.0 strategy**

Italy's Start-up Act ([1]) defines a strategy aimed at creating favourable conditions for the establishment and development of innovative enterprises. It also fosters knowledge spillovers to the whole economic fabric and supports a new Italian productive system oriented towards high-tech and high-skill sectors.

This strategy puts together different measures adopted since 2012. In fact, the Italian government has worked since then on the creation of coherent legislation aimed at the development of an ecosystem of innovative start-ups with high technological content. Law 221/2012 included many of the policy proposals put forward in the April 2012 'Restart, Italia!' report by the Ministry of Economic Development, as well as suggestions coming from a consultation with the main players in the Italian start-up ecosystem.

The law introduced a definition of innovative start-ups in the Italian legal system. For the first time, this type of enterprise could draw upon an exhaustive set of regulations and new instruments relevant for the whole lifecycle of a company. Thanks to the law, Italian innovative start-ups can enjoy a number of benefits, such as reductions in red tape and fees, various exemptions, tailor-made labour regulation, a flexible remuneration system, tax credits and incentives for investments, and the possibility to collect equity through crowdfunding portals. The Italian start-up ecosystem has been quite responsive to these policies: at the end of 2016, the number of registered innovative start-ups amounted to 6 745, an increase by 382 units (6 %) compared to the end of September 2016. These innovative start-ups represent 0.42 % of the estimated 1.5 million limited companies active in Italy (up from 0.38 % in June 2016).

Furthermore, the policy for innovative start-ups is in constant evolution: recent interventions have improved and broadened the range of measures. These include the 'Smart&Start Italia' (a subsidised financing scheme for innovative start-ups), the 'Italia Start-up Visa' (a centralised and simplified mechanism for granting work visas to applicants intending to set up a new innovative start-up), and some fiscal benefits such as the 'Patent Box' (which allows companies to exclude for tax purposes 50 % of their income deriving from the commercial use of intangible assets). At the end of 2016, the 'Italia Start-up Visa' programme recorded 161 applications.

Finally, in September 2016, the government presented its new 'Industry 4.0' strategy ([2]), which aims at modernising production processes and move Italian firms up in the value chain, primarily through the use of fiscal incentives. The plan includes measures to support innovative investment, SMEs' equity financing and preferential treatment for innovative start-ups. To recall a few: (i) a 250 % *iperammortamento* rate to support investment in digitalization; (ii) a 30 % tax deduction for equity investments in start-ups and innovative small and medium-sized enterprises (up to EUR 1 million); (iii) a partial absorption of start-ups' losses by their sponsoring firms during the first four years; (iv) capital gains de-taxation; (v) venture capital funds; (vi) a renewal of the *Nuova Sabatini* law for 2017-2018 which partially covers SMEs' interest expenditure granted on bank loans to invest in new machinery and equipment; (vii) a EUR 1 billion refinancing of the Central Guarantee Fund for SMEs.

([1]) http://www.sviluppoeconomico.gov.it/index.php/it/impresa/competitivita-e-nuove-imprese/start-up-innovative
([2]) http://www.sviluppoeconomico.gov.it/index.php/it/incentivi/impresa/industria-4-0

In addition to the several incentives introduced in previous years, Italy adopted new measures to improve its innovation performance. First, in May 2016, the country launched (with a two-year delay) its new 2015-2020 national research programme, which is fully operational since July 2016. The programme has a budget of EUR 2.5 billion for the 2015-2017 period and is structured around six priorities (i.e. human capital, internationalisation, research infrastructures, public-private cooperation, southern Italy, and efficiency and quality of public spending). Second, in September 2016, the government presented its new 'Industry 4.0' strategy (see Section 4.4 and Box 4.5.1.).

14.3. Additional references to R&I

[4.3.3, Education and skills, p.47]

Recent measures on higher education, albeit partial, are aimed at addressing staff and student support issues, and rewarding research performance. The 2016 Stability Law provided funding for hiring new full and associate professors (Giulio Natta chairs), albeit through an ad-hoc procedure, and for 861 young researchers on 'tenure-track' positions (1.6 % of Universities' teaching staff in 2015). The 2017 Budget Law increases public financial support for tertiary students. Public funding for universities has increased significantly and better linked to performance. All these measures are positive partial steps, as they signal an attempt to reverse previous staff and funding policies. However, they are not sufficient to solve the issues of ageing teaching staff and inadequate spending.

[4.4, Barriers to investment, p.49]

The government announced several measures to support investment. The 2017 Budget Law confirmed the possibility for companies to deduct 140 % of the amount spent on investment and introduced a new *iperammortamento* rate of 250 % for digital investments as part of the new 'Industry 4.0' strategy (see Section 4.5.3). These measures may have a positive but temporary impact on investment. At the same time, the notional return on new equity or reinvested earnings exempted from the payment of the corporate income tax ('allowance for corporate equity' (*ACE*)), which strengthened firms' financial position (Bank of Italy, 2016a, p. 18-19), was reduced from 4.75 % to 2.3 %. Despite the low interest rates, this decision could be premature, considering that banks' financing conditions remain difficult, in particular for SMEs, and that additional equity is needed to support investment in innovation. The reduction of the corporate income tax rate (from 27.5 % to 24 % as of 2017) could help support investment in a more structural manner. Initiatives to support investment in SMEs were also initiated. In September 2016 a multi-pronged 'Industry 4.0' strategy was presented to modernise the industrial sector, mostly through investment in innovation and digital technologies. ([52]) The plan might be constrained by the current lack of digital skills: only 67 % of the population were regular Internet users in 2016, well below the EU average of 79 %. 'Industry 4.0' seeks to address this problem among young people, including through new curricula in post-secondary and tertiary education, but the digital skills gaps among the middle-aged workforce and the elderly remains.

([52]) Only 7 % of SMEs were selling online in 2016 (EU average: 17 %), whereas only 29 % of Italian consumers bought online goods or services (EU average: 55 %).

15. Latvia

15.1. Research and Innovation

Latvia's innovation performance has slightly improved. The country moved up from the group of 'modest innovators' (<50 % of EU average) to the group of 'moderate innovators' (50-90 % of EU average) (European Commission, 2016c). However, Latvia's business R&D intensity remains one of the lowest in the EU and cooperation between science and business remains low. Latvia's research and innovation system strongly depends on support from EU funds.

The implementation of Latvia's research and innovation strategy for smart specialisation (RIS3) is progressing. It is supported by a re-launched entrepreneurial discovery process (11 thematic sectoral councils). The implementation of RIS3 is monitored by the strategic innovation council. The first monitoring report of RIS3 in Latvia is expected in June 2017.

Most public investment in research and innovation is supported by EU funds. Research and innovation financed by the EU funds has encountered some delays under the new programming period 2014-2020. Authorities are putting measures in place to increase the quality of investments, such as *ex ante* assessments and analysis of eco-systems of each priority of smart specialisation as well as involvement of foreign experts in the assessment of some project proposals. Latvia is also putting in place measures to increase its success rate in Horizon 2020 calls.

Public research suffers from underfunding, fragmentation and low internationalisation. Reforms to consolidate research institutions are ongoing ([53]). New rules for the allocations of both project funding (with international standards of peer review) and institutional funding (with elements of performance-based funding) were introduced. However, public research funding remains fragmented and regulations for the assessment of projects are complex. At the request of the Latvian authorities, a *specific support* under the European Commission's Horizon 2020 policy support facility ([54]) has been launched to develop concrete recommendations in this area including governance and organisational aspects.

Business investment in research and innovation remains low in international comparison. Over the last eight years Latvia had a positive growth of business R&D investment of about 4.8 % per year. However, in 2015, business investment in R&D declined to 0.15 % of GDP (from 0.24 % in 2014). Overall, business investment in R&D remains among the lowest in the EU. The take-up of R&D tax incentives is increasing, though in absolute terms the amounts are still limited.

The sectoral distribution of SME's is not conducive to innovation. SMEs are, to a large extent, concentrated in sectors with low and medium-low research intensity, such as metal processing and machinery, wood products and food processing (82 %). There is however a growing eco-system of hi-tech start-ups, supported by conferences, accelerator funds, a new start-up association and cross-border experience sharing.

([53]) In 2016 the Ministry of Education and Science decreased the number of research institutions receiving basic funding from 44 to 21.

([54]) https://rio.jrc.ec.europa.eu/en/policy-support-facility

15.2. Additional references to R&I

[3.4.1. Investment situation, p. 29]

There are specific investment needs in the healthcare sector, in transport and energy infrastructures, as well as in research and innovation. These needs are discussed in Sections 3.3 and 3.5.

[3.2.2. Access to finance, p. 18]

Public support for access to finance is being actively promoted, but it is still at an early stage. Public financial funds primarily offer SMEs guarantees and loans for growth, largely supported by European Structural and Investment Funds. The government supported the creation of the Baltic Innovation Fund, managed by the European Investment Fund, to provide growth capital for SMEs and promote the development of Latvia's venture capital market. The rollout of the new support schemes started at the end of 2016 for financial products directly managed by the government agency Altum (Box 3.2.1). It is expected in 2017 for financial products to be procured to third parties.

Box 3.2.1: **Selected highlight: Altum – single development financing institution**

Latvia has been very active in enhancing access to finance for SMEs. A range of financial instruments for SMEs have been made available (public loans, public guarantees and microfinance measures) and a number of venture capital, pre-seed and seed capital funds have been established since 2011, to help young and innovative businesses throughout the different stages of growth. Previously, the support instruments were managed by different entities, now a single public development institution is in charge.

The new one-stop-shop for public financial support for businesses 'Altum' (the joint stock company Development Financing Institution Altum) was created in 2014 and merged with the other two existing institutions in 2015, completing the consolidation of the support activity in a single entity. At the end of 2015, Altum managed a portfolio of financial instruments of the total value of 1.5 % of GDP, made up of 8 900 projects, of which 90 % were loans and guarantees and 10 % venture capital funds. Altum provides financial and non-financial support, including counselling, training, mentoring, in various fields such as energy efficiency of buildings, agricultural business and even housing loan guarantees for families with children. Altum is also the contact point for the European Investment Bank and the European Investment Fund in Latvia. A substantial part of funding is provided for by European Structural and Investment Funds, with a 2014-2020 allocation from the European Regional Development Fund exceeding 0.6 % of GDP. ALTUM cooperates with all major banks in the country and it also operates as a fund of funds providing indirect financial support through acceleration, seed and start-up as well as expansion capital funds. ALTUM operations have only been recently rolled out, but stakeholders are appreciative of its work and of the design of the system, which has the potential to improve access to finance in Latvia.

[3.3.2. Education, p.23]

Latvia is implementing higher education reforms. It is introducing a new model for higher education financing, with elements that reward quality. An independent national accreditation agency was also set up in 2015-2016 (European Commission, 2016a). In 2016, a World Bank study was commissioned to assess the governance of higher education institutions with a view to enhancing internal governance, funding mechanisms, academic recruitments and remunerations schemes, to be completed in April 2018.

[3.6.3. Public procurement, p. 37]

The use of central purchasing for local authorities and innovation-oriented procurement are low. The amendments to the national public procurement rules in 2013 aimed to expand central purchasing for local authorities by making it compulsory, but results so far are limited. Data from Tenders Electronic Daily show that the Latvian contracting authorities make recourse to centralised purchasing only rarely (in 4 % of the tender procedures, compared to an EU average of 8 %). However, aggregated purchasing at demand level not only leads to better prices but more importantly to better quality thanks to economies of scale, expertise, human resources and know-how. Public procurement for innovation and other demand-led policy instruments is largely absent in Latvia. Government procurement of advanced technology products in Latvia takes 98th place in the total evaluation of 138 countries (World Economic Forum, 2016).

16. Lithuania

16.1. Executive Summary

While Lithuania's GDP growth has recovered strongly from the crisis, investment and productivity growth rates are not back to their pre-crisis levels. Poor research and innovation outcomes, the mediocre quality of education and ineffective adult learning programmes weigh more heavily on Lithuania's productivity performance as the country becomes richer. They are also an obstacle to future growth as productivity gains are expected to come increasingly from knowledge-based activities. Improving public investment planning, increasing transparency and competition in public procurement, better coordination and implementation of research and innovation policies, and raising the quality of education provide opportunities to spur productivity growth.

16.2. Research and Innovation

Overall, the innovation performance of Lithuania remains moderate. European Innovation Scoreboard (EIS) 2016 ranks the country 24th in EU. Despite some improvements, Lithuania's innovation performance therefore remains among the lowest in the EU. Lithuania faces numerous challenges to improve its innovation performance. In particular, the low efficiency of the public R&D system, the need to incentivise the commercialisation of research results, and the urgency to foster a governance system and a policy mix that are supportive of innovation.

Lithuania's investment in R&D steadily increased in recent years to reach 1.04 % of GDP in 2015. However, growth in R&D investment is mostly propelled by the use of European Structural and Investment Funds, only a modest contribution is coming from businesses. Public R&D intensity increased up to a value slightly above the EU average in 2015 ([55]), while business R&D intensity lags behind ([56]). As a result, Lithuania is not on track to meet the national R&D intensity target of 1.9% of GDP.

Private sector capacity to invest into research and innovation remains low in Lithuania due to the structure of the economy. The medium-high-tech and high-tech sectors are small ([57]) and their aggregate share in the economy stagnates. Photonics and bio-pharmaceuticals are the leading Lithuania’s high-tech sectors. The latter has a strong science base with good connections to business and has proven capable of attracting foreign direct investment. Generous tax incentives have so far failed to increase business R&D investment significantly, indicating a possible need for more guidance and promotion. However, the tax relief was recently extended to 5 years in the hope of boosting its use. Also, on the regulatory basis for pre-commercial procurement of innovation was created in 2015.

([55]) Public R&D intensity (public R&D expenditure as % of GDP) stood at 0.76 in 2015 (EU average: 0.71).

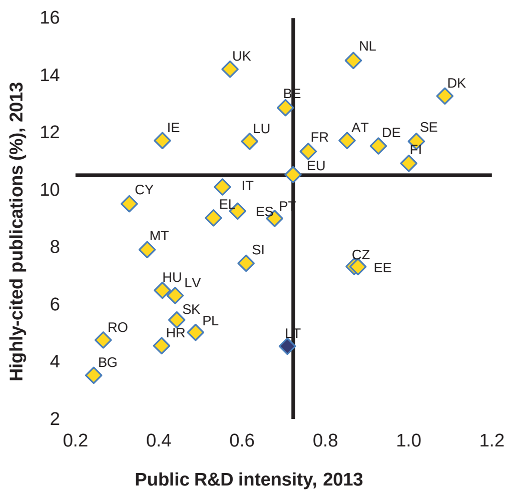
([56]) Business enterprise expenditure on R&D (BERD) as % of GDP stood at 0.28 in 2015, with Lithuania ranking 25th in the EU (EU average is 1.30).

([57]) Value added in high-tech and medium-high-tech manufacturing and in knowledge-intensive services as % of total value added – 29.7 (ranks 28th), EU: 48. Compare with added value in manufacturing – 19.3 (ranks 8th), EU: 15.5.

The cooperation between businesses and the public R&D sector is weak. There were only 1.7 public-private co-publications per million of population ([58]) in 2014 (ranking 27th in the EU). Businesses only modestly use research infrastructures available in open access centres and scientific valleys financed by European Structural and Investment Funds (ESIF). These infrastructures are expected to incur heavy upgrading and maintenance costs for the national budget by 2020([59]) (Technopolis group; Ernst and Young, 2014). There is a need for a systemic approach to improve knowledge transfer, for university intellectual property rights policies that favour collaboration with businesses, and for incentives for researchers to take part in firms' R&D activities. Available R&D infrastructures need to open up to the business sector and the regional economic systems in which they operate.

Return on public R&D investment is low. Although public R&D intensity is at around the EU average, the volume of highly cited scientific publications ([60]) fell during recent years to pre-crisis levels, placing Lithuania second last in the EU. On a value-for-money comparison, Lithuania is also one of the worst performers in EU (Graph 3.5.1). The majority of R&D output is produced by public research institutions, with weak capacity to exploit results for economic benefits. The dependence of public funding on ESIF raise sustainability concerns for the future.

Graph 3.5.1: Highly-cited publications and public R&D intensity



(1) Fractional Counting method
Source: European Commission

Lithuania has pockets of international scientific excellence, but these do not outweigh the disadvantages of the low critical mass for research. The scientific potential is dispersed across too many institutions ([61]) and the *status quo* is maintained by an inefficient research funding system that is not well suited to promoting excellence. Public research institutes were merged but attempts to merge

([58]) As compared with the EU average of 34 per million of population in 2014.

([59]) These infrastructures will require additional ~ EUR 118 million for the upgrading of outdated equipment.

([60]) Scientific publications within the top 10% most cited scientific publications worldwide as % of total scientific publications of the country: 4.5% (2013), ranks 27st among EU Member States. EU average: 10.5%.

([61]) Lithuania is a country with less than 3 million inhabitants and it has 22 universities and 23 colleges.

universities were met with limited success so far ([62]). Large emigration of the high-skilled has created a shortage of talent for Lithuania's research community. Moreover, the research entities attract an insignificant number of foreign talent, partly due to the heavy burden associated with hiring foreign specialists (OECD, 2016c). As a result, low scientific production is exacerbated by an additional problem of the lack of available quality human resources ([63]) in public and private sectors.

The research and innovation policy planning and implementation continue to suffer from fragmentation and lack of coordination. The policy planning and implementation is split among several ministries and implementing agencies. Often, their work overlaps and is poorly coordinated. This leads to a lack of leadership and sometimes ill-conceived policy. Recently, however, important policy reform initiatives have been launched and are hoped to provide a significant impetus to country's innovation performance ([64]) ([65]). Furthermore, the government requested that the European Commission's Horizon 2020 Policy Support Facility supports the design of Lithuanian policies on cooperation between the public science base and business and the attraction of innovation-oriented foreign direct investment[66]. The launch of this policy support activity is envisaged in early 2017.

16.3. Additional references to R&I

[3.2.2. Access to finance, p. 16]

Lithuania faces a shortage of sustainable, well-functioning financing sources for business development. The presence of seed and venture capital is meagre and funding opportunities are not well known to businesses, despite the fact that business access to venture capital markets increased dramatically during 2011-2014 (Paliokaitė, Krūminas and Stamenov, 2016 ([67]). The shortage of alternative financing sources partly accounts for the high dependence on bank loans - Lithuanian SMEs tend to refer to banks for loans more often than the EU average, and at the same time they are denied funding most often in the EU. The percentage of Lithuanian SMEs which received the full amount of the bank loan they applied for is among the lowest in the EU (46% compared to 67% EU average) according to the EC SAFE survey (European Commission/European Central Bank, 2016).

Lithuania has made strong efforts to increase venture capital investment in recent years. Among EU countries, Lithuania ranks 8th in venture capital financing as a share of GDP (European Commission, 2016a). Lithuania had the fastest growth in venture capital financing among the Member States and now ranks above the EU average. Developing the venture capital market is important, since Lithuanian firms facing financial constraints are often those with higher levels of labour productivity.

([62]) Only two universities merged and as a result formed the Lithuanian University of Health Sciences.

([63]) New doctoral graduates per thousand population aged 25-34 – 1.11 (2014), ranks 22nd. EU average – 1.97

([64]) Science and Innovation policy reform guidelines were issued by the President's Office and adopted by the parliament in 2016.

([65]) The Smart Specialisation Coordinating group was set up as platform for stakeholders' involvement in the policy mix. It will continue to work in 2017-2020 and this might improve co-ordination of research and innovation policies.

([66]) https://rio.jrc.ec.europa.eu/en/policy-support-facility

([67]) EUR 179.6 million were secured for loans, guarantees and venture capital in a new "Business Financing Fund" (managed by INVEGA).

Lithuania contributed to the Baltic Innovation Fund, which is jointly financed by each of the Baltic countries and which invests in existing private equity and venture capital funds that then finance high potential firms in the Baltic countries. The government promotes new forms of financing – a law on crowd-investing is enforced as of 1 December, 2016. Venture capital financing is expected to pick up further in 2017. However, the financial portfolio of alternative financing sources still mostly relies on European Structural and Investment Funds, raising concerns about their longer-term sustainability.

[3.3.5. Education, p. 25]

Higher education is grappling with maintaining the quality and efficiency of funding in the face of large drops in student numbers. The number of young people entering higher education has decreased by 9 % since 2015 and by 21% since 2012 for demographic reasons (MOSTA, 2016a). Due to the allocation of public funding for higher education on the basis of input rather than output indicators, the competition to attract students has resulted in a mushrooming of overlapping study programmes and a lowering of entry requirements ([68]). There has, however, been a light redistribution of students across study fields and an increase in the number of entrants into natural sciences. Consequently, the class sizes have dropped - in 2016, one third of all study programmes in Lithuania had no more than 10 enrolled students. The reform of tertiary education is high on the political agenda – in December 2016, the parliament adopted a resolution urging the government to work out a restructuring plan. Setting up the institutions' financial incentives in a way that promotes quality and efficiency of the higher education will be the key challenge of this reform.

[3.4.4. Productivity enhancing policies, p.29]

Knowledge-based activities are expanding, but the high-tech sector remains small. There are few firms in medium-high and high-technology sectors. Chemicals, refined petroleum products, apparel, textiles and furniture are the most important sectors within manufacturing. Knowledge-based activities within manufacturing and services are expanding and they are of particular importance for innovation and productivity growth. These include for example biotechnology industries, laser manufacturing, mechatronics and information technology. Innovation and firm productivity growth would benefit from greater international knowledge spill-overs and improvements in firms' absorptive capacity, which would make Lithuania more attractive for foreign direct investment and boost the participation of Lithuanian firms in global value chains.

[Box 3.4.4: Investment challenges, p.31]

While public investment in R&D has been solid, both the scientific and innovation output of publicly funded research institutions has been poor. Moreover, public investment has failed to leverage with matching private investment into R&D which has been low with meagre upward trend. Improving the competitive aspect of public funding allocation, creating incentives for public actors to engage with the private sector and improving the overall policy planning and coordination are the priority areas to work on in order to increase the country's innovation output.

([68]) For example, management studies are offered by 23 higher education institutions (HEIs) in 40 study programmes; business studies are offered by 20 HEIs in 32 study programmes. (MOSTA, 2016b)

17. Luxembourg

17.1. Executive Summary

Reducing the economy's reliance on the financial sector remains a central long-term challenge. A strategic document commissioned by the authorities to foster a transition towards a new industrial model was released last November. Its effective impact will depend, however, on the specific measures that will be implemented. Furthermore, the ultimate success of the diversification strategy is potentially constrained by a number of factors such as innovation and entrepreneurship. Labour cost developments also play a role in more price sensitive sectors, potentially limiting the variety of areas that can be targeted to those with high added value.

17.2. Research and Innovation

Reducing the economy's reliance on the financial sector remains a central long-term challenge. As highlighted last year, the relatively large weight in the economy of this sector is a risk factor (European Commission, 2016a). Diversification towards high value-added emerging activities remains a major challenge for the economic sustainability and development of Luxembourg. Given its technological development and high labour costs, Luxembourg's comparative advantage is likely to lie in sectors with high added value and high-skilled activities. Activities in these sectors tend to be technology- and knowledge-intensive. Areas identified as most promising are Information and Communication Technologies (ICT) (see Box 3.4.1), materials (composites), space and logistics. ([69]) The successful diversification of the economy will partly depend on efforts to strengthen investment in innovation and knowledge-based capital (KBC).

Luxembourg is pursuing a transition towards a new industrial model. A strategic study on 'the third industrial revolution' commissioned by the government was released last November. The study encourages the transition to a new industrial model based on the convergence of ICT, renewable energy and new transport modes([70]).Targeted areas include increasing energy efficiency, developing a high performance computing infrastructure, as well as setting up technology platforms for co-located industry and university researchers working on common transversal issues. The study will now be subject to a consultation with the relevant institutions. A national committee under the responsibility of the Minister for the Economy has been set up to coordinate the implementation of the measures, some of which have already received the endorsement of the government. The effective impact on diversification will depend on the specific measures to be implemented.

The low level of investment in intangible capital may have had a negative impact on total factor productivity (TFP). Despite their relative resilience during the crisis, Luxembourg is the only Member State, with Finland and Greece, where investment in intangible capital decreased after the crisis. Investment growth in knowledge-based capital (KBC) ([71]) has also significantly slowed down.

([69]) Cf. Alexander S, Rumpf, G, del Rio, JC; RIO Country Report 2016: Luxembourg (pending publication)

([70]) Namely: energy, mobility, building sector, food sector, industry, finance, smart economy, circular economy, prosumers and social model.

([71]) These investments include expenditures in human capital, e.g. in the form of education and training, public and private scientific research, business expenditures for product research and development, market development and organisational and management efficiency.

This raises concerns because such investment is an important driver of productivity and growth (Corrado et al., 2012) as it usually underpins innovations and their subsequent adoption. The decline may suggest a slowdown in innovation performance detrimental to total factor productivity growth.

The sharp decrease in business expenditure on research and development (R&D), a key type of intangible investments, is a matter of particular concern. Public R&D intensity increased fivefold between 2000 and 2015, but business R&D intensity dropped in the same period from 1.5 % of GDP to 0.7 %.

Box 3.4.1: **Analysis of the ICT sector.**

Information and communications technology is one of the priority sectors selected in the context of the economic diversification strategy where significant improvements have been made. Between 2008 and 2012, the sector recorded the fourth highest growth in the EU. In 2013 it further expanded by 4.8% representing 7.3 % of the national gross value added (Observatoire de la compétitivité, 2016, page 156). Strong technological infrastructure underpins this good performance. In recent years, additional measures have been taken to encourage the development of young innovative companies in this sector. For instance, the: Fit4start programme helps a selection of start-ups through a combination of financial support for prototype development and coaching. In January 2016, the ICT Seed Fund was launched to finance new innovative high-tech ICT businesses.

The favourable position of ICT activities in the Luxembourg's economy could be hampered in the medium term by the shortage of high-level experts. Luxembourg is one of the top Member States for digital skills: 86 % of people aged 16-74 have basic or above basic digital skills (EU average: 56 % in 2016) and 97 % of individuals aged 16-74 are regular internet users (EU average: 79 % in 2016). However, the sector suffers from a shortage of qualified ICT experts. In 2016, 61 % of businesses that recruited or tried to recruit staff for jobs requiring ICT specialist skills reported problems in filling these positions (EU average: 41 % in 2016). This is also related to Luxembourg's low number of Science, Technology and Mathematics (STEM) graduates. A mere 3.5 people per 1000 aged 20-29 graduated in STEM in 2014, the lowest performance in the EU-28 (EU average: 18 graduates per 1000 in 2013). However, this low number is also due to the large number of Luxembourgish students who study abroad. In response to this problem, in May 2015 Luxembourg launched the new "Digital4Education" initiative as part of the "Digital Lëtzebuerg" strategy. One year after the launch of the "Start&Code" programme, offering the possibility to young unemployed people and refugees to participate in a six-week IT training course, Employment Minister Nicolas Schmit presented the state of play. By 2017, 90 participants will have completed the training, 15 % of whom are refugees.

17.3. Additional references to R&I

[3.4.4. Business environment,, p. 36]

Businesses are engaged in innovation, although business R&D expenditure remains low. Luxembourg's SMEs are overall more innovative than their EU peers. However, private R&D investments and non-R&D innovation expenditures are below the EU-average. Luxembourg SMEs also lag behind their peers in terms of the commercialisation of innovation, especially on-line. The government has launched a comprehensive range of measures to encourage the creation of innovative start-ups. It is also taking action to raise the SME community's awareness through initiatives such as the 'Pakt Pro-Commerce'.

[Box 3.4.4: Investment challenges, p. 41]

Business sector investment remains low compared to the euro area average. This could in part be due to the presence of a large financial sector and the low investment intensity associated with its activities. Nevertheless, the low level of investment in intangible capital, and in particular the sharp decrease in business R&D expenditure, contrasts starkly with public R&D intensity, which increased fivefold between 2000 and 2015. This points to a weakness in the framework conditions for cooperation between public and private research and of not completely adequate comprehensive approach to the innovation eco-system.

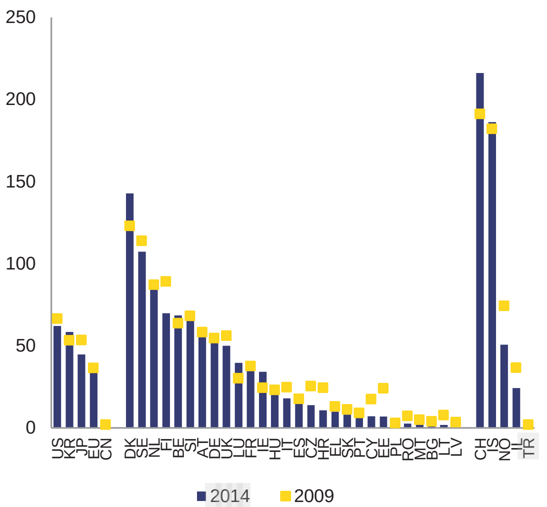
18. Malta

18.1. Research and Innovation

Important steps have been taken to strengthen the research and innovation (R&I) system. R&I performance has improved, leading to a narrowing of the innovation gap with the EU average, as measured by the European Innovation Scoreboard (EIS) ([72]). R&D investment, in particular by the public sector, has grown considerably in recent years leading to higher-quality scientific output. ([73]) This notwithstanding, R&D investment, both public and private, remains low, the quality of scientific and technological output, and the availability of researchers underperform the EU average. Finally, some other challenges remain, in particular in areas where progress until now has been limited like in science-business linkages (see figure 3 below) or the share of enterprises collaborating with a university or public research centre.

The structural changes that the Maltese economy is undergoing require more investment in knowledge and intangible assets to sustain productivity growth in the future. However, Malta has one of the lowest levels of Business Expenditure in R&D in the EU, at just 0.5 % of GDP in 2014. In addition, venture capital markets are underdeveloped and the ease of doing business in Malta, as measured by the World Bank, is one of the lowest in the EU. The key policies in this respect are the Smart Specialisation Strategy and the alignment of the National R&I Strategy, which are in the process of implementation. This includes the mobilisation of additional financing for research towards the seven key areas identified under the Smart Specialisation Strategy. Timely and efficient implementation would contribute to building the R&I eco-system in Malta.

Graph 3: Number of public-private co-publications per million population



Source: European Commission

([72]) Malta is classified into the "moderate innovator" group.

([73]) Scientific quality is measured as a percentage of total scientific publications of the country within the 10% most cited scientific publications worldwide. It increased from 4.2 % in 2000 to 7.9 % in 2013.

18.2. Additional references to R&I

[3.3.4 Education and Skills, p.21]

The provision of skills does not adequately match those demanded by the labour market. The economy is registering a high growth in ICT services, but the share of graduates in Science, Technology and Mathematics is still lower than the EU average — 1.5 % compared to 1.8 %. While ICT specialists represent a relatively high and increasing share of the workforce (4.6 % compared to 3.7 % in the EU), only 52 % of the population had at least basic digital skills (EU average 55 %) in 2015. In addition to the gap in professional and technical skills, employers stress the weakness in soft/transversal skills, such as communication, English language, team work, problem-solving, customer handling, etc. (National Employee Skills Survey, 2016).

[3.4.4 Access to Finance, p.26]

The authorities have also made a diversified range of alternative mechanisms of financing available. They aim to foster investment (soft loans, rent and interest rate subsidies, loan guarantees), SMEs and SME growth, the upgrading of the qualifications of personnel, R&D and start-up firms (Business Start and Start-up Finance). In addition, Malta has signed three financial instruments worth EUR 32 million with the European Investment Bank ([74]) during 2016. These horizontal measures may be complemented by new sectoral measures that have been announced in the 2017 budget aiming at specific activities such as hospitality services. However, this year's SAFE survey shows a sharp increase in the importance attached by business to the administrative difficulties found when trying to have access to public support measures for financing (over two and half times higher compared to 2015).

([74]) Innovfin Large: 20 millions euros loans guaranteed; SME Initiative supports Banif Bank to provide around €6 million of new loans to SMEs in Malta, over the next two years; and SME Guarantee: 6 million euros of guarantee on loans for innovative SMEs in Malta approved through APS Bank.

19. The Netherlands

19.1. Executive Summary

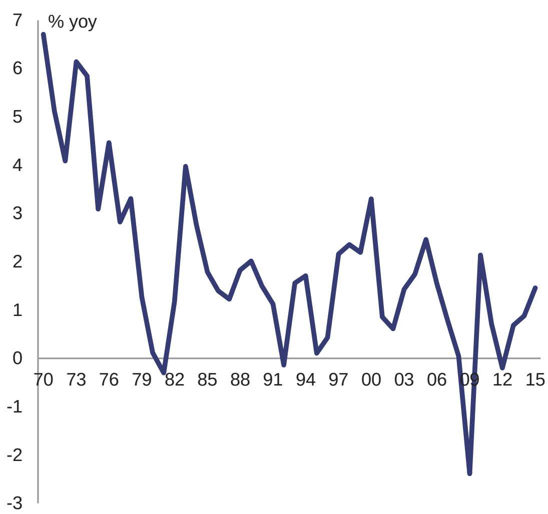
Growth friendly public expenditures are lower than that of top performers, hampering the development of a more innovation-intensive economy. The well-performing education system and scientific base of the Netherlands, which is marked an 'innovation leader', provides a sound basis for boosting innovation and growth capacity via education and R&D activities. Nevertheless, spending on education is substantially below that of top performers such as the Nordic countries, and the public R&D intensity is set to decline. Higher public expenditure on growth-friendly areas such as R&D and education has the potential to unlock investment in knowledge-based capital, including private R&D, and improve long-term growth potential.

19.2. Research and Innovation

[4.5.1 Productivity developments and its key drivers, p.39]

Productivity in the Netherlands is generally high, but productivity growth remains below pre-crisis averages. In 2015, aggregate labour productivity in the Netherlands was almost 27 % above the EU average but the declining trend in growth rates remains. Despite small fluctuations annual growth of GDP per hour worked remained relatively low at 1.5 % in 2015 (see Graph 4.5.1). There are several potential explanations for the slow growth, such as a low investment in R&D or low levels of knowledge diffusion. As the contribution of labour supply to output growth is limited, labour productivity and skills will be increasingly important for overall economic growth.

Graph 4.5.1: **GDP per hour worked (constant prices, year-on-year growth)**

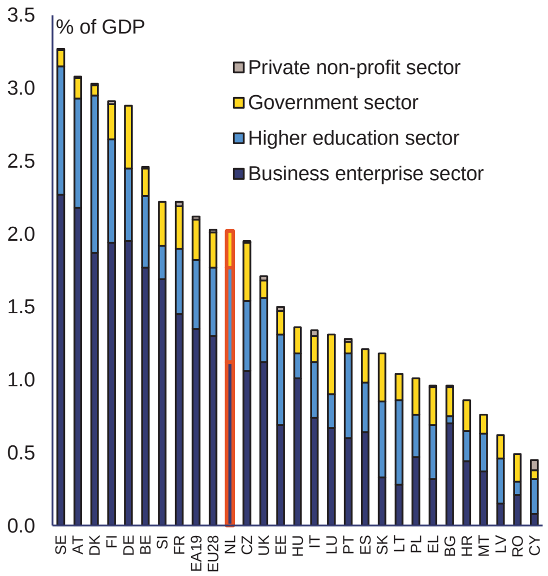


Source: European Commission (Ameco)

Public and private R&D spending is relatively low in the Netherlands, limiting the growth potential of the economy. Although the Netherlands is currently an 'innovation leader' (European Commission 2016c), the total R&D intensity of 2.01 % of GDP in 2015 is still significantly below the

Europe 2020 target of 2.5 %. Private R&D intensity (1.12 % of GDP) remains low compared to other innovation leaders([75]). Similarly, the public R&D intensity of 0.90 % in 2015 is lower than in the most innovative European economies. Moreover, total public R&D support, including both direct and indirect fiscal instruments, is projected to decline from 0.94 % of GDP in 2016 to 0.82 % of GDP in 2021 (Vennekens and van Steen, 2017). Applied research institutes are required to compensate for this decrease in public funding by obtaining more private funding. Nevertheless, while closer links between public research and industry are important, a generally high quality of public research is a precondition for public-private cooperation.

Graph 4.5.2: **R&D expenditure by sector (2015)**



Source: European Commission (Eurostat)

There is scope to transform the Netherlands' world-class science base into a more innovation-intensive economy, including more investment in knowledge-based capital. The science base is one of the best in the world, with 14.5 % of scientific publications among the 10 % most-cited worldwide, which is the best performance in the EU. The openness and attractiveness of the science system in the Netherlands is notably reflected in the high proportion of international scientific publications, strong public-private collaborations and a high share of foreign doctoral students (European Commission, 2016c).

Also, labour market institutions have potential negative implications for productivity growth and innovation performance. Framework conditions, such as a high-quality educational system and well-functioning product and labour markets, are vital for productivity growth. The relatively stringent employment protection for permanent contracts may hinder productivity growth via its impact on labour turnover rates. According to Andrews, Criscuolo and Gal (2015), potential labour productivity in the Netherlands could be increased substantially by reducing the stringency of employment protection.

The Netherlands has a strong and highly educated workforce for innovation, but has faced challenges responding to emerging labour market needs. The population with a tertiary level of education is high,

([75]) These include Denmark (1.87 % of GDP), Germany (1.95 % of GDP), Finland (2.94 % of GDP) and Sweden (2.27 % of GDP).

in comparison to the EU average. However, the share of graduates in science, technology, engineering and mathematics (STEM) fields is low, at only 14.7 %([76]), notably because STEM fields attract a low share of women. The share of women graduating in these fields is only 25 %, one of the lowest shares in the EU. The Technology Pact 2020, which targets all levels of education, was recently updated for the 2016-2020 period, and the human capital agendas for the top sectors, are designed to increase the number of skilled workers([77]).

Moreover, the Netherlands continues to develop effective policies to attract highly-skilled workers from abroad. The knowledge immigration scheme in place since 2014 has become the largest channel of non-EU labour migration to the Netherlands and is popular with employers (OECD, 2016a). It facilitates the recruitment of some 12 000 highly-skilled migrants per year**.** As of October 2015, the administrative procedure for obtaining a residence permit has been streamlined for researchers, students and skilled migrants (Ministry of Education, Culture and Science, 2016).

19.3. Additional references to R&I

[4.1.4. Quality of public finances, p. 22]

Public expenditure in growth-enhancing areas is low compared to peer countries. Within the budgetary scope, it is important to use government resources efficiently, in order to promote long-term growth and employment. Some expenditure categories are regarded as growth-enhancing, such as public investment (gross fixed capital formation), which accounted for 3.5 % of GDP in 2015, above the EU average of 2.9 % (EA 2.7 % of GDP). Moreover, in 2014 the Netherlands spent 5.4 % of GDP on education, which is less than the top-performing peer countries such as Finland, Sweden or Denmark (see section 4.3.3). Similarly, public R&D intensity (0.9 % of GDP) remains lower than in most innovative European economies. Looking forward, direct public support for R&D is projected to decline between 2016 and 2020 (see section 4.5.1).

[4.6 Public Administration, p. 42]

The quality and effectiveness of the public administration is high and the business environment largely favourable, both by EU and international standards (European Commission, 2016a). Satisfaction rates with the quality of transport infrastructure are the highest in the EU (OECD, 2016c) According to the World Economic Forum (2016), the Netherlands has moved up to become the most competitive economy in the EU, and the fourth most competitive economy in the world. According to the same source, it is among the top 10 countries in the world for competitiveness in infrastructure, health and primary education, higher education and training, goods market efficiency, technological readiness, business sophistication, and innovation. For scientific research and cooperation between universities and the private sector the Netherlands is among the top five.

([76]) Based on Eurostat data, tertiary education levels for science, mathematics and computing, and engineering, manufacturing and construction.

([77]) The focus of the *Techniekpact* broadly covers all ‘technical’ professions. See Ministry of Economics (2016), for comprehensive data.

20. Poland

20.1. Executive Summary

Research and innovation are increasingly regarded as engines of long-term growth in Poland, but challenges remain. The quality of science and innovation' outputs are still far below EU standards. R&D investment has been gradually increasing supported by public financing with a large role of the EU structural funds.

Securing robust productivity growth is becoming increasingly challenging. Efficiency gains are harder to achieve as Poland gradually catches up with the more developed EU Members States. Long-term economic prospects will depend on the country's capacity to move from the production of relatively low-technology goods to more advanced products and services. This will emphasise the importance of inclusive education that provides people with adequate skills and competences, and of improving the quality of higher education and applied scientific research.

20.2. Research and Innovation

Poland's research and innovation performance has marginally improved over the last decade. R&D intensity increased from 0.6 % of GDP in 2007 to 1 % of GDP in 2015, which is still below half of the EU average. The government is committed to reaching the EU2020 national R&D intensity target by 2020 (1.7 % of GDP). Poland´s performance in all dimensions of the European Innovation Scoreboard remains below the EU average (EIS, 2016). R&D investment in Poland currently relies predominantly on public financing, with important support provided by the European Structural and Investment Funds (ESIF).

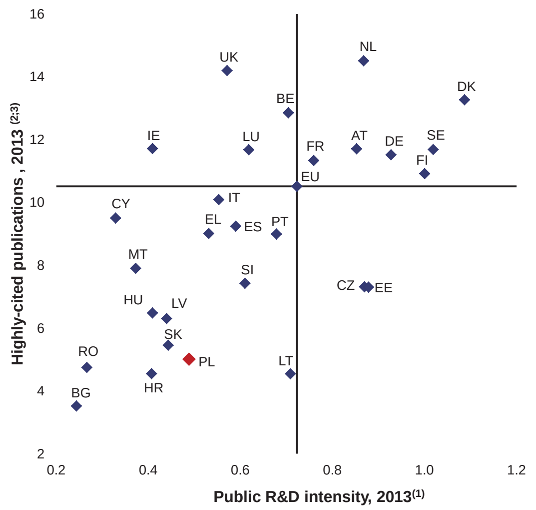
Boosting innovation in the business sector remains a key challenge for Poland. Despite recent increases, business enterprise expenditure on R&D (BERD) remains one of the lowest in the EU, although non-R&D expenditures significantly exceed the EU average. R&D outlays of foreign firms accounted for a large part of the rise in the overall BERD in Poland. BERD dynamics in recent years does not match the increases in availability of public co-funding, as distributed by NCBiR[78].. The 2016 'White Paper on Innovation' sets out legislative and organisational proposals to improve the business environment for innovation (MNiSW, 2016). Two new laws on innovation will be entering into force in 2017 and 2018. As from 2016, companies benefit from new R&D tax incentives. Although it is too early to assess the uptake of these incentives, their availability and size have been already extended in 2017, when the first Act on Innovativeness entered into force (see Box 3.6.1 on Selected highlights).

A limited commercialisation of research results and weak science-business links limit the innovative capacity of the economy. Recent counts of joint patent applications and co-publications are insignificant, as is the number of enterprises declaring cooperation with scientific organisations. The share of R&D expenditures in higher education and research institutions funded by business enterprises is also subdued (EIS 2016). Poland is catching up in numbers of business enterprise

[78] Given the recognised issue of the BERD underreporting, the data do not allow for full analysis of the public R&D support effectiveness; for more details see: Klincewicz et al. (forthcoming).

researchers. Work is on-going to introduce a new legal framework to better adapt academia to market needs (see Section 3.3. on education).

Graph 3.5.2: Highly-cited publications vs public R&D intensity



(1) Values of public R&D intensity for Ireland and Sweden are estimated or provisional;
(2) Scientific publications within the 10 % most cited scientific publications worldwide as % of total scientific publications of the country;
(3) Fractional counting method;
Source: European Commission (European Innovation Survey)

Despite measures taken, strengthening the quality of science and its internationalisation remains a key challenge. The quality of scientific activities in Poland is still far below EU standards. With only 5.0 % of Polish scientific publications among the 10 % most-cited worldwide Poland ranks 24th in the EU (Graph 3.5.1). Only two Polish universities were included in the 2016 Academic Ranking of World Universities (and both were in the last five hundred). Poland ranks 26th and 27th in the EU in terms of the number of PhD graduates and non-EU PhD students, respectively. Recent initiatives (e.g. Pact for Horizon 2020) are to support the internationalisation by e.g. moving the evaluation focus from the quantity to the quality of publications. Moreover, The Strategy for Science and Higher Education comprises three key pillars of reforms, focusing on higher education and science system ('Law 2.0'), science's links with business and its societal impact. The first elements of the reforms came into force in October 2016. Reform of the Higher Education Sector is being prepared with the Horizon 2020 Policy Support Facility[79] (27).

Although R&D is increasingly regarded as an engine of long-term economic growth, the effective design and implementation of policies remains challenging. The government has launched a comprehensive revision of the whole strategic and legislative R&D framework, as presented in the Responsible Development Plan. The Plan identifies the economy's limited capacity to innovate as one of five major growth barriers in Poland and includes a number of measures to overcome barriers to innovation. It proposes a stronger thematic focus of R&D investment by prioritising national and regional smart specialisations. The delivery of this complex revision of the whole R&D framework

[79] Policy Support Facility website, https://rio.jrc.ec.europa.eu/en/policy-support-facility

will be challenging in terms of avoiding discrepancies between policy concepts and their implementation[80] and limiting overlaps between numerous support measures.

20.3. Additional references to R&I

[Box 3.4.1: Investment challenges and reforms in Poland, p.29]

Weak links between academia and the business sector and the quality of science are crucial barriers to e.g. the development of in-house R&D activities and for investment in knowledge-intensive areas. The government has launched a revision of the legislative R&D framework (see Section 3.5).

(80) For example the recent amendments in the Act on Research Institutes withdraws, among others, the requirement of open procedures for the directors' post.

21. Portugal

21.1. Executive Summary

School outcomes are improving but the skill level of the labour force, including digital, remains low. Tertiary attainment has stagnated below EU average and higher education offer is scattered. In spite of efforts made, obstacles to more structured university business cooperation and knowledge transfer remain, hampering innovation and the transition to a knowledge based economy.

21.2. Research and Innovation

Despite some progress, the economy does not make the most of its scientific production and related human resources. R&D intensity fell from 1.58 % of GDP in 2009 to 1.28 % in 2015, diverging further from the EU average of 2.04 % and the national target. The main reason for the decline was a contraction of business enterprise R&D expenditures from 0.75 % of GDP in 2009 to 0.60 % in 2015. Public R&D intensity fell after 2009, but there are signs of recovery (2009: 0.69 %; 2015: 0.66 %). This reduction of R&D investments adversely affected productivity growth[81]. Portugal has made much progress in improving its human resources base in science and technology and its scientific excellence. The country produces more science and engineering graduates and has more researchers in the labour force than the EU average (Eurostat). Highly cited scientific publications increased from 7.6 % in 2006 to 9.0 % in 2013 but the country still ranks only 16th in the EU. However, Portugal ranks low (around one fifth of the EU average) on public-private scientific co-publications and patent applications. This shows that there are difficulties in developing technological outputs from R&D activities. Portugal occupies a very low (24th) position as regards the Innovation Output Indicator, which measures the extent to which ideas from innovative sectors are able to reach the market. This constrains the transition towards a more innovation-driven economy.

There is no integrated strategy for cooperation between academia and business to deliver the skills and knowledge needed for innovation. The governance and finance systems of Portuguese universities do not provide the most efficient environment for university-business cooperation and innovation. Career paths in academia are based mainly on publications, and cooperation with the private sector or work within it is seen as a career gap with no impact on career progress[82]. The tertiary education attainment rate for 30-34-year-olds has risen substantially over the past decade. Yet the country ranked only 23rd within the EU in 2015. The high emigration rate of graduates (see Section 4.3) further reduces the number actually reaching the labour market. Moreover, many businesses lack absorption capacity for the highly educated. For the relatively few firms in knowledge-intensive sectors that do have the absorption capacity, universities do not seem to be supplying enough of the skills needed. The Digital Skills and Jobs coalition addresses the issue. The country is among the EUs' worst performers as regards new computer science graduates among the 25-34-year-olds (Eurostat). The increasing demand for ICT professionals is not being met by the current supply[83]. Firms perceive

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([81]) During the period 2007-2016 total factor productivity has declined and then registered a small recovery (AMECO)

([82]) The State of University-Business Cooperation in Portugal (2013)

([83]) The study "e-skills in Europe-Portugal" estimates a shortage of 9.600 ICT specialists in 2016, which may expand to 15.000 by 2020 universities as being too bureaucratic to invest in. Companies contract only a small amount of R&D services from other institutional sectors and R&D spending financed by national business enterprises is only 35 % of the EU average. Additionally, firms do not perceive academic publications as relevant sources of information for innovation (FCT, 2013). Nor are they inclined to take on more qualified human resources such as PhD holders despite the tax incentives in place for companies employing PhD holders[84]. The new diploma 'Fostering Scientific Employment' (Decree-Law 57/2016) was adopted in 2016 with the aim of improving researchers' working conditions and career prospects. This is important in a context of highly unstable research careers.

In spite of the efforts made, there is still a lack of structured coordination between the various incentives for commercialising research outputs. Portuguese regional clusters encourage knowledge and technology transfer between universities and low-medium technology-intensive manufacturing industries. The Recognition of Competitiveness Clusters (Decree 2909/2015) reshaped cluster policy to instigate public-private collaborative partnerships and networks (OECD, 2016). But value added in high-tech manufacturing is only 0.57 % of total value added (EU average 1.69 % 2014 Eurostat). The National Innovation Agency funds R&D programmes that promote cooperation between universities, firms and R&D performing organisations. The National Reform Programme 2016 also includes a set of initiatives to foster knowledge transfer and strengthen the link between R&D and innovation in companies. The 2016 programme for modernising and upgrading polytechnic institutes focuses on matching R&D activities to regional needs. Tax credits to business R&D (SIFIDE) rose between 2006 and 2014 (OECD R&D Tax Incentives). Yet there is no regular and consistent monitoring to assess whether the initiatives are effective.

Framework conditions are not conducive to an innovation-friendly environment, as barriers to competitiveness still persist. Portugal is a "Moderate Innovator" in the European Innovation Scoreboard but ranks in the top 10 in terms of SMEs innovating in-house. The government aims to foster balanced development of the collaborative economy showing willingness to accommodate innovative business models in the regulatory framework. A framework for short-term rental activities for tourists has been introduced, and legislation to enable platforms to provide passenger transport services is being prepared. Portugal stands out from the EU average in entrepreneurial activity, especially in enterprise birth rates and entrepreneurial intention[85]. This is in line with the remarkable progress in "Starting a Business" from the World Bank Doing Business Report 2016. Nevertheless, business survival rates are below 50 % reflecting unfavourable framework conditions for business growth, innovation and scale-up. High-growth innovative enterprises (HGIEs) represented only 0.07 % of firms in 2014, half the EU average and the country dropped 8 positions in the 2016 Global Competitiveness Report. Firms' technological and managerial capabilities are still holding back competitiveness, especially in SMEs (European Commission, 2017c). The National Strategy for Entrepreneurship (*Startup Portugal)* launched in 2016 aims to improve the business ecosystem, provide alternative ways of financing, and promote the internationalisation of start-ups.

21.3. Additional references to R&I

[4.3.3. Education, p.37]

([84]) In 2015 Portugal ranked only 17th in the EU terms of Researchers (FTE) employed by business as % of total employment

([85]) "Framework Conditions for HGIEs" (2017)

The low level of skills among the Portuguese labour force is an obstacle to innovation and economic transformation. The Government's new initiative to promote adult education Programa Qualifica – is based, namely, in the establishment of the ‘Qualifica’ centres focused on promoting adult qualification by recognizing, validating and certifying prior learning and competences acquired by adults in different life contects complemented by vocational education and training adapted to each individual. The revamped ‘Qualifica’ centres, that replaced the previous network of specialized Centres on adult qualification, have been reinforced with upskilled staff. The government has also launched the ‘Qualifica passport’, a new online tool that not only registers the learning and competences acquired by adults, but also allows to understand what the adult lacks in order to achieve a certain qualification. The outcomes of the National Skills Strategy project could help boost efforts to tackle adults' skills gaps. The Vocational Education and Training system further expanded the number of people enrolled and the number of trainings provided in 2016. However, the remaining overlap between programmes undermines the system's efficiency and its effectiveness in terms of labour market integration (European Commission 2016b).

[4.4.3. Business Environment, p.42-43]

Inefficiencies have been identified in the areas of the judicial system, including insolvency framework implementation, public procurement, sector-specific regulations, including energy and transport, the business environment and the innovation framework. Efficiency indicators for civil, commercial and tax litigation remain poor and insolvency court proceedings are still long. Despite progress, there are still shortcomings as regards the transparency and reliability of public procurement data and procedures. Transparency in concession contracts and public-private partnerships is still hindered by contracting authorities' lack of the necessary expertise to manage complex contracts. Reform measures concerning port concessions and the governance model for urban transports have been stalled. The efficiency and sustainability of the electricity sector are challenging mainly due to a still high tariff debt.

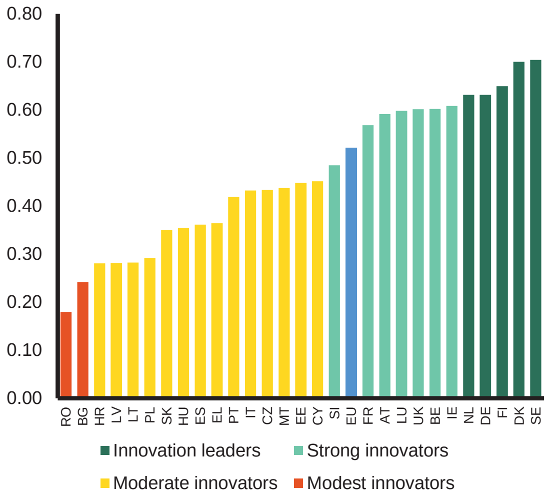
Unfavourable framework conditions and inadequate alternative financial incentives continue to curtail Portugal's performance in the area of innovation. Information and communication technologies are lagging behind and the cooperation between business and academia is not strong enough. This is having a negative impact on the innovation capacity of the Portuguese economy.

22. Romania

22.1. Research and Innovation

Structural shortcomings in the R&I system are holding back its growth contribution. Structural challenges to R&I remain unchanged (European Commission, 2016a). These include insufficient funding, institutional fragmentation, low quality of the public science base, and weak public-private collaboration. In 2015, the European Innovation Scoreboard (European Commission, 2016j) placed Romania in the lowest country category ('modest innovator'), with scores well below the EU average on all dimensions and indicators (Graph 3.5.1). The lack of dynamism in R&I has implications for long-term competitiveness and growth prospects.

Graph 3.5.1: **Innovation performance of EU Member States in 2015**



Source: European Commission EIS2016

R&D intensity improved but the lack of investment impedes R&I capacities take-off. Although R&D intensity ([86]) improved in 2015 (Graph 3.5.2), Romania still has one of the lowest levels among EU Member States. Out of the total 2014-2020 structural funds allocated only 3.4 % were allocated for R&I, far from the EU average of 10.6 % for the same period. The 2016 budget provided for a slight increase in public R&D expenditure up to 0.29 % of GDP, largely insufficient to reach the 1 % of GDP target of public investments in R&D ([87]) by 2020.

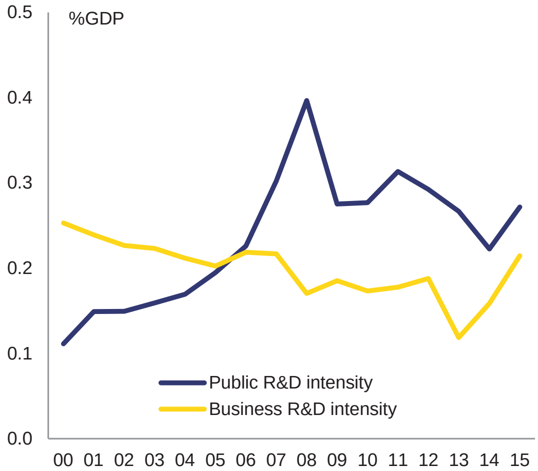
Recently adopted measures to stimulate business investment have yet to gain traction. In 2015, less than 200 business entities applied for the 50 % supplementary corporate tax deduction for R&D expenditure, even fewer than the 223 entities in 2014. Despite the slight increase in business R&D intensity in 2015, at 0.21 % of GDP it is still one of the lowest in the EU. To stimulate business R&D activities, the government introduced in August 2016 an exemption from paying the salary income tax

([86]) Research and development (R&D) is the statistical proxy for expenditure in the R&I system (Eurostat). Intensity is measured as R&D expenditure in percent of GDP.

([87]) Romania's Europe 2020 target is 2 % of GDP investments in R&D, with 1 % from the public sector and 1 % from the private sector.

for all R&D activities. Also, to stimulate the activity of computer programmes development, a measure of payroll taxes exemption was set up and is in place starting with 2017, for employees in start-ups with main activity in this area.

Graph 3.5.2: **Evolution of business R&D intensity and public R&D intensity in Romania, 2000-2015**

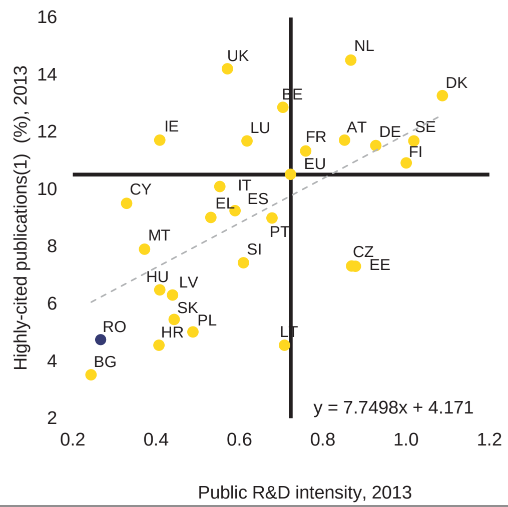


Source: European Commission

Pervasive bottlenecks obstruct SMEs' investment in innovation. SMEs have a low level of innovation and knowledge flows between public R&D and the business sector (Graph 3.5.3) are weak, as borne out by Romania ranking at the bottom of the 'Linkages & Entrepreneurship' dimension of the Scoreboard ([88]). Red tape, poor infrastructure and the low level of entrepreneurial education hamper innovative entrepreneurship and the development and growth of technological start-ups.

([88]) It covers performance indicators on SMEs innovating inhouse, innovative SMEs collaborating with others and public-private scientific co-publications.

Graph 3.5.3: **Quality of scientific output and public R&D investment levels**



Source: European Commission

Key steps have been undertaken to improve governance and reduce fragmentation. Developing and implementing effective smart specialisation strategies requires: (i) building on the strengths of clusters of entrepreneurial knowledge and resources, and (ii) involving all regional and national players. In this context, the establishment of the National Council for Science, Technology and Innovation Policy ([89]) may be an important step towards improving the still weak coordination between the national and the regional levels in a coherent innovation system. High fragmentation in public research performance, with more than 150 public institutions undertaking R&D, and inefficient technological transfer policy remain issues to be tackled.

The government is taking steps to improve the R&I environment. Under 'specific support' provided under the European Commission's Horizon 2020 Policy Support Facility ([90]) recommendations began to be drawn up in 2016 to create an environment conducive to the growth of technological start-ups. In September 2016, the European Investment Fund and the Romanian Ministry of European Funds launched a EUR 59.3 million ([91]) *Competiveness fund-of-funds* to finance SMEs via several financial intermediaries.

22.2. Additional references to R&I

[3.4.4 Business environment, p.30]

Administrative procedures for business and the public are being simplified. During 2016 the Government adopted several emergency ordinances to simplify administrative procedures and facilitate relations between citizens and the public administration. This new legislation streamlines the

([89]) The National RDI Strategy 2014-2020, provides for the creation of a consultative body responsible for coordination and harmonization of R&I policy, under the coordination of the prime-minister

([90]) https://rio.jrc.ec.europa.eu/en/policy-support-facility/

([91]) Funded by the European Regional Development Fund.

process of submitting forms and promotes widespread use of email. In addition, in January 2017 the new government passed measures in support of entrepreneurship and simplification such as an increase of the threshold for micro-enterprises, an exemption of profit tax for R&D companies, and the elimination of 102 fees and duties.

[3.3.4 Education and skills, p.24]

A high share of students do not possess an adequate level of basic skills. The 2015 OECD Programme for International Student Assessment (PISA) found high levels of low achievement in basic skills (Graph 3.3.4). More than half of students from the lower socio-economic quarter are underachievers, indicating that socio-economic status has a large impact on student performance. Underachievement is also high in all other socio-economic quarters and the share of top performers in science is low. This risks hindering the country's future innovation potential and affect its long-term competitiveness. Efforts were made to revise the curricula towards competence-based learning, but results will take a long time to become visible ([92]).

([92]) Following the revision of the curricula for primary education (grades 1-4), a new curriculum for grades 5-8 is set to be phased in from September 2017. Plans to reform the curricula for high-school education have been delayed.

23. Slovakia

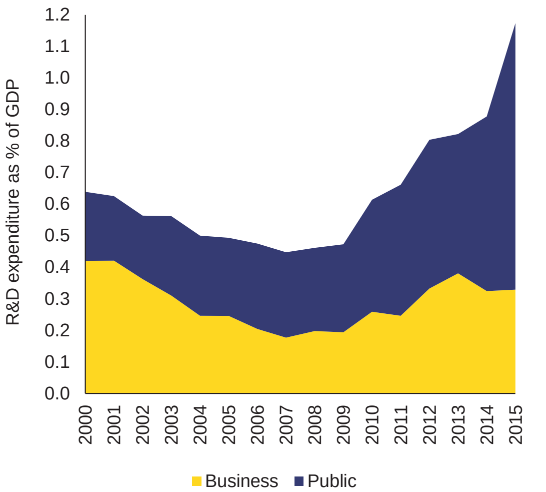
23.1. Executive Summary

Small and medium-sized enterprises can play a vital role in Slovakia's economic diversification, while innovation policy and resource efficiency continue to present challenges. Slovakia's relatively dynamic small and medium-sized enterprises sector is being granted greater policy attention, including through a new Act on the promotion of small and medium-sized enterprises and an action plan to support entrepreneurship. Regulated professions face comparatively high restrictions. Meanwhile, and in spite of rising R&D intensity, Slovakia's science base is still ranked below that of most other Member States. Business R&D spending and cooperation between the public sector, research institutions and business are stagnating. Policy measures supporting research and innovation are not effective and reforms are proceeding slowly. Finally, Slovakia's energy efficiency is relatively low and energy dependence is high. The electricity market is blighted by distortions and hurdles for new providers. Municipal waste management continues to to give cause for concern.

23.2. Research and Innovation

In spite of rising public R&D expenditure, business R&D investment remained unchanged at relatively low levels in recent years. Overall, R&D spending increased from an annual average of 0.83 % of GDP in 2012-2014 to 1.18 % in 2015 (EU average: 2.03 % of GDP). Public R&D spending accounted for the entire increase in recent years (Graph 3.4.2) and was driven by the greater use of EU funds; however, it remains to be seen if public R&D investment can be maintained at its 2015 high as calls to draw funds from the new operational R&I programme are only just being launched. Business R&D expenditure remained virtually unchanged at 0.33 % of GDP in 2015, one of the lowest levels in the EU and well below Slovakia's indicative target of 0.8 % for 2020.

Graph 3.4.2: **R&D intensity in Slovakia in 2000-2015**



Note: Excludes private non-profit R&D spending.
Source: European Commission

Slovakia's science base still ranks at the low end compared with other EU Member States[93]**.** The low volume of business R&D activities in the country is also reflected in the low proportion of researchers employed by business relative to total employment (1 % in 2014, vs an EU average of 3.6 %). While Slovakia saw an improvement in its overall innovation performance between 2012 and 2014 according to the innovation index of the European Innovation Scoreboard, it still underperforms by EU standards and is classed as a moderate innovator (European Commission, 2016d). Poor links between the public sector, research institutions and businesses are evident from the low number of public-private co-publications per million inhabitants (8.1, EU: 33.9) and the below-EU-average scores in indicators for commercial and non-commercial research outputs in Slovakia.

Upgrading Slovakia's Research and Innovation (R&I) performance requires improvements in the governing policy framework. The slow progress made towards a more efficient and attractive R&I system risks hampering Slovakia's transition from a cost-based to a more innovation-driven growth model. The underperformance of the public research system also seems to be linked to inefficiencies in public funding. This constitutes a bottleneck to growth, and the lack of sufficient public-private cooperation is hampering business R&D investment[94]. The main challenges are linked to the need to improve governance in R&I and to increase coordination among governing institutions for developing and implementing R&I policy.

Support measures for business R&I exist, but some remain relatively small-scale. Several national initiatives such as the development of clusters and innovation vouchers to foster cooperation between the research and business sectors received only limited funding. A special 125 % tax super-deduction for private companies investing in R&I entered into force in January 2015. However, it is not used extensively by companies, which claim that the eligibility criteria are unclear and the scheme is not generous enough[95]. (38) Most of the measures in the pipeline are to be financed by the R&I Operational Programme, but many have been delayed and some calls for demand-driven projects were only published in late 2016.

Progress on implementing R&I reforms is slow. The national smart specialisation strategy adopted in November 2013 aims to identify strategic specialisation areas and supporting measures, and to put in place a modernised R&I governance structure. However, the action plan to implement the strategy was again postponed. In 2016 the Slovak Academy of Sciences launched an evaluation of its institutions with a view to improving the quality of research. The conversion of the Academy into a public organisation, which was intended to improve cooperation with the business sector, has been postponed. These continual delays hamper the effective and timely implementation of the reforms envisaged and slow down investment from the Structural Funds.

Further general plans in support of R&D are being developed. The Slovak government adopted a decision in 2016 on the launch of three new programmes to be implemented by the Slovak Research and Development Agency in 2016-2019 with a budget of EUR 92 million. The programmes are linked to the national smart specialisation strategy and the Horizon 2020 European funding programme. They

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([93]) For instance, in 2013 Slovakia ranked 23rd among EU Member States on the 'share of national publications within the top 10 % most-cited publications worldwide' indicator (5.5 vs EU average of 10.5), with no significant progress made between 2007 and 2013.

([94]) For instance, Slovakia ranks 19th among EU Member States on the 'public-private co-publications per million population' indicator (8.1 vs EU average of 34), with no progress made between 2008 and 2014.

([95]) E.g. in the Czech Republic, companies can deduct 200 % of R&I expenses.

aim in particular to provide support to business R&D, including through cooperation with public research organisations, and to support projects which received high scores in the Horizon 2020 evaluation but were not allocated funding. Scientists will receive assistance with preparing proposals for grants from the European Research Council.

23.3. Additional references to R&I

[Sectoral policies , Small and medium-sized enterprises (SMEs) and diversification, p.31]

A new national business centre is planned to support enterprises. The centre aims to provide comprehensive support to entrepreneurs and SMEs. Pilot testing of the centre got under way in mid-2016 but full operation and the replication of business centres in the regions have been postponed due to delays in launching the relevant national project financed from the Operational Programme for research and innovation (OP RI). For the very first time, Slovakia received a substantial financial allocation of EUR 400 million from the ESIF for dedicated support of SMEs. Although the first calls have been launched, a number of national projects from the Operational Programme for research and innovation (R&I) to promote the growing, scaling-up, internalisation and competitiveness of SMEs have not yet materialised.

[Box 2.1: Contribution of the EU budget to structural change in Slovakia, p.13]

(…) ESI Funds supported progress on a number of structural reforms in 2015 and 2016 via ex-ante conditionalities and targeted investment. Examples include the timely transposition of the EIA directive in the amended Water Act and the development of the transport plan, which has facilitated the preparation of realistic and mature road and railway projects. These reforms have prepared the ground for better implementation of public investment projects in general, including those financed from national sources and from the other EU instruments mentioned above. The fulfilment of ex-ante conditionalities is on track, except for in research, technological development and innovation...

(…) Relevant CSRs focusing on structural issues informed the design of the 2014-2020 programmes. These include activities aiming at strengthening the administrative capacity of authorities dealing with ESI Funds, improving the energy efficiency of public and residential buildings, and promoting cooperation between academia, research and the business sector. The latter is done by supporting research and development activities in enterprises, transfer of high value-added technology, and implementing innovation measures…

24. Slovenia

24.1. Research and Innovation

Improvements in the efficiency of R&D spending could help to increase productivity and potential growth. Although R&D investment as percentage of GDP is above the EU average, the efficiency of spending is low. This is due to the low performance of the public research system. ([96]) Some initial steps have been taken to foster openness of the public research system and its cooperation with businesses. ([97]) In addition, Slovenia lacks an effective governance structure for R&I in view of weak coordination across responsible departments and collaborative links between major stakeholders in innovation policy. The implementation of policy reforms in line with the research and innovation strategy appears to be on hold. Moreover, the new Law on R&D is not yet in place.

24.2. Additional references to R&I

[3.2 Education and skills, p.37]

Reform of Slovenia's higher education system has been debated for a number of years and the latest initiative is to launch reforms in two phases. The first phase is a revision of the Higher Education Act from November 2016, which introduces important changes to quality assurance and financing of higher education (European Commission, 2016b). The provision to internationalise higher education by allowing study programmes in foreign languages did not get the necessary political support. The second phase involves a more fundamental reform via a new Higher Education Act in 2017. This will primarily aim to regulate the system of financing higher education staff with a view to establishing an efficient balance between pedagogical, research and project activities at higher education institutions. The reform may reduce funds for some institutions, therefore the consultation process will likely be challenging.

([96]) This is evidenced for instance by a low score on the indicator "Share of scientific publications within the top 10 % most cited scientific publications worldwide" (7.4% in Slovenia compared to 10.5% at the EU average).

([97]) Specific Support to Slovenia under the Horizon 2020 Policy Support Facility (European Commission DG RTD 2016).

25. Spain

25.1. Executive Summary

Innovation performance remains weak, despite some modest improvements. Expenditure for research and development as a share of GDP and innovation performance have both continued to decline. A complex governance framework and lack of an evaluation culture weigh on the effectiveness of R&I support. Despite some bright spots, coordination of regional and national innovation policy is still limited. Obstacles to cooperation between universities and businesses remain, in particular regarding technology transfer and the inter-sectoral mobility of researchers.

The business environment hampers efficient resource allocation and productivity growth. The average cost of starting a business is higher than in most Member States and varies substantially across regions. Shortages of digitally skilled labour slow down the integration of digital technologies into the economy. The implementation of the market unity law only made minor advances in 2016 and regulation of professional services remains restrictive and the corresponding mark-ups high. Venture capital remains underdeveloped, even though public support instruments contributed to stimulating its supply.

25.2. Research and Innovation

Low investment in research and innovation (R&I) is contributing to low levels of total factor productivity. The Spanish economy started growing again in 2015; however, the increased external competitiveness which is partly driving this upturn is based largely on cost advantages. Maintaining growth and competitiveness will require raising productivity, which since the onset of the financial crisis primarily improved through low productive firms exiting the market. For sustained productivity as well as employment growth, boosting total factor productivity is essential. One way to do this is to reinforce R&I investment, an area where Spain trails behind.

Spain's innovation performance continues to decline relative to the EU average. Spain remains a "moderate innovator" (the second-lowest category) in the European Innovation Scoreboard 2016, but its gap to the EU average has been widening since 2013 (20^{th} out of 28). Spain's relative performance is weakest in the following dimensions: business R&D and innovation investment; SMEs' innovation activity; and knowledge transfer and collaboration. Both business and public R&D expenditure decreased continuously, from 1.35 % of GDP in 2010 to 1.22 % in 2015. The public budget for R&D (GBAORD) has dropped by 30 % between 2010 and 2014. However, indirect support in the form of tax credits has gained importance, both domestically and compared to other OECD countries. GBAORD in 2016 also indicates a trend reversal. Nonetheless, budgets remain at 2006 levels, and reaching the 2 % national R&D intensity target by 2020 overall appears highly unlikely. The low innovation performance outlined above coincides with a level of private R&D expenditure far below the EU average (0.64 % of GDP vs. 1.3 %), which has moreover been slowly declining since 2008.

Regional administrations play an important role in Spanish R&I policy, and differences in performance are large. Regional innovation capacity varies strongly on some dimensions. This is most evident for employment in higher-technology manufacturing and knowledge-intensive services, and sales of innovative products and services by SMEs, where there are innovation leaders as well as modest innovators among Spain's regions (Hollanders *et al*., 2016b). Some R&I policy responsibilities are devolved to regional governments and regional funding accounts for around 60 % of public R&D

funding (ERAC, 2014). Regional R&I policy consists of a wide range of tools and incentives to promote business-driven innovation, technology transfer and knowledge circulation. Spanish regions have designed and adopted smart specialisation strategies in the context of the programming of the European Structural and Investment Funds (ESIF). However, national and regional policies for R&I are not operating in full synergy. While some regional strategies focus on the development of genuine regional strengths, others merely replicate national-level priorities, carrying a risk of duplication.

Weaknesses in Spain's governance framework for research and innovation (R&I) hamper the effectiveness of public R&I support. **Weaknesses in Spain’s R&I governance framework, especially on the regional level, hamper the effectiveness of public R&I support**. The complexity of the R&I governance framework and the lack of coordination persisting, despite efforts made, between regional initiatives as well as between central and regional-level actions prevent realising those potential synergies. Nevertheless, there are examples of successful coordination, such as the agreements between central and regional administrations on Scientific and Technological Infrastructures (ICTS), and on joint innovative public procurement initiatives. The participation of some Spanish regions in transnational smart specialisation initiatives may also benefit inter-regional coordination. Another critical aspect of Spain's weak R&I governance is the lack of systematic evaluations at national and regional level of the effectiveness of R&I support tools, as it impedes the development of more effective R&I programmes.

Public-private cooperation in research and innovation remains weak. In 2014, the level of business-financed public R&D declined further, reaching 0.034 % of GDP (compared to an EU average of 0.052 %), and the number of public-private scientific co-publications per million population dropped to 16.3 (EU average: 34). The Offices for the Transfer of Research Outcomes (‘OTRIs’) lack institutional support and experience in knowledge management. Excessive bureaucracy and heterogeneity hamper effective knowledge transfer. Inter-sectoral mobility of researchers is low due to weak incentives for public sector research personnel to engage in public-private cooperation activities, the low number of firms carrying out R&D, and the rigidity of universities’ administrative procedures in this respect. These circumstances are reflected in the low share of researchers in total staff employed by private companies (2 % compared to an EU average of 3.6 %). The government has approved tax incentives for hiring research staff and is exploring the combination of vocational training with university education (see Section 4.3.2). An industrial PhD scheme has been established in 2014 and should soon produce the first graduates. A comprehensive national policy on knowledge transfer is however still missing. In 2016, the government announced measures to boost the contribution of the private sector to public research through sponsorship and patronage.

Venture capital (VC) has a large potential in Spain for supporting innovation, including by magnifying the impact of public funding. ICT and digital projects accounted for 81 % of new VC investments in Spain in 2015. The largest recipient sectors were life sciences, communications, and computer/consumer electronics. There has been a noticeable increase in the number of new VC entities, with 30 new venture capital funds entering the Spanish market in 2015. This growth is driven by the ongoing economic recovery as well as government initiatives to foster venture capital, most notably through the establishment of a public fund of funds ("Fond-ICO Global"). Since 2013, Fond-ICO has invested EUR 256 million in private VC funds, which in turn have invested EUR 793 million in Spanish companies.

Nevertheless, venture capital supply remains underdeveloped. Despite sound growth since 2014, venture capital investment in Spain remains below its pre-crisis level, and is very low compared to most Member States in terms of GDP share. In particular, Spanish VC funds stand out by their small volumes (EUR 38 million on average compared to EUR 71 million EU-wide). One reason is the lack of attractive opportunities for investors to exit from their VC investments: Spain's public stock market for small firms is not very dynamic, which makes IPOs of VC-backed firms very rare.

There was some improvement in setting priorities for the allocation of public R&I funding, but the use of performance-based criteria remains limited. Funding programmes such as the 'María de Maeztu' and 'Severo Ochoa' initiatives under the 'institutional strengthening' pillar of the national R&I plan provide for a funding increase to reward scientific excellence and proven impact. These programmes can be a stepping stone for a wider use of performance-based funding. A further positive development (in line with the 2014 ERAC peer review of Spain's R&I system) is the prioritisation of available public funding towards global societal challenges in the 2016 calls for proposals under the national R&I plan. Having been legally incorporated in 2015, the State Agency for Research responsible for managing the allocation of central government R&I funding is expected to be fully operational in 2017.

25.3. Additional references to R&I

[Box 2.1: Contribution of the EU budget to structural change in Spain, p.11]

ESI Funds helped implement a number of structural reforms in 2015 and 2016 via ex-ante conditionalities and targeted investments. Examples of these reforms include improving the participative governance mechanisms to incentivise cooperation between universities, firms and research institutions and to increase research and innovation investment by the private sector (all this has been made possible through improving the quality of the RIS3 for all regions). The transposition of the Energy Efficiency and Buildings Directives enabled more efficient and cost-effective investments in energy efficiency. These reforms have prepared the ground for better implementation of public investment projects in general, including those financed from national sources and from the other EU instruments mentioned above.

The Relevant CSRs focusing on structural issues were taken into account when designing the 2014-2020 programmes. These included strengthening research, technological development and innovation, increasing SMEs access to finance, fostering sustainable transport infrastructures, improving labour market access and promoting social inclusion. Spain has also received support from the Youth Employment Initiative to combat youth unemployment. Nearly 277 000 young people have participated in it of which 53 500 are in employment, education or training after the support from this initiative has ended.

In addition to the challenges reflected in past CSRs, **the ESI Funds address wider structural obstacles to growth and competitiveness.** The Funds contribute to increasing the share of R&D expenditure co-financed by the private sector with a view to reaching 60 % and to facilitating that 25 % of Spanish firms with more than ten employees incorporate technological innovation; improving the coverage of fast and ultrafast broadband for 100 % of households (30 Mbps internet) and 50% of the population (100 Mbps); fostering entrepreneurship and start-ups and making firms more competitive and better able to engage in higher added-value activities (including through ICT), with a view to ultimately increase their presence in international markets. And ease access to finance mainly by channelling EUR 1.5 billion through financial instruments. These funds will also contribute to increasing the employment rate, reducing early-school leaving and reducing the amount of people at risk-of-poverty or exclusion.

[4.3.2 Education, p.41]

Spain is taking measures to foster cooperation between universities and business. Spain had the highest number of applications to the Knowledge Alliance EU grants in 2016, which shows the interest of education and research institutions for university-business cooperation. However, the reduced mobility of students and academic staff, lack of incentives to engage with businesses in teachers' career progression schemes and the rigidity of university governance remain significant obstacles to cooperation and innovation. The government has approved a number of fiscal incentives to help businesses to expand their limited innovation capacity by encouraging them to hire research staff and to offer apprenticeships to university and VET students. The government envisages expanding the dual model to higher education and some universities have already signed agreements with companies to develop dual training in engineering programmes.

[4.4.1 External sustainability and competitiveness, p.47]

Faster productivity growth and rebalancing towards higher value added sectors could help to sustain export growth, but also moderating import growth. With cost advantages hinging increasingly upon productivity increases, promoting innovation and supporting research and development is becoming more central to ensuring competitiveness of the Spanish economy. It would furthermore pave the way towards higher quality levels and a shift to higher technology content of products, reducing the pressure to compete primarily on costs.

[4.4.2 Productivity, pp.47-48]

Low productivity is partly explained by Spain's large share of small companies and their low productivity compared to other large MS. In 2013, 95% of Spanish companies were micro enterprises (below 10 employees), 13 percentage points more than in Germany. Small companies tend to exhibit lower productivity than large ones, mainly due to scale effects and lower investment in R&D limiting their absorptive capacity for innovation.

Restrictive business regulation and weaknesses in innovation policy contribute to slowing down firm and productivity growth. Tax and other regulations applicable to large companies may constitute disincentives to Spanish firms to grow beyond certain turnover and personnel thresholds. Only some of those have been reduced by recent reforms (European Commission 2016e). Firms' inter-regional expansion is hampered by a still somewhat fragmented national market (see section 4.4.3). Liberalisation of professional services, whose regulation in Spain is relatively restrictive (see next section), has also been shown to have positive effects on allocative efficiency and thus within-sector productivity. Given the interlinkages of this sector with the rest of the economy, knock-on effects on other sectors are also likely to be significant (Canton et al., 2014). Finally, business R&D is relatively weak (see section 4.5.1), limiting not only firm-internal innovation to enhance productivity, but also their absorptive investment capacity to benefit from R&D spillovers.

[4.4.3 Business environment, p.49]

Firms' innovation activity is still below pre-crisis levels, and the share of high-growth innovative enterprises (HGIE) in the economy remains low. Spain's industrial structure is characterised by a high share of SMEs operating in low-tech sectors (Fernández-Zubieta et al., 2016), and the number of enterprises active in innovation has decreased from 35 000 to around 15 000 between 2008 and 2015 (COTEC, 2016). HGIEs tend to have higher total factor productivity than average SMEs (Hölzl, 2016)

Although HGIE growth rates in terms of turnover and employment have picked up in recent years, fewer companies experience high-growth periods in Spain than on average in the EU (0.08 % vs. 0.16 %; Costa et al., 2016).

[Box 4.4.1: Investment challenges and reforms in Spain, p.51]

Tax rates and regulation, as well as low equity supply, hamper investment in innovation and a move towards higher value added activities. Spain continues to have one of the highest effective marginal corporate tax rates in the EU. The debt bias in the taxation of corporate financing discourages equity investment and the deepening of equity markets. Although the venture capital industry is becoming increasingly dynamic, venture capital supply levels are still far below those in other large EU Member States (Section 4.5.1). This hinders investment in high and medium-high tech innovation, as such business projects depend on equity capital due to their often high-risk nature. Tax incentives for hiring research staff have been introduced, which may boost companies' innovation capacity.

26. Sweden

26.1. Executive Summary

The economy benefits from a broadly favourable business environment, although issues remain in a few specific areas. The country performs well in terms of efficient public administration, access to finance for small and medium-sized enterprises, and innovation and internationalisation by businesses. The public procurement system is generally efficient and well-functioning, although in specific instances it is not fully transparent. Despite general success in promoting digitisation as well as research and innovation, some indicators point to a slowdown in recent years.

Some barriers to investment and long-term growth remain. In particular, construction investment is held back by several interlinked housing supply bottlenecks. Investment by small and medium-sized enterprises is in some cases constrained by insufficiently transparent public procurement procedures. Finally, while the cooperation between academia and large businesses seems to work quite well, collaboration with small and medium-sized enterprises is not at the same level, thus inhibiting optimal use of their innovative potential and weighing on their R&D investments.

26.2. Research and Innovation

Sweden is one of the world's most innovative economies. The country benefits from an excellent science base, highly qualified human resources as well as from the presence of many internationally competitive firms both in the manufacturing and services sectors. Nevertheless, a slight decline has been registered in recent years in both innovation performance (European Innovation Scoreboard index: from 0.722 in 2013 to 0.704 in 2015 ([98]) and in business R&D intensity (from 2.59 % in 2008 to 2.27 % in 2015).

For a small, open, knowledge-based economy like Sweden, it is important to remain attractive for domestic and foreign business investment in research and innovation. So far Sweden's innovation model has mainly relied on a limited number of multinational enterprises and has not fully exploited the potential of innovative SMEs and start-ups. The economy's competitiveness and innovation capacity is somewhat constrained some insufficient framework conditions for SMEs, by a lack of collaboration between SMEs and academia and faces the risk of an insufficient supply of highly-skilled human resources.

In terms of innovation-friendly framework conditions for SMEs, there remains scope to further improve the flexibility of product and services markets. Sweden's performance in the barriers to entrepreneurship and the barriers to trade and investment sub-indicators of the OECD's product market regulation indicator ([99]) (PMR) is not outstanding, probably due to the complexity of its regulatory procedures. Overall, the country only ranks 19th at EU level on the PMR: improvements in this area may further reduce the obstacles that innovative SMEs encounter when starting and developing their activities.

([98]) https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

([99]) http://www.oecd.org/eco/growth/indicatorsofproductmarketregulationhomepage.htm

The existing open living labs culture and research and innovation (R&I) foundations system are essential to promote collaboration between universities and SMEs. Initiatives such as the five Innovation Partnership Programmes ([100]) are welcome as they target systemic and challenge-driven innovation based on strong socio-political consensus with long-term goals. They are usually driven by industry actors but also involve key players of the R&I system. Their aim is to create innovative solutions to strengthen competitiveness and leverage local-national lead markets to global markets.

There is a risk that the economy's innovation performance will be hampered by an insufficient supply of highly-skilled human capital, in particular in science and engineering. The number of new graduates in science and engineering per thousand 25-34 year-olds declined from 16.8 in 2012 to 15.5 in 2014, positioning Sweden below the EU average (17.6). In addition, despite the fact many enterprises invest in ICT training for their employees, there is a shortage of employees with specialist skills in this area. This is in part linked to gradually declining educational performance: in terms of new tertiary graduates in computing per thousand 25-34 year-olds, Sweden only ranks 16th in the EU. If these trends are not reversed, Sweden may suffer from a shortage of highly-skilled human resources in science, technology and engineering in the future. This could negatively affect the productivity and innovation performance of the country, ultimately becoming a barrier to R&D investments.

The government has launched several initiatives to further improve innovation and competitiveness. The new 'Smart industry' initiative launched in 2016 aims to boost competitiveness and innovation performance in the years to come. In addition, the new Research Bill 2017-2020, which was submitted to Parliament in November 2016, is going to support both basic and applied research as well as human resources development through an additional budget of around SEK 2.8 billion (EUR 0.3 billion) in 2017-2020. A big share of this budget will go to universities (SEK 1.3 billion or EUR 0.14 billion) to improve researchers' careers and boost excellence in research, make universities engage in more external collaboration to tackle societal challenges, and promote gender balance.

26.3. Additional references to R&I

[4.4.1 External competitiveness, p. 42-43]

The declining export market share does not suggest any underlying fall in competitiveness. As explained before, it primarily reflects broader trends affecting many export-focused industrialised economies. This conclusion is further supported by cost competitiveness metrics: the real effective exchange rate has depreciated by about 8 % over the 3 years ending 2015 (mainly reflecting the weakening of the Swedish krona), and unit labour costs have evolved broadly in line with that of the euro area in recent years. Sweden also does well in terms of non-cost competitiveness, including via an attractive business environment and a generally strong R&D and innovation performance (European Commission, 2016a, p. 17). There is therefore no indication that the falling export market share represents deeper competitiveness problems.

[4.4.3 Business environment, p.43]

([100]) The specific partnership programmes included in this initiative are (i) next generation's travel and transport, (ii) smart cities, (iii) circular and bio-based economy, (iv) life sciences and (v) connected industry and new materials. Further details are available on: http://www.government.se/articles/2016/07/innovation-partnership-programmes--mobilising-new-ways-to-meet-societal-challenges/

Companies benefit from a high-quality and competitive business environment. In several areas the country stands out, including public administration, access to finance, innovation and internationalisation by businesses. The authorities monitor progress and regularly evaluate policy measures to ensure that challenges are identified and dealt with early on.

27. United Kingdom

27.1. Research and Innovation

Public R&D investment is flat and remains low by EU standards, though domestic funding is set to rise. Underinvestment risks jeopardising the UK's scientific excellence and impact its long-term economic growth potential. Public investment in R&D has been stagnant in recent years, having declined from its 2009 peak (0.63 % of GDP) to 0.55 % of GDP, lower than in most EU Member States. This has not so far diminished the UK's scientific excellence, which continues to rank highly in the EU context, but there could be a lagged impact. The 2016 Autumn Statement announced an increase in the annual science budget of GBP 2 billion (EUR 2.4 billion) by 2020-21, linked to a new Industrial Strategy challenge fund. The UK's research and innovation system faces uncertainty as a result of the decision to withdraw from the EU. HM Treasury has committed to underwrite funding for UK participants in Horizon 2020 projects bid for while the UK remains in the EU, as well as the EUR 1.4 billion (GBP 1.14 billion) to be co-invested in RTDI projects through the European Regional Development Fund (ERDF) by 2020 (see Box 2.1).

Private R&D investment has been increasing in recent years but remains below the EU average. Private R&D investment was 1.12 % of GDP in 2015, compared to an EU average of 1.3 %. The UK is also below the EU average for in-house innovation by SMEs and patent applications (European Innovation Scoreboard, 2016). This reflects, to a certain extent, the UK's specialisation in services. Manufacturing is slightly over 10 % of UK GDP, one of the lowest shares in the EU. Knowledge-intensive services made up 45.5 % of the UK economy in 2014, higher than the EU average, and the UK performs well in exporting them (European Commission, 2016e). The proposed new Industrial Strategy Challenge Fund (see above) can help support R&D, particularly in manufacturing.

Building stronger science-business linkages can ensure that the excellent output of the public research base translates into the creation of new firms focusing on high-tech activities. The UK ranks above the EU average in terms of the amount of public-private scientific co-publications, although the number of these publications has fallen since 2010. The amount of public research financed by the private sector is well below the EU average. The UK's Catapult Centres aim to be world-leading facilities for connecting businesses with the research and academic communities. The creation of UK Research and Innovation, bringing together the Research Councils, Innovate UK and the science and innovation functions of the Higher Education Funding Council for England, can help improve the rationale and complementarity of different government schemes.

27.2. Additional references to R&I

[3.5. Investment and Productivity, p.32-33]

Nevertheless, a number of persistent structural problems weigh on investment, the efficient allocation of resources and hence productivity. The UK has the lowest capital stock of all G7 nations (HM Government, 2017). There are shortcomings in infrastructure (Section 3.6), the workforce has significant gaps in basic and technical skills (Section 3.4), the land market is very tightly regulated (Section 3.2) and there is evidence that the quality of management in UK firms and the dissemination of technological innovations could be improved (Bloom *et al.*, 2016). The latter contributes to the UK's long tail of low-performing firms (Productivity Leadership Group, 2016).

The government is focused on the need to boost productivity growth but this will be challenging. An Industrial Strategy green paper published in January 2017 (HM Government, 2017) summarised the UK's growth and productivity challenges and set out the government's approach to tackling these and building on the UK's existing strengths. The green paper is based around a 10 pillar strategy and emphasises the importance of long-term investment in economic capital, including infrastructure, skills and knowledge, promoting a dynamic economy that encourages innovation, and measures to help specific sectors and places. In the 2016 Autumn Statement, the government announced a new 'National Productivity Investment Fund' (NPIF). This will provide a total of GBP 23 billion (EUR 28 billion) of additional funding between 2017-18 and 2021-22 for housing, transport, digital communications and R&D.

European Commission

ERA PROGRESS REPORT 2016

COUNTRY SNAPSHOT

Austria

Written by Science Metrix
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Research and Innovation

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COUNTRY SNAPSHOT

Progress of Austria towards ERA Roadmap

	Indicator	Performance					Growth				
	Name	**Reference year**	**Score**	**Cluster**	**Lead/Gap (Δ %)**	**EU-28**	**Reference Period**	**CAGR**	**Trend (2005–2015)**	**Lead/Gap (Δ % pt)**	**EU-28**
Across Priorities	**1 – Adjusted Research Excellence**	**2013**	**48.6**	**2**	**9**	**44.4**	**2010–2013**	**2.6%**		**-3.8**	**6.4%**
	2A – GBARD to transnatl coop (EUR/researcher)	**2014**	**6,958**	**1**	**178**	**2,507**	**2010–2014**	**3.4%**		**-4.3**	**7.8%**
	2B – Roadmap for ESFRI projects	**National roadmap implemented in 2014, ESFRI projects identified**									
	3 – EURAXESS job ads per 1 000 researchers	**2014**	**71.3**	**2**	**52**	**47.0**	**2012–2014**	**14.0%**		**6.2**	**7.8%**
	4 – Share of women among Grade A HES	**2014**	**21.5%**	**3**	**-8**	**23.5%**	**2007–2014**	**6.0%**		**2.6**	**3.4%**
	5A – Research institute–private collaboration	**2012**	**12.6%**	**2**	**73**	**7.3%**	**2008–2012**	**14.7%**		**11.2**	**3.5%**
	5A – Higher education–private collaboration	**2012**	**20.9%**	**1**	**74**	**12.0%**	**2008–2012**	**1.7%**		**0.4**	**1.3%**
	5B – Share of papers in Open Access (Total)	**2014**	**53.3%**	**3**	**2**	**52.2%**	*Not computed*				
	6 – Collab papers w/non-ERA per 1 000 researchers	**2014**	**57.7**	**2**	**14**	**50.7**	**2005–2014**	**2.9%**		**-1.2**	**4.1%**
	Headline Composite	2016	56	2	12	50	*Not computed*				
Priority 1	**Adjusted Research Excellence [c]**	**2013**	**48.6**	**2**	**9**	**44.4**	**2010–2013**	**2.6%**		**-3.8**	**6.4%**
	GBARD as share of GDP [c]	2014	0.804%	2	20	0.671%	2008–2014	2.8%		3.3	-0.5%
	European Innovation Scoreboard	2015	0.591	2	13	0.521	2008–2015	0.2%		-0.5	0.7%
	GBARD as share of government expenditures	2014	1.53%	2	10	1.39%	2005–2014	2.2%		3.0	-0.8%
	R&D tax incentives as share of GBARD	2013	15.0%	2	32	11.4%	*Not computed*				
	Share of GBARD allocated on project basis	2014	28.2%	*Not computed*			2009–2014	0.3%		*Not computed*	
	Patent applications per 1 000 researchers	2013	36.8	1	24	29.8	2005–2013	-1.1%		0.2	-1.2%
	Researchers per 1 000 active population [c]	2014	9.59	2	30	7.40	2005–2014	3%		0.8	2.4%
	Publications per 1 000 researchers [c]	2014	567	2	18	481	2005–2014	-0.3%		-1.9	1.6%
	Priority 1 Composite	2016	62	2	24	50	*Not computed*				
Priority 2	**A – GBARD to transnatl coop (EUR/researcher) [c]**	**2014**	**6,958**	**1**	**178**	**2,507**	**2010–2014**	**3.4%**		**-4.3**	**7.8%**
	A – Collab papers w/ERA per 1 000 researchers [c]	2014	132.3	1	101	65.7	2005–2014	2.3%		-1.3	3.6%
	A – Public-to-public partnerships (EUR/researcher) [c]	2014	1,610	2	215	512	2012–2014	49.9%		7.8	42.1%
	A – Co-invention rate w/ERA partners [c]	2011–13 [R]	23.6%	2	81	13.0%	2007–2013 [R]	0.0%		0.5	-0.5%
	B – Roadmap for ESFRI projects	**National roadmap implemented in 2014, ESFRI projects identified**									
	B – Participation in developing ESFRI projects	2016	0.0%	3	-100	20.7%	*Not computed*				
	B – Participation in operational ESFRI landmarks [c]	2016	27.6%	2	-9	30.2%	*Not computed*				
	Priority 2 Composite	2016	60	2	20	50	*Not computed*				

	Indicator	Performance					Growth				
	Name	Reference year	Score	Cluster	Lead/Gap (Δ %)	EU-28	Reference Period	CAGR	Trend (2005-2015)	Lead/Gap (Δ % pt)	EU-28
Priority 3	**EURAXESS job ads per 1 000 researchers [c]**	**2014**	**71.3**	**2**	**52**	**47.0**	**2012-2014**	**14.0%**		**6.2**	**7.8%**
	Open, transparent, merit-based hiring process [c]	2012	38.2%	3	-22	49.0%	*Not computed*				
	Share of doctoral students from EU countries [c]	2013	19.6%	1	166	7.4%	*Not computed*				
	Priority 3 Composite	2016	67	2	6	63	*Not computed*				
Priority 4	**Share of women among Grade A in HES [c]**	**2014**	**21.5%**	**3**	**-8**	**23.5%**	**2007-2014**	**6.0%**		**2.6**	**3.4%**
	Gender dimension in research content [c]	2011-15 (R)	0.98	3	0	0.97	2005-2015 (R)	-1.6%		-1.1	-0.5%
	Share of women among heads of HES institutions [c]	2014	23.5%	2	17	20.1%	*Not computed*				
	Share of women researchers [c]	2013	29.6%	4	-11	33.2%	2005-2013	2.3%		1.5	0.8%
	Share of women among PhD graduates [c]	2012	41.8%	4	-12	47.3%	2005-2012	-0.6%		-1.9	1.2%
	Priority 4 Composite	2016	40	3	-13	46	*Not computed*				
Priority 5	**A - Research institute-private collaboration [c]**	**2012**	**12.6%**	**2**	**73**	**7.3%**	**2008-2012**	**14.7%**		**11.2**	**3.5%**
	A - Higher education-private collaboration [c]	**2012**	**20.9%**	**1**	**74**	**12.0%**	**2008-2012**	**1.7%**		**0.4**	**1.3%**
	A - Share of public R&D funded privately [c]	2013	6.0%	3	-26	8.1%	2009-2013	-0.6%		-1.5	0.9%
	A - Public-private collab papers per capita [c]	2014	59.0	2	74	33.9	2008-2014	2.7%		2.9	-0.1%
	B - Share of papers in Open Access (Total) [c]	**2014**	**53.3%**	**3**	**2**	**52.2%**	*Not computed*				
	B - Share of papers in Open Access (Green)	**2014**	**45.9%**	**2**	**3**	**44.7%**	*Not computed*				
	B - Share of papers in Open Access (Gold)	**2014**	**23.6%**	**2**	**13**	**21.0%**	*Not computed*				
	B - National Open Access policies adopted	Yes, OA policies for research data [2012 (2)]; Yes, OA policies for scientific publications [2012 (2)]									
	Priority 5 Composite	2016	48	3	17	41	*Not computed*				
Priority 6	**Collab papers w/non-ERA per 1 000 researchers [c]**	**2014**	**57.7**	**2**	**14**	**50.7**	**2005-2014**	**2.9%**		**-1.2**	**4.1%**
	Share of doctoral students from outside EU [c]	2012	9.0%	3	-65	25.5%	2005-2012	3.6%		0.1	3.5%
	Licence & patent rev. from abroad, share of GDP [c]	2013	0.25%	3	-61	0.64%	2006-2013	7%		-2.2	9.6%
	Co-invention rate w/non-ERA partners [c]	2011-13 (R)	6.9%	4	-30	9.8%	2007-2013 (R)	4.4%		2.1	2.3%
	Priority 6 Composite	2016	43	3	-22	55	*Not computed*				

COUNTRY NARRATIVE

Austria's performance towards achieving the European Research Area (ERA) is above average, falling into Cluster 2 on the headline composite indicator and leading the EU-28 average by 12 %. Note that this composite score relies on the core high level indicators that were selected as being the most relevant in monitoring progress in achieving the ERA by the European Research Area and Innovation Committee (ERAC Secretariat, 2015). As such, it provides only a partial view of all the relevant and complementary dimensions captured by the indicators listed in the above table. The reader should be careful in extracting conclusions on overall performance, acknowledging the presence of variability across all the dimensions within and between priorities.

1. More effective national research systems

Austria's overall performance in Priority 1 falls into Cluster 2 for the priority composite indicator, as well as across the majority of indicators. Of note is the fact that Austria's performance exceeds that of the EU-28 average by between 9 and 32 % in this priority.

Austria is performing particularly well in the number of patent applications per 1 000 researchers, leading the EU-28 by 24 % and falling into Cluster 1 relative to the ERA average. Over the 2005-2013 period, however, this indicator saw a mean annual decline of 1.1 %.

Their annual growth rate in the adjusted research excellence indicator fell behind the EU-28 average by 3.8 percentage points, which is likely to constitute evidence that other countries are catching up as opposed to signaling a decrease in Austria's performance, which still saw positive growth (a compound annual growth rate [CAGR] of 2.6 % over the 2010-2013 period).

Austria allocated 28.2 % of GBARD on a project basis in 2014. This high level of funding allocated directly to institutions is consistent with some general trends reported in previous studies, and the significant participation that higher education organisations take as recipients of public funding for research and innovation (R&I) -related activities (Claeys-Kulik & Estermann, 2015; Jonkers & Zacharewicz, 2016). However one has to consider the slow growing but consistent trend towards the adoption of performance-based criteria to decide on organisational funding, including the recent changes made to the governance and operations of some of the main research funding organisations, including the Austria Science Fund (FWF) and the Austrian Promotion Agency (FFG) (Claeys-Kulik & Estermann, 2015; Jonkers & Zacharewicz, 2016). Since 2011 performance agreements are also applicable to institutional funding granted to the Austrian Academy of Sciences (ÖAW) - the largest non-university research organisation in the country - and more recently (2015) to the Institute of Science and Technology (IST) Austria; these performance agreements include defined indicators to measure performance.

Austria is one of the ERA countries where public investments in education and research has increased in spite of a turbulent external economic environment and a general drive of European governments to adopt budget consolidation measures (Schuch & Gampfer, 2016). Public investments in research and development (R&D) were expected to grow in 2016, including competitive funding available to universities and the R&D tax incentive (Schuch & Gampfer, 2016). Austria's GBARD as a share of gross domestic product (GDP) and as a share of government expenditures both exceeded the annual growth rate in the EU-28 over the reference period, by 3.3 and 3.0 percentage points, respectively. Notwithstanding the positive dynamics in GBARD relative to GDP, the overall economic environment continues to affect the likelihood that Austria will reach its EU2020 target of an R&D intensity of 3.76 % relative to GDP (Eurostat, 2016; Schuch & Gampfer, 2016).

2. Optimal transnational co-operation and competition

Austria performs well in Priority 2 overall with their priority composite indicator score falling into Cluster 2 and exceeding the EU-28 average by 20 %. Austria's performance was particularly strong in the Sub-priority 2a and some weaknesses were found in Austria's performance in the Sub-priority 2b.

a. Jointly addressing grand challenges

Austria's performance in Sub-priority 2a was well above the EU-28 average, falling into Clusters 1 and 2. Their strongest performance was in participation in public-to-public partnerships, which led the EU-28 average by 215 % in 2014 after having experienced strong growth from 2012-2014 (CAGR of 49.9 %). Austria systematically ranks among the top five countries in terms of EU-level initiative participation; this includes activities related to grand challenges, joint programming initiatives, ERA-NETs and others, often assuming leadership roles in terms of coordination and in the development of performance metrics for research (Niehoff, 2014; Schuch & Gampfer, 2016).

Despite this active participation in joint programming, Austria shows a general tendency to maintain a low proportion of R&D expenditures dedicated to R&D activities focused on societal challenges. In practice the agency that takes the largest responsibility in supporting this kind of R&D is the FFG. In 2013 and 2014, about 30 % of FFG's funding was allocated to thematic R&D programmes, including renewable energy as well as information and communications technologies (Schuch & Gampfer, 2016). It is worth noting that Austrian participation in pan-European R&I activities frequently involves the use of portable international grants building on the Lead Agency Model, which also aims to build mutual recognition of procedures and mechanisms to allocate public funding for research. This kind of collaboration is particularly strong with Germany and Switzerland (Schuch & Gampfer, 2016). In the near future, Austria's high level of participation in EU-level collaboration may face challenges due to financial constraints (Schuch & Gampfer, 2016).

Austria also led in the production of papers with ERA countries per 1 000 researchers, falling into Cluster 1 and exceeding the EU-28 average by 101 %. Despite the fact that Austria's performance in this indicator had increased over the 2005-2014 period (CAGR of 2.3 %), this was at a slower annual rate than in the EU-28 (CAGR of 3.6 %) suggesting that other countries are catching up to Austria's strong performance as opposed to Austria experiencing a decline in performance. This trend was also observed for the share of GBARD allocated to transnational cooperation.

b. Make optimal use of public investments in research infrastructures

Sub-priority 2b is among Austria's weaker performing areas, with performance scores falling into Clusters 2 and 3, and lagging behind the EU-28 average for both indicators. In 2014, however, Austria implemented their national roadmap and identified European Strategy Forum on Research Infrastructures (ESFRI) projects in which to participate, as well as some bottlenecks expected to limit long-term financial commitments related to EU-level research infrastructures. The country also has in place a Task Force responsible to guide the strategic development of research infrastructures, as mandated by the federal Strategy for Research, Technology and Innovation (Schuch & Gampfer, 2016). While Austria's score for ESFRI project participation fell into Cluster 3 (note that there is no fourth cluster for this indicator), the country participated in 27.6 % of landmark projects in 2016, earning them a corresponding Cluster 2 ranking.

3. An open labour market for researchers

Austria's performance in Priority 3 is above average, falling into Cluster 2 on the priority composite indicator and exceeding the EU-28 average by a small but positive margin of 6 %.

Austria's research organisations enjoy a high level of institutional autonomy in regard to human resource practices (Schray, Grther, Bertges, & Klee, 2014). Austria has a long tradition of adherence to the Scientific Visa Directives, while immigration laws are constantly being revised in order to enhance the country's attractiveness as base for a research career (Schuch & Gampfer, 2016).

Austria is particularly strong in the share of doctoral students coming from other ERA countries, ranking in Cluster 1 and exceeding the EU-28 average by 166 %. This positive performance can be explained, at least to some extent, by presence of specialised programmes to promote mobility and attract talent into Austrian organisations. At more advanced levels, the Austrian Programme for Advanced Research and Technology (APART) provided support to national and international students interested in conducting post-doctoral research for a period of up to three years (OAW, n.d.). In 2012 alone, some 30 % of the APART fellows conducted their research abroad; similarly, in 2010-2012, some 18 % of fellows were non-Austrian nationals (Deloitte, 2014). For the period 2015 and 2016, the program was suspended to allow for some review to its structure and may not continue in its current form (Personal communication from country representatives, September 2016).

Although Austrian universities are required by law to advertise for research positions internationally, these ads may not necessarily be in English language. Despite this fact, Austria is performing well in the number of EURAXESS job ads per 1 000 researchers, exceeding the EU-28 average and also exhibiting a higher rate of growth over the 2012-2014 period. Austria is actively combining a national portal and a network of EURAXESS service centres at different universities (Schuch & Gampfer, 2016). In addition to the wider dissemination of research positions via job portals such as EURAXESS, a series of connected services are also intended to enhance the attractiveness of Austria for researchers. For example, through ‘dual career services’ organised by several Austrian research organisations, the spouses or partners of newly appointed researchers can obtain individualised assistance to find employment opportunities in different regions, including the city of Vienna (Deloitte, 2014).

Performance was weaker in the area of open, transparent and merit-based hiring processes, which in 2012 fell 22 % below the EU-28 average and resulted in a Cluster 3 placement. Some concrete challenges remain particularly because of the lack of tenure track opportunities and weak career perspectives particularly for young researchers who are often faced with precarious contracting conditions (Schuch & Gampfer, 2016).

4. Gender equality and gender mainstreaming in research

Priority 4 is an area in which Austria has room for improvement, with a Cluster 3 classification on the priority composite indicator, two indicators falling into Cluster 4, and several indicators trailing behind the EU-28 average.

According to recent amendments to the Austrian Universities Act, universities should ensure that 50 % of governing bodies’ members are women; universities are also required to develop plans for the promotion of women and gender equality, and have provisions for adequate work-family balance (Schuch & Gampfer, 2016). Together with Cyprus and Finland, Austria is one of the few ERA countries that has implemented policies to monitor and rectify gender pay gaps in research (Lipinsky, 2014). Indeed, Austria’s Federal Government Equal Opportunity Act obliges all universities to provide an annual income report detailing any gender pay gaps at the institution; performance agreements have also been established between universities and the federal government that link progress in the promotion of gender equality and access to research funding (Lipinsky, 2014). At the level of funding organisations, including the FFG and FWF, gender and equal opportunity considerations are factored into funding competitions and into reporting mechanisms in a fashion consistent with the precepts of Horizon 2020 (BMWFW & BMVIT, 2015). Another progressive initiative to note is the Käthe Leichter awards for Women and Gender Studies and for Equality in the World of Work, which serve to reward outstanding achievements by women in the social sciences, humanities and cultural sciences for outstanding achievements in gender equality (Deloitte, 2014; Lipinsky, 2014).

Notwithstanding progress in this area, performance was weakest in the share of women researchers and among PhD graduates, both of which placed Austria in Cluster 4 relative to the ERA average. While the trend for the share of women researchers showed positive signs over the 2005-2013 period, exceeding the rate of improvement among the EU-28 by 1.5 percentage points, the share of women among PhD graduates experienced a mean annual decrease of 0.6 % over 2005-2012, while the EU-28 generally saw an increase in this area (CAGR of 1.2 %). In contrast to the findings presented here, there is evidence that the share of women scientists in non-university research increased from 20 % to 25 % between 2004 and 2013, with the strongest growth recorded in the younger age groups, lower-income groups, and lower functional levels (BMWFW & BMVIT, 2015; Schuch & Gampfer, 2016).

The FFG runs the FEMtech research projects funding aimed to support innovative projects that include consideration of the gender dimension in R&D (BMWFW & BMVIT, 2015). Austria is not, however, highly specialised in the inclusion of a gender dimension in research content, falling into Cluster 3 and tying the EU-28 average for this indicator.

5. Optimal circulation, access to and transfer of scientific knowledge including via digital ERA

Austria’s overall performance in Priority 5 falls behind the ERA average (i.e. into Cluster 3) but exceeds the EU-28 average by 23 % on the priority composite indicator.

a. Knowledge transfer

Austria has set in place a national regulatory framework to govern issues related to knowledge and intellectual property rights (IPR) transfer, including provisions that oblige both research organisations and funding agencies to actively contribute to innovation and competitiveness (Schuch & Gampfer, 2016). In practice, most public universities have technology transfer offices as well as IPR exploitation strategies. Networking initiatives, support to science parks or clusters, vouchers and other technology transfer instruments are the main instruments used by Austrian organisations to underpin knowledge transfer; significant activity occurs through AplusB (Academia plus Business) centres, Competence Centres, Josef Ressel centres, Impuls Centres, as well as regional Knowledge Transfer and Exploitation of IPR Centres (Schuch & Gampfer, 2016). The Christian-Doppler laboratories and centres are a good example of efforts to improve the connection between universities and industry, including by supporting the establishment of temporary laboratories at universities to work on applied and fundamental research with the participation of industry partners; in 2014, the investment in these centres reached approximately EUR 25.7 million (Schuch & Gampfer, 2016). Similarly, the Ludwig Boltzmann Gesellschaft (LBG) is actively working on areas related to health research and open innovation (LBG, 2016).

Austria performs well in Sub-priority 5a overall, falling into Clusters 1 or 2 and exhibiting large leads over the EU-28 average performance scores for all but one indicator. In particular, collaboration between higher education and private sectors exceeded the EU-28 average by 74 % in 2012, and research institution collaboration with the private sector also exceeded the EU-28 average by a large margin (73 %). While both of these indicators also exhibited growth from 2008-2012, this was much higher for collaboration between research institutes and the private sector, which exhibited a mean annual growth rate of 14.7 % (exceeding the EU-28's mean annual growth rate by 11.2 percentage points).

Performance was weaker in the share of public R&D funded by private sources, for which Austria's performance score resulted in a Cluster 3 placement (although their performance was only slightly below the EU-28 average). While there was modest growth for this indicator in the EU-28 over 2009-2013, Austria experienced a mean annual decrease of 0.6 %.

b. Open access

Austria's performance in Sub-priority 5b is close to average, with a Cluster 3 placement on the total share of papers in open access (OA) in 2014 but a 2 % lead over the EU-28 average. Performance is also above the EU-28 average for the share of papers in gold open access. The below-average performance relative to the ERA but above-average performance relative to the EU-28 in the total share of papers in OA is due to the fact that many Associated Countries (i.e. non-Member States) are performing very well in this indicator, pulling up the ERA average relative to the EU-28's.

A number of Austrian research performing and research funding organisations are signatories of the Berlin Declaration on OA to Knowledge in the Sciences and Humanities. While significant progress has been made in the adoption of open access to publications, the process has been more gradual in the case of open access to data (Schuch & Gampfer, 2016). The FWF is perceived as a leading agency in terms of the promotion of OA in Austria. The agency has had provisions around OA since 2008, although monitoring of compliance was not strict; however, starting from January 2016, the acceptance of final reports on FWF projects will be on the condition that all peer-reviewed publications resulting from those projects are reported as OA publications (Schuch & Gampfer, 2016). Additional initiatives implemented by Austrian funding organisations include the financing of publications in gold, green or hybrid open access outlets (subject to certain limits in the pricing of these publications), participation in open access repositories (e.g. PubMed Central), and even the adoption of calls to support the establishment of open access journals, mainly in the social sciences and humanities (Schuch & Gampfer, 2016).

6. International cooperation

Asides from the headline indicator of papers produced in collaboration with non-ERA partners per 1 000 researchers, which falls into Cluster 2 and was 14 % above the EU-28 average in 2014, Austria's performance is below average for Priority 6. In addition to a Cluster 3 placement for the priority composite indicator and a corresponding deficit of 22 % to the EU-28 average, Austria's performance falls into Cluster 3 and trails behind the EU-28's for the share of doctoral students from outside the EU, licence and patent revenue from abroad as a share of GDP, and co-invention rate with non-ERA partners.

Research partnerships beyond Europe are expected to receive a significant push from the December 2015 adoption of the 'Beyond Europe' programme by the Federal Ministry of Science, Research and Economy (Schuch & Gampfer, 2016). With a mandate to link Austrian companies and research institutions with their peers abroad, initial investment in this programme is on the order of EUR 4.6 million. The Beyond Europe programme identifies three different categories of countries according to the priority that Austria grants to their partnerships; the first group includes China, India, the United States and Russia; the second group includes Australia, Brazil, Canada, Japan, Malaysia, Singapore, South Africa, Sub-Saharan Africa, and South Korea; finally, there is the group of partners in Latin America, other African countries, some Gulf countries and some East Asian countries (NRTIS-TF, 2015; Schuch & Gampfer, 2016). A diversity of multilateral cooperation agreements in the area of R&I are also in place with Argentina, China, India, Japan, Russia, Singapore, South Korea, Taiwan and other countries; many of these are handled by different instances of the Austrian grant making organisations (Schuch & Gampfer, 2016).

Summary

Austria is making progress towards the achievement of the ERA and performs well in most of the priority areas. Most of the headline indicators fall into Cluster 2, although Austria falls into Cluster 3 for the share of women among Grade A positions in the higher education sector (Priority 4) as well as the total share of papers in open access (Sub-priority 5b). Austria is a leader within the ERA in the collaboration between the higher education sector and private firms (Sub-priority 5a), which falls into Cluster 1. Despite relatively strong performance on the headline indicator in Priority 6, the other indicators in this area would suggest that it is an area for improvement for Austria.

Austria published a complete and detailed 2016 National Action Plan (also called an ERA national roadmap). This includes the main objectives, measures, instruments, milestones, and assessment tools to measure completion for all priorities. For instance, in regard to Priority 4 (in which Austria has more room for improvement), objectives outlined are as follows: '(a) Increasing the shares of women in all areas and at all hierarchy levels where they are under-represented; (b) Integrating the gender dimension into structures and policies in science and research; (c) Considering the gender dimension in research content and teaching' (BMWFW, 2016).

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ANNEX: METHODOLOGICAL NOTES

	Indicator	Data availability	Flag								
			Exception to ref. year	Exception to ref. period	Break in time series	Definition differs	Estimated	Provisional	Potential outlier	Revised	Eurostat estimate
Priority 1	**Adjusted Research Excellence**	Available									
	GBARD as share of GDP	Available				2005-2014					
	European Innovation Scoreboard	Available									
	GBARD as share of government expenditures	Available				2005-2014					
	R&D tax incentives as share of GBARD	Available				2013					
	Share of GBARD allocated on project basis	Available		2011-2014		2009-2014					
	Patent applications per 1 000 researchers	Available					2005, 2008, 2010, 2012				
	Researchers per 1 000 active population	Available			2007		2005, 2008, 2010, 2012, 2014	2014			
	Publications per 1 000 researchers	Available					2005, 2008, 2010, 2012, 2014	2014			
Priority 2	**A - GBARD to transnatl coop (EUR/researcher)**	Available					2008, 2010, 2012, 2014	2014			
	A - Collab papers w/ERA per 1 000 researchers	Available					2005, 2008, 2010, 2012, 2014	2014			
	A - Public-to-public partnerships (EUR/researcher)	Available					2012, 2014	2014			
	A - Co-invention rate w/ERA partners	Available									
	B - Roadmap for ESFRI projects	Available									
	B - Participation in developing ESFRI projects	Available									
	B - Participation in operational ESFRI landmarks	Available									
Priority 3	**EURAXESS job ads per 1 000 researchers**	Available					2012, 2014	2014			
	Open, transparent, merit-based hiring process	Available									
	Share of doctoral students from EU countries	Available									
Priority 4	**Share of women among Grade A HES**	Available	2013	2006-2013							
	Gender dimension in research content	Available									
	Share of women among PhD graduates	Available									
	Share of women among heads of HEI	Available									
	Share of women researchers	Available		2006-2013							
Priority 5	**A - Research institute-private collaboration**	Available				2012					2012
	A - Higher education-private collaboration	Available									
	A - Share of public R&D funded privately	Available									
	A - Public-private collab papers per capita	Available		2009-2013							
	B - Share of papers in Open Access (Total)	Available									
	B - Share of papers in Open Access (Green)	Available									
	B - Share of papers in Open Access (Gold)	Available									
	B - National Open Access policies adopted	Available									
Priority 6	**Collab papers w/non-ERA per 1 000 researchers**	Available					2005, 2008, 2010, 2012, 2014	2014			
	Share of doctoral students from outside EU	Available									
	Licence & patent rev. from abroad, share of GDP	Available						2013			
	Co-invention rate w/non-ERA partners	Available									

The European Research Area (ERA) Progress Report 2016 shows the state of play in ERA. A lot has happened in the European research landscape since the last edition in 2014. The ERA Roadmap at EU level was endorsed by the Council in early 2015. This called for top action priorities that will have the biggest impact on Europe's science and innovation systems. Member States were invited to draw up national action plans based on this approach. Last year almost all Member States and a number of Associated Countries have published their National Action Plans on ERA showing clear political ownership of ERA.

This analysis carried out in 2016 shows strong progress in all ERA priorities across the EU. This was possible because of a true partnership among the Member States and Associated Countries, the Commission and research stakeholder organisations. But we cannot be complacent. European strength in the field of Research and Innovation is needed more than ever to reinforce competitiveness but is also increasingly challenged to deliver on impacts. The Commission's policy agenda on Open Science, Open Innovation and Open to the World will open up ERA to future challenges, like digitalisation and global networks. There are new barriers to break down to create more wealth and security for our citizens.

Studies and reports