



EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION

Directorate A - Policy Development and Coordination

A.4 – ‘Reforms and economic impact – country intelligence’

Research and Innovation analysis in the European Semester 2019 Country Reports

This document, compiled by DG Research & Innovation, collects all the research and innovation (R&I) aspects covered by the 2019 European Semester Country Reports. In particular, for each Member State the document shows: (i) the R&I relevant findings 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; and (iv) the relevant parts of “Annex D” on the investment needs.

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1. AUSTRIA

1.1. Executive summary

Focussing investment (both public and private) on innovation, digitalisation, sustainability, childcare and skills is important for productivity and growth in Austria. Austria's investment rate is above the EU average, but is expected to moderate. High investment in research and development is not fully translating into innovation outcomes and digital technologies are still not widely used, particularly among small and medium-sized enterprises.

Stagnating productivity requires boosting innovation results and supporting innovative businesses. Austria is investing heavily in research and innovation but has not yet managed to overcome the stagnation in total factor productivity. Efforts are still needed to strengthen science-business links, support knowledge-intensive sectors, promote eco-innovation and link up regional 'smart specialisation strategies'. Structural challenges remain for starting and scaling-up innovative businesses in Austria. Apart from regulatory barriers, the lack of later-stage funding options play a role, as well as skills shortages in some professions.

High-speed connectivity in rural areas is lacking, increasing the divide in digitalisation and innovation capacities between regions.

1.2. Research and Innovation

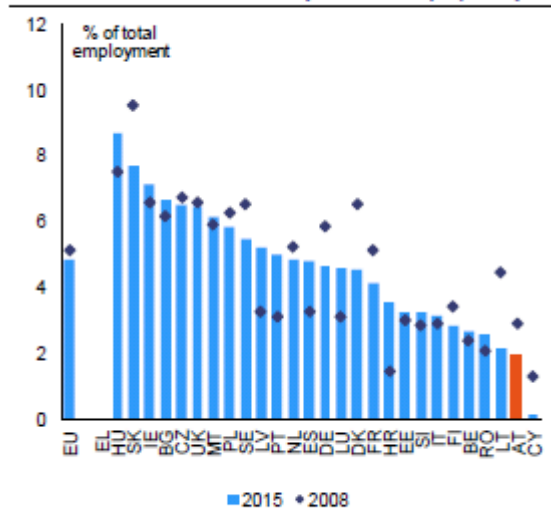
R&D investments have been increasing continuously, driven by the public and private sector. R&D intensity in Austria has surpassed 3 % of GDP since 2014, reaching 3.16 % of GDP in 2017. This is still far from the national target of 3.76 % of GDP for 2020. The private sector is the key driving force behind this trend, accounting for more than 70% of total R&D intensity. With 2.22 % of GDP in 2017, Business Expenditure on R&D is the second highest in the EU. Business Expenditure on R&D as a percentage of GDP performed by small and medium-sized enterprises has also increased since 2007 and was the third highest in the EU in 2015. Austria ranked fifth in the EU with respect to total government support to business R&D (as a percentage of GDP) in 2015, with R&D tax incentives accounting for 54 % of total support (OECD, 2018d). After significant increases between 2006 and 2009, public R&D intensity has stabilised at around 0.93 % of GDP in 2017. In 2015, five out of the 30 most R&D intensive regions in the EU were in Austria (European Commission, 2018j).

However, there is room to improve the overall effectiveness of the research and innovation system by better translating R&D investments into excellent science and ground-breaking innovation. Despite the relatively high level of investment in the public science base and the increasing international openness of the research system ⁽¹⁾, Austria has not progressed since 2007 with respect to the key indicators of scientific excellence (such as scientific publications within the top 1 % or top 10% most cited scientific publications worldwide). The performance on these indicators stays around EU average. Despite an increase in its innovation performance since 2010, Austria is still not an Innovation Leader, but remains in the second rank category of Strong Innovator (European Commission, 2018k). In particular, concerning employment in fast-growing

¹ The country ranked fourth in international co-publications as a percentage of total publications in 2017.

innovative firms ⁽²⁾, Austria performs poorly, ranking in the bottom three of EU Member States in 2015 (see Graph 3.4.2). Unicorn companies ⁽³⁾ are also rare in Austria with only Tricentis, a software testing solutions company from Vienna, reaching unicorn status in 2018 (Dealroom, 2018). Despite significant increases in R&D investments in the high-tech and medium-high tech manufacturing sectors over the last decade, the shares of these sectors in total value added slightly decreased.

Graph 3.4.2: Employment in fast-growing enterprises in innovative sectors (% of total employment)



(1) Greece: no data
Source: European Innovation Scoreboard, Eurostat

Further investing into small and medium-sized enterprises’ innovation capacity and in complementary intangible assets could generate productivity gains. The share of small and medium-sized enterprises innovating in-house is below the one of *Innovation Leaders* such as Finland, Sweden and the Netherlands, while the sales of new-to-market and new-to-firm product innovations are even below the EU average (European Commission, 2018k). This is related to a dominant focus on incremental innovation (OECD, 2018e). Besides R&D investments, it is increasingly important to invest in other intangible assets (such as e.g. software and databases, but also training, design, organizational capital, etc.) which are complementary and increasingly essential for business success and productivity growth in Austria (European Commission, 2019a).

Public and private investments into intangibles, such as organisational capital, market research and training (as percentage of GDP) are below their levels in other *Innovation Leaders* and *Strong Innovators* ⁽⁴⁾. Furthermore, Austria’s non-R&D innovation expenditure is clearly below the EU average ⁽⁵⁾.

Science-business links are well-established overall, but their full potential is not yet exploited. In 2017, Austria ranked fourth in the EU regarding public-private scientific

² Number of employees in high-growth enterprises in 50 % most innovative sectors, as a share of total employment for enterprises with 10 or more employees. High growth firms are defined as those firms with an average annual growth in employees greater than 10 % a year, over a three-year period, and with 10 or more employees at the beginning of the observation period.

³ Privately held start-up company valued at over USD 1 billion.

⁴ SPINTAN and INTAN data.

⁵ Non-R&D innovation expenditure includes the acquisition of machinery, equipment and software, expenditure for acquisition of other external knowledge, ‘training’, ‘market introduction of innovations’ and ‘other preparations expenditures’.

co-publications as a percentage of total publications, but has not progressed since 2007. It has a consolidated and diverse landscape incentivising collaboration and technology transfer between public and private sectors. The *OECD* highlights the importance of stronger linkages between industry and science targeting ground-breaking innovation in strategic fields. This also requires better strategic steering and coordination of research and technology organisations (OECD, 2018e)

Austria's innovation performance would benefit from more cooperation between its *Länder* and with other countries in corresponding Smart Specialisation fields. The Austrian Smart Specialisation approach is based on the national RTI strategy and regional strategies at the level of the nine *Länder*. In 2016, a policy framework was presented to improve the interaction between the national strategy and regional strategies (OEROK, 2016). The progress in implementing the Smart Specialisation Strategy process differs between the *Länder*, with some being Smart Specialisation pioneers and others still catching up. There are also important regional differences in relation to the R&D intensity, which ranges from 1 % of the regional GDP in Burgenland to 5.16 % in Styria in 2015. Such regional disparities can be addressed by strengthening cooperation between the Austrian *Länder* and with regions in other countries (OECD, 2018e).

1.3. Additional R&I references

[1. Economic Situation and Outlook, Investment, p.7]

Long-term economic growth will depend on ensuring that sufficient investment will be directed towards productivity-enhancing factors, including digitalisation, skills, research and innovation (see Section 3.4).

[Box 2.1: EU funds and programmes contributed to addressing structural challenges and to fostering growth and competitiveness in Austria, p.14]

Furthermore, numerous Austrian research institutions, innovative firms and individual researchers have benefited from other EU funding instruments, notably Horizon 2020 which has provided EUR 989 million to improve innovation and research in Austria.

EU Funds supported closer collaboration between business and research institutions, and R&D investments in the private sector. The ESI Fund support which will be granted to the enterprises selected for support by the end of 2017, will trigger EUR 621 million of private investment, and will result in an employment increase of 1,211 full time equivalents. Horizon 2020 supported 1,687 research projects covering a broad thematic spectrum.

EU funding contributes to the mobilisation of private investment through financial instruments. In addition to a risk capital fund co-financed with ESIF, the European Fund for Strategic Investments (EFSI) provides total financing of EUR 1.3 billion in Austria and is supporting EUR 4.4 billion in private and public investments. Austria ranks 23rd as to the overall volume of approved operations as a share of GDP. Under the Infrastructure and Innovation window, 15 projects ⁽⁶⁾ were approved and financed by the EIB with EFSI backing, for approximately EUR 1.2 billion in total financing set to trigger EUR 3.7 billion in total investment.

[3.1. Public finances and taxation, Health care, p.22]

⁶ Among which 3 are multi-country projects.

A further move away from price as the sole award criterion could raise quality and promote innovation, notably where it is still used widely, such as in tendering for medical devices (50 % in Austria in 2017).

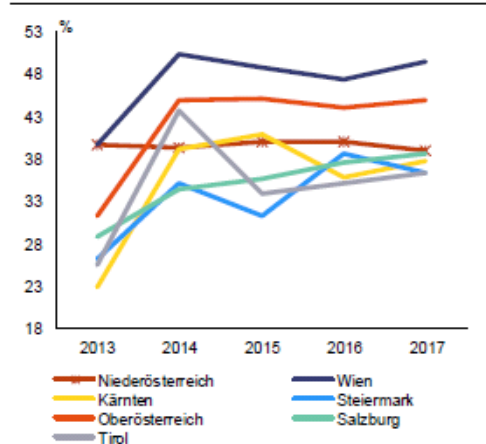
[3.2. Financial sector, SME's access to finance, p.28]

However, the availability of venture capital in Austria, compared to other Strong Innovators and Innovation Leaders ⁽⁷⁾ ⁽⁸⁾, remains low. Funding sources for venture capital funds are also less diverse than in Innovation Leaders (Graph 3.4.4). The main contributor to venture capital funds is the government ⁽⁹⁾, while the contribution of capital markets is very low.

[3.3. Labour market, education and social policies, 3.3.3. Education, p.37]

The human resources base in science and technology has expanded overall but shortages in engineering and computing specialists persist. Austria increased the share of researchers in the labour force between 2007 and 2015, ranking seventh in the EU. Almost 2/3 were employed in the business sector. New graduates in science and engineering per thousand of population aged 25-34 have also increased significantly over the last decade. Graduates in computing saw less expansion. Academic jobs in science, technology, engineering and mathematics are forecast to increase twice as much (25 %) between 2013 and 2025 compared to the EU average (CEDEFOP, 2018). Companies report already in 2018 that they cannot fill one sixth of their open positions in these fields (Industriellenvereinigung, 2018). The Austrian Research and Technology Report identifies a particular need to have more technical and engineering graduates with a focus on IT (BMBWF, BMDW, BMVIT, 2018) Both the Austrian University Development Plan 2019-2024 and the performance based funding agreements 2019-2022, aim to address these issues.

Graph 3.3.4: Tertiary attainment by NUTS 2 region in per cent



(1) Burgenland and Vorarlberg have been excluded since no figures are available for 2012 and 2013
Source: Eurostat

⁷ As defined by the European Innovation Scoreboard 2018 – *Innovation leader*: SE, DK, FI, NL, UK, LU
Strong innovator: DE, BE, IE, AT, FR, SI.

⁸ On the volume of venture capital as a share of GDP, Austria ranked 12th in the EU in 2017.

⁹ The Seed Financing Programme of the Austrian Federal Promotional Bank (AWS) supports the creation and growth of innovative firms in high tech sectors by offering seed money specifically tailored to their needs.

[3.4. Competitiveness reforms and investment, Investment needs, p.39]

The strong cyclical upswing masks underlying weaknesses of the Austrian economy related to regulatory rigidities and insufficient productivity-enhancing investments.

The Austrian economy has experienced a strong economic upswing in 2018. This has been visible in strong investment growth, but also other key indicators of business dynamism, such as start-up numbers. This positive economic climate however masks structural challenges that bear down on continued growth prospects and economic resilience. These include the only slowly returning productivity growth, the still moderate innovation outcomes and insufficient progress towards a digital and sustainable Austrian economy. In its national Research, Technology and Innovation strategy 2011-2020 (BKA et al., 2011), Austria set itself the aim of becoming an Innovation Leader by 2020 (it is currently a Strong Innovator; see below). This remains the crucial reference for assessing its growth- and productivity-targeting policy measures.

Focussing investments on innovation, digitalisation and sustainability is needed to boost productivity and strengthen growth in Austria.

Untapped human capital hampers productivity and long-term growth (see Section 3.3). In parallel, productivity-enhancing investments are important to ensure sustainable growth, in particular measures addressing the growth and competitiveness of Small and Medium Enterprises. Lack of diffusion of digital technologies and business models among such firms are bottlenecks for productivity. Furthermore, high investments in R&D are not yet fully translating into innovation outcomes, highlighting inter alia the need to foster science-business links. Investments into eco-innovation, the circular economy, energy efficiency, renewables and sustainable mobility are needed for more sustainable growth.

[3.4. Competitiveness reforms and investment, Digital transformation, p.41]

A call to establish Digital Innovation Hubs in the regions has been launched. These hubs will support small and medium-sized enterprises, universities and municipalities in the uptake of digital technologies.

Austria support for research and innovation in information and communication technology companies is part of wider R&D- and business-support programmes.

[3.4. Competitiveness reforms and investment, 3.4.2. Market functioning and the services sector, Service sector regulation, p.43]

A key factor influencing the scale-up rate of Austria's smaller firms is their innovation capacity notably as regards innovation that is more than incremental (see Section 3.4.1). Austria's Research Promotion Agency is allocating roughly 30 % of its funding to research in small and medium-sized enterprises. For high-growth innovative companies in particular, the lack of venture capital and other sources of equity financing is a major barrier to growth (see Section 3.2).

[3.4. Competitiveness reforms and investment, 3.4.2. Market functioning and the services sector, Circular economy, renewables and resource efficiency, p.44]

The market uptake of available energy efficiency solutions and technological innovation, in particular in small and medium-sized enterprises has the potential to drive the energy efficiency market further.

Austria's eco-innovation performance is negatively impacted by only moderate investment in environmental and energy R&D and insufficient structures for

cooperation between eco-innovators. Austria ranked eighth on the 2017 Eco-innovation Scoreboard thanks to a flourishing environmental technology sector and several environment-related financial incentives offered by the government (European Commission, 2017c) However, with 0.02 % of GDP, Austria's government budgetary appropriations allocated to R&D in the area of environment and energy were below the EU average (0.04 %) in 2016 and less than half compared to the leading countries Germany, Finland and Portugal with 0.07 % each (European Commission, 2017c). The supplier structure of environmental technologies is small and dominated by small and medium-sized enterprises, meaning that financial and human resources are limited. This often hampers R&D activities as well as its market success. Better interconnectedness among environment technology clusters and networks would mitigate these issues.

Further progress requires social and technological innovation and strategic implementation across all value chains.

1.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Despite a very high research and development intensity, Austria is not yet on par with Europe's Innovation Leaders as regards innovation outcomes, which points to a need for improving the efficiency of the research and innovation system and to fully exploit the potential of science-business links. Therefore, priority investment needs ⁽¹⁰⁾ have been identified to **enhance research and innovation capacities and the uptake of advanced technologies**, within the framework of regional smart specialisation strategies that identify priority areas based on regional needs and potential, and in particular to:

strengthen the science-business links, inter alia, by supporting collaborative research, development and innovation and technology transfer. Support investments in research and development infrastructure that allows small and medium-sized enterprises to participate in the research and development process;

encourage cooperation activities on corresponding smart specialisation priorities and new value chains between different Austrian regions and with other countries, including in the context of the EU Strategies for the Alpine and Danube regions;

strengthen eco-innovation and research and development focusing on low-carbon technologies and on making the economy more circular.

Scaling up, innovation capacity and the availability of venture capital remain an issue for Austria's smaller firms. Therefore, priority investment needs have been identified to **enhance growth and competitiveness of small and medium-sized enterprises**, and in particular to:

strengthen the innovation capabilities of small and medium-sized enterprises. Encourage investments in product, process and service development, and upgrading technological capacities;

¹⁰ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

encourage the entrepreneurial eco-system by providing support for clusters and networks and promote the entrepreneurial spirit;

consolidate the favourable start-up climate and improve the conditions for scaling up innovative businesses, inter alia, by providing support for access to finance, for start-up accelerators and incubators and related consultancy services. Provide support for developing prototypes, demonstrators and proof of concept.

Austria lags behind in developing information and communications technology products and services, and in particular the small and medium-sized enterprise sector in adopting new digital technologies and business models. Therefore, priority investment needs have been identified to **reap the benefits of digitisation for companies**, and in particular to:

increase information and communications technology up-take and the adoption of new business models in small and medium-sized enterprises, inter alia, by improving digital skills and by supporting digital innovation hubs as service-providers to small and medium-sized enterprises;

offer risk-reduced environments for small and medium-sized enterprises to develop digital products and services, for example by supporting test environments for early trials and market adaptation of emerging technologies and digital applications.

2. BELGIUM

2.1. Executive summary

Further investment in transport infrastructure and energy transition, innovation, education and training would strengthen Belgium's long-term growth potential, while helping to address regional disparities. Total investment in Belgium is among the highest in the EU at 23.5 % of GDP in 2017. The relatively good performance overall is due to private investment. Addressing labour shortages, especially of employees with backgrounds in science, technology, engineering and mathematics, will require investment in the training and education system.

The concentration of innovation in a few industries and barriers to competition and investment in product and services markets are weighing on productivity growth. Another factor weighing on productivity growth is that high R&D spending, partly driven by tax incentives, are concentrated in a few industries and there is insufficient diffusion of innovation to the rest of the economy.

Tertiary education attainment is high, yet there are too few graduates in science, technology, engineering, and mathematics, which are particularly important for innovation and economic growth.

Economic disparities across regions and provinces in Belgium remain. While the GDP per capita is on average higher in Belgium than in the EU, there are important inter- and intra-regional disparities in terms of revenue, employment, education and innovation.

2.2. Research and Innovation

Belgium is a strong innovator thanks to an excellent public science base and very good interlinkages between public research and industry. In the Innovation Scoreboard ⁽¹¹⁾, Belgium is in the same group as Germany and France, but behind innovation leaders like the Netherlands. The excellence of its public science base, the linkages between public research and industry and the presence of a number of R&D centres of multinational companies are among the strong points of its research and innovation system. Belgium benefits from adequate public and private infrastructures. Regions are participating in 16 out of 28 partnerships in the Smart Specialisation Thematic Platforms. However, differences exist among provinces.

Private R&D intensity is high, but public R&D intensity can improve and is mostly driven by R&D tax incentives. Belgium's overall R&D intensity increased remarkably, from 1.84 % in 2007 to 2.58 % in 2017, mostly thanks to growth in business R&D intensity (from 1.28 % to 1.76 %). Public R&D intensity increased too, but remains below that of most other Member States with a similar level of economic development. Public R&D undertaken in Flanders is higher than for Belgium as a whole (Debackere et al, 2018), suggesting that public research is likely to be below the EU average (0.7 %) in other Regions/Communities. Nevertheless, indirect public support for business R&D is high (see Box 3.4.2), without any bias against small and medium-sized enterprises (SMEs).

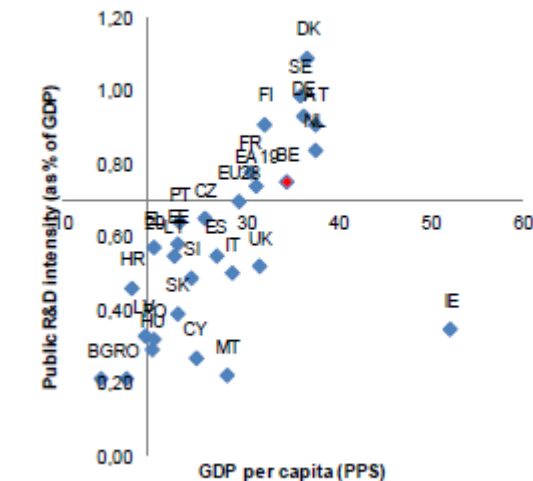
As Belgian R&D investment is concentrated in a few business sectors (mainly in the pharmaceutical industry – see previous country reports), public authorities have been pushing for R&D in other areas. The share of environmental inventions in total patents has risen very substantially since the early 90s, as in many countries, but still lags the OECD average by around 30 % on a per-capita basis (OECD, 2017b). The National Pact for Strategic Investment aims to boost coordination of investment in R&D in cross-cutting areas like digitalisation (cybersecurity, e-health), health, mobility, intelligent transport systems and energy. Belgian regions have had a consistent policy of supporting the emergence of new industries, in particular in the low-carbon economy, notably through 'smart specialisation'.⁽¹²⁾

The renewal of the Belgian economy as measured by entry and exit firm ratio is slower than in peer countries. This occurs despite a good access to funding and efforts to boost entrepreneurship. Start-ups can be found in several sectors, notably in financial technology, media and healthcare. Belgian start-ups are also quick to venture into international markets and are very much focused on business-to-business connections. However, Belgium ranks 23rd in terms of employment in high-growth innovative enterprises (2.7 %, while the EU average is 4.8 %). According to the 2018 Digital Transformation Scoreboard, there has been a downward trend in the number of newly created information and communication technologies start-ups for the last 5 years and in 2018, with regional variations.

¹¹ According to the European Innovation Scoreboard 2018, available at: https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

¹² In the area of low-carbon technologies, Flanders has notably large clusters in for instance eco-innovation and sustainable chemistry, while Wallonia has a Competitive Cluster in green chemistry, environmental biotechnologies and innovative materials (as well as private clusters).

Graph 3.4.2: Public R&D intensity (government plus higher education) and GDP per capita (PPS) - 2014



Source: European Commission

2.3. Additional R&I references

[1. Economic situation and outlook, Potential growth, p. 9]

The high level of productivity is notably due to large private capital accumulation, a highly skilled workforce and strong innovation performance in key sectors (pharmaceuticals, minerals, chemicals).

[Box 2.1: EU funds and programmes contributed to addressing structural challenges and to fostering growth and competitiveness in Belgium, p.17]

Competitiveness of SMEs, sustainable and quality employment, social inclusion, educational and vocational training as well as research and innovation were the main themes covered by ESIF Funds.

About 28 % of the total ESI funds spent in Belgium aims to increase the competitiveness of SMEs. This is achieved by supporting innovation and research activities and stimulating the growth of the e-economy by developing synergies between businesses, R&D centres and higher education, supporting entrepreneurship and by improving skills of the workers.

EU funds have helped to address policy challenges identified in the 2018 CSRs. ESI Funds contributed in addressing two of the three recommendations of the 2017 and 2018 reports, namely through the above mentioned investments in educational and vocational training as well as through research and innovation and support to SMEs.

Under the Infrastructure and Innovation window, 22 projects financed by the EIB with EFSI backing were approved, for a total of about EUR 1.6 billion set to trigger EUR 7.1 billion in total investment.

[3.1. Public finances and taxation, 3.1.2. Composition of public spending, Investment, p. 22]

Regions and communities are responsible for education and most research;...

[3.3. Labour market, education and social policies, 3.3.2. Education, training and skills, p. 39]

Tertiary education attainment is high, but there are too few graduates in sectors most supportive of innovation and growth, like science, technology, engineering and mathematics (STEM).

[3.4. Competitiveness and investment, 3.4.1. Competitiveness, productivity and innovation, Competitiveness and productivity, p. 43]

The fact that only a few firms drive most aggregate productivity gains may point to obstacles in the diffusion of innovation (see *infra*).

[3.4. Competitiveness and investment, 3.4.1. Competitiveness, productivity and innovation, p. 44]

Despite higher R&D spending than in the EA (2.5 % against 2.1 % of GDP, respectively), the Belgian economy does not perform proportionately better in terms of patents, innovative products creation and high-tech exports (Basselier *et al.*, 2017).

[3.4. Competitiveness and investment, 3.4.1. Competitiveness, productivity and innovation, Investment, p. 44]

Focussing investment in transport and energy infrastructures and innovation would strengthen the long-term growth potential of Belgium, while contributing to address regional disparities. In spite of a relatively high level of investment (¹³), investment needs remain significant. R&D investment is concentrated in a few sectors, while innovation diffusion remains limited. Public support to research and innovation is uneven among Regions and Communities.

[3.4. Competitiveness and investment, 3.4.1. Competitiveness, productivity and innovation, Digitalisation, p. 47]

Reinforcing the digitalisation of the Belgian economy has been identified in the National Pact for Strategic Investment as a promising avenue to boost productivity and the innovation capacity of the country.

The shortages of professionals in sciences and engineering and, more broadly, the lack of ‘knowledge entrepreneurs’ are two important barriers to developing start-ups in Belgium (e.g. ICT start-ups) and will ultimately dent Belgian growth prospects (see Section 3.3.2).

[Box 3.4.2: R&D tax incentives, p. 48]

¹³ Total national investment in Belgium remains relatively high at 23.5 % of GDP in 2017. Total investment (measured as gross fixed capital investment) was above the EA average (20.6 % of GDP) and of each of its main trading partners, France, Germany and the Netherlands

Box 3.4.2: R&D tax incentives

Belgium has one of the highest worldwide indirect public support to business R&D – as share of GDP. In Belgium, in addition to direct support from the regions, firms can benefit from several tax benefits in support of R&D, introduced by the federal government from 2005 onwards. According to OECD data, Belgium has the higher worldwide of indirect public support to Business R&D (0.30 % of the GDP in 2015).

An innovation box has replaced the old Belgian patent box. The new regime - approved by the Code of Conduct Group on Business Taxation - requires a stronger link between the intellectual property (IP) that can benefit from the regime, and the R&D that created this IP. As a reminder, the economic evidence on the effectiveness of patent/innovation boxes as a means to encourage R&D remains limited and it may be used as a tax competition tool.

Belgian tax incentive schemes do not target a particular category of enterprises. Four schemes of partial exemption of advance payment of the withholding tax on wages of R&D personnel exist, along with tax deduction or tax credit for investment in R&D fixed assets that aim to develop new products or patents. Most schemes do not target particular categories of enterprises, but incentivise indifferently SMEs or big enterprises, firms that make profits or losses (OECD, 2017a). For instance, the absence of a profit requirement for eligibility, implies no bias in favour of incumbents (Acemoglu, 2013)

Combination of different measures decreases the effectiveness of public support to business R&D in Belgium. Recent studies (Dumont 2017, Teirlinck, Spithoven and Bruneel 2018) give indications that the combination of different measures decreases the effectiveness of public support to business R&D in Belgium, pointing out the need to account for all schemes when assessing additionality of the public support in the country and inviting for a coherent approach between federal R&D tax support schemes and regional government level R&D direct subsidies.

These studies give robust evidence that tax benefits based on the wages of researchers are effective in building R&D capacity in enterprises, with a higher impact for smaller (Bronzini 2016, Dumont, Spithoven and Teirlinck 2016) and less R&D intensive firms. However, no indication of additionality for the public support through corporate income taxation (tax credit for R&D investment and tax deduction of 80 % of patent income) were found in these studies (Dumont 2017). This is in line with a comparative study of all the R&D tax schemes in the EU (EC 2015) which highlighted tax benefits based on the wages of researchers as a best practice among the various types of R&D tax incentives. In particular, the economic evidence on the effectiveness of patent/innovation boxes as a means to encourage R&D remains limited.

Assessing the whole tax incentives to business R&D system in the framework of a spending review, as indicated by the Country Specific Recommendation 1/2018, could lead to measures to improve the efficiency and composition of public spending, to reduce the complexity of the taxation system and the erosion of taxable bases in order to create room for investments (see Section 3.1, supra).

[3.4. Competitiveness and investment, 3.4.3. The regional dimension and the infrastructure investment, p. 55]

Differences between regions and provinces persist, in terms of innovation, labour market, level of education, health and mobility (see relevant sections in the report).

[3.4. Competitiveness and investment, 3.4.3. The regional dimension and the infrastructure investment, Sustainable growth and climate change, p. 55]

Belgium performs well in the circular economy but lack of specific skills is an obstacle to innovation and entrepreneurship in this area. ...and there is a lack of eco-innovation and circular economy related skills in small and medium-sized enterprises⁽¹⁴⁾.

¹⁴ European Commission, Eco-Innovation Observatory, https://ec.europa.eu/environment/ecoap/country_profiles_en.

Flanders plans to prioritise investment in infrastructures, in particular on mobility, school buildings, welfare and research and development.

2.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The country is a strong innovator thanks to its attractive research centres. However, attracting young people in digital/science technology careers remains a challenge. There is scope for strengthening innovation performance and fostering productivity growth by identifying smart specialisation areas based on regional needs and potential. As well, there is scope for improvement by increasing the uptake of Research, Development and Innovation outcomes in concrete products and marketed items, enhancing research and innovation capacities and the uptake of advanced technologies. Territorial specificities in the three regions (Brussels, Flanders and Wallonia with a potential focus on sub-regional dimensions) will be taken into account when developing solutions to sustain Research, Development and Innovation in Belgium.

Priority needs ⁽¹⁵⁾ have therefore been identified to :

invest in the growth of firms through support to their activities, both in a material aspect e.g. development capacities, living-labs, test-beds, joint interregional and cross-border projects and in a more immaterial aspect (networking, cluster development, transnational cooperation);

develop the capacities of research facilities in the orientation of research and the commercialisation of their outcomes;

facilitate the creation of links and collaborations between research centres, universities and small and medium-sized enterprises in order to have the same links with small and medium-sized enterprises as the ones existing with large companies;

reinforce marketing and product finalisation of research;

stimulate integrated cooperation in new value chains across regions and across borders.

The potential of Belgian small and medium-sized enterprises and innovation start-ups is not fully exploited and there has been a downward trend in the number of newly created Innovation and Communication Technology start-ups in the last 5 years.

Priority investment needs have therefore been identified to enhance growth and competitiveness of small and medium-sized enterprises and in promoting development of skills, digitalisation (especially in Wallonia) and new start-ups in line with the smart specialisation strategy, to:

reinforce access to finance and advanced business services for small and medium-sized enterprises to create a boost for the establishment of new firms;

¹⁵ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

assist small and medium-sized enterprises and provide support to start-ups in the development of new business models;

develop small and medium-sized enterprises' and start-ups' skills and capacities in the exportation of their products and services;

develop skills in higher education and research institutions and closer collaboration with small and medium-sized enterprises and start-ups to support their business needs mentioned above.

Although Belgium improved its digital performance in the private and public sector over the last few years, it still falls short of other countries. With a good level of fixed and mobile connectivity, there is an opportunity to move to very-high capacity networks in order to provide new services to both citizens and businesses. The level of digital skills is good but stagnating, showing that more than one third of the labour force has insufficient digital skills. Priority needs have therefore been identified to reap the benefits of digitisation for citizens, companies and governments, to:

strengthen the capacity of the industry (including small and medium-sized enterprises) to adapt to digital transformation, exploit the potential of digitalisation and increase the Information and Communication Technology uptake within the private and public sector;

promote skills development for smart specialisation, industrial transition (Wallonia is one of the regions chosen in the pilot phase for regions in industrial transition) and entrepreneurship.

3. BULGARIA

3.1. Executive summary

Investment in skills, social cohesion, infrastructure, and research and innovation is needed to support competitiveness, productivity and the process of catching up with the rest of the EU. Insufficient investment is holding back the modernisation of the economy. Bulgaria's considerable labour and skills shortages warrant investments in training and reskilling; addressing the lack of digital skills; improving the quality and inclusiveness of education and aligning it to the needs of the labour market; and improving the capacity of public employment services. Investments in transport, energy and water infrastructure will improve the conditions for attracting foreign direct investment and will strengthen companies' competitiveness. More investment in research and development (R&D) is needed to boost productivity gains, as well as strengthened links between businesses and research institutions and a better integrated research and innovation system.

3.2. Research and Innovation

Weak innovation performance is not supportive of productivity gains. Bulgaria ranks 27th in the European Innovation Scoreboard (European Commission, 2018d) with a performance level below 50 % of the EU average. Bulgaria's relative weaknesses are in the categories of innovative companies, finance and support, attractive research systems and links between companies and research institutions. The share of small and medium-sized enterprises introducing product or process innovation is only 11 % of the EU average; the share of those innovating in-house is 14 % of the average.

R&D spending remains very low in both the private and public sectors. Private sector R&D expenditure amounted to only 0.53 % of GDP in 2017 (compared to the EU average of 1.36 %), even though it has been improving since 2007, particularly for manufacturing and information and communication technology. Large multinational companies account for half of the entire business sector's R&D investment. Regional concentration is also strong, with more than 70 % of R&D investment going to the South Western region, primarily to Sofia. The public sector's R&D spending is among the lowest in the EU (European Commission, 2018e). In 2017 it amounted to only 0.21 % of GDP, far from the EU average of 0.69 %. However, in 2018 Bulgaria doubled its public research budget to support its 2017-2030 Strategy for Research and its commitment to gradually increasing public R&D spending to 1 % of GDP by 2025. The lack of an adequate funding portfolio in R&D remains a barrier for fostering public-private cooperation and internationalisation as well as reintegration of researchers and innovators.

High fragmentation and slow pace in implementing reforms prevent the move towards a more innovation-oriented research and innovation system. There is a large number of universities and research institutes, but most of them show low performance in research and production of high-quality scientific publications ⁽¹⁶⁾. To address the recommendations stemming from the evaluation of its national research and innovation system (European Commission, 2015), Bulgaria has started to fund its public research institutions on the basis of performance criteria and has created national scientific programmes that aim to consolidate resources and research potential. However, it is too early to assess results.

Science-business cooperation remains very weak. Public-private scientific co-publications as a percentage of total publications declined to 0.8 % in 2017, compared to an EU average of 3.9 %. Patent applications are also very low ⁽¹⁷⁾. In addition, the availability of human capital in the R&D system is a source of significant concern. Bulgaria has only four researchers per thousand employees (STIP, 2018), and mainly in the public sector.

Important projects to encourage business innovation and digitisation are on the way. Over 2014-2020, EU funds are financing four centres of excellence and nine centres of competences, as well as regional research projects outside Sofia. Together with other EU grants and financial instruments for innovation under the smart specialisation strategy, these investments are expected to lay the basis for collaboration between research institutes, universities and the private sector. They should facilitate knowledge transfer, help to create university spin-offs and attract (venture) capital. The sustainability and performance of these projects are vital for future investments, both in terms of infrastructure and soft measures. Meanwhile, the flagship 'Sofia Tech Park' continues to face challenges. The underuse of its scientific infrastructure, governance issues and its long-term financial sustainability are some of the concerns. Clusters and their potential in Bulgaria are underdeveloped as they often lack a critical mass.

The smart specialisation strategy seems to be limited to guiding EU-funded investments. Instead of empowering local businesses and communities, it remains very much a top-driven bureaucratic exercise. The Council for Smart Growth, which should

¹⁶ In 2015, 3.6 % of total publications were highly cited, compared to the EU average of 11.1 %.

¹⁷ In 2014, eight Patent Cooperation Treaty patents per million population compared to the EU average of 102.

set priorities and coordinate and monitor the strategy, has undertaken little activity, thus weakening the whole process.

3.1. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Bulgaria, p. 18/19]

EU funding provides a significant contribution to Bulgaria's public investment. The financial allocation from European Structural and Investment Funds to help Bulgaria tackle reform challenges amounts to EUR 11.7 billion in the 2014-2020 multiannual financial framework, potentially representing around 2.8% of GDP annually. Furthermore, numerous Bulgarian research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided around EUR 65 million.

EU funding is helping to mobilise private investment. European Regional Development Fund grants for enterprises alone have mobilised additional private capital of about EUR 113 million. In addition, 5.2 % of the European Regional Development Fund and the Cohesion Fund are earmarked for delivery via financial instruments in areas like research, development and innovation, small and medium-sized enterprises and entrepreneurship, energy efficiency, urban development and environmental management. These resources will raise a further EUR 247 million of public and private investment.

Six projects involving Bulgaria have so far been approved under the infrastructure and innovation window of the Fund. They amount to EUR 302 million in total financing, which should, in turn, generate EUR 769 million in investments. The European Investment Bank is providing a EUR 100 million loan to finance a boost in production levels and research and development.

[4.2. Financial sector, 4.2.6. Access to finance, p. 33]

Access to finance for small and medium-sized enterprises in Bulgaria is in line with the EU average and has further improved, backed by EU measures. Access to finance is the most important concern for only 6 % of Bulgarian small and medium-sized enterprises compared to 7 % at EU level (ECB, 2018). Small and medium-sized enterprises have benefited from the overall improvement in the banking environment but also from EU funding through programmes such as Innovation and Competitiveness (EUR 1.27 billion) and Small and Medium-sized Enterprises Initiative (EUR 102 million). The EU financial instruments provide a good alternative to grants for investment in both innovation and technical modernisation, but the awareness of these types of funding opportunities is still low.

Venture capital and business angels' financing are still limited. The small size of the market is an obstacle to attracting large equity investors, hence public support has played a decisive role for developing this ecosystem. The Fund Manager of Financial Instruments in Bulgaria (the Fund of Funds) is in charge of implementing all the EU-funded innovation and competitiveness financial instruments.

[4.4. Competitiveness reforms and investment, 4.4.1. Competitiveness, p. 47]

Further competitiveness gains could be achieved by improving non-cost factors such as infrastructure and innovation capability, as well as by making the institutional and business environment more efficient.

[4.4. Competitiveness reforms and investment, 4.4.2. Investment and productivity, p. 47]

Investments in skills, infrastructure and research and innovation are needed to support competitiveness, productivity and the convergence process with the EU. Improved R&D investments, strengthened links between businesses and research institutions and a better integrated research and innovation system are needed to remove bottlenecks to productivity gains and boost innovation capacity.

[4.4. Competitiveness reforms and investment, 4.4.2. Investment and productivity, Business environment/Productivity, p. 49]

Bulgaria's progress in implementing the Small Business Act(68) is weak, especially in the areas of skills and innovation, responsive administration, environment and, above all, entrepreneurship, where Bulgaria ranks last in the EU (European Commission, 2018g).

The main obstacles to productivity growth are a lack of skilled labour (see Section 4.3), the challenging business environment, insufficient spending on research and innovation and the slow digitisation of the economy.

[Box 4.4.1: Investment challenges and reforms in Bulgaria, p. 50]

The national promotional institution is the Bulgarian Development Bank (99.9% state-owned). The Bank's main goal is to support small and medium-sized enterprises focusing on start-ups and innovation,...

[4.4. Competitiveness reforms and investment, 4.4.4. Regional disparities, p. 56]

Even the capital region is lagging behind the EU average in innovation and research and development. Research activities and infrastructure are concentrated in Sofia and several of the biggest cities like Plovdiv, Varna, Burgas, Ruse, Gabrovo, Stara Zagora and Blagoevgrad ⁽¹⁸⁾. Companies are late in spreading the benefits of technological progress and this weighs heavily on total factor productivity. According to the 2018 Regional Innovation Scoreboard, South Western and south Bulgaria are 'moderate innovators' while north and east Bulgaria are at the bottom, with innovation performance decreasing slightly over time ⁽¹⁹⁾.

3.2. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Bulgaria's weak innovation performance is not supporting productivity gains. Synergies with Horizon Europe including its widening instruments can help improve performance. High priority investment needs ⁽²⁰⁾ have therefore been identified to enhance research and innovation capacities and the uptake of advanced technologies, and in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

¹⁸ Bulgaria: Diagnostic Review – mapping of infrastructure, equipment and apparatus, 2017.

¹⁹ Regional Innovation Scoreboard 2018.

²⁰ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

increase the number of innovative firms (introducing and developing innovations) in high tech and knowledge intensive sectors, in line with the smart specialisation strategy;

increase the competitiveness and efficiency of the research system by putting emphasis on performance and by creating incentives for attracting qualified researchers (e.g. improving working conditions, international collaboration and mobility, cooperation with businesses);

develop skills in universities and research institutions to increase the commercial viability and market relevance of their research projects and ability to participate in research consortia;

support collaboration between research and businesses, technology transfer and commercialisation of research outcomes;

promote business investment in research and innovation, intangible assets and entrepreneurial universities.

The business environment for small and medium-sized enterprises remains a challenge as Bulgaria is underperforming in the area of entrepreneurship with the lowest score in the EU. High priority investment needs have therefore been identified for growth, competitiveness and skills development of small and medium-sized enterprises, and in particular to:

foster the creation of new firms as well as scale-ups, in particular through financial instruments and investments in intangibles and also through cooperation networks and consolidation of clusters, including coordination with other Danube Region States;

encouraging the entrepreneurial ecosystem, in particular outside Sofia, and the sustained engagement of small and medium-sized enterprises in the Entrepreneurial Discovery Process;

develop market-driven special Information and Communications Technology skills in small and medium-sized enterprises;

develop entrepreneurship skills including by searching for synergies between governmental and private business initiatives for support of start-ups and entrepreneurship.

The number of digitalised enterprises in 2017 was among the lowest in the EU while the relative improvement of digital public services resulted in an increased number of e-government users. In addition to digital skills, cyber-security is an issue. Investment needs have therefore been identified to sustain the relative progress and reap the benefits of digitalisation for citizens, companies and governments, and in particular to:

increase Information and Communications Technology uptake in small and medium-sized enterprises, including supporting infrastructures and services; all with a view to improving the number of enterprises reaching a high digital intensity;

upscale and accelerate e-government, including the take-up of EU-wide interoperable services.

4. CROATIA

4.1. Executive summary

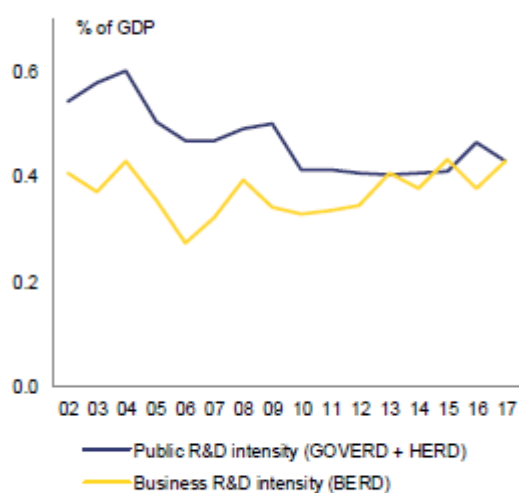
Boosting the economy's growth potential requires investments in transport, energy and environmental infrastructure, skills and research and innovation. Croatia's low level of capital investment, i.e. in equipment and infrastructure, affects the growth potential. Investment in public and private R&D and digitalisation would help to support the economy's capacity to innovate, if acting in synergy with investment in the education system to improve people's skills.

The suboptimal performance of the research, development and innovation system represents an additional barrier to increasing the competitiveness of Croatian businesses.

4.2. Research and Innovation

Croatia's R&D intensity is low and its small and medium-sized enterprises are weak innovators. The overall R&D intensity in 2017 amounted to 0.86 % of GDP, equally split between the public and private sectors. Based on recent trends, Croatia will not reach its national target of 1.4 % of GDP by 2020, though the reintroduction of tax breaks for R&D in 2018 (see section 4.1) may contribute to filling the gap. Business investment in R&D is low and largely concentrated in large companies in pharmaceutical, telecommunications, agriculture and food industries. Meanwhile, the 2018 European Innovation Scoreboard shows a decline between 2010 and 2017 in all three aspects of small and medium-sized enterprises innovation: product and process innovations; marketing and organisational innovations; and small and medium-sized enterprises innovating in-house. As a result, the overall score of Croatia in this area was 72 % of the EU level in 2017 (European Commission, 2018k).

Graph 4.4.3: Business and public R&D intensity



R&D intensity measures spending on research and development as a share of GDP.
Source: Eurostat, own calculations.

Excessive fragmentation of the science base and policy shortcomings affect the quality of public research. The share of Croatia's total scientific publications that are among the top 10 % most cited publications worldwide is rising slightly, but compared to the EU average (11.1 %) it remains very low at 4.2 %. Lack coordination and effective management in research and innovation policies leads to poor targeting and inadequate

prioritisation of support instruments. In addition, some of the undertaken reforms of public research institutes and universities remain unfinished. With every faculty having a separate legal entity status, it is difficult to develop a university-wide vision or set a strategic direction (Kralj and al., 2011). Performance criteria for institutional funding, formally introduced in 2013, are still not being used, and as a result, project-based funding allocation is not competitive. Internationalisation and international co-publications are rare ⁽²¹⁾. Still, some excellence niches in ICT, biomedical and natural sciences exist at the Universities of Zagreb (Faculty of electrical engineering), Rijeka and the Ruđer Bošković Institute, and the increasing numbers of graduates in the field of computing places Croatia among the best performing Member States ⁽²²⁾. The Ericsson-Nikola Tesla partnership with the University of Zagreb on ICT is a good yet isolated example of science-business cooperation.

Measures to reduce fragmentation and improve the efficiency of research and innovation policies are lagging. As a precondition to access ESIF-funding, in 2016 Croatia introduced the 'smart specialisation' strategy 2016-2020 (RIS3), aimed at fostering innovation, overcoming fragmentation in the system and ensuring that R&D activities are organised around key economic priorities. However, its implementation is lagging. Centres of Competence and Centres of Excellence are in the process of being established or are still to deliver clear outcomes. Both schemes implemented along other measures, which are lagging behind are intended to improve connections between academia and businesses. As a result, the funding for policies to support businesses and innovation (EUR 1.665 billion from the ERDF) has not yet been used in full ⁽²³⁾. In an effort to overhaul the RIS 3 governance, in July 2018, an inter-ministerial National Innovation Council was set up to oversee its implementation. Thematic Innovation Councils formally established in September 2018 are yet to bring any concrete results. In addition, there is the intention to strengthen the monitoring of smart specialisation strategy and other policy instruments with a view to creating a basis for evidence-based policymaking. Recent analysis done by the Croatian government together with the World Bank could be used to prioritise interventions under the smart specialisation strategy and reform innovation environment.

4.3. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and fostering growth and competitiveness in Croatia, p. 16]

Croatia is one of the largest beneficiaries of EU solidarity. The financial allocation from the EU funds, aiming to support Croatia in facing development challenges, amounts to up to EUR 10.7 billion for 2014-2020, potentially equivalent to above 3 % of GDP annually. Furthermore, numerous Croatian research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 62 million.

Under the Infrastructure and Innovation window, 8 projects financed by the EIB with EFSI backing were approved, for a value of about EUR 109 million in total financing set to trigger EUR 571 million in total investment.

²¹ Croatia ranks 24th in the EU by international co-publications as a share of total (European Commission, 2018k).

²² Croatia ranks 9th in the EU by computing graduates per thousand population aged 25-34 (Eurostat)

²³ Only 5.5 % of ERDF allocations earmarked for the implementation of RIS3 have been spent by beneficiaries by the end of 2018 (SFC 2014 reporting system).

[4.1. Public finances and taxation*, Taxation, p. 26]

After the 2014 abolition of tax incentives for R&D (which were not in line with EU State aid rules), new input-based tax incentives ⁽²⁴⁾ were legislated in July 2018. They are expected to have a positive impact on R&D performance and innovation as they focus on the most segments with the most pronounced deficit of R&D investment – SMEs and basic research (see section 4.4).

[4.2. Private sector debt and financial sector*, Access to finance, p. 26]

The Croatian Bank for Reconstruction and Development and the Croatian Agency for small and medium-sized enterprises, Innovations and Investments help improve access to finance by providing credit lines with subsidised interest and specific loans for innovation and innovation commercialisation.

[4.4. Competitiveness reforms and investment*, 4.4.2. Market functioning and investment, p. 51]

Investment gaps are pronounced in research and development, environment and transport. Better-targeted government investment in research and development can spur progress towards a more innovative economy.

[4.4. Competitiveness reforms and investment*, 4.4.3. Regional disparities, p. 54]

Industrial production is highly concentrated in the Zagreb and Primorje-Gorski Kotar counties (World Bank, 2018b), while large cities (Zagreb, Split, Rijeka, Osijek) display the highest potential for innovation, including poles of world class excellence in information and communication technology, biomedical and natural sciences in both the capital and Rijeka.

4.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The innovativeness of the Croatian economy is low and progress in improving innovation performance is very limited. High priority investment needs ⁽²⁵⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, by taking into account territorial differences, and in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

increase the number of innovative firms in the smart specialisation areas with the highest growth potential;

²⁴ The maximum tax relief: 100 % of eligible R&D costs for basic research, 50 % for industrial research and feasibility studies and 25 % for experimental development. There are ceilings per project and entity, and deduction rates can be increased by 20 percentage points for small enterprises and 10 percentage points for medium sized enterprises.

²⁵ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

develop universities' and research institutions' capacity to enhance market relevance of their research projects, build critical research mass and attract talent in the strategic smart specialisation areas;

support collaboration between universities and businesses, enabling transfer of technology and commercialisation of research outcomes; support cross-regional, transnational and interregional projects;

strengthen governance of the smart specialisation strategy.

Croatia has made progress in digitalisation but further action is needed to exploit its potential. Priority investment needs have been identified to reap the benefits of digitalisation for citizens, companies and governments, and in particular to:

support integration of digital technology in small and medium-sized enterprises including infrastructures and services, by taking into account territorial differences;

promote the range of interoperable e-services and their uptake by citizens;

upscale and accelerate Digital Public Services in a systemic way.

Croatia ranks last among peers in business environment; Croatian firms are weakly integrated in global value chains. Business investment in research and development is low and concentrated in large companies, with low participation of small and medium-sized enterprises. High priority investment needs have been identified to enhance growth and competitiveness of small and medium-sized enterprises, and in particular to:

move up the global value chains;

identify new markets, cooperation networks; stimulate potential for innovation clusters by looking into emerging trends, markets and concentration in high-performing sectors;

enhance quality of business support institutions and business environment.

Skills shortages and mismatches are among the main barriers for further economic development of Croatia. High priority investment needs have been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

reskill and upskill in smart specialisation areas, with a particular attention to supporting acquisition of key competences including digital skills;

strengthen education and training institutions including higher education and centres of vocational excellence to foster skills for innovation and stimulate entrepreneurship culture.

5. CYPRUS

5.1. Executive summary

Investment in environment, energy, digitalisation, workers' skills and innovation is crucial for increasing productivity and making Cyprus' growth model less vulnerable to the external environment. Investment has recently recovered, but it

remains concentrated in less productive sectors. Cyprus needs to significantly improve its waste management system and the circular economy. It can also make much better use of its renewable energy sources— particularly solar— and address current energy inefficiencies. Investing in the digital economy and in improving workers' digital skills is essential for bolstering productivity. To ensure that growth benefits all of society, more investment is needed in vocational education and training, adult learning, childcare and health. In addition, more investment in research and development (R&D) would increase the currently low innovative capacity of the economy.

5.2. Research and Innovation

Cyprus has a small but growing research and innovation system, which plays a limited role in economic growth. The R&D intensity ⁽²⁶⁾ in Cyprus stood at 0.56 % of GDP in 2017, higher than its EU 2020 target (0.5 %) — a target that was not deemed to be ambitious enough. Both public and private R&D spending remain well below the EU average. In 2017, public R&D expenditure was around 0.3 % of the GDP, one of the lowest in the EU. Tertiary education and business sector R&D expenditure also lag behind the EU average. The size of the research and innovation system and the available resources are very limited: at around EUR 110 million, which puts the country among the lowest positions in the EU.

The research output is a point of strength for innovation. In 2017, about three quarters of the total number of publications were international co-publication (among the highest in the EU) and in 2014 more than 10 % of Cyprus' publications were among the top 10 % worldwide most cited scientific publications (above EU average), (CWTS, 2018). In 2017, 55.9 % of the population aged 30-34 had a tertiary education (among the highest in the EU). The tertiary education sector is considered a driver of economic growth with potential for further expansion in the future (E&Y, 2018), thus contributing to Cyprus' ambition of becoming a regional hub for higher education and research. However, interaction between academia and the business sector is limited.

The information and communication technologies and pharma-chemical sectors have the potential to promote transfer knowledge. Though still in their starting phase, these sectors can generate a demand for research and innovation. An analysis of business R&D composition (RIO, 2017) shows that it is currently concentrated in the information, communication and technology and pharma-chemical sectors, which account for around 80 % of its value in the services and manufacturing sectors respectively. Export and patent data confirm this analysis. Around 20 % of Cyprus' export (USD 600 million) originates from each of the two sectors (MIT, 2017) and patents awarded between 2009 and 2013 are concentrated in civil engineering, the pharma-chemical sector and information, communication and technology (even if the influence of the patent-box legislation on the patent data is difficult to assess) (KUL, 2018). These sectors are among the priorities of Cyprus' Smart Specialisation Strategy and several research centres in the country work in these fields.

Incentives have been put in place to improve knowledge transfer. In 2018, the law allowing universities to create spin-offs was enacted. In addition, a policy support facility measure to stimulate the utilisation of research laboratories of government-funded organisations by the business community is planned to start in 2019. The government

²⁶ Gross domestic expenditure on R&D as a percentage of GDP.

also plans to set up a single national point, built on the one-stop shop principle, to coordinate all knowledge transfer activities, which are currently split among knowledge transfer offices in universities and research centres, with low capacity.

Progress in implementing the smart specialisation strategy is key in diversifying the economy. Although it was adopted in 2015, the implementation of the strategy has been delayed. Most of the projects are expected to start in 2019. In addition, the priority areas of the strategy are broad, rather than focusing on a few well-defined areas reflecting specialisation. An update of the strategy would allow for a more forward-looking identification of the investment needs based on the analysis of remaining bottlenecks and the evaluation results of the current strategy.

5.3. Additional R&I references

[Box 2.2: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Cyprus, p. 18]

Financial allocation from European Structural and Investment Funds aimed to support Cyprus in facing development and social challenges, amounts to approximately EUR 917 million in the current Multiannual Financial Framework for 2014-2020, equivalent to around 0.7 % of GDP annually and 26 % of all public investment per year on average. Furthermore, numerous Cypriot research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 134.2 million.

By the end of the period, it is expected that public support in research and innovation will leverage some additional EUR 12 million of private investments.

In the Infrastructure and Innovation window, 1 project was approved and financed by the European Investment Bank with the European Fund for Strategic Investments backing for approximately EUR 35 million, set to trigger EUR 53 million in total investment.

[3. Summary of the main findings from the MIP in-depth review, Evolution, prospects and policy responses, p. 21]

Measures have also been taken to attract foreign investors and improve competitiveness by addressing issues related to internationalisation of small and medium-sized enterprises, improving workers' skills and strengthening innovation.

[4.3. Labour market, education and social policies, 4.3.4. Healthcare, p. 47]

More efforts are needed to improve research opportunities, continuous learning, digital skills for the health personnel and the system's overall attractiveness.

[4.4. Competitiveness Reforms and Investment, 4.4.1. Productivity and investment*, p. 48]

To support Cyprus' long-term growth, investments are needed in environment, energy, digitalisation and innovation. Research and development (R&D) spending in Cyprus remains one of the lowest in the EU, hindering the innovation capacity of the research centres and the business sector (see below).

Major factors, such as low digitalisation, barriers to investment, composition of investment — skewed to construction — and low R&D affect productivity performance.

[4.4. Competitiveness Reforms and Investment, 4.4.3. Governance and institutional quality*, Public administration, p. 55]

In addition, a national research and innovation council was created, while discussions are currently underway for the establishment of a Deputy Ministry for Research, Innovation and Digital Transformation.

5.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Cyprus remains a moderate innovator, with innovation performance having declined since 2010. Public and private research and development expenditure levels are among the lowest in the EU and interaction between academia and businesses is very limited. In order to strengthen innovation performance and foster productivity growth, investments should be geared towards already identified or potential new smart specialisation areas, on the basis of national needs and potential. Priority investment needs ⁽²⁷⁾ have been identified to enhance research and innovation capacity of the business sector and increase the uptake of advanced technologies, and in particular:

promotion of business investment in research and innovation and entrepreneurial universities and collaboration between research institutions, universities and businesses;

promotion of business technology transfer, networking, clusters and open innovation, including in cooperation with other countries;

support of activities that allow innovations to reach the market, including diffusion of digital and other key enabling technologies, especially for start-ups and small and medium-sized enterprises;

support of the establishment of Living Labs, test-beds and ecosystems that bring together the demand and supply sides to promote the development and actual use of innovative solutions for public sector needs.

Cyprus has a moderate digital enabling environment and low performance on digital transformation. Priority investments needs have been identified to reap the benefits offered by digitalisation and E-services for citizens, businesses and public sector, and in particular to:

provide support for the increase of Information and Communications Technology uptake in small and medium-sized enterprises, including supporting infrastructures and services;

increase the range of e-service provision (e-government, e-procurement, e-inclusion, e-health, e-learning, e-skilling, e-commerce) and their uptake by citizens and businesses.

Increasing entrepreneurship and the innovation capacity of the business sector and boosting investments and access to finance are crucial for the country to improve competitiveness of small and medium-sized enterprises. High priority investment needs

²⁷ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

have been identified to enhance growth and competitiveness and to increase export market shares of small and medium-sized enterprises, and in particular to:

foster the creation of new firms, growth of start-ups/scale-ups, accelerators; develop and implement new business models for small and medium-sized enterprises through business advisory services;

facilitate access to finance and advanced business services for small and medium-sized enterprises;

boost internationalisation of small and medium-sized enterprises through cooperation and clustering, identification of and participation in new export markets, participation in industry led and research driven inter-regional cooperation networks and clusters;

support training and reskilling for smart specialisation areas within firms, research institutions, advisory services and build the necessary administrative capacity, in particular in digital skills.

6. CZECH REPUBLIC

6.1. Executive summary

Focusing investments in education and upskilling, domestic innovation, and transport and digital infrastructure would strengthen the potential for long-term growth. Labour and demographic constraints in a manufacturing-intensive economy warrant more investment in education and upskilling to ensure the country is prepared for future technological changes. Affordable childcare and tailored active labour market policies, to help people find, stay in or return to work, require particular attention to achieve inclusive growth. If combined with an increased focus on domestic innovation, productivity could be raised across the entire business spectrum, including small and medium-sized enterprises.

The country has not yet created a fully functioning innovation ecosystem based on domestic research and development. The country remains a moderate innovator at EU level, despite an increase in research and development intensity. This may be linked to public investment lacking a coherent strategy to increase the modest research performance and improve cooperation between the private sector and the academia. Productivity is driven mostly by large foreign companies, while domestic firms lag behind in terms of value added generation. Moreover, total factor productivity, indicating how efficiently capital and labour are being used in production, has been growing at a relatively slow pace. Therefore, investment needs to support technology uptake and increase the innovation performance of firms, notably the domestic small and medium-sized enterprises.

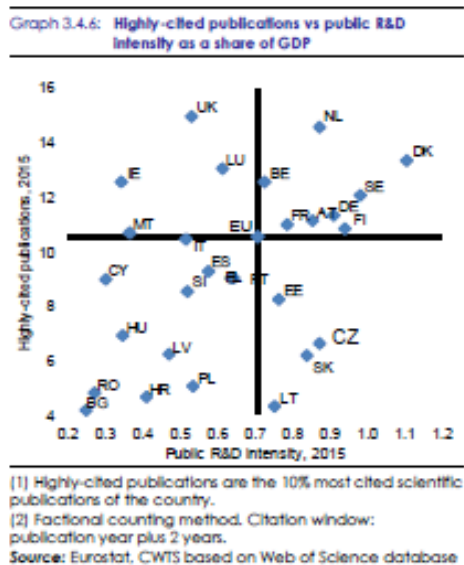
6.2. Research and Innovation

The Czech Republic has not yet created a fully functioning innovation ecosystem based on home-grown research and development. According to the latest European Innovation Scoreboard, the country is only a moderate innovator and the differential towards the EU average worsened since 2010, notably in relation to SMEs' innovation and collaboration activities (European Commission, 2018d). The overall R&D intensity in 2017 stood at 1.79 % of GDP. Business expenditure on R&D increased from 0.77 % of GDP in 2010 to 1.13 % of GDP in 2017. However, close to two thirds of these

expenditures are incurred by foreign firms. While some of these firms have set up medium and high-tech research and innovation facilities, their activities are mainly directed towards experimental development rather than industrial research. Thus, further investments are needed to improve the innovation potential of domestic firms, notably SMEs.

Public R&D investment lacks a coherent strategy to increase the modest research performance. Its level of intensity stood at 0.66 % of GDP in 2017 and if the current trend is maintained, the 2020 target of 1 % of GDP might not be reached. The increase in public R&D ⁽²⁸⁾ funding was partly linked to the inflow of EU funds, suggesting this increase may not be sustainable. While a large percentage of EU funding was allocated to the building of research infrastructures, further investments are needed to better leverage their economic spillovers. Furthermore, institutional funding for R&D activities allocated to higher education institutions and research institutes remains low and unrelated to their performance, so far with limited impact of the new evaluation methodology.

The performance of the public science base remains modest. Although its share of the top 10 % most cited publications and international co-publications kept increasing since 2000, the country underperforms given its level of public R&D investment (Graph 3.4.6). Even in scientific areas where the country has historically been specialised ⁽²⁹⁾ the performance is subpar. Besides the shortage of skilled human resources in scientific and technical fields, graduates are not systematically provided with the most relevant (e.g. soft skills) or up-to-date scientific knowledge. Consequently, further investments are needed to produce and train graduates in key fields.



Despite some encouraging initiatives, the low cooperation between the private sector and the academia hampers technology diffusion. Although there are examples of academia-business cooperation ⁽³⁰⁾, this tends to occur mostly on an ad-hoc basis. Even in scientific and technological fields where the country is relatively specialised, academia-firms cooperation is not yet systematic, as shown by the share of public-private

²⁸ Public R&D intensity stood at 0.55 % of GDP in 2007.

²⁹ Chemistry, physics and astronomy, 'medical sciences', 'life sciences'

³⁰ Skoda Auto-funded PhD programmes, Honeywell-Masaryk University cooperation in South Moravia

co-publications (³¹). In the absence of regulatory or funding incentives, higher education institutions and research organisations do not systematically integrate industry needs in their activities.

The financing of innovation is still under development. The National Innovation Fund, which was aimed at providing venture capital for start-ups and spin-offs, was cancelled. Instead, support to start-ups will be provided via equity investments through a fund of funds managed by the European Investment Fund. It remains to be seen whether this type of support will be appropriate for the needs of the Czech startups. On the other hand, there are currently no appropriate funding instruments supporting early-stage and proof of concept projects.

The country has not yet developed a coherent policy framework for moving up the value chain. There is scope for increasing the consistency and synergies between the competitiveness strategy, the research, development and innovation policy and the smart specialisation strategy. Recent institutional changes have led to research and innovation responsibilities being further split between different governmental bodies, with limited overall coordination. The identification of appropriate ‘qualifying criteria’ for research and innovation activities will be crucial for attracting higher value-added foreign investment under the forthcoming ‘Investment Incentives’ package (³²). The recently proposed amendment to the R&D tax incentive does not fully address the issue of uncertainty (e.g. assessment of projects will still be performed by tax authorities instead of qualified research and innovation experts). There is an investment need to provide soft measures for firms (e.g. business support services, innovation hubs) and ensure a systematic evaluation of these instruments’ effectiveness.

Czech companies are among Europe’s top performers in e-commerce but lack advanced digital technologies. 18.4 % of the total turnover for small and medium-sized enterprises (SMEs) and 36.7 % for large companies comes from electronic sales. A growing proportion of SMEs also use e-commerce across borders at levels above the EU average. Nonetheless, only 28 % of all companies use enterprise resource planning software to share information between different functional areas and only 15.5 % use advanced cloud services. SME’s ability to digitalise will be crucial for boosting their innovation, productivity, competitiveness and internationalisation. Furthermore, although the authorities are rolling out an Industry 4.0 strategy, there is limited investment in artificial intelligence, machine learning, big data or blockchain technology, activities that could upgrade Czech firms in the global value chains.

6.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 14]

There was limited progress in removing bottlenecks hampering research and innovation. The announced ‘Investment package’, if well designed, could attract higher value investments in the country and thus strengthen the innovation potential. Nonetheless, the Czech Republic remains only a ‘moderate’ innovator as the proportion of innovative Czech enterprises is below the EU average.

³¹ The share of public-private co-publications in ‘engineering sciences’, ‘medical sciences’ and ‘life sciences’ in 2016-2017 is lower than the EU average in those same fields.

³² Through an amendment of the Investment Incentives Act.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in the Czech Republic, p. 15]

The Czech Republic is one of the largest beneficiaries of the European Structural and Investment Funds (ESI Funds). The total allocation in the current multiannual financial framework amounts to EUR 24 billion, potentially amounting to around 1.8 % of the annual GDP. Furthermore, over 780 projects implemented by research institutions, innovative companies and researchers benefited from EUR 221 million of additional EU funding via Horizon 2020, covering a very broad thematic spectrum from transport, energy and ICT to environment, health and agriculture.

ESI Funds contribute to the removal of bottlenecks in research and innovation and support closer cooperation between business and research institutions. Overall, by the end of 2018, EU funding helped to improve infrastructure for more than 4 800 researchers and nearly 4 000 companies.

Under the EFSI Infrastructure and Innovation Window, 13 approved projects worth EUR 189 million are expected to trigger around EUR 711 million in total investment.

[3.3. Labour market, education and social policies, Labour market, p. 28]

Indeed, investment is needed to support the transformation of the national economy towards higher-value added production, which can increase labour productivity and innovation.

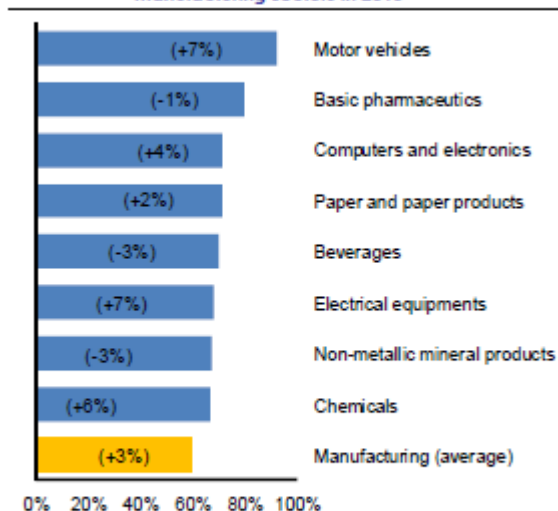
Deployment of high-level skills and closer cooperation with the business sector would enable the diffusion and uptake of innovation and industrial transformation.

[3.4. Competitiveness reforms and investment, 3.4.1 Competitiveness and productivity, p. 32/33]

Between EU accession and the start of the financial crisis, TFP saw an annual increase of around 3 %. Until the financial crisis, TFP growth was boosted by foreign direct investment (FDI), the availability of a cheap but skilled labour force, and technology imports. The lower levels of growth after 2009, however, may signal that the pre-crisis growth model may be losing steam. As the technology imports have not been replaced with home-grown innovation, the country may risk being caught in the middle-income trap (European Commission and EIB, 2018).

Foreign investment is a major contributor to the economy but spillovers remain limited. Almost one third of all employment is generated by FDI, more than in any other country in the region. Foreign firms account for around two thirds of value-added in the manufacturing sector, while their proportion exceeds 90 % in the automotive industry (Graph 3.4.3). They have around 25 % higher costs per employee than the national average, but also significantly larger labour productivity and turnover per employee. The gap between foreign and domestic firms in terms of value added and labour productivity has remained constant since 2008, suggesting limited spillovers in terms of technology and knowledge transfer (2018 Country Report; Pavlinek & Žížalová, 2016; Mýtna Kureková, 2018). While there were some indirect spillovers (i.e. increased requirements and competition from foreign firms), many domestic firms provide low value added products and services in the global supply chains. This may suggest an investment need to support the uptake of technology and increase the innovation performance of domestic firms.

Graph 3.4.3: Value-added of foreign-controlled firms as a share of total value added in specific manufacturing sectors in 2015



(1) The compound annual growth in 2011-2015 between brackets

Source: Eurostat FATS database

Addressing the investment needs in education, infrastructure and innovation can strengthen the country's long-term growth potential. Due to labour and demographic constraints impacting the manufacturing-intensive economy, further investment in education and upskilling is critical for ensuring that the country is ready for future technological changes (see Section 3.3). Increased focus on the home-grown innovation environment should boost the performance of domestic firms and upgrade them into the global supply chains, while reducing the dependency on foreign investment.

[3.4. Competitiveness reforms and investment, 3.4.2 Single Market integration, p. 38]

Access to certain regulated professions in the country continues to be more restrictive compared to the EU average. This relates particularly to notaries, lawyers, architects and civil engineers ⁽³³⁾. These restrictions could potentially hamper competition, long-term growth, innovation and competitiveness.

[3.4. Competitiveness reforms and investment, 3.4.3 Regional dimension, p. 39/40]

Despite having higher productivity, better education, improved innovation capacity and better connectivity, Prague with its adjacent areas in Central Bohemia and Brno suffer from certain negative externalities.

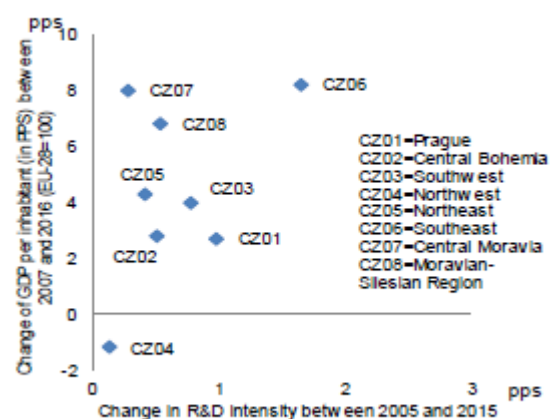
Severozápad and Jihovýchod regions together with Střední Čechy are moderate innovators, with a particular emphasis in the area surrounding Brno. Their productivity is quite high at country level, excluding the levels seen in Prague. The core parts of these regions are the metropolitan areas and the regional centres, which have the potential to drive regional productivity and innovation.

The innovation intensity of the less developed regions is significantly lower in addition to large productivity gaps.

³³ COM(2016) 820 final and SWD(2016) 436 final

Regional cities like Ostrava, Olomouc or Liberec have a significant potential to develop quality innovation but may need to improve their digital infrastructure.

Graph 3.4.8: Change in GDP per inhabitant vs change in R&D intensity in the Czech NUTS 2 regions



Source: European Commission

In addition, the level of R&D expenditure in Severozápad region is around three times lower than in the second-worst region in this regard (Graph 3.4.8).

Some less developed regions are undergoing a process of economic restructuring. Due to their historical focus on old industrial sectors, three regions (Ústecký, Karlovarský, Moravskoslezský) are supported by a specific government resolution called the Strategic Framework for Economic Restructuring (RESTART). These regions also have a higher proportion of people at risk of poverty and social exclusion, negative net migration, low focus on innovation, reduced accessibility to public transport services and environmental concerns (e.g. air quality).

[3.4. Competitiveness reforms and investment, 3.4.4 Governance quality, p. 41]

Efforts are needed to increase the expertise at all governance levels, including authorities that manage funds, central and local authorities, universities and research institutes implementing the projects, as well as local actors and grass-root organisations.

6.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The Czech Republic is lagging behind as regards the proportion of innovative companies which are crucial drivers of competitiveness. High priority investment needs ⁽³⁴⁾ have been identified to strengthen research and innovation capacities and the uptake of advanced technologies, in particular to strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential in order to:

increase attractiveness and competitiveness of the research system by improving management practices and reducing red tape, funding based on the quality of research,

³⁴ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

creating incentives for attracting qualified researchers, and upgrading research infrastructures where there is clear evidence of commercial interest and proven links to the smart specialisation;

support cooperation and knowledge transfer between research/academia and businesses in priority sectors;

increase the number of innovative firms and start-ups in the smart specialisation sectors with the highest potential also taking into account regional specialisations;

promote investment in universities and secondary schools reflecting the smart specialisation priorities.

Although the Czech Republic ranks around the EU average in terms of the integration of digital technology, households' uptake and companies' use of data-driven technologies remain limited. Priority investment needs have been identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

upscale and accelerate e-government, including the take-up of eHealth and Europe-wide interoperable services;

support integration and uptake of digital technology in small and medium-sized enterprises, including infrastructures and services.

Small and medium-sized enterprises lag behind in investment into research, development and innovation activities and the upgrade of their position in the global value chains. High priority investment needs have been identified to improve the competitiveness of small and medium-sized enterprises and support technology diffusion and uptake, in particular to:

support companies to move up in global value chains, increase productivity and facilitate participation in industry led and research driven international and macro regional clusters;

strengthen the research and innovation capacities of small and medium-sized enterprises by supporting development and implementation of new business models and adoption of new and emerging technologies;

provide support for proof of concept, early stage and scale-ups of innovative firms via financial and soft support measures (e.g. business support services, innovation hubs, etc.);

support small and medium-sized enterprises' internationalisation to grasp new business opportunities related to the digital, carbon-neutrality, resource efficiency and circular economy transitions.

Digitisation and automation may lead to growing skills mismatches. High priority investment needs have been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, in particular to:

provide businesses and research institutions with tools to adapt and develop skills for smart specialisation, industrial transition and entrepreneurship;

support growth of small and medium-sized enterprises by specific training and reskilling for smart specialisation areas and innovation management, and building administrative capacity (with a special attention to digital skills and industrial transition);

improve the practise-based approach in vocational education and training, higher education system, supporting the linkages between schools and companies.

7. DENMARK

7.1. Executive summary

Investment needs are emerging for skilled workers, research and development, and transport infrastructure. Investment as a share of GDP has risen above the euro area average, and Denmark has an investment-friendly business environment. Still, some factors are weighing on capital holding back investment. Investment in research and innovation is concentrated in a number of larger companies. This suggests it is important to broaden the innovation base to include more companies and to ensure innovation diffusion. Despite educational spending as a share of GDP that is among the highest in the EU, increasing shortages of skilled workers are holding back investment in Denmark. Prioritising investments in areas such as vocational education and training, and adult and lifelong learning, is key to sustaining labour supply.

7.2. Research, Innovation and Digitisation

Denmark acknowledges the significant role of research & innovation (R&I) investments as growth enablers. Denmark had one of highest research and development (R&D) intensities in the EU in 2017. At 3.1 % of GDP, it has already reached the 2020 target of 3 % of GDP. However, R&D intensity has stagnated since 2009, mostly due to a decrease in business expenditure on R&D as a percent of GDP (BERD) (although R&D intensity is still high compared to other EU Member States. The pharmaceutical and biotechnology sectors remain the clear leaders in R&D spending in Denmark due to the presence of leading global pharmaceutical companies. As part of the government's political agreement on business and entrepreneurial activities from 2017, corporate income tax deductions for BERD investments will gradually increase from 100 % to 110 % as of 2026.

Innovation is concentrated in a relatively small number of large enterprises. Although Denmark is an innovation leader overall according to the *European Innovation Scoreboard (EIS) 2018*, this is due to investment in R&D by a few very large businesses. Business expenditure in R&D (BERD) in small and medium-sized enterprises as a percentage of GDP slightly declined between 2007 and 2015 but remains among the highest in the EU despite Denmark's below-EU-average public support for BERD i.e. direct government support and R&D tax incentives (OECD, 2018b). However, about 70 % of business R&D is performed by the top 50 R&D performers in the country which is a high percentage in the OECD context (OECD, 2017). This may indicate that there is a need to foster spillovers from large companies to small and medium-sized enterprises. In addition, the share of small and medium-sized enterprises introducing product or process innovation is declining. Sales of new-to-market and new-to-firm innovations is now below the European average. There is therefore a need to further build up capacities in small and medium-sized enterprises to internalise external knowledge and new technologies.

Over the last decade, a process of structural change towards high-technology sectors has taken place in Denmark. The joint contribution of high-tech manufacturing, medium-high-tech manufacturing and knowledge-intensive services to gross value added (GVA) increased between 2007 and 2016 and corresponds to more than half of Denmark's GVA. In particular, the value added from high-tech manufacturing increased by almost 10 % in the last ten years.

The public science base is characterised by its high quality and increasing openness. In 2016, Denmark outperformed other EU member states in international scientific collaboration when measured by co-publications per capita of population. On scientific excellence, the country ranks third in the EU in highly scientific publications in the top 10 % of citations (2014-2017) as well as in the number of universities in the 2017 Shanghai ranking per million of population. Through its 2017 strategy for R&I, *Denmark: Ready to seize future opportunities*, the government wants to further boost the quality of Danish research to meet the highest international standards while aligning research with pressing societal challenges. One example is the 'pioneer centre' initiative aiming at ground breaking basic research.

Increasing the efficiency of the R&I system to boost overall productivity is a priority. Despite being a top R&D investor in the EU, Denmark's scientific excellence has rarely materialised into ground-breaking innovation. Denmark ranks only 13th in employment in fast-growing enterprises in innovative sectors and the share of high-growth firms is below the EU average. Reinforcing the entrepreneurial ecosystem by helping small and medium-sized enterprises to access advanced business support could boost employment in fast-growing enterprises. At the same time, co-operation on internationalisation and interregional clusters could also be encouraged. Moreover, since disruptive innovators depend greatly on risk financing, the fact that venture capital as a percentage of GDP decreased between 2007 and 2016 constrains the scaling-up of innovative companies. The Danish government has requested a peer review under the Horizon 2020 policy support facility to look into ways to support 'world-class knowledge-based innovation' focusing on knowledge-based technological services for businesses, collaboration, and networks and knowledge-based entrepreneurship.

Denmark has taken steps towards smart specialisation. Although Denmark has no formal smart specialisation strategy, a number of strategies, including the government's growth plans and the regional growth strategies, are oriented towards smart specialisation. In particular, the regional growth fora coordinate and ensure synergies between the Danish government's growth strategy and specific regional strengths. Moreover, Denmark takes part in the activities of the smart specialisation platform.

Denmark is positioned high in the EU in the use of digital technologies by enterprises (61 % in 2017). Nevertheless, the authorities aim to further strengthen the digitisation and e-commerce through its digital growth strategy. One of the initiatives is the small and medium-sized enterprises: *Digital* that provides grants to help clarify how the company can be digitised and to identify the economic and business potential. The initiative also aims at improving the use of e-commerce by small and medium-sized enterprises. Only 31 % of Danish small and medium-sized enterprises sell online, while the percentage for large enterprises is almost double that (57 %).

7.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 14]

Furthermore, there has been some progress on incentivising cooperation between businesses and universities, by setting up specific programmes and establishing the Innovation Fund.

[Box 2.1: EU funds help overcome structural challenges and foster development in Denmark, p. 15]

Denmark is a beneficiary of European Structural and Investment Funds (ESI Funds), and the financial allocation is up to EUR 1.5 billion in the current Multiannual Financial Framework, equivalent to around 2 % of all public investment per year on average. Furthermore, many Danish research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 889 million.

EU funds have supported closer collaboration between businesses and research institutions. They have also supported R&D investments in the private sector. By the end of 2018, ESI Funds had supported more than 1 100 enterprises in building cooperation with research institutions, and almost 600 enterprises in introducing new products in their markets. Horizon 2020 supported 1 547 research projects covering a very broad thematic spectrum from vaccine development to fish farming.

Under the ‘infrastructure and innovation’ window, 17 projects were approved for financing by the European Investment Bank (EIB) with EFSI backing ⁽³⁵⁾, for a total financing of approximately EUR 567 million set to trigger EUR 3.9 billion in total investment.

[3.4. Competitiveness reforms and investment, 3.4.1. External position and competitiveness, p. 33/34]

Investment in the education system, R&D and transport infrastructure is key to boost productivity growth. Maintaining the high level of investment in education will allow Denmark to face the challenges of a changing labour market. Labour shortages are increasing and companies report that the lack of skilled workers is the main investment barrier. This underlines the need to prioritise investment in vocational education and training, adult- and lifelong learning (see Section 3.3). Despite the high overall R&D level, the concentration of R&D activities in a small number of large firms calls for R&D capacity building within small and medium-sized enterprises.

[3.4. Competitiveness reforms and investment, 3.4.3. Infrastructure, Broadband, p. 39]

In addition, the Innovation Fund Denmark has allocated funds to several major 5G projects involving universities, industry and operators.

Box 3.4.1: Investment challenges and reforms in Denmark, p. 41/42]

Recent initiatives also help to further foster cooperation between academia, business and the research community. However, private R&D expenditure remains concentrated in larger companies.

The lack of skilled staff hampers investment for firms in Denmark, according to the EIB investment survey (EIB, 2018). While a number of recent labour market and education

³⁵ 9 of which are multi-country projects

reforms seek to address this issue, it is also key to reduce the dropout rates of students and to incentivise them to choose vocational education and training (VET). Moreover, investment in research and innovation is concentrated in a number of larger companies. This suggests that it is important to broaden the innovation base to include more firms and to ensure innovation diffusion.

The Danish Growth Fund and the Innovation Fund are the Danish state's investment funds. The Growth Fund supports and promotes growth for start-ups as well as for small and medium-sized enterprises. The Innovation Fund supports research and innovation projects. The funds contribute by providing capital and expertise. In 2017, the Danish Growth Fund supported more than 800 companies by providing capital amounting to DKK 2.5 billion (1.2 % of GDP) while the Innovation Fund provided funding amounting to DKK 1.2 billion (0.6 % of GDP).

7.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Overall, Denmark is an Innovation Leader, but private research and development investment is increasingly concentrated on a small number of large businesses. This means that the majority of Danish small and medium-sized enterprises are not sufficiently preparing for the future through innovations in products and processes. Investment needs ⁽³⁶⁾ have been therefore identified to enhance research and innovation capacities and the uptake of advanced technologies in small and medium-sized enterprises, and in particular to:

promote cooperation between small and medium-sized enterprises and academia and encourage universities/research centres to be actively involved in projects, whilst developing entrepreneurial ecosystems; cooperation could involve stakeholders in other regions, and also across borders notably in the framework of the EU Strategy for Baltic Sea Region;

invest in firms' capacity to internalise external knowledge and new technologies, strengthen market-oriented research and development, including through the establishment of Living Labs, and facilitate innovation uptake in small and medium-sized enterprises, in order to allow them to participate in global value chains;

strengthen effective connectivity between actors in the innovation ecosystem in order to facilitate a quicker commercialisation of research in the high growth smart specialisation areas;

increase the diffusion of the latest digital developments and other key enabling technologies through the network of digital innovation hubs via science/business collaboration to allow Danish small and medium-sized enterprises to exploit new technologies to generate growth.

Among Danish small and medium-sized enterprises, there are relatively few with a high growth rate, and employment in fast growing firms is below the European average. Investment needs have therefore been identified to enhance growth and competitiveness

³⁶ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

of small and medium-sized enterprises, which could boost productivity growth, and in particular to:

promote the creation of, and broaden the scope, of innovative firms among small and medium-sized enterprises (foster growth of start-ups/scale-ups/accelerators) and enable them to sufficiently prepare for the future through innovations in products and processes in the smart specialisation areas with the highest growth potential;

facilitate growth and internationalisation of small and medium-sized enterprises through the use of networks and clusters on a regional, interregional and international level. The partnerships and knowledge sharing can be the basis for further innovations and co-operation, in line with the EU Strategy for the Baltic Sea Region. This could open up potential for new exports, high tech sales, and boost employment creation.

The improving economic situation following the financial and economic crisis has led to shortages of skilled labour, and firms are facing challenges in recruiting certain types of workers. There is room to improve the matching of supply and demand of relevant digital skills. Investment needs have therefore been identified for the development of skills for smart specialisation, industrial transition and entrepreneurship, in synergy with lifelong learning actions under Policy Objective 4; and in particular to:

specific training and reskilling for smart specialisation areas at all levels within firms and building the necessary administrative capacity, with a particular attention to digital skills and the need to address industrial transition;

trainings on managing innovations to small and medium-sized enterprises, research institutions and to entities that provide support and advisory services;

strengthening the integration of education and training providers including universities and vocational education and training centres within national and regional innovation, technology diffusion and skills development ecosystems;

support cooperation on promoting mobility of researchers across borders to better utilise the available human capital.

8. SPAIN

8.1. Executive summary

Supporting Spain's sustainable growth requires investments to foster innovation and resource efficiency, to promote skills and employability, to upgrade rail infrastructure for transporting goods, extend energy connections with Europe, as well as to promote job quality and social inclusion. Capital formation in Spain rebounded after the crisis, though mainly in the private sector. Further investment on public and private research and investment, including for small and medium-sized companies, as well as on digitisation and resource efficiency, would bolster competitiveness and the innovation capacity of the economy, if acting in synergy with investment on skills. In all these areas, investment should be targeted at addressing the specific regional needs.

Innovation is hampered by a number of factors and this also affects productivity. Spain is a “moderate innovator” in the EU. The innovation performance of the country suffers from underinvestment in public and private R&D, but also from weak

coordination across all levels of government and insufficient reliance on policy evaluation. Skills shortages and mismatches are another important barrier to the development and use of advanced technologies. Stronger cooperation between academia and businesses could contribute to the diffusion of knowledge and help increase the presence of innovative firms. All these factors underlie Spain's low performance in terms of knowledge-intensive exports, particularly services.

...Small and medium-sized firms account for around half of R&D investment by firms, but are less able to absorb knowledge and technology.

8.2. Research, Innovation and Digital economy

In an EU comparison, Spain is a moderate innovator. In 2017, Spain's innovation performance measured on the basis of the 2018 European Innovation Scoreboard increased relative to the EU average in 2010, but remains below the EU average. The summary innovation index incorporates a particularly low score on firm investments in innovation expenditures; linkages between innovative small and medium-sized companies and between academia and businesses; and share of innovative firms. Spain also underperforms the EU average in terms of knowledge-intensive services.

Spain's innovation and productivity performance is hampered by a lack of stable investment in R&D and innovation. The investment gap in intangible assets compared to the EU, notably for private R&D investment, has been widening in recent years, when both public and private R&D intensity in Spain have been on a declining trend (Graph 4.4.4). Overall R&D expenditure accounted for 1.20 % of GDP in 2017, and the national 2 % R&D intensity target for 2020 will not be reached unless these trends are drastically reversed. The size of the innovation fabric in Spain is small compared to the size of its economy, and this hampers the structural change towards a knowledge-based economy. Spain is below the EU average both in employment and share of value added of knowledge intensive activities ⁽³⁷⁾.

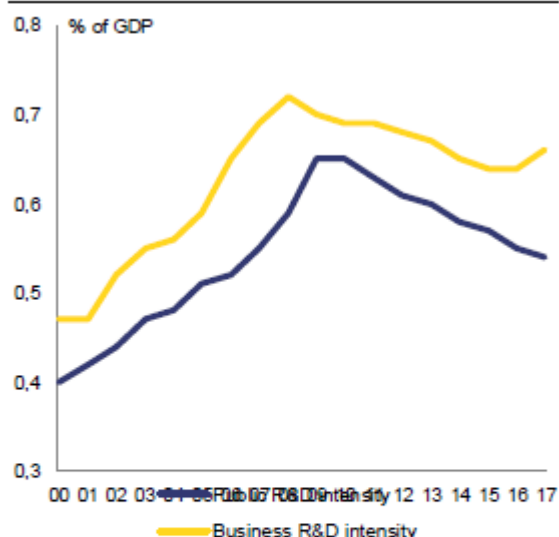
Business innovation capacity is constrained by low R&D investment by large firms, and low absorption capacity by small firms. The Spanish small and medium-sized enterprises (SMEs) account for around 50 % of the R&D investment done by firms, higher than the EU average (22.7 %) ⁽³⁸⁾. However, small and medium-sized companies have less financial and human resources, and more limited absorptive capacity for knowledge and technology than large firms. At the same time, large firms in Spain have lower innovation investment than their European counterparts. Weak knowledge flows among stakeholders could be linked to lower investment.

The public research and innovation system suffers from underinvestment and a low take-up of public funds available. Public R&D investment is the lowest in almost a decade (Graph 4.4.4). Furthermore, the execution of the dedicated public research and innovation budget lines was very low, at around 30 %, in 2017, due to high reliance on credit-based financial instruments that have had low take-up. The level of public investment for R&D remains unchanged in the absence of a new Budget Law for 2019.

³⁷ Share of value added in high tech knowledge intensive services is 4.4% compared to 5.1 % in EU. It is 4.6 % in medium-high-tech manufacturing, compared to 5.8% in the EU (OECD, 2017).

³⁸ Eurostat: BERD performed by SMEs in % of GDP/BERD in % of GDP

Graph 4.4.4: Evolution of business R&D intensity and public R&D intensity 2000-2017



(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: breaks in series between 2002 and the previous years and between 2008 and the previous years.

Source: Eurostat.

Human resources remain a crucial challenge for the Spanish research and innovation system. Despite Spain's high number of science and technology graduates and the relatively high share of the population with tertiary education (see Section 4.3.2 on education), the number of researchers in Spain is below the EU average (2.8 % vs 3.9 % of the labour force in 2016), and decreasing. The share of researchers employed in the private sector is also lower than the EU average (37 % vs. 49 % in 2016) and the cooperation between business and science is very limited. In the public sector, the number of researchers has also decreased, and their average age has increased (European Commission, 2017c). Recent measures were put in place to address this, notably the obligation not to let the number of researchers decline further in the public sector and increasing the number of grants in post-doctoral programmes. Steps to reduce the number of temporary contracts in public research organisations have been taken in early 2019. However, reforms to consolidate careers in research through a 'tenure track' system in universities and public research organisations are still pending. Finally, there are no policies to direct students towards intermediate technical fields, where there is a lack of qualified personnel.

The quality and structure of the Spanish R&D system is being improved, but the coordination and synergies between national and regional policies need to be reinforced. The recently created Ministry of Science, Innovation and Universities now covers previously split competences, allowing for a more comprehensive vision of policy needs and synergies in policy-making. There has been steady growth over the past decade in Spain's scientific quality – measured by the share of domestic publications that are among the top 10% most cited scientific publications worldwide - and in the openness of the Spanish research system - as measured by the share of international co-publications in total publications, where Spain now is above EU average (62). Finally, the Spanish Research Agency, created in 2015, is now operational and manages public

research grants. Efforts to improve coordination between national and regional initiatives in research and innovation policies will need time to show an impact (Section 4.4.3).

There have been limited steps to develop an evaluation culture for public research and innovation policy. The Spanish Innovation Agency (CDTI) has commissioned an impact evaluation of the innovation programmes, but most of the public research and innovation initiatives lack systematic assessments of quality, impact and efficiency using comparable methodologies. The Government is developing a more ambitious information system on science, technology and innovation intended to facilitate monitoring and evaluation. The system will include regional data and will be open to regional administrations.

Spain does not fully exploit the growth potential offered by digitisation, but is taking some positive steps. Spain has a lower number of information and communication technology specialists in the work force than the EU average (2.9 % vs. 3.7 %), and one in five Spanish companies (both large and small and medium-sized enterprises) report serious difficulties in hiring these specialists. In addition, small and medium-sized enterprises lag behind big companies in digitisation, with lack of knowledge and technical skills among employees representing main barriers. In response, the strategy ‘Industria Conectada 4.0’, adopted in 2015, has launched several actions to boost digitalisation among companies ⁽³⁹⁾. The Spanish Digital Agenda dates from 2013 and plans to update it focus on specific issues. The Government is currently working on the Strategy “Spain Start-Up Nation”, an overarching strategy to embed innovation and digitalisation in all aspects of economy and society. This strategy would include a new plan for the deployment of digital infrastructure; investment in enabling digital technologies; programs to promote skills and talent, or a national strategy on Artificial Intelligence ⁽⁴⁰⁾. Spain is also committed to the advancement of new digital technologies via EU-coordinated programmes ⁽⁴¹⁾.

Despite significant investments in infrastructure, the take-up of high-speed connections remains low, as only 30 % of Spanish households subscribe to ultrafast broadband. On the other hand, fibre-to-home subscriptions have overcome other technologies (cable and DSL). Regarding 5G deployment, operators as well as public authorities are preparing the ground with pilot projects. 3,4-3,8 GHz band is already assigned and free for providing 5G services and a 700 MHz auction is expected in early 2020.

8.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 16/17]

Limited progress has been achieved in implementing product market reforms and improving research and innovation in recent years. In the past few years, Spain has received recommendations to address regulatory fragmentation in its internal market and to strengthen research and innovation, a prerequisite for sustainable productivity growth. Public support for R&D remains low. There were a few advances in innovation

³⁹ Such as a self-assessment tool for enterprises (<https://hada.industriaconectada40.gob.es/hada/register>)

⁴⁰ In addition, new initiatives such as the announced Retail Modernisation Plan 2019-2020 or a foreseen “Strategy for sustainable tourism” will promote innovation and digitisation specific economic sectors.

⁴¹ Euro HPC Joint Undertaking, European Blockchain Partnership, declaration on cooperation on Artificial Intelligence

governance and public-private cooperation in research and tertiary education, but some of the measures taken may need some time before they have a measurable impact.

The level of public investment in R&D remains unchanged in the absence of a new Budget Law for 2019 and there have been limited steps to enhance the evaluation culture for innovation policies.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Spain, p. 18]

Spanish research institutions, innovative firms, researchers and academics benefitted also from Horizon 2020 EU funding instrument with EUR 3.3 billion disbursed so far.

Actions financed include closer collaboration between businesses and research institutions, thus boosting the research and innovation system. As a result, European Structural and Investment Funds helped more than 3 000 enterprises in building cooperation with research institutions and about 450 firms in introducing new products on the markets in 2017.

86 projects involving Spain were approved under the infrastructure and innovation window of the European Fund for Structural Investment; amounting to EUR 7 billion which should, in turn, generate EUR 30.7 billion of investments.

The pilot action on Industrial Transition helps to develop a comprehensive strategy for regional economic transformation building on their smart specialization strategy, clusters and digitization of industry plans. The action encourages interregional cooperation and the creation of value chains across European regions, identifies collaboration and funding opportunities at European, national and regional level, promotes regional and cluster partnerships focusing on mutual learning and sharing of good practices in innovation policies.

[3. Summary of the main findings from the MIP in-depth review, 3.2. Imbalances and their gravity, p. 20]

For Spain, the areas where the gap with the best performers are larger concern the business environment, taxation, skills and active labour market policies, as well as research and innovation.

[Box 3.1: Outward spill-overs, p. 26]

The simulation for Spain shows that there may be a small but positive net spill-over to the rest of the euro area from structural reforms. The simulated reforms cover all areas: product market regulation and entry costs, labour market participation, taxation structure and R&D subsidies.

[4.1. Public finances and taxation, 4.1.2. Fiscal framework, p. 32]

With support from the European Commission, the expenditure reviews, carried out by the Spanish Independent Authority for Fiscal Responsibility (AIReF) in 2018 and approved

for 2019, have the potential to lead to improvements in the efficiency and effectiveness of public spending in selected areas (⁴²).

[4.1. Public finances and taxation, 4.1.3. Taxation, p. 34]

The R&D tax credit is one of the most generous and generic in the EU. However, it does not seem to lead to a significant increase in private R&D investment. The uptake in tax incentives for R&D might be fostered by removing administrative barriers limiting their implementation (Cordón and Gutiérrez Lousa, 2010; Busom, Corchuelo and Martínez Ros, 2014). Evidence shows that the probability of using tax incentives decreases when firms, in particular small and medium-sized businesses, face financial constraints (Busom, Corchuelo and Martínez Ros, 2014).

[4.3. Labour market, education and social policies, 4.3.2. Education and skills, p. 52]

Cooperation between universities and businesses remains weak, but some new initiatives appear promising. The Spanish universities association and the conference of business organisations jointly agreed to increase business participation in the universities' decisions on curricula and teaching methods, with the aim of increasing employability of university graduates (⁴³). The Government supported the creation of the CERVERA Network to boost knowledge transfer. However, the mobility of students and academic staff is still limited, academic staff lack training opportunities, the university governance is still rigid and the Offices for the Transfer of Research Outcomes face a high administrative burden.

[4.4. Competitiveness, reforms, and investment, 4.4.1. Productivity, competitiveness, and investment*, p. 58/59]

Supporting Spain's long-term sustainable growth requires investments to foster and help absorb innovation, including in small and medium-sized enterprises, as well as to promote resource efficiency, upgrade rail infrastructure for freight transport and extend energy connections with Europe. Further investment in both public and private R&D, as well as digitisation and digital skills, would bolster the innovation capacity of the economy, if acting in synergy with investment on education and labour market policies (see Section 4.3).

The large presence of small companies in the economy and a low innovation capacity largely explain Spain's productivity gap. Small companies tend to record lower productivity than large ones, mainly due to scale effects and limits to their absorptive capacity for innovation. This is compounded by the fact that companies tend to be less productive than their counterparts in other large Member States at all size levels, and is reflected in Spain's comparatively low share of innovative firms across sectors, as measured by the 2018 European Innovation Scoreboard.

⁴² The 2018 reviews comprise seven evaluations of subsidies in the following areas: prescription drugs, active labour market policies, university education scholarships, promotion of talent and employability in R&D and innovation (pre- and post-doctoral aid programmes), the re-industrialisation and industrial competitiveness programme (RIC), the Spanish national post service and finally an overall evaluation of the strategy and procedures in granting subsidies. The 2019 reviews comprise the evaluation of the following expenditure items: expenditure in hospitals, investments in public infrastructure, tax benefits and hiring incentives.

⁴³ See, the joint agreement between the Spanish Universities Association (CREU) and the Conference of Spanish Business Organisations (CEOE).

Structural impediments to the free flow of the factors of production and improved efficiency of production, ranging from skill gaps to the low innovation performance and fragmented product and service market regulation are key drivers of Spain's relatively low score in allocative efficiency and productivity.

[Box 4.4.1: Global Value Chains: the role of Spain, p. 61]

The services sector has contributed the most to the increase in the domestic value added content of total exports, mainly driven by wholesale and retail trade, as well as R&D services and Other business activities.

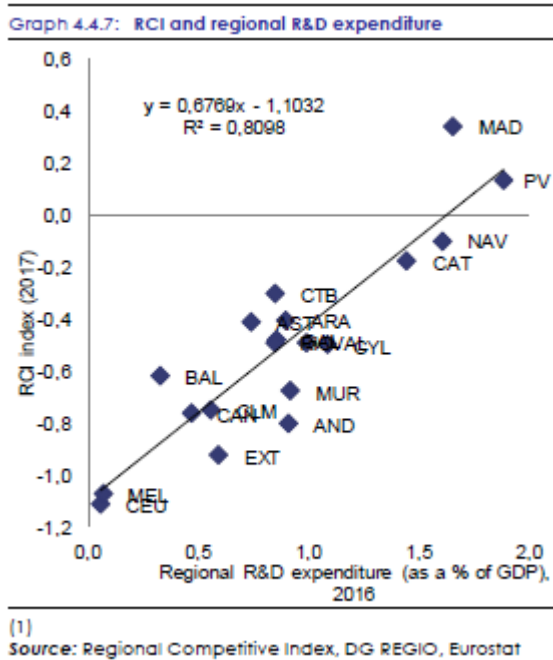
[Box 4.4.2: Investment challenges and reforms in Spain, p. 66]

Skills mismatches constrain productivity growth and innovation (see Sections 4.3.1, 4.3.2, and 4.4.1). The high share of temporary employment reduces both workers' and employers' incentives to invest in training and improving job-specific skills. Labour market relevance of tertiary education in particular is weak, because of lack of cooperation between universities and because small and medium-sized companies have a limited capacity to engage with the higher education system and invest in training. Whereas secondary vocational educational training is being strengthened and promoted, enrolment rates are still low.

[4.4. Competitiveness, reforms, and investment, 4.4.3. The regional dimension, p. 69/70]

The latter – which is an aggregate of the main labour market indicators – is also the dimension where Spain displays the largest divergences across regions (see Section 4.3), together with infrastructure, business sophistication, and innovation.

Innovation performance is below the EU average in most Spanish regions, with the exception of the Basque Country, which is considered a strong innovator (Regional Innovation Scoreboard, 2017). The majority of Spanish regions fall within the group of moderate innovators (performance between 50 % and 90 % of the EU average). Regional competitiveness is highly correlated with the level of regional R&D investment (Graph 4.4.7), which is concentrated in the four regions with the highest GDP per capita (Madrid, the Basque Country, Navarre, and Catalonia). In addition, with the exception of Navarre, Madrid, and Catalonia, all other Spanish regions are below the EU average on public-private scientific co-publications and none are within the high performing group. Moreover, cooperation between small and medium-sized enterprises remains low, affecting the dissemination of technologies and innovations from national best performing firms and regions to laggards.



Through the development of Smart Specialisation Strategies, Spain has taken initiatives to boost its innovation potential ⁽⁴⁴⁾, but coordination between national and regional levels in research and innovation remains weak. Reinforced and more focused smart specialisation strategies together with stronger monitoring and evaluation can help to improve innovation performance in all Spanish regions. In particular, smart specialisation may boost industrial transition in the regions that face specific challenges for economic transformation. Recent efforts to improve coordination between national and regional initiatives to exploit synergies between national and regional research and innovation policies and support schemes will need time to show an impact ⁽⁴⁵⁾.

8.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Spain remains a moderate innovator and the innovation capabilities of its public sector and companies are insufficient to increase their productivity. High priority investment needs ⁽⁴⁶⁾ are therefore identified to enhance research and innovation capabilities and the uptake of advanced technologies within the framework of regional smart specialisation strategies identifying priority areas based on regional needs, in particular to:

foster investment in research and innovation, in particular to increase the number of innovative firms in the Smart Specialisation Strategy sectors, including innovative public procurement and development of new products, processes and services;

enhance technology transfer and market-oriented cooperation between businesses, research centres and universities, in particular through the development and use of

⁴⁴ Valoración del proceso RIS3 (estrategias de especialización inteligente) en España. February 2018.

⁴⁵ E.g. the Spanish Council for Scientific, Technological and Innovation Policy; the Network on Public Policies for research, development and innovation – REDIDI; and the new Ministry of Science, Innovation and Universities.

⁴⁶ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

innovation eco-systems and the increase of the capacity of firms to internalise external knowledge;

stimulate interregional cooperation in new value chains, also with other Member States;

increase synergies and complementarities between national and regional operational programmes through joint programming for a more efficient use of public resources.

In order to increase the uptake of new generation Information and Communication Technology by businesses and to improve the access to e-government and other public e-services, priority investment needs are identified to reap the benefits of digitisation for citizens, companies and governmental bodies, and in particular to:

support the uptake of digital technologies and Information and Communication Technology based business models for SMEs, including infrastructures and services like digital innovation hubs, as well as promoting e-skilling and market-driven Information and Communication Technology skills in small and medium sized enterprises;

develop and promote interoperable e-government and e-services (health, education and other public services), in particular in remote and outermost regions, and including joint provision of services in border areas.

The reduced size of Spanish small and medium sized enterprises affects their innovation capacity and productivity. High priority investment needs are therefore identified to enhance growth and competitiveness of small and medium sized enterprises, and in particular to:

promote entrepreneurship, growth of start-ups/scale-ups, incubators and accelerators, access to advanced business services, and new business models for small and medium sized enterprises, in particular through investment in intangibles;

boost exports, by increasing the number of regular exporters, in particular of SMEs with a focus on developing the link between exporting and innovation;

encourage entrepreneurial ecosystems by supporting networking, business transfer ecosystems, (industry-led) cluster development and deployment of joint interregional innovative projects, also cross-border.

Skill gaps and mismatches hinder productivity and technology diffusion, and affect the development of innovative competences in Spain. In this sense, priority investment needs are identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

stimulate innovation management, specific training and re-skilling in the areas of smart specialisation, industrial transition and entrepreneurship, in particular on key enabling technologies and emerging fields;

integrate education institutions within national and regional innovation ecosystems to increase the commercial viability and market relevance of their research projects.

9. ESTONIA

9.1. Executive summary

Focusing public and private investment on human capital, infrastructure, research and innovation and on promoting resource efficiency would strengthen Estonia's long-term growth potential. Current skills shortages and underinvestment in research and development limit productivity gains for the economy. Further investment in innovation, including in digitisation and automation can make firms more productive.

Research, innovation and technological transformation are key to boosting productivity growth. A significant proportion of the Estonian companies operate in medium and low-technology sectors. Low investment in research and development partly explains why productivity has been lagging behind. More targeted investment in research and economy-wide innovation would increase productivity and competitiveness. A stronger connection between the public research system and the private sector will also help the economy grow. Digitisation and automation could support the competitiveness of small and medium-sized firms in the medium term but require specific skills. Modernising the insolvency framework can also help unlock Estonia's business potential.

9.2. Research and Innovation

Investment that supports the move towards high-technology and knowledge intensive sectors is likely to be required to sustain productivity growth. The Estonian economy is dominated by low and medium-low technology sectors. About 10 % of its manufacturing companies operate in high-tech and medium high-tech manufacturing sectors and create about 21 % of jobs and 24 % of value added. The share of employment in fast-growing companies in innovative sectors (⁴⁷) in Estonia is low (3.2 %), below the EU average of 4.8 %. At the same time, many of these firms specialised in contract manufacturing, with research, development, and innovation activities performed abroad. This makes the sectors vulnerable to international competition as wages continue to increase. Income convergence in the country can be sustained if more companies develop R&I activities and move up in global value chains. This contrasts with Estonia's strength in knowledge-intensive services that increasingly provide value added to the economy. Further investment from both the private and the public sectors is required to ensure that innovation is wide-ranging, develop new products and services, enter new markets and improve the skills of available human resources.

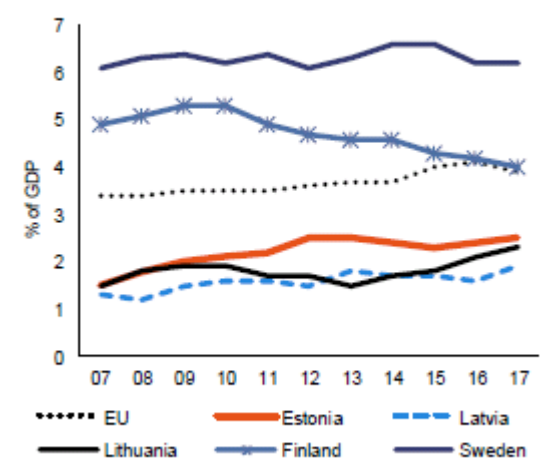
Estonia's innovation performance has dropped, as measured by the European Innovation Scoreboard. Although the country remains a 'moderate innovator' (European Commission, 2018h), the low proportion of innovative small and medium-sized enterprises, decline of non-R&D innovation expenditure and the weak collaboration between companies and the public sector drag down the innovation performance (European Commission, 2018i). In 2017, small and medium-sized enterprises carrying out product or process innovation stood at less than 30 % of the EU average, and for marketing or organisational innovation this figures was less than 20 %. The proportion of small and medium-sized enterprises that reported doing in-house innovation is a little higher, but still below 40 % of the EU average (ibid). To overcome barriers to entry in new sectors and markets, small and medium-sized enterprises need targeted support for

⁴⁷ Number of employees in high growth enterprises measured in employment (growth by 10 % or more) in the top 25 % most innovative sectors, defined according to CIS*KIA scores

innovation. It helps that Estonia already has a business-friendly environment and high tertiary education attainment.

Estonia performs well in terms of some intellectual property production, but below the EU average in terms of investment in this area (see Graph 3.4.6). Amount of trademark and design applications was above the EU average (European Commission, 2018i). In patent application, Estonia is doing better in comparison to its Baltic peers but well below the EU average and the Nordic countries. In the manufacturing sector, the number of companies developing new products or services is relatively low, and the awareness and knowledge of procedures to acquire patents is limited.

Graph 3.4.6: Investment in intellectual property products (gross)



Source: European Commission

Investment in R&D by the private sector is relatively low and concentrated. Business R&D intensity decreased slightly to 0.61 % of GDP in 2017 and is at half of the EU average (1.36 %). R&D investment appears highly concentrated in a small number of firms, and has declined in small and medium-sized enterprises (from 0.55 % of GDP in 2010 to 0.32 % in 2015, slightly above the EU average of 0.30 %). Business R&D expenditure is largest in the information and communication technology (40 %) and manufacturing (25 %) sectors. Although Enterprise Estonia launched a scheme to support product development and R&D, significant investment will be needed to help Estonian companies to catch up with European peers and foster competitiveness and productivity.

The weak link between the science and the economy is a persistent shortcoming for Estonia's R&I system. On the one hand, there is a lack of prioritisation of research topics in areas of relevance for the economy and some adjustments to the smart specialisation strategy are needed. On the other hand, the research results are insufficiently exploited, partially due to the limited R&D absorption capacity of companies in Estonia. Firms only commissioned 6 % of research activities to universities and public research organisations which is close to the EU average. Most doctoral degree graduates remain in the research sector, and their employment share in business is rather low (an average of 2 % per one thousand in the active population versus 4 % in the EU). To engage businesses and science in collaborative projects and increase companies' technological capacity, policy measures, based on the smart specialisation strategy, include incentives in the baseline funding of R&D institutions and new infrastructure investments in strategic areas – mainly in information and communication technologies and resources valorisation.

Measures designed to address the shortcomings in the R&I system have had limited impact. For example, support for competences centres, the innovation and development vouchers, and the 'ADAPTER' platform ⁽⁴⁸⁾ have not led to a visible increase in reported R&D activities. The role of the clusters has also been limited because of resource constraints. The 'NUTIKAS' programme, promoting applied research in smart specialisation areas, is under revision due to its slow uptake. ⁽⁴⁹⁾ New initiatives are being introduced to support: product development ('My First Product'), the commercialisation of breaking scientific results ('Proof of Concept') and digitisation in the manufacturing sector. In addition, Estonia requested an external analysis of its R&I system through the Horizon 2020 Policy Support Facility to support its efforts to better connect the research and economy.

Public expenditure in R&D has increased, but remains below the EU average. Public expenditure in R&D reached 0.66 % of GDP in 2017, below the EU average of 0.69 % of GDP. While currently around 48 % of funding for R&D is provided by the EU, Estonia plans to increase the state budget allocation for R&D to 1 % of GDP ⁽⁵⁰⁾. The quality of the country's scientific results, measured by the number of published articles with the top 10 % of the most cited articles, is below the EU average, although it has improved ⁽⁵¹⁾. Estonia's public research system benefits from a high number of international scientific co-publications and an increasing number of foreign researchers (10 % of the total) and doctoral students (17 %) in 2017. The substantial increase of baseline funding for higher education and research institutions (tripled over the last four years, from EUR 9 million to EUR 27 million and growth will continue in 2019) is likely to help the long-term sustainability of the public R&D system. However, the increase in the quality of the science base in Estonia still does not leverage R&D activities carried out by companies.

9.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 13/14]

Estonia has taken measures to strengthen the research and innovation system over the past years, but the level of R&D intensity, especially in the business sector, remains low. National authorities adopted the third Estonian R&I strategy in 2014 – "Knowledge-based Estonia 2014-2020", which aims at addressing some country-specific recommendations in the field of R&D – mainly internationalisation and specialisation of the R&D system. The Estonian authorities put in place several measures to improve science-business cooperation. Nevertheless, the weak level of knowledge transfer from the public science base to the private sector, the lack of specialisation of research topics in sectors that are relevant for the economy and the low technological capacity of firms continue to drag down Estonia's innovation performance. The measures introduced in the previous years to promote R&D (innovation and development vouchers, ADAPTER, NUTIKAS) so far had only limited impact.

⁴⁸ ADAPTER is a network of Estonian universities, research and development organisations, providing a quick and reliable link for companies and organisations to the research and development community.

⁴⁹ With a total budget of EUR 50.7m, only over EUR 12m have been granted among 35 awarded projects

⁵⁰ Implementation Plan 2016-2019 for achieving the objectives of the Estonian Research and Development and Innovation Strategy 2014-2020 "Knowledge-based Estonia"

⁵¹ Estonia has an average of 7.6 scientific publications ranked among the top 10 % most-cited worldwide publications versus the EU average of 11.1

Estonia has made some progress to broaden the innovation base by introducing several new funding schemes in 2018. These include support product development in companies, the commercialisation of breaking scientific results, and digitalisation in the industry. Nevertheless, the innovation performance of small and medium-sized enterprises, business R&D investment and the proportion of companies reporting research activities continue to be low.

[2. Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Estonia, p. 15]

EU funding also has helped addressing policy challenges and the implementation of the 2018 country specific recommendations. Actions financed, among others, facilitating private sector R&D investments; enhancing cooperation between business and academia; improving public services' quality, including by providing support to the local government reform.

Eight projects involving Estonia have so far been approved under the infrastructure and innovation window of the European Fund for Strategic Investments. They amount to EUR 129 million in total financing, which are expected to generate EUR 527 million in investments. The European Investment Bank is providing financing of R&D and innovation to Europe's leading producer of ultracapacitors, a cutting edge emerging technology designed to store energy efficiently.

[3.1. Public finances and taxation, 3.1.2. Taxation framework, p. 18]

The corporate income tax system has no special provisions to favour investment in research and development. However, companies can deduct all business-related expenses and the corporate income tax only applies to the income distributed to shareholders.

[3.2. Financial sector, 3.2.2. Access to finance, p. 21]

The significant EU and national support provided through Kredex, the Baltic Innovation Fund (EUR 130 million) and the EstFund (EUR 60 million), served as a stimulus to some large institutional investors, such as pension and insurance funds, to invest in young and growing companies (⁵²). It also helped to increase the number of start-ups and to scale up the most successful ones.

[3.3. Labour market, education and social policies, 3.3.3. Education and skills, p. 30/31]

Demographic trends (⁵³) and emerging automation mean that Estonia needs to better capitalise on its human resources and its education system to deploy higher skills and enable the uptake of innovation.

⁵² See <http://www.estvca.ee/> Baltic Innovation Fund managed to raise EUR 335 million, 40 % of which coming from the pension funds.

⁵³ The distribution between the different stages of education has changed considerably, reflecting changes in the population's age structure. In 2017, the number of higher education students decreased by one third compared to the peak year of 2010. Declining trends since 2005 in secondary education have reversed, while the number of students in basic education continues to increase. In pre-school, numbers have been decreasing since 2015 (Statistics Estonia, 2018).

The proportion of graduates in science, technology, engineering, mathematics) – who play a key role in R&D investments – is increasing (29 % in 2017) but their proportion (per thousand-population aged 25 - 34) is low (12.2 % vs EU- 15.5 %).

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment needs, p. 32/33]

Efficient investments in skills, innovation, research, and infrastructure are crucial for boosting Estonia's productivity and long-term competitiveness. Skills shortages and mismatches are among the main obstacles to business investment and limit larger productivity gains (see Section 3.3). The insufficient investment in research, development and innovation, as well as weak links between companies' needs and priorities of the research institutions, are bottlenecks to productivity developments. Investing in companies' digitisation and automation can make them more productive.

At the same time, productivity-enhancing private investment in R&D has been low (see further on in this section).

The proportion of economy-wide investment in intangible assets increased, but remains well below the EU average. In 2017, investment in intellectual property was 10.4 % of total investment, with the biggest contribution coming from professional and scientific activities and the information and communication technologies sector. Investment in intellectual property products by the manufacturing companies was below the economy-wide average. This can be partially explained by the structure of the economy, with many large companies engaged in contract manufacturing, and small-size firms lacking the knowledge and resources needed to invest in intellectual property.

Further effort and investments is important as exporting companies are characterised by higher productivity and growth prospects and can support the transfer of innovation and knowledge in the country.

[Box 3.4.1: Investment challenges and reforms in Estonia, p. 36]

In recent years, Estonian companies have been affected by skills shortages and high barriers to entry in sectors where significant investment in R&D and innovation is needed to build a competitiveness base. Investment and productivity may be boosted by modernising the insolvency framework and by improving cooperation between academia, research and businesses.

Cooperation between academia and businesses remains insufficient. This may be related to the limited impact of the measures designed to promote private research and innovation activities, and also to some regional specificities.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment needs, Circular economy, p. 39]

Estonia's investment needs in the transition towards the circular economy are clear. Despite the government's support for eco-innovation and the circular economy, Estonia's composite eco-innovation score is almost 40 % below the EU average. Resource efficiency is one of the most important areas of the circular economy and eco-innovation in Estonia, but it stands out as the most alarming one.

[3.4. Competitiveness reforms and investment, 3.4.3. Regional dimension, p. 41]

Weak performance in innovation and low private investment in research and development hold the more remote regions back from increasing their proportion of knowledge-intensive activities. Current public support for innovation activities has not met regional or business needs, calling for strengthening the involvement of businesses in the design of innovation policies and cooperation between research institutions and companies. Only around 25 % of the main innovation support programme NUTIKAS is so far covered by contracts (over 90 % to the companies located in Harju and Tartu counties).

[3.4. Competitiveness reforms and investment, 3.4.4. Institutional quality, p. 43]

The use of public procurement to support strategic objectives, including innovation, is still limited. To support contracting authorities in tendering more innovative solutions, the Estonian government ran ‘The public sector as a smart customer’ project. It included the development of a manual on innovation procurement, raising awareness among contracting authorities, expert counselling and mentoring, trainings, creation of sectoral networks and support for innovation procurement.

9.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The relative strengths of Estonia are in business-friendly environment, very good start-up’s’ ecosystem and well-developed research infrastructure. In contrast, the general innovation performance of the country is moderate and rather in decline, the industry relies on a narrow base of high-tech companies, and the proportion of employment in fast-growing companies in innovative and high value added sectors remains low and holds back productivity growth and competitiveness. High priority investment needs⁽⁵⁴⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, where appropriate in cooperation with other countries and in line with the EU Strategy for the Baltic Sea Region. This is, in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

increase the number of innovative companies in the smart specialisation sectors;

strengthen the supply side of research and innovation by increasing the attractiveness, competitiveness and sustainability of the research system and diversification of the applied research areas;

support collaborative research between universities and businesses, making it possible to transfer technologies, commercialise research results and increase the capacity and role of clusters and competence centres.

Estonia ranks high in the provision of digital public services, however some weaknesses present in areas such cyber security and open data availability. Despite the good performance in public sector, companies do not make a full use of digital opportunities.

⁵⁴ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

Priority investment needs have been identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

increase information and communications technology uptake in small and medium-sized enterprises, including digitalisation, marketing and e-commerce;

increase public sector capacity to analyse and safely manage open and big data;

upscale and improve the user-friendliness of public e-services, including in a cross-border context.

Small and medium-sized enterprises are important in terms of overall added-value and employment. However, they are small, productivity growth remains relatively slow and they are not sufficiently integrated in domestic and international clusters and relatively low positioning in the global value chains. High priority investment needs have been identified to enhance growth and competitiveness of small and medium-sized enterprises, and in particular to:

internationalise their activities so that they can move up in global value chains;

increase productivity and growth prospects of the small and medium-sized enterprises;

promote entrepreneurship and increase start-ups survival rates;

identify new export markets and promote participation in international cooperation networks and clusters, particularly in the Baltic Sea region.

Despite the leading position of Estonia in e-Government, the transition of industry and small and medium-sized enterprises to new technologies is held-back by the low capacity of the companies to innovate and insufficient digital skills within companies. Investment needs have been identified to help companies to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

provide small and medium-sized enterprises and research institutions with targeted trainings on management skills, innovation, technological transfer and on re-skilling in smart specialization areas;

develop the capacity of universities' and research institutions' to improve the commercial viability and market relevance of their research projects, including through more researcher mobility between research institutions and companies;

increase the level of digital skills available in companies to boost productivity.

10. FINLAND

10.1. Executive summary

Furthermore, investment in equipment and research and development declined during the financial crisis, further affecting Finland's potential for growth.

With the disruptive technological change that affected Finland's largest private research and development spender (Nokia) a decade ago, Finland experienced a sharp decline in business spending on research and development. Recovery has not been observed so far.

Focusing investments ⁽⁵⁵⁾ on human capital, on research and innovation, and on energy and transport infrastructure, would strengthen the long-term growth potential of Finland. While the overall investment level in Finland appears largely satisfactory, investing further in people's skills, education and training and in coordinated professional services to the unemployed and the inactive is needed to offset workforce losses from population ageing, reduce inactivity and long-term unemployment and potentially increase productivity. The ratio of research and development to GDP has not yet recovered from the crisis years and appears insufficient to diversify exports towards higher tech goods in the medium-term.

Productivity growth remains a challenge. A recovery in productivity growth is essential to ensure future economic prosperity, especially as Finland's population is ageing and spending on health is set to increase. Other factors are holding back Finland's growth potential: its investment in research and innovation, which has the most potential for innovation output, remains in decline. Moreover, it is rather narrowly focused. There is indeed a wide and increasing gap between the most productive firms and the least productive ones. Public support for research and development has also declined in recent years.

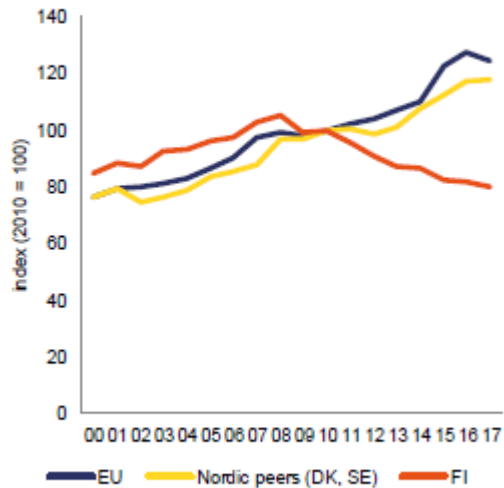
10.2. Research and Innovation

Falling investment in intellectual property ⁽⁵⁶⁾ in Finland, including research and development, remains a source of concern. Since 2009 business research and development intensity declined strongly. One of the reasons for the decline was disruptive technological change, which strongly affected the country's largest private research and development spender (Nokia) (Fornaro *et al.*, 2018). As a result, Finland experienced the steepest drop in business expenditure on research and development among EU countries, from 2.7 % of GDP in 2009 to 1.8 % in 2016. Consistently, investment in intellectual property in volume terms still declined in Finland in 2017 (see Graph 3.4.4). The decline was no longer limited to the electronics sector. Other sectors were affected as well, notably electrical equipment (see Graph 3.4.5). Nevertheless, at 4.0 %, the share of investment in intellectual property in GDP in Finland remained slightly above the EU average (3.9 % of GDP).

⁵⁵ Both private and public investment.

⁵⁶ Intellectual property products is a national account concept (NA.117) that comprises research and development (NA. 1171), mineral exploration and evaluation (cost of drilling, aerial or other surveys, transportation, etc.) (NA.1172), computer software and large databases (NA.1173) and entertainment, literary or artistic originals of manuscripts, models, films, sound recordings, etc. (NA.1174).

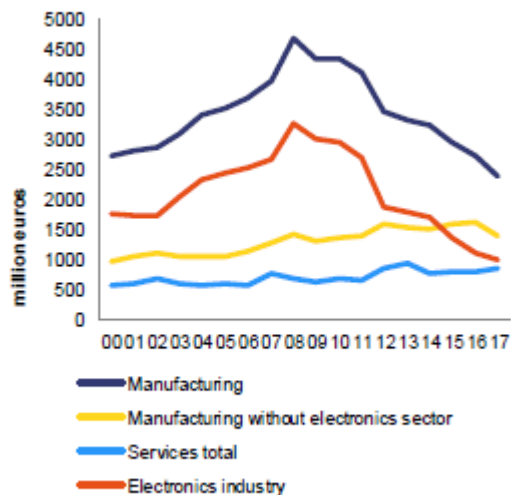
Graph 3.4.4: Intellectual property product investment in volume



Source: European Commission

The proportion of fast-growing innovative firms remains below the EU average⁽⁵⁷⁾. The growth of firms in innovative sectors is an important factor for structural change of the economy. This is important for Finland, where a disruptive technological change has led to a decline of certain sectors of the economy (mobile phones, paper industry). Despite various promotional activities⁽⁵⁸⁾, start-up rates in Finland remain below the EU average and there is potential for additional targeted policy action. In recent years, the availability of venture capital has declined considerably, compared to pre-crisis levels, but non-research and development innovation expenditure of firms has decreased as well (Eurostat, 2015).

Graph 3.4.5: Research and development gross capital formation by industry and year - flows



Source: European Commission

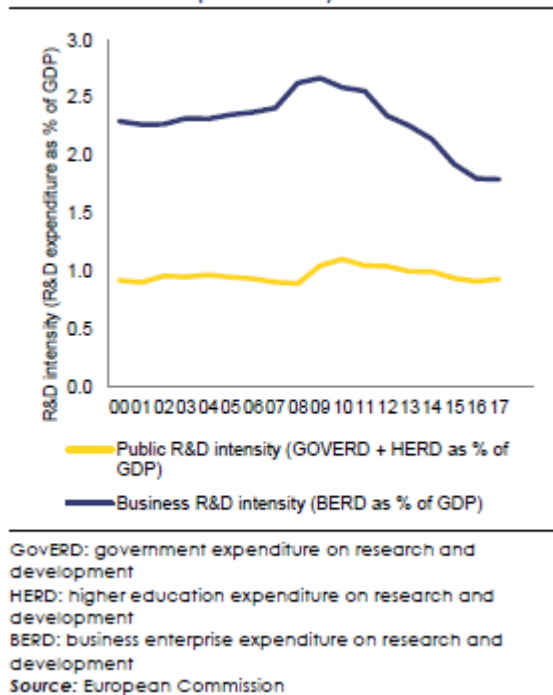
⁵⁷ The share of employment in high-growth enterprises in innovative sectors was 9.5 % in 2015, down from 11.4 % in 2013 and ranking low in the EU.

⁵⁸ Including schemes such as Aalto University's 'Start-Up Sauna', a 1500 square meter industry hall and co-working space that is a focal meeting point in Northern Europe for entrepreneurs and investors alike.

After a decline, public research and development expenditure is now stabilising. Public research and development intensity declined from 1.1 % in 2009 to 0.9 % in 2017 (see Graph 3.4.6). Nevertheless, Finland still ranks at the top of the EU in public research and development intensity. Public-sector funding of business research and development stood at only 0.08 % of GDP in 2015, a modest proportion compared to other innovation leaders ⁽⁵⁹⁾ and has been stagnating since 2011. At the same time, private co-financing of public research, which is an important basis for knowledge transfer and an indicator of science-business cooperation, is also below the EU average (2015, Finland: 0.047 % of GDP, EU 0.050 % of GDP) and on a downward trend since 2007.

Overall, Finland remains an ‘innovation leader’. In the European Innovation Scoreboard, Finland is an ‘innovation leader’ (European Commission, 2018j). While its performance declined between 2010 and 2014, it improved every year since. High-quality human resources, attractive research and development systems, an innovation-friendly environment, relatively high levels of public and private funding of research and development and innovation, and intellectual assets lead to a good performance in the European Innovation Scoreboard and constitute favourable framework conditions for innovation. However, these conditions are not yet matched by corresponding economic outputs. Relatively low sales and employment impacts constitute Finland’s weakest innovation dimensions in the European Innovation Scoreboard.

Graph 3.4.6: Evolution of public and business research and development intensity



Recent policy initiatives are expected to address some of Finland’s weaker elements in the European Innovation Scoreboard. In its National reform programme of spring 2018, the government highlights cooperation between higher education institutions and business as one of the key bottlenecks to be addressed in order to stimulate innovations and placing them on the market. The policy focus, as reflected in the reform programme, has shifted towards the creation of internationally competitive centres of expertise as well

⁵⁹ Finland performs well below the EU average of 0.2 % in 2015 and ranked only 18th in the EU in this indicator in 2015.

as to the support of research infrastructures and the development of favourable business environments in technology-intensive sectors with the potential for upscaling, such as clean-tech, the bio-economy, information and communications technology and health.

Finland promotes research and development projects in areas relevant for the National energy and climate plan. Finland shows strong leadership in clean energy innovation and private research and development spending. ⁽⁶⁰⁾ A few years ago, the country was doing more than three times better than EU average in terms of financing clean energy research (in % of GDP). It is committed to double the funding of some of its clean energy funding programmes by 2021. Still, it has to be seen how recent cuts in overall research and development funding will affect Finland's performance on clean energy research.

Digital transformation of public services still falls short of what could be expected by businesses. Digital public services for businesses remain limited and significant differences persist among businesses in integration of digital technology. Finnish small and medium-sized enterprises are also reluctant to use the untapped potential of online trade within and beyond the EU (European Commission, 2018k).

10.3. Additional R&I references

[1. Economic situation and outlook, Potential GDP growth, p. 7]

After the disruptive technological change that affected the country's largest private research and development spender (Nokia) a decade ago, intellectual property investment appeared to stabilise at a level close to the EU average but below the level of Finland's EU peers.

[1. Economic situation and outlook, Regional disparities, p. 9]

Overall, large or mid-sized cities with universities, such as Tampere and Turku, steadily grow. Conversely, rural heartland areas, sparsely populated rural areas as well as smaller cities and towns have lower growth prospects and face specific challenges. This may suggest that the sustainability of regional convergence depends crucially on targeted investment to enhance innovation performance, business environment and skills in each region based on their specific competitive advantages and potentials (see Sections 3.3 and 3.4).

[1. Economic situation and outlook, Competitiveness, p. 10]

After the setback of its electronics sector, Finland experienced a shift in specialisation from consumer towards intermediate goods and from high tech to medium tech industrial sectors. This was accompanied by a concomitant decline in total factor productivity, which highlighted an insufficient level of investment in research and development and innovation.

[2. Progress with country-specific recommendations, p. 15]

The European Structural and Investment Funds are important in addressing key challenges to inclusive growth and convergence in Finland, notably by supporting

⁶⁰ Finland is strong as regards resulting patents in energy field (twice the EU average of the number of patents per inhabitants).

competitiveness and boosting research and innovation, creating employment and facilitating education and training.

[Box 2.1: EU funds help overcome structural challenges and foster development in Finland, p. 16]

Finland is a beneficiary of European Structural and Investment Funds support. EU funds allocated to Finland in facing development challenges amount to EUR 3.8 billion in the current multiannual financial framework (2014-2020), potentially representing around 0.2 % of GDP annually. Furthermore, numerous Finnish research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 766 million.

EU funding has helped to address policy challenges identified in the country-specific recommendations. The European Structural and Investment Funds contribute to enhancing Finland's capacity to deliver innovative products, services and high-growth companies and help to create employment opportunities by promoting labour market access, education, training and social inclusion for people in unemployment or inactivity. By 2018, 190 000 people attended projects investing in human capital, 9 000 companies in projects run by research and development institutions, and 4 300 companies in projects to promote growth and international business operations. Over 1300 companies started to export or expand their exports. More than 1800 products and services were developed and piloted in innovation platforms. Horizon 2020 supported over 1200 research projects covering a very broad thematic spectrum from accelerating uptake of nanotech materials to smart electric mobility in cities.

[3.3. Labour market, education and social policies, 3.3.3. Education and skills, p. 32]

Undergoing restructuring and budget cuts could compromise the quality of higher education. Higher education was subject to cumulative budget cuts of EUR 850 million in 2011-2018. This led to staff reductions and deterioration of teaching and research conditions that have caused some of the best professors and key researchers to leave the country. The 'Vision for higher education and research in Finland 2030' aims to mobilise the higher education sector to find solutions to these challenges. It targets having 50 % of the 25 to 34-year-olds to finish at least a bachelor degree, improving opportunities for life-long learning and providing some additional resources for high quality research.

[3.4. Competitiveness reforms and investment, Investment needs, p. 35]

Focusing investments on human capital, on research and innovation, and on energy and transport infrastructure would strengthen Finland's long-term growth potential. Research and innovation intensity has not yet recovered from the crisis years and appears insufficient to diversify exports towards higher-tech goods in the longer term. Research and innovation are also needed to match Finland's carbon neutrality objectives.

[Box 3.4.1: Investment challenges and reforms in Finland, p. 36]

In manufacturing, the decline in research and development investment was not limited to the electronics sector. This might signal further specialisation in lower value-added industries. Public expenditure on research and development stabilised. Foreign direct investment remained relatively low, even though inflows were markedly on the rise (see Section 3.4).

Business Finland is the main public funding agency in Finland. It helps businesses go global. It also supports and funds innovations. Funding awarded by Business Finland in 2017 amounted to EUR 492 million.

Finland has experienced a shift in specialisation towards intermediate goods and from high tech industrial sectors to medium tech industrial sectors. The shift partly underpins an insufficient level of research and development and innovation investment to kick-start growth and to diversify exports towards higher-tech goods in the medium-term. There is potential for further increasing cooperation between academia and businesses as an incentive to investment in research and development (see Section 3.4). Also, long processing times for permits slow down firms' investment progress (Confederation of Finnish Industries, 2019).

[3.4. Competitiveness reforms and investment, 3.4.3. The regional dimension, p. 43]

The disparities in terms of innovation performance between the NUTS2 regions ⁽⁶¹⁾ are not as significant as the differences in GDP per head. Finland's innovation performance stands at 128 % of the EU average (European Commission, 2017).

All regions lag behind the EU-average in non-research and development innovation expenditure and exports of medium-high technology manufacturing.

All Finnish regions score above EU average when assessing the quality and conditions in the regional innovation ecosystem (European Commission, 2018m). The main regional bottlenecks range from lower scores in the participation rate of adults in learning, access to broadband, the availability of technical and design/creativity skills in the private sector to foreign direct investment and technology transfer.

10.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Despite the focus on building a well-functioning innovation ecosystem, business research and development intensity, public research and development support and other innovation expenditure of firms have declined, and scope for improvement remains for science-business cooperation and internationalisation. Priority investment needs ⁽⁶²⁾ have therefore been identified to enhance research and innovation capacities and the uptake of advanced technologies, where appropriate, in line with regional smart specialization strategies, and in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential; develop research, competence and innovation clusters that draw from regional strengths in all regions, notably in northern sparsely populated and other transition regions; including making use of piloting, testing and demonstration environments; advancing development platforms; and increasing business-academia cooperation as well as interregional

⁶¹ There are three levels of Nomenclature of Territorial Units for Statistics (NUTS) defined. This category refers to regions belonging to the second level (NUTS 2, also known as NUTS II), which is largely used by Eurostat and other European Union bodies.

⁶² The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

cooperation in new value chains, also across borders within the framework of any relevant strategy, markedly the EU Strategy for Baltic Sea Region;

strengthen innovation work in companies; including promoting the development and commercialization of products, services and production methods and introduction of new technologies; supporting prototypes, piloting and demonstrations of new products, materials and production methods; developing applied research, studies and experiments as well operational and commercialization processes that support businesses; enhancing innovations that reduce harmful environmental effects and risks; and promoting research and development and innovation activities related to the quality and sustainable use of environment and resources that create important preconditions for businesses, as well as corresponding piloting and demonstration actions.

The proportion of fast-growing innovative firms and start-up rates remain below the EU average. Priority investment needs have therefore been identified to enhance the growth and competitiveness of small and medium-sized enterprises in line with the smart specialization strategy, and in particular to:

create new business activities; including supporting start-ups and development of new business, as well as commercialization and entry into market of small and medium-sized enterprises' ideas, products and services;

promote small and medium-sized enterprises growth and expansion abroad; including strengthening the business competence and readiness to expand abroad of growth-oriented companies aiming to international markets; supporting investments and development projects by small and medium-sized enterprises; developing company clusters, networks and other forms of cooperation, involving also large companies and including improving the visibility of the Baltic Sea Region as a cluster of entrepreneurship to attract investment and expertise.

Even though Finland is among the advanced digital economies in the EU, digital transformation of public services require a sustained effort, digital public services for businesses remain limited, significant differences persist among businesses in integration of digital technology, e-commerce and selling online cross-border lag behind. Investment needs have therefore been identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

increase Information and Communications Technology up-take in small and medium-sized enterprises;

enhance e-government and e-services, including the take-up of Europe wide and cross-border interoperable services.

Finland's innovation leadership lacks economic impact, skills shortages persist, and knowledge transfer remains insufficient. Investment needs have therefore been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

promote innovation management in small and medium-sized enterprises; and support reskilling for smart specialization areas within firms, regions and smart cities, including in cooperation with the Baltic Sea Region;

develop capacities of higher education and research institutions to enhance the commercial viability and market relevance of their research projects as well as to take

part and cooperate in interactive and open innovation processes; and strengthen the integration of education and training institutions with innovation ecosystems, also across borders.

11. FRANCE

11.1. Executive summary

Under the Great plan for investment 2018-2022 (*Grand plan d'investissement 2018-2022*), France has also planned measures for a total of EUR 57 billion to sustain the greening of the economy, address skills mismatch, foster innovation and digitise public services.

Public and private investments need to prioritise actions to strengthen research and innovation, facilitate the energy and climate transition, improve skills, tackle unemployment, and adapt to the future of work, as well as to respond to inequalities within the country. Improving education, training and innovation performance could stimulate potential growth over the medium term.

Despite recent initiatives, the gap with respect to EU innovation leaders is not closing. France is making artificial intelligence a national priority and is emerging as a major start-up hub notably for companies in the digital sector. However, private investment in research and development has remained stable since 2015 and new companies have difficulties to grow. In addition to the recent measures to facilitate the mobility of researchers to firms, furthering links between science and business could help to spread innovation. The efficiency of public schemes and tax incentives that sustain research, development and innovation could be further evaluated and improved.

Major differences among regions can be noted in terms of regional investment in research and development and innovation performance,...

11.2. Research and Innovation

Research and development investment remains stable since 2015 and France has not been able to reduce the gap with EU innovation leaders. Total research and development intensity ⁽⁶³⁾ stood at 2.25% in 2016, which was above the EU average (2.03%) but slightly lower than in 2015 (2.27%), which hints to a certain stagnation of research and development efforts. Investment from the business sector has been the main driver of the overall positive trend of research and development investment but their level is still far below the 2% target. Business expenditure on research and development rose to 1.43% of GDP in 2016, compared to 1.27% in 2007. Public expenditure on research and development amounts to 0.78% of GDP in 2016, above the EU average (at 0.7%). Overall, France is not on track to meet its total research and development intensity target of 3% for 2020. France is also among the more research and development intensive EU Member States that reported business research and development intensity growth rates lower than the EU average in 2007-2016 (European Commission, 2018i). According to the 2018 European Innovation Scoreboard, France ranks 11th in the EU and its position compared to the best performers has not changed

⁶³ R&D investment as a percentage of GDP.

over the last years. Firms' non-research and development innovation expenditure ⁽⁶⁴⁾ are one of the weak dimensions. Furthermore, the business dynamism seems to be subdued, as suggested by the low and declining share of employment in high growth enterprises (9.4% compared to EU average of 14% in 2016), in particular in those companies belonging to the 50% most innovative sectors (4.1% in 2015, down from 5.1% in 2008 and below the EU average of 4.8%).

The basis for ERDF interventions in favour of Research, Development and Innovation is the elaboration of smart specialisation strategies at regional level. The success of these strategies will depend on the territories' ability to mobilise and concentrate the resources on action plans designed to support their strategic objectives and activities. Updating these strategies from the 2014-2020 period will be needed, especially in the new regions resulting from the new regional organisation. The success of this process will also depend on the ability to coordinate the approach over time, to support an entrepreneurial discovery process involving the regional innovative ecosystem in the long term, based on the defined strategy, to coordinate with other French and European regions with a view of optimising the benefits of the transfer of skills, knowledge and technologies in the territories. All these challenges could benefit from the exchange of good practices among French regions, and also regions inside the cross border and inter-territorial cooperation.

While the quantity of human capital in science is high, there may be room to strengthen the efficiency of the public research system. The French scientific system benefits from a number of strengths and in particular the share of French graduates in science and engineering (21.6 per thousand population) is the second highest in the EU. However, an international comparison of public research systems, measuring their performance in terms of outcome indicators (number of publications, citations and patents) against the resources used (*DG Trésor, 2018*) suggested that the French performance could be improved. Its performance is comparable to that of Germany. In addition, France only ranks 10th in the EU for the share of top 1% highly cited scientific publications.

Links between science and business could be further incentivised through researchers' careers. A limited number of public researchers is taking part in business creation and collaborates with existing companies. Since 2000, only 51 requests of public researchers to join companies and 231 requests to create new businesses have been examined by the Deontology Commission ⁽⁶⁵⁾. The draft Pacte law (*'Loi Pacte'*) would relax some of the underused rules of the current law (*Loi Allègre*) and includes provisions to promote researchers' mobility by allowing researchers to dedicate 50% of their working time to newly created companies, as well as to return to public research while preserving their firms' shares. However, researchers' careers and advancement are still largely based on research output such as publications.

Partnership research between businesses and public research has to be improved. Between 2012 and 2014, 15% of innovative firms collaborated with public research organisations and universities (compared to 17% in Germany). France continues to score

⁶⁴ This indicator measures non-R&D innovation expenditure as a percentage of total turnover. Several of the components of innovation expenditure, such as investment in equipment and machinery and the acquisition of patents and licenses, measure the diffusion of new production technology and ideas. (*Community Innovation Survey*)

⁶⁵ This number may underestimate the real number of public researchers that have moved to the private sector since not all public researchers ask for a review of the Deontology Commission.

below the EU average for public research and development financed by businesses. Many commercialisation structures have been set up since 2010 with the Investment for the Future Programme (*'Plan d'investissement d'avenir'*, PIA) for a total public support reaching EUR 5.4 billion between 2010 and 2020. In particular, the first results of the 14 Technology Transfer Accelerator Offices (*Société d'accélération du transfert de technologies, SATT*) in terms of licencing, patents, spin-offs are below expectations and the target of financial equilibrium by 2020 will not be achieved (*Cour des Comptes, 2018b*). Following the Court's recommendations, underperforming Technology Transfer Accelerator Offices structures will be closed in 2019, such as SATT Grand Centre. Evidence also suggests the need to further develop targeted training in partnership research for staff working in commercialisation structures. Support to competitiveness clusters (*'pôles de compétitivité'*) has been renewed for a fourth phase (2019-2022) and priority will be given to clusters organisations well connected with others structures at local level, concentrated on national industrial priorities and with a track record in EU projects.

The efficiency of public schemes and tax incentives for research, development and innovation needs to be further evaluated. The French landscape is characterised by a wide range of direct and indirect support schemes and a generous support to business research and innovation efforts. This includes the R&D tax credit scheme (*Crédit d'Impôt Recherche, CIR*) the most generous among OECD countries, amounting to 0.24% of GDP in 2018. However, the overall performance of the research and development and innovation ecosystem does not yet match the large amount of public support. International organisations have already drawn attention on this issue in the past (OECD, 2014). This warrants the need for a comprehensive evaluation of the policy mix to inform future implementation. ⁽⁶⁶⁾ A group of French experts' repeated the call for regular evaluations of public schemes (*Lewiner report*). The Innovation Council (*'Conseil de l'innovation'*), set up in July 2018, is tasked with supervising the simplification measures including better coordination between regional and national support to innovation.

France is making artificial intelligence a national priority. Drawing on the findings of the Villani Report (2018), a national strategy for artificial intelligence ("AI for humanity") has been designed and foresees EUR 1.5 billion in public investments until 2022. This strategy will take advantage of the quality of human resources in mathematics, computer science, cognitive sciences and existing leading research centres. Priority areas include mobility, environment, security and health, notably the creation of a Health Data Hub. The Innovation and Industry Fund (*Fonds pour l'innovation et l'industrie*), financed through privatisations ⁽⁶⁷⁾, will also contribute to provide funding for artificial intelligence. Timely development of related technologies, such as the Internet of Things, 5G networks, high performance computing and, more generally, the data economy, will be one of the keys to the success of these initiatives.

11.3. Additional R&I references

[1. Economic situation and outlook, Potential growth, p. 9]

⁶⁶ Several studies are currently being conducted by France Stratégie.

⁶⁷ The draft law PACTE allows the French state to sell shares in Groupe Aéroport de Paris, Française des jeux and Engie by reducing current shareholding minimum requirements. The proceeds of these privatisations will be invested to generate a return used to finance the EUR 10 billion Innovation and Industry fund.

Total factor productivity growth may also be hampered by tax complexity (see Section 4.1) and weaknesses in the business environment, which can weigh on firms' growth, hinder innovation and internationalisation of firms (see Section 4.4).

[1. Economic situation and outlook, Regional disparities, p. 16]

Employment, R&D investment rate and innovation performances are also quite heterogeneous among regions (see Section 4.4).

[2. Progress with country-specific recommendations, p. 19]

A number of initiatives have been launched to improve firms' business environment, while room for improvement remains as far as competition in the services sector and public support schemes for innovation are concerned. New initiatives supporting research and innovation activities have also been launched, but there is still room to improve the efficiency of public support schemes.

Limited progress has been made in increasing the performance of the innovation system,...

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in France, p. 21]

France is one of the largest beneficiaries of the European Structural and Investment Funds (ESI Funds). Financial allocation from the ESI Funds, aimed to support France in facing development challenges, amounts to up to EUR 27 billion in the current Multiannual financial framework, equivalent to around 0.1 % of the GDP annually or around 2.9 % of all public investment per year on average. Furthermore, numerous French research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 4.14 billion.

EU funding has helped to address policy challenges identified in the 2018 CSRs. EU Funds supported closer collaboration between business and research institutions, and R&D investments in the private sector. By the end of 2018, ESI Funds supported 3 171 enterprises working with Regional Innovation Strategies and 317 million private match investments were made. 17 383 start-up enterprises were supported.

France has managed to mobilise EFSI on its priorities — innovation, digital, energy transition. France benefits the most in volume from the Fund, while it ranks 11th as to the overall volume of approved operations as a share of GDP.

[3. Summary of the main findings from the MIP in-depth review, Evolution, prospects and policy responses, p. 23]

A series of initiatives have been undertaken to improve the business environment and R&D and innovation performance. A draft law to support the growth and transformation of firms (*'projet de loi relatif à la croissance et la transformation des entreprises'*, PACTE) is currently being debated in the parliament. This law aims at reducing the number of size-related legal, social and fiscal thresholds that hinder business' growth. It also includes measures to better link R&D activities carried out by the public sector with the activities of the private sector (see Section 4.4).

[Box 3.1: Spillovers of structural reforms — the case of France, p. 26]

The set of reforms implemented do not exactly correspond to past country-specific recommendations, but illustrate the potential impact that this theoretical package of structural reforms covering different areas (product market regulation and entry, labour market participation, taxation structure and R&D subsidies) could have on the French economy.

Knowledge spillovers resulting from the international diffusion of innovations can also lead to positive spillovers *via* intangible capital formation. Nevertheless, the spillovers effects stemming from those channels tend to be limited.

[4.4. Competitiveness reforms and investment, 4.4.1 Investment and productivity*, p. 50]

A Grand Plan d'Investissement aims at mobilising EUR 57 billion of investments over the period 2018-2022, for sustaining the environmental transition (EUR 20 billion), enhancing skills (EUR 15 billion), improving innovation (EUR 13 billion), and digitising public services (EUR 9 billion).

Further investments in infrastructures, skills and innovation in France could foster potential growth, support competitiveness and reduce regional disparities. Additional investment may contribute to improve the performance of research, development and innovation activities as well as to address the challenges of the digital economy.

[Box 4.4.1: The Investment Plan for Europe - in France, p. 54]

France managed to highly mobilise EFSI on its priorities — innovation, the energy transition and the digital — in the regions.

120 infrastructures and innovation projects have been financed by the European Investment Bank (EIB) with EFSI backing, which amounts to approximately EUR 9.3 billion in total financing and set to trigger EUR 45.8 billion in total investment.

Under the SME Financing component of the plan, the European Investment Fund (EIF) has developed in France several tools: equipment loans, innovation loans and equity investments in SMEs through investment funds. The EIF has also signed agreements with commercial banks to provide them with a guarantee that they will finance innovation loans for research and development of SMEs.

[Box 4.4.2: Investment challenges and reforms in France, p. 55]

Access to finance is a barrier to investment only for very fast growing companies or break-through innovation.

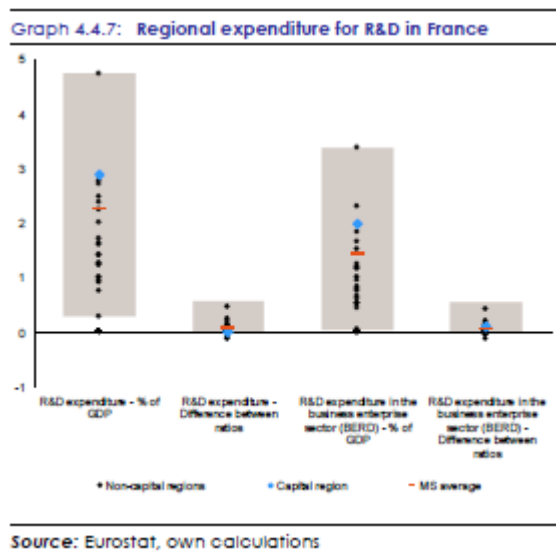
[4.4. Competitiveness reforms and investment, Circular economy, eco-innovation, waste management and emission reduction, p. 58/59]

France has strongly supported the development of eco-industries, eco-innovation and the circular economy over the last decades.

Further investments may be needed to increase eco-innovation, waste management, and emission reduction. Despite the progress made thanks to the national industrial policy '*Nouvelle France Industrielle*', legislative and financial barriers can still impede many companies to invest in eco-innovation. Banks are still cautious as to funding breakthrough innovations.

[4.4. Competitiveness reforms and investment, 4.4.3 Regional disparities in investment, p. 61]

Regions differ significantly in terms of R&D expenditure and innovation performance. With R&D expenditure of 4.75 % of GDP in 2015, Midi-Pyrénées is the only region that exceeds the 3% target (Graph 4.4.7). Only six other regions spend above the EU average of 2.04%. The regional efforts in R&D by private businesses mimic the same relative ranking. As regards innovations, Ile-de-France has the highest innovative score while Midi-Pyrénées and Rhône- Alpes also show good performances. Several metropolitan regions and regions that are still in industrial transition or rural rank below the EU average. Outermost regions are at the low end of the scale.



11.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Despite being a strong innovator, France's innovation performance remains below that of EU innovation leaders and shows much disparity among regions. France is not on track to meet its total research and development intensity target of 3% for 2020. National and regional needs and potential are to be taken into account, as well as regional innovation smart specialisation strategies and synergies with Horizon Europe and InvestEU. Internal disparities will have to be considered when increasing regional investments in research and development to levels closer to the ones of the most advanced French regions (e. g. Ile-de-France and Midi-Pyrénées).

High priority investment needs ⁽⁶⁸⁾ are identified to enhance research, development and innovation capacities, in particular to improve collaboration and collaborative schemes (e. g. clusters) between public research institutions and private companies and contribute to increase the competitiveness of the French economy by developing new processes, new technologies, and new products that can be implemented in the production sector to increase competitiveness.

⁶⁸ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

Priority investment needs have therefore been identified to:

on the basis of the updated regional innovation smart specialisation strategies, increase the attractiveness of French research development and innovation activities at regional level, including through recruit of highly qualified and skilled researchers;

support the transformation and the development of new value chains, by supporting the development of the necessary skills, technologies and infrastructures and by stimulating the integrated cooperation in new value chains across programmes and across borders;

reap the benefits of digitisation for citizens, small and medium sized enterprises and governments, in particular in inter-regional projects.

France performs below the EU average on entrepreneurial activity and the small and medium sized enterprises regional competitiveness index shows high internal disparities. High priority investment needs have therefore been identified to enhance growth and competitiveness of Small and medium sized enterprises and to implement a smart industrial transformation and induce more connections among actors (clustering) in particular to:

contribute to the generation of new start-ups through the facilitation of the integration of Research Development & Innovation outcomes into the economic exploitation by new small and medium sized enterprises in the productivity and services sectors;

contribute to the scaling-up of the newly created start-ups, assist young heads of Small and medium sized enterprises in the early stage of life of their enterprise (e. g. nurseries);

contribute to improve the position of French small and medium sized enterprises within EU internal and external markets including through cross-border and transnational cooperation.

12. GERMANY

12.1. Executive summary

Sizeable investment efforts and innovation combined with structural reforms, would make the German economy more resilient to unfavourable external and domestic developments and ensure a sustainable and inclusive growth model. The German economy is facing challenges in a number of sectors, which have traditionally performed well internationally. Stronger investment and innovation efforts are needed to boost productivity and help diversify Germany's growth model, keeping up with technological change and demand shift and dynamics. Higher investment in and expenditure on education and skills, very high-capacity broadband and research and development are key to raising long-term growth potential.

Focusing private and public investment on network industries and services such as digital, energy and transport infrastructure, as well as on education and innovation, could improve Germany's growth potential. Despite some acceleration in public investment, the country's investment ratio in 2017 was still below the average of the rest of the euro area. Higher investment in research and innovation, especially among small and medium-sized enterprises, could increase total factor productivity. Higher expenditure on education and skills could help to tackle short-term labour shortages and demographic ageing, while ensuring growth that is inclusive.

Given the reduction in labour force potential caused by demographic change, productivity growth will increasingly depend on investment in productive capital and innovation, including in digitalisation. Firm-level data show that the gap between the most and the least productive companies has widened, suggesting that there are obstacles to the spread of technology.

12.2. Research and Innovation

Germany has a strong research and innovation system, but in a context of slow productivity growth and negative demographic trends, higher investment in R&D and innovation could help the country secure its competitive position. R&D expenditure in Germany increased to 3.02 % of GDP in 2017, the fourth highest R&D intensity in the EU. The increase in business R&D intensity since 2010 (+0.27 pps.) has been higher than the increase in public R&D intensity (+ 0.04 pps.). According to the European Innovation Scoreboard, Germany's overall innovation performance has stagnated since 2010, and small and medium-sized enterprises' innovation activity is declining. ⁽⁶⁹⁾ Over the last few years Germany has taken measures to further strengthen its sound research and science base, but there is scope for boosting scientific excellence further. Germany currently ranks eighth in the EU on the key indicator reflecting scientific excellence ⁽⁷⁰⁾. Its policies have been effective in promoting incremental innovation, especially in the manufacturing sector, but the framework conditions for risky and disruptive innovations could be improved. In 2018, the German Government adopted the High-Tech Strategy for 2025, which is designed to promote knowledge transfer and entrepreneurship. An agency for the promotion of disruptive innovation is to be set up. The Strategy also includes a 3.5 % R&D intensity target and R&D tax incentives for small and medium-sized enterprises.

While cooperation between public research institutes and the business sector is generally well established, small and medium-sized enterprises are not benefiting fully from it. Germany's approaches to encouraging science-business cooperation (e.g. through the Fraunhofer Society organisations) are often taken as examples of best practice. However, the country's high scores on the relevant indicators ⁽⁷¹⁾ are often the result of strong cooperation between a few large manufacturing companies and public research institutes. As regards the share of SMEs cooperating with academia or public research institutes, Germany scores only slightly above the EU average ⁽⁷²⁾.

Private investment in R&D is increasingly concentrated in large firms and in medium-high tech manufacturing sectors. While overall business expenditure on R&D shows strong growth rates, R&D has become increasingly concentrated in large firms and in medium-high-tech manufacturing sectors, particularly the automotive sector. R&D expenditure of large companies has increased considerably, whereas small and medium-sized enterprises' R&D expenditure has stagnated over the past decade (ZEW, 2018c). Small and medium-sized enterprises' expenditure on R&D as a percentage of GDP was at 0.17 % also much lower than the EU average of 0.30 % in 2015.

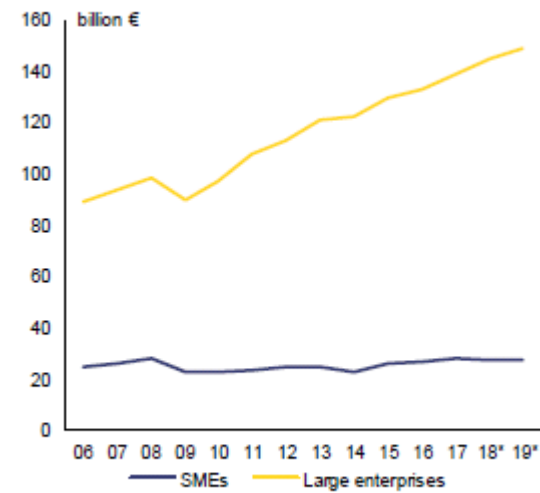
⁶⁹ The European Innovation Scoreboard shows a decrease in relative performance since 2010 in most of the indicators related to innovation in SMEs, intellectual assets and the impacts of innovation. <https://ec.europa.eu/docsroom/documents/30681>.

⁷⁰ The proportion of the country's scientific publications that rank among the top 10 % most cited scientific publications worldwide.

⁷¹ With a volume of public R&D financed by business enterprises representing 0.12 % of GDP in 2015 (EU average: 0.05 %), Germany ranks first among EU countries.

⁷² Based on data from the Community Innovation Survey for 2014.

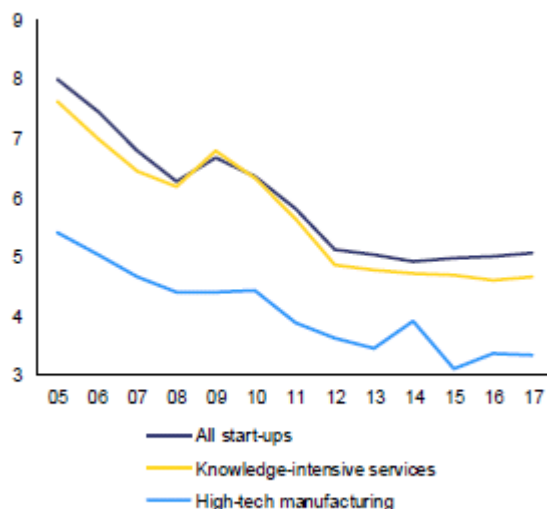
Graph 4.4.2: Expenditure for R&D in Germany



(1) 2018 and 2019 figures based on planned data
Source: ZEW

Entrepreneurial activity is hampered by regulatory barriers to starting a business and is increasingly influenced by demographic developments. Entrepreneurial activity has gradually been declining in most age groups, including those with highest entrepreneurial activity (i.e. between 30 and 50 years). The firm birth ratio has been declining in recent years, falling from 9.2 % in 2008 to 7.1 % in 2015, well below the EU average of 9.6 %. While low unemployment and the rising opportunity cost of starting a business are still the main reasons for the decline in start-up activity, regulatory barriers, such as those that affect the relative ease of starting a business, and demography are further significant factors. According to the World Bank indicator on the Ease of Starting a Business, Germany performs rather poorly (113th in the world). Demographic trends are expected to have a growing impact on entrepreneurial activity and the transfer of businesses in the coming years. At the end of 2018, the Federal Government launched an initiative (*Gründungsoffensive*) designed to boost entrepreneurial culture in Germany and to raise awareness of existing support programmes. However, more could be done to promote entrepreneurial skills in settings including secondary and tertiary education.

Graph 4.4.3: Start-up rates in Germany



(1) Start-up rate: start-ups by 100 incumbent firms
Source: ZEW

Start-up rates in Germany have been declining, and employment in fast-growing firms in innovative sectors has fallen. Start-up rates in Germany have been on the wane for the last 15 years in various sectors and regions. Start-up activity has been declining not only in non-technological sectors, but also in knowledge-intensive services and high-tech manufacturing (Graph 4.4.3). According to the Community Innovation Survey, the share of businesses with innovative activities has fallen, but continues to be among the highest in the EU. The share of employment in fast-growing companies in innovative sectors has fallen since 2012, and Germany performs below the EU average (see European Commission, 2018g).

12.3. Additional R&I references

[Box 1.1: The automotive sector in Germany, p. 15]

Germany is still an innovation leader in the automotive sector but securing its competitive position will require further investment in training, research and innovation. So far, the competitiveness of the German car industry has been determined largely by the supply of qualified labour and an efficient innovation ecosystem. The technological transformation of the car industry will require even stronger investment in quality education, in-house training, retraining and life-long learning. The automotive industry accounts for about 35 % of business R&D expenditure in Germany and about 40 % of patents. Nearly half of all global patents on automation in the automotive sector come from German firms. However, Germany faces strong competition from the US and China with regard to battery research. Even though R&D in Germany is increasingly focused on new technologies, especially those relating to automation and connectivity, this may not be sufficient to offset potential losses resulting from a lower degree of ambition in the area of e-mobility and other alternative power trains.

[2. Progress with country-specific recommendations, p. 17/18]

Moreover, expenditure on education and research and development has been falling short of the relevant national target.

There has been some progress in raising expenditure on research and innovation.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Germany, p. 19]

EU solidarity continues to support structural change in Germany. Under the current Multiannual Financial Framework (2014-2020), the financial allocation from the European Structural and Investment Funds (ESI Funds) - assigned to Germany to help the country face development challenges - exceeds EUR 27.9 billion. This is equivalent to about 0.1 % of annual GDP. Moreover, many German research institutions, innovative firms and individual researchers have benefited from other EU funding instruments. An example is Horizon 2020, which has provided EUR 5.6 billion to improve innovation and research in Germany.

The European Regional Development Fund (ERDF) has supported closer collaboration between business and research institutions, as well as R&D investment in the private sector. By the end of 2017, 1 510 enterprises had been selected for support by the ERDF in building cooperation with research institutions and 3 860 enterprises in introducing new products to their markets. Horizon 2020 has supported 5 585 research projects

covering a very broad thematic spectrum from ‘Innovation in SMEs’ (small and medium-sized enterprises) to ‘Health, demographic change and wellbeing’.

In absolute terms, Germany is the fourth biggest recipient of finance from the European Fund for Strategic Investments, but it ranks 22nd when considering the overall volume of approved operations as a share of GDP. Total financing amounts to EUR 7.3 billion and is set to trigger EUR 35.2 billion in additional private and public investments. For the Infrastructure and Innovation window, 74 projects ⁽⁷³⁾ were approved at a total value of about EUR 6.4 billion, set to trigger EUR 29.1 billion in total investment.

[3. Overall findings regarding imbalances, risks and adjustment issues, Imbalances and their gravity, p. 20]

Stronger investment in innovation, quality education and skills, very high-speed broadband networks, sustainable transport and electricity infrastructures combined with structural reforms aimed at improving the investment-friendliness and efficiency of the tax system can raise potential growth in future.

[Box 3.1: Spillovers of structural reforms – the case of Germany, p. 22]

This simulation complements earlier QUEST simulations designed to model a more immediate demand stimulus. Earlier simulations include an increase in public investment and a reduction in personal income tax (European Commission, 2017a) and increases in expenditure on R&D and education (European Commission, 2018a).

[4.3. Labour market, education and social policies*, 4.3.1. Labour market, p. 38]

Shortages of qualified staff may be an obstacle to economic development, requiring further investment. ⁽⁷⁴⁾

[4.3. Labour market, education and social policies*, 4.3.3. Education and skills, p. 45]

Some 55 % of small and medium-sized enterprises report a shortage of skilled employees, especially of highly qualified engineers, technicians, researchers, medical staff and similar professionals.

[4.4. Competitiveness reforms and investment*, 4.4.1. Productivity and investment needs, p. 47]

To maintain Germany's competitive advantage and ensure sustainable and inclusive growth stronger investment efforts are needed in innovation, digitalisation, quality education and skills, very high-capacity broadband network and sustainable infrastructures. Higher expenditure and investment in research and innovation, in particular among small and medium-sized enterprises, but also in education and skills

⁷³ Including 36 multi-country projects.

⁷⁴ In a business survey (DIHK, 2018), 68 % of companies cited a shortage of qualified staff as an obstacle to investment, and the share of firms that said the shortage of skilled workers was impeding their innovation activity was even higher, at 82 % (DIHK, 2017). Limited availability of skilled staff was also the most frequently mentioned investment barrier in the EIBIS survey (EIB, 2018), with 84 % of firms naming this as an obstacle (EU average 77 %). Economic simulations suggest that the lack of about 440 000 skilled workers may be slowing down economic growth by about 0.9 pps. (IW, 2018).

(See Section 4.3) necessary for digital and technological adoption, can raise potential growth.

Productivity growth will therefore be crucial to support growth and will increasingly depend on investments in Information and Communication Technologies and non-Information and Communication Technologies capital, and on investments in intangible assets, such as research, development and innovation, raising total factor productivity.

[4.4. Competitiveness reforms and investment*, 4.4.1. Productivity and investment needs, Digitalisation, p. 51]

Since July 2017, the ‘go digital’ support programme has been providing small and medium-sized enterprises all over the country with consultancy services via innovation vouchers, to advance their own digitalisation in the areas of IT security, digital marketing and digitalised business processes. Digital hubs are promoting closer cooperation between start-ups, small and medium-sized enterprises, industry, science and public administration (European Commission, 2018h). However, a lack of skilled human resources and capacities often holds these companies back from investing in digitalisation projects (see Chapter 4.3).

In November 2018, the Federal Government adopted its artificial intelligence strategy, designed to consolidate Germany’s role as a research location and use by small and medium-sized enterprises. The Agency for Innovation in Cybersecurity is being set up in 2019 with a view to funding innovative projects characterised by radical technological novelty, which could change the market.

[4.4. Competitiveness reforms and investment*, 4.4.1. Productivity and investment needs, The environment and the circular economy, p. 52]

The EU and national circular economy ambitions and targets require a sustained increase in investments, including in R&D. Stronger investments, including in R&D, will be needed to reach the objectives of PROGRESS but also to comply with the new recycling targets for the post-2020 period and the EU Action Plan for the Circular Economy. Eco-innovation is an important enabling factor for the transition to a low-carbon, circular economy. Product design approaches and new business models can help to produce systemic circularity innovations, creating new business opportunities.

[4.4. Competitiveness reforms and investment*, 4.4.2. Regional disparities, p. 55]

Compared to other regions in the EU, the innovation performance of German regions is relatively good. All German regions are either strong innovators or innovative leaders. Five German regions (Oberbayern, Tübingen, Stuttgart, Berlin and Karlsruhe) belong to the 25 most innovative regions in Europe. Still, there are major regional differences: the south of Germany is more innovative than the north and the east (European Commission, 2018j). This generally correlates with a greater share of high-technology employment, R&D expenditure and higher productivity levels. There are no headquarters of major companies located in the eastern *Länder*; this could partially explain the weakness of private research and development in these regions.

12.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Germany boasts some of the most innovative regions in the EU, however performance varies between regions and the country as a whole has slipped from its former position of 'Innovation Leader' to 'Strong Innovator'. Therefore priority investment needs ⁽⁷⁵⁾ have been identified to 'enhance research and innovation capacities and the uptake of advanced technologies', and in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential.

facilitate the transition towards new technologies, based on smart specialisation strategies.

boost expenditure on research and development and innovation, particularly private investment of small and medium-sized enterprises and in the East of Germany. Continue investment in the development of key enabling and emerging technologies.

enhance technology transfer between the public and private sectors, in and across regions and beyond borders, especially in new value chains.

build synergies and joint projects with other Länder, regions and Member States.

Widespread adoption of new Information and Communications technology would support productivity growth in Germany, leading to more sustainable trajectories. Therefore priority investment needs have been identified to 'reap the benefits of digitisation for citizens, companies and governments', and in particular to:

increase Information and Communications Technology uptake in small and medium-sized enterprises, including supporting infrastructures and services, supporting the development and implementation of business models based on new technologies, with a special focus on digital newcomers and laggards.

enhance the provision of public e-services including possible cross-border activities when there is a need and improve their uptake by citizens.

Private research and innovation in Germany is concentrated in large enterprises rather than small and medium-sized enterprises, the latter having fallen behind their international counterparts, which impacts on their competitiveness. Hence, priority investment needs have been identified to 'enhance growth and competitiveness of small and medium-sized enterprises' especially in the East of Germany, and in particular to:

support small and medium-sized enterprises to increase their own innovation competence, by implementing innovation and fostering cooperation with other small and medium-sized enterprises and research organisations, also in other Member States.

provide support for small and medium-sized enterprises to bridge the critical stages of development (incl. scale-up), especially for innovative start-ups, in particular in transition regions. Improve possibilities for small and medium-sized enterprises business succession by providing advice and funding.

⁷⁵ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

make the economy more circular and resource-efficient, for example by supporting eco-innovations and business models for more sustainable products and production systems.

The German economy faces the challenge of a significant shortage in qualified workers, the risk of automation and shortcomings in respect of life-long learning outcomes. Investment needs have been identified to 'develop skills for smart specialisation, industrial transformation and entrepreneurship', and in particular to:

provide support for upskilling of the workforce, refining and reshaping of skill sets of existing occupations and (re)training workers towards new demands, including the cross-border labour market.

promote the good practises for high-tech leadership skills and develop measures within smart specialisation strategies to overcome the shortage of highly-skilled professionals.

strengthen the integration of education and training institutions, including higher education and centres of vocational excellence, within national and regional innovation, technology diffusion and skills development ecosystems.

develop skills in smart specialisation areas for small and medium-sized enterprises, in particular in relation to digitalisation, industrial transformation and entrepreneurship, in cooperation with education and training institutions.

13. GREECE

13.1. Executive summary

Several years of underinvestment have led to major investment gaps in Greece. Strengthening investment will be instrumental in underpinning longer-term growth. Priority areas for public and private sector investment include transport and logistics; the sustainable regeneration of urban areas and the most disadvantaged and deprived areas; energy efficiency and infrastructures; environmental protection; digital technologies; employment, skills, education and training, social inclusion and integration, health and research and development, mainly through the development of smart specialisation strategies in sectors such as agro-food and tourism.

13.2. Research and Innovation

The economic crisis had a limited impact on research and development (R&D) expenditure, but the overall levels remain low, negatively affecting Greece's growth potential. Investment in R&D has increased in nominal terms from EUR 1.6 billion in 2008 to EUR 2 billion in 2017. However, it remains low compared with other countries (1.1 % of GDP against the EU average of 2.1 % of GDP). The business sector is for the first time the largest R&D investor in Greece, followed by the higher education and the public sector (Amanatidou et al., 2018).

Despite the recent significant increase in business R&D, in 2017 it was still well below the EU average (0.6 % of GDP vs 1.4 %). The science-business links also remain weak as evidenced by the drop in the number of public-private scientific co-publications as a proportion of total publications (⁷⁶). In addition, overall technological development

⁷⁶ Compound Annual Growth Rate 2010-2017: -4.8 %.

remains low as also reflected in the very low number of patents compared with other countries (⁷⁷). Therefore, investments are necessary in the short and medium term to tackle these problems.

The Public Research and Innovation system has benefited from stable levels of funding in the past decade. However, the low level of public R&D intensity (⁷⁸) coupled with the absence of a performance-based funding system, has a further negative impact on already relatively low levels of scientific excellence (⁷⁹). The government is adopting a series of measures to tackle persistent weaknesses and some of the most pressing challenges in the research and innovation system. Various co-financed projects have recently been set up to boost research and innovation activities, such as the Research-Create-Innovate initiative with an allocated budget of EUR 543 million. For instance, the set-up of an equity fund supported by EU funds has been set up to inject liquidity in start-ups and innovative businesses.

Research and innovation strategies for 'smart specialisation' have been developed at national and regional levels in line with international practice. These have led to the identification of key growth sectors such as agro-food, tourism, health, information and communication technology, energy and sustainable development, transport and logistics. However, the national priority areas have not yet benefited from smart specialisation strategies with concrete time-limited deliverables aimed at stimulating new investments.

13.3. Additional R&I references

[2. Overall findings regarding imbalances, risks and adjustment issues, Evolution and prospects, p. 16]

In addition, the reduced administrative burden to set up a company and the product and labour market reforms are also expected to stimulate competition and business innovation, bringing new competitors to the market.

[Box 3.3.2: Technical support by the Structural Reform Support Service, p. 41]

In the area of growth and business environment, the Commission has supported Greece in boosting competitiveness and innovation for businesses and in building a strong and green economy.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment*, p. 43/44/45]

Key public and private sector sectoral investment priorities include transport and logistics, sustainable regeneration of urban and most disadvantaged and deprived areas, energy efficiency and infrastructures, environmental protection, digital technologies, employment, skills, education and training, social inclusion and integration (see Section 3.3.6), health and R&D, mainly through the development of smart specialisation strategies in sectors such as agro-food and tourism.

⁷⁷ 11 PCT patents per population in 2014 vs. EU average of 102.

⁷⁸ 0.6 % of GDP in comparison with the EU average of 0.7 % in 2017.

⁷⁹ 8.6 % of highly cited publications in comparison with the EU average of 11.1 % in 2017

Innovation and human capital investments are insufficient for sustaining productivity growth and the lack of digital skills among the population at large hinders employability and the development of innovative businesses.

In 2017 and the first quarter of 2018, several significant measures were adopted to support innovation. These included tax exemptions for innovative companies; a regulatory framework for mediation principle in civil and commercial cases; stronger enforcement of intellectual property rights; and a licensing system for essential patents through the operation of the Industrial Property Organisation.

The reduction in the stock of intangible capital stems from low investment rates in R&D and other intangibles as recorded in national accounting and from economic competencies and intangibles not captured in national accounts⁽⁸⁰⁾. Greece therefore has a good opportunity to increase productivity if it implements policies to identify and remove investment barriers for different types of intangibles.

Export growth is not only robust in general, but also broad-based and balanced in geographic and sectoral terms, and is therefore resilient to future external shocks. However, Greece was starting from a low base and compared to the rest of the EU, its exports are directed towards primary products and goods with low value added and a low innovation component.

[Box 3.4.1: Investment challenges and reforms in Greece, p. 47]

Key public and private sector sectoral investment priorities include transport and logistics, sustainable regeneration of urban and most disadvantaged and deprived areas, energy efficiency and infrastructures, environmental protection, digital technologies, employment, skills, education and training, social inclusion and integration, health, and research and innovation, mainly through the development of smart specialisation strategies in sectors such as agro-food and tourism.

The development bank is envisaged to support enterprises and to promote the economy and the business environment by supporting small and medium-sized enterprises, fostering innovation, facilitating investments in infrastructure and encouraging equity investments and other alternative financing sources.

[Box 3.4.2: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Greece, p. 60]

Greece remains a large beneficiary of EU solidarity. The financial allocation from European Structural and Investment Funds (ESI Funds) aimed to support Greece in facing the severe consequences of the financial and economic crisis and address its development challenges amounts to up to EUR 21.4 billion for 2014-20, potentially representing 1.7 % of GDP annually and over 40 % of annual public investment. Furthermore, numerous Greek research institutions, innovative firms, and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 781 million.

⁸⁰ Analysis by DG Joint Research Centre – Knowledge for Finance, Innovation and Growth Unit – based on INTAN-INVEST data (<http://www.intan-invest.net/>)

20 projects ⁽⁸¹⁾ involving Greece have so far been approved under the infrastructure and innovation window of the European Fund for Strategic Investments. They amount to EUR 2.3 billion in total financing, which should in turn generate EUR 7.4 billion of investments.

13.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The Greek economy is characterised by very low public and private investments in innovation and a low ranking in the Global Competitiveness Index (last of the EU28). Specifically in relation to small and medium sized enterprises innovators, performance has fallen since the start of the crisis. In order to strengthen innovation performance and foster productivity growth, smart specialisation areas are identified based on national and regional needs and potential. High priority investment needs ⁽⁸²⁾ are identified to enhance research and innovation capacities and the uptake of advanced technologies, in particular:

promote business investment in research and development and foster collaboration between public and private research on targeted smart specialisation areas;

facilitate business technology transfer, networking, clusters and open innovation;

support activities that allow innovations to reach the market, especially for start-ups and small and medium sized enterprises in the digital market;

develop skills related to smart specialisation areas, in particular reskilling and digital skills.

Greece ranks very low in the uptake of information technologies and is last of the EU28 on the e-government scoreboard. High priority investment needs are identified to close the gap with respect to the Digital Agenda for Europe, to reap the benefits of digitalisation for citizens, businesses and the public sector, in particular:

support the increase of information and communication technology uptake in small and medium sized enterprises (business to business, business to consumer, consumer to consumer), including supporting infrastructures and services;

expand and complete the range of e-service provision (e-government, e-procurement, e-inclusion, e-health, e-learning, e-skilling, e-commerce) and their uptake by citizens, businesses and the public sector.

Access to finance for small and medium sized enterprises remains a very problematic area and framework conditions for entrepreneurship, innovation, and start-ups are unfavourable. Credit conditions tightened significantly during the financial crisis and remain very restrictive compared to other EU countries. High priority investment needs are identified to enhance the growth and competitiveness of small and medium sized enterprises, in particular:

⁸¹ Among which three are multi-country projects.

⁸² The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

foster growth of start-ups / scale-ups and accelerators, and develop integrated business advisory services;

promote entrepreneurship and support for new business models;

encourage industrial cluster development and enhanced cooperation between small and medium sized enterprises and universities/research centres.

14. HUNGARY

14.1. Executive summary

Increased investment in research, innovation, infrastructure and skills are important to improve productivity and long-term growth that benefits society as a whole. Public and private investment as a share of GDP is high, but its composition could be better geared to raise productivity. Research and innovation capacities need to be enhanced to improve moderate innovation performance. Investment is crucially needed in skills, education and training to boost future economic growth in Hungary.

Productivity growth remains modest. It has been slow for a decade compared to Hungary's regional peers. Large productivity differences persist between larger, more capital-intensive foreign firms, and smaller, more labour-intensive domestic counterparts. Only few firms innovate, reflecting weaknesses in the entrepreneurial culture and product market competition. Low funding for public research and development is detrimental to the research and innovation system. The skills level of managers and workers are not high enough to secure the spread of efficient business practices such as digitalisation.

14.2. Research and Innovation

Hungary's overall innovation performance is moderate and has declined relative to the EU. The low level of intellectual asset accumulation is also reflected in the low number of patent, trademark, and design applications, the small number of innovative businesses and the low level of internationalisation by small and medium sized enterprises. This fact is also reflected in the European Innovation Scoreboard (European Commission, 2018f). Smaller firms are especially reluctant to innovate, hindering their involvement in global value chains. According to the 2016 Community Innovation Survey, only 17.9 % of small firms introduced new products or processes, which is less than half of the EU average. The main self-reported causes for failing to innovate were the lack of ideas, the perceived lack of demand for innovation, and low market competition.

R&D investment remains below the EU average, and is dependent on EU funds. In 2017, R&D spending intensity increased by 0.15 percentage points to 1.35 % of GDP, partly due to the accelerated advance payments of EU funds. This is still well below the Europe 2020 target of 1.8 %. Business R&D, which amounts to 0.99 % of GDP, is concentrated in a few large, mainly foreign-owned companies, and benefits from generous government support. Public funding of private R&D is among the highest in the EU. At the same time, public sector R&D expenditure declined from 0.49 % of GDP in 2006 to 0.35 % by 2017, well below the EU average of 0.7 %.

The quality of public science suffers due to underfunding. The shortage of financial resources is detrimental to the career opportunities of researchers in the public sector and their number fell by 1.5 % since 2010. This trend is accompanied by a decrease in the

number of research units, and a falling proportion of highly cited publications. The proportion of science and engineering graduates has also declined since 2014 and is among the lowest in the EU. Science-business cooperation remains below the EU average due to the traditional divide between research, education and innovation entities in Hungary. In 2017, eight university-business cooperation centres were set up with EU co-financing to foster collaboration. The centres should develop sustainable institutional operations and to run innovation projects. Scientific performance and technology transfer would benefit from investment in public research capacities, which are a key source of knowledge and human resources for innovation in domestic companies.

The smart specialisation strategy would benefit from being updated, reinforced and more focused. Hungary introduced its national smart specialisation strategy in 2014 as a precondition to accessing European Structural and Investment Funds, in order to increase the performance of its scientific, technological and innovation system. In 2018, the National Research, Development and Innovation Office started revamping the monitoring system of the strategy and drafting its first monitoring report.

Recent policy measures create uncertainty in academic and research fora. Hungarian higher education institutions have the lowest financial autonomy in the EU according to a recent evaluation (EUA, 2017a). In addition, the April 2017 amendment of the Higher Education Act raised further concerns regarding academic freedom (EUA, 2017b). The Central European University, the largest higher education beneficiary under Horizon 2020, signalled its intention to leave Hungary because of the regulatory uncertainty created by this amendment. More recently, the government has announced that it plans to reform R&D financing to boost innovation performance. The Hungarian Academy of Sciences has rejected the proposed changes to its financing (HAS, 2018b) and closing its selected institutions for fear of breaching academic independence. It now faces financial difficulties as the funding of non-wage expenditure by the central budget has been cut from January 2019. These policy-related uncertainties may result in losing top research talent to abroad and risk a persistent decline in research quality.

14.3. Additional R&I references

[1. Economic situation and outlook, Productivity and potential growth, p. 12]

Low innovation activity and inadequate management practices hold back productivity growth within individual firms.

[Box 2.1: EU funds and programmes contribute to addressing help overcome structural challenges and to fostering growth and competitiveness development in Hungary, p. 16]

Hungary is one of the main beneficiaries of EU solidarity. European Structural and Investment Funds (ESI Funds) aimed to support Hungary in facing development challenges, amount to EUR 25 billion under the current Multiannual Financial Framework, equivalent to around 2.9 % of GDP annually or around 53.6 % of all public investment per year on average. Furthermore, a number of Hungarian research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 212 million.

The European Regional Development Fund (ERDF) supported closer collaboration between business and research institutions, improved research infrastructures and R&D investments in the private sector.

ESI Funds allocate about EUR 2.3 billion in the form of loans, micro-loans, guarantees and equity, supporting investments on R&D, innovation, information and communication technology, energy efficiency, and social investments. Under the Infrastructure and Innovation window, 5 projects involving Hungary and financed by the European Investment Bank with EFSI backing were approved, worth about EUR 420 million and triggering EUR 1 billion investment.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment needs, p. 33]

Increased investment in innovation, transport infrastructure and resource management are important for sustainable and inclusive growth. R&D spending is well below the EU average and the Europe 2020 target, holding back innovation performance and contributing to the large productivity gap between foreign and domestic firms.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment needs, Digitalisation and business organisation, p. 34]

According to the 2016 Community Innovation Survey, just 18.5 % of small Hungarian firms introduced marketing or organisational innovations, compared to 38.4 % in the EU on average.

[3.4. Competitiveness reforms and investment, 3.4.2. Market functioning, Regulation in the services sector, p. 39]

The authorities continue to entrust certain services to state-owned or private firms specifically created for these purposes (e.g. textbook publishing, waste collection, mobile payments, tobacco wholesale and retail, golden visas etc.). The lack of competition in these sectors may become detrimental to innovation and efficiency.

[3.4. Competitiveness reforms and investment, 3.4.3. Regional differences, p. 40]

Significant regional disparities exist in terms of innovation performance within Hungary (European Commission, 2017b).

The majority of spending is dedicated to improving transport infrastructure, but investment in regional innovation infrastructure also features prominently.

[3.4. Competitiveness reforms and investment, 3.4.4. Institutional capacity, Business environment and institutional performance, p. 41]

Fast track legislation combined with the increased number of new laws worsens the stability of the legal framework. For businesses, it leads to higher costs and discourages innovation and high value-added investments.

14.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Hungary's overall innovation performance remains moderate relative to that of the EU, while investment in research and development and science-business cooperation are below the EU average. High priority investment needs ⁽⁸³⁾ are identified to enhance research and innovation capacities and the uptake of advanced technologies in the smart specialisation areas and in particular to:

support the inter-institutional links and cooperation among stakeholders of research/academia and business, build critical research mass and attract talent in the strategic smart specialisation areas in order to turn research and development results into business applications, especially in cities with university capacity;

build on the existing research capacities as knowledge centres of smart economic transformation, support knowledge transfer and strategic partnerships;

support networking, cooperation and exchange of experience beyond national boundaries, including joint cross-regional, transnational and interregional projects.

High speed broadband coverage will be sufficient by 2021 in Hungary, however it still belongs to the low-performing countries in terms of Information and Communications Technology uptake and the use of data-driven technologies. Priority investment needs are identified to reap the benefits of digitalisation for citizens and companies, by:

increasing Information and Communications Technology uptake in small and medium-sized enterprises, including supporting infrastructures and services, taken into account the territorial differences;

improving digital skills, special attention needed in the education of both sides – consumers and business.

Hungarian small and medium-sized enterprises suffer from low productivity and innovation activity, hindering their involvement in global value chains. High priority investment needs are identified to enhance growth and competitiveness of small and medium-sized enterprises, including in rural areas and in particular to:

raise productivity and the value added of the economy by increasing the number of innovative firms, invest in firms' capacity to apply new technologies in order to rank up in global value chains;

encourage the entrepreneurial ecosystem, foster the creation of start-ups/scale-ups, accelerators, develop new business models for small and medium-sized enterprises, in particular through investment in intangible;

raise competitiveness and internationalisation of small and medium-sized enterprises, also through participation in industry led and research driven international clusters and cooperation among the Central and Eastern European and Danube Strategy countries.

Human capital represents a bottleneck to productivity gains. High priority investment needs are identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular through:

⁸³ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

specific trainings in re- and upskilling in smart specialisation areas, innovation management, entrepreneurship and innovative business models within firms, with attention to the need to address industrial transition and circularity; adjust skills development to the business needs.

Cooperation actions in the context of the EU Strategy for the Danube Region and the Thematic Smart Specialisation Platforms would be beneficial. To strengthen innovation performance and foster productivity growth, smart specialisation areas should be identified on the basis of national and regional needs and potential.

15. IRELAND

15.1. Executive summary

Regional differences in skilled labour, competitiveness and productivity are sizeable. This is mostly due to the concentration of multinationals in Dublin that employ large numbers of highly-skilled employees by offering higher salaries. The resulting lack of qualified employees and skilled managers in small and medium-sized enterprises reduces their innovation capacity and competitiveness.

Prioritising both public and private investment in infrastructure, decarbonisation, housing, innovation, skills and social inclusion is essential for sustainable and long-term inclusive growth. Investment in research and development, skills and digitalisation is needed to address the lagging productivity of domestic firms and reduce the increasing reliance on multinationals.

The announced Future Jobs Programme could help small and medium-sized enterprises invest more in research and development and encourage them to take up new technologies. It could also support small and medium-sized enterprises in diversifying exports, integrating themselves in global value added chains and increasing workers' skills.

The performance of the Irish economy is increasingly dependent on the activities of a limited number of foreign firms. The diversification of exports and productivity performance can improve the resilience of the local production base. This would require more effective public research and innovation efforts.

15.2. Research and Innovation

Deepening the innovation process remains equally important, either through increased R&D efforts or enhanced spill-overs from the cooperation with multinationals or research centres. Diversifying exports and integration in global value chains, and building up human capital are also means of attaining higher levels of resilience and sustainable growth. However, progress in these areas has been so far rather limited.

Business R&D expenditure is increasing, while its intensity remains below the EU average. Business R&D expenditure increased from EUR 1.5 billion in 2006 to EUR 2.2 billion in 2017. However, 64 % of total business expenditure is by foreign firms operating in a few sectors. In contrast, the R&D efforts of most domestic firms remain moderate, albeit increasing. Business R&D intensity stood at 0.7 % of GDP (1.2 % of GNI*) in 2017, below the EU average of 1.3 %. Ireland is on target to reach both the goal of 1 200 R&D performers (i.e. firms spending over EUR 100 000 on research, development and innovation) with 1 184 companies in this category and the goal of 200

large R&D performers (where spend is over EUR 2 million on research, development and innovation), with 184 firms in this category. However, the most recent *Innovation in Irish Enterprises* survey shows no progress towards meeting the share of innovative enterprises target (Eurostat, 2017) of 73 % of enterprises (57 % of all Irish enterprises with more than 10 employees consider themselves R&D active in 2016, down from 61 % in 2014).

Foreign firms operating in Ireland tend to benefit more from public sector R&D support. Accounting for 80 % of total public R&D spending, tax credits are the main instrument of public R&D support in Ireland (Irish Government Economic and Evaluation Service, 2018). Although evaluations conclude that that tax credits have a considerable additional impact (60 %) (National Competitiveness Council, 2018b, OECD, 2018), they also report that multinationals account for 99 % of the tax credits claims for investments in intangible capital (45 % for physical capital). In cooperation with the OECD, the Irish authorities are currently exploring ways to improve the impact of public sector R&D on SMEs, both through direct and indirect measures.

Stronger linkages between multinationals and domestic firms could help improve the diffusion of innovation throughout the economy. Technology spillovers can increase the productivity of Irish firms through, inter alia, cooperation agreements with multinationals, but research has shown that spillovers may appear only if local firms engage in innovation activities themselves ⁽⁸⁴⁾. This finding underscores the importance of policies aimed at increasing the R&D efforts of domestic firms. Although the Global Sourcing Initiative provides opportunities for Irish firms to connect into global supply networks, multinational firms are not always inclined to these cooperation agreements. Alternative and complementary ways of increasing spill-overs and promoting the integration of all capable local firms into the supply chains could further enhance linkages (OECD, 2018c).

In addition, cooperation between firms and public research centres is improving although much work lays ahead in this area. ⁽⁸⁵⁾ The recently launched Disruptive Technologies Innovation Fund has been endowed with EUR 500 million to further encourage cooperation between domestic firms and research centres, as well as national and foreign firms. Other initiatives such as Science Foundation Ireland Research Centres and Enterprise Ireland and the Industrial Development Agency Ireland's Technology Centres help to foster this collaboration.

Low levels of public R&D remain a concern. It will be difficult for Ireland to reach its 2020 R&D investment target of 2.5 % of Gross National Product. In 2017, Ireland had an overall, public and private, R&D intensity of 1.05 % of GDP (1.7 % of GNI*) compared to an EU average of 2.0 %. Ireland's public R&D intensity declined from 0.5 % in 2010 to 0.3 % of GDP in 2017 ⁽⁸⁶⁾. In absolute terms, although public expenditure in R&D grew from EUR 836 million to EUR 907 million over the same period, it decreased from EUR 951 in 2016. These relative low levels of expenditure may have a negative impact

⁸⁴ As shown by Schieldslag and others (2018)

⁸⁵ The level of business enterprise funding of public R&D continues being one of the lowest in the EU (22nd)

⁸⁶ This decrease was partly due to the upwards revision of Ireland's GDP from 2015 onwards.

on the ability to sustain in the longer run the high quality of the Irish scientific production and the highly qualified human resources needed in the Irish economy. ⁽⁸⁷⁾

New initiatives are being launched to foster business research and innovation. A key step is the announcement of the EUR 3.16 billion capital funding under the ‘Business, Enterprise and Innovation Priority Investments’ to projects highlighted in Project Ireland 2040 over the five years to 2022. The third Innovation 2020 Progress Report outlines advances made in delivering the 140 actions. Ireland has revised the Research Prioritisation themes to align the research funding to 14 priority areas (so-called Smart Specialisation areas) (Department of Business, Enterprise and Innovation, 2018a). The ‘Review of R&D&I Supports available to Businesses in Ireland to Maximise Business Expenditure on Research and Development’ (Indecon, 2017) also provides policy recommendations.

In July 2018, the Irish authorities announced an ambitious programme to help domestic firms improve their productivity. Future Jobs Ireland includes a focus on ‘raising productivity, particularly among SMEs and Irish-owned companies’. (Department of Business, Enterprise and Innovation, 2018) The framework includes various instruments to foster the diffusion of new technologies by Irish firms with a view to increasing their productivity. Future Jobs Ireland 2019 will be formally launched at the end of February 2019.

15.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 15]

While the Government has announced the ambitious 'Future Jobs' programme and made operational the Disruptive Technologies Innovation Fund (see Section 4.4.1 and Annex A), the use of direct policy instruments remains to be explored and tax credits remain the main instrument of public R&D.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Ireland, p. 16]

At the end of 2018, EUR 2.3 billion (70 % of the total ESI Funds) had been allocated to specific projects supporting, in particular, closer cooperation between businesses and research institutions and R&D investment in the public and private sectors.

ESI Funds have helped to address policy challenges identified in the 2018 Country Specific Recommendations (CSRs). By the end of 2018, around EUR 207 million from the European Regional and Development Fund had contributed to fostering R&I and small and medium-sized enterprises’ competitiveness (CSR3) by providing financial support to 47 000 businesses, assistance to 1 500 start-ups and training to around 50 000 participants and 42 500 businesses. Funds also supported 860 researchers and 370 new industrial partners to engage in innovation activities and collaborate with research centres. As a result, 4 700 new jobs and over 70 new start-ups and spin-offs were created and some 250 patent licences were granted. Horizon 2020 and European Agricultural Fund for Rural Development (EAFRD) respectively contributed with an additional EUR 621 and EUR 39 million to promote R&I in Ireland. The EAFRD financed 17 European Innovation Partnerships and provided training to 68 000 beneficiaries.

⁸⁷ Irish universities have already fallen down the latest international rankings. Six of the eight top-ranked Irish universities have lost ground in the QS World University Rankings 2019

So far, 21 projects involving Ireland have been approved under the infrastructure and innovation window of this fund. They amount to EUR 1 billion in total financing, which should, in turn, generate EUR 4.9 billion in investments.

[4.3. Labour market, education and social policies, 4.3.3. Education and skills, p. 40]

Additional funding of more than EUR 150 million has been provided for higher education in budgets 2017-19 to support targeted initiatives including skills programmes, performance and innovation funding, technological university development and apprenticeships in the sector.

[4.4. Competitiveness reforms and investment, 4.4.1. Competitiveness and productivity growth, Competitiveness*, p. 43]

A large part of the divergence between the two measures relates to the depreciation of foreign-owned domestic capital and activities related to trade in R&D, such as imports of intellectual property services, which are excluded from the headline current account balance.

The trade balance is influenced by the activities of multinationals through, inter alia, contract manufacturing, merchanting ⁽⁸⁸⁾ and imports of services related to R&D.

[4.4. Competitiveness reforms and investment, 4.4.1. Competitiveness and productivity growth, Productivity, p. 44/47]

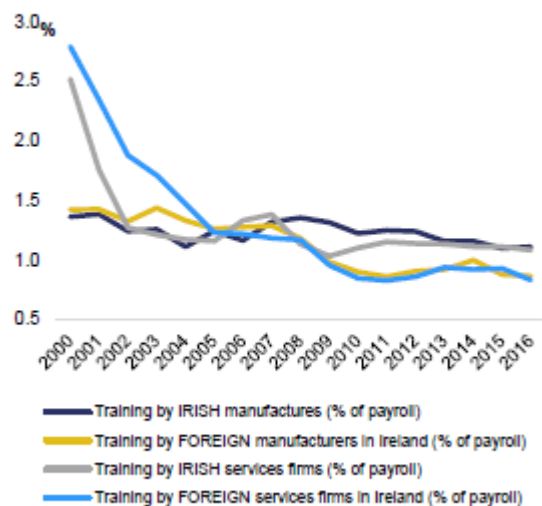
The foreign-domestic divide explains the differences in productivity growth, employment and wages within sectors. Within-sector productivity differences are particularly important in R&D, pharmaceuticals, telecommunications and wholesale and retail.

In the medium to long term, the availability of a diverse and skilled labour pool may be the main factor contributing in improving productivity. Despite public-sector sponsored programmes in fields such as digital skills, significant challenges remain (Section 4.3). Further efforts will be required to meet the need for skilled workers in areas of increasing demand such as construction and logistics. Irish firms might also increase their absorption capacity of new technologies by improving their staff training. Training activities within firms can help workers in foreign, technologically advanced firms to acquire skills that may be transferred later on to local firms when workers move across firms. In 2016, two out of three SMEs surveyed reported that their main priority was investing in training staff (Gargan et al., 2018). However, the share of payroll costs of firms' expenditure on structured training of employees has been falling both in Irish-owned and foreign firms operating in Ireland in the manufacturing and services sector (Graph 4.4.5). The number of sectors reporting more substantial reductions in training spending is quite significant: computer, electronic and optical products, publishing, broadcasting and communications, electrical equipment and other services. ⁽⁸⁹⁾

⁸⁸ 'Contract manufacturing' is a process in which resident multinational companies issue contracts to foreign firms to produce goods on their behalf. As resident companies own these goods, their sales are recorded as exports of the resident country even though they do not enter the domestic economy. 'Merchanting' refers to the purchase and resale of goods which do not enter the merchant's economy.

⁸⁹ Trading between Irish-owned firms and foreign multinationals could also facilitate technology transfer. However, survey data (DBEI(2018a)) suggest that the share of Irish inputs in the procurement of foreign firms has been falling in recent years as well.

Graph 4.4.5: Training expenditure domestic firms and multinationals in Ireland. Manufacturing and Services 2000-2016



Source: Department of Business (DBEI(2018a))

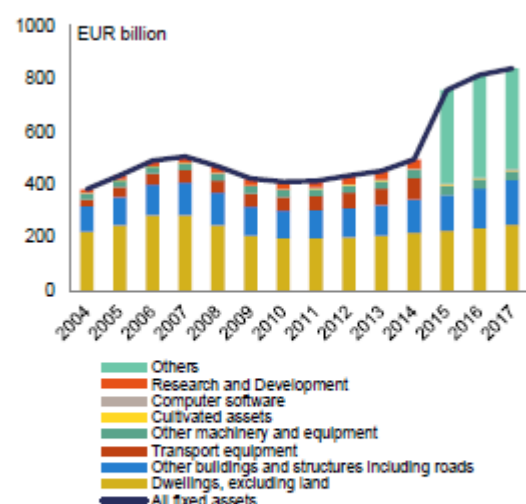
[4.4. Competitiveness reforms and investment, 4.4.1. Competitiveness and productivity growth, Digitisation, p. 47]

About 16 % of public R&D expenditure is dedicated to the ICT sector, the second highest in the EU (European Commission, 2018c).... Furthermore, the efficient adoption of digital technologies by domestic companies across a broader range of sectors, besides ICT, may help to improve their productivity, innovation capabilities and market reach.

[4.4. Competitiveness reforms and investment, 4.4.2. Public and private investment needs, Evolution of investments, p. 48]

The large imports by some multinationals of R&D assets, including intellectual property, had a significant impact on the capital stock, increasing the share of mobile stock (Graph 4.4.6).

Graph 4.4.6: Net Capital Stock held at the end of the year by asset type



(1) For confidentiality reasons, from 2015 onwards figures for the stock of Transport equipment – which includes the aircraft – and Research and Development assets are suppressed. Starting with 2015, these two components are captured therefore by the Others category, which is computed as the difference between Total fixed assets and the remaining categories for which data is published.
Source: CSO

[4.4. Competitiveness reforms and investment, 4.4.2. Public and private investment needs, Investment needs, p. 49]

Investment challenges relate primarily to infrastructure, decarbonisation, housing supply, skills and innovation. Skills shortages, in particular digital and managerial skills (Section 4.3.1 and 4.4.1), and a low level of investment in R&D by domestic firms (see above) may hinder the overall productivity of the economy, in particular for the domestic sector, and further widen the productivity gap between multinationals and domestic companies.

[4.4. Competitiveness reforms and investment, 4.4.2. Public and private investment needs, Investments for sustainable development, p. 54]

Market uptake of available energy efficiency solutions, technological innovation, digitalisation and up-skilling of the workforce in the energy renovation sector and promoting the multiple benefits of energy efficiency to further drive demand have the potential to drive the energy efficiency market further.

[4.4. Competitiveness reforms and investment, 4.4.2. Public and private investment needs, Investments for Regional Cohesion, p. 55]

The indicators driving the regional competitiveness gaps are business sophistication and innovation, market size and labour market efficiency.

Upgrading the innovation capacity and skills of domestic firms may help narrow the regional competitiveness and productivity gap across the regions. The regional productivity gap is largely explained by the concentration of multinationals in the South-East region, which have higher productivity than the domestic firms and account for 64% of the total innovation expenditure (OECD, 2018a). The low research and innovation capacity of domestic firms is partly due to their weak managerial skills. The innovation capacities and skills of the Irish-owned small and medium-sized enterprises could be

increased by reinforcing their cooperation with research centres and multinationals and by providing them with targeted public R&D support, in particular in the lagging regions (the Northern & Western; and Midland regions)(see section 4.4.1).

15.4. Annex D

Policy Objective 1: A Smarter Europe - Innovative and smart industrial transformation

Ireland is considered a strong innovator while none of its three regions are innovation leaders. The country continues to lag behind in the level of investment in research and innovation that affects leveraging business investments in research and innovation, the linkages between research and enterprises and the creation of patented intellectual assets and innovation outcomes. Business research and innovation investment is concentrated on a small number of foreign multinationals operating in a few sectors only in Ireland. Innovation capacity, capability, and the ability of Irish-owned firms to fully utilise new technologies is weakened in particular by low research and innovation levels.

To help create a balance in research and innovation between the foreign multinationals and domestic companies, high priority investment needs (⁹⁰ have therefore been identified to provide adequate public funding by new targeted forms of measures that address Irish small and medium-sized enterprises specific needs in research and innovation, create a stronger, targeted innovation capacity and capability in and for Irish domestic small and medium-sized enterprises based on a reinforced link with cooperation with research centres and large businesses, and also based on a reinforced link with evolving Smart Specialisation areas and a more effective and faster innovation diffusion, and in particular to:

enhance Research and Innovation capacities and the uptake of advanced technologies;

enhance Competitiveness and growth of Irish-owned small and medium-sized enterprises;

strengthen innovation performance in all regions and foster productivity growth by prioritising smart specialisation areas on the basis of national and regional needs and potential, including green innovation;

encourage cooperation activities on corresponding Smart Specialisation priorities and exchange of experience (inter-regional among the Irish regions and including with neighbouring countries, clusters and in the context of the EU Atlantic Strategy). This would also help to address persisting regional differences in the research and development intensity. Stimulate interregional cooperation in new value chains, also with other countries;

strengthen eco-innovation and research, development and innovation focusing on green and blue innovation, including in the area of water, innovation on clean energies, climate change mitigation and low-carbon technologies and on making Ireland a more circular economy.

This means in practice, in particular, to

⁹⁰ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

create stronger linkages between multinationals and domestic firms to improve innovation diffusion (technological spill-overs); stronger cooperation between firms and public research centres to strengthen the innovation capacities of domestic small and medium-sized enterprises (improving the relatively weak science-business linkages and capitalise on Ireland's scientific excellence); reinforce Irish small and medium-sized enterprises absorption capacities to successfully apply new technologies, in particular in low-carbon and clean energy technologies; incentivise domestic small and medium-sized enterprises to engage in knowledge investments (i.e. in research and innovation) and in human capital investments (i.e. lifelong learning to improve managerial and digital skills);

invest in Irish firms' capacity to internalise external knowledge, spill-overs in innovation and new technologies in order to participate at a higher level in global value chains; foster public and business investment in research and innovation; overcome barriers to research and innovation activity; increase the number of innovative indigenous firms; enhance cooperation and exchange of experience (inter-regional, including with neighbouring countries, clusters, in the EU Atlantic Strategy context); link regional research and innovation actors to industrial stakeholders from different Member States;

use innovation as a way to reduce energy consumption and greenhouse gas emissions. This could be through promotion of innovative energy efficiency solutions in businesses, including in their premises, installations and processes. In addition, the use of innovative renewable energy technologies could also contribute to this goal;

create policies and schemes to overcome barriers to innovation take-up; further develop industrial clusters that include small and medium-sized enterprises, within and outside national borders.

The improvement in economic conditions over the last two years has translated itself into close to full employment. This has led to shortages of high-skilled labour and a mismatch between skills available and the needs of Irish firms to upgrade their own skills levels and competitiveness. Irish firms continue to face challenges/lose workforce to established foreign multinational companies, in particular regarding more highly skilled employees. Ireland should look to improve the match between the supply of and demand for SME-relevant skills, in particular managerial and digital skills. High priority, targeted investment needs have therefore been identified for the development of skills for Smart Specialisation, industrial transition and entrepreneurship, in synergy with small and medium-sized enterprises-relevant lifelong learning actions and upskilling under Policy Objective 4, and in particular to:

develop and upgrade skills for smart specialisation, industrial transition and entrepreneurship;

reap the benefits of digitalisation for companies and citizens via the 2025 EU Gigabit Society compatible broadband speeds being delivered from the ERDF 2014-2020 period.

This means in practice, in particular, to:

foster innovation management in Irish SMEs, in particular with regard to upgrading managerial skills and the need to address the issue of smart industrial transition; integrate high education and vocational excellence with national, regional and transnational innovation, its diffusion and skills development systems;

create new business models and forms of employment arising from the digital transformation, whilst ensuring fair working conditions and social protection; help the small and medium-sized enterprises across the country to use superfast and ultrafast broadband being delivered to allow such enterprises to increase their competitiveness, to innovate, increase productivity, and to reach new markets and customers, and grow rapidly; foster the adoption of digital technologies in Irish small and medium-sized enterprises; enable Business-to-business, Business-to-customer and Customer-to-customer new business opportunities.

16. ITALY

16.1. Executive summary

Adequate investments are needed to strengthen administrative capacity, human capital and innovation, as well as to reduce regional disparities. Investment in human capital is a pre-requisite for boosting public and private investment. Investment in innovation would improve productivity and growth prospects in the medium and long term.

Productivity growth has been sluggish over the past two decades. The productivity gap between Italy and the EU continues to widen. In 2018 labour productivity is expected to have remained stable, while growth in total factor productivity (measuring how efficiently labour and capital are used in production) is expected to have grown by some 0.5 %, only half as fast as the EU average. This is largely due to low investment and innovation, barriers to competition, weaknesses in the public sector and a non-supportive business environment.

Structural factors hold back investment and other key productivity drivers. Weak human capital slows down Italy's transition to a knowledge-based economy. In the public sector, weak administrative capacity remains a barrier to public investment. Measures to boost private investment and innovation like the 'Impresa 4.0' plan generally had a positive effect, but the most efficient measures need to be made permanent following an in-depth assessment. Furthermore, micro and small firms face specific difficulties to adopt productivity-enhancing strategies. Measures to support knowledge (such as technological clusters) and cooperation among firms help smaller firms in particular to tackle these difficulties and increase their low productivity.

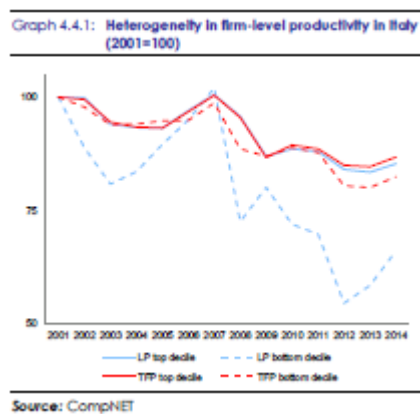
The regional divide remains acute. ...Moreover, lower levels of education and innovation limit the positive impact of measures adopted to support private investment....

16.2. Research and Innovation

The adoption of productivity enhancing strategies by smaller firms is limited in Italy. About one out of two Italian firms does not innovate (⁹¹), with only 20% of strong innovators in manufacturing and 12% in services. This despite the fact that process and organisational innovation, particularly relevant for smaller firms and traditional sectors (Istat, 2018b), as well as product innovation, enhance productivity, even of small firms. The ability of smaller firms to benefit from synergies along the value chain, following innovative investment, is limited by the high degree of vertical fragmentation of the

⁹¹ Based on the 2014 Community Innovation Survey.

Italian production chain and the low degree of formal cooperation among firms (Istat, 2018b; Bugamelli *et al.* 2018; Confindustria, 2018a; Del Gatto *et al.*, *forthcoming*). This results in a polarization between many micro and small firms with limited resources, skills, propensity to export to foreign markets and innovation and few larger, highly innovative, productive firms active in international markets (Bugamelli *et al.*, 2018). Low innovation also implies slower transition to a green economy ⁹²). These features makes smaller firms particularly vulnerable to external shocks and contributes to explaining the widening of productivity heterogeneity across firms during the crisis (Graph 4.4.1).



The weak dynamics of knowledge intensive sectors limit productivity prospects in the medium-long term. The share of value added in knowledge intensive sectors is low. Moreover, this share is stagnant in high-tech and medium-high tech manufacturing (the latter going back to pre-crisis level only in 2017) and even declining in high-tech knowledge intensive services (from 4.6% in 2007 to 4.2% in 2016).

Public schemes supporting innovative investment remain temporary and still lack an in-depth assessment of their efficiency. R&D tax incentives generally have a positive but modest effect on investment in intangibles (Graph 4.4.2). While an evaluation of the Impresa 4.0 package is not available yet, provisional data suggest it has been effective in stimulating investment decisions in 2017. The deduction of 250 % of investment in innovative technologies (*Iperammortamento*), including ICT, and the R&D tax credit were considered rather effective in stimulating investment decisions in 2017 by almost 50 % of firms, especially by larger ones (Istat, 2018b). According to Italian authorities, the R&D tax credit was largely taken up by firms in industrial sectors and only marginally by firms in the service sector, where productivity is especially lagging behind. Both *Iperammortamento* and the R&D tax credit are extended to 2019, but will be reduced on average, particularly for larger investment. Most of these measures remain temporary and unstable in a context in which 84% of Italian firms consider uncertainty about the future as an obstacle to investment decisions (EIB, 2018). Making permanent some of these measures based on an in-depth assessment would enhance their impact, including by easing firms' investment planning. Targeting investment in specific research areas can be more effectively achieved through direct public support (Nascia *et al.*, 2018).

There is a need for adequate investments in human capital, innovation and strengthened administrative capacity and to reduce regional disparities across sectors. Investment in higher education and skills (Section 4.3) is pre-requisite for

⁹² Only 16% of Italian firms offer green products or services compared to 25% in the EU.

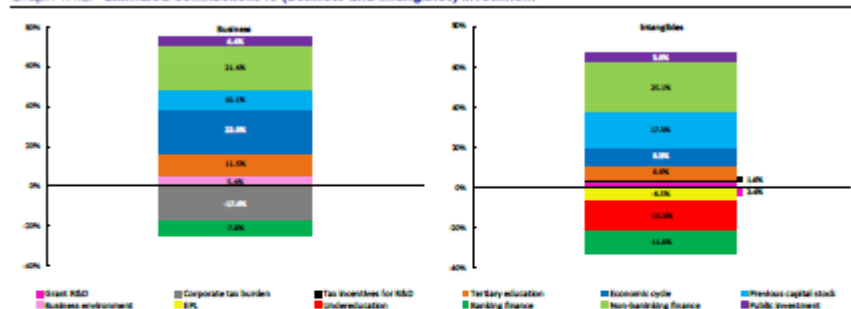
boosting public and private investment. Investing in innovation and supporting small firms' efficiency would enhance productivity.

Investment in human capital is needed also to counter Italy's slows transition to a knowledge-based economy. While the availability of human capital is significantly and positively correlated with the number of innovative start-ups (UPM, 2018), the expenditure for tertiary graduates is low (Section 4.3), hampering innovation and productivity growth. The situation is worse in those fields relevant for innovation, as shown by the lower share of graduates with respect to the EU in fields such as computing (0.6% against 2.5% in 2016), science and engineering (12.2% against 15.5%). There is a need to boost studies in these fields and to strengthen specific skills, such as financial skills, including through on-the-job training.

Policies supporting knowledge and cooperation among smaller firms go in the right direction. Measures such as technological clusters and network contracts, which support cooperation among firms and the exploitation of economies of scale, improved the performance of participating firms (Confindustria, 2017; Istat, 2018c). The Competence Centres, yet to be activated, are meant to provide technological transfer to SMEs on industry 4.0 technologies and related ICT training. The Digital Innovation Hubs, 21 of which are already operational, accompany SMEs' digital transformation and networking in larger digital value-chains.

There is a need to raise the low level of investment in intangibles. Investment in intangibles and, more specifically, in R&D (respectively 2.9 % and 1.4 % of GDP in 2017) has been considerably below the euro area average (respectively, 4.1 % and 2.2 % in 2017) since the early 2000s. R&D expenditure is also below Italy's EU2020 target of 1.5 % of GDP. Business R&D expenditure is particularly low compared to the euro area average (0.8 % of GDP against 1.4 % in 2017). Nevertheless, among SMEs it increased from 0.13 % of GDP in 2007 to 0.22 % in 2015, although it is still below the EU average of 0.3 %. Public support to business expenditure remains low but increased from 0.05 % of GDP in 2008 to 0.12 % in 2016, with an increasing share due to tax incentives (0.08 % from 0.02 % in 2008) (OECD, 2018). Public expenditure in R&D is also below the euro area average (0.5 % of GDP with respect to 0.7 %) and is declining since 2012, mostly due to the declining trend in the higher education sector, despite its potential to crowd-in private investment in intangibles (Briguglio *et al.*, *forthcoming*).

Graph 4.4.2: Estimated contributions to (business and intangibles) investment



(1) Estimated contributions correspond to the independent impact of each explanatory variables (see legend) to the investment trend based on estimated coefficients from an augmented accelerator model.
(2) Data refer to time series for Italy covering 1999-2018Q1 (business) and 1996-2018Q1 (intangibles). Investment and macroeconomic data are from national accounts.
(3) Banking finance corresponds to the share of NPLs. Non-banking finance corresponds to firms' self-financing and equity
(4) Education refers to tertiary education (including the impact over-education)
(5) Business environment is provided by the world bank doing business index
(6) Public investment for intangibles refer to R&D
(7) Economic cycle corresponds to previous GDP
(8) EPL stands for employment protection legislation (OECD) for temporary employment
Source: D. Briguglio *et al.* (forthcoming)

16.3. Additional R&I references

[1. Economic situation and outlook, Real GDP growth, prospects and risks, p. 8]

Despite the recent albeit moderate pick-up in TFP growth, helped by the cyclical recovery of business investment, structural obstacles remain. They hamper an efficient allocation of production factors across the economy and the diffusion of innovation and technological change (to use labour and capital more efficiently) has been insufficient.

[2. Progress with country-specific recommendations, p. 18]

Progress was also limited concerning women labour market participation and innovation, research, digital skills and infrastructure, and vocational oriented tertiary education.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Italy, p. 20/21]

EU programmes are also widely used in Italy **to foster research and innovation**. ESI funds allocate EUR 4.2 billion to research and development in the current multiannual financial framework. By the end of the programming period, programmes co-financed under ESI Funds should support 6 945 enterprises in building cooperation with research institutions and 4 528 enterprises in introducing new products in their markets. Programmes co-financed under ESI funds are also expected to support 3 750 full time equivalents new researchers and 4 962 full time equivalents researchers working in improved research infrastructure facilities. Furthermore, private investment matching public support in innovation or R&D projects is expected to reach EUR 2.18 billion by the end of 2014/20. An additional boost to research and innovation comes from Horizon 2020, as participants from Italy received EUR 3.01 billion so far, with a projection to reach EUR 5.42 billion by the end of 2014/20, which would be 49.2% increase compared to 3.63 billion received in FP7. Applicants from Italy were awarded with 1812 Seals of Excellence, ranking Italy 2nd in the EU.

81 projects involving Italy have so far been approved under the infrastructure and innovation window of EFSI. They amount to EUR 7 billion in total financing, which should, in turn, generate EUR 30.6 billion in investments.

[3. Overall findings regarding imbalances, risks and adjustment issues, Evolution, prospects and policy responses, p. 23]

Moreover, effective reforms to boost competition on product markets and thereby increase innovation and productivity suffer from a piecemeal approach.

[Box 3.1: Structural reforms and potential spillovers – the case of Italy, p. 25]

The simulated reforms cover the following areas: product market regulation and entry, labour market participation, tax structure and R&D subsidies.

[4.1. Public finances and taxation, 4.1.4. Taxation*, p. 32]

Only a few of the tax expenditures to support private investment and innovation, expiring in 2018, have been extended, while also being reduced in scope (Section 4.4).

[4.4. Competitiveness and investment, 4.4.1. Investment and productivity*, p. 47/48]

The underperformance of Italy's aggregate productivity hides a considerable heterogeneity across firms. It is linked to low levels of investment and innovation, as well as weak competition in several sectors (Section 4.4.2), weaknesses in the institutional and administrative framework and a challenging business environment (Section 4.4.4).

While public investment might indirectly worsen financing conditions, it can crowd-in private investment (Graph 4.4.2), by creating favourable conditions, for instance through the promotion of relevant infrastructure (e.g. research, transport, energy).

[4.4. Competitiveness and investment, 4.4.3. Regional dimension, p. 55/56]

The divergence in investment between the North and the South is particularly marked for intangibles and innovation. The number of employees employed in high-tech industries is almost twice as big in the North (3.7 % versus 2 %) and R&D expenditure is 1.5 times bigger (1.4 % of regional GDP, compared to 0.9 % of regional GDP in the South). The number of patents per inhabitant is 10 times higher in the North than in the South (106.8 versus 10.1 per 1 million people) (Nascia *et al.*, 2018).

Weaknesses in the innovation ecosystem in the South constraint the impact of measures to support private investment. The Southern manufacturing industry has benefited from the fiscal incentives of the Impresa 4.0 plan. However, its weaker pre-existing conditions, such as the local level of education and innovation, limited their impact. According to data of Italian authorities, the R&D tax credit was mostly absorbed by firms in the North (70 % of the total costs with respect to only 10 % for Southern firms in 2017), while 54 % of firms benefitting from the Start-ups Act are located in Lombardia, Emilia Romagna, Lazio e Veneto (UPM, 2018).

Institutional weaknesses in Southern regions, together with other factors, remain important bottlenecks for an effective delivery of policies. For instance, they prevent Italian regions from grasping the full benefits of Smart Specialisation strategies in terms of innovation and competitiveness⁽⁹³⁾.

16.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Expenditure on research and innovation in Italy is significantly below EU average and the country is considered a moderate innovator. Italy has room to foster productivity growth by enhancing research and innovation capacities and the uptake of advanced technologies, in line with national and regional smart specialisation strategies. High priority investment needs⁽⁹⁴⁾ are identified to address the technological, economic and societal challenges, while tackling strong regional divergences, in particular to:

increase the number and the scale-up of innovative firms in knowledge-intensive sectors with the highest growth potential;

⁹³ Focused investment on research, development and innovation on selected priorities.

⁹⁴ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

foster knowledge exchanges between research organisations and businesses, especially innovative small and medium sized enterprises, in particular through collaborative partnerships and training.

support innovative services for research organisations and companies that cooperate with the aim of transforming new ideas into commercially viable innovative enterprises.

Given the lack of integration of digital technologies in the economy and the low level of digital skills, investment needs have therefore been identified to promote digitisation for citizens, companies and governments, and in particular to:

increase digital skills in small and medium sized enterprises and their uptake of digital technology solutions, including e-commerce, e-payments, cloud-computing services, and also internet of things, cybersecurity and artificial intelligence;

improve the deployment of digital public services for both citizens and businesses.

Italian small and medium sized enterprises perform below EU average in terms of productivity and growth. Investment needs have therefore been identified to enhance growth and competitiveness of small and medium sized enterprises, and in particular to:

foster growth and productivity-enhancing strategies through promotion of entrepreneurship, managerial and financial skills, skills related to industrial transition (e.g. energy efficiency and circular economy), and value chains integration;

support internationalisation of small and medium sized enterprises to move up in the global value chains, including by joining cooperation networks and inter-regional clusters;

facilitate access to finance and address regional disparities through a balanced use of grants and financial instruments in less-developed regions and a wider use of financial instruments in more-developed ones.

17. LATVIA

17.1. Executive summary

Latvia can boost its long-term growth potential by focusing private and public investments on innovation, human capital and regional development. Latvia remains a catching-up economy and its main national development focus is on increasing its GDP per capita. As evidenced by falling productivity growth rates, the easy gains of the early catch-up stage have been exhausted. This means that productivity growth will have to increasingly rely on knowledge-intensive activities. Latvia's weakest point has been innovation, which requires investments in research and development, in developing people's knowledge and skills, and in other intangible assets.

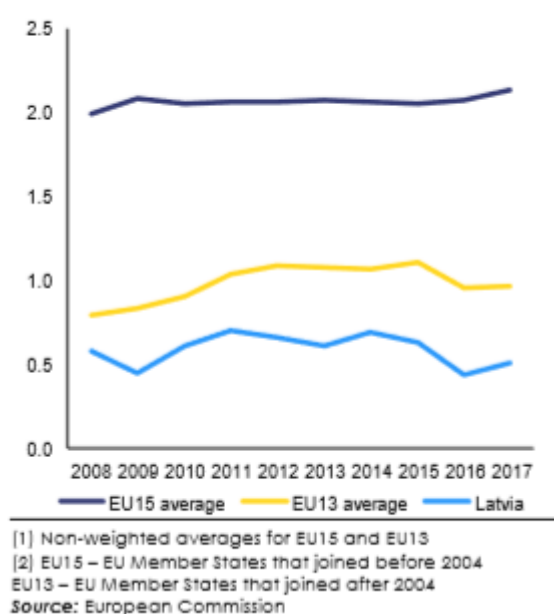
The higher education system is fragmented and while tertiary education attainment rates are high, the proportion of science, technology, engineering and mathematics graduates is low. Vocational education and training is being modernised, but the share of students in this type of education and their employability are below the EU average, as is participation in adult learning. The low level of digital skills among the labour force limits the use of digital technologies by businesses and the potential for innovation.

Latvia invests very little in research and development. In 2017, the share of expenditure on research and development was 0.51 % of GDP (against 2.1 % in the EU average). This level was among the lowest in the EU and rather stable over the last decade. Moreover, research funding relies almost entirely on EU funds. Latvia is a moderate innovator with some strong points like its information, communications and technology infrastructure, but its performance is lagging behind in human resources, in public-private sector cooperation, and in investment in intellectual property. Latvia's innovation performance could benefit from the more active involvement of its largest state-owned companies, which have the resources to afford substantive investment capacity.

17.2. Research and Innovation

Investment in research and development in Latvia is low and dependent on European Structural and Investment Funds (ESIFs) ⁽⁹⁵⁾. In 2017, R&D intensity recovered somewhat from last year's drop, reaching 0.51 % of GDP (see graph 3.4.8). The increase was mainly fuelled by renewed ESIF funding which raised the public funding level to 0.37 % of GDP. Business expenditure on R&D also increased, but the level of 0.14 % of GDP is among the lowest in the EU. A substantial increase in investment in R&D is necessary to effectively develop a national research and innovation (R&I) system with a focus on increased and sustainable funding from national sources. Moreover, Latvia will likely not meet its national R&D intensity target of 1.5 % of GDP. Latvia's total expenditure on R&D is now at about the same level as it was a decade ago, making this the only national target where Latvia has achieved no progress, largely due to the low political importance given to R&D funding.

Graph 3.4.8: Research and development expenditure, % of GDP



⁹⁵ In 2017 Latvian national funding represented 44% of the total financing for research and development, totalling EUR 60.1 million. In comparison, amount of foreign investments (structural funds as well as other foreign funding) was 30% of the total financing for research and development, totalling EUR 41.1 million.

Public research is of varying and inconsistent quality due to underfunding and the fragmentation of research performers and of the governance of the R&I system. In 2015, the share of publications in top journals was 5.9 %, compared with the EU average of 11.1 %. This is largely due the fragmentation of research institutions and because Latvia lags behind the EU average in terms of numbers of researchers, PhD students and STEM graduates. This weakness is aggravated by inadequate administrative capacity and the scattering of policymaking and implementation among a multitude of ministries and agencies. In 2018, Latvia received recommendations from the European Commission's Horizon 2020 Policy Support Facility, which advised it to put the research funding management under one roof and to increase the share of competitively-won research funding for the research institutions. The government has taken the first steps to address the latter issue, but the recommendation to tackle the fragmented governance remains to be addressed.

A broad variety of instruments to promote innovation exists but these are underutilised. The majority of the successful research-industry cooperation focuses around the 'Competence Centres' scheme, which draws industry to work together with research institutions. The portfolio of innovation support measures includes vouchers, technology transfer and development programmes. However, the share of firms engaged in innovative activities is fairly small ⁽⁹⁶⁾, which may explain the lack of demand for some of the instruments on offer. The supply of researchers from the public sector ⁽⁹⁷⁾ and the mobility of researchers to the private sector is rather low and not increasing ⁽⁹⁸⁾, which hinders the development of innovation activities. The government is promoting closer research cooperation among the largest state-owned enterprises and is asking them to set their medium-term innovation strategies. The poor innovation performance likely requires an adjustment in Latvia's smart specialisation strategy to focus on the areas of its economy with the most potential.

17.3. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in in Latvia, p. 16]

EU funding is contributing to major developments in the Latvian economy by promoting growth and employment via investments in areas such as research, technological development and innovation, business competitiveness, sustainable transport, employment and labour mobility. Over 40 supported research project supported by the European Regional Development Fund (ERDF) have been commercialised, and support has already been approved for 3 111 businesses, including 382 start-ups, generating 665 new jobs.

9 projects involving Latvia have so far been approved under the infrastructure and innovation window of EFSI. They amount to EUR 207 million in total financing, which should, in turn, generate EUR 567 million in investments.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment, Investment needs, p. 38]

⁹⁶ Value added in high-tech (HT) and medium-high-tech (MHT) companies was 2.3 % of GDP in 2016.

⁹⁷ The number of researchers (FTE) employed by the public sector has been steadily decreasing over the decade and in 2016 was equal to 2.7 per thousand active population, ranking 22nd, EU average — 3.9.

⁹⁸ Researchers (FTEs) employed in businesses per thousand active population in 2016 value 0.6, ranking 24th, EU average — 3.9.

In order to continue converging with the EU average, investment in innovation, human capital and regional development is needed. At the moment, Latvia does relatively well in exports of knowledge-intensive services, but the share of high-tech goods in its exports is low. In order to facilitate the economy's transformation, Latvia needs to invest in human capital, including skills and health (see section 3.3.4). It needs to invest more in research and development both in the private and public sectors, including by engaging the state-owned enterprises more closely in its innovation system.

[3.3. Labour market, education, and social policies, 3.3.4. Education and skills, p. 36]

In 2017, performance-based funding (around 3% of total funding for higher education) was distributed to 14 higher education institutions that have successfully involved students in research and development, participated in international research projects and cooperated with businesses.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment, Digitalisation, p. 43]

Latvia has implemented various policy measures over the last few years to improve in areas of moderate performance (e.g. the innovation voucher) and to consolidate areas of strong performance (e.g. the Law on Aid for Start-up Companies) ⁽⁹⁹⁾. However, challenges remain in the integration of digital technologies, in access to finance and in the supply and demand of digital skills. The low and decreasing number of graduates in STEM subjects contributes to the acute shortage of highly qualified human resources in the Latvian R&I system, both in the research institutions and in the productive sector.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment, Environment and climate, p. 45]

Latvia's eco-innovation performance is negatively impacted by businesses' low investment. The low financial capacity of SMEs means little innovation on sustainable development ⁽¹⁰⁰⁾ is taking place. The fragmented support landscape presents another barrier. The overall position of Latvia in the Eco-Innovation Index 2017 has declined and Latvia now ranks 22nd in the EU (European Commission, 2017b). Prioritisation of research and more investment in the bio-economy, smart materials, sustainable energy solutions are beginning to deliver the first results, but they need to be continued in order to help Latvia shift its economy to environmentally sustainable foundations.

[3.4. Competitiveness reforms and investment, 3.4.2. Single market integration, Internal market for goods and services, p. 46]

Most Latvian producers (65 %) are concentrated in low- technology industries, such as basic wood and metal processing, with little innovation prospects.

[3.4. Competitiveness reforms and investment, 3.4.3. Regional development, p. 49]

⁹⁹ European Commission, Digital Transformation Scoreboard 2018.

¹⁰⁰ Eco-innovation is 'any innovation that makes progress towards the goal of sustainable development by reducing impacts on the environment, increasing resilience to environmental pressures or using natural resources more efficiently and responsibly'.

Enterprises in Latvia are characterised by their lack of innovation prospects (see 3.4.1), small size (EBRD, 2017), low added value/complexity, high resource intensity and lack of integration in global value chains.

[3.4. Competitiveness reforms and investment, 3.4.4. Quality of governance, Public sector reform, p. 50]

The stated aim remains to make the central government leaner, more effective, responsible and flexible by centralising support functions (such as accounting), reducing staff levels on average by 2 % per year, fostering innovation and training, and making the remuneration system more competitive with the private sector.

[Box 3.4.1: Investment challenges and reforms in Latvia, p. 54]

R&D investment in Latvia is among the lowest in the EU and is overly dependent on EU funds. While a variety of instruments are on offer to boost R&D investments, they are not fully utilised due to lack of demand. Given that some of the largest, best funded companies in Latvia are state-owned, directing them to engage in R&D activities more actively is one of the few policy levers available to promote R&D investment. Latvia has taken the first steps in this respect by requiring its largest state-owned enterprises to lay down their R&D strategies (see Section 3.4.1).

17.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Latvia's innovation performance lags behind most other EU countries with low added value/complexity, high resource intensity and lack of cooperation and integration in global value chains. This has direct consequences on the country's productivity and competitiveness. High priority investment needs ⁽¹⁰¹⁾ have therefore been identified to enhance research and innovation capacities and the uptake of advanced technologies, where appropriate in cooperation with other countries, in line with the EU Strategy for the Baltic Sea Region, and in particular to:

strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

increase the number of innovative firms in the smart specialisation sectors by fostering research and innovation to facilitate the transition towards new technologies and value added activities;

strengthen research and innovation by increasing the attractiveness and the competitiveness of the research system;

support collaborative research between universities and businesses.

Latvia rates highly in the offer of digital public services by the government with some weaknesses in quality and open data availability. However, companies and people (for lack of skills) do not make sufficient use of the digitalisation opportunities. Priority

¹⁰¹ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

investment needs have therefore been identified to reap the benefits of digitalisation for citizens, companies and governments, in particular to:

upscale and accelerate e-government, interoperability of systems and open data availability;

increase information and communications technology uptake in small and medium-sized enterprises, including supporting infrastructures and services;

increase e-services provision and their uptake, with special focus on rural areas, elderly people and in a cross-border context.

In Latvia the level of private research and development expenditure is the lowest in the EU, inevitably limiting the advancement of companies towards the technological frontier, as well as their productivity and competitiveness. High priority investment needs have therefore been identified to enhance growth and competitiveness of small and medium-sized enterprises, in particular to:

promote entrepreneurship, in particular start-ups and accelerators, also via technology transfer and development programmes and promoting alternative sources of financing;

strengthen the competitiveness and growth prospects of innovative small and medium-sized enterprises for more sophisticated products and services, to move up the global value chain;

support small and medium-sized enterprises to internationalise activities and identify new export markets, cooperation networks and interregional clusters, particularly in the Baltic Sea region.

The transition to new technologies in Latvia is hampered by low digital proficiency within companies. Moreover, insufficient availability of skilled human resources is one of the country's biggest issues.. Investment needs have therefore been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, in particular to:

reskill and upskill small and medium-sized enterprises in smart specialisation areas, with a particular attention to digital skills and entrepreneurship in order to increase productivity;

enhance market relevance, innovation and viability of research institutions' projects, via ad hoc training activities.

18. LITHUANIA

18.1. Executive summary

Focusing investments on human capital, innovation, using resources more efficiently and improving transport connections would boost productivity and growth potential. Skills shortages are hindering private investment, especially with the labour force shrinking, and together with poor health status of the population are limiting productivity gains. Strengthening innovation in the private sector and increasing its capacity to absorb technology could support the shift toward activities that are more

knowledge-based and add higher value to the economy. Focusing on efficiency of investment would help Lithuania reach its strategic goals.

The labour force's low level of digital skills is limiting the use of digital technologies by businesses and the potential for innovation.

The poor quality of research and limited business-science cooperation are hindering productivity growth. The research and innovation system is fragmented and private R&D investment is among the lowest in the EU. This is yielding innovation results that are mediocre overall and is limiting the growth potential of the Lithuanian economy. Progress with the reform of innovation policy has been slow. The higher education reform envisages consolidating universities' fragmented research capacities, but these measures have yet to be implemented. Developing coherent policy measures to support science-business cooperation and introduce a simplified and consolidated research and innovation support system remains a challenge.

18.2. Research and Innovation

The competitiveness of the country's research and innovation (R&I) system is hampered by the shortage of skills and a lack of a coherent programme for publicly funded science to collaborate with businesses. Lithuania is a moderate innovator, ranking at around 70 % of the EU average (European Commission, 2018j). In particular, the low level of R&I outputs shows that policies to date have not yet delivered the expected benefits for the economy and competitiveness. Despite gradual progress, the proportion of innovative businesses in Lithuania is lagging behind the EU average, in particular those introducing product, organisational or marketing innovations (OECD, 2018b). Cooperation between businesses and universities or research centres — an important channel of knowledge transfer and commercialisation — remains scarce.

Investment in R&D is below the EU average and remains highly dependent on ESI Funds. In 2017, total R&D investments amounted to only 0.9 % of GDP, compared to an EU average of 2.1 and far away from its 2020 target of 1.9 %. Public investment, which is funded mainly from EU funds, made up the bulk of R&D investment at 0.6 % of GDP. Private R&D investment reached only 0.3 % of GDP, which is one fifth of the EU average and constitutes one of the lowest private investment levels in the EU ⁽¹⁰²⁾. Public R&D investment is focused on the Smart Specialisation strategy, which is rather broad and covers most economic sectors, thus contributing to a thin spread of limited funding.

The underfunding of researchers and fragmentation of the R&I system is resulting in low quality of public research. As part of the ongoing reform of the higher education system, multiple amendments to the Law on Research and Studies in 2017-2018 provide for a gradual increase in researchers' salaries by 40 % over 2018 and 2019 and the 83 % increase in PhD scholarships announced for 2019. They also introduced industrial PhDs and a progressive move to reward institutional performance by incentivising cooperation with industry, internationalisation and participation in Horizon 2020. The merging of universities with the aim of consolidating the country's fragmented research capacities is ongoing (see Section 3.3.5). To ensure its success, this process requires close monitoring by universities and authorities and a strengthening of their administrative capacities, especially in relation to the development and implementation of coherent joint research agendas of the merged entities.

¹⁰² Business expenditure on R&D as % of GDP — Lithuania ranks 25th in the EU.

The economy's capacity to innovate and absorb R&I is limited. Innovating firms in Lithuania are relatively small in size. They are weakly integrated around domestic clusters and into global value chains, with low potential of attracting critical mass investments and developing large-scale innovations. Low business demand for research and innovation is mainly predetermined by the structure of the economy, which mostly consists of lower value added industry and services. In Lithuania total value added in high and medium high-tech manufacturing and knowledge-intensive services is among the lowest in the EU and stagnant since 2007. Further investment in innovative SMEs, including internationalisation and support for moving up global value chains, clusterisation and cooperation activities could support a shift to high-tech/higher value added products.

The ongoing reform of innovation policy aims to raise innovation levels and absorption capacity. The leadership of the Ministry of the Economy and Innovation has been strengthened through being given additional responsibilities to ensure the promotion of innovation and boost the experimental development part of research and innovation (¹⁰³). The reform takes into account the recommendations stemming from the European Commission's Horizon 2020 Policy Support Facility in 2017, which is focused primarily on increasing the engagement between business and science and the attraction of innovation intensive FDI (RIO, 2018). The implementation of recommendations is uneven, however. The highest uptake is in relation to FDI-related recommendations and progress is still required on aspects such as the overhaul of financial incentives for science-business cooperation or the revision of the system to financially reward research performance. The success of the reform will require ensuring the coherence of R&I policies, underpinned by efficient coordination of the policy mix and close cooperation between the involved authorities.

18.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 14]

However, progress in addressing the issues in the labour market, education and health sector, improving the design of the tax and benefit system, as well as in increasing productivity by making public investment and research and innovation policy more efficient, was limited.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Lithuania, p. 16]

Actions financed through European Regional and Development Fund (ERDF) and European Social Fund (ESF) cover, among other things: ...promoting R&I in the private sector and cooperation between science and business.

In addition, the European Fund for Strategic Investments (EFSI) has allocated EUR 399 million to 13 infrastructure and innovation projects and 6 SMEs projects in Lithuania. This is set to trigger EUR 1.5 billion in additional investments. Lithuania ranks 11th in the overall volume of approved EFSI operations as a share of GDP.

[3.1. Public finances and taxation, 3.1.2. Tax policy, p. 18]

¹⁰³ Stipulated in the new Law on Technologies and Innovation, adopted in 2018 and changes to the Law on Research and Studies, 2018.

Lithuania's R&D incentives are generous but appear ineffective in motivating private sector R&D investment. In 2017, private R&D expenditure amounted to 0.3 % of GDP, compared to an EU average of 1.4 %. The fiscal instruments in place to support R&D include a deduction of 300 % of R&D expenditures from taxable income if certain innovation criteria are met and a scheme allowing faster depreciation of some R&D capital assets. A reduction in compliance costs and relieving the administrative burden on small businesses could widen the use of R&D tax incentives.

[3.2. Financial sector, 3.2.2. Access to finance, p. 22]

Difficulties in accessing finance affect SMEs' innovation and growth. More than one of eight SMEs considered access to finance its most important concern. This is among the highest and almost double the EU average. Despite the improved availability of funding, SMEs access to finance score remained close to the EU average. (European Commission, 2018d). These bottlenecks affect the entrepreneurial ecosystem and the innovation capacity (see Section 3.4.1), hindering SMEs' growth.

[3.4. Competitiveness reforms and investment, 3.4.2. Investment, Investment needs, p. 34]

The economy needs additional investment in innovation, resource efficiency and connectivity to ensure a smoother integration into the single market and raise productivity growth. The level of innovation and technology absorption capacity of businesses in Lithuania is low.

[3.4. Competitiveness reforms and investment, 3.4.2. Investment, Resource efficiency, p. 36]

Eco-innovation, where Lithuania is also below the EU average, could help resource productivity to improve.

[Box 3.4.1: Investment challenges and reforms in Lithuania, p. 38]

Recently, however, productive investment — machinery and other investment (including R&D) — has started to grow at a healthy pace. This has been driven by private investment in the context of high capacity utilisation and labour shortages, supported by high corporate profits, positive expectations and easy financing conditions (see Section 1). In the coming period, investment should remain one of the main drivers of growth, with support also from faster use of EU funds from 2019.

The Investment and Business Guarantees Agency (INVEGA) promotes start-ups, SMEs and innovations.

Poor innovation results are not helping to support the competitiveness of the economy and attract investment. Investment in R&D, especially in the private sector, is low while tax incentives, although generous, do not appear to be motivating enough for companies to innovate due to their complexity. Cooperation between the public and private sectors is limited. To address this issue, the government has started implementing the reform of innovation policy (see Section 3.4.2).

18.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Lithuania's general innovation performance and the proportion of innovative and high added value businesses, which both are the main drivers of productivity and competitiveness, are lagging behind the EU28 average. High priority investment needs⁽¹⁰⁴⁾ have therefore been identified to enhance research and innovation capacities and the uptake of advanced technologies, where appropriate, in cooperation with other countries and in line with the EU Strategy for the Baltic Sea Region, as well as building on the lessons learned in Lithuania during the implementation of the Commission pilot project on industrial transition, and in particular to:

strengthen innovation performance and productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

increase the number of innovative firms in the smart specialisation sectors with the highest potential, and taking into account regional specialisations;

strengthen the supply side of research and innovation by increasing the attractiveness and competitiveness of the research system;

support collaborative research between universities and businesses, thereby enabling technology transfer and commercialisation of research outcomes.

Uptake of broadband by households and use of advanced data-driven technologies by firms remain limited despite Lithuania's relatively high ranking in terms of broadband coverage. Priority investment needs have therefore been identified to reap the benefits of digitalisation for citizens, companies and governments, and in particular to:

increase Information and Communications Technology uptake in small and medium-sized enterprises, including supporting infrastructures and services;

promote the range, quality and interoperability of e-services provision and their uptake by citizens, with special focus on rural areas and the older population, and in a cross-border context;

upscale and accelerate open data, e-government.

Firms in Lithuania are relatively small and weakly integrated into domestic and international clusters and global value chains. The start-up ecosystem is relatively young and dynamic and needs further development. High priority Investment needs have therefore been identified to increase the growth and competitiveness of small and medium-sized enterprises, and in particular to:

strengthen the competitiveness and growth prospects of the innovative small and medium-sized enterprises;

internationalise their activities and move up the global value chains;

identify new export markets and promote participation in cooperation networks and interregional clusters, including in the Baltic Sea region;

¹⁰⁴ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

promote entrepreneurship, as well as the creation and growth of start-ups/scale-ups and accelerators.

The transition to new technologies in Lithuania is hampered by weak innovation and a low degree of digital proficiency within companies. Investment needs have therefore been identified to develop skills for smart specialisation, industrial transition and entrepreneurship and in particular to:

provide small and medium-sized enterprises and research institutions with targeted training on how to manage innovations;

support small and medium-sized enterprises in re-skilling in smart specialisation areas;

develop universities' and research institutions' capacity to improve the commercial viability and market relevance of their research projects; develop digital skills in small and medium enterprises in order to increase their productivity.

19. LUXEMBOURG

19.1. Executive summary

Focussing investments ⁽¹⁰⁵⁾ on fostering digitisation and innovation, improving housing supply and sustainable transport infrastructure, and stimulating skills development would improve economic resilience, and strengthen the long-term potential growth of Luxembourg. Public investment remains high and focussed on knowledge-intensive sectors, including a strong Information and Communication Technology sector. However, this has not spilled over, nor helped to stimulate private investment in innovation and digitisation, which remains low and appears insufficient to support the transition to a data-driven economy, and to improve significantly the low levels of economic digital integration and sluggish productivity growth. While firms increasingly perceive the shortage of qualified workforce as an obstacle to investment, heavy traffic congestion and insufficient housing supply may also be negatively affecting the country's attractiveness (see Section 3.2), which calls for significant investments in construction and sustainable transport infrastructure (see Section 3.4). Effective investments in education and training are needed to make the most of people's potential and thus improve inclusion and employability, and foster technological and digital transformations to improve productivity and long-term growth potential (see Section 3.3).

Luxembourg has kept up its efforts to strengthen knowledge-intensive sectors and pursue its economic diversification strategy. Stronger private investment in research, technological innovation and digitisation can be key drivers of productivity growth and of the transition to a data-driven economy. The weak connection between the public science base and businesses calls for action to promote knowledge transfer to firms. The lack of a national research and innovation strategy and stagnant public support for business research and development investments, are among other challenges that prevent Luxembourg from exploiting the full potential of its innovation eco-system.

¹⁰⁵ Both private and public investment.

19.2. Research and Innovation

The further development of other high-added value activities is required to boost productivity growth. Knowledge-intensive sectors – such as Information and Communication Technology or space – request the provision of knowledge from the public research system and large investments in research and development from the business sector, which are two of the key challenges for Luxembourg. With a rapid development of its public science base over the last decade, Luxembourg had the highest compound annual growth rate of public research and development intensity among EU Member States, rising from 0.26% of the GDP in 2007 to 0.58% in 2017. In addition, Luxembourg's public science base has become one of the top performers in the EU in terms of quality outputs, efficiency, and internationalisation of the system.

Nevertheless, the valorisation of research results remains a challenge requiring additional investment to boost knowledge transfer. Although there are several initiatives to strengthen science-business collaboration (i.e. BRIDGES programme), the declining levels of collaboration between the public research system and the business sector calls for adequate funding schemes to boost knowledge transfer in the country.

Business investment in research and development continued to decline, and, while above the EU average, research and innovation capacities of small and medium-sized enterprises have decreased from 2010 to 2017 ⁽¹⁰⁶⁾, although several initiatives have been taken by the authorities. Private research and development intensity in Luxembourg has been declining over the last 15 years, reaching 0.68% of GDP in 2017. Small and medium-sized enterprises' investments in research and development have decreased dramatically (from 0.41% of the GDP in 2007 to 0.12% in 2015) and are well below the EU average of 0.30% of the GDP. The stagnation of public direct support to business research and development activities since 2007 (at only 0.05 of GDP, one of the lowest in the EU) might be one of the reasons behind this drop and shows that further investments are needed to boost research in firms. The RDI promotion law adopted in June 2017 provides the legal framework for several aid schemes for enhancing research, development and innovation activities in businesses, notably supporting innovation capacity in Small and medium-sized enterprises and shared research infrastructures between the public and private sectors. Luxinnovation keeps providing support to Small and medium-sized enterprises in several areas –such as improving their innovation performance or increasing digitisation activities. Nevertheless, additional financial resources in the areas highlighted in the law, will not only help reversing the declining trend in business research and development investments but will also support the diversification strategy of the country.

Luxembourg lacks a national strategy for research and innovation linked to its technological, environmental and socio-economic challenges and opportunities. The country did not yet develop a common single policy approach for research and development with a prioritisation based on a robust assessment of expected economic impacts. In addition, the public support to public research and business research and innovation is fragmented among several governmental structures. The national authorities are currently working in several long-term plans, such as in the design of a new strategy on a data-driven economy (see also diversification of the economy). The reformulation of these research and development priorities, implemented by the National

¹⁰⁶ Even if above the average, the innovation performance of small and medium-sized enterprises measured by the 2018 European Innovation Scoreboard decreased from 2010 to 2017.

Research Fund, under the mandate of the Luxembourg Government, aims at providing an input for the future national R&I strategy and at better supporting the connection between the research and the economy by concentrating financial resources in strategic sectors. Luxembourg adopted its smart specialisation strategy in December 2017, aiming at addressing key socio-economic challenges, while concentrating on a limited number of specific sectors, namely Industry 4.0, Cleantech, Healthtech and Information and Communication Technology.

19.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 16]

Public investment remains high and other measures to foster innovation remain activated. Yet, private investment, especially on innovative technologies and digitisation, remains low compared with the euro area average.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Luxembourg, p. 18]

Financial allocation from the European Structural and Investment Funds (ESIF), aimed to support Luxembourg in facing development challenges, amounts to up to EUR 140 million in the current Multiannual Financial Framework, equivalent to around 1% of all public investment per year on average. Furthermore, numerous Luxembourg research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 87.57 million.

Increasing R&D investment is of crucial importance for creating greater economic diversification and increasing the number of Small and Medium size Enterprises involved in research.

An example of EFSI-backed project in the country is “Flen Pharma”, a small and medium-sized enterprise which develops medical devices to care for wounds. Thanks to EFSI financing, the company has been able to expand its Research and Development department and hire extra highly-skilled staff.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment challenges, p. 40]

Focussing investments ⁽¹⁰⁷⁾ on fostering digitisation and innovation, improving housing supply and sustainable transport infrastructure, and stimulating skills development would improve economic resilience, and strengthen the long-term potential growth of Luxembourg. Strategic public investment remains high and focussed on knowledge-intensive sectors, including a strong Information and Communication Technology sector. However, this has not spilled over, nor helped to stimulate private investment in innovation and digitisation, which remains low and appears insufficient to support the transition to a data-driven economy, and to improve significantly the low levels of economic digital integration and sluggish productivity growth.

[Box 3.4.1: Investment challenges and reforms in Luxembourg, p. 41]

¹⁰⁷ Both private and public investment.

Public investment is high, with the government pursuing its strategy for developing five knowledge-intensive sectors, which now contribute around 10 pps to GDP growth. By contrast, private investment in research and innovation remains low in the broad business sector and appears insufficient to improve significantly the current low levels of digital economic integration and sluggish productivity growth, which has quasi stagnated since 2015. While shortage of qualified workforce is increasingly perceived as an obstacle for investment, the public investment strategy has developed technologies with the potential to support a broader digital integration of the economy. Focussing investments in digital diffusion and digital human capital may foster business innovative investment conducive to higher productivity growth.

In Luxembourg, the SNCI (Société Nationale de Crédit et d'Investissement) is a public banking institution, providing financial support to domestic firms for development investments, including fixed assets, innovations or commercial projects, either in Luxembourg or abroad. SNCI also grants transfer loans to start-ups and SME's and may take equity positions, either directly or in association with financial partners or its subsidiary, CD-PME S.A.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment challenges, Energy, Environment and climate change, p. 45]

Luxembourg is a top player within Europe in eco-innovation.

[3.4. Competitiveness reforms and investment, 3.4.3. The Grande région, p. 47/48]

Luxembourg is a major partner of the "Grande Région". This political organisation focuses on facilitating access to the cross-border labour market through different labour mobility initiatives (including those linked to transport, education and training). It also endeavours on promoting an eco-friendly lifestyle (eco-technologies, waste treatment, cultural heritage, etc.), on developing health and social care services as well as supporting research and innovation.

In terms of innovation and competitiveness, Luxembourg needs to continue developing partnerships in the context of the Grande Région, building on its Smart specialisation strategy. The Luxembourg smart specialisation strategy is firmly anchored within the larger national innovation strategy and economic perspective. In a context of rising worldwide competition in research and innovation, where no Member State can succeed in isolation, it is thus crucial for Luxembourg to continue developing partnerships in this sector, in particular by strengthening collaboration between stakeholders in the research community, businesses and higher education. In this aspect, the *Grande Région* is rather competitive and has relatively high levels of innovation potential. The conditions for supporting effective growth in competitiveness and innovation-based development, and the critical mass to support innovation and cooperation, are present. The region as a whole features strong institutional capacities, stable macroeconomic conditions, good regional infrastructures, healthy populations, relatively high shares of employment in high-tech sectors, the presence of regional larger-scale markets (many urban/ metropolitan centres) and high levels of technological readiness.

Projects are ongoing to, inter alia, research collaborations in developing smart and sustainable multimodal mobility-on-demand transit solutions.

19.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Luxembourg appears too dependent on the financial sector and lags behind in diversification of its economic structure. Strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential.

Investment needs ⁽¹⁰⁸⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, and in particular to:

support technology transfer and diffusion of innovation through networks between businesses and research centres and through networks of digital innovation hubs and incubators;

enhance cooperation in key digital technologies, eco-innovation, support cluster development through the implementation of interregional projects across EU national borders;

stimulate integrated cooperation in new value chains across programmes and across borders.

Even though companies perform above the EU average in business digitisation, electronic information sharing, radio frequency identification and the use of social networks, small and medium-sized enterprises lag behind in e-commerce. Investment needs have been identified to reap the benefits of digitisation for citizens, companies and governments and in particular to:

facilitate the integration of digital technologies by companies;

develop sustainable and circular district and cities;

invest in common smart mobility systems through cooperation with neighbouring countries.

Most of the Scoreboard's indicators on innovation in small and medium-sized enterprises are on a declining trend, including commercialisation of innovation. The percentage of small and medium-sized enterprises introducing product or process innovations also declined as did the percentage of small and medium-sized enterprises innovating in-house. Investment needs have been identified to enhance growth and competitiveness of small and medium-sized enterprises and in particular to:

encourage industrial cluster development and enhanced cooperation between small and medium-sized enterprises and universities/research centres, and the sustained engagement of small and medium-sized enterprises in the Entrepreneurial Discovery Process;

¹⁰⁸ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

develop small and medium-sized enterprises skills and capacities in the exportation of their products and services and the commercialisation of innovation, especially online.

A large share of companies report difficulties in filling Information and Communications Technology vacancies, which suggests a skills mismatch. Investment needs have been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

provide small and medium-sized enterprises with training and reskilling possibilities for smart specialisation areas with a particular attention to digital skills and encourage them to mutualise their training needs by supporting and co-financing clusters, and joint national, regional, transnational and international cooperation in innovation sectors.

20. MALTA

20.1. Executive summary

Focussing investments on skills development, innovation, infrastructure and natural resource management would strengthen the sustainability of Malta's economic growth. In the long run, the increased economic activity may exacerbate existing bottlenecks and put further pressure on natural resources and infrastructure, while labour shortages, low skill levels and low innovation reduce firms' growth prospects. Investment is needed to support environmental sustainability, enhance educational outcomes and skills, and improve the innovation framework.

The research and innovation potential of Maltese firms remains limited. Malta's innovation performance is gradually improving but remains relatively modest. R&D is largely dependent on foreign direct investment, while domestic innovation is lacking. Access to finance is more difficult for innovative firms without collateral. The effectiveness of existing measures to support home-grown research and innovation remains limited.

20.2. Research and Innovation

Malta's innovation performance is moderate but gradually improving. Malta remains a moderate innovator, although its innovation performance has increased since 2010 (European Commission, 2018l). The country ranks seventh in the EU in terms of fast-growing firms in the most innovative sectors (Eurostat), it hosts over 200 foreign direct investment operations in niche sectors based on low volume/high value added operations (European Commission, 2019d) and it has experienced rapid development of the digital content and software development industry.

Low investment in intangibles assets such as R&D explains the modest research and innovation performance. R&D intensity remained flat in recent years (0.55 % of GDP in 2017 against 2.07 % for the EU) and the country is likely to miss its target of 2 % R&D intensity by 2020. The recent slight increase in public R&D intensity is partly explained by the significant inflow of structural funds. The low level of public R&D investment in the public science base limits the full usage of the country's scientific and technological potential. Although the University of Malta (the only public research performer in the country) has improved its scientific performance (Malta ranks 11th in the EU in terms of top scientific publications) with a relative specialisation in medical sciences, it currently does not receive dedicated institutional funding for conducting R&D.

Firms' limited capacity to engage in R&D hinders innovation creation and technological spill-overs. Business enterprise R&D expenditure intensity has declined since 2012 (0.34 % of GDP in 2017 against 1.36 % for the EU). Research-intensive sectors are heavily dependent on foreign investment (e.g. pharmaceuticals, medical devices, electronic components), which means that core R&D activities are undertaken at the multinationals' headquarters outside Malta. Surveys confirm that firms mainly engage in non-R&D-based innovation with a focus on design, process, organisational and market innovation (European Commission, 2018l; EIB, 2018). The limited R&D potential of domestic firms partly explains the lack of robust academia-business linkages and knowledge transfer activities.

The effectiveness of measures to support home-grown research and innovation remains limited. Despite the existence of sectoral strategies (e.g. on blockchain technologies, see also Section 3.4.2), the country has not yet set up a coherent and long-term competitiveness strategy for moving the domestic economy up the value chain. The Research and Innovation Strategy 2014-2020 has little visibility and its implementation is scattered between various governmental bodies ⁽¹⁰⁹⁾ with limited coordination. It is unclear whether existing measures supporting business R&D investments, such as the two R&D tax incentives schemes ⁽¹¹⁰⁾ and the 2014-2020 Research and Development scheme, are effective, given their low uptake.

20.3. Additional R&I references

[1. Economic situation and outlook, Growth outlook and risks, p. 7]

Existing investment gaps in terms of human capital and innovation ecosystem (see Section 3.3 and 3.4), if not addressed, would weigh on the sustainability of Malta's development.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Malta, p. 16]

ESI Funds contribute to boosting investment in research and innovation and increasing the employment rate.

Various reforms have been undertaken as preconditions for ESI Funds support ⁽¹¹¹⁾. These include the timely transposition of the EU public procurement and environment directives into national legislation, structural reforms in research, development and innovation, ... Many projects have been launched to stimulate private investments in key strategic areas, in line with the 'smart specialisation' strategy.

Examples include a project backed by the EFSI up to 5 EUR million, implemented by an intermediary bank. This project should trigger about EUR 17 million in investments and should allow 12 SMEs to benefit from improved access to finance. As an example of EIB financing, support was provided to STMicroelectronics to invest in research, development and innovation activities regarding the next generation of semiconductor devices.

¹⁰⁹ These include the Malta Council for Science and Technology, Malta Enterprise, and the Support Division Unit in charge of ERDF funding, under the Office of the Prime Minister.

¹¹⁰ 'Aid for Research and Development Projects' and 'Tax credits for R&D and Innovation scheme'.

¹¹¹ Before programmes are adopted, Member States are required to comply with a number of so-called ex-ante conditionalities, which aim at improving conditions for the majority of public investments areas.

[3.3. Labour market, education and social policies, 3.3.1. Labour market, p. 29]

Since economic growth is increasingly linked to innovation, higher quality and added value investment in upgrading skills, qualifications and education and specific actions to integrate young people, lower socio-economic groups, the low-skilled, people with disabilities and migrants remain crucial.

[3.3. Labour market, education and social policies, 3.3.2. Education and skills, p. 31/32]

Malta took measures to increase the attractiveness of vocational education and training and strengthen its role in the economic and innovation ecosystem. Vocational and applied subjects were introduced in secondary schools, adding over four subjects in the 2019-2020 school year with support from the European Social Fund (ESF). The number of apprenticeships increased by 100 students, in the 2017 academic year. Furthermore, the Malta College of Arts, Science and Technology engaged in 703 partnerships with local industries.

A systematic identification of skills to support the transition to a more sustainable economic development model is lacking. Although some measures back technical and highly qualified training and provision in environmental, engineering or ICT studies (e.g. Malta's College of Arts Science and Technology training programmes), they are modest in scope and budget. The majority of schemes (e.g. PhD support, Get Qualified scheme) are generic and they would benefit from targeting specific disciplines or sectors. In addition, systematic coordination between the different governmental bodies on this issue would benefit from further strengthening.

[3.4. Competitiveness and investment, 3.4.1. Productivity growth and drivers, p. 34/35]

A number of financial instruments, grant schemes and tax incentives launched in the last decade by the government and co-financed by the EU aim at providing finance for small and medium-sized enterprises (SMEs) and start-ups.

Addressing investment gaps in infrastructure, innovation and skills would support the future growth and the long-term sustainability of the Maltese economy. Facilitating innovation, strengthening links between research systems and businesses, and helping firms climb up the added value chain would help boost productivity. In addition, labour and skill shortages are perceived in several sectors, with lack of staff with the right skills being mentioned as a barrier to investment by a large majority of firms. Investment aimed at upskilling the workforce may help tackle the challenge (see Section 3.3).

[3.4. Competitiveness and investment, 3.4.1. Productivity growth and drivers, Environmental sustainability, p. 36/37]

The potential role of innovative technologies in addressing sustainability concerns remains underexplored. There are currently no R&D funding or support measures to develop new/improved technologies addressing environment and climate change. Existing measures supporting R&D and technology development by firms (e.g. grants, tax incentives) remain general in scope and do not specifically target these priority areas. Several on-going initiatives aim at developing new or improved technologies in the transport sector. However, their scope and scale remain modest given the needs of the country. Funding for R&D projects is also modest, with less than EUR 1.5 million allocated to projects addressing energy efficiency and aquaculture/agriculture. In the

tourism sector (which is a priority in the smart specialisation strategy), it remains unclear whether the two on-going projects (Mediterranean Centre and re-generation of lower Valletta) adequately address the issue of sustainability.

[3.4. Competitiveness and investment, 3.4.2. Market functioning, Digital economy, p. 39]

Malta has recently introduced a new regulatory framework on innovative technologies, including blockchain. On 1 November 2018, a comprehensive legislative package, regulating the use of distributed ledger technology platforms, including blockchain, came into force. The new regulatory framework comprises three acts, covering: (i) virtual financial assets, including crypto-currencies; (ii) innovative technology arrangements and services; (iii) the establishment of the Malta Digital Innovation Authority. Such legislation aims at promoting Malta as a digital innovation hub, as well as providing legal certainty in an area which is still mostly unregulated within the EU.

To incentivise digital entrepreneurship, the Malta Information Technology Agency Innovation Hub continued its accelerator programme, which provides seed investment to help early-stage start-ups validate, prototype, test and take their business idea to the market.

[Box 3.4.1: Investment - challenges and reforms in Malta, p. 42]

In addition, insufficient innovation and limited capacity to scale up R&D activities still represent a challenge to firms' growth (see Section 3.4).

20.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Malta's research and innovation performance has improved but the proportion of innovative enterprises is still lagging behind. Priority investment needs ⁽¹¹²⁾ have therefore been identified to strengthen research and innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential and in particular to:

promote business investment in research and innovation science-business cooperation and enhance research and development capacity in sectors linked to the smart specialisation;

enhance development and provision of key digital technologies;

support networking, clusters, cooperation, joint cross-regional and interregional projects;

promote the development of innovative firms in the smart specialisation areas;

improve energy and resource efficiency, water-management cycle, waste management and sustainable mobility, such as for instance in the shipping industry;

¹¹² The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

foster investment in eco-innovation.

Even though Malta scores well on broadband coverage, investment needs are identified to reap the benefits of digitisation for citizens, companies and governments, including:

Information and Communication Technologies up-take in small and medium sized enterprises, including infrastructures and services;

e-government, including the take-up of Europe-wide interoperable services.

Small and medium enterprises have experienced significant growth, both in terms of added value and employment. However, the limited natural resources of the country may limit their potential. Therefore, investment needs are identified to enhance growth and competitiveness of medium-sized enterprises by helping them to turn environmental challenges into opportunities, in particular in order to:

foster the creation of new firms, growth of start-ups/scale-ups, accelerators; develop and implement new business models for medium sized enterprises that address country's environmental challenges in the areas;

encourage the entrepreneurial ecosystem, including development of industrial clusters and enhanced cooperation between medium sized enterprises and universities/research centres, particularly in the areas of green economy, circular economy, resource efficiency;

facilitate access to finance and advanced services for medium sized enterprises;

increase medium sized enterprises competitiveness and internationalisation by moving up in the global value chain.

High priority investment needs are identified to enhance skills for smart specialisation, industrial transition and entrepreneurship, especially having regard to sustainability issues in particular to:

promote innovation and eco-innovation management in medium sized enterprises; promote specific training and reskilling for smart specialisation areas and eco-innovation;

strengthen the integration of education and training institutions within innovation, technology diffusion and skills development ecosystems;

develop skills for higher education and research institutions to increase the commercial viability and market as well as sustainability relevance of their research projects.

21. NETHERLANDS

21.1. Executive summary

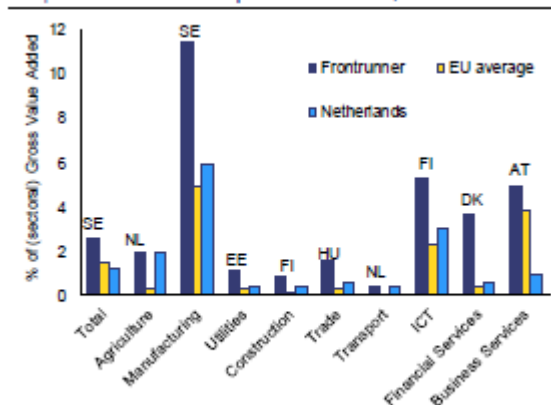
Investments in Research and Development, human capital, climate and energy are needed to support productivity growth and maintain a strong innovation capacity. While the research and development investment intensity rose to over 2%, it is still well below the 2.5% national target and the level of top performers. In terms of labour productivity, the Netherlands is one of the best performing countries in many sectors. This implies that productivity growth should come from new innovations. A further

increase in research and development investment, especially in the private sector, is needed for this to happen. Technical skills and qualified professionals are crucial for the Dutch economy's innovation capacity and productivity growth. This points to the need to invest more in training, to promote flexible upskilling and reskilling opportunities for all. Improving society's innovation capacity also requires investments to support education in the field of science, technology, engineering and mathematics.

21.2. Research and Innovation

Despite the Netherlands being a top innovator, R&D expenditure remains below national targets. R&D intensity was 1.99% in 2017, lower than the national R&D target of 2.5% and below other top innovators. Private R&D expenditure is relatively low in high-tech manufacturing. Private R&D reached 1.17% of GDP in 2017, up from 0.79% in 2009, but below the EU average (1.3%) and top performers. This difference is usually explained by the structure of the Dutch economy, with a relatively small R&D intensive manufacturing sector and a relatively large service sector. A sectoral analysis of business expenditure on R&D shows that the Netherlands is the European leader in sectors such as agriculture and transport. However, in other sectors such as ICT or manufacturing (e.g. pharma and hardware, including computer and optic instruments), the country trails significantly behind the frontrunners (Graph 4.4.4). When considering intangibles in general the Netherlands is one of the largest investors in the EU. This explains its high ranking in international benchmarks (such as the European Innovation Scoreboard).

Graph 4.4.4: Business expenditure on R&D, 2015



Source: Ecnys, 2018

Leveraging further private investment is needed to meet the 2.5% of GDP target. According to analysis by the Rathenau Institute, total R&D expenditure needs to increase by EUR 5.8 billion between 2016 and 2020 to reach the national target (Vennekens and De Jonge, 2018). Looking ahead, the government is seeking to use public R&D investment to bolster private R&D via public-private partnerships. A potential policy lever to achieve higher public and private investment may come from the Dutch enterprise policy and the new mission-driven innovation policy. The latter focuses on maximising the economic opportunities that accrue from societal challenges through public-private partnerships in certain top sectors.

Further innovation and investment in R&D are needed to achieve the long-term targets of climate policy and the energy transition. The draft Climate Agreement recognises that forward-looking research and innovation are necessary to enable the achievement of the 2030 targets for emission reduction and create the basis for the realisation of the 2050 ambitions. The new mission-driven innovation policy will support

an agenda for climate and energy whereby public investments in R&D needs to be tuned with private resources. Eco-innovation and innovative technologies would lead to necessary cost reductions for environmental improvements and competitive business development.

The composition of innovation support mechanisms may need to be examined. Effectively supporting private R&D investment requires the right mix between direct and indirect government instruments. The Act for the Stimulation of Research & Development (*Wet Bevordering Speur- & Ontwikkelingswerk*) is an R&D tax credit that lowers the wage costs of R&D employees and other R&D costs, while the ‘innovation box’ provides a tax break on corporate profits from innovative activities. In 2018 these indirect instruments amounted to EUR 1.2 billion (0.2% of GDP) and EUR 1.5 billion (0.2% of GDP) respectively. In 2016, direct subsidies to private R&D amounted to just EUR 137 million, limiting the direct steering capacity of the government. In addition, while tax benefits based on the wages of researchers appear to be a more effective tool to boost R&D, especially among SMEs, the effectiveness of the innovation box remains limited (European Commission 2015a, Dumont 2017, CPB 2018a, Alstadsæter et al. 2015).

Regional innovation strategies for smart specialisation ⁽¹¹³⁾ strengthen innovation eco-systems thanks to concentrated investments based on regional needs and potential. Regional differences in R&D expenditure largely correspond to the relative concentration of R&D intensive large firms in some regions and the predominance of small firms, with relatively lower R&D expenditure, in other regions. Smart specialisation in the Netherlands concentrates investment in R&D and innovation on selected priorities, identified in four regional smart specialisation strategies covering the country, where the impact on competitiveness can be the greatest, and stimulates cooperation between research institutes and businesses, in particular small and medium size enterprises. This regional dimension of the innovation policy strengthens cooperation across stakeholders and across sectors and triggers targeted additional investments that complement national innovation policy based on particular regional strengths. The provinces, supported by the European Regional Development Fund, are the main public funding resource for regional smart specialisation that leverage significant private funding. The four current strategies will be revisited in 2019 in parallel with further development of the national mission driven innovation policy.

21.3. Additional R&I references

[1. Economic situation and outlook, Investment, p. 8]

In terms of investment needs, higher investments in R&D, human capital and climate and energy are necessary to support productivity growth and to maintain a strong innovation capacity (see Section 4.4.1).

[2. Progress with country-specific recommendations, p. 13/14]

¹¹³ Smart specialisation strategies aim to prioritise public research and innovation investments through a bottom-up approach for the economic transformation of regions, building on their strengths and competitive advantages and facilitating market opportunities in new inter-regional and European value chains (see also https://ec.europa.eu/regional_policy/sources/docoffic/2014/com_2017_376_2_en.pdf)

Substantial progress has been made over the past years in the area of public finances, this includes a reform of the long-term care system, and the protection of expenditure in growth-friendly areas; such as education, innovation and research.

On the recommendation to use fiscal and structural policies to raise public and private investment in research, development and innovation, while respecting the medium-term objective, the Netherlands has made substantial progress. The announced increase in R&D expenditure in 2019 has been incorporated into the budget law. The main fiscal tool to foster R&D is set to increase by 2020. However, a gap remains compared to the national R&D target of 2.5% of GDP, implying that more effort is needed.

Substantial progress has been made in general in addressing CSR 1, in particular, by implementing fiscal stimulus measures, including public investment and increasing R&D expenditure, while respecting the medium term objective.

[Box 2.1: EU funds help overcome structural challenges and foster development in the Netherlands, p. 16]

The financial allocation from European structural and investment funds, whose aim is to help the Netherlands face development challenges, amounts to up to EUR 1.9 billion in the current multiannual financial framework. In addition, numerous Dutch research institutions, innovative firms and individual researchers have benefited from other EU funding instruments, in particular Horizon 2020 which has provided EUR 2.6 billion to boost innovation and research in the Netherlands.

EU funds support investment in R&D in the Netherlands. The European structural and investment funds stimulate investments in innovation in the private sector, among others, by providing loans or grants to develop experimental new products and services, set-up living labs and encourage cooperation between small and medium-sized enterprises (SMEs) and research institutions. Over 400 enterprises have received support to cooperate with research institutions and over 1 500 SMEs to introduce new products to the market. Private investment that matches R&D support has exceeded EUR 300 million. The “Uniiq – Proof of Concept Fund for South-Holland” uses EU Funds to invest EUR 22 million in supporting SMEs to convert an idea into a concrete, marketable product or service. EU funds also contribute to a EUR 4 million investment to develop the “High tech X-Gen wind turbine”, which is compact, maintenance-friendly, silent, affordable and suitable for the built environment. Horizon 2020 has supported over 3 300 research projects covering a broad range of areas from health to energy transition.

For infrastructure and innovation, 27 projects financed by the European Investment Bank and backed by the European fund for strategic investments have been approved to the tune of EUR 2 billion.

[Box 3.1: Spill-overs of structural reforms – the Netherlands, p. 21]

An ambitious reform package would boost Dutch GDP, with small but positive spillovers to the rest of the euro area. The simulated reforms cover all areas: product market regulation and entry, labour market participation, taxation structure and R&D subsidies.

[4.1. Public finances and taxation, 4.1.1. Expenditure developments*, p. 22]

In its 2019 Budgetary Plan, the government highlights increased spending on education, research and innovation (EUR 1.9 billion, 0.25% of GDP),...

Moreover, focusing on supply-side investment, such as education, R&D and innovation is expected to have beneficial effects on potential growth in the medium run.

[4.3. Labour market, education and social policies, 4.3.2. Education and skills, Investment needs, p. 47]

Technical skills and qualified professionals are crucial for the Dutch economy's innovation capacity and productivity growth. This points to the need to invest more in training, to promote flexible upskilling and reskilling opportunities for all, facilitate career transitions, and promote professional mobility and lifelong learning. Improving society's innovation capacity also requires investments to support education in the field of science, technology, engineering and mathematics.

[4.4. Competitiveness reforms and investment, 4.4.1. Productivity and investment needs*, p. 48]

Investments in R&D, human capital and climate and energy are needed to boost productivity and to maintain a strong innovation capacity. While R&D investment intensity rose to 1.99% in 2017, it is still well below the 2.5% national target and the level of top performers. On productivity levels, the Netherlands is close to or at the frontier in many sectors. This implies that productivity growth should come from new innovations. A further increase in R&D investment, especially in the private sector, is needed for this to happen. Technical skills and qualified professionals are crucial for the Dutch economy's innovation capacity and productivity growth (see Section 4.3).

[Box 4.4.1: Circular economy, p. 52]

There are still a number of barriers to promoting innovation in the circular economy. The Netherlands ranks surprisingly low in the EU Eco-Innovation Index, with scores below the EU average for 4 out of 5 indicators: eco-innovation inputs, outputs, activities, and socio-economic outcomes (e.g. changes in employment, turnover or exports that can be related to eco-innovation activities).

[Box 4.4.2: Investment challenges and reforms, p. 54]

The Netherlands qualifies as an "innovation leader" (European Innovation Scoreboard 2018), benefiting from an attractive research system and an innovation friendly environment. However, the level of R&D investment remains a weak point. While the Netherlands performs reasonably well in terms of public R&D investment, it underperforms on private investment compared to both the EU average and the top performers. The government has reaffirmed the intention to increase efforts to reach an R&D intensity of 2.5% of GDP. This will require extra investments from the government and private sector (see Section 4.4).

[4.4. Competitiveness reforms and investment, 4.4.2. Single market integration, Digitalisation, p. 55]

The Knowledge and Innovation Agenda 2018-2021 opens up new topics (such as creative industries) and more cross-sectoral ones, while developing societal challenges and key technologies. The information and communications technologies agenda is

instrumental in developing a more cross-sectoral approach and in fostering radical innovation.

[4.4. Competitiveness reforms and investment, 4.4.3. Institutional quality, Business environment, p. 55]

According to the World Economic Forum Global Competitiveness Index, the Netherlands ranked 6th out of 140 countries in 2018, just behind four non-EU countries and Germany. In comparison to other EU countries, its score is significantly high in infrastructure, innovation and business sophistication.

21.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Even though the Netherlands ranks high in terms of innovation and competitiveness indices, expenditure on research and development relative to gross domestic product remains below national targets, with private expenditure on research and development below the EU average. High priority investment needs⁽⁶³⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, within the framework of regional smart specialisation strategies that identify priority areas based on regional needs and potential, and in particular to:

develop and utilise the innovation eco-system and stimulate market oriented cooperation between business and research centres in order to increase business investment in research and innovation, in particular in small and medium-sized enterprises;

stimulate interregional cooperation in new value chains, also with other Member States;

strengthen investment in developing new processes, products and services;

support the development of campuses and living labs with participation of small and medium-sized enterprises;

address skills challenges for smart specialisation and the innovation capacity of small and medium-sized enterprises, linked in an integrated manner to investments in the above areas.

Such investments could also help address the important challenges that the Netherlands faces related to the energy and climate transition and the circular economy.

22. POLAND

22.1. Executive summary

Increasing investments to support innovation, education and skills development, better infrastructure and cleaner energy are crucial for Poland's future growth. Investment remained low in recent years, leaving many opportunities untapped. In this context, support to vital innovations and greater take up of innovations, together with investment in education and skills, has a crucial role in increasing the growth potential.

Poland lags on innovation, with recent legal changes only partially addressing challenges. Despite past efforts to improve the R&D framework and significant support from EU funds, Poland's innovation performance remains modest. Innovative activities by companies are hindered by a number of obstacles. Overall, the country's innovation potential is hampered by underdeveloped science-business links. Some of these deficiencies, however, are addressed by the higher education reform, designed to boost the quality of Poland's science base.

22.2. Research and Innovation

Poland's innovation performance remains modest and is uneven across regions. Knowledge-intensive sectors in Poland contribute less to total value added than in regional peers, and low-tech sectors still play a dominant role in the country's economic structure (European Commission, 2018g). Despite continuous and sizeable efforts to improve the innovative capacity of the economy (European Commission, 2017a, 2018c), Poland continues to rank in the lower end of moderate innovators in the European Innovation Scoreboard (European Commission, 2018e). In terms of spending, in 2017 gross domestic expenditure on R&D remained at about half of the EU average of 2.1 % of GDP. On a regional level, in 2015 five regions spent well above 1 % of regional GDP on R&D, but in four regions this ratio was below 0.35 %.

Science-business links continue to be underdeveloped in Poland. Weak cooperation between science and business is a drag on productivity and competitiveness. Although under national and regional Smart Specialisation Strategies ⁽¹¹⁴⁾ considerable efforts were made to strengthen knowledge transfer, Poland scores low in science-business links ⁽¹¹⁵⁾ (European Commission, 2018c). The National Centre for Research and Development and the Foundation for Polish Science offer multiple schemes to support joint projects between business and science, but the available budgets are significantly lower than those devoted by individual firms for in-house industrial R&D (European Commission, 2018g). The obstacles to science-business cooperation are linked to financial and non-financial incentives, such as complex administrative procedures for project funding and the limited skills of academics in managing joint public-private R&D projects (European Commission, 2018k).

The higher education reform addresses some of the challenges for developing the science base. The new law on higher education and science was adopted in July 2018. It increases the autonomy of higher education institutions, strengthens funding at central university level and reduces external oversight of it, lessening administrative burdens. The act, however, proposes only limited increase in remuneration for scientists. The evaluation process of scientific organisations will be carried out within disciplines and rely on formal measures of performance for each scientist within the organisation.. The act has ambiguous effects on the internationalisation of Polish science. While it introduces a requirement for PhD graduates to know a foreign language, it sets its level of command at intermediate only. Also, international exposure is no longer compulsory for scientists applying for the title of professor (European Commission, 2018g). Nevertheless, the competitive calls launched by the National Agency for Academic Exchange in 2018 are expected to promote mobility and internationalisation within the

¹¹⁴ Smart Specialisation is a place-based approach characterised by the identification of strategic areas for intervention based both on the analysis of the strengths and potential of the economy and on an Entrepreneurial Discovery Process with wide stakeholder involvement.

¹¹⁵ For example, in 2017 there were only 5.4 public-private co-publications per million inhabitants as compared to the EU average of 40.9 (European Commission, 2018EIS).

country's research and innovation system. The 'Excellence Initiative – a research university' and the 'Łukasiewicz Research Network' aim to overcome the fragmentation of the research sector. Although promising, the latter has still not been established, due to stalled legislative work in 2018.

The innovative activity of businesses is hampered by some barriers. Polish small and medium enterprises engage in cooperation with each other much less than in most other Member States (European Commission, 2018e), so the actual impact of clusters and formalised corporate networks remains limited in diffusing innovative solutions. These linkages did not improve considerably despite the fact that the EU Structural Funds financed a number of institutions supporting business innovation ⁽¹¹⁶⁾ under the 2007-2013 EU financial perspective (European Commission, 2018f). The tax deductibility of R&D spending was increased, the former regional special economic zones were broadened and now cover the entire country and a preferential corporate and personal income tax rate on income from intellectual property rights will be implemented from 2019. Progress in digitalisation of businesses, a factor conducive to innovation ⁽¹¹⁷⁾, is hampered by limited access to highly qualified specialists, as indicated by one third of ICT sector companies (European Commission, 2018ds).

22.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 15/16]

The introduction of tax incentives and improving access to finance for R&D activities also contributes to 'some progress' in relevant CSRs.

Progress on strengthening the innovative capacity of the economy and improving the regulatory environment was mixed. Despite measures taken, including number of amendments to the act on higher education, only limited progress was observed in ensuring better links between research, innovation and industry. Some progress was achieved in improving the effectiveness of R&D tax incentives and better targeting financial instruments at the innovation cycle. In 2016-2018, Poland has reformed its R&D tax incentives with new regulations and changes encouraging wider use of the R&D tax breaks.

There was also limited progress on supporting closer cooperation between business and research institutions. The Ministry of Science and Higher Education continued the industrial doctorate programme, but the establishment of the Łukasiewicz Research Network was stalled as of August 2018.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Poland, p. 18]

Financial allocations from European Structural and Investment Funds aiming to help Poland tackle development challenges amount to EUR 86 billion in the current EU multi-year budget (multiannual financial framework), equivalent to around 2.6 % of GDP in

¹¹⁶ These include science/technology parks, entrepreneurship incubators, technology transfer offices and innovation brokers.

¹¹⁷ Digital technologies allow knowledge diffusion, support new business models and enable SMEs to scale up quickly through tools such as cloud computing or data analytics. Poland is committed to the advancement of new digital technologies through digital investment priorities of Digital Europe Programme.

2014-2020. Furthermore, numerous Polish research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided some EUR 400 million.

EU Funds supported closer collaboration between business and research institutions, and R&D investments in the private sector. By the end of 2018, European Structural and Investment Funds helped 2 200 firms build cooperation with research institutions and 3 400 firms introduce new products in their markets. Horizon 2020 supported 1 100 research projects, covering a very broad spectrum from health, food security and sustainable use of biological resources to nuclear research.

The Commission is also assisting the authorities in their efforts to improve public financial management, and to enhance research, development and innovation.

In addition, the European Fund for Strategic Investments has allocated EUR 3.8 billion in Poland. The bulk of this financing is provided under the infrastructure and innovation window.

[3.1. Public finances and taxation, Tax system, p. 20]

In addition, a tax incentive to support innovation ('IP Box') was implemented. This supplemented an investment tax credit, which was increased in 2018 to support private investment.

[3.3. Labour market, education and social policies, Education and skills, p. 29]

The supply of new researchers is small, with the ratio of new doctoral graduates to population aged 25-34 being among the lowest in the EU.

[3.4. Competitiveness and investment, 3.4.1. Productivity and investment, Investment and productivity trends, p. 34]

Investments to support skills development, innovation, better infrastructure and cleaner energy are crucial for Poland's future growth. Workers' skills are also key, highlighting the importance of investment in skills development (see Section 3.3). Investment with a potential to introduce vital innovations and to facilitate innovation diffusion is also of particular importance. Transport, communication and energy networks can play a crucial productivity-enhancing role and facilitate the efficient market functioning and deployment of innovation-oriented investment.

[3.4. Competitiveness and investment, 3.4.1. Productivity and investment, Climate and environmental issues, p. 37]

Finally, innovations in the areas linked to environmental protection have in themselves a significant potential for cost savings and productivity gains. Given a low starting point, this potential appears particularly strong in Poland (Wiśniewska, 2017).

[3.4. Competitiveness and investment, 3.4.2. Market functioning, p. 38/39]

High competition, fast deployment of innovation and high-quality goods and services offered at relatively low cost are a feature of several sectors in Poland.

In recent years, state-owned and state-controlled companies (SOEs) gained importance, following the government's agenda to transform the SOEs into key private investors and innovation leaders.

22.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Poland's innovation performance remains far below the EU average, much of which is due to meagre research and development investments, especially private ones, and modest cooperation of public and private innovation partners. High priority investment needs ⁽¹¹⁸⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, to be implemented in synergies with other EU programmes and initiatives such as Horizon Europe, Life, Coal Regions for Transition Initiative, Catching-up Regions Initiative and others, and in particular through:

supporting risky elements of research and development business investments, including pilot lines, early product validation, certification and advanced manufacturing;

facilitating business – science cooperation schemes and projects to enable larger research commercialisation and providing research-based and innovative solutions for business;

building critical research mass and attracting talent in strategic smart specialisation areas;

enhancing research and development networking and cooperation (intra-regional, regional, clusters, international, including within the Baltic Sea Strategy), especially within smart specialisations to foster truly innovative projects and ensure better integration into regional and global networks.

The productivity of small and medium-sized enterprises is growing slowly. Smaller businesses also strive to remain competitive and trade on domestic and foreign markets. High priority investment needs have been identified to increase the competitiveness and internationalisation of small and medium-sized enterprises, in particular through:

supporting measures increasing productivity such as improvement of technology, management practices and workplace skills for better integration in global value chains;

facilitating access to advanced business services;

further stimulating the entrepreneurial environment, including industrial cluster development, enhanced cooperation between small and medium-sized enterprises and research institutions, and sustained engagement of small and medium-sized enterprises in the development of smart specialisation areas.

The use of information technologies by firms and digital interaction of citizens with public authorities remain low. Priority investment needs have been identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

upscale and accelerate e-government, including e-health;

¹¹⁸ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

support the integration of digital technology by small and medium-sized enterprises to increase productivity and efficiency;

promote digital skills, including upskilling and reskilling to address the gap between the demand for and availability of a digitally-skilled workforce.

Labour shortages translate into growing skills mismatches, which hamper the growth of innovative and fast-developing sectors. Investment needs have been identified to enhance skills within small and medium-sized enterprises and research institutions as regards smart specialisation areas, industrial transition and entrepreneurship through:

developing skills in smart specialisation areas, innovative business models, technology transfers and innovation management, also as an integral part of other investments under Policy Objective 1;

strengthening of work-based learning in smart specialisation areas.

23. PORTUGAL

23.1. Executive summary

Higher public and private investment in innovation, upskilling, resource efficiency, transport infrastructure and modern employment policies would strengthen the long-term sustainable growth potential of Portugal. The country has one of the lowest investment rates in the EU. Research and development investment has recently regained strength but remains insufficient to upgrade the Portuguese national research and innovation system. The low qualification level of workers is an obstacle to investment and productivity growth. People's lack of digital skills hinders their inclusion in society and their employability and reduces the potential for higher productivity.

Bottlenecks in the innovation system are affecting Portugal's productive specialisation and hindering structural change. After various years of decline, the share of research and development expenditure over GDP increased recently. In parallel, some export sectors have been able to increase their technology intensity and policy support to start-ups is improving. Nonetheless, Portugal remains specialised in low and medium-low technology sectors, with multiple challenges constraining its ability to tap into knowledge-intensive sectors. Insufficient links between academia and business hinder the effectiveness of the innovation system. Policies are being deployed to improve the working conditions and employability of scientific professionals, promote investment in intangible assets, and raise digital skills.

23.2. Research and Innovation

After declining since the crisis, R&D intensity recovered in 2016, although it remains insufficient to upgrade the Portuguese national research and innovation system and its connection to the economy. R&D intensity reached 1.3 % of GDP in 2017 after steadily decreasing since 2010. Business R&D intensity, at 0.67 % of GDP, surpassed public R&D intensity (0.63 % of GDP) in 2017. A 2018 resolution adopted by the Portuguese government established the pillars for a national strategy on 'technological and business innovation' that includes revised targets for public and private investment in R&D: 3 % R&D intensity by 2030 with an ambitious share of one third public and two thirds business driven. The government's goal is to reach an R&D intensity of 1.8 % of GDP by 2020.

Portugal's economic structure is anchored in traditional low and medium-low tech sectors, slowing down structural change. There has been meagre progress to upgrade the country's economic structure towards higher shares of value-added in high-tech manufacturing and services. However, technological upgrading has taken place in traditional sectors, such as footwear and textiles that boosted their global competitiveness and labour productivity (PORDATA and AICEP, 2018). The resilience and internationalisation of these sectors resulted from clear priorities, strategically aligned with EU funding cycles, and early 'clusterisation' in close cooperation with universities and business associations. Other traditional sectors such as agriculture, benefiting namely from the support of EU funds, would benefit from continuing investment in technological upgrades and the qualification of its human resources in particular in the rural areas. Hence, relevant traditional sectors should benefit from the government's *Industry 4.0* programme to provide human resources with qualifications and tackle technological gaps. At the same time, emerging sectors such as information technology are creating new opportunities to upgrade the economic structure.

Promoting investment in intangible assets, including R&D but also economic and digital competences, offers significant potential for the country to boost its productivity (European Commission, 2018c). The *Qualifica* scheme for the overall upskilling of the population and INCoDe.2030, the country's national strategy to enhance digital competences, both seek to address this bottleneck (see Section 4.3.3).

Research careers lack stability and attractiveness, and new qualifications are needed to better address the needs of the labour market. Portugal has made significant progress in increasing the number of science and engineering graduates, reaching levels close to the EU average in 2016 (Eurostat). However, the number of graduates in computing remains below the EU average (see Section 4.3.3). Industry (including in information technology fields) expressed concerns about the difficulty to find qualified people. Portugal lacks enough specialised medium and high-skilled workers to cover the current and future labour market demand in the smart specialisation priority fields. The share of researchers in the labour force expanded but the absorption capacity of businesses remains an obstacle, although it is slowly improving. Research careers in the public sector do not offer stability or competitive salaries in relation to other EU Member States. Contracts are typically short-term and based on scholarships with limited social benefits. To improve the status of research careers, the *Scientific Employment* programme includes a fiscal incentive through which firms receive a 120 % fiscal rebate when they hire doctoral graduates and the Interface scheme, which provides funding to incentivise hiring doctoral graduates under longer-term contracts, funding 50 % of their salary during 3 years.

Bottlenecks in science-business links hamper the efficiency of the research and innovation system, and a package of measures has been set in motion. The share of public-private scientific co-publications in Portugal declined over the last decade with the country ranking among the lowest in the EU in 2017. Mutual trust between academia and business is not wide-spread, entrepreneurial research is not incentivised and knowledge transfer is not duly considered (European Commission, 2018a). To improve framework conditions for collaboration, Portugal has launched Interface Programme. Collaborative Laboratories were identified under the Interface scheme and the country's cluster policy was strengthened in 2017 to cover advanced technological sectors in the *Competitiveness Clusters* initiative. Moreover, 'Portugal 2020' launches calls for *co-promotion projects*, establishing joint research and innovation centres, demonstration projects and pilot lines. The forthcoming Organisation for Economic Cooperation and Development (OECD) Review preliminary recommends the setup of regional innovation platforms that give

small and medium-sized enterprises access to critical resources for innovation, and support mutualisation and partnerships between knowledge-transfer organisations.

Portugal is a moderate innovator according to the 2018 European Innovation Scoreboard. Employment in fast-growing enterprises has increased over time, with Portugal ranking slightly above the average in the EU in 2015. The innovation performance of small and medium-sized enterprises has, however, deteriorated since 2010 for product, marketing and organisational innovations and for small and medium-sized enterprises collaborating with others. Fewer venture capital investments since the pre-crisis period (see Section 4.2) may undermine the scale-up of innovative firms, despite an overall improvement in the start-up ecosystem due to the implementation of *StartUp Portugal*.

23.3. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and fostering growth and competitiveness development in Portugal, p. 17]

Financial allocation from European Structural and Investment Funds aimed to support Portugal in facing development challenges, amount to up to EUR 25.9 billion in the current multiannual financial framework, potentially representing around 1.9 % of GDP annually. Furthermore, numerous Portuguese research institutions and firms have benefited from other EU funding instruments, notably Horizon 2020 which provided EUR 560 million.

Actions financed include promoting research and innovation and synergies between academia and business; improving access to finance for small and medium-sized enterprises, stimulating entrepreneurship and innovation. This has paved the way for over 13 000 enterprises to receive support with over 1 000 receiving support to introduce new products and 600 enterprises cooperating with research institutions, favouring overall the creation of 37 000 new jobs.

25 projects involving Portugal have so far been approved under the infrastructure and innovation window of European Fund for Strategic Investment. They amount to EUR 1.2 billion in total financing, which should, in turn, generate EUR 4.3 billion in investments.

[4.1. Public finances and taxation, 4.1.3. Fiscal framework and state-owned enterprises*, p. 27]

In Portugal, expenditure for the long term — which includes education, transport and R&D expenditure — accounted for 7.7 % of GDP in 2016, slightly below the EU average.

[4.1. Public finances and taxation, 4.1.4. Taxation issues, including tax administration*, p. 31]

Furthermore, while Portugal offers one of the highest implicit R&D tax subsidy rate for large profitable companies in the EU (OECD, 2018f), private R&D expenditure as a percentage of GDP remains relatively low compared with the EU average. Closely monitoring and evaluating the different R&D tax measures would help better understand their effectiveness, notably in boosting investment.

[4.3. Labour market, education and social policies, 4.3.3. Education, vocational training and skills*, p. 46]

Following the presentation in early 2018 of the OECD Review on higher education, science, technology and innovation systems, the government approved a number of legal and programme initiatives notably for degrees and diplomas, for access of international students to higher education and for recognition of foreign degrees.

[4.4. Competitiveness reforms and investment, 4.4.1. Productivity growth and investment*, Investment, p. 48/49]

Properly targeted public investment can do much to boost potential growth by fuelling productivity growth through improved human capital and more technological innovation.

Investment challenges relate primarily to infrastructure, skills, innovation, climate change and the environment. Skill shortages, in particular digital skills (see Section 4.3), may hinder productivity, especially for small and medium-size enterprises. Current R&D intensity is insufficient to upgrade the national research and innovation system and its connection to the real economy (see Section 4.4.1).

[4.4. Competitiveness reforms and investment, 4.4.2. The services sector and single market integration*, Energy, environment and transport investment challenges, p. 54]

Market uptake of available energy efficiency solutions, technological innovation, digitalisation and up-skilling of the workforce have the potential to drive the energy efficiency further up.

[4.4. Competitiveness reforms and investment, 4.4.3. The regional dimension, p. 54]

According to the 2017 regional innovation scorecard of 2017, Portuguese regions are ‘moderate’ innovators. The Metropolitan Area of Lisbon and the region Norte had the highest R&D intensity, while Azores, Madeira and the Algarve had the lowest (see Graph 4.4.3).

23.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Portugal remains a "moderate" innovator and overall low research and development intensity hinders the upgrade of the economic productive structure. The implementation of smart specialisation areas, based on national and regional potential, strengthens innovation performance and fosters productivity growth. High priority investment needs ⁽¹¹⁹⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, aiming at complementarity and compatibility with Horizon Europe instruments, in particular to promote:

public and private investment in research and innovation, as a tool to move up the value added chain and to increase innovation in firms across sectors, and develop technologies for transition to a carbon neutral economy;

collaboration between public and private research and support technology transfers in a few specialisation identified areas;

¹¹⁹ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

mobility of qualified human resources between universities, research and development institutions, tech centres and companies.

Digital skills and uptake of digital technologies by firms and people remain low. Priority investment needs have been identified to increase uptake to reap digitisation benefits for citizens, companies and governmental bodies and promote digital inclusion, and in particular to:

promote the acquisition and development of digital skills and market-driven information and communication technology skills;

support the integration of digital technologies into businesses and production processes of micro and small and medium-sized enterprises, including by developing infrastructures and services like digital innovation hubs;

increase the range of digital services provided (e-government, e-procurement, e-inclusion, e-health, e-learning, e-skilling, e-commerce) and taken up by citizens, with special focus on rural, remote and outermost regions and on vulnerable groups of the population.

A predominance of micro and small companies affects innovation capacity and productivity. Internationalisation levels are relatively weak, with the share in medium-high and high-tech exports substantially lower than the EU average. High priority investment needs have been identified to enhance small and medium-sized enterprises growth and competitiveness, and in particular to:

enable firms to scale up, create jobs, internationalise and promote a climate neutral industrial transformation;

encourage the entrepreneurial ecosystem, networking, new marketing tools, strengthening of managerial skills and financial literacy, knowledge-sharing across sectors and national borders;

facilitate access to credit and to equity capital and improve awareness of the available funding opportunities and advanced business services for small and medium-sized enterprises.

Skills gaps hinder productivity, technological diffusion and affect the development of innovative competences. Priority investment needs have been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

stimulate training and re-skilling in smart specialisation areas, in particular in key enabling technologies and related skills and in the new emerging fields.

24. ROMANIA

24.1. Executive summary

Public and private investment in infrastructure, education, healthcare, social inclusion and innovation would improve productivity and long-term growth. Public investment has been subdued in recent years and is expected to recover only slowly while private investment could be affected by increasing uncertainty. The education system does not sufficiently prepare people for employment and better social integration.

Increased public and private financing of innovation would help Romania's economy move towards higher value added activities.

Romania's modest performance in research and innovation limits growth prospects.

The country lacks a coherent strategy to help firms move towards higher value added activities. Public and private spending on research and development is one of the lowest in the EU, resulting in a low quality of the public science base and a low innovative capacity. Links between science and business are underdeveloped, while technology imports are not being substituted by home-grown innovation.

24.2. Research and Innovation

The competitiveness gap between foreign-owned and domestic firms has not narrowed. This suggests a gap in the take-up and financing of research and innovation activities. Foreign-owned firms account for two-thirds of Romania's exports of goods (Foreign Investors Council, 2017a) and increased their share of total value added from 39 % in 2008 to 44 % in 2015 (Eurostat). They have a strong presence in key medium-tech and high-tech manufacturing sectors, with their share of value added in the manufacturing of motor vehicles exceeding 90 %. Their labour productivity is also twice that of domestic firms. Conversely, the agro-food sector, dominated by small, domestic holdings, is characterised by very low levels of productivity, which means that Romania is not able to fully exploit its significant agricultural potential (NBR, 2018d).

The innovation gap separating foreign-owned and domestic firms signals that technology imports have not been substituted with home-grown innovation. Several multinationals in the automotive and IT sectors have set up research and development activities in Romania. Most seek experimental development rather than industrial research. However, technology spillovers to domestic firms remain limited, in part because foreign-owned firms primarily source from other foreign companies. Domestic firms mainly supply low value-added components (ACAROM; AKH Romania, 2018). No targeted policy has been developed to leverage technology spillovers from foreign direct investment and promote research and innovation as a driver for future competitiveness (Foreign Investors Council, 2017b; Horobeț & Popovici, 2017).

The economy's overall innovative capacity remains low. Romania ranks last in the EU in terms of innovation and its performance has deteriorated since 2010 (European Commission, 2018c). Furthermore, the start-ups' survival rate beyond 5 years dropped from 60 % in 2009 to 40 % in 2014 (European Commission, 2018d). With the exception of the ICT sector, Romania has few fast-growing firms (¹²⁰).

At sub-national level, research and innovation is more diversified and dynamic. Innovation is modest in all Romanian regions, albeit with a large gap between best and worst performers. Under the 'Catching Up Regions Initiative', smart specialisation strategies and governance structures were set up in two pilot regions (Nord-Est and Nord-Vest), leading to the development of regional entrepreneurial discovery processes (¹²¹) and a pipeline of projects to be co-financed by EU funds. The initiative is being rolled-out to all Romanian regions.

¹²⁰ Enterprises with an average annualised growth in the number of employees of more than 10 % per year over a 3-year period and at least 10 employees at the moment growth began.

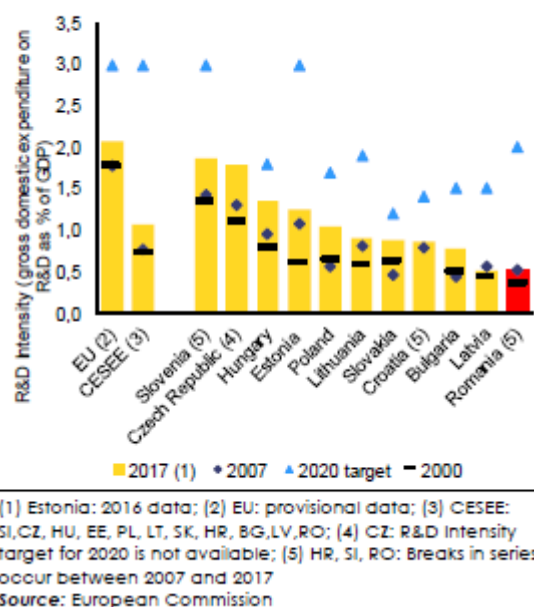
¹²¹ An inclusive and interactive bottom-up method under which participants from government, industry, academia and civil society build connections and partnerships, identify potential investment opportunities and develop project pipelines.

Investment in research and development (R&D) remains critically low. R&D intensity (i.e. R&D expenditure as a percentage of GDP) has been flat since 2000, at 0.5 % in 2017 vs. 2.7 % in the EU as a whole (Graph 4.4.10). Public R&D intensity fell from 0.32 % in 2011 to 0.21 % in 2017. Despite an increase in recent years, business R&D intensity remains well below the EU average (0.29 % vs. 1.36 % in 2017). This under-investment in business R&D results in a number of researchers per capita in the private sector over six times lower than the EU average and in a very low number of patent applications. In early 2017, government emergency ordinance 3/2017 introduced a 10-year tax exemption for R&D firms, but procedural norms are still in preparation.

Public R&D funding is insufficient and declining. This has translated into an overall stagnant scientific performance ⁽¹²²⁾ and a low level of international scientific cooperation ⁽¹²³⁾. Although substantial investments are needed, the government has no clear plans to address this issue.

The economy's research and innovative capacity could be improved by increased science-business cooperation. Higher education institutions do not systematically integrate industry needs into their teaching and research programmes. Knowledge transfer offices are not yet fully operational despite EU funds having been allocated for this. The continued decline in the number of tertiary graduates in science, technology, engineering and mathematics (European Commission, 2018e), further hampers knowledge transfer. Romania is also confronted with a significant migration of skilled people, having one of the largest scientific diasporas among EU countries (European Commission, 2018h). Further investments supporting science-business cooperation and skills are needed.

Graph 4.4.10: R&D intensity 2000, 2007, 2017 and 2020 target



Romania has not yet developed a coherent vision for moving towards higher value added activities. Existing policies (the Competitiveness Strategy, the National Strategy for research and development and the 2014 Small and Medium-sized Enterprises

¹²² Measured as the share of top 10 % most cited publications in total publications.

¹²³ Measured as the share of international co-publications in total publications.

Strategy) are loosely coordinated and do not provide adequate measures for firms to move up the value chain. Non-financial measures targeting start-ups and innovative small and medium-sized enterprises (e.g. business support services, support to competences) remain underdeveloped, whilst existing schemes (mostly funding measures) are not customer-oriented (European Commission 2018d). The use of financial instruments with an innovation component is limited, even if some equity instruments were set up. The combination of EU funds grants and financial instruments is largely unexplored.

24.3. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural changes and to fostering growth and competitiveness in Romania, p. 17]

EU funds allocated to Romania amount to EUR 30.8 billion for the 2014-2020 programming period, potentially representing around 2.4 % of GDP annually. Furthermore, Romanian research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020.

Moreover, the European Social Fund is currently supporting ongoing active labour market measures for about EUR 473 million, while other EU funds will also enable the hiring of 174 new researchers.

[4.4. Competitiveness reforms and investment, 4.4.2. Productivity and investment, Productivity developments, p. 46]

In 2017, Romania recorded the highest total factor productivity growth in the EU despite some factors holding back further gains: low infrastructure, dysfunctionalities in labour and product markets (see Sections 4.3 and 4.4.3), weak innovation capacity, and a cumbersome business environment (see Section 4.4.5).

[4.4. Competitiveness reforms and investment, 4.4.2. Productivity and investment, Investment activity, p. 46/47]

Investments in infrastructure and innovation are particularly needed to set growth on a sustainable path. Romania's long-term economic prospects depend on the economy's capacity to move from the production of relatively low-technology goods to higher value-added products and services. This requires a significant increase in the financing of research and innovation activities.

According to a recent survey (EIB, 2018), firms invest most in machinery and equipment and least in research and development.

[4.4. Competitiveness reforms and investment, 4.4.2. Productivity and investment, Digitalisation, p. 49]

Digitalisation is a key challenge for boosting innovation and competitiveness. In this respect, Romania presents a very mixed picture.

[4.4. Competitiveness reforms and investment, 4.4.5. Governance and institutional quality, Corporate governance of state-owned enterprises, p. 57]

In November 2018, the government adopted a framework allowing for the creation of government-owned investment funds. The framework sets the funds' objectives in very

broad terms: job creation, the development of infrastructure, stimulating innovation and increasing competitiveness.

24.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Romania's expenditure on research and innovation is significantly below the EU average and the country displays a stagnant research and innovation performance and low technological outputs. High priority investment needs ⁽¹²⁴⁾ are identified to enhance research and innovation capacities and skills and the uptake of advanced technologies, in all Romanian regions, including in the capital region, taking into account the results of the Catching Up Regions Initiative and in particular to:

support collaboration between public research institutions and innovative industries, increase the attractiveness and performance of research and development organisations and encourage applied research through innovation hubs and joint national and transnational investments in early product validation, commercialisation, patenting, start-up formation and technology transfer;

support Entrepreneurial Discovery Processes and Project Development Labs at national and regional level and provide training on skills for beneficiaries on marketing research results and developing project and business plans in order to strengthen the preparation and implementation of smart specialisation projects;

strengthen research and innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

reinforce the current research and innovation infrastructures, capacities and skills to ensure participation in Horizon and other EU programmes and initiatives, to integrate international, cross border networks and transnational clusters and set-up joint research and education programmes and co-financing schemes;

link higher education and vocational centres to the national and regional innovation and smart specialisation reskilling system;

support the capacities and skills development of regional and national stakeholders, involved in the design and implementation of smart specialisation strategies and projects, in close cooperation with beneficiaries.

Romania performs significantly below the EU average in terms of digital public services and the integration of digital technologies by businesses. Priority investment needs are identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

strengthen the Information and Communications Technology up-take by small and medium-sized enterprises, including investments in infrastructures, foster digital skills and services and further support digital innovation hubs, living labs, etc.;

¹²⁴ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

increase measures for e-government, including the introduction and consolidation of Europe wide interoperable services, e-inclusion, e-health, e-learning, e-skilling.

Romania's share of innovative companies is behind the EU average and the country is confronted with a persistent low level of business investment in research and innovation. Priority investment needs are identified to enhance growth and competitiveness of small and medium-sized enterprises, and in particular to:

support the creation of new companies (start-ups, scale-ups), increase their survival rates and raise their degree of competitiveness and internationalisation;

increase the innovation capacities of companies, by introducing product, organisational or marketing innovations, by providing training on innovation management and smart specialisation specific skills, marketing research results skills, by supporting key enabling technologies and acceleration of market access and by supporting industrial cluster development and integration into industry-research driven cooperation networks, including cooperation with the EU Strategy for the Danube Region countries;

facilitate access to finance for small and medium-sized enterprises, including by encouraging seed and early stage finance for high-potential innovative start-ups.

25. SLOVAKIA

25.1. Executive summary

Addressing the various investment needs in Slovakia — including those in education, innovation, infrastructure and energy technology — will help secure future growth and prosperity. Strategic investments in education and training and in research and development can help to bring out the best in young and future workers and researchers. Making the economy more knowledge-based will require investments in digital connectivity and the digital transformation of enterprises. Shortages of skilled labour and future economic and social trends will require investment in improving people's skills and in social infrastructure.

Productivity gains have driven past convergence and can enhance Slovakia's future economic potential. Cohesion policy remains an important driver of productivity-enhancing reforms, but insufficient administrative capacity to manage funding limits its transformative potential. Promoting research and innovation is a prime avenue for unlocking productivity gains but this is still hampered by a fragmented public research system. Boosting private and public R&D investment, consolidating the public research system to make it attractive for top researchers, and supporting smart specialisation and digitalisation are key policy priorities. Promoting the circular economy and resource efficiency, including by protecting environmental assets such as clean air, water and forests, is critical in order to make Slovakia's productivity growth sustainable.

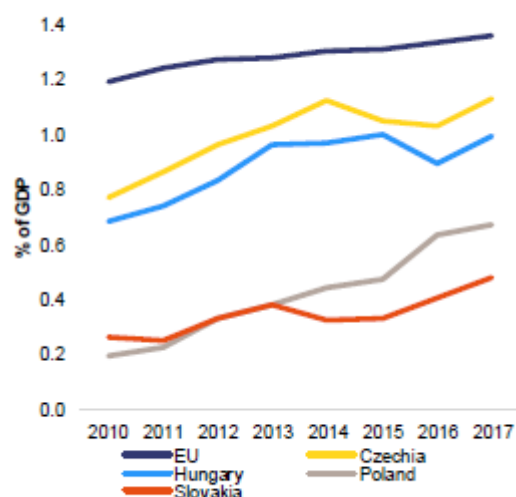
25.2. Research and Innovation

Slovakia is highly dependent on EU funding for research and development (R&D) as private investment is weak. 39 % of national R&D investment relies on foreign funding sources, notably EU Funds, which represent 89 % of all these funds (both among the highest in the EU). Although overall R&D investment has risen from 0.45 % of GDP since 2007 to peak at 1.2 % in 2015, it dropped again to 0.88 % in 2017. While public R&D investment rose from 0.27 % in 2007 to 0.4 % in 2017, business R&D intensity

remains among the lowest in the EU at 0.48 % of GDP. The sharp decline in public R&D funding in 2016 due to the transition between EU funding periods illustrated the over-reliance of the Slovak research system on the European Structural and Investment Funds and raises questions about the sustainability and adequacy of national R&D funding.

Business expenditure in R&D appears too low to substantially boost innovation performance. Overall, business R&D remains one of the lowest in the EU and has centred around medium-high-tech manufacturing (¹²⁵), areas dominated by multinational firms. A lack of R&D strategy and targeted measures, the limited engagement of research institutions and limited research capacity contribute to low private R&D expenditure. In addition, at 0.14 % of GDP in 2016, business expenditure in R&D by small and medium-sized enterprises remains significantly below the EU average. As a result, innovation progress is low, and Slovakia remains a moderate innovator according to the European Innovation Scoreboard. Various measures are underway to improve the small and medium-sized enterprises ecosystem, mostly financed by the European Structural and Investment Funds. The National Business Centre in Bratislava, offering full assistance to small and medium-sized enterprises as a one-stop shop, is now fully operational and is being rolled out to regions.

Graph 3.4.2: Business expenditures on R&D in % of GDP



Source: JRC

A fragmented research system harms the effectiveness of public R&D investment and scientific research quality. The share of high-quality scientific publications among all Slovak science publications remains low (¹²⁶), and only been one Slovak award grantee has been supported by the European Research Council since 2007. This indicates persistent weaknesses in translating rising funding into high-quality scientific output and international collaboration. Research, development and innovation policy suffers from ineffective coordination between ministries and implementing agencies, and major reforms have been regularly postponed. Domestic technological development is low, as

¹²⁵ While the medium-high-tech business expenditure in R&D in 2015 was EUR 113 million, the high-tech areas attracted only EUR 7.5 million.

¹²⁶ Scientific publications of the country within the top 10 % most cited scientific publications worldwide as percentage of total scientific publications of the country. The latest governmental review of spending on education admits low quality of scientific output and recommends increasing the amount of competitive grants in public R&D expenditures in order to support excellence in research (Slovak Government 2017).

shown by weak patenting activity (¹²⁷), and although the number of public-private scientific co-publications shows some encouraging results (¹²⁸), science-business linkages are low, hindering broader knowledge diffusion.

To stimulate private investment, the government extended the rate of the R&D tax allowance to 100% of qualifying expenditure. This strengthens the hybrid R&D tax allowance (¹²⁹) introduced in 2015, which accounted for 11% of total government support for business expenditure in R&D. The Regional Investment Assistance Act introduces a preference for tax relief over direct cash subsidies for investors, encouraging them to invest in higher value-added technologies (see section 3.1).

The use of critical EU funding for research and innovation remains inefficient. The support from EU funds to research infrastructure resulted in the completion of physical infrastructure, but without sufficient accompanying funding for maintenance and staffing. The cancellation of various calls and administrative inefficiencies again resulted in the de-commitment (¹³⁰) of EUR 81 million funds from the Operational Programme Research and Innovation. This was despite efforts to enhance the transparency of the project evaluation process by engaging foreign experts, improving selection criteria and enhancing alignment with the Smart Specialisation Strategy. However, various essential R&I-related projects to increase research and innovation capacities, promote transfer of knowledge and technologies, enhance cooperation of research institutions and business, mobilise private investment and support long-term strategic research have been gradually launched only as of end of 2018.

The Smart Specialisation Strategy is still in its infancy. While Slovakia's Strategy dates back to 2013, the areas of specialisations — the five priority domains (¹³¹) — were only agreed in 2017 based on a dialogue with entrepreneurs to fine tune areas of specialisation. Although steps were taken to enhance the efficiency of its governance, limited progress has been made in implementing the 2017 Smart Specialisation Strategy Implementation Plan, which comprises essential measures such as: i) update of the national infrastructure roadmap to avoid duplication in further investment; ii) preparation of the State research, development and innovation strategy; iii) reform of research, development and innovation financing or iv) transforming the Slovak Academy of Science to public institution.. Only recently the government announced its intention to undertake an international research, development and innovation audit and revise the Strategy before 2020. Maintaining an ongoing dialogue with entrepreneurs (entrepreneurial discovery process) to fine-tune areas of specialisation will be essential for well targeted use of EU funds.

25.3. Additional R&I references

[1. Economic situation and outlook, Regional disparities, p. 10]

¹²⁷ Patent counts per million inhabitant in 2014 (9.3).

¹²⁸ The 2.9 % share of public-private scientific co-publications within the total number of publications ranked Slovakia 11th in the EU for the year 2017.

¹²⁹ At a rate of 50 % to labour costs and at a rate of 25 % to other qualifying expenditures.

¹³⁰ If a sum committed to a programme has not been claimed by the end of the third year following the programme's adoption, any unpaid money ceases to be available to that programme, i.e. it is 'de-committed'.

¹³¹ i) Vehicles for the 21st century, ii) Industry for the 21st century, iii) Health, food and environment, iv) Digital Slovakia and creative industry, v) Medical technology.

The current shape of regional disparities is a result of several factors. These include weaker infrastructure, an underdeveloped business environment, a low rate of innovation and an unfavourable educational structure in some of the regions.

[2. Progress with country-specific recommendations, p. 15]

Limited progress has been made in stimulating business innovation, and measures to consolidate the public research system and make it more efficient have not yet been adopted.

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Slovakia, p. 17]

In the current Multiannual Financial Framework, Slovakia receives more than EUR 15 billion in support to address development challenges. This is equivalent to around 2.5 % of GDP annually. This significant budget is to be invested in various areas, from creating jobs and growth to supporting sustainable transport as well as protecting the environment and investing in research and innovation.

Horizon2020 provided almost EUR 90 million to 285 Slovak research institutions, innovative firms and individual researchers.

[3.3. Labour market, education and social policies, Education and skills, p. 35]

Teaching institutions could engage more with local businesses, form innovation partnerships, and support the diffusion of state-of-the-art technologies to boost relevant skill levels. Promoting career options within smart specialisation areas requires employers to invest in the training of young people and in up-skilling and re-skilling the existing workforce.

[3.4. Competitiveness and investment, 3.4.1 Productivity and investment, p. 36/37]

To increase Slovakia's productivity and maintain the convergence process, sustained investment efforts are needed in R&D, digital and transport infrastructure, and energy efficiency. The remainder of this chapter examines key investment gaps, including the need to boost R&D spending, which can help transform the heavily manufacturing-based economy into one of increasingly home-made innovation and technology.

While access to credit and financing is generally good, further potential lies in areas such as support to small and medium-sized enterprises, innovations and start-ups,... However, the allocation under the European Structural and Investment Funds for financial instruments after the selection of intermediaries is only gradually being distributed to relevant beneficiaries.

Economic Policy Strategy 2030, focusing on raising productivity by supporting human resource development, R&D, a less energy intensive economy, the business environment, and agriculture. In September 2018, the Government approved a pilot version of the National Investment Plan for 2018-2030, focusing primarily on transport, energy, electronic communication, education, research and innovation, healthcare, environment, agriculture, social inclusion, employment and regional development.

[3.4. Competitiveness and investment, 3.4.1 Productivity and investment, Digital transformation, p. 39]

In 2018, the Government adopted the Action Plan for Smart Industry (Slovak Government 2018). Its intended implementation date is 2020, and it aims to increase the competitiveness of Slovak businesses, create favourable conditions for automation trends in manufacturing, improve the start-up environment, support innovation, facilitate investment in digital solutions and ensure the availability of a sufficiently skilled workforce (see section 3.3.).

Only 21% of companies used cloud services and 31% of businesses shared information between different parts of their operations via resource planning software. The take-up of these and other digital trends could be aided by setting up Digital Innovation Hubs.

Kosice IT Valley can serve as a good example of a cluster driving the growth of a regional information communication technology hub. Besides Bratislava and Žilina, it is one of the main centres of the information communication technology industry. It connects public administration, education institutions, research and businesses to create new partnerships that stimulate growth and create high value-added jobs.

[3.4. Competitiveness and investment, 3.4.1 Productivity and investment, Energy and climate change, p. 41]

Initiatives such as the newly-founded Slovak Battery Alliance build on the economy's automotive cluster and offer a new field for research and innovation.

[3.4. Competitiveness and investment, 3.4.2 Single Market integration and the services sector, p. 42]

A heavily regulated business environment in professional services and network industries can reduce competition. This leads to higher consumer prices and limits innovation.

[3.4. Competitiveness and investment, 3.4.3 Regional disparities, p. 43]

The Bratislava region is a growth pole and a 'strong' innovator according to the European Innovation Scoreboard. Notwithstanding Bratislava's swift economic growth, there is still unused potential for developing cross-sectoral collaboration in research, development and innovation through clusters and networking, fostering knowledge transfer between academia and businesses.

[3.4. Competitiveness and investment, 3.4.4. Institutional quality and governance, Business environment and institutional quality, p. 44]

European investors point to a lack of qualified workforce, corruption, unfair practices in public procurement and in the use of the EU funds, low legal certainty and insufficient support of research and development as main concerns (AHK et al. 2018).

25.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

Slovakia has shown limited progress in improving research and innovation performance with targets for research and development spending below the EU average. High priority

investments ⁽¹³²⁾ have been identified to enhance research and innovation capacities and the uptake of advanced technologies, and in particular to strengthen innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential to:

increase attractiveness, efficiency and competitiveness of the research and innovation system, supporting consolidation and sustainability of the whole research system, notably stabilisation of infrastructure and creating incentives for attracting and retaining qualified researchers in the smart specialisation areas;

capacity building to enhance cooperation between the business and academia, mobilising knowledge and technology transfer and strengthening research capacities in industries;

support a transnationally and/or macro regionally co-ordinated research and innovation funding;

support small and medium sized enterprises internationalisation to grasp new business opportunities related to the digital, carbon-neutrality, resource efficiency and circular economy transitions;

foster business investment in research and innovation and enhance networking, cooperation and exchange of experience between academic researchers and companies.

In digitalisation, there is still a significant gap between Slovakia and the EU average. Investment needs are identified to reaping the benefits of digitisation for citizens, companies and governments, and in particular to:

increase the information and communications technology uptake in small and medium sized enterprises, including supporting infrastructures and services;

increase the quality and effectiveness of e-service provision taking into account regional differences and prioritising regions lagging behind;

cooperate with neighbouring countries in developing mutually recognisable e-services.

Small and medium-sized enterprises are not the moving force of the Slovak economy and smart specialisation is still at its beginning. High priority investment needs are identified to enhance growth and competitiveness of small and medium-sized enterprises, in particular to:

support companies to move up in global value chains, increase productivity, facilitating participation in industry led and research driven international clusters;

enhance the research and innovation capacities of small and medium sized enterprises by supporting development and implementation of new business models, adoption of new and emerging technologies and provision of advanced business services to small and medium-sized enterprises.

¹³² The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

Labour shortages lead to growing skills mismatch. High priority investment needs are identified to develop skills for smart specialisation, industrial transition and entrepreneurship, in particular to:

provide enterprises and research institutions with tools to adapt and develop skills for smart specialisation, industrial transition and entrepreneurship;

training and reskilling for smart specialisation areas at all levels within small and medium sized enterprises and building the necessary administrative capacity with a special attention to digital skills;

improve the practise-based approach in vocational education and training, higher education system, supporting the linkages between schools and enterprises also taking into account the lessons learnt from the Catching-up Regions Initiative in Prešov region.

26. SLOVENIA

26.1. Executive summary

Focusing investment ⁽¹³³⁾ on skills, environmental, transport and energy infrastructure, as well as on research and development would strengthen competitiveness and productivity. Investment as a share of GDP in Slovenia remains below the EU average. Skills constraints and a slow digital transformation limit productivity growth, while insufficient environmental infrastructure, lacking sustainable transport connections and a low share of green energy hinder economic development in less developed regions. The research, development and innovation ecosystem remains inefficient. There are only weak links between businesses and research institutions.

26.2. Research and Innovation

Slovenia is a strong innovator but recent progress was limited and weaknesses persist. According to the 2017 summary innovation performance index Slovenia falls in the category of strong innovators with a score just below the EU average. More importantly, its performance change from 2010 to 2017 was rather moderate, with an increase of only about 1.4 % (European Commission, 2018f). One of the main weaknesses is the reduced and inefficient R&D expenditure in the public sector. Slovenia is also relatively weak in terms of the effects of innovation activity on competitiveness. This weakness is reflected particularly in the low shares of exports of knowledge-intensive services and of persons employed in high-growth enterprises.

Innovation performance across Slovenia's regions is uneven. East Slovenia is a moderate innovator, though it has improved its innovation performance over time. In contrast, West Slovenia is a strong innovator albeit with a decreasing innovation performance.

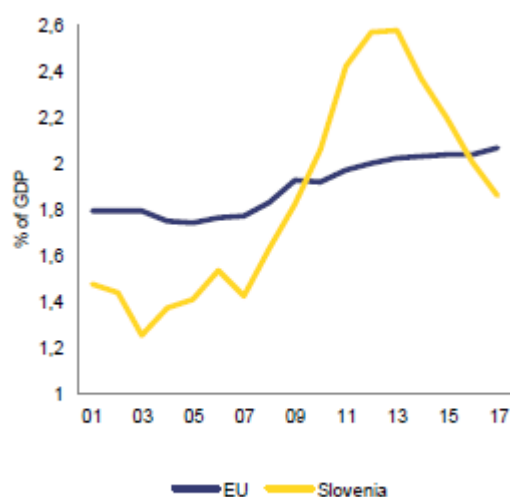
Slovenia has not yet reached the R&D-intensity target of 3.0 % of GDP. Slovenia's investment in R&D is slightly below the EU average and remains dependent on EU funds, with the European Regional and Development Funds (ERDF) providing 33.9 % of public R&D expenditure. In 2017, Slovenia's overall R&D intensity was 1.86 % of GDP, a significant decline from its 2013 value of 2.58 %. This decline was mainly caused by a

¹³³ Both private and public investment.

decrease in business enterprise expenditure on R&D from a peak of 1.98 % of GDP in 2013 to 1.39 % of GDP in 2017. In addition to grants, the Slovenian government strongly relies on tax incentives to promote R&D in firms. R&D tax incentives accounted for 63 % of total government support for business expenditure for R&D in 2015 (OECD, 2017a). Public R&D expenditure fell to its lowest level ever at 0.47 % of GDP in 2017, down from a peak of 0.66 % of GDP in 2010. This decline is mostly due to fiscal consolidation and the cyclical nature of EU funds.

The efficiency of Slovenia's public R&D spending and the quality of its research system remain relatively low. The Slovenian Research Agency is responsible for the allocation of funding based on research excellence criteria. Looking at scientific excellence (as measured by the share of publications among the top 10 % most cited worldwide), Slovenia lags behind the EU average, and ranks only 17th among EU Member States. However, the share of international co-publications in the total number of publications was 58.8 % in 2017 and exceeded the EU average (49.4 %). Slovenia achieved compound growth in international co-publications of 4.5 % between 2010 and 2016.

Graph 3.4.3: R&D funding



Source: Eurostat

Support for young researchers has declined and Slovenia has problems attracting foreign research talent. Slovenia's education system performs well in producing science and engineering graduates and doctoral graduates. Yet, the decline in public investment in R&D has also been felt in a reduction of funding for young researchers. In 2017, the Slovenian Research Agency provided funds for 840 young people involved in doctoral studies (European Commission, 2017b). The number of researchers (full-time equivalents) employed by the public sector (whether in government or higher education) per thousand active population has declined from 4.3 in 2011 to 3.7 in 2016. There is little influx of foreign researchers and academics. This is partially due to the public sector employer system and the old-fashioned habilitation system in universities. Slovenia attracts a lower share of international students at all levels of tertiary education, especially at the doctoral level: less than 9 % of Slovene doctoral students are international compared to an OECD average of 25.7 % (OECD, 2017b). International mobility or mobility between academia and industry are not incentivised. These are key obstacles to the attraction and re-integration of talent and to the much-needed openness of Slovenia's research and innovation system (European Commission, 2018b).

The share of innovative enterprises in Slovenia is decreasing and lags behind the EU average. In the period 2014-2016, 40 % of all enterprises in Slovenia carried out innovation activities, and this share was 6 pps higher in the period 2012-2014. Looking at the shares per enterprise segment, only about 34 % of small companies carried out innovation activities, while the share rises to 80 % in large ones (Statistical Office of the Republic of Slovenia). The employment share in fast-growing firms within innovative sectors is well below the EU average. In Slovenia, only 3.2 % of the workforce was employed in fast-growing firms in innovative sectors, whereas the EU average was 4.8 %. This indicates at a lack of dynamism, which is especially pronounced in innovative parts of the economy (European Commission, 2018i).

Most SMEs in Slovenia have a low innovation capacity. They tend to be poorly integrated in domestic, regional or international clusters, with a low potential to attract critical mass investment and to develop large-scale innovations. A lack of sufficiently equipped R&D units in SMEs (low absorption capacity) seriously limits the opportunities for science-industry cooperation. Only 19.9 % of Slovenian enterprises are engaged in co-operations with government, public or private research institutions. 14.4 % of Slovenian enterprises co-operate with higher education institutions (European Commission, 2014). The research interests in most of Slovenia's (small) firms lie in cost reduction and relatively routine improvements in their processes. Their "R&D" or development departments mostly perform routine procedures, such as quality control and testing. Investing in knowledge is not seen as part of their competitive strategy. In contrast, firms from the highly impactful medium-and high-tech segments (e.g. the automotive sector, machinery) are more intensively involved in science-industry links.

Finding business and research partners can be a challenge due to small market size. Slovenia recognizes this shortcoming by taking part in several interregional innovation actions. These include the Interregional innovation pilot project (Sustainable buildings - Smart campus pilot project), the Industrial transition project focusing on addressing challenges of skills mismatches, modernisation and adaptation to new technologies, and the Smart Specialization Cooperation in Central Europe project. At the same time, Slovenia performs well in delivering projects within the cross-border programmes and macro-regional strategies. Slovenia could benefit from further possibilities, such as further enhancing transnational partnerships for SMEs by participating in business networks.

The Slovenian smart specialisation strategy aims at tackling many of these challenges inter alia by establishing Strategic research and innovation partnerships (SRIPs). It was adopted in 2015 and governs the delivery of almost EUR 1 billion of EU funds. It aims to develop top-level conditions for creativity and innovation in several niche areas. SRIPs have been established around nine focus areas of the strategy. Through SRIPs, the governance of smart specialisation is entrusted to around 700 non-governmental stakeholders (including knowledge, institutions, businesses, NGOs etc.) which paves the path for a structural transformation empowering and strengthening the innovation ecosystem of Slovenia. SRIPs have already helped to improve the internationalisation and networking of Slovene research and innovation stakeholders through their participation in thematic smart specialisation platforms. For example, Slovenia is co-leading the thematic area 'SME integration to Industry 4.0' through the 'Factories of the Future' SRIP, and the thematic area 'Digitalisation and Safety for Tourism', through the 'Sustainable Tourism' SRIP, and is a partner in other areas. This enables Slovene stakeholders to learn from more experienced peers from well-advanced regions and Member States, thus improving the skills, knowledge and expertise available in the R&D sector in Slovenia.

Slovenia lacks a well-coordinated system to govern its R&D efforts and is not implementing strategic R&D policy reforms. Frequent changes in public governance of the national research and innovation system combined with fragmentation of policies and instruments remain challenges. One of the key problems identified by public research organisations and business entities is the irregularity of the government's announcements and the funding of support measures such as the co-financing of joint R&D projects. In 2018, further calls for co-financing of R&D projects were issued, and a new instrument related to the smart specialisation strategy was introduced in August 2018. The so-called DEMO projects under the call should fit within the focus areas of the SRIP action plans. The Slovenian authorities have requested support from the Horizon 2020 Policy Support Facility with a special focus on the internationalisation of the Slovenian science base, and its cooperation with businesses (European Commission, 2018g). Additionally, Slovenian business could benefit from investment in high performance computing and artificial intelligence.

26.3. Additional R&I references

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Slovenia, p. 15]

The financial allocation from European Structural and Investment Funds (ESI Funds) aimed to support Slovenia in facing development challenges, amounts to EUR 3.9 billion in the current Multiannual Financial Framework, equivalent to around 1.4 % of the GDP annually. Furthermore, numerous Slovenian research institutions, innovative firms and individual researchers benefited from other EU funding instruments, notably Horizon 2020 which provided around EUR 210 million.

ESI Funds supported closer collaboration between business and research institutions, and R&D investments in the private sector with direct support for nearly 6000 enterprises.

EU funding contributes to mobilisation of public and private investment through grants and financial instruments. Around EUR 306 million (7.8 % of the total) is earmarked to be delivered in the form of loans, microloans, portfolio guarantees and equity. The investments carried out via Financial instruments will be focused on R&D, SMEs,...

[3.4. Competitiveness and investment, 3.4.1 Productivity growth, p. 31]

Investments in R&D, digitalisation and infrastructure, in particular related to transport and rail, would help the convergence process. Slovenia's growth potential would benefit if the trend of declining investment into research, development and innovation could be reversed. Investments in the digitalisation of Slovenia's firms, which are active in more traditional sectors, as well as in the uptake of e-government solutions are also important to ensure that Slovenia remains competitive.

[Box 3.4.1: Barriers to investment in Slovenia, p. 35]

Despite the encouraging growth in private sector investment total investment as share of GDP in Slovenia is still relatively low compared to other EU Member States. This is also reflected in the below-average investment in R&D, which is also largely determined by EU Structural and Investment Funds.

26.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

The national targets for spending on research and development remain far from achieved and the proportion of innovative enterprises lags behind the EU average. High priority investment needs ⁽¹³⁴⁾ have therefore been identified to enhance research and innovation capacities and uptake of advanced technologies, and in particular to:

strengthen research and innovation performance and foster productivity growth by identifying smart specialisation areas on the basis of national and regional needs and potential;

increase the value added of the economy and strengthen the strong innovator position by increasing the number of innovative firms in the smart specialisation areas;

foster cooperation between research and business including across the EU Strategy for the Adriatic-Ionian Region, EU Strategy for the Alpine Region and EU strategy for the Danube Region via strategic research and innovation partnerships, centres of competence, interregional projects and use of Cloud services.

The uptake of Information and Communications Technology services in small and medium-sized enterprises and further development of digital public services remain a challenge. Priority investment needs have therefore been identified to reap the benefits of digitisation for citizens, companies and governments, and in particular to:

increase uptake of Information and Communication Technology in small and medium-sized enterprises, including supporting infrastructures and services; all with a view to improving the number of enterprises reaching a high digital intensity;

increase the uptake of e-Government services (e-inclusion, e-health, e-learning, e-skilling) and general use of internet services by citizens.

Scale-up and growth rates of enterprises remain low which, combined with a challenging business environment and low capacities for technology transfer, hinders the growth of the economy. High priority investment needs have therefore been identified to enhance growth and competitiveness in small and medium-sized enterprises, and in particular to:

promote entrepreneurship and increase survival rates of firms in particular by facilitating the economic exploitation of new ideas and integration of business education in the business ecosystem;

raise competitiveness and internationalisation of small and medium-sized enterprises, through stronger participation in industry led and research driven international and macro-regional clusters; This can be the basis for further innovations and co-operation, in line with the EU Strategy for the Adriatic-Ionian Region, EU Strategy for the Alpine Region and EU strategy for the Danube Region;

¹³⁴ The intensity of needs is classified in three categories in a descending order – high priority needs, priority needs, needs.

reduce barriers for doing business, especially in less developed regions at level 3 of the Nomenclature of Territorial Units for Statistics, through upgrading the entrepreneurial support ecosystem;

address increasing demographic challenges by supporting silver economy small and medium-sized enterprises.

Skills shortages and mismatches are among the main barriers for the further economic development of Slovenia. Priority investment needs have therefore been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, and in particular to:

reduce the capacity constraints in the economy, address technological change and industrial transition challenges by providing training and skilling in smart specialisation areas;

support small and medium-sized enterprises growth and open up internationalisation opportunities by providing skills trainings on (innovation) management, stock market participation, business development, internationalisation.

27. SWEDEN

27.1. Executive summary

Strengthening investment ⁽¹³⁵⁾ in new housing, education and skills could further enhance Sweden's long-term growth potential. It would also be beneficial to maintain investment in transport infrastructure and innovation. The investment rate in Sweden has stood well above the EU average for the last decade; nevertheless, some parts of the economy could benefit from more investment. Investment in education and skills will also be crucial to help boost productivity growth and address the skills mismatch in some parts of the labour market. Finally, there is a need to maintain investment in transport infrastructure and Research and Development at high levels to support long-term productivity growth and to fully exploit business potential.

The economy benefits from a favourable business environment, although specific barriers to investment and long-term growth remain. 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. However, investment and innovation could benefit from a closer cooperation between academia and business.

27.2. Research, Innovation and Digitisation

Sweden remains one of Europe's most innovative economies. Sweden has consistently been one of the top-performing countries in the European Innovation Scoreboard ⁽¹³⁶⁾, both in terms of R&D investment ⁽¹³⁷⁾ and outcomes (European Commission, 2018a). Overall, the country benefits from an excellent science base, highly qualified human resources and internationally competitive and innovative large companies, both in the manufacturing and services sector.

¹³⁵ Both private and public investment.

¹³⁶ Available at: <http://ec.europa.eu/docsroom/documents/33147>

¹³⁷ Sweden has the highest R&D intensity in the EU, 3.33 % of GDP in 2017, up from 3.27 % in 2016.

Maintaining high levels of investment, favourable framework conditions and a broader innovation base are key to securing this leading position. Sweden's innovation model has traditionally relied on a limited number of large globally active technology companies. The internationalisation of these companies against the backdrop of mergers and acquisitions has, however, led in some cases to headquarters moving abroad. Research and innovation activities of these companies have also become more internationally mobile. In this context, it is essential for Sweden to create an environment that nurtures the innovation potential of SMEs and start-ups.

The economy's innovation capacity could be further improved by increased collaboration between academia and SMEs. The share of public R&D financed by the business sector (an important indicator of public-private cooperation) has declined since 2011, with Sweden now ranked below the EU average. While Sweden still performs well on the share of public-private co-publications, notably in engineering science, performance has considerably declined in this area too. Against this backdrop, there is room for boosting knowledge transfer via joint projects, a better matching of the specialisation of the public science base to that of the private sector, exchange of staff between firms and universities and for more university spinoffs to turn research results into new products and services (Tillväxtanalys, 2014)

There are emerging bottlenecks in the supply of high-skilled human resources. Ensuring a supply of specialist human capital is vital to support R&D investment as well as digitisation (see chapter 4.3). This concerns in particular science and engineering graduates, as well as workers with advanced digital skills.

Recent policy initiatives are addressing these key challenges. The Research Bill 2017-2020 provides additional financial resources to support both basic and applied research as well as human resources development, notably within higher education. The bill furthermore launches six new 10-year research programmes. Academia-business cooperation is promoted via Innovation Partnership Programmes (¹³⁸).

Sweden's Smart Industry Strategy recognises the need to enhance digitisation of SMEs (¹³⁹). Swedish businesses are embracing digitisation and actively using digital technologies to improve efficiency, productivity and sales. However, SMEs overall somewhat lag behind large companies in this area. To develop innovation capacity in SMEs, the authorities promote projects that validate technology and business concepts, as well as some industry-specific innovation-enhancing measures, such as reducing the processing industry's emissions of greenhouse gases.

27.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 13]

Substantial progress and full implementation have been achieved in several policy areas, in particular fiscal governance and research and innovation.

¹³⁸ Specific partnership programmes include (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/>.

¹³⁹ Smart industry – a strategy for new industrialisation for Sweden. <https://www.government.se/information-material/2016/04/smart-industry---a-strategy-for-new-industrialisation-for-sweden/>

[Box 2.1: EU funds and programmes contribute to addressing structural challenges and to fostering growth and competitiveness in Sweden, p. 15]

Programmes supported by ESI Funds are helping to create strong innovation environments, clusters and accessibility of research resources for industry. Sweden uses the ESI Funds to implement smart specialisation strategies in all eight regions by involving over 5 600 enterprises that will cooperate with research institutes to develop marketable products.

So far, 35 projects (¹⁴⁰) have been approved under the infrastructure and innovation window of the EFSI (EUR 2.4 billion in total financing, supporting EUR 9.2 billion in investments).

[4.3. Labour market, education and social policies, 4.3.3. Education, p. 42]

Sweden spends more on tertiary education than the EU average but the allocation per full-time student has continuously decreased. Total expenditure in this area corresponds to 1.5 % of GDP, with the largest proportion of funding (80 %) coming from public sources (Swedish Higher Education Authority, 2018) (¹⁴¹).

[4.4. Competitiveness reforms and investment, 4.4.1. Productivity and investment, Productivity Developments, p. 45]

Sweden also does well in terms of non-cost competitiveness, including via an attractive business environment (see Section 4.4.4) and strong research and innovation performance (discussed under the heading '*Research, innovation and digitisation*' below).

[Box 4.4.1: Investment challenges and reforms in Sweden, p. 48]

Barriers to investment in Sweden are overall low (European Commission, 2018a). Some reforms were adopted in public procurement (see Section 4.4.3), research and innovation (see Section 4.4.1) and construction investment.

Cooperation between academia and business could be further enhanced, particularly for SMEs. Initiatives such as the Innovation Partnership Programme (see Section 4.4.1) could, over time, help promote increased collaboration.

[4.4. Competitiveness reforms and investment, 4.4.3. Regional dimension and infrastructure, Regional Differences, p. 50/51]

Because of this tendency towards agglomeration, middle-income regions risk falling behind in productivity and growth. Over 2010-2015 their investment rates were significantly below the Swedish average (18-20 % of GDP vs. 23 % for Sweden as a

¹⁴⁰ Among which 19 are multi-country projects.

¹⁴¹ The total expenditure on the higher education sector includes research, the costs of government managing agencies and study support to students.

whole). This lower level has repercussions on infrastructure, R&D investments (¹⁴²) and innovation performance (¹⁴³).

Sweden has developed Smart Specialisation strategies to foster regional development. Eighteen out of 21 counties have already put in place Smart Specialisation strategies (Research and Innovation Strategies for Smart Specialisation). The aim is to mobilise stakeholders to identify priority areas with the greatest potential for innovation and growth based on the regions comparative advantage and existing assets and resources. Investments from the European Regional Development Fund already support these strategies within the current programming period, in particular within research and innovation with a special focus on SMEs. This support is expected to continue in the next period. In order to reach full effect, the Research and Innovation Strategies for Smart Specialisation system would profit from politically-anchored regional strategies and better coordination with national level priorities.

[4.4. Competitiveness reforms and investment, 4.4.4. Institutional quality and governance, Business Environment, p. 51]

Sweden continues to have a high-quality and competitive business environment. The country stands out in public administration, access to finance, innovation and ability of SMEs to exploit international opportunities.

27.4. Annex D

Policy Objective 1: A Smarter Europe – Innovative and smart industrial transformation

In order to reach its ambitious national target for research and development expenditure of 4% of GDP and secure its position as European leader in innovation, Sweden needs to make a continuous effort to broaden the innovation base and maintain high level of investments in research and development. Regional differences in terms of innovation performance and competitiveness are accentuated. Investment needs (¹⁴⁴) have therefore been identified to further enhance research and innovation capacities and the uptake of advanced technologies, and in particular to:

encourage the development and implementation of tailor-made smart specialisation systems at regional (programme) and national level. Promote further international and regional cooperation to exchange knowledge and achieve critical mass for the specialisations; thereby particularly focusing on the 3 middle-income regions (Småland and the Islands, Central Norrland and North Middle Sweden) and the Northern Sparsely Populated Areas in order to support them to catch up and scale up their investments. Promote the coordination between the smart specialisation strategies and national Innovation Partnership Programmes and other relevant strategies (notably the EU strategy for the Baltic Sea Region) and other (non-) European countries;

¹⁴² R&D expenditure in 2015 was below 1.5 % of GDP, while other Swedish regions had 3-4 %.

¹⁴³ The Regional Innovation Scoreboard level ranges from 102 (North Central Sweden) to 165 (Stockholm, the most innovative region in the EU), with the EU average equal to 100 (European Commission, 2017b).

¹⁴⁴ The intensity of needs is classified in three categories in a descending order - high priority needs, priority needs, needs.

further encourage regional growth processes and promote research and innovation capacities, supporting existing cluster and network structures, strengthening the business competitiveness and the business uptake of advanced technologies; thereby contributing to diminishing the competitiveness and innovation gaps particularly in the middle-income regions and Northern Sparsely Populated Areas;

strengthen links, cooperation and knowledge transfer between academia and business and promote a more active involvement of universities in projects. Support marketable and market-oriented research and development and raise business awareness of upcoming scientific developments. Support the establishment of living labs and test-beds and eco-systems that bring together the demand and supply side ensuring a better uptake of innovation in small and medium-sized enterprises;

support pilot lines, early product validation, technology transfer and the building of capacities in the development and provision of key digital technologies, artificial intelligence, cybersecurity, high performance computing and in particular in the area of digital skills and deep tech.

The potential of Swedish small and medium-sized enterprises and innovative start-ups is not fully exploited, there is a low proportion of SMEs with new-to-market/new-to-firm innovations and the proportion of Swedish female entrepreneurs is among the lowest in the OECD area. Investment needs in research and innovation are identified to further enhance growth and competitiveness of small and medium-sized enterprises, and in particular to:

promote continuous Entrepreneurial Discovery Processes through strengthened entrepreneurial ecosystems and the sustained engagement of small and medium-sized enterprises in these processes; support Project Development Labs;

encourage female entrepreneurship including in the Northern Sparsely Populated Areas in order to reach the full potential of the economy and support small and medium-sized enterprises that employ third-country nationals and other vulnerable groups for the cause of integration;

promote the creation of new firms, growth of start-ups/scale-ups, accelerators, as well as new business models and increase the proportion of small and medium-sized enterprises with new-to-market and new-to-firm innovations by giving support to product, organisational and marketing innovations. Stimulate the uptake on enabling technologies, eco innovation and green- and blue-tech sector technology, as well as the acceleration of market access and internationalisation, especially in Northern Sparsely Populated Areas;

support the development of regional, interregional, and international networks to disseminate knowledge, create partnerships, and promote further innovation and global value chains.

Despite the fact that Sweden is characterised by a highly skilled labour force, it lacks Informations and Communications Technology specialists. Employment in high-tech sectors is above EU level only in the three large-city-regions; the skills gap figures among the top barriers to growth for companies. Therefore, investment needs have been identified to develop skills for smart specialisation, industrial transition and entrepreneurship, in synergy with lifelong learning actions under Policy Objective 4; and in particular to:

promote innovation management in small and medium-sized enterprises and support vocational education and training and reskilling in smart specialization areas within firms; building the necessary administrative capacity, including in smart cities in cooperation with peers in the Baltic Sea Region, with a particular attention to digital skills and the need to address industrial transition;

promote skills development for higher education and research institutions to increase the commercial viability and market relevance and uptake of their research projects as well as their capacities to take part in interactive and open innovation processes, including across borders;

strengthen the capacity of small and medium-sized enterprises to adapt to digital/technological transformation and increase their Informations and Communications Technology uptake, support the automation of work/processes;

encourage the development of novel applications and the diffusion of digital and other key enabling technologies through extra-regional networks of digital innovation hubs and living labs.

28. UK

28.1. Executive summary

The UK needs to address shortfalls in its investment in both physical capital and people to deliver inclusive, long-term growth. It has long been an outlier among advanced economies for its low investment rate. UK investment also fell particularly sharply in the financial crisis. Shortfalls in both physical and human capital investment contribute to weak productivity. On the physical capital side, the UK needs to deliver a higher level of investment in research and innovation, equipment and house building, and to modernise and expand infrastructure networks while bringing down project costs. On the skills side, the main challenge is to improve the effectiveness of education and training systems in areas such as basic and technical skills, where the UK performs comparatively poorly.

28.2. Research and Innovation

UK R&D investment intensity has been around 1.7 % of GDP for the past decade, below the EU average. In 2017, it rose to 1.69 % of GDP, still well below the EU and OECD averages (2.07 % and 2.4 % respectively). Private R&D intensity rose steadily from 1.02 % of GDP in 2012 to 1.13 % in 2017. This is partly thanks to public support through direct schemes managed by UK Research and Innovation and indirect schemes such as differentiated R&D tax incentives for SMEs and large companies. Together these were estimated to total more than 0.25 % of GDP in 2015. However, public R&D investment dropped from 0.57 % of GDP in 2013 to 0.51 % in 2017. As part of its Industrial Strategy (see above), the government aims to increase R&D investment intensity to 2.4 % of GDP by 2027. This would require public and private sector R&D investment to increase by around half. An additional GBP 1.6 billion (EUR 1.8 billion) of public R&D spending was announced in the 2018 Autumn Budget. Further plans on how to meet the targets are under development.

R&D investment is concentrated in a limited number of companies and regions. Three quarters of all private R&D investment is concentrated in 400 companies (HM Government, 2017). South-East England and East England are responsible for 20 % and

17 %, respectively, of all R&D investment in the UK, with current R&D intensities (2.4 % and 3.4 %) at or above the proposed 2027 target. In contrast, Northern Ireland, Wales and North-East England each account for barely 2 % of UK R&D investment, with R&D intensity currently around 1 % of GDP in the latter two regions (ONS, 2018h & Eurostat, 2018).

Despite an excellent research base, relatively weak science-business linkages hamper innovation diffusion. UK universities are regarded as global research powerhouses producing excellent scientific outputs ⁽¹⁴⁵⁾. However, the business sector does not seem to be able to capitalise on this scientific strength. Science-business linkages are relatively weak, both in terms of scientific co-production ⁽¹⁴⁶⁾ and business-funded public R&D ⁽¹⁴⁷⁾. As a result, the UK scores poorly on knowledge diffusion in international rankings ⁽¹⁴⁸⁾. There have been calls to strengthen the existing knowledge diffusion infrastructure (Haldane, 2018) ‘by creating some stronger and longer diffusion spoke’ to address the ‘long tail’ of companies suffering from low productivity growth (see above). Recent policy action to address these weaknesses includes the creation of UK Research and Innovation, bringing all support schemes for research and innovation under one umbrella, and the creation of the Industrial Strategy Challenge Fund.

28.3. Additional R&I references

[Box 2.1: EU funds help overcome structural challenges and foster development in the UK, p. 16]

Numerous research institutions, innovative firms and individual researchers benefited from other EU funding instruments, in particular Horizon 2020, which has granted EUR 5.1 billion (GBP 4.5 billion) in investments.

The financing goes towards the promotion of R&D investment in the private sector; the strengthening of SME competitiveness and the stimulation of closer collaboration between enterprises and knowledge institutions.

The ‘Infrastructure and Innovation’ window comprised 23 approved projects financed by the EIB with EFSI backing, for a value of approximately EUR 1.6 billion (GBP 1.5 billion) of financing in total, set to trigger EUR 17 billion (GBP 15 billion) in investments.

[3.3. Labour market, education and social policies, Education, p. 27]

Potential changes to the UK’s immigration policy could have a negative impact on research and teaching prospects. According to Universities UK (2018), over 400 000 international students came to study in the UK in 2016-2017, representing 19 % of all students. On average, every student from another Member State generated (through expenditure on tuition fees and subsistence) GBP 22 000 (EUR 24 900) gross added value and GBP 5 000 (EUR 5 650) in tax receipts. International staff made up 20 % of all

¹⁴⁵ In 2015, 15.3 % of UK scientific publications ranked among the top 10 % most cited publications worldwide.

¹⁴⁶ The UK ranks 10th in the EU in terms of the number of public-private co-publications as a percentage of total publications.

¹⁴⁷ Public expenditure on business-funded R&D was 0.021 % of GDP in 2015, less than half the EU average.

¹⁴⁸ According to the Global Innovation Index by Cornell University, INSEAD and WIPO, the UK ranks only 38th globally in terms of knowledge diffusion.

university staff and 30 % of all academic staff in 2017 (up to 43 % for some subjects such as engineering) (ibid.). Around 11 % of the UK Higher Education sector's GBP 7.9 billion (EUR 8.9 billion) research income in 2016-2017 was from European sources, the majority (9 % of the total) coming from EU funding.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and innovation, Productivity, p. 33]

While the 2018 Innovation Scoreboard (European Commission, 2018e) presents the UK as a 'leading innovator', UK businesses have not capitalised on a strong science base, due to low R&D investment and a lack of institutional infrastructure to support innovation diffusion (see below). The Digital Transformation Index (European Commission, 2018f) points to below-average digital infrastructure and 'entrepreneurial culture' as barriers to the digitalisation of the UK economy and associated innovation.

[3.4. Competitiveness reforms and investment, 3.4.2. Investment, Climate, energy and environment, p. 39]

According to the draft plan, the government has allocated GBP 2.5 billion (EUR 2.8 billion) to investment in low-carbon innovation in 2015-2021 (BEIS, 2019).

[3.4. Competitiveness reforms and investment, 3.4.3. Regional disparities, p. 40]

Four variables seem to explain most of the variation in productivity performance across regions (European Commission, 2017b). These are innovation, market size, higher education and life-long learning, and infrastructure. Disparities in innovation performance across regions are linked to disparities in R&D investment (see Section 3.4.1). 'Sales of new-to-the-market or new-to-the-firm innovations' and 'business expenditure in R&D' are subject to the maximum dispersion across UK regions according to the 2017 Regional Innovation Scoreboard. Good transport and digital infrastructure can mitigate some of the difficulties resulting from limited market size and agglomeration economies, but the UK has shortcomings in both areas (see Section 3.4.2). The deficit of digital infrastructure may be acting as a barrier to the diffusion of new technologies and development of new business models in some regions.