EUROPEAN COMMISSION
DIRECTORATE-GENERAL FOR RESEARCH & INNOVATION

Directorate G – Research and Innovation Outreach
Unit G1 – 'ERA and country intelligence'

Research and Innovation analysis in the European Semester 2020 Country Reports

This document, compiled by DG Research & Innovation, collects all the research and innovation (R&I) aspects covered by the 2020 European Semester Country Reports. In particular, for each Member State the document shows: (i) the R&I relevant findings and related policy challenges from the Executive Summary of the Report; (ii) the R&I specific section of the Report; (ii) any additional references to R&I issues in other sections of the Report.

Contents

1. AUSTRIA

1.1. Executive summary

In a context of growing uncertainty and rapid technological change, further structural reform and targeted investment could help Austria achieve more sustainable and inclusive growth. (…) future productivity growth hinges on improving innovation outcomes, digitalisation, the business environment and human capital.

Identifying investment needs in green technology and sustainable solutions, and securing adequate funding will be key to delivering on climate and energy objectives and shaping a new growth model. To remain competitive in international markets, Austria will need to focus investment on the ecological transition, research and (digital) innovation, and human capital. For the last decade, its investment ratio has been above the euro area average, but investment growth is expected to be less lively in the coming years. The high level of R&D expenditure is not translating sufficiently into innovation outcomes. Digital technologies are still not widely used, particularly among smaller businesses, and restrictive service sector regulation is hampering investment.

Austria's future competitiveness depends partly on additional efforts in research and innovation. Austria has been exceeding the European R&I investment target since 2014. However, its innovation outcomes do not fully reflect this. R&D intensity is very uneven due to a lack of coordination between federal states. Further challenges are the modest level of investment in basic research, low employment in fast-growing innovative firms, the limited availability of venture capital (especially in scale-up stages), and the untapped potential of female researchers.

1.2. Research and Innovation

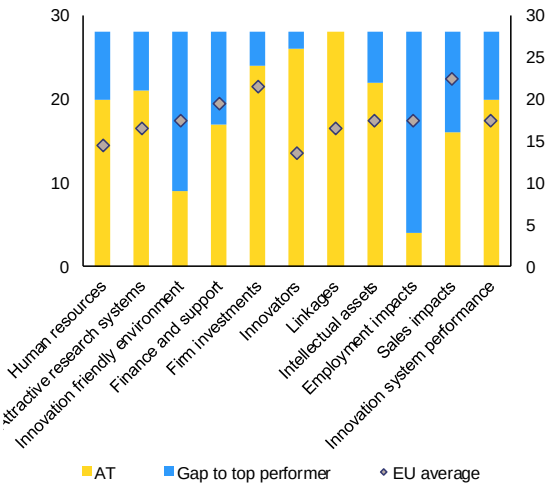
Austria is second in the EU in terms of R&D intensity and continues to increase its R&D investments. R&D investment is an important lever for supporting productivity growth (Weyerstrass, 2018). Austria has set itself an ambitious national R&D expenditure target of 3.76% of GDP by 2020 and wants to be an *Innovation Leader* (European Commission, 2019f). Although it may not reach its target, R&D expenditure increased further in 2018 to 3.17% of GDP (EU: 2.11%). The private sector has been the main driver, with Business Expenditure on R&D (BERD) rising faster than public expenditure ([1]). The government supports BERD mainly through R&D tax incentives (56% of total support in 2016) (OECD, 2018b), while direct support (e.g. via grants) has decreased slightly since 2015. However, there are big regional disparities in R&D expenditure (European Commission, 2019a). On NUTS-1 level, all three Austrian

([1]) Business R&D intensity 2.22%; annual growth rate 2.5%; public R&D intensity 0.93%; annual growth rate 1.3%.

regions fare among the top *Strong Innovators*, with West Austria performing better on the 'Regional Innovation Index' (119.9) than South (116.2) and East Austria (114.8). Of the three, West Austria also saw the biggest improvement from 2011 (European Commission, 2019g).

Scientific impact indicators show potential for increasing the effectiveness of the R&I system. Although its overall scientific performance is above the EU average([2]), it remains below that of other EU countries with similar public R&D intensities([3]) (Schuch and Testa, 2020). Austria excels in fewer scientific fields and performs considerably below the EU average in engineering and medical sciences (European Commission, 2018d). There was an overall increase in public R&D investment over the last decade, mainly for applied research although public competitive funding for basic research has also increased in recent years. The current Research Technology and Innovation (RTI) strategy acknowledges the need to improve framework conditions for basic research. In early 2019, the federal government announced a new measure (the *'Exzellenzinitiative'*) to promote cutting-edge research. This is included in the new government programme and will be managed by the Austrian Science Fund (FWF) over the next legislative period.

Graph 3.4.2: **Austria's innovation strengths and weaknesses**



Source: European Commission, European Innovation Scoreboard

Smart specialisation has helped to strengthen cooperation and public-private dialogue on innovation, but regional disparities persist. Austria's approach to smart specialisation is based on the national RTI strategy and regional strategies at the level of the nine *Länder*. Regional priorities are aligned with and complement the thematic

([2]) Austria ranked 8th in the EU for top 10% publications and 4th for international co-publications.

([3]) Finland, Sweden, Netherlands, Belgium.

priorities in the federal strategy (OECD, 2018c). However, R&D expenditure varies significantly across regions, which could be addressed by strengthening cooperation between the Austrian *Länder* and with regions in other countries (OECD, 2018c). The national RTI strategy 2021-2030 is currently being finalised in close consultation with a wide range of stakeholders, including the nine *Länder*, via the twice-yearly '*Länderdialog*' (a policy platform for national and regional governments and agencies in science and R&I). The new government plans to adopt it in 2020. It is important that all actors, including SME representatives, are actively involved also in the implementation of the strategy.

R&I priorities are well aligned with EU priorities on sustainable development. Austria's energy and climate strategy '#mission 2030' stresses the importance of R&I for achieving long term climate and energy targets (BMNT/BMVIT, 2018). In May 2018, Austria joined the global research initiative 'Mission Innovation' (BMVIT, 2018) in order to accelerate its clean energy transition (see also Section 3.5). This includes the commitment to double public R&D investments in clean energy by 2020/2021 in selected priority areas.

Although Austria has a strong human resource base in science and technology, female researchers are still underrepresented. In 2017, Austria ranked fourth in the EU in terms of new graduates in science and engineering ([4]). However, the underrepresentation of women in research may signal that the economy is not using its human resource potential to the full (OECD, 2018c). The proportion of female researchers, including in the business sector, remains below the EU average (European Commission, 2019h) ([5]). As the result of measures to achieve gender balance (e.g. individual support for early-stage researchers), the proportion of women among professors in public universities has grown significantly and progress was made on ensuring gender parity in committees (BMBWF/BMVIT/BMDW, 2019).

Austria's economy could benefit from more investments in intangible assets that complement R&D activities. In the last two decades, intangible assets complementing R&D (e.g. software, databases, copyrights, training, design etc.) have grown in importance as drivers of innovation and growth. Investments in intangible assets could reverse the slowdown in productivity growth (see above). However, Austria's public and private sector invests less into intangible assets than those in *Innovation Leaders* or other *Strong Innovators* ([6]) (Bauer *et al.*, 2020).

([4]) Per thousand population aged 25-34, significantly increasing in the last decade

([5]) Average 29% women researchers in AT vs. 33 % in the EU.

([6]) SPINTAN and INTAN data

1.3. Additional R&I references

[1. Economic situation and outlook, United Nations' Sustainable Development Goals, p. 11]

(…) In relation to SDG 9 (industry, innovation and infrastructure), more innovation outcomes would improve the performance.

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

(…) Some progress was made on CSR 3 on investments in research and development, innovation and digitalisation, and supporting productivity growth by stimulating businesses' digitalisation and company growth and reducing regulatory barriers in the service sector.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Austria, p. 16]

EU cohesion policy funding has brought many social and economic benefits. Funding from the European Regional Development Fund (ERDF) has enhanced research and innovation (R&I) infrastructure, promoted business investment in R&I and developed links and synergies between firms, R&D centres and the higher education sector.

Horizon 2020, the EU's framework R&I programme, allocated EU funding of €1.3 billion in Austria (including €263 million for more than 400 SMEs).

[3.2. Financial sector, 3.2.3. Capital markets and access to finance, p. 31]

Austria is lagging behind peer countries as regards the availability of equity capital, including venture capital. As percentage of GDP, venture capital investment is still relatively low (0.02%) compared to Denmark (0.1%) and Sweden (0.09%), but it has been catching up steadily (Invest Europe, 2019). The small size of the market also involves a high degree of volatility. After the crisis, venture capital investments dropped sharply, driven by a decline in private investment, while the public sector took a more prominent role (European Commission, 2017). Since 2015, venture capital investment has increased exceeding even pre-crisis levels, but it remains scarce for companies outside Vienna (Flachenecker *et al*., 2020). The recent expansion has been driven by an increase in funding for start-up and later-stage companies (see Graph 3.2.3). Administrative barriers and restrictive service sector regulations may be partly responsible for the low supply of domestic equity capital (AVCO, 2019). Several funds were put in place through the 'Venture Capital Initiative', including three in the investment phase. These funds invest, *inter alia*, in IT, medical engineering and industrial biotechnology. The new government programme includes improved incentives for private venture capital for innovative start-ups and SMEs.

[3.4. Competitiveness, Reforms and Investment, 3.4.1. Investment and productivity trends, p. 40]

Recent dynamics show only a gradual shift to more productive sectors. Austria's ambition is to become an *Innovation Leader* ([7]). However, its share of high-tech, medium-high-tech and knowledge intensive services is lower than the EU average and that of most *Innovation Leaders* and *Strong Innovators*. More recently (2007-2016), there has been a slow structural shift towards more productive sectors. However, even these show relatively low productivity growth in international comparison (Schuch and Testa, 2020).

Total factor productivity (TFP) growth remains insufficient to catch up with innovation leaders. After nearly a decade of TFP stagnation, the trend has been more positive in recent years (+1% in 2018). However, TFP growth is not sufficient to catch up with peer countries (e.g. Germany), where the post-crisis TFP growth came sooner and was more pronounced. As in most EU countries, the growth is also lower than in past decades (European Commission, 2019a). Investment, *inter alia* into intangible assets, is an important lever for improving TFP growth (Weyerstrass, 2018). However, while Austria is investing strongly in R&D and brands, its performance is only average in terms of intangible investment-to-capital ratio ([8]) (see below). This means that intangible investment makes only an average contribution to productivity growth (Bauer *et al.*, 2020).

Investments to support digitalisation and innovation, coupled with improved business regulation, are Austria's main levers for boosting productivity growth. Austria invests heavily in R&D but has so far not managed to turn these investments into proportional innovation outcomes, as also reflected by SDG 9. Its overall innovation performance has been stagnating and, thus, the gap to *Innovation Leaders* is not closing ([9]). A further bottleneck for productivity growth is the weak diffusion of digital technologies and business models among smaller companies, coupled with average digital skills in the adult population (see Section 3.3.4). Firms' innovation capacity and digitalisation are tightly linked to business dynamics, not least as regards starting up and scaling up. High administrative burden and restrictive regulation in some areas also have a dampening effect on the business environment. Overall, there seems to be some room to improve productivity growth by stimulating business entry and

([7]) As defined by the European *Innovation Scoreboard 2019 – Innovation leader*: SE, FI, DK, NL, *Strong innovator*: LU, BE, UK, DE, AT, IE, FR, EE.

([8]) Though especially cross-country comparison on investment in intangibles have to be analysed with care, as data collection is still in early stages. Amongst others, companies sometimes book these investments as expenditure instead. Also, in Austria, ICT output may be underestimated as Statistik Austria does not yet use hedonistic price indices (Streissler, 2016).

([9]) In the *European Innovation Scoreboard*, Austria ranked 7th for 2016, 10th for 2017 and 9th for 2018. Only the four best ranked countries were considered as Innovation Leaders

dynamism, which could also lead to better resource allocation and allow unproductive firms to leave the market. Investment in the ecological transition could also offer significant opportunities to improve productivity and competitiveness (see Section 3.5).

[3.4. Competitiveness, Reforms and Investment, 3.4.3. Market functioning, goods and service sector, Business dynamics, p. 45]

(…) However, scaling-up remains a problem for Austrian companies. The proportion of high-growth firms is below the EU average: 6.8% vs 9.9% (OeNB, 2018; Flachenecker *et al.*, 2020). High-growth firms are particularly prevalent in the services sector and especially for ICT (European Commission, 2019i). Austria has one of the lowest proportions in the EU of high-growth firms active in innovative sectors (European Commission, 2019f). Its economic structure is characterised by a large manufacturing sector and firms focusing on incremental innovation may account for this. Another key factor influencing the scaling-up rate of smaller firms is access to finance, in particular risk capital (see Section 3.2.3). More support for innovative firms in high-tech sectors, such as ICT, could provide growth opportunities (OECD, 2018c).

[3.5. Environmental Sustainability, p. 50]

(…) Austria is already strong in some eco-tech industries, such as water management and waste treatment, which is reflected in SDG 6. Investing in the eco-tech sector, green skills and eco-innovation could bring further positive economic and employment effects. It could help Austria achieve its climate and environmental goals while helping firms compete on the world market.

[3.5. Environmental Sustainability, 3.5.4. Just transition to a climate-neutral economy, p. 52]

Overall, Austria is not yet accessing the socio-economic benefits that a forceful ecological transition and low-carbon pathway offers. Austria's lead in environment-related innovation has narrowed in recent years. Consistent and generally higher pricing of carbon emissions would boost environment-related innovation (OECD, 2019a, p. 46).

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Austria, p. 66]

(…) In order to tackle these transition challenges, investment needs have been identified for supporting innovation for reducing greenhouse gas emissions, developing alternative economic activities and cushioning related employment shifts. Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in the creation of new firms, including through business incubators and consulting services;
- investments in research and innovation activities and fostering the transfer of advanced technologies;

- investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- investments in enhancing the circular economy, including through waste prevention, reduction, resource efficiency, reuse, repair and recycling;
- upskilling and reskilling of workers.

The smart specialisation strategies of Styria and Upper Austria[10] provide an important framework to set priorities for innovation in support of economic transformation when implementing Just Transition Fund investments.

2. BELGIUM

2.1. Executive summary

- **(…) Administrative burden, weak policy coordination and highly concentrated innovation are weighing on investment and productivity growth.** Belgium performs well in innovation, but the efficiency of the high level of public support for business R&D is not proven, as overall investment is high but remains concentrated in a limited number of large firms. The gap between the best and the least performing firms is widening, which might signal an insufficient diffusion of technological advances. (…)

2.2. Research and Innovation

There is room to further improve the already well performing Belgian R&I system. In the 2019 European Innovation Scoreboard, Belgium is part of the group of 'strong innovators' in 6th place in the EU. Belgium has a very attractive research system with a strong science base and strong universities [see Section 3.3]. R&D expenditure in the private sector is relatively high, although mainly concentrated in a few multinational companies. On the other hand, at 0.7% of GDP the level of business R&D performed by SME's is among the highest in EU. SMEs are strong innovators and have strong linkages with their partners according to the EU innovation scoreboard. Enterprises providing ICT training are also amply represented. Belgium R&D intensity increased remarkably from 1.9% in 2007 to 2.8% in 2018, mostly thanks a growth in business R&D intensity (from 1.3% to 2.0%). However, non R&D innovation expenditures are relatively low. The public R&D intensity increased too (from 0.54% in 2007 to 0.8% in 2018), but remains slightly below that of most other Member States with a similar level of economic development.

The efficiency of government support for business R&D could be improved. Belgium has the second highest level of government support for business R&D among OECD countries. Direct government funding of R&D is close to OECD average, while indirect R&D support through tax incentives is especially large. Recent analyses by

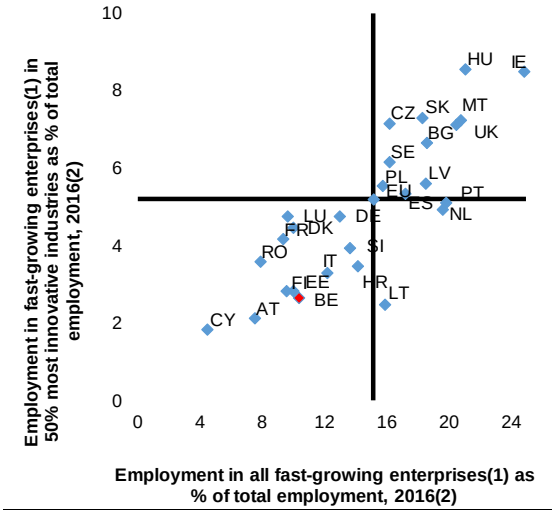
[10] As defined in Article 2(3) of Regulation (EU) No 1303/2013 (CPR)

Dumont (2019), the OECD (2019b) and the Belgian Court of Auditors (2019a) show that the efficiency of public R&D schemes could be improved. The OECD points in particular to the fact that these schemes do not demonstrate strong 'additionality', in terms of extra R&D expenditure expected to translate in net job creation, new investment and innovation. Digitalisation of the economy was also identified in the National Pact for Strategic Investment as one of the priority avenues for boosting productivity and innovation.

Improving R&D governance by increased coordination and systematic assessment of policies remain a challenge for the system (Cincera, M. & Kelchtermans, S., 2020)**.** The R&I governance system in Belgium is rather complicated with multiple governments at federal, regional and community level responsible for (parts of) R&I policy. This multi-level governance of the Belgian system creates specific challenges (Boekholt, P. et al., 2011) such as the risk of sub-optimal scale of public-private investments that may create disincentives for structural co-operation between the leading research performers and businesses at an inter-regional level. Co-operation and coordination mechanisms for international issues exist mainly at operational level, while co-operation and coordination on national issues is more sporadic.

Belgium's weaknesses in terms of entrepreneurship and company dynamics do not allow it to draw maximum economic benefit from the strength of its R&I system. The renewal of the Belgian company population is slower than in peer countries. With only 2.8% of people employed in fast-growing innovative enterprises in 2016, Belgium is well under the EU average of 5.2% and ranks 25th in the EU for this indicator. Moreover employment in all fast-growing enterprises as a share of total employment in 2015 was 10.2% compared to 15.2% for the EU28 (see Graph 3.4.6).

Graph 3.4.6: **Employment in fast-growing enterprises in 50% most innovative industries and employment in all fast-growing enterprises, both as % of total employment, 2016**



Source: European Commission

2.3. Additional R&I references

[Box 2.1: EU Funds And Programmes to Address Structural Challenges and to Foster Growth and Competitiveness in Belgium, p18]

(…) **EU Cohesion policy funding is contributing to major transformations of the Belgian economy** by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility. By 2019, investments driven by EU Funds have already led to 165 new research projects supported to market products.

[Education and training, p.42]

(…) There is scope for improving equity, effectiveness and efficiency in higher education. Belgian universities (11 out of 12) perform strongly on research, knowledge transfer, international orientation and regional engagement (U-Multirank, 2019).

[Box 3.4.5: Investment challenges and reforms in Belgium, p57]

(…) The EU supports investment in Belgium also via the European Fund for Strategic Investments (EFSI). By October 2019 total financing under the EFSI amounted to EUR 1.6 billion, intended to trigger EUR 8.4 billions in additional investments. By the end of 2020, EFSI and other EU financial instruments will come under the roof of the new InvestEU programme that promotes a more coherent approach to financing EU policy objectives and increases the choice of policy implementation options and implementing partners to tackle country specific market failures and investment gaps. In addition, under InvestEU, Member States can set-up a national compartment by allocating up to 5% of their structural funds to underpin additional guarantee instruments supporting the financing of investments with a higher level of local specificities. InvestEU will be policy-driven and focus on four main areas, all relevant for Belgium: Sustainable Infrastructure, Research, Innovation, and Digitisation, Small Businesses, and Social Investment and Skills. Reflecting the federal structure of Belgium, promotional banks and agencies have been set up at federal(1) and regional (2) levels to support private sector initiatives and implement specific sectoral policies, through a range of loan and guarantee products using both own resources as well as EU financial instruments. The Flemish region's promotional institution, PMV, has shown interest in becoming an implementing partner for InvestEU.

[2019 Country-Specific recommendations (CSRs)**,** p76 and 78**]**

CSR 3: Focus investment-related economic policy on sustainable transport, including upgrading rail infrastructure, the low carbon and energy transition and research and innovation, in particular in	Belgium has made **Limited** progress in addressing country-specific recommendation: (…) **Limited Progress.** Limited progress has been made on research and innovation, in

digitalisation, taking into account regional disparities. Tackle the growing mobility challenges, by reinforcing incentives and removing barriers to increase the supply and demand of collective and low emission transport.	particular on digitalisation, taking into account regional disparities. Research and development (R&d) expenditures in the private sector is relatively high, although it is concentrated in a few multinational companies. Despite an increase in public R&D intensity from 2007 to 2018, it remains below the increase in public R&D intensity in most Member Sates with a similar level of economic development. The R&D investment could be more widespread towards smaller firms. The efficiency of the R&D public schemes could be improved as these schemes are not based on 'additionality' principle, in terms of net job creation, new investment or extra earnings from innovation. The R&D governance system is complicated with multiple governments at federal, regional and community level responsible for (parts) of research and innovation (R&I) policy. Cooperation and coordination exist mainly at operational level regarding national issues. The shortage of highly skilled professionals, in particular in sciences, engineering and math, and the lack of "knowledge entrepreneur" hampers Belgian growth prospects. Finally, regions are conducting R&D programmes to support the low-carbon transition. In temrs of digitalisation, a policy framework with financing measures for promoting the uptake and deployment of Artificial Intelligence have been put in place in Flanders and Wallonia and a similar initiative was put in place in Flanders with regard to cybersecurity. Coordinated efforts between the federal level, the Regions and the Communities are needed to roll out 5G and Belgium risks lagging behind in 5G deployment.

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[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Belgium, p.90]

(…) In order to tackle the transition challenges, investment needs have been identified for alleviating the socio-economic costs of the transition, through actions targeting in particular:

- investments in research and innovation activities and fostering the transfer of advanced technologies;
- investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;

3. BULGARIA

3.1. Executive summary

There has been **limited progress** in: (…)

- focusing investment-related economic policy on research and innovation, (…) taking into account regional disparities;

Regarding the national targets under the Europe 2020 strategy (…), there was no progress towards the R&D intensity target.

The potential for research and innovation to support productivity remains underutilised. The low level of public and business investment, the inefficient and fragmented research system and weak science-business links remain key obstacles to an innovation-oriented economy.

3.2. Research and Innovation

Bulgaria's research and innovation (R&I) system faces a number of structural shortcomings. In particular, these include low levels of public and private R&I investment, fragmentation of the public science base, lack and ageing of skilled human resources, weak science-business links and inefficient governance. All these deficiencies are holding back the potential contribution of R&I to productivity and economic growth and will strongly limit the capacity for upwards convergence in the midterm. Addressing these bottlenecks would help Bulgaria in making progress towards achieving SDG 9 'Industry, innovation and infrastructure'. Currently, Bulgaria is among the worst performers ('modest' innovator) in the European Innovation Scoreboard ([11]), with an overall level still below 50% of the EU average.

[11] European Commission, Innovation Scoreboard 2019, https://ec.europa.eu/growth/industry/innovation/facts-figures/scoreboards_en

R&D spending remains very low both in the public and in private sectors. R&D intensity is very low: 0.75% of GDP in 2018, far below the national target of 1.5% (see Graph 4.4.7). The extremely low public R&D intensity (0.21% of GDP in 2018) is particularly concerning, also given that it has been on a mostly decreasing trajectory since 2000. This hinders the required capacity building, as research infrastructure is outdated and low wages act as deterrents to attracting and retaining young talent. Business R&D intensity (0.54% of GDP in 2018) is on a decreasing path as well. Investment in research remains fragmented and concentrated in the capital region and multinational companies.

Bulgaria announced its intention to gradually increase public R&D spending. By 2025 it should reach to 1% of GDP. The authorities also announced a doubling of the budget for research programmes to support the strategy for development of scientific research 2017-2030. In addition, the government has approved 11 national scientific programmes for 2018-2022, with a budget of more than €30 million. On the other hand, the Smart Growth Council that was set up in 2015 to provide independent, robust and coordinated management of national and EU funding is under-utilised.

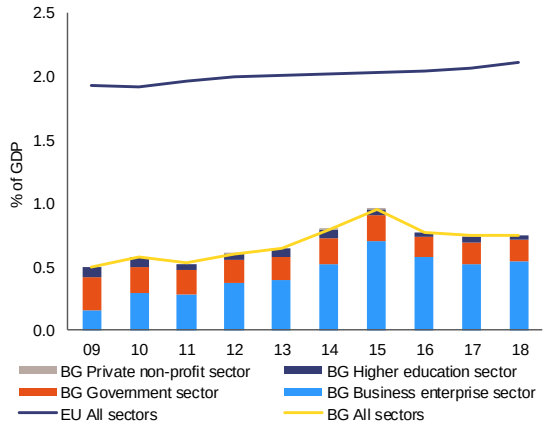
High fragmentation of the research and higher education system is a key obstacle to improving its performance. The small public research budget is distributed over a large number of universities and research institutes ([12]). This situation exacerbates the consequences of the very low public R&D expenditure: the quality of the Bulgarian science base (measured by the share of highly cited scientific publications in all national publications) is the lowest among all EU countries ([13]). Bulgaria has introduced an update of the Research Performance Assessment procedure ([14]), but the structural reform of the research landscape that was essential to tackle its fragmentation and increase performance has not been carried out. The proposed creation of a state Agency for Innovations and Applied Research to ensure stronger governance and ownership of the R&I policies could lead to positive developments.

[12] 51 Universities (state and private financing), 42 Institutes of the Bulgarian Academy of Sciences (BAS), 17 Institutes of the Agrarian Academy (AA).

[13] In 2016, 3.1% of Bulgarian publications were highly cited, compared to the EU average of 10.3%.

[14] Horizon 2020 PSF Specific Support to Bulgaria Expert Panel conclusions: https://rio.jrc.ec.europa.eu/en/policy-support-facility/specific-support-bulgaria.

Graph 4.4.7: **Intramural R&D expenditure by sectors of performance**



Source: European Commission

Links between academia and businesses are still insufficiently developed to support knowledge and technology transfer. This is also reflected in the low share of public-private scientific co-publications. Several relevant initiatives to promote innovation, knowledge transfer and science-business links are slowly progressing, supported by the ESIF. The future regional innovation centres, as well as the Centres for Competence and Centres of Excellence, will serve as a link between science and business and local/national authorities ([15]). Participation of Bulgarian scientists and innovation entrepreneurs in European programmes, as well as synergies between national and operational programmes and other Commission programmes such as Horizon 2020, are limited.

3.3. Additional R&I references

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

There has been limited progress with (…) focusing investment-related economic policy on research and innovation (…)

[Box 2.1: EU funds and programmes to address the structural challenges and to foster growth and competitiveness in Bulgaria, p. 19]

EU Cohesion policy funding is contributing to important transformations of the Bulgarian economy by investing, among other things, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, education, employment and social inclusion.

[15] 14 Centres of Excellence (CoE) and Centres of Competence (CoC) financed by OP 'Science and Education for Smart Growth' 2014-2020.

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Bulgaria, p. 80]

In order to tackle these transition challenges, high priority investment needs have been identified for diversifying and making the regional economy more modern and competitive, as well as alleviating the socio-economic costs of transition. Key actions of the Just Transition Fund could target in particular: (…)

- investment in research and innovation activities and fostering transfer of advanced technologies;

4. CROATIA

4.1. Executive summary

After contracting significantly during the recession, investment in Croatia has been recovering over the last five years. The recovery was due to the uptake of EU funds, while residual private and public investment remains low. Nonetheless, the investment rate remained slightly below that of its peer countries and below the EU average. Investment is expected to rise over the next few years. Identifying investment needs in green technologies and sustainable solutions, and securing adequate funding will be crucial if Croatia is to meet its climate and energy objectives and shape a new growth model. Croatia has also investment needs in transport. Investing more in skills, research and innovation would boost Croatia's comparatively low productivity.

Croatia has made limited progress in addressing the 2019 country-specific recommendations.

(…) There has been limited progress in the following areas:

- Investment in R&D has increased substantially, but its efficiency remains low. Energy efficiency and investment in renewable energy are hampered by administrative and legislative hurdles.

(…) Croatia is within reach of achieving its target on tertiary education attainment. The country is still below its target for investment in research and development.

4.2. Research and Innovation

Investment in R&D increased substantially, but largely thanks to ESIF funds, while efficiency of spending is low. In 2018, overall investment in R&D jumped to 0.97% of GDP, up from 0.86% in 2017. Public expenditure on R&D rose to 0.51% of GDP, while business investment expenditure increased to 0.47% of GDP. Stronger public investment on fundamental R&D would play a key role in boosting the innovation system.

The research and innovation system produces scientific output of modest quality and struggles to attract talent. The legal autonomy enjoyed by university faculties can

lead to low cooperation across universities (both within and outside the country, as well as with the business sector) and hinder interdisciplinary research. Croatia stands out compared to other countries in terms of its overproduction of low-quality publications, as measured by the number of uncited publications per full-time equivalent R&D personnel, where Croatia scores highest in Europe (World Bank 2019c). A draft law on science and higher education in Croatia aims to reform the system by introducing measures to recognise and reward research excellence: an efficient promotion system for researchers, tenure track employment for young scientists and higher salaries for project work, and rewards for international cooperation. The draft law would bring in a new system of university governance, expand performance-based funding to include science-business cooperation as an assessment criterion and spell out guidelines for research ethics. If adopted and properly implemented, this law has the potential to kick-start a modernisation process of the Croatian research and innovation system.

Croatian companies are concentrated in low to medium-tech sectors, and government support to R&D-based innovative firms is lacking. According to the European Innovation Scoreboard, Croatia is a moderate innovator. Croatia's best scores are on non-R&D innovation and its weakest points are in knowledge-intensive service exports and venture capital expenditure. Companies are concentrated in low and medium-tech sectors, notably in trade and tourism, which affects the current low level of investment in R&D. The structure of the economy has remained broadly unchanged over the past 15 years, with no shift towards more knowledge-intensive sectors (European Commission 2018b). State-owned enterprises, which contribute around one fifth of the national economy turnover, lack incentives for competition through innovation and research (Račić, et al., 2020). Croatian firms, especially smaller and younger companies, indicate a positive link between R&D-based innovation and productivity growth. Nonetheless, government support programmes are heavily skewed towards helping mature and larger companies, with less support given to diversification and new ventures (World Bank 2019c). In addition, many support programmes are overcomplicated and poorly adapted to business needs.

Croatia is unlocking its innovation potential and performance through smart specialisation. Through its Smart Specialisation Strategy, Croatia aims to overcome the fragmentation of the innovation system to boost productivity and innovation. An inter-ministerial National Innovation Council and Thematic Innovation Councils have been set-up to oversee its implementation. These initiatives are showing signs of improvement in the governance and coordination of innovation policies. However, their impact will depend on whether these Councils will be used as platforms for regular, structured discussions on innovation policy under the Smart Specialisation Strategy.

4.3. Additional R&I references

[1. Economic situation and outlook p.8]

Sustainable Development Goals

Over the past five years, Croatia performed well in most areas covered by the United Nations Sustainable Development Goals (SDGs). (…) Moderate progress was achieved in areas such as good health and well-being (SDG 3), quality education (SDG 4), affordable and clean energy (SDG 7), and industry, innovation and infrastructure (SDG 9).

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Croatia, p. 18]

(…) EU Cohesion policy funding is contributing to major transformations of the Croatian economy. It promotes growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable development (energy, environment and transport), employment and labour mobility. By 2019, investments driven by EU Funds have already supported 933 new enterprises as well as co-financed equipping 151 schools with IT equipment in order to increase skills of the students.

[4.2.1. Financial Sector, Access to Finance, p. 29]

Several EU funding programmes have been put in place to boost funding to companies with a high growth potential. Support from European Structural and Investment Funds (ESIF), and in particular the European Regional Development Fund (ERDF), helped fund over €1 billion of investment since 2014. Nearly half that amount was made up of favourable loans and guarantees, promoted by The Croatian Agency for SMEs, Innovation and Investment (HAMAG-BICRO). ESIF loans for growth and development targeting SMEs operating for at least two years took the lion's share of funding. The Croatian Venture Capital Initiative was established in June 2018 to kick-start risk capital investments in start-ups. It has raised €12.2 million of private-sector funding, on top of the original €35 million injection from the European Investment Fund (EIF) ([16]). In January 2019, the EIF and the Croatian Bank for Reconstruction and Development launched the Croatian growth investment programme, a €70 million co-investment programme to support fast-growing SMEs. In July 2019, a grant scheme targeting innovative SMEs ('Innovations in S3 areas') was launched with funding of €85 million.

[4.4. Competitiveness reforms and investment p.45]

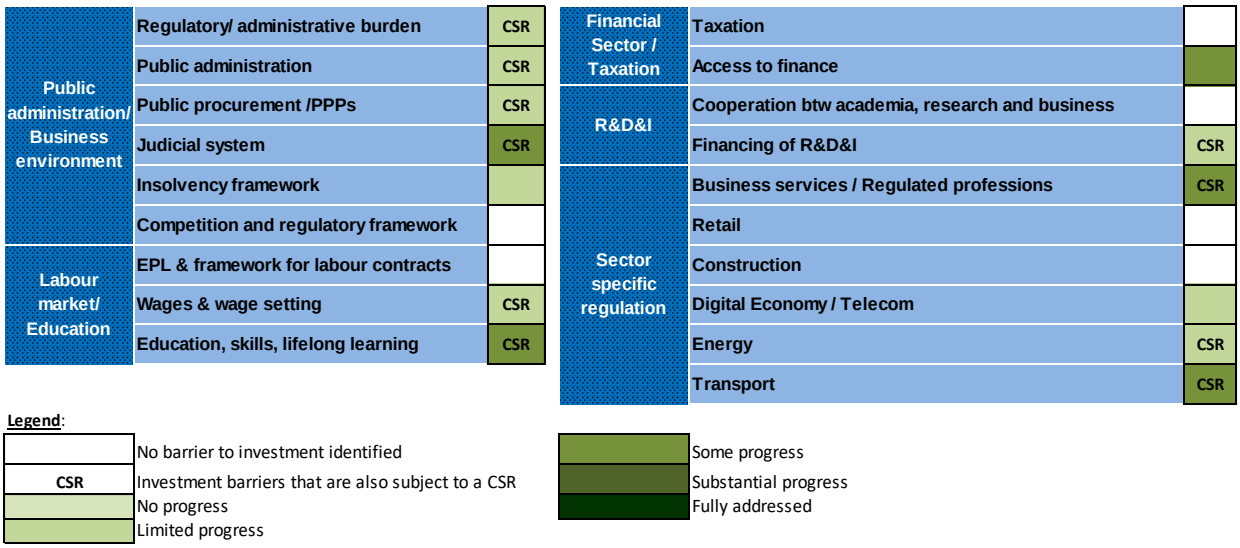
Skills shortages, low R&D investment, rigidities in the business environment and weaknesses in public administration are key drivers of Croatia's productivity gap. Employers find it increasingly difficult to find employees with the right skills, while low activity rates and low participation of the workforce in lifelong learning hamper

[16] As of September 2019, 24 start-ups have already secured an investment of €50,000, on top of the 9 venture capital investments of over €3.75 million over late summer 2019. Of these, 17 aim to bring start-ups to Croatia.

skill activation (CEDEFOP, 2018). At 0.5% of GDP, business R&D expenditure is among the lowest in the EU. Croatia is among the worst performers in the EU on several aspects of the business environment, including starting a business, paying taxes and dealing with construction permits. As a result, business dynamism is also below the EU average. Significant weaknesses remain in several aspects of the public administration and governance framework, including the burden of government regulation and the perceived quality of public services.

[Box 4.4.5: Investment challenges and reforms in Croatia, p. 48]

Section 2. Assessment of barriers to investment and ongoing reforms



(…) By the end of 2020, EFSI and other EU financial instruments will come under the roof of the new InvestEU programme that promotes a more coherent approach to financing EU policy objectives and increases the choice of policy implementation options and implementing partners to tackle country specific market failures and investment gaps. In addition, under InvestEU, Member States can set-up a national compartment by allocating up to 5% of their structural funds to underpin additional guarantee instruments supporting the financing of investments with a higher level of local specificities. InvestEU will be policy-driven and focus on: Sustainable Infrastructure, Research, Innovation, and Digitisation, Small Businesses, and Social Investment and Skills.

[Annex A: Overview table, p. 58]

CSR 3: Focus investment-related economic policy on research and innovation, sustainable urban and railway transport, energy efficiency, renewables and environmental infrastructure, taking into account regional disparities. Increase the administration's capacity to design and implement public projects and policies.	Croatia has made **limited progress** in addressing CSR 3.
Focus investment-related economic policy on research and innovation,	**Limited progress.** Investment in R&D increased substantially, but its efficiency remains low and highly dependent on EU funds. Investment is focused towards 'close–to-market' initiatives run by bigger companies, leaving research activities underfunded.

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Croatia, p. 69]

(…) Investment needs have been identified to tackle these challenges, while alleviating the socio-economic costs of transition and improving environmental sustainability and resource efficiency. Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in research and innovation activities and fostering transfer of advanced technologies.

5. CYPRUS

5.1. Executive summary

The long-term sustainability of the growth model of Cyprus is put at risk by rising external uncertainties and pending structural reforms. (…) More generally, investment lags behind in areas that could strengthen Cyprus' economic structure and increase its potential growth, such as digital transformation, R&D, renewable sources of energy, sustainable transport and the circular economy. (…)

Overall, Cyprus has made limited ([17]) progress in addressing the 2019 country-specific recommendations (…) in improving R&D

Cyprus has made some progress in reaching its national targets under the Europe 2020 strategy. It met its targets for R&D spending (…).

5.2. Research and Innovation

While Cyprus benefits from a highly educated population, its R&D system remains very small, and its role in economic development is limited. In 2018, 57.1% of the population aged 30-34 had a tertiary education. However, only a small percentage of these graduates have degrees linked to technological innovation. Cyprus is among the lowest performers in the EU in terms of science and engineering graduates. The R&D intensity increased progressively from 0.21% in 2000 to 0.5% of GDP in 2018, but is among the lowest in the EU. Both public and private R&D intensities remain well below the EU average. ([18])

The quality of the public research system is a point of strength, but its interaction with the business sector is very limited. Despite being founded recently (in 1992), public universities and research centres in Cyprus, achieve relatively good scientific performance. ([19]) However, university-business cooperation is very weak, due to both low demand from the business side and a lack of entrepreneurial culture in the academic sector. As a result, the commercialisation of research results remains at a low level (Demetriades et al., 2020). ([20])

Even though the volume of research and innovation (R&I) activities remains limited, several sectors increased investments. The business landscape in Cyprus is not conducive to a high level of research and innovation activities. 95% of the business population are micro companies — mainly risk-averse, family-run businesses without

([17]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a country-specific recommendation is presented in the overview table in Annex A.

([18]) In 2018, public R&D intensity was 0.28%, the fourth lowest in the EU (average of 0.69%), of which 0.23% comes from tertiary education (EU average of 0.46% of GDP). The R&D expenditure in the business sector was the second lowest in the EU, at 0.20% of GDP in 2018, compared an EU average of 1.41% in 2018.

([19]) In 2018, about 69% of the total number of publications were international co-publications (among the top ranking in the EU) and in 2016 9% of Cyprus' publications were among the top 10% worldwide most cited scientific publications, (Centre for Science and Technology Studies, 2019).

([20]) Incentives have been adopted recently to stimulate academia-business cooperation**.** Following the adoption of the law allowing universities to create spin-offs in 2018, an expert panel appointed by the Horizon 2020 Policy Support Facility provided recommendations in December 2019 on how to stimulate the use of public laboratories by businesses.

professional management and innovation capacity. ([21]) However, despite these structural features, investments in the pharmaceutical and software publishing sectors have led to a significant increase in business R&D expenditure since 2016 (Business R&D expenditure as a percentage of GDP increased from 0.11% in 2015 to 0.20% in 2018).

A new R&I Strategy Framework for the period 2019-23 has been announced by the National Board for Research and Innovation in May 2019, with ambitious yet uncertain outcomes. Key enablers of this strategy framework include a new integrated governance system, in particular the establishment of a Deputy Ministry for Research, Innovation and Digital Policy, and a focus on knowledge transfer and commercial exploitation to stimulate R&I activity in the private sector. One of the planned measures is the creation of clusters of excellence, gathering universities and businesses in the areas of environment/climate, agrotech, maritime, health and ICT, in line with the national Smart Specialisation Strategy, which should be updated to reflect the recent changes at national level and new priorities at EU level. Several measures have been announced, most of them to be implemented with existing financial resources. Consequently, it is not clear whether a key deliverable of the strategy, the target of tripling the national R&D intensity to 1.5% by 2023 (with half of the expenditure expected from the private sector) can be achieved.

Despite efforts, the implementation of the Smart Specialisation Strategy to boost innovation performance continue to face several challenges. Cyprus mobilised a wide range of public and private innovation actors. Reinforcing the bottom-up dimension of the process by involving local innovation stakeholders, boosting the matching of academia with businesses and putting in place a monitoring and evaluation mechanism remain important to help diversify the economy and increase competitiveness. The establishment of the Deputy Ministry of Innovation and Digital Policy is expected to facilitate the implementation of the strategy.

5.3. Additional R&I references

[2. Progress with country specific recommendations. p. 16]

Measures to promote sustainable transport are only at an initial stage. (…) Some progress was recorded on research and innovation as the new strategy is in place and efforts to bring universities and businesses together are moving ahead.

[Box 2.2: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Cyprus, p. 20]

([21]) According to the 2018 Global Competitiveness Report (World Economic Forum, 2018), Cyprus is ranked 101st on the reliance of companies with regard to professional management. In terms of the attitudes towards entrepreneurial risk, it is ranked 40th, while it is ranked 78th regarding the embracing of disruptive ideas**.**

While achieving more harmonious development through reducing economic, social and territorial disparities, EU cohesion funding also plays a significant role in addressing structural challenges in Cyprus. The cohesion policy programmes for Cyprus have allocated €188 million for smart growth (including support to research & innovation and to small and medium-sized enterprises) (…).

[3. Summary of the main findings from the MIP in-debth review. p. 24]

Some policies are in place to improve the business environment and competitiveness, but implementation needs to be stepped up. Most of the progress made concerns e-governance and strengthening entrepreneurship, by also addressing issues related to the internationalisation of small and medium-sized enterprises. (…) Furthermore, regarding digitalisation, a new deputy ministry is expected to be established, which will be responsible for the implementation of a digital transformation strategy and R&D policy (…).

[4. Competitiveness, reforms and investment. Investment, p. 52]

Public investment has recovered since the crisis. (…) In coming years, more projects related to renewable sources of energy, and natural gas, waste management and R&D are planned, which could boost potential growth and address environmental challenges.

Long-standing needs for investment in environment, energy, digitalisation and innovation remain unaddressed, and could impede Cyprus' growth potential in the future. (…) Despite a progressive increase since 2000, research and innovation intensity remains among the lowest in the EU. (…)

[ANNEX A. Overview table. p. 71]

Europe 2020 (national targets and progress)	
R&D target: 0.5% of GDP	0.55% in 2018 almost unchanged from 2017 and exceeding the target.
CSR 4: Focus investment-related economic policy on sustainable transport, environment, in particular waste and water management, energy efficiency and	Cyprus has made **limited progress ([22])** in addressing CSR 4.

([22]) The assessment of the investment CSR 4 does not take into account the contribution of the EU 2021-2027 cohesion policy funds as the Regulatory framework underpinning the programming of the 2021-2027 EU cohesion policy funds, has not yet been adopted by the co-legislator, pending inter alia an agreement on the Multiannual Financial Framework.

renewable energy, digitalisation, including digital skills, and research and innovation, taking into account territorial disparities within Cyprus. Adopt legislation to simplify the procedures for strategic investors to obtain necessary permits and licences. Improve access to finance for SMEs, and resume the implementation of privatisation projects.	
and research and innovation, taking into account territorial disparities within Cyprus.	**Some progress** has been made as the new national research and innovation strategy for 2019-2023 has entered into force. The law allowing universities to create spin-offs was adopted as well as measures to stimulate academia-business cooperation.

[ANNEX D. Investment guidance on just transition fund 2021-2027 for Cyprus. p. 80]

(…) Based on this preliminary assessment, it appears warranted that the Just Transition Fund concentrates its intervention on these two areas. To make such transition effective, investment needs have therefore been identified for diversifying, greening and making the economy more modern and competitive and for alleviating the socio-economic costs of the transition. Key actions of the Just Transition Fund could target in particular investment in:

- (…) research and innovation activities fostering the transfer of advanced technologies;

6. CZECHIA

6.1. Executive summary

Czechia's ability to diversify its economy will be crucial for maintaining a solid catch-up in living standards. The industry-intensive economy, underpinned by trade openness and foreign investment has allowed Czechia to steadily catch up with the rest of the EU. However, this growth model may have reached its limits. The direction of the economy will depend on its capacity to diversify and increase productivity and the value added of its products and services, while remaining an attractive destination for investment. Future growth also depends on Czechia's ability to face the challenges associated with population ageing, technological change and ensuring environmental sustainability. Factors such as: (i) the low investment in sustainable transport and in the transition to low-carbon energy sources; (ii) a moderate performance in domestic

research and innovation; and (iii) acute labour and skill shortages, are a major structural obstacle to a successful socio-economic transition. Implementing these structural reforms would help Czechia achieve further growth in living standards and ensure a sustainable development.

Domestic innovation is important for supporting a sustainable economic growth model. Czechia remains a moderate innovator at EU level, despite some progress in recent years. Public investment is not underpinned by systemic reforms to improve research performance and cooperation between the private sector and academia. On the back of an insufficient number of graduates in science, engineering and computing as well as skills shortages, the innovation performance of domestic firms and the technology transfer remain rather low.

Support for innovative domestic firms remains limited. The promotion and support of entrepreneurship remains low, hampering productivity growth. Foreign investment has been a major contributor to the country's growth but spillovers to the domestic firms have been limited. Czech firms are highly integrated in global and regional value chains but their main focus is still on low value added activities, particularly in manufacturing. While some successful innovative initiatives were brought to market, venture capital and equity capital remain very low. There are plans to increase financial support to innovative firms, particularly those delivering higher value added products and services. Improving the insolvency framework could also enhance economic efficiency.

6.2. Research and Innovation

Home-grown innovation is crucial for supporting sustainable economic growth. Czechia remains a moderate innovator according to 2019 European Innovation Scoreboard (14th in the EU) but its performance has been gradually increasing. Business R&D intensity increased from 0.77 % of GDP in 2010 to 1.19% in 2018 (EU average 1.41%). A significant gap exists between the innovation performance of domestic firms and that of the large foreign-owned ones with a higher R&D spending (see 2018 country report). This gap could be narrowed through higher engagement of domestic enterprises in research and innovation in order to move up in the value chains.

Low returns, fragmentation, moderate scientific quality and low internationalisation lead to a modest performance. The total R&D expenditure has grown steadily since 2010, reaching 1.93% of GDP in 2018, slightly below the EU average of 2.11%. Public R&D expenditure also rose from 0.56% in 2010 to 0.73% in 2018, still below the 2020 target of 1% of GDP. Despite the substantial increase in public R&D funding, the quality of scientific outputs (top 10% most cited scientific publications at 5.1% in 2016) remains modest at around half the EU average. Although the research system is more internationalised (as measured by international co-publications, at 46.5% in 2018), Czechia still ranks low at the EU level. In addition, the high fragmentation of the public research sector results in R&D funding being thinly spread. Addressing these challenges would lead to further progress on reaching SDG 9.

Public R&D expenditure is not supported by systemic and comprehensive reforms. Although some measures have been adopted, and expenditure is increasing, it is still too early to assess their impact. The on-going Metodika 17+ reform is yet to be fully implemented by research organisations and higher education institutions (a comprehensive rollout is expected in 2020).

Links between academia and business are insufficient to support knowledge and technology transfer. A low degree of public-private scientific co-publications (2.9% compared to an EU average of 5.5%) suggests a weak public-private cooperation. Regulatory barriers persist for spin-off creation and cooperation is often informal. In the public sector, researchers' careers largely depend on their publications track record, discouraging them to work with the industry. Still, there are signs that knowledge flows may be improving, notably via increased researchers' mobility. The number of scientists in full time employment in the private sector has steadily increased to 3.9% in 2017 from 2.4% in 2010.

The effectiveness of the institutional governance of research and innovation policy remains limited. Competence for research and innovation policy is shared between different authorities without an adequate coordination mechanism or synergies. A leading central institution with a cross-cutting coordination and practical overview role is lacking. Consequently, the decision-making bodies mostly work in silos. While research and innovation policy is supported by several strategies, these strategies lack coherence and coordination, leading to potential overlaps, uncertainties and lack of ownership by different entities. The Innovation Strategy 2019-2030, adopted in January 2019, supported by the majority of stakeholders, aims to move the country up the value chain and help it become an innovation leader by 2030. However, it remains to be seen how effective the shared ownership and implementation of the separate pillars of the strategy will be. The effectiveness of the strategy will depend on the successful implementation of the action plans prepared by the authorities.

Innovation is hampered by insufficient numbers of graduates in science, technology, engineering and mathematics. The share of tertiary educated people aged 25-34 has doubled since 2007 but at 33.3% in 2018, Czechia still ranks low at the EU level. The shortage of skilled labour is due to a lower number of graduates but also because of a mismatch in the fields of study (TACR, 2019). Figures for graduates in science and engineering (11.9%) and computing (2.8%) indicate a slight deceleration in these areas in 2017 ([23]). The lack of ICT specialists on the market can significantly hamper digital transformation of companies. Updating the curricula is a lengthy process and there seems to be a lack of proper understanding of what industry requires and consequently what gets included in the study programmes. The quality and relevance of graduates' training may therefore not fully reflect market demands, with detrimental effects in medium and high-tech industry.

[23] Negative growth rates between 2013 and 2017 – science and engineering -1.5% and computing -2.5%.

Innovation performance varies considerably between the regions. The country harbours a few pockets of scientific and technological excellence. By hosting the majority of R&D stakeholders, Prague has a privileged position and is the only strong innovator region in Czechia. While a couple of the regions also start to emerge, others lag behind. For instance, Jihomoravský region has been very successful in knowledge transfer (over 20 spin-offs created) but also in tying businesses and academia together, principally through the work of South Moravian Innovation Centre. Czechia, being a country involved in widening participation, has the opportunity to coordinate activities financed under Horizon 2020 ([24]). Such projects that potentially lead to knowledge transfer enable cooperation with international and business partners and stimulate synergies between national, private and other EU funds. These projects to create centres of excellence will receive funding for up to 7 years after which the question of sustainability may arise.

6.3. Additional R&I references

[2. Progress with country-specific recommendations; Box 2.1: EU Funds and programmes to address structural challenges and to foster growth and competitiveness in Czechia, p.16]

While reducing economic, social and territorial disparities to ensure a more even economic development, EU Cohesion Policy funding is helping to transform the Czech economy. European Regional Development Fund (ERDF) and Cohesion Fund (CF) projects promote growth and employment through investments in research, technological development and innovation, competitiveness of business, sustainable transport, employment and labour mobility. (...)

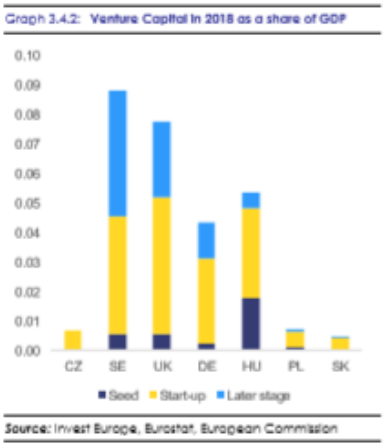
[3.4. Competitiveness, reforms and investment; Productivity, p.31]

Innovation-driven high-growth enterprises are key to economic development and industrial renewal (...)

[3.4. Competitiveness, reforms and investment; Productivity, p.32]

Venture capital remains very low. Czechia ranks among the countries with the lowest funds raised through venture capital (see Graph 3.4.2). Funding is mostly concentrated in start-ups and almost nonexistent in the seed and later development stages, especially for high-risk projects. (...)

[24] E.g. ongoing projects such as RICAIP and CETOCOEN.



[3.4. Competitiveness, reforms and investment; Productivity, Box 3.4.3: The National Development Fund, p.33]

Investments under the Fund will be linked to the National Investment Plan unveiled in December 2019. (...) Education, research and innovation and digitalisation account for only around 2%. Projects under the Fund will also take into account the priorities of the National Innovation Strategy, the Strategy for a Digital Czechia and other documents that will be part of the country's new economic strategy.

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

Funding for innovative enterprises remains limited. Various public financial resources are distributed through individual entities, mostly in the form of direct support incentives, particularly grants and matching grants (Květoň and Benedetti-Fasil, 2020). Without other types of financial instruments or a vibrant entrepreneurial and financial ecosystem, innovation continues to be hampered. Authorities introduced an amendment to the Investment Incentives Act in 2019. The aim is to provide further financial support to innovative enterprises that draw more from R&D and, in particular, to projects with higher value added. Additionally, the Tax Incentives Act amended in 2019 is supposed to address some of the shortcomings of the R&D tax incentives scheme and to boost the uptake of R&D tax breaks for innovative enterprises.

[3.4. Competitiveness, reforms and investment; Productivity, p.34]

The EU supports investment in Czechia also through the European Fund for Strategic Investments (EFSI). By December 2019, total financing under EFSI amounted to €874 million, intended to trigger €4.7 billion in additional investments. €254 million went to infrastructure and innovation projects, whereas €621 million was allocated to financing SMEs. (...) InvestEU will be policy-driven and focus on four main areas: sustainable infrastructure, research, innovation, and digitisation, small businesses, and social investment and skills. (...)

[3.4. Competitiveness, reforms and investment, Box 3.4.4: Automation and Artificial Intelligence in Czechia, p.37/38]

Automation and artificial intelligence (AI) have become major policy priorities for the Czech government. To jump on board with 'the fourth industrial revolution', the Czech authorities have launched various national strategies on AI, innovation and digitalisation. (...) Public funding for research and development in AI (around €10 million in 2017) is below EU average.

(…) **There have been encouraging developments in the research and innovation of AI, mostly in Prague and Brno.** The AI Center (AIC) and the Institute of Informatics, Robotics and Cybernetics (CIIRC), both attached to the Czech Technical University in Prague, conduct state-of-the-art research and aim to transform Prague into a global AI hub. Similarly, Brno has established itself as a well-functioning regional innovation ecosystem with various centres of excellence in research, like the Brno Technical University, Masaryk University or the Central European Institute of Technology (CEITEC), focusing on the specialisation of the Jihomoravský region in areas such as cybersecurity, microscopy, nanotechnology and biotechnology. Smaller scale initiatives are taking place in Olomouc, Ostrava, Liberec and Pilsen. Currently more than 1,000 researchers in AI work with a funding of €250 million and according to the business environment, the Czech educational system offers more than 100 different masters programmes focused on AI. Consequently, Czech research teams, with the support of the government have officially expressed interest in hosting one of the European AI excellence centres. This may require further coordination activities among the Czech academia. (...)

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

(…) Conversely, richer regions achieve much better educational outcomes and have a greater innovation capacity, making them more attractive for private investment. (…)

Regional innovation distribution reflects the concentration of economic activity. The share of innovative firms in most regions is lower than the EU average. Nonetheless, Prague is a strong innovator, with an R&D intensity of 2.9% of GDP. Innovation has also strengthened in the Jihomoravský region, particularly in Brno, in sectors like cybersecurity, electron microscopy and space technologies and in Střední Čechy in life sciences, physics and materials. Ostrava and Olomouc also have solid scientific bases, whereas Liberec and České Budějovice excel in areas such as textile or biology. Jihozápad is a high performer in design applications, including Pilsen – an engineering success story. Conversely, R&D intensity is only 0.3% of GDP in the less developed region of Severozápad. The growing network of regional innovation centres providing business development support could generate positive spillovers to regions with potential (Zlínský region) or where the harvested fruits of innovation and smart specialisation are still limited (Vysočina region). Regional authorities also managed to strengthen their role in promoting and cultivating the business and innovation

environment, despite the fragmented governance (World Bank, 2019b). At the same time, the current economic situation helps firms become less dependent on grants.

Educational performance lags behind in the less developed regions. While more than 57% of the Prague population aged 30-34 has a tertiary degree, in the less developed regions it drops below 30%, or even below 20% in Severozápad. The latter has a different education structure of the population (a higher percentage of basic education) and very limited research (least numbers of researchers per capita). (...)

Graph 3.4.5: Regional Competitiveness Index 2019

Source: European Commission

[3.4. Competitiveness, reforms and investment, Box 3.4.5: Investment challenges and reforms in Czechia, p.43]

(…) Nevertheless, investment in R&D and other intangible assets like education and digitalisation remain rather modest.

(…) Labour and skills shortages are also perceived as main barriers, while modest investment in R&D and insufficient links between academia and businesses are limiting knowledge and technology transfers.

Selected barriers to investment and priority actions underway

2. Labour shortages and skill mismatches are perceived as one of the main barriers to investment by private firms. In light of the labour shortages, employers plan to attract more foreign workers. Meanwhile, firms do not invest as much in training employees as the EU average, particularly in the manufacturing sector. However, one sign of progress was the launch of the 2019-2030 innovation strategy.

[3.5. Environmental sustainability, p.47]

The transition from coal is expected to have significant consequences at regional level. (…) Tailored-made support for SMEs, start-ups, innovation ecosystems and technology development together with retraining and the creation of new job opportunities for affected groups will also be vital components. (…)

(…) The country is also below the EU average on eco-innovation. Activities related to R&D in the area of energy are very low, representing only around 0.1% of GDP (down from 0.3% in 2011). Moreover, out of the €21 million invested in research in 2016, around half went to activities related to nuclear and fossil fuels (IEA, 2019).

7. DENMARK

7.1. Executive summary

Denmark has benefited from a prolonged period of sustained and balanced economic growth, but challenges remain. Additional public funding has been allocated for education, research and transport to improve productivity and bolster long-term competitiveness. The anti-money-laundering framework has been strengthened, but further measures will be necessary to regain trust in the integrity and anti-money laundering defence capabilities of Danish financial institutions. Despite recent measures, the high level of household debt combined with high house price levels and risky loan taking remains a potential financial stability risk. Denmark's ambitious target for reducing greenhouse gas emissions will require significant investments and reforms across the economy([25]).

The government budget surplus in 2019 is estimated to have reached 2.2% of GDP, largely due to a significant hike in pension yield tax revenue. The budget is forecast to remain in surplus in 2020 and to be close to balance in 2021, as the unexpectedly high pension yield tax revenue levels off and public expenditure, notably on education, research and healthcare, is set to increase. In addition, the repayment in 2020-2022 of unduly collected housing tax revenue (amounting to 0.8% of GDP) will also contribute to reducing the government surplus.

Denmark faces significant investment needs. Although it has an investment-friendly business environment, some factors are holding back investment. Investment in research and innovation is concentrated in a small number of large companies. Broadening this investment to a wider range of companies would promote innovation diffusion. The growing productivity gaps between large and small companies suggest weaknesses in this diffusion of technological advances. Channelling investments to vocational education and adult and lifelong learning is also key to preventing skills mismatches and labour market tensions. Road congestion is projected to increase around the larger cities, and there is a need to decarbonise the transport sector. To deliver on the climate and energy objectives and shape a new growth model, Denmark needs to identify

([25]) This report assesses Denmark's economy in light of the European Commission's Annual Sustainable Growth Strategy, published on 17 December 2019. In this document, the Commission sets out a new strategy on how to address not only the short-term economic challenges but also the economy's longer-term challenges. This new economic agenda of competitive sustainability rests on four dimensions: environmental sustainability, productivity gains, fairness and macroeconomic stability.

investment needs in green technologies and sustainable solutions, and secure adequate funding for these projects.

Denmark has made some([26]) progress in addressing the 2019 country-specific recommendation on investment.

Denmark has taken measures to focus investment-related economic policy on education and skills. The 2020 budget allocates more funds to research in energy and climate technology, but without specific measures to broaden the innovation base. The government has presented a specific transport plan to tackle road congestion in key areas (Section 3.4).

Denmark has made good progress towards its targets under the Europe 2020 strategy, notably in employment, research and development, greenhouse gas emissions, renewable energy and tertiary education. However, Denmark is not likely to achieve its target of reducing the number of people at risk of poverty or social exclusion.

7.2. Research and Innovation

Denmark has a strong R&D system, but there is room to improve its economic impact. At 3.05 % of GDP in 2018, Danish R&D expenditure ranks at the top of the EU and is above the 2020 target of 3 % of GDP. According to the European Innovation Scoreboard (European Commission 2019j), room for improvement remains with respect to the economic benefits from innovation, such as employment impacts and the deployment of innovation in companies (EIS 2019). A key policy challenge is how to better exploit R&D investments in terms of furthering innovation activities and outcomes in private companies and society in general.

Private sector R&D spending is concentrated in a relatively small number of large firms, especially in pharmaceuticals. The 50 largest R&D active companies accounted for 70 % of the total Danish private R&D investment, significantly higher than in a range of other advanced economies. The eight largest companies alone accounted for almost 40 % of the total private R&D expenditures. The pharmaceutical sector is responsible for almost 60 % of the total R&D expenditures, significantly higher than the worldwide average of 19 %. Overall R&D spending remains high, but the absolute number of R&D active companies has declined since 2009, largely because smaller firms not engaging in R&D. Only 33 % of SMEs introduced product or process innovations. Moreover, since 2010 these innovation activities have even slightly decreased (European Commission 2019c). Widening R&D spending to SMEs might well have the added benefit of improving the slowing pace of technology diffusion.

([26]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a country-specific recommendation is presented in the overview table in the annex.

Despite Denmark's strong R&D system, the number of new enterprises per capita is low. Denmark provides rather favourable regulatory conditions for entrepreneurs, but risk capital and private early stage (pre-seed and seed) investment in start-ups is low. Despite the efforts of the government to attract private venture capital and to provide early-stage funding through the Growth Fund and incubators, overall venture capital expenditure is among the lowest in Europe at 0.06 % of GDP in 2018. Despite that, Denmark ranks as the second-best performer in the EU for the availability of venture capital investments. Although many companies are created in Denmark, start-ups struggle to scale up and grow. A smaller share of businesses survive over the one, three and five year mark than in most EU countries. Additionally, young, high-growth innovative companies are often leaving Denmark as they scale, sometimes as the result of foreign acquisitions.

Private foundations play an important role but are not well integrated in the innovation system. A specific feature of the Danish National Innovation system is the important role played by private foundations. These account for a significant share of the privately funded R&D and also invest in related initiatives or physical spaces, such as incubators, networks, prizes or events. As the funding by private foundations is set to increase in the coming years, there is growing importance of strengthening coordination among private foundations and the responsible ministry (European Commission 2019c).

Denmark lacks an integrated innovation strategy. Though there are many initiatives that have a strategic ambition, there is a lack of an overarching vision across the whole of government that clearly spells out what Denmark wants to achieve within the global innovation landscape, and how it intends to get there. Due to recent changes across the Danish National Innovation System, ministries and their agencies became increasingly specialised within their specific mission and mandates. A Policy Support Facility expert panel highlighted that Denmark as an innovation leader can put forth the 'next level' of what leading practice means by articulating a clear, deliberate, overarching strategic direction of the innovation system, allowing to deploy and synchronise actions across the innovation system towards an ambitious goal and value proposition (European Commission 2019c).

7.3. Additional R&I references

[2. Progress with country specific recommendations. p. 16]

Research and development has been subject to CSR in 2016 and in 2019. Although overall research and development spending is high in Denmark, this has not translated into higher productivity growth. In 2016 Denmark was recommended to promote cooperation between businesses and universities. Denmark demonstrated sufficient progress in this area through a number of measures, including a prominent role to research and technology organisations and the creation of an innovation fund, which supports investments and long-term projects/partnerships. Nevertheless, the research and innovation activity remains concentrated in a small number of large firms and foundations and mostly in the pharmaceutical and biotechnology sectors. Therefore, in

2019, the Council recommended broadening the innovation base to include more companies.

[Table 2.1: Summary table on CSR assessments. p. 16]

Denmark	**Overall assessment of progress with 2019 CSRs: Some progress**
CSR 1: *Focus investment-related economic policy on education and skills, research and innovation to broaden the innovation base to include more companies, and on sustainable transport to tackle road congestion.*	**Some progress**: • Some progress on education and skills; • Limited progress on research and innovation to broaden the innovation base to include more companies; • Some progress on sustainable transport to tackle road congestion.
CSR 2: *Ensure effective supervision and the enforcement of the anti-money laundering framework.*	**Some progress:** • Substantial progress on new legislative measures; • Some progress on supervision and enforcement of the anti-money laundering framework; • Some progress on increasing budget and hiring additional personnel.

As part of the 2020 budget, research in climate technology will be markedly strengthened, however without specific measures to broaden the innovation base and include more companies. The Research Reserve for 2020 has been increased from the original plan by 38 %, totalling DKK 1.925 billion. The budget earmarks an additional DKK 1 billion for green research in 2020 raising it to a total of DKK 2.3 billion. These expenses will focus on areas such as agricultural transformation, environmentally-friendly transport and sustainable cities. The aim of the increased R&D budgets is to contribute to the objective of reducing greenhouse gas emissions by 70 % by 2030 and will open new possibilities for SMEs to participate in climate-related R&D activities.

Denmark has taken measures to focus investment-related economic policy on education and skills. The 2020 Budget Bill has allocated a marked increase in public expenditure on primary schools. Furthermore, a broad political agreement (October 2019) earmarked DKK 102 million to initiatives to upskill low-skilled workers. These initiatives should help to address sector-specific labour shortages. Nonetheless, there is a continued need to incentivise youth to choose a vocational education and training (VET) programme, and to increase the skills level of people on the margins of the labour market.

[3.4.1. Competitiveness and productivity trends p. 38]

So-called "green enterprises" belong to the highly productive segment of Denmark's economy. The examples of Danish wind turbinr industry and other energy technologies show that it pays off to position itself within strategic value chains from the research stage up to deployment, commercialisation and export. Denmark has a unique opportunity to build on its leading position both in energy technologies and climate ambition to set standards by clearly stating objectives and funding targets in research and innovation

[3.4.2. Investment, infrastructure and market integration, p.39]

The EU supports investment in Denmark also via the European Fund for Strategic Investments (EFSI). By December 2019 total financing under the EFSI amounted to EUR 940 million, intended to trigger EUR 6,057 million in additional investments. The current experience with the EU financial instruments and the EFSI budgetary guarantee demonstrated a need for simplification, streamlining and better coordination of the EU's investment support instruments during the next 2021-27 programming period. By the end of 2020, EFSI and other EU financial instruments will come under the roof of the new InvestEU programme that promotes a more coherent approach to financing EU policy objectives and increases the choice of policy implementation options and implementing partners to tackle country specific market failures and investment gaps. In addition, under InvestEU, Member States can set-up a national compartment by allocating up to 5 % of their structural funds to underpin additional guarantee instruments supporting the financing of investments with a higher level of local specificities. InvestEU will be policy-driven and focus on four main areas: Sustainable Infrastructure, Research, Innovation, and Small Businesses.

[3.4.3. Institutional quality and governance p.43]

Denmark is committed to making progress and investing in digital technologies. Denmark signed the Declaration on cooperation on Artificial Intelligence. In March 2019, the Danish government launched its National Strategy for artificial intelligence (AI). With the strategy, the government aims to provide a common ethical and human centric foundation for AI as well as a set of goals for using AI within the public, private and research sector. The strategy also establishes a number of initiatives to further strengthen Denmark's development and application of AI. For instance AI solutions are sought to support voice recognition and assisting citizens in danger (e.g. experiencing heart attack etc.). In addition, the country is preparing the new "Digital Strategy 2020-2024" for further enhance the digital interaction of businesses and citizens with the public administration.

[ANNEX A. Overview table. P. 50]

Europe 2020 (national targets and progress)

Focus investment-related economic policy on education and skills,	**(…)**
research and innovation to broaden the innovation base to include more companies,	**Limited Progress:** Denmark has taken measures to increase funding for research and innovation. The Research Reserve for 2020 has been increased from the original plan by 38 %, totalling DKK 1.925 billion. The budget earmarks an additional DKK 1 billion for green research in 2020 raising it to a total of DKK 2.3 billion. However no specific measures were proposed to broaden the innovation base and to include more companies.

[ANNEX D. Investment guidance on just transition fund 2021-2027 for Denmark. p. 62]

(…) The smart specialisation strategies ([27]) provide an important framework to set priorities for innovation in support of economic transformation. In order to tackle these transition challenges, investment needs have therefore been identified for making the regional economy more modern and competitive. Key actions of the Just Transition Fund could target in particular:

- (…) investments in research and innovation activities and fostering transfer of advanced technologies;

8. SPAIN

8.1. Executive summary

Supporting growth, productivity and the green transformation through public investment would have positive spill-overs on other Member States. Simulations show that a fiscally neutral investment programme financed by indirect taxes and focused on boosting skills, research and innovation, as well as on addressing challenges related to energy, water management, carbon emissions and climate change, would support Spanish growth and increase productivity, while facilitating the green transition. It would also have a small but positive impact on the rest of the euro area.

([27]) As defined in Article 2(3) of Regulation EU 1303/2013 (CPR)

Spain has made limited progress on the 2019 country-specific recommendations (CSRs) ([28]): (...) There has been limited progress on fostering innovation, resource and energy efficiency and on developing rail freight infrastructure. Improvements in the funding and governance of the research and innovation system have been modest. On electricity interconnections with neighbouring countries, work is ongoing but further progress is needed.

Spain is making progress towards achieving the Sustainable Development Goals (SDGs). Spain has made most evident progress with SDG 3 "Good health and well-being". Moderate improvements are also recorded for a broad range of the other SDGs. This notwithstanding, some of the individual underlying indicators are significantly lower than the EU average (share of early school leavers, people at risk of poverty, research and innovation, perception of corruption, recycling of municipal waste, land degradation and water). ([29])

Spain's innovation performance is below the EU average in all regions. Innovation suffers from public and private underinvestment in R&D, and the coordination of research and innovation policy across different levels of government remains a challenge. Lack of cooperation between academia and businesses hampers knowledge diffusion. Business innovation is constrained by the low absorption capacity of small firms. Regulatory fragmentation across regions also makes it more difficult for firms to scale-up. Regulatory barriers continue to restrict competition in certain professional services and in retail. A more effective implementation of the Law on Market Unity would promote competition and better regulation, and reduce regulatory fragmentation.

The low innovation performance of the economy is also related to shortages of technical skills. High early school leaving rates undermine equal opportunities and contribute to the high share of low skilled in the population. The low attractiveness of vocational education and training amplifies shortages of medium to high technical skills. School-to-work transitions remain difficult, as job opportunities are limited and often of low quality. At the same time, the economy does not create enough high-skilled occupations, reflecting its low innovation dynamics.

([28]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a CSR is presented in the overview table in Annex A.

([29]) Within the scope of its legal basis, the European Semester can help drive national economic and employment policies towards the achievement of the United Nations Sustainable Development Goals (SDGs) by monitoring progress and ensuring closer coordination of national efforts. The present report contains reinforced analysis and monitoring on the SDGs. A new annex (Annex E) presents a statistical assessment of trends in relation to SDGs in Spain during the past five years, based on Eurostat's EU SDG indicator set.

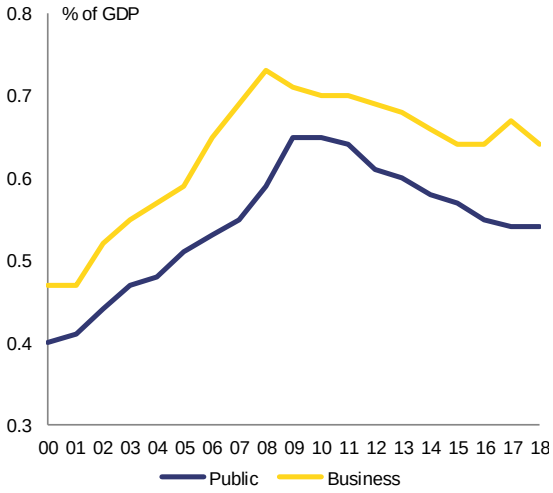
8.2. Research and Innovation

Spain's innovation performance is below the EU average, though it has recorded some improvement since 2011. Spain ranks as a "moderate innovator" in the EU (European Innovation Scoreboard, 2019). Spain scores high on indicators such as sales of new-to-market/firm innovations, broadband penetration, new doctorate graduates and tertiary education. Weak points are firm expenditures on R&D, links between innovative small and medium-sized companies, and links between academia and business, knowledge-intensive service exports, and the proportion of innovative SMEs. Spain also ranks below the EU average in knowledge-based capital assets, including organisational capital (OECD, 2018 and 2019). Overall Spain's weak innovation performance hampers productivity growth and the structural change towards a knowledge-based and green economy. Measures to improve the Spanish research and innovation performance would contribute to advancing towards SDG 9 (Industry, innovation and infrastructure).

Low investment in R&D is holding back Spain's innovation performance. Total R&D expenditures declined from 1.35% of GDP in 2009 to 1.24% in 2018. Public R&D expenditure was cut during the crisis and the cuts have not been reversed. Public investment in R&D declined from 0.65% to 0.54% of GDP between 2009 and 2018, well below the EU average of 0.69%. Private investment in R&D fell from 0.73% of GDP in 2007 to 0.64% in 2016. It has since recovered to 0.7% in 2018, but it is still low compared with the EU average of 1.41% (2018).

Although the quality of the Spanish public research system has improved in recent years, on average the quality is still lagging behind. The research system has changed in various ways, including an update of the evaluation criteria for research staff. This has spurred growth in the volume of research. However, the quality of research, measured by the percentage of Spanish scientific articles in the top 10% most cited publications worldwide, is still lagging behind (Salazar-Elena J.C. and Sanchez-Martinez, M., 2020), and it remains below the EU average (European Innovation Scoreboard, 2019).

Graph 4.4.9: **Evolution of business 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.

There has been limited progress in developing systematic evaluations of public research and innovation policy. Spain has made progress on the evaluation of research projects submitted for public funding, but there is still scope for improvements in other aspects of public research and innovation policy, especially impact evaluations. More could be done to apply international best practices and expertise to evaluation.

Human resources are still a critical challenge for the Spanish research and innovation system. The low proportion of researchers employed by firms (in 2017 0.55% of total employment against 0.85% in the EU as a whole, and more than 1% in other big Member States (Eurostat) reduces Spain's capacity to absorb innovations. The proportion of the population with tertiary education has risen to above the EU average over the past decade. However, Spanish tertiary education does not seem to be responding adequately to the need to improve the innovation capacity or meet market needs (see also above under 'productivity' and Section 4.3.2).

Spain has taken action to improve coordination and synergies in research and innovation policies. The Spanish Ministry for Science, Innovation and Universities led the design of the post-2020 strategic framework for innovation in coordination with other relevant national and regional bodies. The splitting of that Ministry into two in early 2020 - a Ministry for Science and Innovation and a Ministry for Universities - could make coordination more challenging. Spain has also actively engaged with smart specialisation strategies, notably through the participation of Spanish regions as leaders of 12 out of 32 interregional partnerships on energy, agri-food and industrial modernisation. The Spanish Network on Public Policies for Research, Development and

Innovation (RED IDI) has published guidance on monitoring and evaluation of smart specialisation strategies in preparation for the next Structural Funds programming period (RED IDI, 2019). However, ensuring that Spain's multi-level system of research and innovation governance operates smoothly remains challenging.

SME participation in innovative projects is low. Besides Technological Centres and Platforms, Spain's Association of Science and Technology Parks includes at least 23 technology parks sponsored by universities, with Tecnocampus (Barcelona) and The Cube (Madrid) being among the leading start-up hubs in Europe. However, while in the EU as a whole the percentage of SMEs cooperating with partner organisations on innovative projects is almost 12%, the figure in Spain is 6.4%. The low level of utilisation of available knowledge by Spanish firms prevents them from participating in innovation projects on a larger scale (Salazar-Elena J.C. and Sanchez-Martinez, M., 2020). Some improvements have recently introduced with the Cervera Transfer Network Programme and the Missions Programme, both managed by CDTI, along with the new University Sexennium on Knowledge Transfer. However, more could be done to promote SME participation in innovative projects.

The "General Guidelines of the New Industrial Policy 2030" focus on five priority themes: competitiveness, sustainability, digitisation, alignment with EU policy and the role of SMEs. The guidelines were issued by the Ministry of Industry, Trade and Tourism in February 2019. They provide a framework for industrial policy measures in areas of high relevance for growth and jobs and the greening of the economy. Implementation, resources and efficiency of spending will be key for the success of the new industrial policy. In this regard, the AIReF spending review of the national Re-industrialisation and Industrial Competitiveness Programme (RIC) (AIReF, 2019e) showed that the Programme does not improve firm's competitiveness, has a high financial cost, does not respond to identified needs, and that procedures for using the programme are cumbersome (see Box 4.1.4). This Program has been reviewed to respond to AIReF's recommendations. In addition, the Strategic Framework on SME Policy 2030 was adopted in April 2019. It aims at improving SME competitiveness and promoting a growth friendly environment.

Public support for private investment in research and innovation has a low impact. Public support in the form of loans has become less attractive with the normalisation of credit conditions. Spain offers one of the most generous tax benefits for research amongst OECD countries and partner economies, through a combination of tax credit for research and exemption for social security contributions exemption for qualified research staff. However, the tax scheme has had a limited impact (see Section 4.1.4.). Furthermore, venture capital is underdeveloped in Spain (see Section 4.2.3.).

Digital economy

Spain is committed to the advancement of new technologies. While the Ministry of Science has published its strategy for research in the field of artificial intelligence (AI) (Ministry of Science, Innovation and Universities, 2019), eleven other ministerial departments are working on a new National AI Strategy. Furthermore, Spain benefits

from having in place a high-performance computing infrastructure and a national cybersecurity strategy designed to complement EU policies with national policies (Department of National Security, 2019).

8.3. Additional R&I references

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

There has been limited progress on investment to foster innovation, resource and energy efficiency and to complete rail freight infrastructure and electricity interconnections. The draft National Climate and Energy Plan is ambitious in scope, but it relies to a large extent on mobilising private investments, which have not materialised yet. There has been some progress on the ongoing development of electricity interconnections with France and with Portugal. There were certain steps taken to support sustainable mobility, but overall there was limited progress in fostering resource efficiency. Investments in rail infrastructure for freight have not increased in 2019. Spending on R&D remains low compared with other Member States. Coordination of research and innovation policies across government levels remains a challenge and the evaluation of research programmes and policies is not systematic. The assessment of this CSR does not take into account the contribution of the EU 2021-2027 cohesion policy funds. ([30])

[Box 2.1: EU Funds and programmes to address structural challenges and to foster growth and competitiveness in Spain, p. 18]

EU Cohesion policy funding is contributing to the transformation of the Spanish economy, by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility. By 2019, investments driven by the European Regional Development Fund (ERDF) increased accessibility by building or upgrading more than 200 km of roads; supported research, as over 11,000 researchers work in improved research infrastructures; promoted energy efficiency realising more than 40 MW of additional capacity to produce renewable energy; achieved 1,400,000 additional households with access to broadband of at least 30 Mbps, the upgrading of schools for 200,000 pupils, as well as the reduction of greenhouse gas emissions by 250,000 tons of CO2 t-eq. The European Social Fund (ESF), as well as the Youth Employment Initiative (YEI), of which Spain is the biggest beneficiary, supported notably the rollout of the 2014 education reform and the set-up of youth policies durably anchored in public employment services, based on strong partnerships. Over 4 million actions, including workshops, trainings and outreach campaigns, so far led to 1.8 million qualifications and 884 970 jobs. 200,000 young

([30]) The regulatory framework underpinning the programming of the 2021-2027 EU cohesion policy funds has not yet been adopted by the co-legislators, pending inter alia an agreement on the multiannual financial framework (MFF).

people (50%) were still working or engaged in training or education after completing a Youth Guarantee programme.

[Box 3.1: Public investment and potential spill-overs, p. 22]

The European Commission's QUEST model ([3]) was applied to simulate the impact of a public investment package totalling €130 billion over 10 years. The assumed additional public investment is equivalent to 1% of GDP at its 2019 level, every year over a decade. This simulation follows the 2019 country-specific recommendations on investment-related economic policy. Consequently, the public investment package is assumed to include growth and productivity-enhancing expenditures on research and innovation, skills, the green transformation in the areas of transport, energy, carbon emissions, water management, recycling, and environmental damages from extreme weather events. For simplicity, the simulation assumes that neutralising fiscal measures in the form of increased indirect taxes are implemented. The output elasticity with respect to the public capital stock is assumed to be 0.12, which is a mid-range estimate (Arslanalp et al., 2010). Monetary policy is assumed to retain its accommodative stance at the zero lower bound for the first two years and gradually normalise afterwards.

Reducing decisively Spain´s large external liabilities would require maintaining large current account surpluses for sustained periods of time. Spain's NIIP is still far from a level that could be considered prudential (-61% of GDP in 2019) or in line with fundamentals (-23% of GDP) (see Graph 3.1) ([31]). Although at present the current account surplus exceeds the level implied by fundamentals (see footnote 12), further progress in reducing the NIIP could prove more challenging under less benign growth scenarios (see Table 3.2). Measures to raise non-cost competitiveness through investment in research and innovation, as well as improving labour skills have been modest so far (see Sections 4.3 and 4.4).

[Box 4.1.2: Spending reviews, p.33]

Third, AIReF issued 19 recommendations for improving the State Programme for the Promotion of Talent and its Employability in Research, Development and Innovation. This programme benefited from €305 million in 2017, about 5% of the R&D+I budget. Although the programme is a relatively small budget item, the funds earmarked for it have fallen sharply, although serious challenges remain in terms of boosting Spain's competitiveness and productivity (see Section 4.4.1). In particular, AIReF recommended a strategic reorientation of the Programme, focusing on excellence,

([31]) The country-specific prudential threshold for the net international investment position is derived from a univariate signalling approach that identifies at which net international investment position level an external crisis is likely to begin. The net international investment position level explained by fundamentals represents the net international investment position that would result if a country had run its current account in line with fundamentals since 1995. See Turrini and Zeugner (2018).

reviewing the coverage and generosity of grants, fostering public-private collaboration in grants, and optimising the processes making up the Programme's grants system (AIReF, 2019d).

[4. Competitiveness, reforms and investment. 4.4.1. Investment, competitiveness and productivity. Productivity and development. P. 67]

Improving within-firm productivity and allocative efficiency are key to raising overall productivity in Spain. Within-firm productivity depends on the ability of firms to innovate, invest in tangible and intangible assets and make best use of their human capital endowment, as well as on their organisation and management. On many of these dimensions, Spain underperforms its peers. The quality of human capital is affected by low and/or under-utilised skills and skills mismatches on the labour market. Evidence also points to significant gaps in managerial practices in Spain compared to best international practices (see Box 4.4.2), as well as under-investment in research and innovation. In addition, regulatory fragmentation and labour market segmentation hamper the efficient allocation of resources.

[Box 4.4.3: Investment barriers and challenges in Spain, p. 71]

2. Restrictive and fragmented regulations across regions continue to discourage investment (see Section 4.4.2). Despite the commitment to implement the Law on Market Unity there are still few tangible results. Reform of professional services are still pending. No measures have been taken to eliminate unnecessary size-contingent regulations that prevent firms from growing. Policies designed to support investment in research and innovation have a limited impact, and despite improvements, science-business cooperation could be improved.

[ANNEX A, overview table, p. 84-92]

CSR 3: Focus investment-related economic policy on fostering innovation, resource and energy efficiency, upgrading rail freight infrastructure and extending electricity interconnections with the rest of the Union, taking into account regional disparities. Enhance the effectiveness of policies supporting research and innovation.	Spain has made **Limited Progress** in addressing CSR 3
• Focus investment-related economic policy on fostering innovation,	**Limited Progress:** Spain has made limited progress on increasing investment in research and innovation. Efforts to increase R&D investment by both large and small firms through improved public support for private

	investments have seen limited progress. The rationale of R&I policy initiatives is not always clear. Some of the new political initiatives/strategies (IA, Blue Economy, Start Up) lack a budget, coordination with existing strategies, and an assessment of their potential impact.
• Enhance the effectiveness of policies supporting research and innovation.	• **Limited progress.** There has been limited progress on increasing the systematic use of evaluations of research and innovation policies. Some measures have been introduced to decrease red tape or to improve working conditions of researchers. Profound reforms to improve carriers of top researchers, to stimulate mobility and to promote jobs and carriers for industrial-based researchers are still lacking. Reforms to improve collaboration between public research and private firms are still missing. Coordination between Autonomous Communities and the national government could still be improved.

[ANNEX D: Investment guidance on Just Transition Fund 2021-2027 for Spain]

(…) In order to tackle these challenges, high priority investment needs have been identified for diversifying and making the regional economy more modern and competitive in Asturias, León, Palencia, Cádiz, A Coruña, Córdoba, Almería, and Teruel. The smart specialisation strategies ([32]) of these regions provide an important framework to set priorities for innovation in support of economic transformation. Based on this preliminary assessment, it appears warranted that the Just Transition Fund concentrates its intervention on these areas, complementing the efforts of the national just transition strategy. Key actions of the Just Transition Fund could target in particular:

([32]) As defined in Article 2(3) of Regulation EU 1303/2013 (CPR)

- investment in the creation of new firms, including through business incubators and consulting services;
- investment in deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- investment in the circular economy;
- investment in research and innovation activities and fostering the transfer of advanced technologies;
- productive investments in SMEs, including start-ups; and,

9. ESTONIA

9.1. Executive summary

Estonia's economy is benefitting from the favourable labour market and business environment. Innovation has increased but has not led to any substantial rise in labour productivity.

There has been some progress in addressing skills shortages and foster innovation by improving the capacity and labour market relevance of the education and training system.

There has been limited progress in focusing investment-related economic policy on sustainable transport and energy infrastructure, including interconnections, on fostering research and innovation, and on resource and energy efficiency, taking into account regional disparities.

- **Research and Development, including digitalisation, have not delivered economy-wide productivity gains.** Business investment in R&D remains low compared to other countries, posing a barrier to productivity growth. The transfer of knowledge from universities to companies and the commercialisation of research results are slow. The intermediaries able to support industrial innovation are not yet established or are not functioning at their full potential. While Estonia's overall innovation performance has improved, the levels of research-based innovation capacity and activity in the business sector remain low.

- **Major investment needs persist.** Well targeted investment in research and innovation would strengthen Estonia's long-term potential. Business investment has accelerated but investment in research and innovation and intellectual property assets is relatively low.

9.2. Research and Innovation

Low private research and development investment remains a barrier to productivity growth. In 2018, R&D investment was below the national target, due mainly to low private funding. Estonia has a R&D intensity (R&D expenditures as % of GDP) target of 3%, with public funding at 1% of GDP and private sector funding at 2%. Around 50% of government spending on research comes from European Structural Funds. The only substantial change is the 50% increase in basic funding for universities in 2017. The actual funding increases in other areas have been quite modest. R&D expenditure in the public sector reached 0.79% of GDP in 2018, surpassing the EU average of 0.69%. However, the leverage effect on the level of R&D expenditure in the business sector (0.59% of GDP in 2018) remained limited. At the end of 2018, renewed political commitment to the 3% goal and to the 1% public part was agreed.

The levels of research-based innovation capacity and activity in the business sector are low. Estonia improved its performance in the 2019 European Innovation Scoreboard and moved back to the group of strong innovators. Non-research innovation expenditure was 176.1% of the EU average according to the 2019 European Innovation Scoreboard. In contrast, research-based expenditure was only 43.8% of the EU average. Efforts to develop and activate research-based innovation capacity and the R&D function in companies have so far been insufficient. In 2019, the grant scheme launched in 2018 by Enterprise Estonia to support product development in the manufacturing sector, underwent a substantial change, including an increased budget of €20 million from the Structural Funds, and the introduction of more flexible requirements. However, the interest in this grant has been low so far, in part because of insufficient publicity. Another important programme supporting innovation, NUTIKAS, was also simplified to improve the uptake by the private sector. While it previously only financed applied sciences were financed, under the revised rules companies can finance their own costs to build in-house capabilities for research and innovation. The results are still to be seen.

Estonia underwent a peer review of its research and innovation system under the EU Policy Support Facility. The review found that Estonia is in the 'middle-income trap' and needs to increase the national effort in R&D by creating distinctive competitive advantages. The main recommendations included ensuring political commitment to the importance of R&I in national policy and a 1% target for government spending on R&D, better targeting of R&I policy, establishing innovation agency to support R&D, strengthening 'intermediary organisations', and modernising research at universities (European Commission, 2019g, p.8). The Estonian authorities keep the 1% spending target in sight. They made immediate steps towards transforming part of Enterprise Estonia into an innovation agency. The recommendation to establish thematic priorities for R&I policy in the light of the societal challenges was taken on board by the Prime Minister's R&D Council. The recommendation to modernise universities in order to meet national needs was partly followed by requiring outside representatives to account for the majority in university councils. The most difficult recommendation to implement proved to be the most important one-strengthening the system of intermediary organisations able to support industrial innovation.

There is a high concentration of investment activities in the private sector. Overall, fewer than 300 companies (0.3% of the total) made any investment into R&D, yet 90% of those investments are carried out by ⅓ of these companies. In information and communication technology, this concentration is even more pronounced: 13 companies invested 90% of the R&D investment in this sector in 2016 (Kattel, 2019).

Cooperation between research institutions and enterprises was still limited. As an indicator of the lagging cooperation, the share of public-private co-authored publications was 53.1 per million population in 2018 (EU average 86.4). Developing the capacities of the public research system enabled it to reach a good level of scientific performance (For instance, the share of highly-cited publication among all national publications was 9.7% in 2016, close to the EU average of 10.3%). However, the economic valorisation of these capacities remains hindered by weak linkages with industry (As shown for instance by the share of public-private copublications in the total number of publications, which was only 2.4% in 2017 vs. an EU average of 5.5%). While leading universities established structures such as TalTech Innovation and Business Centre Mektory (in 2013) and the University of Tartu's Centre for Entrepreneurship and Innovation (in January 2018), the system of innovation intermediaries remains weak. Estonian industry lags behind the EU average in the number of researchers employed in private companies (Karo, 2019). The number of employed researchers with a PhD has been constantly decreasing in the business sector as a whole, as well as in key sectors such as manufacturing, information and communication industries (Kattel, Napierala, 2019). Initiatives such as university extension services could help strengthen the system of intermediary organisations able to support industrial innovation (European Commission, 2019g).

Estonia is on track to improve coordination between innovation and research policies. The Ministry of Education and Research is in charge of national research and education policy. The Ministry of Economic Affairs and Communications oversees technological development and innovation policy. Coordination has recently improved somewhat as the Prime Minister's Research and Development Council seems to take a more decisive role. The Council is an expert consultative body that advises the government, but it could do more. As discussed by the Council after it received the 'peer review' final report in autumn 2019, it may strengthen coordination by making strategic decisions on thematic priorities and funding. A promising step towards better coordination is the initiative to merge the national entrepreneurship strategy and the research and development strategy: the process of writing a single strategy — TAIES — provides clear opportunities to improve coordination. The *Peer review of the Estonian R&I system* also pointed to the need to ensure better coordination of research priorities with societal needs through greater involvement of the other sectoral ministries.

Several weaknesses have limited the impact of smart specialisation on Estonia's innovation performance. Weak coordination of research policies with business development ones, as well as insufficient reaction to changes in competitive arenas, have prevented the country from reaping the full benefits of smart specialisation. The renewal of smart specialisation priorities for research and innovation investment in view

of the next programming period provides an opportunity to identify growth areas in line with the latest developments, and the strengths and potential of the Estonian economy, based on continuous dialogue with stakeholders of the research and innovation ecosystem.

9.3. Additional R&I references

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

Regarding R&I, Estonia has made progress in strengthening its R&D system, but not in the business sector. The country's difficulties in retaining researchers in business organisations have turned into a permanent weakness. However, there are signs that the governance of the R&D system is improving in terms of merging research and business strategies and making strategic choices. Estonia has made some progress in addressing the 2019 country-specific recommendations (CSRs).

(…) With respect to CSR 3 (investment), Estonia made **limited progress**. R&D investments in the private sector have remained low and have decreased further over the last years to 0.59% of GDP in 2018.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Estonia, p. 16]

EU Cohesion policy funding is contributing to major transformations of the Estonian economy by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility.

Using the resources of European Regional Development Fund and Horizon 2020 project Tartu opened bike-sharing system in 2019. The system includes 69 electrically provided bike stations and 750 bikes (500 of them are electrical). The biggest bike-sharing network in the Baltics has 36,000 registered users.

[Annex A: Overview table, p. 52]

CSR 3: Focus investment-related economic policy on sustainable transport and energy infrastructure, including interconnections, on fostering research and innovation, and on resource and energy efficiency, taking into account regional disparities.

Estonia has made **limited progress** in addressing CSR 3. R&D investments by the private sector have remained low and have decreased further over the last years to 0.59% of GDP in 2018. Regarding investment in energy infrastructure, Estonia has made substantial progress, as the implementation of the Baltic interconnection project is proceeding as expected. Estonia has made some progress regarding investment in energy efficiency, but improving access of low and medium income households to finance could facilitate further improvements. Estonia has made limited progress with

focusing its investment related economic policies on resource efficiency and no progress with respect to sustainable transport.

10. FINLAND

10.1. Executive summary

The Finnish economy faces some structural challenges, but the announced government policies, if fully implemented, could go some way towards reducing the problems identified. Finland is among the most advanced economies in the EU and among the front-runners in digital technologies and clean energy innovation.

Focusing investment-related economic policy on human capital, on research and innovation, on low carbon and energy transition, and on sustainable transport, would strengthen the country's long-term growth potential. The ratio of R&D to GDP has not recovered since the crisis years and appears to be insufficient to diversify exports towards higher tech goods in the medium term.

There has been limited progress in the following area:

- As regards investment-related economic policy on research and innovation, low carbon and energy transition and sustainable transport, the Finnish government has announced plans to strengthen investment in these areas.

Regarding progress in reaching the national targets under the Europe 2020 strategy, the ery ambitious R&D investment target of 4% of GDP is unlikely to be met.

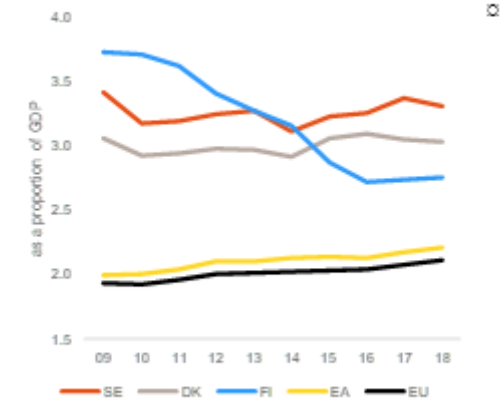
10.2. Research and Innovation

R&D expenditure remains among the highest in the EU, but remains well below the national 2020 target of 4 % of GDP and also falls short of Finland's Nordic peers (see Graph 3.4.4). Finland ranked second after Sweden in the EU in the 2019 European Innovation Scoreboard (European Commission, 2019d). Nevertheless, the technological change, which contributed to the decline of the handset business and the consequent industrial restructuring, led to a steep decline in business R&D expenditure (see Graph 3.4.5). The decline was mostly driven by the manufacturing sector and in particular by the electronics industry and in companies with over 500 employees. In companies with less than 500 employees, the volume of R&D has actually grown in 2011–2018. Since 2016, the service sector has accounted for the majority of the increase in the Finnish business enterprise sector's R&D expenditure, while R&D expenditure by the manufacturing sector as a whole has only been slowly recovering (see Graph 3.4.6). Overall, addressing the R&D challenge would lead to progress on the UN sustainable development goal (SDG) 9 — Industry, innovation and infrastructure (see Annex E).

Public R&D investment has largely stabilised. After a strong decline between 2010 and 2017, public R&D expenditure stabilised at 0.9% of GDP in 2017 and 2018. While public support to private R&D is directed mostly at small and medium-sized enterprises (SMEs), investment by SMEs in R&D remains low, when compared to that of larger companies. In its recent programme, the new Finnish government has committed to increasing public R&D investment and has kept the target of 4 % of GDP for 2030 (see below).

Examples of successful academia-business link exist at regional level. The research and innovation system leads to high-level academic performance (the country has a relatively strong scientific performance (ranked 6th and 10th in the EU in terms of top publication and international co-publications), even though its Nordic peers outperform it). At the same time, the translation of research results into business innovation is less effective. On a positive note, Aalto University offers research and innovation services to students and businesses (for example, incubator, business modules and web-based information technology courses). In particular, Europe's leading start-up event in Europe, 'Slush', originated in Aalto's student community, while a significant proportion of Finnish start-ups entrepreneurs are Aalto graduates. Another successful example is research and innovation in the forest industry, which made Finland one of the world's frontrunners in the bio-economy area. Neste, the former state petrol company of Finland, has emerged as an example of a fossil-fuel-based company turning to biofuels. Furthermore, Finland has: i) devoted substantial funding to the bioeconomy; ii) sustainably managed large forestry resources; and iii) generated excellent research in the area of wood-derived materials. Its largest bio-product mill in Äänekoski received investment funding from the European Investment Bank and the European Fund for Strategic Investments (the cost of the plant was €1.2 billion, of which €200 million was a loan from the European Investment Bank; the European Fund for Strategic Investments guaranteed a €75 million loan, as announced during the launch of 'Investment Plan for Europe' in July 2015; the Government provided €32.1 million state aid supporting renewable energy and energy efficiency investments; in addition, state-owned Finnvera guaranteed a €400 million loan). Numerous research projects develop novel products from wood fibres. Cutting edge research and technology allows Finland to compete with countries where forests grow ten times faster and harvesting takes place all year round. At the same time, the Technical Research Centre of Finland, which has traditionally played a major role in supporting innovation in the business sector, suffered substantial funding cuts and lost some of its co-financing from the private sector (the VTT Technical Research Centre of Finland Ltd is a state-owned and -controlled non-profit limited liability company. It provides research and innovation services and information for domestic and international customers and partners, both in private and public sectors. VTT is part of Finland's innovation system and operates under the mandate of the Ministry of Economic Affairs and Employment).

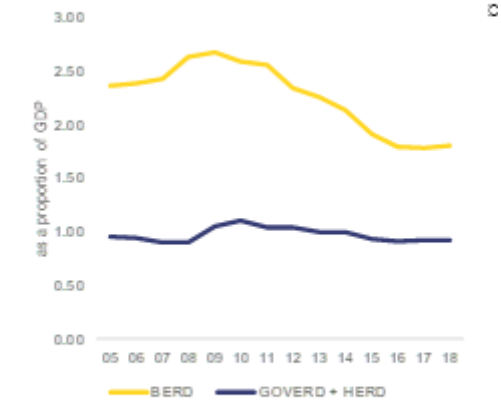
Graph 3.4.4: Development of R&D expenditure (as a proportion of GDP)



Source: European Commission

Recent policy initiatives aimed at strengthening the country's research and innovation performance are being implemented. The merging in 2018 of Tekes (Finnish Funding Agency for Technology and Innovation) and Finpro (Finnish Export Promotion Agency) into Business Finland, together with structural changes to the Finnish Innovation Fund Sitra, aimed at exploiting synergies and at strengthening Finland's research and innovation performance (Halme et al., 2020). More recently, the new government has acknowledged the need to promote Finland's attractiveness to encourage both foreign and domestic R&D investment. In addition, the new government's fiscal plans include an increase in expenditure on education and additional investment in research, environment and infrastructure in order to increase the international competitiveness of the Finnish research framework.

Graph 3.4.5: Trend of public and business R&D expenditure intensity by sectors of performance (as a proportion of GDP)



BERD: business R&D expenditure
GovERD: government R&D expenditure
HERD: higher education R&D expenditure
Others: private non-profit sector R&D expenditure
Source: European Commission

There are promising developments regarding smart specialisation in Finland's regions, but there remains insufficient coordination of the process at central level.

In Finland, smart specialisation is tightly linked with smart regions. Finland's aim for 2014-2020 was to complement regional strategies with the national innovative cities (INKA) programme. One of its goals was to match the objectives of the national innovation strategy and regional R&I strategies (Suomen kumppanuussopimus, 2014-2020). However, the programme was abolished in 2017. At present, it is not clear how regional smart specialisation strategies will be consolidated and linked to the national R&D and innovation system. In particular, it is not clear which tool or which body will be used to achieve this.

10.3. Additional R&I references

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

On investment-related economic policy, the amount of public money to support research and development is expected to increase.

[Table 2.1: Assessment of 2019 CSR implementation, p. 19]

CSR 3: Focus investment-related economic policy on research and innovation, low carbon and energy transition and sustainable transport, taking into account regional disparities.

Finland has made **limited progress** in addressing CSR 3:

- Limited progress has been made on public research and development, since budgetary amounts are expected to increase.

[Box 2.1: **EU funds and programmes to address structural challenges and to foster growth and competitiveness in Finland**, p. 20]

EU Cohesion policy funding is contributing to transformations of the Finnish economy and society by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, low carbon society, employment, education and social inclusion. By 2019, investments driven by the ERDF have already led to the creation of more than 5,800 new jobs and 320 new enterprises. Almost 10,000 companies had participated in projects run by research and development institutions, more than 1,400 companies had started to export or expand their exports.

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

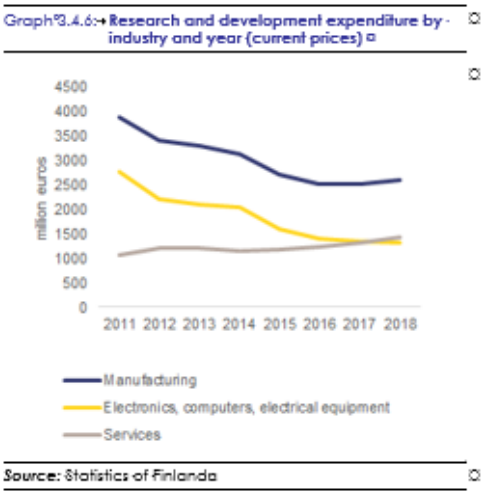
Business Finland is the main public funding agency in Finland. It helps businesses go global. It also supports and funds innovations. Funding awarded by Business Finland in 2018 amounted to €535 mln.

Selected barriers to investment and priority actions underway

2/ There is potential for further increasing cooperation between academia and businesses and for subsequent translation of research into innovation. At the same time, coordination of smart specialisation at central level appears insufficient to consolidate regional smart specialisation strategies and to link them with the national R&D and innovation system.

[3.4.2. BUSINESS ENVIRONMENT AND MARKET INTEGRATION, P.49]

Overall, Finland offers one of the best business environments in Europe**, and there are continuous improvements**. (…) In addition, Finland has the highest proportion of venture capital investment in Europe (mostly concentrated in the manufacturing and information and communication technology sectors) (Flachenecker *et al.*, 2020).



[Annex A: Overview Table, p. 60]

CSR 3: "Focus investment-related economic policy on research and innovation, taking into account regional disparities"

Limited progress has been made on public research and innovation investment. The amount of public money for research and development support is expected to increase, but remain broadly stable as a proportion of GDP. A roadmap will be drawn up to raise overall R&D investment to 4% of GDP and to make Finland the best place in the world for innovation and experiment.

11. FRANCE

11.1. Executive summary

Reforms and targeted investment in skills, digital infrastructure and research and innovation have the potential to unlock productivity gains in the economy. According to the French National Productivity Board, the weak productivity growth of French businesses can be explained in part by factors common to most EU countries.

Country-specific factors such as France's comparatively low skilled workforce, low uptake of information and communication technologies and suboptimal innovation performance also play a role. The implementation of several investment plans as well as the ongoing reform efforts will contribute to addressing these challenges. The full impact of these measures on productivity will take time to materialise. Moreover, the performance in research and innovation is still hampered by the complexity of the research and innovation ecosystem. Continued efforts are crucial to improve the impact and efficiency of public support for research and innovation and reinforcing the links between science and business.

Overall, France has made some progress in addressing the 2019 country-specific recommendations. (…) There has been substantial progress in implementing measures to facilitate firms' growth (PACTE Law in 2019). There has been limited progress in:

- improving research and innovation performance; and

11.2. Research and Innovation

French research and development (R&D) investment as share of GDP is still below the 3% target for 2020. Total R&D intensity remained stable in 2018 at 2.20% GDP, above the EU average of 2.12%. However it decreased from 2015 where it stood at 2.25%. Public R&D spending ([33]) for 2017 and for 2018 (0.73% of GDP) were almost the same as in 2007. Business sector R&D spending for 2017 and 2018 (1.44% GDP) were the same as in 2012. As mentioned in last year's country report (European Commission, 2019d), France is not on track to meet its R&D intensity target of 3% for 2020.

Despite the multitude of initiatives to incentivise innovation ([34]), France is still stagnating on a global scale compared to the most innovative countries. France remains the 16th most innovative country in the world according to the World Intellectual Property Organisation's Global Innovation Index and ranks 11th in the 2019 European Innovation Scoreboard and is positioned as a *strong innovator* behind the group of *innovation leaders* (European Commission, 2019h). However, France scores

([33]) R&D Expenditure in the Government Sector (GOVERD) + Higher education expenditure on R&D (HERD) (as % of GDP)

([34]) Among others, the *Crédit Impôt Recherche*, *Programme d'investissement d'avenir*, *Sociétés d'Accélération de Transfert Technologique*, *Instituts de Recherche Technologiques*, *Pôles de compétitivité*, *Agence nationale pour la Recherche*, deep tech plan, modifications of the *Allègre* law through the *PACTE* law, *Fonds pour l'Innovation et l'Industrie*, and Innovation Council.

particularly well on foreign doctorate students, lifelong learning, venture capital investment and innovators ([35]).

The Innovation and Industry Fund (*Fonds pour l'Innovation et l'Industrie*) was not operational in 2018 due to a complex funding mechanism (Cour des Comptes, 2019). The Court of Auditors recommended that the Government replace the fund (amounting to €10 bn) with a support package for innovation integrated under the State's budget. Overall, France would benefit from a more efficient and concerted innovation strategy (Chouat et al., 2019) and the upcoming multiannual research programme law could help in this respect.

Closer links between public research and businesses could be improved by promoting entrepreneurship in researchers' careers. The status of researchers in France suffers from not being an attractive career (Berta et al., 2019). Low wages compared to other OECD countries, precarious contracts and complex administrative procedures are impeding factors ([36]). The poor results of Technology Transfer Acceleration Offices (*Sociétés d'Accéleration de Transfert de Technologies*) led the Court of Auditors to request the closure of the underperforming ones (Cour des Comptes, 2018b). The Action Plan for Business Growth and Transformation (*Loi relative à la croissance et la transformation des entreprises*, PACTE law) included measures to improve researchers' mobility between the public and private sectors, to simplify access by private firms to public research results and to reinforce the use of the industrial property protection. It is however too early to assess their impact.

Despite the highest number of graduates in science and engineering in Europe and the good quality of its researchers, France struggles to increase the efficiency of its public research system. France tops the ranking in the EU for new graduates in science and engineering (in 2017, 22.2‰ of the population aged 25-34, which has been increasing since 2016 and is well above EU average of 15.7 ([37])). The number of international co-publications has steadily increased since 2007 (58.4% of total number of publications in 2018) but French scientific publications only rank in 11th position (9.9% of scientific publications of the country within the top 10% most cited scientific publications worldwide, below the EU average of 10.3% in 2016 ([38])). Six years after its creation, the Strategic Research Council (*Conseil Stratégique de la Recherche*) has yet

([35]) The indicator 'innovators' include: SMEs product/process innovations, SMEs marketing/organisational innovations and SMEs innovating in-house (European Commission, 2019h)

([36]) A researcher with 7 years of experience earns €2,200 per month in France. In the UK, the average salary of a senior lecturer and researcher (function accessible 7 years after obtaining a Ph.D.) is €4,200, while in Japan, post doctoral fellows earn on average €3,000 (Chouat, F. et al, 2019)

([37]) Figure for 2018 not available

([38]) Figures for 2017 and 2018 not available

to identify research priorities as required by its mandate. While the National Institute of Research in Digital Sciences fully coordinates all actions in the artificial intelligence sector, the coordination of other research actions and the strategic planning are widely dispersed. Following a government decision, a draft law on a multiannual research programme is planned for 2020 to give visibility to laboratories, boost research projects in strategic areas and foster research partnerships (Vidal, 2019).

The evaluation of tax incentives for research, development and innovation delivered mixed results. The most important R&D tax credit scheme in France is the '*Crédit d'Impôt Recherche*'. It is one of the most generous tax credit scheme among OECD countries (€5.6 bn, 0.24% of GDP in 2018). This R&D tax credit alone accounts for about 60% of the total financial public support to business R&D in France. The contrast between the large amount of public support and its overall low impact has been questioned by several observers (Salies 2017, European Commission, 2019d). The evaluations recently published by the National Commission for the Evaluation of Innovation Policies (*Commission Nationale d'Evaluation des Politiques d'Innovation*) also showed additionality effects around 1 to boost private R&D spending but no clear conclusion could be drawn on the impact on innovation (France Stratégie, 2019c). Additional impact studies, focused on macroeconomic issues, are ongoing. Referring to a recommendation of the Court of Auditors, the government announced in the 2020 budgetary plan a reduction of the R&D tax credit contribution to the operating costs linked to research from 50% to 43% of staff cost, leading to a potential saving of €230 mn per year.

11.3. Additional R&I references

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

(…) **There is also room to improve investment-related economic policy**. (…) However, there is a need to simplify the overall research and innovation ecosystem. Recent evaluations of the R&D tax incentive (CIR) point to a limited impact of the instrument on innovation and productivity (see Section 4.4). The assessment of this CSR does not take into account the contribution of the EU 2021-2027 cohesion policy funds ([39]).

(…) **In 2019, France has made some progress ([40]) in addressing the country specific recommendations** (see Table 2.1**).** Substantial progress has been made in implementing

([39]) The regulatory framework underpinning the programming of the 2021-2027 EU cohesion policy funds has not yet been adopted by the co-legislators, pending inter alia an agreement on the multiannual financial framework (MFF).

([40]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a CSR is presented in the Overview Table in Annex A. This overall assessment does not include an assessment of compliance with the Stability and Growth Pact.

the measures to foster the growth of firms**.** Some progress has been made in addressing skills shortages and mismatches, focusing investment to ensure the energy transition, improving the digital infrastructure (…). Limited progress has been made in (…) improving the research and innovation performance and reducing regulatory restrictions.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in France, p 27]

(…) **EU Cohesion policy funding is contributing to transformations of the French economy** by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment, labour mobility**,** skills and social inclusion. By 2019, investments driven by the European Regional Development Fund (ERDF) have already led to connect to high speed broadband more than one million households, over 1,600 new researchers have been recruited, and support was already decided for 162,000 enterprises including 48,500 start-ups, generating 36,880 new jobs. (…) As an example, the COMPETITIV´eko project is promoting cross-border cooperation and knowledge exchange between SMEs, business clusters, technological centres and economic development agencies in the Basque Country and Navarre in Spain, and Nouvelle Aquitaine in France. Aimed at boosting the competitiveness of companies with few resources, it focuses on areas within the regions' smart specialisation strategies. This will enable each region to develop its own competitive advantages where common interests exist.

[4.1, Public Finances and Taxation, Deficit development, p 27]

(…) **Social protection and healthcare represent more than half of total public expenditure.** (…) In turn, expenditure on general public services and on economic affairs amounted to 11.0% and 10.2% of the total, respectively. The latter includes, among others, expenditure on transport, energy, on general economic, commercial and labour affairs and on research and development.

[4.1, Public Finances and Taxation, Taxes on capital, p.33)

(…) **While it is too early to assess the impact of the reform of capital taxation ([41]) on investment, first results point to an increase in the attractiveness of France.** Researchers (France Stratégie 2019a, IPP2019a) consider it is too early to conclude whether the reform is bearing fruit on investment, as not enough data will be available until 2021 (…).

[4.4.1. Productivity Trends, p.49]

([41]) Transformation of the wealth tax (ISF) into a real estate wealth tax (IFI) and implementation of a flat tax on some capital revenues (dividends, interests and capital gains) at 30% since 2018

(…) **Apart from the factors common to all advanced economies, the French National Productivity Board identified weaknesses in skills and technology adoption to explain weak productivity growth**. The National Productivity Board report concluded that the major factors explaining the weak productivity growth of the French firms were the low skills of the workforce compared to the OECD average, skills mismatches (see Section 4.3) and the low performance due to low uptake of information and communication technologies (Guillou et al, 2018). More broadly, weak innovation performance is also cited as a hindering factor, including insufficient business innovation, a low degree of automation and digitalisation, and the lack of coordination between public and private research and development (see section Research, development, and innovation).

[4.4.2. Investment, p.50]

(…) **Productivity and non-price competitiveness challenges as well as energy transition could be addressed by targeted investments**. (…) Additional, more efficient or repurposed investments in research and development, innovation, digitalisation and skills could be relevant to address competitiveness and productivity challenges in the long term. Indeed, expected benefits include design of new innovative products, access to new markets, better quality of exported goods and services, enhanced participation in global value chains, and improved management. Energy transition requires investments to mitigate climatic evolutions and stimulate sustainable and inclusive growth.

[Box 4.4.5: Investment challenges and reforms, p.52]

(..) **Barriers to investment are overall moderate in France.** Firms continue to face a relatively heavy and complex regulatory framework, and legislative instability weighs on business perception. Nevertheless, several reforms are being implemented (e.g. PACTE or ESSOC laws) to ease the administrative burden and foster firms' growth. The labour market and unemployment benefit reforms may as well address obstacles to invest (EIB, 2019). Public support for R&D is characterised by complexity and low levels of efficiency, which may hamper the growth prospects of small and young firms and the development of new research activities.

Artificial Intelligence: Prophesee
A loan of €20 mn supports the growth of Prophesee, a pioneering French company in artificial intelligence, specialising in the design of neuromorphic vision sensors and artificial intelligence algorithms. With this loan, the company will continue its research and development on innovative technologies for autonomous cars, health and the Internet of things.

InvestEU - the next EU investment programme for 2021-2027

The InvestEU programme will build on the successful model of the Investment Plan for Europe and bring together, under one roof the main European investment tools. The

policy-driven model will finance four main areas, all relevant for France: (i) sustainable infrastructure (sustainable energy and digital connectivity), (ii) research, innovation, and digitisation (research to market and digitisation of industry are highly relevant for France), (iii) small businesses, and (iv) social investment and skills.

[2019 country specific recommendations (CRSs), p.72]

CSR 3: Focus investment-related economic policy on research and innovation (while improving the efficiency of public support schemes, including knowledge transfer schemes), renewable energy, energy efficiency and interconnections with the rest of the Union, and on digital infrastructure, taking into account territorial disparities. Focus investment-related economic policy on research and innovation (while improving the efficiency of public support schemes, including knowledge transfer schemes),	France has made **some progress** in addressing CSR 3. **Limited progress**. Some evaluations of the R&D tax incentive (*Crédit d'Impôt Recherche*) have been carried out and point to a limited impact on innovation. Additional impact studies, focused on macroeconomic aspects, are on-going. The Innovation and Industry Fund is not yet operational as pointed by the Court of Auditors. More incentives for researchers working in the public sector to collaborate with industry have been proposed in the PACTE Law. Overall, the R&D&I system in France remains very complex with numerous funding tools and structures.

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for France, p84]

(…) In order to tackle these transition challenges, investments needs have been identified to diversify the regional economy and alleviate the socio-economic costs of the transition. The smart specialisation strategies (42) of these regions provide an important framework to set priorities for innovation in support of economic transformation.. In addition, Hauts-de-France is funding the digitalisation of local SMEs in the framework of the European Commission pilot action "Regions in Industrial Transition". The Just Transition Fund could complement these efforts by targeting its actions in particular on:

- investments in the creation of new firms, including through business incubators and consulting services;

([42]) As defined in Article 2(3) of Regulation (EU) No 1303/2013 (CPR)

- investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- investments in research and innovation activities and fostering the transfer of advanced technologies;

12. GERMANY

12.1. Executive summary

Meeting sustainability goals and raising growth potential at the same time requires steady long-term investment efforts, in particular in network industries and in education, training, research and innovation. (…) Higher investment in research and innovation can accelerate the pace of transition to a carbon-neutral and circular economy. Higher expenditure on education and skills could make the future labour force more productive and alleviate the impact of demographic ageing.

Overall, Germany has made limited ([43]) progress in addressing the 2019 country-specific recommendations. (…) There has been some progress in:

- achieving an upward trend in investment, including in research and innovation;

Regarding progress in reaching the national targets under the Europe 2020 strategy, Germany is performing very well on the employment rate, on reducing poverty and on investment in R&D.

12.2. Research and Innovation

Germany invests considerable resources in R&D but private investment in R&D is increasingly concentrated in large firms, while SMEs and start-ups face challenges. R&D intensity has increased during in recent years, from 2.5% of GDP in 2007 to 3.1% in 2018 (third highest in the EU). A new national R&D intensity target of 3.5% by 2025 was included in Germany's high-tech strategy (BMBF, 2018). With two thirds of R&D performed in the business sector, German business R&D intensity (2.2% in 2018) is the third-highest in the EU. However, business R&D is predominantly performed by large firms in R&D-intensive industries, whereas SMEs' R&D expenditure has stagnated over the past decade (ZEW, 2019). Germany ranks eighth in the European Innovation Scoreboard (EIS) and its performance has stagnated since 2011. Recent years have seen a decrease in particular in SMEs' level of innovation activities. This is reflected in the numbers of SMEs introducing product or process innovations, introducing marketing or organisational innovations, or innovating in-house. The 2019 EIS ranked Germany

([43]) Information on the level of progress and measures taken in response to the policy advice in each subpart of a country-specific recommendation is presented in the overview table in the Annex A.

eighth, sixth and eighth, respectively, for these indicators, while in 2011 Germany was first in all three (European Commission, 2019f; Pellens et al., 2020).

Following a decreasing trend over the last 15 years, the start-up rate in Germany declined further in 2018. German start-ups still face difficulties in attracting funding (KfW, 2019b). The government launched several initiatives to address these key challenges (see Section 4.2). Programmes such as EXIST-Potential and Young Entrepreneurs in Science support entrepreneurship among students, while a new Transfer Initiative aims to improve science-industry knowledge transfer. There are plans to expand existing cluster initiatives in 2019 with a new Future Cluster Initiative. An agency for the promotion of disruptive innovation has been set up and is scheduled to start operations in 2020. The German Parliament adopted a new law introducing a tax incentive for R&D from 1 January 2020. The law allows businesses to claim a tax credit worth 25% of the eligible expenses (personnel costs of research staff or 60% of the fees for subcontracting). All companies regardless of size are entitled to the incentive for qualifying R&D projects. However, the base is capped at € 2 million, translating into a maximum tax credit of € 500,000 per company per year, which should benefit mainly SMEs. The tax credit can be paid out even where there is no tax liability.

Ensuring a sufficient supply of highly skilled workers is vital for business investment in innovation and digitalisation and for high-growth enterprises. The lack of qualified personnel is the most important factor hampering investment in innovation and digitalisation, in particular for SMEs and high-growth enterprises (European Commission/European Central Bank, 2019; ZEW, 2019; Pellens et al., 2020). This is despite some positive trends over the last 5 years. Regarding 25-34 year-olds, these trends include increases in the proportion who have successfully completed tertiary education, in the numbers of new graduates in science and engineering, and in computing graduates (European Commission, 2019f). In terms of ICT graduates, despite a small increase from 4.5% (in 2016) to 4.7% (in 2017) of total graduates, there is still a lack of ICT specialists in the country. The number of IT specialist vacancies increased by 51% from 82,000 in 2018 to 124,000 in 2019. IT specialist positions are unoccupied for sixth months on average (Bitkom, 2019). The proportion of female ICT specialists in Germany is slightly below the EU average (1.3% vs 1.4% of total graduates) (European Commission, 2019g).

The generally strong performance of the innovation ecosystem is supporting the development of high-growth businesses, while shortages of skilled staff are hampering it. Limited access to early-stage and growth finance (see Section 4.2), and the scarcity of staff with the right skills are considered major obstacles to investment by high-growth businesses (Flachenecker et al., 2020). This problem is partly rooted in demographic changes, as the cohort of people with the most entrepreneurial activity (aged 30-50) has been shrinking over recent decades. Furthermore, Germany faces a general shortage of qualified labour for particular professions (Pellens et al, 2020). A number of policy initiatives are under way to address skills shortages. In December 2018, the federal government adopted the new skilled labour strategy. A new immigration law, entering into force in March 2020, aims to increase immigration of

skilled labour from third countries. To create a stronger culture of life-long learning, the government adopted in July 2019 a National Continued Education Strategy. The MINT action plan, adopted in February 2019, aims to increase the attractiveness of science and technology education.

Research and innovation have a key role to play in ensuring an effective and credible climate policy. In its 2030 climate action programme, adopted in 2019, the government recognised that climate protection requires the mobilization of the entire innovation system, a strong entrepreneurial commitment to R&D, further governmental research and innovation impetus, and research funding. Specific R&D support is envisaged to help expand the use of climate-friendly, low- or zero-emission, technologies. Within the overall concept of 'Research Factory for Batteries', support will be provided for technology development and innovation along the entire battery value chain including sustainable recycling. There is also a focus on options for storing and using CO_2 and a hydrogen strategy will be developed.

12.3. Additional R&I references

[Economic situation and outlook, p. 10]

Private investment remains solid despite slowing economic growth. … Altogether, private investment's share of GDP increased to 19.2% in 2019. The fastest growing components in recent years have been housing (see Section 4.4) and other investment (comprising essentially research and development and other intellectual property).

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

EU cohesion policy funding has made a valuable contribution to Germany's economic transformation. Through the promotion of research, technology and innovation, but also environment-friendly economic development and SMEs, substantial progress has been made since 2014. By end 2018 the European Regional Development Fund (ERDF) has supported 18,300 businesses and 2,000 start-ups. Furthermore, it has contributed to the creation of over 6,700 new jobs in enterprises and improved infrastructures for more than 2,400 researchers.

[Imbalances and their gravity, p. 18]

Combining investment policies with structural reform is a potentially powerful tool. Stronger investment in innovation, quality education and skills, very high-speed broadband networks, sustainable transport, electricity infrastructures and affordable housing, could be combined with a set of structural reforms to unleash productive potential.

[Box 3.2: Spillovers of a sustained increase in public investment – the case of Germany, p. 20]

The European Commission's QUEST model([4]) was applied to simulate the impact of increasing public investment by 1 percentage point of GDP over a period of 10 years. Such a policy would largely go in the direction of the proposal of a study commissioned by the German Trade Unions and the Employers' Association (Bardt et al., 2019) to implement an investment programme totalling €450 billion over the next 10 years (around 1.3% of GDP annually). This is the estimated additional investment required to meet Germany's investment needs in the areas of decarbonisation, digitalisation, transport, education and research and development.

[Financial Sector, p. 36]

Recent initiatives focus on providing finance to high-tech and innovative sectors. Other relevant initiatives include the expansion of the Tech Growth Fund with Venture Tech Growth, and the expansion of the Collective Industrial Research Programme. In October 2018, KfW's programmes were pooled in KfW Capital as an independent growth-oriented venture capital company, which committed €147 million of investment until October 2019.

[Competitiveness reforms and investment, p. 46]

According to the Council of Economic Experts, which has been appointed as the German National Productivity Board, the main drivers of productivity growth in the future are investment in education, research and innovation and an environment that sets the right incentives for private investment (German Council of Economic Experts, 2019b). The Federal Ministry for Economic Affairs and Energy published a new 'SME Strategy' and a 'national industry strategy for 2030', which contain measures to foster innovation and improve the framework conditions for businesses, including corporate taxation and competition.

[Resource productivity, p. 49]

A recent study suggests that public support for innovations with environmental benefits (eco-innovations) is an effective policy measure to significantly increase firms' material productivity (Flachenecker and Kornejew, 2019). The study further shows that this improvement has led to substantial increases in firms' competitiveness, while reducing their carbon footprints (SDGs 8, 12 and 13).

[Digital Single Market, p. 57]

The National Pact for Cybersecurity is bringing together all relevant stakeholders to implement the measures envisaged under the national cybersecurity strategy, such as the Creation of an Agency for Innovation in Cybersecurity and the introduction of an IT-Security Label to inform consumers about IT security features in products.

[Box 4.5.7: Transformation of the transport sector, p. 58]

With its strong innovation ecosystem, transport-vehicle manufacturing basis and well-developed infrastructure, Germany has the capacity to be at the forefront in developing new technologies which can enable the transport sector to shift towards greater sustainability and environmental and climate protection. The expected growth in the market for electric vehicles will lead to a significant increase in demand for batteries. Batteries' sustainability, environmental and energy performance will become increasingly important as the market grows. Through the European Battery Alliance, Germany is actively promoting the development of a competitive and sustainable battery value chain.

[Just Transition, p. 61]

The federal government will fund additional measures in its own remit (e.g. rail and road infrastructure, research institutions). These projects amount to up to €26 billion, adding up to a total budget of up to €40 billion until 2038. (…)

Given the weight of coal-related economic activity and the more peripheral nature of the Lausitz region, the transition to an innovation-based economy looks especially daunting there. The European Commission has proposed a Just Transition Fund to support people in the regions most affected (see Annex D).

[[Annex A, Overview table, p. 63]

2019 country-specific recommendations (CSRs)	
CSR 1: While respecting the medium-term budgetary objective, use fiscal and structural policies to achieve a sustained upward trend in private and public investment, in particular at regional and municipal level. Focus investment-related economic policy on education; research and innovation; digitalisation and very-high capacity broadband; sustainable transport as well as energy networks and affordable housing, taking into account regional disparities. Shift taxes away from labour to sources less detrimental to inclusive and sustainable growth. Strengthen competition in business services and regulated professions.	Germany has made **Limited Progress** in addressing CSR 1
research and innovation;.	Some Progress Germany invests considerable resources in R&D, still private investment in R&D is increasingly concentrated in large firms while SMEs and start-ups face challenges. R&D intensity has increased during the last years, from 2.46% of GDP in 2007 to 3.13% in 2018 (3rd highest in the EU). A new national R&D intensity target of 3.5% by 2025 was included in Germany's High Tech Strategy (BMBF, 2018). With two thirds of the R&D performed in the business sector, German business R&D intensity (2.16% in 2018) is the third highest in

	the EU. However, business R&D is predominantly performed by large firms in R&D-intensive industries, whereas small and medium-sized enterprises' R&D expenditure has stagnated over the past decade.

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for Germany, P. 77/78]

A second affected area will be the Mitteldeutsches Revier, which is comprised of eight regions (Leipzig, the City of Leipzig, and Nordsachsen situated in the Land Saxony, and Burgenlandkreis, Saalekreis, the City of Halle, Mansfeld-Südharz, and Anhalt-Bitterfeld situated in the Land Saxony-Anhalt). Even though the share of directly employed (0.32% or 2,400 workers in 2016) and indirectly employed (0.2% or 1,400 workers) in the lignite sector is smaller, the Mitteldeutsches Revier will face challenges due to very low innovation and research potential and a rapidly aging population. (…)

In order to tackle these challenges, priority investment needs have been identified for diversifying and making the regional economy more knowledge and service-based. Furthermore, investment needs for alleviating the socio-economic costs of the transition have been identified. The smart specialisation strategy[44] of the Länder provides an important framework to set priorities for innovation in support of economic transformation in the three Reviere. The Just Transition Fund could complement these efforts by targeting its actions in particular on:

- Productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- Investments in the creation of new firms, including through business incubators and consulting services;
- Investments in research and innovation activities and fostering the transfer of advanced technologies;

13. GREECE

13.1. Executive summary

On progress in reaching the national Europe 2020 strategy targets, Greece is performing well on reducing the rate of early school leavers, increasing tertiary education attainment and reducing greenhouse emissions. It is on track to reach its targets on research and development, the use of renewable energy resources and energy

efficiency. By contrast, the employment rate and poverty reduction fall short of the target.

Productivity growth remains low and is coupled with high investment needs. Despite gradually recovering, the Greek economy still faces low investment, in particular by the private sector. Flagship privatisation projects and attracting foreign direct investment are crucial for increasing private investment. Other factors holding back productivity growth include: (i) low business investment, notably in research and development, (ii) a still high regulatory burden, (iii) inefficiencies in public administration and the justice system, iv) access to finance constraints, and (v) skills mismatches.

13.2. Research and Innovation

Although Greece has improved its innovation performance, it continues to be a 'moderate innovator'. Creation and diffusion of innovation is a key driver of productivity growth. Greece ranked among the lowest countries in the Commission's 2019 European Innovation Scoreboard (European Commission, 2019e). It performs particularly well on innovation in small and medium enterprises and on the linking of these enterprises with others. Greece is also doing well in increasing its share of employment in fast growing innovative sector businesses and in knowledge-intensive activities. However, Greece lags behind in terms of creating an innovation-friendly environment with adequate levels of finance and support.

Public and private spending on research and development as a percentage of GDP has been steadily increasing since 2010, but is still relatively low. At 1.18% in 2018, Greece is approaching its national target of research and development intensity of 1.30% of GDP set for 2020 ([45]). Despite this increase, Greece remains below the EU average (2.11%) (European Commission, 2019j). The business sector continued to be the largest contributor to total spending, which amounted to 0.57% of GDP, of which two thirds came from the service sector (OECD, 2017).

While employment in research and development activities is increasing, the loss of skilled human capital is a major challenge for the Greek research and innovation system. In 2018, the number of people engaged in research and development activities increased by about 7.4% overall; the increase for researched was notably 4.7% (European Commission, 2018d, provisional). However, the brain drain continues to be one of the most important challenges (see also Chapter 4.3 and Amanatidou et al, 2020). Policy initiatives such as the establishment of the Hellenic Foundation for Research and Innovation, to promote research activity and support new researchers, and the Knowledge Bridges, which maps the profiles of highly skilled Greek professionals abroad and supports networking, are steps in the right direction.

([45]) The target was set in Greece's 2019 national reform programme and was revised upwards from 1.2% of GDP.

Links between academia and the productive sector remain weak. While Greek universities perform well in terms of research output, this is not converted into productive uses, as demonstrated by the comparatively low number of patents ([46]). Furthermore, private funding for public research and development as a percentage of GDP is slowly increasing (0.041% in 2017 from 0.031% in 2016). Nonetheless, the level of public-private scientific co-publications remains comparatively low (2.3%, as a percentage of total number of publications in 2018, compared to the EU average of 5.6%). As a policy response, the country launched the 'Research-Create-Innovate' funding scheme in 2017 to encourage business research, development and innovation and knowledge transfer.

Innovation performance in Greece has not yet reached its full potential. Greece has integrated smart specialisation strategies in its innovation policy framework (47). According to the latest Community Innovation Survey (European Commission, 2019f), 57% of Greek businesses engage in innovative activity (above the EU average of 51%), pointing to a relatively high engagement of businesses in the innovation process. However, large disparities in innovation capacities remain, due to lack of robust governance, including low administrative capacity and weak coordination mechanisms. In this context, Greece is faced with particular challenges in developing adequate responses for the territories most likely to be affected by the industrial transition towards sustainability ([48]). Only 3 out of 13 regions established a Smart Specialisation Technical Office, and only one is operating. Business mobilisation also remains low at regional level. Finally, innovation and growth enabling finance remains limited, as supply of seed, start-up and 'later stage' venture capital investment remains around half of the EU average: 0.02% of GDP in 2018, compared to 0.05% of GDP in the EU (Invest Europe, 2019, Flachenecker et al., 2020).

13.3. Additional R&I references

[1. Economic Situation and Outlook, Potential growth p.9, Regional disparities p.12]

Low investment in research and development, high regulatory burden and skills mismatches weigh on productivity growth. By a variety of metrics, Greece is one of the countries with the lowest business dynamism in the EU. High regulatory burden, and inefficiencies in the public administration and the justice system hinder

([46]) 11 Patent Cooperation Treaty patents per population in 2014 versus an EU average of 102.

([47]) Smart specialisation is set as an ex-ante conditionality in the cohesion policy (2014-2020) policy framework, requiring every Member State and region to have a well-developed strategy in place as a pre-requisite for receiving any EU Structural Funds support for their planned innovation measures. In this context, Greece developed a centrally administered national research and innovation smart specialisation Strategy (RIS3), and 13 regional strategies, which were approved in 2015.

([48]) During the 2021-2027 European Regional Development Fund programming period, all Member States will have to demonstrate preparedness to manage industrial transitions.

productivity growth. Low business investment in research development and innovation, the relatively low labour market relevance of education, and increasing skills mismatches also point to weak growth prospects in the future. Reform efforts in the last years are slowly bearing fruit, as visible in the mildly positive total productivity developments in the past year.Low business investment in research development and innovation, the relatively low labour market relevance of education, and increasing skills mismatches also point to weak growth prospects in the future.

[1. Economic Situation and Outlook, Regional disparities p.12]

[...]The large disparities in GDP per capita are due to a number of regional disparities in areas such as labour productivity, labour market conditions, investment, research and development activity, innovation and competitiveness (see section 4.4.4).

[2. Progress with country specific recommendations, P.16]

Some progress has been made in promoting investment in research and development. Total spending on research and development, as a share of GDP, has been steadily increasing since 2010, reaching 1.18% in 2018, but is still lagging significantly behind the EU average (2.11%). In December 2019, the authorities completed the evaluation of 2,912 proposals submitted in the context of the flagship call "Research-Create-Innovate". Overall, the budget of all announced calls regarding research and development has reached € 877 million.

[Table 2.1: Overall assessment of progress with 2019 CSRs]

Some progress in focusing investment-related economic policy on research and development

[3. Summary of the main findings from the MIP in-depth review, Evolution and prospects, p.20]

(…) Other sectors such as information technology services, research and development, and other business services could help to diversify service exports (see Box 4.4.1).

[4. Reform priorites, 4.3. Labour market, education and social policies, 4.3.2. Education and skills, p.38]

(…) While Greek universities perform well in terms of research output, they underperform on teaching quality (Hellenic Quality Assurance and Accreditation Agency, 2019).

[4.4. Competitiveness, reforms and investment, 4.4.4. Regional disparities, p.59]

(…) There are important gaps across regions also regarding investment in research and development: research and development expenditure ranges from 1.53% of GDP in Kriti to as low as 0.19% in Notio Aigaio. This low intensity of research and development weighs on Greece's growth potential.

The 2019 Regional Innovation Scoreboard considers nearly all of the Greek regions as "moderate innovators". In line with the low intensity of research and development, the Notio Aigaio region is assessed as only a "modest innovator", while Kriti stands out as a "strong innovator".

[Box 4.4.6*:* EU funds and programmes to address structural challenges and to foster growth and competitiveness in Greece, p.66]

EU cohesion policy funding helps to transform the Greek economy by promoting growth and employment. By 2019, investments driven by the European Regional Development Fund and the Cohesion Fund had improved energy efficiency in 19 100 households, and 42 800 people benefitted from a modern water supply and wastewater facilities. So far, financial support to 18 600 businesses has generated 6 300 direct jobs; projects worth €1 billion have been approved for co-financing in the field of innovation and research;

Agricultural and fisheries funds also help address the country's investment needs. Greece benefits from the European Agricultural Fund for Rural Development (EARDF) with €5 billion and the European Maritime and Fisheries Fund (EMFF) with €523 million. It also benefits from other EU programmes such as the Connecting Europe Facility, which contributes €575 million to strategic transport networks and Horizon 2020, which has allocated €1 billion to research and innovation actions.

[Annex A: Overview table, Research and development, p. 75]

Some progress. Despite steady increases in total spending on research and development since 2010, Greece is still lagging behind the euro area average (1.18% for Greece in 2018 compared to 2.11% for EU). Nonetheless, there are persisting weaknesses, with the loss of skilled human capital remaining a major challenge. Despite a relative high engagement of businesses in innovative activities, the production of academic research is not appropriately oriented to support the productive sector, as reflected by the low number of patents. Further, large disparities in innovation capacities remain, due to lack of robust governance, including low administrative capacity and weak coordination mechanisms. In December 2019, the authorities completed the evaluation of 2,912 proposals submitted in the context of the flagship call "Research-Create-Innovate". Overall, the budget of all announced calls regarding research and development has reached €877 million.

[Annex a: Overview table, Research and development, R&D target: 1.30% of GDP, p.77]

In 2018, Greece reached a research and development intensity of 1.18% of GDP, according to provisional data by Eurostat (compared to 1.13% of GDP in 2017).In 2018, research and development intensity was composed of 48% private investment (0.57% of GDP) and 51% public investment (0.60% of GDP).

14. HUNGARY

14.1. Executive summary

Increased investment in research, innovation, infrastructure and skills are essential for improving productivity and for 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 towards raising productivity. Research and innovation capacities need to be enhanced to improve moderate innovation performance. Territorial inequality could be alleviated by improving infrastructure and public services in deprived areas. Investment is crucially needed in skills, education and training to boost future economic growth in Hungary. Other relevant investment spending items are childcare, healthcare and social inclusion. Greening the economy requires investment in energy efficiency, climate change resilience and waste management. The institutional framework needs to improve to ensure that the economic and social benefits of these investments are maximised.

Hungary has made limited progress ([49]) in addressing the 2019 country-specific recommendations.

There has been limited progress in the following areas:

(…) The Hungarian economy allocates an increasing amount of funding to investment in research and innovation and transport but framework conditions remain weak. (…)

Regarding the progress in reaching the national targets under the Europe 2020 Strategy, Hungary is performing well in boosting the employment rate, reducing relative poverty and reducing greenhouse gas emissions. More effort is needed to raise research and development spending, higher education attainment, energy efficiency and renewable energy use and to reduce early school leaving.

Key structural issues analysed in this report, which point to particular challenges for Hungary's economy, are the following:

- **Despite recent improvement, output per worker remains among the lowest in the EU.** Domestic companies mainly contribute to international production chains through assembly-type activities, which add little local value. This specialisation is

([49]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a country-specific recommendation is presented in the overview table in the Annex.

related to the still moderate innovation performance of the Hungarian economy despite increasing expenditure on research, development and innovation. The shortage of highly skilled workers is a key obstacle to innovation. Cooperation among researchers and businesses is weak, hindering knowledge transfer from abroad, and towards smaller domestic enterprises. Hungary's adoption of productivity-enhancing digital technologies is among the lowest in the EU, and it is hindered by low digital skills.

- **Educational outcomes are below the EU average and large differences between schools remain, hindering social mobility.** (...) The shrinking pool of applicants to higher education is likely to limit tertiary educational attainment rates, which holds back innovation and productivity growth. The shortage of teachers is increasingly challenging.

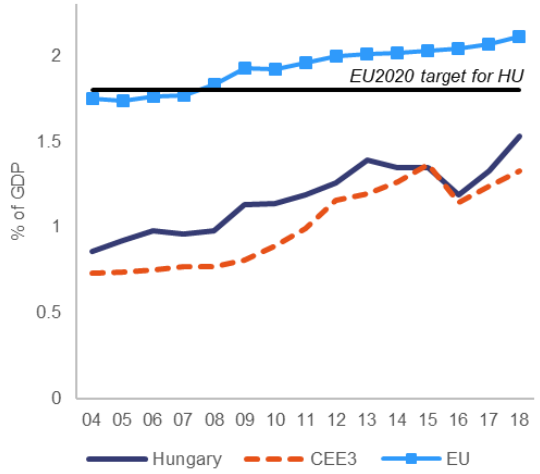
14.2. Research and Innovation

Strengthening the research and innovation capacity of domestic firms could secure long-term growth and competitiveness. According to the European Innovation Scoreboard (European Commission, 2019f), Hungary is a moderate innovator with an increasing performance, and has progressed towards Sustainable Development Goal 9. There is scope for improvement by increasing the supply of high-skilled labour, raising R&D expenditure in the public sector and encouraging cooperation among potential innovators.

Spending on R&D is increasing slowly, but remains below the 2020 target. R&D spending increased from 0.98% of GDP in 2008 to 1.53% of GDP in 2018. This value is high among Central Eastern European countries, but lower than the EU average of 2.11% and Hungary's 2020 target of 1.8% (see Graph 3.4.3). The increase over the years took place in the business sector, while R&D spending in the public sector decreased by 0.09% of GDP between 2008 and 2018.

Public support for private R&D is large. According to the State Aid Scoreboard, business R&D and innovation expenditure benefited from state subsidies worth 0.35% of GDP in 2017, the highest level in the EU. Tax exemption schemes include tax credits for small and medium-sized enterprises when buying tangible assets; and a tax credit for large-scale investments (above HUF 100 million) in research, which can be carried forward for 12 years. Such incentives can promote innovation but also warrant monitoring against misuse.

Graph 3.4.3: **R&D expenditure**



(1) CEE3 is the average of Czechia, Poland and Slovakia
Source: Eurostat

The shortage of talent and skill limits the innovative activity of Hungarian enterprises. In 2018, 28% of enterprises performed innovation, which is below the EU (34%) and regional (39%) average (EIB, 2019) ([50]). Obstacles to innovation include the limited supply of highly skilled labour. Tertiary education attainment rates are among the lowest in the EU (see Section 3.3.3). The number of science, engineering and computing graduates was 11.9 per 1,000 population in the 25-34 age group, compared to the EU average of 18.3.

Weak cooperation limits the country's research and innovation capacity. Participation in Horizon 2020 projects is modest, highlighting the low level of international cooperation by research entities. As a result, Hungarian scientific performance lags behind the EU average in terms of highly cited publications or international co-publications. Cooperation with the business sector is mostly limited to large companies due to the lack of demand and capacity of smaller firms. Researchers seldom bring their results to the market. The roll-out of the 8 Higher Education and Industry Cooperation Centres (FIEKs), aimed at improving academia-business cooperation, continued in 2019.

Recent changes have increased government influence over scientific institutions. A National Science Policy Council (NTT) was set up to advise the government on strategic issues and supervise the operation of the National Research, Development and Innovation Fund. In addition, the research institute network of the Hungarian Academy of Sciences was separated from the Academy and reorganised under the newly founded

([50]) Regional peers include Czechia, Poland and Slovakia. Data of the latest Community Innovation Survey refer to 2016. They show that 29% of Hungarian firms performed innovation, compared to an EU average of 50.6%.

Eötvös Loránd Research Network (ELKH). Through the appointment of members to the new bodies, the government has increased its influence over the R&D field, creating uncertainty to guarantee scientific freedom. An increasing proportion of public sector researchers are considering leaving for the private sector or abroad; these intentions are particularly high among talented, young and competitive researchers (Nyírő et al., 2019). Policy uncertainty may negatively impact the successful Momentum (Lendület) Programme, under which the Hungarian Academy of Sciences attracts young researchers from abroad. If established researchers exit the system, it could become an obstacle for future European Research Council and Horizon 2020 participations. Moreover, the end of the Central European University's academic operations in Hungary, the largest Horizon 2020 beneficiary, risks cutting off the access of local partner universities to international R&D programmes.

Unclear governance and a limited involvement of stakeholders have so far prevented Hungary from grasping the full benefits of smart specialisation. The mobilisation of innovation actors throughout the smart specialisation process has been unbalanced and piecemeal. Recent efforts to set up Territorial Innovation Platforms can help to improve the engagement of stakeholders, and reach a more selective definition of investment priorities and improved monitoring. Still, frequent institutional changes are a challenge for coordination and the distribution of tasks.

14.3. Additional R&I references

[1. Economic Situation and Outlook - Productivity and potential growth p. 8]

(…) Microeconomic factors, including low innovation activity and the slow reallocation of resources towards more productive firms, continue to hold back productivity growth (see Section 3.4.1).

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

(…) Limited progress has been made in focusing investment-related economic policy on research and innovation, low-carbon energy, transport infrastructure, waste management and energy and resource efficiency, taking into account regional disparities.

[Box 2.1 EU funds and programmes to address structural challenges and to foster growth and competitiveness in Hungary p. 18]

(…) **EU Cohesion policy funding is contributing to major transformations of the Hungarian economy.** Cohesion policy funds are supporting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility.

[3.4.1. Productivity and investment trends p. 36]

The innovation system does not adequately support the growth of leading firms. Contrary to international experience, productivity growth of the most efficient

Hungarian firms has been slower than that of laggard firms, and they have progressively fallen behind the global productivity frontier (Muraközy et al, 2018). The productivity of national frontier firms could benefit from less cumbersome product market regulations and excellence in higher education and research (Andrews et al., 2015), areas where Hungary lags behind the most innovative economies.

The shortage of skills limits local firms' ability to add more value to global production chains. Hungarian firms typically focus on 'midstream' fabrication activities, which contribute less to the value of final products than upstream (e.g. design) or downstream (e.g. marketing) tasks (Ali-Yrkkö and Rouvinen, 2015; see Graph 3.4.2). This specialisation pattern persists even in recent greenfield foreign direct investment across Central Eastern Europe (Stöllinger, 2019). Domestic firms may gradually acquire other tasks (e.g. research and development, support services) that improve their value capture, but this process is gradual and not guaranteed (Szalavetz, 2017). High value-added activities of global value chains could be attracted by offering cutting-edge skills and knowledge (Jensen and Pedersen, 2012), which are in limited supply in Hungary (see also Section 3.3.3). Among smaller enterprises, low innovation activity, a lack of production scale and a shortage of skilled employees are the key barriers to productivity growth and to participating in global value chains (HIPA, 2019).

[Box 3.4.1 Investment challenges and reforms in Hungary p. 38, in the R&I chapter, most probably due to editing reasons]

(…) The limited availability of skilled labour is an obstacle for investment and innovation, especially for smaller and less productive firms that cannot afford wages as high as their larger counterparts. The cyclical slowdown of economic growth may alleviate labour shortages to some extent (see Section 1). However, progress to improve education outcomes is slow and the impact of such policies takes hold only gradually. Therefore, the low level of basic competences, limited supply of tertiary education graduates (see Section 3.3.3) and lack of digital skills remain bottlenecks for investment in the medium term.

Box 3.4.2: **Challenges and opportunities of the automotive industry in Hungary**

The automotive industry plays a crucial role in the Hungarian economy. In 2018, it generated 16.5% of export revenue and 4.3% of gross value added, accounted for 2.6% of domestic employment, and hosted 11.4% of the inward foreign direct investment stock at the end of 2018. In all these dimensions, the sector has a greater role in the Hungarian economy than in the rest of the EU, as with other Central Eastern European countries. The sector has contributed significantly to economic growth, adding on average 0.4 percentage points to annual GDP growth since 2010. Yet, in the longer term, the industry faces **increasing global and domestic challenges** and its role is at risk, due to a combination of **rising labour costs**; tightening **environmental standards**; **technological change** in the form of alternative drivetrains and autonomous vehicles; and **trade-policy-related risks** to global supply chains. This box takes stock of the various forces that create a need to adapt in the automotive industry.

The first challenge concerns the position of Central Eastern European countries in automotive supply chains. (…) Domestic value added could rise with the involvement of more Hungarian suppliers or if foreign-owned companies took on service activities that generate more value added ('functional upgrading'). The participation of domestic suppliers is hindered by skill shortages at the level of workers and managers, limitations in manufacturing capacity and product development capabilities (HIPA, 2019). There is some evidence of functional upgrading in foreign-owned companies; for example, the number and the employment of automotive R&D centres in Hungary is growing. However, the acquisition of more advanced tasks could be limited by structural features of the automotive supply chain. Lead firms and their global suppliers maintain tight control over design and strategic R&D activities, which are typically concentrated around the headquarters ([5]). More sophisticated service tasks could be attracted to local subsidiaries through improving human capital and national R&D capabilities, which can offer strategic advantages to lead firms, such as access to cutting-edge technologies. One promising example is the recently built ZalaZone test facility and the autonomous mobility research cluster developing around it.

The second challenge concerns the ongoing shift towards electromobility. (…) On the other hand, these assembly facilities might serve as a stepping stone to attract later investment in research and development. Electric vehicle production could also take off thanks to the start-up manufacturer Fox Automotive. The government's e-mobility strategy (Jedlik Ányos Plan 2.0) plans to expand the charging infrastructure for electric vehicles, and to support domestic research and development in electric mobility.

The third group of challenges stems from international regulatory change and policy uncertainty. (…) However, there is competition both from lower-cost production sites (potentially outside the European Union) and from host countries where the increasing use of Industry 4.0 technology might bring a revival of production. The region's specialisation in cost-sensitive midstream activities was historically driven by the cost advantage compared to Western Europe, but in the longer term this is expected to erode as wages catch up with real convergence. The adoption of Industry 4.0 technologies (especially robots and smart factories) could boost efficiency. So far, about a quarter of domestic suppliers have embraced these technologies (PWC, 2018; HIPA, 2019). Several schemes are already in place to support this process, but the availability of skilled workers remains a bottleneck.

Preserving cost competitiveness while improving local capabilities remains a dual challenge for the local automotive industry. The government has started to move beyond the traditional strategy of attracting assembly-line production to the country through investment incentives by encouraging local R&D activities and launching several targeted programmes for potential local suppliers. However, the underlying issues of skills shortages and modest innovation capacity need

to be addressed by more comprehensive measures to improve education outcomes (see Section 3.3.3) and the performance of the R&D system (see Section 3.4.1).

[3.4.2 Institutional performance and the business environment, p.44]

(…) Fast-track legislation, combined with the high turnover of laws, reduces transparency and the stability of the legal framework. It increases compliance costs for businesses and it can discourage innovation and high value-added investments.

[Annex A. Overview table, p.56]

CSR 3: Focus investment-related economic policy on research and innovation, low-carbon energy, transport infrastructure, and waste management and energy and resource efficiency, taking into account regional disparities. Improve competition in public procurement. Focus investment-related economic policy on research and innovation,	Hungary has made **Limited Progress** in addressing CSR 3 • **Limited Progress** Limited progress. R&D spending increased from 0.98% of GDP in 2008 to 1.53% in 2018. This level is high for Central Eastern European countries, but remains below the EU average of 2.11% and Hungary's 2020 target of 1.8%. Public support for private R&D is considerable. Business R&D and innovation expenditure benefited from state subsidies amounting to 0.36% of GDP in 2017, the highest level in the EU. However, the shortage of talent and skill limits the innovative activity of Hungarian enterprises. Obstacles to innovation include the limited supply of highly skilled labour. Tertiary education attainment rates are among the lowest in the EU. Recent changes have increased government influence over scientific institutions.

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Hungary, p.69]

(…) Key actions of the Just Transition Fund could target in particular:

- investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reductions, energy efficiency and renewable energy;
- investments in research and innovation activities and fostering the transfer of advanced technologies;
- investments in enhancing the circular economy, including through waste prevention, reduction, resource efficiency, reuse, repair and recycling;

15. IRELAND

15.1. Executive summary

There remain significant investment needs in various areas. (…) More investment in R&D, digital infrastructure and skills would address the lagging productivity of domestic firms and would increase the resilience of the economy to external shocks.

(…) Regarding progress towards its national targets under the Europe 2020 strategy, Ireland has met or is very close to its targets for employment, early school leaving, and the reduction of poverty and social exclusion. However, there is scope for improvement in the areas of R&D investment, reducing greenhouse emissions, increasing the share of renewables, energy efficiency and poverty reduction

15.2. Research and Innovation

Ireland is a strong innovator and ranks 10th in the European Innovation Scoreboard 2019. It performed best in terms of impact of innovation on employment, presence of innovators and quality of human resources, including share of population with tertiary education. Two of its weakest aspects are, are public financial support for R&D and public-private linkages (European Commission 2019m). Ireland is also placed 12th in the world and 7th among EU member states in the Global Innovation Index (World Intellectual Property Organisation, 2019).

While there are many strong elements in Ireland's research and innovation system, some weaknesses need to be addressed. In particular, this concerns the amount of R&D funding, the structure of public support for business R&D and cooperation between firms and research bodies.

Ireland's current strategy for R&D, science and technology until 2020 is set out in Innovation 2020. (DBEI, 2015). A mid-term review suggests that most of its objectives are on course to be achieved. Progress so far includes the creation of five new research centres by Science Foundation Ireland and the establishment of a Disruptive Technologies Innovation Fund, with a total value of €500 million until 2027, to encourage collaboration between industry including large companies and multinationals

but especially SMEs and the research sector in developing and deploying such technologies and applications on a commercial basis (DBEI, 2019a). Future Jobs Ireland 2019 identifies the means for achieving quality jobs that will be resilient into the future including developing Ireland as a centre for testing new technologies, while also addressing the impact of economic transition on vulnerable workers (Government of Ireland, 2019a).

However, relatively low levels of R&D investment are a continuing concern. Ireland's R&D intensity (gross domestic expenditure on R&D (GERD) as a share of GDP) was 1.15% in 2018 compared to an EU average of 2.11% ([51]). Although GERD is growing in absolute terms, this is not keeping pace with strong economic growth and Ireland is unlikely to achieve the target of 2.5 % of GNP within the timeframe of 2020 (Government of Ireland, 2019a).

Public R&D expenditure, while increasing, is still lower than past levels of investment, both in absolute terms and as a percentage of GDP. Although estimated at €766 million in 2018, up from €739 million in 2017, the level of the government budgetary allocation for R&D (GBARD) is still well below the pre-crisis peak of € 930 million in 2008. Public R&D intensity is also significantly lower than the EU and OECD averages (DBEI, 2019c).

While business R&D (BERD) in Ireland amounted to almost €2.8 billion or 0.86% of GDP in 2018 and is increasing in absolute terms, it is considerably below the EU average of 1.41%. Also, in 2017 foreign owned companies accounted for 69% of all R&D expenditure and they comprised 82% of the largest 100 firms by R&D spend (Central Statistics Office, 2018a). Furthermore, despite SME innovation indicators being above the EU average, in 2016 a general deterioration has been registered compared to 2014 (European Commission, 2019m). In 2016, only 36% of Irish-owned companies (accounting for 81% of all relevant firms) spent on innovation, compared to 43% of foreign-owned companies. Even though foreign owned companies accounted for only 19% of all relevant firms, they accounted for €2.9bn or 64% of all innovation-related expenditure, including €1.4bn on in-house R&D (Central Statistics Office, 2018b).

Although Ireland provides a relatively high amount of public support for companies, this is largely through an R&D tax credit. The cost of the tax credit has risen substantially since introduction, peaking in 2015 at €708m before falling back to €448m in 2017, and a significant share is claimed by large, foreign-owned firms. Direct grant support for R&D rose until 2010 but has since fallen (Department of Finance, 2016). Recent changes seek to make the tax credit more attractive for micro and small

([51]) Ireland is in just 20th place in the EU in 2018 in terms of R&D intensity measured against GDP, although this is affected by issues relating to the composition and measurement of Ireland's GDP. In terms of modified GNI (GNI*), that excludes distortions from foreign-owned firms, Ireland has a R&D intensity of 2% (2017).

companies and the cap on outsourcing to third level institutions has increased (Department of Finance, 2019g). While the R&D tax credit provides valuable support, more priority for direct funding instruments could help stimulate research and innovation and improve productivity of Irish firms especially SMEs (European Commission, 2019l)..

Cooperation between firms and public research centres continues to develop but faces challenges. The first two calls for collaborative project proposals under the Disruptive Technologies Innovation Fund in 2018 and 2019 allocated €140 million for 43 projects involving collaborative partnerships (comprising of 159 organisations) between industry and SMEs, and public research bodies, in applying industrial research under the six themes of the revised Research Priority Areas, in areas such as health, climate action, food, ICT and manufacturing (DBEI 2018/2019). Also, Innovation 2020 aims to double private funding of R&D in the higher education sector to €48 million by 2020 (DBEI, 2019a). However, although collaboration between Science Foundation Ireland (SFI) and the business sector rose between 2013 and 2017, an increasing share of this collaboration has gone to multinational firms while the share of SMEs has declined (Department of Public Expenditure & Reform (DPER), 2019c)

15.3. Additional R&I references

[1. Economic situation and outlook, Investment, p. 8-9]

Investment in Ireland continues to be driven by volatile investment by foreign multinational corporations. In the first half of 2019, headline investment increased by 112% y-o-y, because of a surge in intellectual property investment in the second quarter of 2019. This surge was matched by a rise in intellectual property imports. These two impacts are largely offsetting and therefore have a broadly neutral impact on GDP.

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

Ireland has made some progress in addressing the 2019 country-specific recommendation on investment and productivity. (…) Measures aiming to diversify the economy and improve the productivity of Irish firms have also recorded some progress. While the bulk of public support for research and innovation is still provided through the Research and Development tax credit, rather than direct support, the 2020 Budget targets more specifically micro and small companies.

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

EU cohesion policy is contributing to major transformations of the Irish economy by promoting growth and employment via investments, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility. Since 2014, over 55,000 enterprises have been granted support, including over 1,800 start-ups, generating over 5,600 new jobs. European Structural Investment (ESI) Funds contributed to research and innovation in

Ireland, supporting over 1,000 researchers and 350 companies cooperating with research institutes.

(…) Ireland benefits also from other EU programmes, such as the Connecting Europe Facility, which allocated EU funding of €107 million to specific projects on strategic transport networks, or Horizon 2020, which allocated EU funding of €812 million (including €202 million for 299 small and medium enterprises).

[4.3. Labour market, education and social policies, 4.3.2. Education and skills, p. 43]

Skillnet Ireland might help address the skills deficit in SMEs, including managerial skills, but its reach is limited. (…) More focus on initiatives to drive productivity growth and innovation capacity among SMEs, such as those promoting the use of technology or workforce development, would also bring actions more in line with Future Jobs Ireland.

[4.4. Competitiveness reforms and investment, 4.4.1. Productivity and competitiveness, p. 49-50]

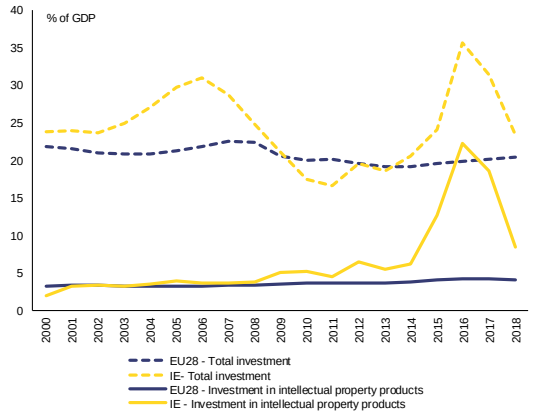
Productivity is particularly high in large firms, in just a few specific sectors of economy. Manufacturing (notably pharmaceuticals and chemicals) made the largest contribution to labour productivity growth during 2000-2017, followed by ICT, professional, scientific, administrative and support services. (…) This calls for a diversification of the economy and more diffusion of innovation from foreign multinational companies to local ones (see Section 4.4.2).

(…) **The cross-government strategic framework Future Jobs Ireland was launched in 2019 to define a new economic pathway for Ireland.** This framework aims to support innovation and technological change, improve the small and medium enterprises (SME) productivity, enhance skills, increase labour force participation and smooth the transition to a low carbon economy.

[4.4. Competitiveness reforms and investment, 4.4.4. Investment, p. 52-53, 56]

Total investment has recovered after the economic downturn but the main investors remain multinational multinational companies. Headline investment figures in Ireland are volatile and largely inflated by the activities of multinationals. Investment by multinationals has particularly increased since the crisis, reflecting Ireland's efforts to attract them and restart the economy. Intellectual property is by far the main type of investment made by multinationals, followed by smaller-scale but still substantial investment in aircraft leasing. In 2015-2018, this accounted for a vast majority of all investments (see graph 4.4.4.).

Graph 4.4.4: **Intellectual Property Investments v Total Investments**



Source: Eurostat

The large gap between investment by multinational corporations and by domestic firms increases the dichotomy of the Irish economy. Productivity in the multinational sector headquartered in Ireland is very high, determined by large-scale investment, particularly in research and development. Hence, Ireland's export share in global trade keeps increasing. Meanwhile domestic firms invest relatively little, despite the post-crisis economic rebound, which typically favours more investment.

(…) **In social infrastructure, Ireland leads in some fields but lags in others**. Long-term, flexible and efficient investment in education, health and affordable housing is vital for economic growth and welfare as it reduces transaction costs, enables knowledge and innovation and boosts community resilience.

[4.4. Competitiveness reforms and investment, 4.4.6. Regional disparities, p. 58]

The ability of the regions to offer an attractive and sustainable environment for firms and residents is another important factor determining the variations in their economic performance. The Eastern and Midland region performs relatively well in the Regional Competitiveness Index (European Commission, 2019d) as the 89th most competitive region in the EU ([52]). It does particularly well in terms of technological readiness, higher education and lifelong learning and health. The Southern region ranks 129th, performing well in terms of technological readiness but less well on infrastructure. The Northern and Western is only 177th, due to lower than average results in terms of infrastructure, market size and efficiency. Existing differences raise concerns about whether the trend of increasing disparities can be reversed in the near future.

([52]) Out of total of 268 regions

Employment in both high-tech and knowledge-intensive services is concentrated in the Eastern and Midland Region and is below the national average in Northern and Western. The share of high tech employment is 10% in the Eastern and Midland, 8% in the Southern region and only 5% in the Northern and Western region. Knowledge-intensive services are 50% of total employment in Eastern and Midland and around the EU average (39%) in the other two regions.

[4.5 Environmental sustainability, 4.5.2 Just transition to a climate neutral economy, p. 64]

However, the transition to a climate neutral society also has potential to provide new job opportunities. (…) The Irish regions' '**s**mart specialisation' strategies ([53]), underpinned by transition labs, ([54]) can provide further guidance on improving the regions' competitive advantage..

[4.5 Environmental sustainability, 4.5.3 Transition to a clean and circular economy, p. 65]

Ireland performs well in the early stages of delivering eco-innovation but it is weaker in technology development and diffusion. Ireland's eco-innovation index is around the EU average but its eco-innovation activities have been decreasing since 2015, showing the need to boost investment in innovation in firms and manufacturers. In terms of eco-innovation inputs, Ireland is very strong in R&D personnel and researchers and green early stage investment, which reflects the strong R&D base and Ireland's capacity to attract high levels of foreign direct investment (Eco-innovation Observatory, 2017). But the rates for environmental technology development and diffusion are below the EU average

[Annex D – Investment guidance on Just Transition Fund 2021-2027 for Ireland p. 83]

The smart specialisation strategies ([55]) provide an important framework to set priorities for innovation in support of economic transformation. In order to tackle these challenges, investments needs have been identified to diversify the regional economy making it more modern and competitive and to alleviate the socio-economic costs of the transition. Key actions of the Just Transition Fund could target in particular: (…)

([53]) Smart specialisation is a place-based approach enabling regions to identify and develop their own competitive advantages.

([54]) Innovation platform engaging a diverse range of stakeholders across regions to work together in addressing complex systemic challenges related to the diversification of the economy through smart specialisation. The transition lab could fund feasibility studies, collaborative projects and pilots and has been proven successful in other countries.

([55]) As defined in Article 2(3) of Regulation EU 1303/2013 (CPR)

- investments in research and innovation activities and fostering transfer of advanced technologies;

16. ITALY

16.1. Executive summary

(…) Limited progress has been made in meeting the targets on the employment rate, R&D investment and poverty and social exclusion.

Productivity growth has been sluggish despite measures to support it. The productivity gap between Italy and the EU continues to widen. (…) This is the result of declining labour productivity in southern regions and in services, as well as slower productivity growth in manufacturing compared to the euro area average. The effectiveness of recent measures to raise productivity growth, including incentives to invest and innovate, has been limited by delays in implementation, policy uncertainty and lack of a comprehensive strategy. (…)

Productivity growth does not show signs of improving, despite positive investment trends. In the last two decades, Italy's labour productivity has stagnated, especially due to the poor performance of the services sector. Trends greatly differ depending on geographical area and firm size, particularly in manufacturing. (…) In this regard, higher levels of firms' digitisation, investments in research and innovation, a more efficient public sector and adequate skills are key. A comprehensive strategy to support productivity and investment is missing. Measures remain fragmented and temporary, not taking sufficient account of sectoral and geographical aspects.

The regional divide remains large and is widening. In the last decade, public spending decreased in the southern regions. (…) Efforts to reduce the gap in private investment have been modest, especially for research and innovation where national policies actually widened the gap. Large disparities also remain in the quality of governance, the level of labour productivity and competitiveness. In this context, the high unemployment in the South leads to low and high skilled individuals migrating, worsening the local brain drain.

16.2. Research and Innovation

R&D expenditure remains relatively low. Public R&D expenditure reached 0.5% of GDP in 2018, the second lowest level among EU15 countries, and on a declining trend since 2013. While business R&D expenditure has been increasing in the last years reaching 0.86% of GDP in 2018, its level remains significantly below the EU average (1.41%). As a consequence, the number of researchers per thousand in the active population employed by business is only half the EU average (2.3% against 4.3% in 2017). Since 2017 most of the R&D growth is due to the activity of new firms investing in R&D, while firms that were already R&D performers recorded stable expenditure. Preliminary data for 2019 show an increase of private R&D expenditure.

The lack of Science, Technology, Engineering and Mathematics graduates risks being critical in the near future. Confindustria's forecast (forthcoming) shows that ICT, chemical and machinery are sectors in which new jobs will be created in the coming years. The interface with the Smart Specialisation Strategies can help to address the skills and education mismatch. Some pilots are taking place in Emilia Romagna Region and Trento Province to connect secondary and tertiary curricula to the regional smart specialisation strategies' domains.

Current policy measures are sustaining the digitalisation and innovation of firms, but there is room for improvement. Digital innovation hubs promote awareness of digital investment opportunities among SMEs, and the National Competence Centres support industrial research and experimental development, relevant training and technology transfer. The outreach, coordination and evaluation of these initiatives are key to strengthening innovation performance. Implementation delays (e.g. in setting up competence centres) reduce the impact of these measures. To ensure their relevance and effectiveness, the measures need to be more selective. The weight of large firms among beneficiaries of policy measures remains high (ISTAT 2019g). A cost-efficiency assessment of these measures could help streamline tax incentives, but is not available yet.

The discontinuity of policies to support knowledge transfer and innovation ecosystems hampers innovation performance. In 2019, only 2% of Italy's publications were public-private co-publications (a proxy for research-business collaboration), compared to 4% for the EU. Moreover, the share is below the EU average in fields such as life, medical and engineering sciences. However, recent initiatives, such as technology clusters and private public partnerships, have been discontinuous and fragmented, thus engendering uncertainty.

Investment in technical, scientific and digital skills is crucial for innovation but remains low. Compared to the EU average, Italy reports a lower share of graduates in science and engineering (12.2% against 15.5%)). According to Confindustria, the lack of STEM(41) graduates could become critical in the near future being ICT, Chemical and Machinery the sectors creating the most new jobs in coming years. ICT specialists account for only 2.8% of the workforce (EU average of 3.9%), while ICT graduates are only 1% of total graduates against 3.6% at EU level(43). Also, Italian enterprises invest less in ICT trainings for employees than firms in the EU on average. In a context of increasing automatisation, 53.9% of Italian enterprises experienced difficulties in recruiting personnel for jobs requiring ICT specialist skills in 2019(45). This adds up to the low levels of digitisation of Italian firms (section 4.4) and the limited attractiveness for digital specialists. According to JRC, Italy is among the countries likely to be most exposed to future mismatches in advanced digital skills.

16.3. Additional R&I references

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

Framework conditions remain relatively unfavourable to firms' growth. High-tech and knowledge-intensive sectors such as computer programming, telecoms and scientific research have a particularly high share of high growth enterprises (HGEs). (…) In Italy, HGE represented about 9% of all active firms (10% in the EU) and 12% of total employment in the business economy (15% in the EU) in 2016. Italian HGEs also tend to be under-represented in innovative industries relative to the EU average. This weak performance depends on a number of factors like the weak availability of entrepreneurial skills and linkages among SME innovators (Flachenecker *et al.*, 2020) and from the weak development of venture capital.

Productivity growth is also limited by the modest and worsening business dynamism of Italian firms. Enterprise churn rate has been steadily decreasing since 2016 across manufacturing and services sectors, particularly for information and communication and professional services (…).

Italy's fragmented system of enterprises also lags behind in digitisation. More than half of Italian enterprises are characterised by low investment in digital technologies and very low digitisation. In 2019, 37.8% of Italian enterprises had a low digital intensity index and 41.8% a very low one (compared to EU averages of 35.6% and 38.6% respectively). Moreover, the penetration rate of artificial intelligence is around one quarter of the EU average (Gonzalez Vazquez *et al*, 2019). (…) There are also delays in terms of ultrafast broadband coverage (24% of households in Italy vs 60% in the EU) and take-up (13% in Italy, 26% in the EU) that are key elements to strengthening the digital economy (60). Gaps are larger in rural areas, also when it comes to fast broadband coverage (43.4% of the households vs national and EU average of 90% and 52.8%, respectively). On the other hand, Italy has completed, already in 2018, the auction for the assignment of spectrum in the 5G pioneer bands, while 5G trials have been ongoing since 2017

Heterogeneity across firms and sectors calls for tailored policy action. Poor performance by smaller firms confirms the need for policies to help businesses grow and adopt productivity-enhancing solutions (e.g. digital innovations accompanied by suitable human capital), increase knowledge exchange, exploit synergies and overcome fragmentation along the value chain that remains a main weakness in the process of digitalisation in manufacturing ((ISTAT 2019g; Confindustria 2018, 2019). (…)

The employment rate of tertiary graduates remains low, while non-academic tertiary education performs better. The employment rate of recent tertiary graduates has been slowly recovering since the 2008 crisis but remains well below the EU average (respectively 62.8% and 85.5%). (…) Opening new paths into tertiary education, particularly for graduates of upper secondary VET, could help lower Italy's early school leaving rate and raise the tertiary educational attainment rate. The overall limited prospect of employment is prompting a growing number of university graduates to leave the country (up by 41.8% since 2013). The outflow of highly skilled people is not offset by a comparable influx from abroad, leading to a net brain drain.

(…) In 2019, the government allocated additional funding for 1,500 tenure-track positions for assistant professors (ricercatore universitario di tipo B), to be distributed among public universities based on size and quality of research. In this respect, the next ANVUR evaluation round of scientific research, whose results influence almost one third of the funding

[4.3 Labour market, education and social policies, 4.3.2 Education and skills, p. 39]

Investing in education and skills is key to reviving Italy's economic performance. (…) The tertiary educational attainment rate is among the lowest in the EU, in particular for scientific or technical studies.

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. Latvia would also benefit from boosting the economic potential of its peripheral regions - increasing their accessibility, and promoting energy efficiency, employment and investment opportunities. Finally, investments in social inclusion and healthcare are needed in order to tackle high inequality and uneven access to employment and public services. Additionally, identifying investment needs in green technologies, sustainable solutions, and securing adequate funding will be key to deliver on the climate and energy objectives and shape a new growth model.

- **Latvia is likely to meet most of its 2020 targets except investment in research and development.** Regarding progress towards its national targets under the Europe 2020 strategy, Latvia has attained its employment rate target and renewable energy target. It met its targets on preventing early school leaving, tertiary education attainment in 2016, and is progressing well containing its greenhouse gas emission growth. At the same time, with its energy consumption continuing to increase, it is at moderate risk to miss its energy efficiency target. However, it is far from its public research and development investment target, which are unlikely to be met by 2020. Moreover, due to an increase in relative poverty, Latvia has moved away from its poverty target.

Latvia invests little in research and innovation and faces a shortage of researchers. In 2018, Latvia invested 0.64% of GDP in research and innovation, which was among the lowest in the EU. Moreover, the investment is highly dependent on EU funding and

has not noticeably increased for more than a decade. The serious underfunding of the system hinders its effectiveness and its attractiveness to researchers, especially young researchers. Moreover, the system suffers from governance fragmentation. On the positive side, Latvia has a vibrant start-up community, which boosts its innovation output somewhat against a backdrop of rather weak performance on other fronts.

17.2. Research and Innovation

Investment in research and innovation in Latvia recently increased, supported by EU funds, but remains low overall. In 2018, research and development expenditure relative to GDP was up 0.64% (0.51% in 2017). More than half of this is public spending. European funds constitute 41.5% of all public investment in research and innovation. Despite the increase in spending, it is insufficient to tackle the significant underfunding of the entire research and innovation system. The share of investment in research and development is considerably below the EU average (2.1% of GDP in 2018) and is also far below Latvia's target of 1.5% of GDP for 2020. The underfunding hinders the effectiveness of the research and development system, its attractiveness to researchers, especially young researchers, and is limiting its added value for the economy. Moreover, the coverage of sustainability-related research and innovation topics is limited. The share of publications in top journals has slightly increased but remains relatively low in international comparison.

Latvia boasts a vibrant start-up community, but the supply of IT specialists is limited and research-industry links are weak. While the employment share of high growth enterprises is slightly above the EU average, the country performs below the EU average in terms of access to finance and other framework conditions (e. g. human capital, regulation and innovation), with the notable exception of entrepreneurial skills, reflected in the steadily growing start-up community. The highest share of high-growth enterprises is found in knowledge-intensive and medium-high tech manufacturing industries, particularly in ICT and machinery and equipment, but also in some medium-low tech sectors such as rubber and plastic products. The development of a technology-oriented start-up ecosystem is promising. However, skills shortages and having still relatively few research-industry and intra-industry links remain key challenges (European Commission, High Growth Enterprises Factsheet Latvia). Latvian start-ups and SMEs also lag in innovation capacity compared to other EU Member States. To address this, in 2018 Latvia's technology transfer programme was amended to improve innovation voucher support for the innovation activities of SMEs.

Human capital imbalances are holding back the development of the Latvian research and innovation system. Demographic trends and underfunding make it difficult for Latvia to keep up with the EU average in terms of numbers of researchers, PhD students and graduates in science, technology, engineering and mathematics. Even if the situation is advancing, there is still ample scope for further improvement, e.g. for reaching the national goal of 7 000 researchers in 2020. Several changes are underway, including changes to the academic career system, study programmes, and higher education governance. In cooperation with the European Commission, a Horizon 2020

Policy Support Facility activity is aiming to develop recommendations on policies for attracting and retaining talents in scientific and technological careers as well as in the business sector.

The fragmentation of the governance of the research & innovation system still represents a challenge for Latvia but is being addressed. Following the recommendations from the European Commission's Horizon 2020 Policy Support Facility activity ([56]), in 2019 the government approved a new strategy for the institutional consolidation of the Latvian science policy system. A unified science policy enforcement body in Latvia should start its activities in 2020. This reform has the potential of reinforcing the research and innovation system and increasing administrative capacity.

17.3. Additional R&I references

[3.4.1 Investment and productivity, Digitalisation, p.42]

Several initiatives aim to boost digital innovations and promote the use of digital technologies. Eight Competence Centres, set up in the areas of Latvia's smart specialisation strategy for an overall investment of €67 million, cover 175 projects and 138 enterprises and are EU-funded. They promote innovation in Latvia through the joint development of products and processes by companies and scientific institutions. Latvia also set a Single Technology Transfer Centre, as part of the Investment and Development Agency of Latvia, to foster industry-science cooperation and the commercialisation of public research.

[3.5. Environmental sustainability, Climate investment needs, p.54-55]

The green transition in Latvia would require investments in transport, buildings, renewable energy, and related education and skills. Latvia's has high potential for wind energy deployment, especially off-shore wind energy, providing a cost-efficient path to further increase its share of renewable energy. In order to curb the rapid growth of fossil energy consumption in the transport sector, investments in public transit systems and infrastructure for electric vehicles would be required. Further efforts to increase the energy efficiency of buildings and district heating systems are needed to address the growing energy consumption in heating. Finally, investments in research and innovation would be important to support the clean transition in Latvia. In its National Energy and Climate Plan Latvia estimates that the total investment needs up to 2030 amount to EUR 550 million for energy efficiency and renewable energy measures in heating, around EUR 1.7 billion for renovation of buildings, EUR 1 billion to decarbonise the transport sector, and EUR 130 million to bio methane (Ministry of Economy, 2019).

([56]) See the Final Report of this Policy Support Facility — https://rio.jrc.ec.europa.eu/en/library/specific-support-latvia-final-report-–-latvian-research-funding-system-0.

Overall, investments needed to reach the emission reduction targets in Latvia correspond to about 2% of GDP (European Commission, 2019d).

18. LITHUANIA

18.1. Executive summary

Productivity is increasing but more slowly than in the pre-crisis period, and the level is still well below the EU average. Investment and productivity have recovered steadily since the financial crisis (apart from 2014-2016 when Russian sanctions generated uncertainty). Hence, productivity is continuing to catch up with the EU average, but this is mostly because of capital accumulation rather than upgrades in technology. In the short term, there has been some pressure on labour costs but with no obvious impact on cost-competitiveness: Lithuania's exports have performed well, (again with the exception of 2014-2016), despite the weaker environment in its main trading partners. This international context is also reflected in low foreign direct investment. In fact, investment is still below historical levels, despite the partial recovery. This is reflected in the fact that Lithuanian exports are not gaining in sophistication. In the longer term, Lithuania could boost its competitiveness by improving the planning and delivery of public investment, notably in innovation and skills.

Removing barriers to innovation and to doing business will speed up the technological upgrading of the economy. Institutional constraints are limiting the growth of companies and inhibiting innovation. The predominant type of businesses in Lithuania are microenterprises, which in general are less innovative and productive than other firms. At the same time R&D intensity is relatively low and spending remains inefficient and overly reliant on European funds. Likewise, public research and innovation are held back by a cumbersome institutional network, and a shortage of talent. Businesses face difficulties accessing finance and international markets. In some sectors, notably energy, regulatory barriers hamper firm entry and competition. Another persistent obstacle to doing business is the insolvency framework, although the new insolvency law may improve the situation.

(…) There has been limited progress in the following areas:(…)

- More action is required to stimulate productivity growth by improving the efficiency of public investment. Further action is also needed to improve the coherence of the policies in place to support science-business cooperation, and to consolidate research and innovation implementing agencies. Public investment is still needed to boost the energy transition, increase resource efficiency and make transport more sustainable.

18.2. Research and Innovation

R&D intensity remains low and relies heavily on funding from European Structural and Investment (ESI) Funds. Investment in R&D is 0.88% of GDP, well below the EU average, and has not yet recovered from the sharp drop in 2016. This is mostly because of the fall in public R&D intensity due to diminishing rates of investment from ESI Funds. Public R&D intensity went from 0.76% to 0.53% in 2018. By contrast, business R&D expenditure has been steadily growing since the crisis, reaching 0.33% of GDP in 2018. Public investment focuses on research and innovation strategies for smart specialisation (RIS3) priorities, which represent industry sectors creating 23.5% of Lithuanian GDP (Smart Specialisation interim evaluation, Strata, 2018). To increase investment efficiency and reduce administrative burden, the RIS3 strategy was revised in 2019 when the priorities were broadened to make it more flexible. The government's goal of a 1.9% R&D intensity by 2020 will not be reached.

Inefficient public funding limits public research and innovation capacities and lowers the quality of output. This is amplified by a cumbersome institutional network and a shortage of talent. The number of publications within the top 10% most cited (as a percentage of the total scientific publications of the country) was 4.6% (10.3% in the EU). The higher education reform modernised the remuneration model for scientific research by increasing salaries and introducing incentives for internationalisation, participation in Horizon 2020, and cooperation with businesses. The envisaged consolidation of the universities network has stalled and only one merger took place in 2018. One merger has been revoked following a Constitutional Court decision casting doubts about other planned mergers. Nevertheless, three leading research centres ([57]) established the first Lithuanian research and technology organisation associating more than a thousand researchers, with the aim to consolidate the country's applied research potential.

The supply of researchers and engineers to public institutions and businesses remains insufficient due to brain drain and low pay. Doctoral students saw the size of their scholarships increased in 2019 but at the end of their studies they face low salaries discouraging them from following a career in research in Lithuania. According to the Global Competitiveness report 2018 (World Economic Forum) Lithuania ranks poorly when it comes to the ease of finding skilled employees, and is average regarding availability of scientists and engineers.

Lithuania's innovation performance has improved but remains weak. According to the European Innovation Scoreboard in 2019 R&I inputs into the innovation system (innovation-friendly environment, non-R&D innovation expenditures) were adequate but output remained weak (unattractive research systems, modest employment impact).

([57]) The Center for Physical Sciences and Technology (FTMC), the Lithuanian Energy Institute (LEI) and the Lithuanian Research Center for Agriculture and Forestry (LAMMC) reinforced by the Science and Technology Park of the Institute of Physics.

Innovating companies are of moderate size, are weakly integrated in international value chains, and struggle to attract investments of sufficient critical mass. Science-business cooperation is limited to high-tech "pockets of excellence". There are signs of a shift from high- to medium-high-tech manufacturing: since 2010 R&D intensity of high-tech manufacturing decreased by 1.9 pps of GDP while intensify in medium-high-tech increased by 13.3 pps.

The start-up landscape is very active, notably in IT and Fintech, a quite innovative niche. Lithuania counts more than 900 start-ups in 2019, mostly in IT and fintech, supported by the Start-up Lithuania initiative, a one-stop-shop facilitating matchmaking between entrepreneurs and investors. To scale up the developing ecosystem, pre-seed/seed stage investment schemes, accelerator programmes, and mentorship services are a prerequisite. A key obstacle is the lack of a favourable environment in research institutions where commercialisation of successful R&D activities is not sufficiently encouraged (Paliokaite et al., 2020).

The government is making efforts to improve the design and funding of the innovation ecosystem. Innovation reform aims to (i) reduce the fragmentation of programmes, funding mechanisms and support services for research and innovation, (ii) improve innovation skills across businesses and public institutions, and (iii) increase innovative and pre-commercial procurement to 20% of total procurement expenditure by 2027. However, the consolidation of research and innovation agencies has stalled. The planned Innovation Support Fund will be funded domestically to limit the dependency on funding from ESIF funds. The future 2030 national development programme is expected to have innovation as a cross-cutting theme across all policy fields.

18.3. Additional R&I references

[Box 1.1: Avoiding the risk of a middle-income trap, p. 13]

(…) Escaping the middle-income trap and making a successful transition to a knowledge-based economy requires deeper structural reforms. The Lithuanian innovation eco-system remains fragmented, while funds are poorly targeted and not available at all development stages of a company. Public funding still relies excessively on EU funds, although the planned Innovation Support Fund may ensure more stability in the future. Private funding for competitive firms is hampered by the increasing concentration in the banking sector. This sector is currently dominated by three banks, although current efforts to introduce new financial institutions and alternative ways of funding have the potential to increase competitive pressures on traditional banks. The attainment of tertiary education is among the highest in the EU but the system is oversized and university graduates tend to emigrate. This contributes to the brain drain which has been identified as an obstacle to research and innovation in the country. Retaining talent will require product market reforms to create demand for skilled labour and improved socioeconomic conditions: poor social security (the absence of an effective safety net) is cited as a one of the main reasons for emigrating, second only to

low pay. Institutional constraints limit the growth of companies and inhibit innovation: preferential tax treatment of microenterprises prevents them from growing and encourages the shadow economy. For example, there is evidence that microenterprises try to avoid the revenue threshold under which they enjoy a preferential tax treatment. There is also some evidence of a similar effect being caused by the threshold for preferential VAT treatment for the self-employed, although the evidence there is less conclusive (see Section 3.4.1). The accumulation of such of distortions may discourage firms from achieving their optimal size and discourage the self-employed from becoming an incorporated business and growing to become more productive. Tax systems with too many exceptions can hamper the efficient allocation of resources.

[Table 2.1: Assessment of 2019 CSR implementation, p. 17]

Lithuania	**Overall assessment of progress with 2019 CSRs: Limited progress**
CSR 1: *Improve tax compliance and broaden the tax base to sources less detrimental to growth. Address income inequality, poverty and social exclusion, including by improving the design of the tax and benefit system.*	**Some Progress** • **Some Progress** in improving tax compliance • **Some Progress with** broadening the tax base to sources less detrimental to growth and • **Some Progress** with addressing income inequality, poverty and social exclusion, including by improving the design of the tax and benefit system.
CSR 2: *Improve quality and efficiency at all education and training levels, including adult learning. Increase the quality, affordability and efficiency of the healthcare system*	**Limited Progress** • **Limited Progress** with improving quality and efficiency at all education and training levels, including adult learning and • **Limited Progress** with increasing the quality • **Some Progress w**ith increasing the affordability and • **Some Progress w**ith increasing the efficiency of the healthcare system.
CSR 3: *Focus investment-related economic policy on innovation, energy and resource efficiency, sustainable transport and energy interconnections, taking into account regional disparities. Stimulate productivity growth by improving the efficiency of public investment. Develop a coherent policy framework to support science-business cooperation and consolidate research and innovation implementing agencies.*	**Limited Progress** • **Limited Progress** with focussing investment-related economic policy on innovation, • **Limited Progress** in the area of energy, • **Limited Progress** in the area of resource efficiency, • **Limited Progress** in the area of sustainable transport, • **Some Progress** in the area of energy interconnections, taking into account regional disparities, • **Limited Progress** with stimulating productivity growth by improving the efficiency of public investment, • **Limited Progress** with developing a coherent policy framework to support science-business cooperation and • **Limited Progress** with the consolidation of research and innovation implementing agencies.

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

Overall, Lithuania has made limited progress in addressing the 2019 CSRs. Some progress was achieved in addressing the CSRs on tax compliance and broadening the tax base. Overall progress remains limited in addressing education and training related issues and with regards to its health system. Lithuania has made limited progress on stimulating investment and productivity growth. Incremental growth of business investment in research and innovation has been slow, and progress on consolidating research and innovation implementing agencies remains limited.

Upon request from a Member State, the Commission can provide tailor-made expertise via the Structural Reform Support Programme to help design and implement growth-enhancing reforms. Since 2017, such support has been provided to Lithuania for over 30 projects. In 2019 for example, the Commission: (…) (iii) provided assistance to government interventions in the field of science, technology and innovation. This included providing advice on the simplification of the institutional

structure and supporting the design of a more effective and harmonised approach to evaluating research projects for public financing.

[Box 2.2. EU funds and programmes to address structural challenges and to foster growth and competitiveness in Lithuania, p. 19]

EU Cohesion policy funding contributes to a major transformation of the economy, promoting growth and employment by investing in, for example, research, technological development and innovation, the competitiveness of enterprises, sustainable transport, employment, and labour mobility. By 2019, investments driven by EU Funds have already led to building or modernisation of 493 km of roads, both regionally and in connection with the Trans-European Transport Network (TEN-T); over 111 supported research projects have been commercialised; support was already provided to 4,891 enterprises including 1,017 start-ups, generating 1,640 new jobs. ESI Funds contributed to a reduction of 447,559 tonnes of greenhouse gases.

[3.3.4. Education and skills, p. 35]

The low proportion of ICT specialists hampers the country's capability to fully exploit its innovation potential. It also limits the potential for productivity growth linked to digitisation. Despite growing demand on the labour market and policy measures taken to fill this gap, the availability of ICT specialists in Lithuania is below the EU average (2.7% vs. 3.9%). Among businesses that have recruited or tried to recruit ICT specialists, 47% reported difficulties in filling their vacancies. Lithuania performs less well than most EU countries in training new ICT graduates.

[Box 3.4.5: Investment challenges and reforms in Lithuania, p. 40]

Assessment of barriers to investment and ongoing reforms

Public administration/ Business environment	Regulatory / administrative burden	
	Public administration	
	Public procurement /PPPs	
	Judicial system	
	Insolvency framework	
	Competition and regulatory framework	
Labour market/ Education	EPL & framework for labour contracts	
	Wages & wage setting	
	Education, skills, lifelong learning	CSR

Financial Sector / Taxation	Taxation	
	Access to finance	
R&D&I	Cooperation btw academia, research and business	CSR
	Financing of R&D&I	
Sector specific regulation	Business services / Regulated professions	
	Retail	
	Construction	
	Digital Economy / Telecom	
	Energy	CSR
	Transport	

Legend:

	No barrier to investment identified
CSR	Investment barriers that are also subject to a CSR
	No progress
	Limited progress
	Some progress
	Substantial progress
	Fully addressed

(…) In 2021, the EFSI and other EU financial instruments will come under the new InvestEU framework focusing on: (i) sustainable infrastructure; (ii) research, innovation and digitisation; (iii) SMEs; and (iv) social investment and skills. (…)

Main barriers to investment and priority actions underway:

1. Investment in R&D is well below the EU average (see Section 3.4.1). In addition, public funding is relatively inefficient with a fragmented network of research and innovation agencies, insufficiently funded basic research, and a poor connection between academics and businesses. Addressing this issue requires a full implementation of the innovation reform programme and the creation of the planned Innovation Support Fund.

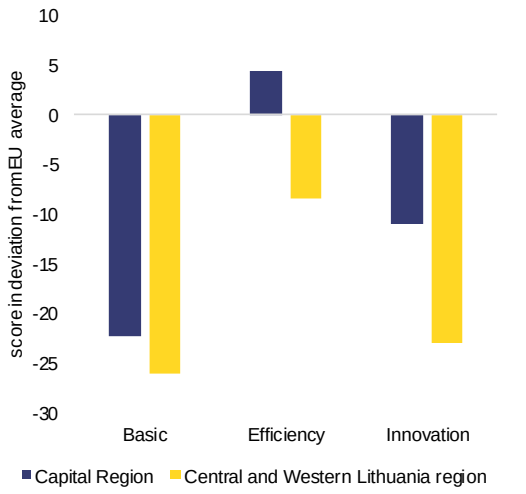
[3.4.3. Single market integration, Digital single market, p. 46]

The authorities are engaged in the implementing the Digital Single Market. The authorities are committed to making progress with new digital technologies and to investing strategically through EU-coordinated programmes. Lithuania is a member of the Euro Joint Undertaking for High-Performing Computing and has signed the declarations on a European Blockchain Partnership and on cooperation on artificial intelligence. Lithuania already has four digital innovation hubs specialising in advanced manufacturing, laser technology, robotics, photonics, e-business models and IT solutions. A growing ecosystem has developed around the blockchain centre in Vilnius and numerous blockchain-based solutions are being developed for both SMEs and start-ups in the field of sustainable financial and smart technologies, including by state-owned companies.

[3.4.4. Regional disparities, p. 48]

There are significant regional disparities in competitiveness. According to the European Regional Competitiveness Index (RCI), the Capital Region of Vilnius scores significantly better than mid-west Lithuania. Both regions have lower scores than the EU average along the basic dimensions like institutions, macroeconomic stability, infrastructure, or health and basic education (Graph 3.4.8). However, differences arise when it comes to the efficiency pillar (higher education and lifelong learning, labour market efficiency and market size) and the innovation pillar (technological readiness, business sophistication and innovation aspects), where the Vilnius scores better than mid-west Lithuania.

Graph 3.4.8: **European Regional Competitiveness Index**



Note: The sub-index "Basic" includes Institutions, Macroeconomic Stability, Infrastructure, Health, and Basic Education. "Efficiency" includes Higher Education, Labour Market Efficiency, and Market Size. "Innovation" includes Innovation, Technological Readiness, Business Sophistication, and Innovation Pillar.
Source: European Regional Competitiveness Index 2019

(…) For example, out of around 700 companies, that benefited from structural fund investment in research, development and innovation, 410 companies operated in the Vilnius region, followed by the Kaunas region with just over 200 companies.

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for Lithuania, p. 67]

In order to make the most affected regions more resilient to potential impacts of decarbonisation and industrial transformation, a diversification of economic activities and creation of new business opportunities deserve serious consideration. The smart specialisation strategy ([58]) provides an important framework to set priorities for innovation in support of economic transformation. Based on this preliminary assessment, it appears warranted that the Just Transition Fund concentrates its intervention on these geographical areas.

In order to tackle these transition challenges, priority investment needs have been identified for development and deployment of innovative solutions for efficient and clean production and energy use and ensuring necessary skills for those affected by the transition. Key actions of the Just Transition Fund could target in particular:

- investments in research and innovation activities and fostering transfer of advanced technologies;

([58]) As defined in Article 2(3) of Regulation EU 1303/2013 (CPR)

19. LUXEMBOURG

19.1. Executive summary

Whereas growth prospects remain shaped by a less supportive external environment, to which the economy is highly sensitive, Luxembourg has made some progress in diversifying its economy, potentially easing the way to a more resilient growth path. Some progress was achieved by focusing investment on fostering digitalisation and innovation, stimulating skills development and developing the transport system. The resilience of the economy would be further strengthened by encouraging private investment and fostering technological diffusion and innovation among firms, while also further improving sustainable transport infrastructure and housing supply.

Relatively weak investment in research and innovation, especially in the private sector, weighs on Luxembourg's innovation potential. This might slow down the development of activities that add higher value to the economy. Stronger private investment in research, technological innovation and digitisation can be key drivers of productivity growth and ease the transition to a data-driven economy. The connection between the public science base and businesses is weak, limiting firms' potential for innovation. The lack of a national research and innovation strategy and insufficient public support for business research and development investment, are just two of the challenges that prevent Luxembourg from exploiting the full potential of its innovation eco-system.

19.2. Research and Innovation

The decline in labour productivity is concurrent with lower investment in research and development, especially in the private sector. The total Research and Development intensity of Luxembourg has decreased over the last decade to 1.21% of GDP (2018) and is far below the national target of 2.3%. From 2007 to 2013, there was a rapid development of the public science base, only partially compensating the significant decrease of business expenditure in Research and Development. In particular, Research and Development by small and medium-sized enterprises decreased from 0.41% of GDP in 2007 to ([59]) has stagnated and remains 20% below EU average. Luxembourg's business Research and Development intensity has since then remained stable at around 0.68% of GDP (2018). Addressing these challenges would lead to progress on Sustainable Development Goal 9.

Despite the efficiency of Luxembourg's research and innovation system, cooperation between public research institutions and businesses remain a challenge. Despite the quality of the scientific output in Luxembourg's public research

([59]) Research and Development investment performance in the public sector as % of GDP

system, which is among the most valued in the EU ([60]), several indicators point to its relatively weak linkages with the business sector. For instance, concerning the volume of public Research and Development funded by businesses (contract research) ([61]), Luxembourg showed one of the lowest scores in the EU in 2016, after having decreased since 2011. Several initiatives have been implemented since 2016 to foster public-private cooperation. For instance, the Industrial Partnership Block Grant ([62]) established by the Luxembourg National Research Fund aims to foster cooperation between Luxembourg based companies active in research and development and public research institutions in Luxembourg. The JUMP competitive funding programme ([63]) was designed to help bridge the technical and funding gap between research-driven discoveries and their commercialisation/utilisation. However, the impact of these measures has not been monitored or evaluated.

The scope and size of public support to business research and innovation is improving ([64]) but remains relatively limited. The adoption in 2017 of a law to promote Research, Development and Innovation was followed by an increase in the total number of projects supported (+18% in 2019), as well as an increase in the average budget per project, from EUR 1.8 million in 2016 to EUR 3.6 million in 2019. Luxinnovation developed programmes to support innovation in small and medium-sized enterprises such as Fit4Innovation and Fit4Start which provide coaching and financing for start-ups. The numbers of small and medium-sized enterprises benefitting from these initiatives is increasing (+84% for the FIT4 programmes, FIT4Digital not included) but the comparatively higher administrative burden they entail for the limited resources of small firms is hindering broader participation.

Several strategies to boost productivity and sustainable development and boost digital integration across the economy were published in 2019. The Data-driven Innovation Strategy proposes specific measures for a secure and datadriven economy. Key initiatives include the support of companies' in-house innovation and of the start-up ecosystem. This strategy is closely linked to the one on Artificial Intelligence as it

([60]) Luxembourg ranks first in EU for international co-publication within the top 10% most cited scientific publications worldwide as a share of total scientific publications of the country and ranks third for scientific publications of the country within the top 10% most cited worldwide as a share of total scientific publications of the country

([61]) As measured by public Research and Development financed by business enterprises, either as % of GDP or of total public Research and Development expenditure.

([62]) Programme by the National Research Fund (FNR) to foster the cooperation between Luxembourg based companies active in Research and Development and public research institutions in Luxembourg; results published on the National Research Fund website

([63]) Programme by the National Research Fund in support to knowledge transfer and innovation

([64]) Support to business Research and Development from 0.041% in GDP in 2009 to 0.054 of GDP in 2015

aligns with Luxembourg's digital ambition to become a data-driven and sustainable economy. Furthermore, the national priorities for public research have been revised and adopted by the Luxembourg government. This will underpin a national strategy for public research, to be in place by mid-2020. However, an integrated research and innovation strategy articulating how to deploy and synchronise actions across all the components and dimensions of the innovation eco-system (including business Research and Innovation) towards a clear, deliberate, overarching strategic direction is currently not planned by the government.

19.3. Additional R&I references

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

Recently, Luxembourg has made some further progress towards the diversification of the economy. In response to somewhat weaker developments recently, two wide-scope strategies have been prepared to foster technological innovation and digital transformation in the broad business sector. Public investment remains high and measures to foster innovation have been integrated in the "Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy", as well as a strategy on artificial intelligence. Their success will depend, to a large extent, on their capacity to activate private investment, especially on innovative technologies and digital integration. Business investment remains low compared with the euro area average, which weighs on Luxembourg's innovation potential and might slow down the development of high-added value activities.

(…) Some progress was also made on economic policies related to investment on fostering digitalisation and innovation and on stimulating skills development.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Luxembourg, p. 20]

EU Cohesion policy funding is contributing to transform Luxembourg's economy by promoting growth and employment via investments. Policy areas include, among others, research, technological development and innovation, renewables and energy efficiency, employment and labour mobility. By 2019, investments driven by EU Funds have already led to 22 researchers working in improved Research and Development infrastructure facilities, 12 firms cooperating with research institutions and 2,161 households with improved energy consumption classification.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment challenges, p. 44]

The slowdown in productivity can be also explained by some country-specific characteristics. Specific potential factors to Luxembourg include a number of microeconomic weaknesses, including low R&D activity among firms compared to other EU countries, shortages of qualified workers (Section 3.3) and lower levels of

digitisation than top performers.([65]). In parallel, capital per worker declined in recent years.

[Box 3.4.1: Investment challenges and reforms in Luxembourg, p. 45]

Selected barriers to investment and priority actions underway:

2. The public investment strategy aims to promote technologies with the potential to support a broader digitalisation of the economy. In contrast, business investment and innovation remain low and appear insufficient to significantly stimulate digital economic integration and productivity growth. The lack of attractiveness of the R&I environment, including the disconnection between private sector R&I and the public research system, hampers investment in business R&I. This is compounded by shortages of skilled workforce, which are increasingly perceived as an obstacle for R&I investment.

(…) InvestEU will be policy-driven and focus on four main areas, all relevant for Luxembourg: Sustainable Infrastructure, Research, Innovation, and Digitisation, Small Businesses, and Social Investment and Skills.

Beyond the EIB Group, other multilateral financial institutions and national promotional banks may have direct access to the Invest EU guarantee. At this stage, Luxembourg's national promotional bank, the SNCI (Société Nationale de Crédit et d'Investissement), has not signalled its interest in participating to the scheme.

Luxembourg relies on the SNCI to provide financial support to domestic firms for development investments, including fixed assets, innovations or commercial projects, either in Luxembourg or abroad. SNCI 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, p. 46]

Despite the high productivity growth potential of Luxembourg's environment, technological and digital integration, and investment, remain low in the business sector. Given the country's high productivity level and high labour intensity, increasing productivity would rely on developing high value added activities driven by innovation and investments that capitalise on the high potential of Luxembourg's digital and technological environment. Luxembourg's digital infrastructure is well developed, as the country has been reported for displaying one of the most digital transformation enabling environments in the EU (Country report 2019, European Commission). The government has stepped up efforts to implement its digital integration and innovation strategy. This,

[65] Top performers include Finland, the Netherlands, Belgium, Denmark or Sweden.

however, contrasts with low levels of digital and technological integration and low productivity growth in the broad business sector, which also shows one of the lowest investment, including R&I (OECD economic surveys: Luxembourg 2019, p.49, Digital Economy and Society Index 2019; EIB Investment Survey Luxembourg 2019), among the EU Member states. All this suggests a low capacity by the business sector to capture productivity gains from incremental investments based on the country's digital and technological environment.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and investment challenges, Diversification of the Economy p. 48]

The government continued implementing its strategy to diversify the economy, but business investment is among the lowest in the EU. (…) The implementation of the recently approved data-driven innovation strategy is expected to foster the development of the strategy sectors. However, business investment, in terms of GDP, has declined further and in 2018 it stood at 12.9% of GDP, among the lowest in the EU. The estimated contribution of the capital stock to real GDP growth shrank further in 2018 and was set at 1.1 percentage points, the lowest record in recent years. Business investment in R&D, at 0.68% of GDP in 2018, is markedly low.

[3.4. Competitiveness reforms and investment, 3.4.3. The Grande Région, p. 51/52]

Luxembourg is at the cross-roads of the *Grande Région.* Luxembourg lies at the heart of the *Grande Région*, which gathers five regions from four countries (Luxembourg, Germany, Belgium and France). This political organisation aims at fostering cross-border cooperation in a region where cross-border mobility is particularly important. The *Grande Région* also promotes a more sustainable way of life, encourages the development of health and social care services and supports research and innovation.

Cooperation at interregional and national level is crucial to build a critical mass and improve access to markets. It seems particularly relevant for Luxembourg to continue building partnerships in research and innovation, notably by reinforcing cooperation not only among researchers but also between academia and business. In this context, the University of the *Grande Région* is one of the most integrated academic consortia, which offers 19 cross-border university courses focussing chiefly on the rational use of resources, cross-border issues and biomedicine.

[3.5. Environmental Sustainability p. 54]

The country’s large financial sector can benefit from the growing sustainable finance market, while eco-innovation and circular economy policies can support job creation and the diversification of the economy.

[3.5. Environmental Sustainability, Synergies to leverage for a greener economy p. 58]

In 2018, Luxembourg ranked first within the EU in terms of eco-innovation ([66]), up from 11th in 2012, due to a strong political support of the government. Two main barriers to eco-innovation are small national market for eco-innovations and pressure on resources due to the need to balance economic development and environmental protection (European Commission, 2018).

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Luxembourg, p. 71]

(…) In order to tackle these transition challenges, investment needs for alleviating the socio-economic costs of the transition have been identified. Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in research and innovation activities and fostering the transfer of advanced technologies;
- investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- upskilling and reskilling of workers.

20. MALTA

20.1. Executive summary

Malta's fast-growing economy is confronted with long-term sustainability challenges. The Maltese economy has been experiencing fast growth and sustained employment creation for several years. Recent reform efforts have helped to encourage investment in a number of important areas. However, several long-term structural challenges remain, including (i) the fiscal sustainability implications of ageing; (ii) low skills levels and (iii) governance vulnerabilities. In addition, demographic and economic growth are expected to put further pressure on Malta's infrastructure and natural resources. It is therefore key to (i) strengthen long-term resilience through innovation; (ii) improve infrastructure quality and (iii) take further steps towards a climate-neutral and environmentally sustainable economy.

Investing in innovation, natural resource management, skills and infrastructure are critical to sustaining Malta's economic growth. In the longer term, investment in areas other than residential construction will be crucial to alleviate growing bottlenecks. Investment is also needed in adequate infrastructure, skills and innovation. (...)

[66] European Commission, Eco-innovation Observatory: Eco-Innovation scoreboard 2018

Productivity has significantly improved, but research and innovation still play a limited role in the economy. Malta has experienced significant growth in investment and productivity experienced a sizeable growth in the past decade. Small and medium-sized enterprises are the main contributors to economic growth and employment. However, research and innovation activity by Maltese firms remains limited. Although Malta's scientific output is improving, academic research does not seem to translate easily into innovation.

20.2. Research and Innovation

Research and innovation play a limited role in the economy. In spite of the increase in innovation performance since 2011 (European Commission, 2019d), research and innovation (R&I) continue to play a limited role in Malta's fast-growing economy. Malta's R&D investment, which is also relevant to progress on SGD 9, is very low (ranked 26th in the EU) and has declined significantly since 2012 (0.55% of GDP in 2018 against 0.83% in 2012). Public R&D investment has also been on a declining trend since 2015, thus placing Malta at the bottom of the EU ranking on this measure. According to the Maltese authorities, Malta will miss its 2020 R&D intensity target of 2% of GDP.

Research and innovation governance remains overly fragmented compared to the small size of the science base. Six different ministries/governmental bodies ([67]) are responsible for R&I policy, while public research is mainly performed by one institution (the University of Malta). Coordination mechanisms remain weak between the different authorities involved in the implementation of the smart specialisation strategy and the R&I strategy. The Horizon 2020 Policy Support Facility's peer review of the Maltese R&I system pointed to the need for a major overhaul of R&I policy governance, with possibly one institution/minister providing political leadership (European Commission, 2019g).

Although Malta is catching up in terms of scientific excellence, the translation of research into innovation remains a concern. In 2018, Malta ranked close to the EU average for the presence of its nationals in international co-publications in academic journals. Although the University of Malta has improved its scientific performance with a specialisation in medical sciences, its research activity suffers from limited national funding for R&D, technological development, and industrial cooperation. Further incentives could also attract new researchers, by (i) improving the framework conditions for doctoral studies and post-doc employment; and (ii) adding popularisation initiatives such as the ESPLORA science centre. Structural funds have been directed towards setting up new research infrastructures. However, academia-business links are underdeveloped due to the low R&D absorption capacity of Maltese firms.

[67] The Office of the Prime Minister; the Ministry of Economy, Investment and Small Business; Malta Enterprise; the Ministry of Education and Employment; and the Ministry of European Affairs and Equality (hosting the ESIF managing authority).

Innovation activity by firms remains limited. Business R&D intensity stood at 0.33% of GDP in 2018 (vs 0.48% in 2012), one of the lowest levels in the EU. There are very few innovative companies in Malta. Most innovative companies are foreign-owned, which partly explains the low uptake of most R&I schemes ([68]). Most Maltese firms are very small and not R&D intensive. However, Maltese small and medium-size enterprises in the specialised knowledge-intensive services and high-tech manufacturing sectors (both of which are usually R&D intensive) accounted for 38% of SME value added in the manufacturing and services sectors in 2018, above the EU average of 33%. At the same time, the share of small and medium-size enterprises introducing innovation and cooperating with others remains markedly below the EU average (European Commission, 2019a).

20.3. Additional R&I references

[1. Economic situation and outlook, Growth performance, p.7]

(...) However, the Maltese economy faces a number of structural challenges, notably an ageing population, low skills levels, governance vulnerabilities, infrastructure bottlenecks, and limited innovation potential (see also Section 3). (...)

[2. Progress with country-specific recommendations, Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Malta, p.18]

EU cohesion policy is contributing to the transformation of the Maltese economy. By 2019, investments driven by the European Regional Development Fund (ERDF) have led to two significant research facilities implemented by the University of Malta: one enabling and supporting technology transfer, entrepreneurship and knowledge exchange with industry (the "Trake project", the other one being a laboratory to monitor resource efficient technologies in real life (the "Sustainable Living Complex"). With the aim of promoting innovation, Malta also approved the 'Sintegram' project in 2018 to develop a national spatial data infrastructure, and to enhance the capacity of geo-spatial technology expertise. (...)

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and Innovation, p.39]

(...) Approximately €33 million was allocated to infrastructure and innovation projects, while €11 million was targeted at financing small and medium-size enterprises.

[3.4. Competitiveness reforms and investment, 3.4.2. Governance and business environment, Business environment, p.39]

[68] Public support schemes are offered to companies by Malta Enterprise, MCST, and through ESIF funds including direct grants and tax incentives. At present, these schemes lack client demand and have very low penetration rates.

(...) In turn, Malta has made progress on policies to encourage entrepreneurship, skills and innovation.

[3.4. Competitiveness reforms and investment, 3.4.3. Single market integration and sectoral performance, Services sector, p.39]

(...) In October 2019, the government also adopted a national strategy on artificial intelligence ('A Strategy and Vision for Artificial Intelligence in Malta 2030'), based on three strategic pillars: investment; start-ups and innovation; and adoption by both the public sector and private sector. (...)

[3.5. Environmental sustainability, p.47]

(...) Ensuring that the necessary skills are available to support the green transition (see Section 3.3.2), and increasing participation in innovation projects, would consolidate the economy's resilience and equity. (…)

21. NETHERLANDS

21.1. Executive summary

While the Dutch economy remains resilient overall, subdued medium-term growth prospects underscore the importance of sustaining the reform momentum. (…) In addition, further investments in R&D, human capital and climate and energy measures are needed to boost long-run productivity growth and address the transition to a low-carbon economy. Tackling these challenges would further support the resilience of the Dutch economy and reduce risks from imbalances.

There has been **limited progress** in the following areas:

- Focusing investment-related economic policy on R&D in particular in the private sector.

Other key structural issues analysed in this report, which point to particular challenges facing the Dutch economy, are the following:

- **Ambitious goals for tackling climate change challenges have been set.** (…) Substantial investment in climate-focused R&D and innovation, as well as renewable energy production and related infrastructure, are needed to support long-term sustainability goals. (…)

- **Investments in R&D, human capital, climate and energy measures can help support productivity growth and address other key societal challenges**. The Netherlands remains one of the most productive countries in the EU, but in common with most mature economies, it has experienced a notable slowdown in productivity growth. Targeted policy action, including investment in sectors with the strongest prospects to raise potential growth for the wider economy, can contribute to tackling the

challenges presented by this global trend. In particular, investments in R&D as well as human capital – notably in training and upskilling and boosting digital skills – can help support long-run productivity growth and maintain a strong innovation capacity. Investment in initiatives to address climate change and promote the energy transition can make a key contribution to wider societal goals, including the need to ensure sustainable and resource-efficient economic growth.

21.2. Research and Innovation

Investments in R&D, human capital and climate and energy can help boost long-run productivity growth and address key societal challenges. Since the Netherlands is among the most productive countries in the world, further productivity gains will likely require application of new technologies and innovations. This underscores the importance of further expanding R&D investment (see below). Consistent with this, boosting technical skills and training qualified professionals are crucial for the Consistent with this, boosting technical skills and training qualified professionals is crucial for the Dutch economy's innovation capacity and productivity growth (see Section 4.1). Furthermore, tackling wider societal challenges, such as climate change and the renewable energy transition, is likely to require substantial investment (see Section 4.5).

Despite relatively low R&D expenditure, the Netherlands remains one of the world's most innovative economies. R&D intensity stood at 2.16% in 2018 ([69]), lower than the national target of 2.5% in 2020 and below other top innovators. Of this, private R&D contributed 1.45% of GDP and public R&D about 0.71% of GDP. Nevertheless, in terms of innovation performance, the Netherlands is among the world's frontrunners. It ranks as one of the four 'innovation leaders' in the European Innovation Scoreboard (European Commission, 2019i), scores among the top 10 countries on the innovation pillar of the Global Competitiveness Index (World Economic Forum, 2019), and Dutch industry has a high share of companies engaged in innovation compared to the rest of the world (European Commission, 2019j).

Headline R&D investment figures understate actual R&D intensity in the Netherlands. The OECD (2017b) explains different sectors' typical R&D intensities and concludes that the Dutch economy is more R&D intensive than could be expected given its sectoral make-up (i.e. with many services and comparatively few R&D intensive industrial sectors, such as pharmaceuticals). Many Dutch multinational firms' R&D also takes place in other countries (which can boost their productivity both in the Netherlands and elsewhere), while there is less investment by foreign multinationals in R&D taking place within the Netherlands (Rathenau, 2019). Moreover, Dutch investments in intangible assets are relatively high. Such investments are not accounted

[69] Dutch R&D figures have been revised upwards by around 10% due to a methodological revision (see CBS (2019), chapter 6, heading 'Revisie')

for as R&D, but in practice often have similar objectives and impact, including improving productivity (Bauer et al., 2020).

A potential policy lever to boost R&D investment may come from the new mission-driven innovation policy. The 'mission-driven top sectors and innovation policy' (missiegedreven topsectoren- en innovatiebeleid) focuses on maximising the economic performance of selected sectors, which is viewed as a key priority for strengthening competitiveness and addressing societal challenges (EZK, 2018). Overall, this new policy approach aims to further boost investment in R&D in order to achieve the long-term targets on key societal challenges grouped into four 'missions': (i) energy transition and sustainability; (ii) agriculture, water and food; (iii) health and care; and (iv) security.

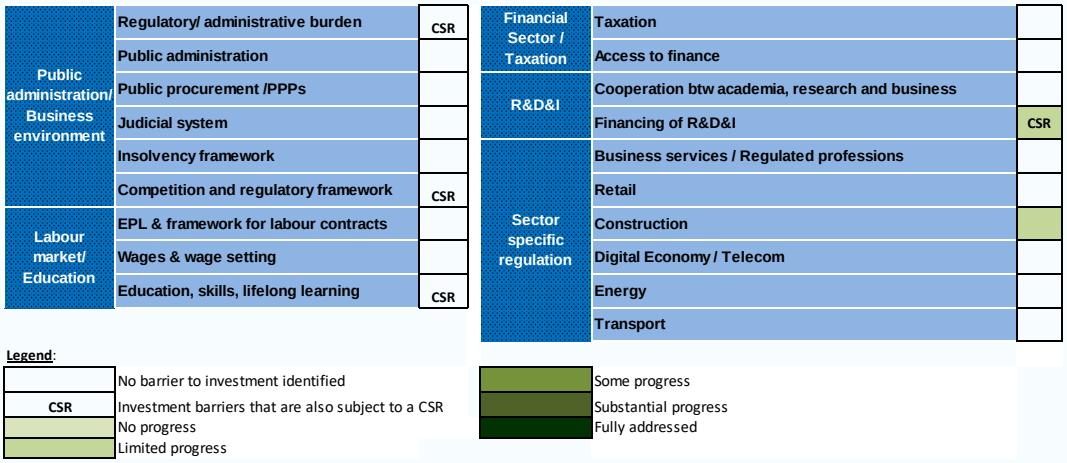
More generally, the Netherlands is aiming to strengthen its R&I policy by ensuring adequate investment in R&D to support productivity growth and address broader societal challenges. In the 2020 budget, the government announced an additional €400 million on a structural basis for fundamental and applied research. Moreover, the new investment fund to boost the Dutch economy's long-run earnings capacity (see box 4.4.1) may also serve as a platform to expand investment in key technologies.

Box 4.4.1: **Investment challenges and reforms in the Netherlands**

Section 1. Macroeconomic perspective

(…)

Section 2. Assessment of barriers to investment and ongoing reform



The Netherlands benefits from an investment-friendly institutional and political setting, with very few genuine regulatory barriers to investment (European Commission, 2015). It qualifies as an 'innovation leader' (European Commission, 2019i), benefiting from an attractive research system and an innovation-friendly environment. According to the World Bank, some sectoral regulations, such as obtaining a building permit, may be burdensome and hamper construction investments. Some small businesses signal the availability of finance as a barrier to investment (EIB, 2019). The Netherlands performs reasonably well in terms of public R&D investment, and has pledged to invest an additional €400 million a year in fundamental and applied research (€200 million each). However, it still underperforms on private R&D investment compared to both the EU average and the top performers. As 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. To boost investment, the government recently set up Invest-NL, a national promotional institution with a mandate to support private-sector investment aimed at tackling key societal challenges and supporting access to finance for SMEs. The government is the sole shareholder, investing up to €1.7 billion in Invest-NL. Invest-NL has indicated that it wants to become an implementing partner for InvestEU. Furthermore, the government has indicated that it is exploring the possibility of launching an investment fund to boost the long-term growth potential of the economy, although details on its financial firepower and target sectors are still to be decided upon.

Through the four regional innovation strategies on 'smart specialisation', the Netherlands is strengthening its innovation ecosystems thanks to concentrated investments based on regional needs. This regional dimension of innovation policy strengthens cooperation between companies, researchers and government across sectors and triggers targeted additional investments based on particular regional strengths. The four regional innovation strategies are being updated and embedded in the mission-driven innovation policy (see above). This should further strengthen their contribution to environmental sustainability. In each of the Dutch regions, priorities have been selected that relate to relevant sustainability priorities, including bio-based economy,

clean and efficient energy, environmental technologies, sustainable agriculture, clean water or reducing the use of raw materials.

21.3. Additional R&I references

[2. Progress with Country-Specific Recommendations, p.16]

Some progress has been made on CSR 3, which calls for supporting investment with a particular focus on R&D, energy and climate, and transport infrastructure. In terms of supporting overall investment, the Dutch authorities are implementing a fiscal expansion (see subsection 4.1), including by boosting investment, and have passed legislation to launch Invest-NL, a national promotional institution with a mandate to support private-sector investment. However, there is still some scope to do more as the Netherlands has some remaining fiscal space. Limited progress has been made on R&D investment. Revised R&D figures show slow progress on private R&D intensity and a slight decline in public R&D intensity (see subsection 4.4.2). Total R&D intensity has stabilised at around 2.2%, but lags behind the national target of 2.5% for 2020 and the R&D intensity of co-leaders in innovation. Although new policy measures have been announced, their impact remains to be seen. (…)

[Box 2.2: EU funds and programmes to address structural challenges and to foster growth and competitiveness in the Netherlands, p.20]

EU Cohesion Policy funding supports transition challenges in the Netherlands by promoting growth and employment via investments in innovation, climate transition, employment and labour mobility. Investments driven by funding from the European Regional Development Fund (ERDF) have already supported over 5,000 enterprises of which over 2,000 enterprises to introduce new products to the market. Almost 600 enterprises received support to cooperate with research institutions. Private investment matching the support for R&D and innovation projects has exceeded €425 million. Also, ERDF funding contributes to the development of innovative low-carbon technologies. (…)

[4.5 Environmental Sustainability, P. 59]

To achieve climate aspirations and to support a more sustainable and resource-efficient economy, substantial investment, including in R&D and innovation, is needed. In addition to significant energy sector investments (see below), the climate agreement envisages forward-looking research and innovation as a necessary driver to achieve long-run emission reduction targets. The new mission-driven innovation policy (see Section 4.4.2) will support an agenda for climate and energy research using both public R&D investments and private resources. The aim is to leverage eco-innovation and emerging technologies to lower the cost of environmental improvements and facilitate competitive yet sustainable business development.

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for the Netherlands, P. 78]

In order to tackle the above transition challenges, investment needs have been identified to support innovation for reducing greenhouse gas emissions, the development of alternative economic sectors and related employment shifts. Key actions of the Just Transition Fund could target in particular:

• Investments in research and innovation activities and fostering the transfer of advanced technologies;

22. POLAND

22.1. Executive summary

Slowing but still very solid economic growth creates a good basis for reforms addressing socio-economic challenges. (…) Key long-term challenges include ensuring a gradual shift towards a knowledge-based economy producing advanced products and services.

Economic growth prospects depend on investment in several policy areas. (…) Investment in innovation will help Poland produce more advanced products and services.

Poland has made limited progress in addressing the 2019 country-specific recommendations. Some progress was observed in strengthening Poland's capacity for innovation.

Progress in reaching the national targets under the Europe 2020 strategy is mixed. (…) Progress remains limited in R&D investment (1.2% of GDP in 2018 vs 1.7% target).

Recent policy measures aim to strengthen innovation. Poland took various measures to enhance the economy's innovative capacity, including changes in higher education, in the organisation of research institutes and the functioning of various tax and subsidy measures. Inputs measured by R&D expenditure have continued rising, while staying well below the EU average. It remains to be seen to what extent these measures will translate into better science-business co-operation and innovation outcomes.

22.2. Research and Innovation

Poland is taking measures to enhance the economy's innovative capacity, but a significant rise in innovative outputs is still to materialise. Poland continues to be a moderate innovator in the 2019 European Innovation Scoreboard (European Commission, 2019d). The total R&D expenditure remains low 1.2% of GDP vs the EU average of 2.1% in 2018, with regional disparities persisting. Although business expenditure on R&D has more than quadrupled in the past ten years, it remains below

the EU average ([70]). In terms of output, no significant results can yet be observed. This is reflected in a sluggish increase in patenting activity and in the share of high-tech exports in recent years, as shown in statistics from the European Patent Office ([71]). However, the extended R&D tax relief, whose uptake has rapidly grown, the 'Innovation Box' ([72]) and the introduction of a new simplified joint-stock company have the potential to support innovative enterprises. The development of venture capital markets remains crucial to facilitate the growth of innovative firms. Measures to enhance the economy's innovative capacity would lead to further progress towards SDG 9.

Polish companies, particularly small ones, show a slow uptake of digital technologies. Less than 8% of small enterprises are highly digitalised compared to 50% of large companies (European Commission, 2020b). The use of robots is rather limited, with, on average, 7.5% of enterprises using them in 2019. To a certain extent, the limited take-up of digital technologies may be driven by firms' difficulties in hiring specialists, despite a high share of graduates in science, engineering and computing (see section 3.3). Micro and small companies also have limited access to specialised ICT training due to personnel availability and cost and wage-related concerns. Under the national Industry 4.0 strategy, the government launched workshops to help acquaint SMEs with the practical use of digital solutions, like artificial intelligence, high performance computing and 3D printing.

Poland is introducing measures to improve its scientific performance. The 2018 Act on Higher Education and Science is under implementation, with implementing legal acts being prepared and adopted. The new evaluation criteria for scientific organisations emphasise the importance of international cooperation and the internationalisation of science. The first edition of the 'Excellence Initiative – Research University' programme was completed in October 2019, with the selection of 10 universities to be reinforced in their research activities. A new configuration of the university councils, including external stakeholders, may positively affect universities' social and economic impact. Doctoral training has been re-organised with the creation of a single doctoral school within higher education institutions. In 2019, the Ministry of Science and Higher Education initiated a reform of the Polish Academy of Science, envisaging, among others, increased prerogatives for the President of the Academy on the supervision of the Academy's institutes, an external review of the Academy's Institutes and the introduction of minimum wage levels for researchers.

([70]) Poland's intensity went from 0.2% of GDP in 2008 to 0.8% in 2018, with an EU average of 1.4% in 2018 (Eurostat).

([71]) https://www.epo.org/about-us/annual-reports-statistics/statistics.html#applications

([72]) The 'Innovation Box' was introduced in 2019 and allows for a preferential 5% tax rate of the income generated by intellectual property rights.

The potential of cooperation between science and business remains underexploited. Cooperation between enterprises and scientific institutes is hardly improving, as confirmed by recent data on joint publications by business, science and public research financed by the private sector (European Commission, 2019a). In 2019, the Łukasiewicz Research Network, comprising 38 research institutes and the Łukasiewicz Centre, was established with the main goal of ensuring excellence of research and development and transfer of knowledge to the economy. It aims to support scientific excellence and the commercialisation of research activities. The Centre acts as an umbrella unit for the Network, ensuring coherence between the institutes' research agendas and State-level strategies. The role of technology transfer centres in the process of innovation diffusion remains limited (European Commission, 2017b; Łobacz, 2018).

22.3. Additional R&I references

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

Since the start of the European Semester in 2011, 42% of all country-specific recommendations addressed to Poland have recorded at least 'some progress' (…).some progress was observed in research and innovation thanks to tax reliefs and measures to facilitate the financing of R&D activities.

[2. Progress with country-specific recommendations, pp.14-15]

Poland has achieved mixed results as regards enhancing the innovative capacity of the economy and the regulatory environment. The country has taken measures to support its research institutions through a comprehensive Higher Education reform that started in 2018. Some measures were taken with respect to strengthening science-business links, including the creation of the Łukasiewicz Network, the introduction of the industrial doctorates programmes and the inclusion of external stakeholders in university councils. In 2016-2019, Poland has diversified and increased the effectiveness of R&D tax incentives by increasing the deducible amounts. (…)

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

Overall, Poland has made limited progress in addressing the 2019 CSRs. (…) With a launch of the Łukasiewicz Research Network and measures to support research institutions through the implementation of the Act on Higher Education some progress was registered in the field of strengthening the innovative capacity of the economy. Overall, limited progress was observed in strengthening investment-related policies. Various measures have been taken in innovation (via dedicated measures of the National Strategy of Regional Development 2030), (…)

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

The 2018 higher education reform is now being implemented, modifying evaluation, management and financing models. New quality assurance institutions have been set up, such as the Council of Scientific Excellence and the Science

Evaluation Committee. Higher education institutions are introducing changes in their organisation, including implementation of new statutes, staff reorganisation and setting up scientific councils. The first full assessment will only be possible after the first full cycle of scientific evaluation and after the first students to follow the new higher education curriculum have graduated. However, there are preliminary indications that the 2018 reform may not be fully effective in improving the quality of teaching. The new law is unclear about requirements for lecturers as for initial pedagogical training and the support for continuing professional development. Academic staff underperforming in scientific publishing can be moved to didactic posts, created in accordance with the new legislation (Żylicz, 2019). Due to lack of specific guidance on the evaluation of doctoral schools, the effectiveness of the process of establishing them is also questionable (id.). The internationalisation of higher education remains limited in Poland (European Commission, 2019b). Although the proportion of international or foreign students increased to 4% in 2017, it is still below OECD average (OECD, 2019a). Experts argue that the current measures are not sufficient to boost international staff mobility (Kosmalska, 2019).

[3.4. Competitiveness, reforms and investments, Investment and productivity developments, pp. 32-33]

The European Fund for Strategic Investments and the national development bank support investment in Poland. Since 2015, total financing under this instrument in Poland has reached around €3.9 billion and is set to trigger €21 billion in additional investments. €3.7 billion has gone to infrastructure and innovation projects. (…) In total, almost 75,200 SMEs and mid-cap companies are expected to benefit from improved access to finance. By the end of 2020, all EU financial instruments are set to come under the roof of the new InvestEU programme. InvestEU will focus on areas relevant to Poland: sustainable infrastructure, research and innovation, digitalisation, social investment and skills. The Bank Gospodarstwa Krajowego (BGK), the national promotional and development bank, supports economic growth by providing finance for infrastructure projects. It also aims to promote entrepreneurship and develop micro companies and SMEs by offering guarantees and surety instruments. BGK is also active in stimulating cooperation between enterprises, the public sector, and financial institutions.

[3.4. Competitiveness, reforms and investments, Investment and productivity developments, p. 33]

Labour productivity has been increasing strongly, but underlying weaknesses in productivity drivers remain. (…) This involves addressing challenges in the business regulatory environment (see Box 3.5.1), the availability of skilled workforce, and the effective diffusion of innovations across the economy.

[Annex D – Investment Guidance on Just Transition Fund 2021-2027, p. 59]

Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in the creation of new firms, including through business incubators and consulting services;
- investments in research and innovation activities and fostering the transfer of advanced technologies;

23. PORTUGAL

23.1. Executive summary

A positive economic performance and policy effort is helping Portugal to address some of its challenges. (…) To address these issues, Portugal is taking steps to improve education, skills, innovation, the business environment, and the efficiency of the justice system.

(…) **Portugal faces significant shortfalls in investment.** Making the economy carbon-neutral by 2050 require significant investment in energy and transport. (…) Low investment in research and innovation hinder Portugal's productive specialisation. The share of R&D expenditure as a proportion of GDP remains below the EU average. This is holding back Portugal's prospects of increasing the share of value-added in the economy.

(…) Portugal has made limited progress on addressing the 2019 country-specific recommendations.

There has been limited progress in the following areas:

- Focusing investment-related economic policy on research and innovation, and on railway and port infrastructure.

(…) **As regards progress towards the national target under the Europe 2020 strategy, Portugal is close to meeting its renewables target and is on track to achieve its energy efficiency targets.** (…) Meeting the targets for research and development investment and higher educational attainment remains challenging.

23.2. Research and Innovation

R&D intensity remains below the EU average, with Portugal being a moderate innovator. R&D intensity increased to 1.35% in 2018, still below the pre-crisis level of 1.58% of GDP. Business R&D intensity, at 0.69% of GDP is higher than public R&D intensity (0.64% of GDP) in 2018 but remains low. The government announced (Portuguese Government Programme 2019-2023) an objective of R&D investment of 3% of GDP by 2030, but specific performance indicators in R&D are yet to be announced.

Subdued investment in intellectual property, intangible assets, including R&D and economic and digital competences weigh on productivity. Investment in intellectual property is well below the euro area average and close to pre-crisis levels. In addition, the contribution from intangible investment to productivity growth is below average (0.13% vs. 0.19%) (Bauer et al., 2020). The same applies to investment in training and organisational capital as a share of GDP (European Commission, 2018b). Moreover, the share of investments to ICT in GDP has declined since 2000. These developments undermine the productivity of firms and their capacity to reap the benefits from digitalisation. The Qualifica scheme for upskilling of the population, the INCoDe.2030 national strategy to enhance digital competences, and "Industry 4.0" are the main initiatives in place to address these challenges, which would lead to progress on SDG 9.

Portugal's economic structure remains anchored in traditional low- and medium-low- tech sectors, pointing to slow structural change. There has been limited progress with upgrading the country's economic structure to achieve higher shares of value-added in high-tech manufacturing and services. Although exports of medium- and high-tech products remain low, they have continued to improve relative to the EU average, going from 48% in 2010 to 58% in 2018 (Godinho, M., Corado Simões, V. and Sanchez-Martinez, M., 2020). In addition, investment in machinery and equipment is now rising again.

Portugal has the potential to address the needs of the labour market and improve research careers. According to the 2019 European Innovation Scoreboard, Portugal has made progress in increasing the number of science and engineering graduates. Levels are now above the EU average and the share of researchers in total employment has increased. Yet, the country ranks low in the EU in terms of computing graduates. To improve research careers, the scientific employment programme includes the SIFIDE fiscal incentive and the INTERFACE scheme.

There are new measures designed to tackle shortcomings in science-business links. Despite the increasing internalisation of its R&D sector, Portugal ranks low relative to the EU in public-private scientific co-publications (European Commission, 2019g). To improve the framework conditions for collaboration, the INTERFACE scheme is designed to strengthen the country's cluster policy for innovation. Moreover, 'Portugal 2020' launches calls for co-promotion projects. Within Capitalizar, a more flexible regime for tax credits is being implemented, and SMEs now have an extended carry-forward period of twelve years.

Portugal strives to integrate the smart specialisation and environmental sustainability agendas. Portugal is supporting internationalisation and science-business cooperation in the circular economy and improving the implementation of its national and regional smart specialisation strategies. However, as concerns the latter, cooperation between the national and regional levels, along with a lack of smart specialisation skills among public and private actors, lead to governance bottlenecks. In addition, their monitoring is limited and does not measure innovation outcomes. To circumvent some of these challenges, Portugal has started to review its approach, with

an emphasis on priorities for research and innovation investment and better coordination of national and regional strategies.

23.3. Additional R&I references

[1. Economic situation and outlook, Regional disparities, p. 8-9]

Competitiveness varies across Portugal, closely matching economic output, GDP per capita, productivity and innovation levels. In a European perspective, Portuguese regions lack competitiveness. In the 2019 Regional Competitiveness Index (RCI), the Metropolitan Area of Lisbon is the most competitive Portuguese region –ranked at 141 out of 282 regions. All the other regions of Portugal are ranked between 212 and 267. When compared with other EU regions with similar characteristics, Lisbon, Centro, Norte and Alentejo show a similar performance on most dimensions of competitiveness, and some of their infrastructure is even rated as excellent. However, Madeira, Azores, and, in particularly the Algarve, underperform on many dimensions.

[1. Economic situation and outlook, Public finances, p. 14]

Portugal is making progress towards achieving the Sustainable Development Goals (SDGs). Areas where progress is more evident refer to SDG 1 "No Poverty", with all its associated indicators showing an improving performance during the last five years. Relatively similar performances are found for SDG 16 "Peace, Justice and Strong Institutions" and SDG 9 "Industry, Innovation and Infrastructure". (…)

[2. Progress with country-specific recommendations, p.16-18]

Limited progress has been made with focusing investment-related economic policy on research and innovation. The implementation of the Portugal 2020 strategy is well underway and a reprogramming aimed at assigning additional funding to investments in innovation was conducted in 2019. Yet, further investments and policy efforts are necessary in particular to foster linkages between R&D actors and businesses and support a thriving innovation driven economy.

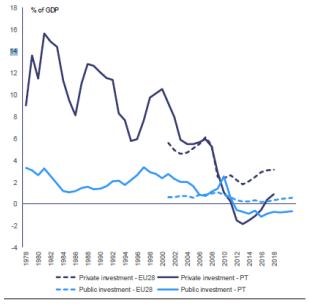
(…) **Portugal has made limited progress in addressing the 2019 country-specific recommendations.** Limited progress has been made with respect to the fiscal-structural part of CSR 1, with the government continuing to tackle expenditure control, cost efficiency and adequate budgeting. However, hospital arrears have again begun to rise at a steady rate. Progress with improving the financial sustainability of state-owned enterprises which struggle to achieve a balanced financial position has also been limited. There has been some progress in addressing CSR 2, with Portugal adopting measures to address labour segmentation. There has also been some progress on skills and education, thanks to new policy measures improving access to higher education, and the implementation of programmes such as Qualifica and INCoDe.2030. Yet, limited progress has been made towards improving the effectiveness and adequacy of the social safety net. As regards CSR 3, there has been some progress on investment-related policy in the area of energy transition, while limited progress for policies in the

areas of research and innovation, and railway and port infrastructure. As regards the business environment (CSR 4), there has been some progress on increasing the efficiency of insolvency and recovery proceedings, as well as on reducing administrative burden. However, limited progress has been made on reducing sector-specific barriers to licensing. There has been no progress with removing regulatory restrictions in professional services, which remain largely sheltered from competition.

[4.4. Competitiveness, reforms and investment, 4.4.1. Productivity growth and investment, Productivity and investment, p. 51]

(…) Investment is increasing from a low base, with net private investment turning positive, but with public investment remaining subdued. The ratio of investment (37) over GDP was 17.6% in 2018 (16.8% in 2017), the highest since 2012. Despite this increase, the ratio remains one of the lowest in the EU. In 2018 net private investment turned positive, while the share of public investment in total investment reached 11%, one of the lowest in the historical series. In this way, public investment remains well below EU standards and government plans (see Section 4.1.3.). In addition, net public investment remained negative, contributing to the gradual erosion of the public capital stock. Targeted public investment could fuel productivity growth through improved human capital and technological innovation and generate a crowding-in effect by providing relevant infrastructure for additional private investment.

Graph 4.4.2: **Historical evolution of net investment**



Source: European Commission

Several barriers are holding back productivity growth and firms' investment. In its first report, the Portuguese Productivity Board (Conselho para a Produtividade, 2018) identifies as main factors hindering productivity growth the low level of qualification of the workforce (particularly for older workers and managers), poor innovation in the private sector and poor interaction between firms and public administration. According to the latest Survey on Framework Regulation Costs performed by the Portuguese Statistical Institute based on 2017 data, the long duration of trials in the justice system and licensing are the major barriers to investment. Additional barriers refer to the low levels of capital accumulation, the higher share of micro-enterprises (95.4%) compared to EU average of 93%, and the existence of regulatory hurdles in key professional services. In addition, according to the 2019 EIBIS Survey (European Investment Bank, 2019) the main barriers to investment are uncertainty, business regulations, energy costs, labour market regulations and shortages of skilled staff.

[4.4. Competitiveness, reforms and investment, 4.4.1. Productivity growth and investment, Digitalisation of Industry, p.53]

Portugal is committed to the development of innovative digital technologies. With the strategy on Artificial Intelligence Portugal 2030, the country is aiming to be at the forefront of education on artificial intelligence. In addition, the strategy on Advanced Computing Portugal 2030 aims at promoting and expanding advanced cyberinfrastructure until 2030. In 2019, Portugal inaugurated its first supercomputer (start of the participation in the European High-Performance Computing initiative) and a second is expected by the end of 2020.

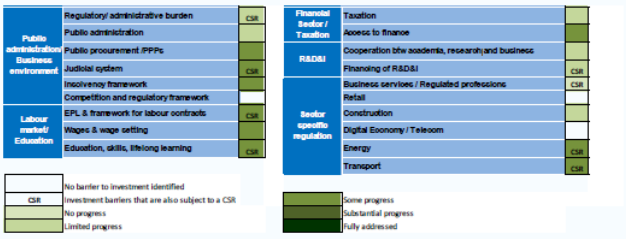
[Box 4.4.1: Investment challenges and reforms in Portugal p .55]

Box 4.4.1: **Investment challenges and reforms in Portugal**

Section 1. Macroeconomic perspective

Portugal's gross fixed capital formation accelerated substantially at the beginning of 2019 driven mainly by infrastructure construction projects. On a full-year basis, gross fixed capital formation is projected to increase by 6.5% in real terms, picking up from 5.8% in 2018. Investment growth is forecast to slow down somewhat in 2020-2021 but to remain strong, supported by the cycle of EU funds. The share of investment in GDP has increased from a historical low of 14.8% in 2013 to 17.6% of GDP in 2018 and is set to rise further to 19.6% by 2021. Portugal's public investment has nonetheless been subdued for a prolonged period, after sustaining very high levels during the first decade of the 2000s. While it is set to continue on the gradually increasing path initiated in 2017, after its lowest level in 2016, the projected share of public investment in GDP, at 2.3% of GDP by 2021, would remain significantly below the average of around 3% for the euro area and the EU as a whole.

Section 2. Assessment of barriers to investment and ongoing reforms



Various factors hinder investment in Portugal. The low level of qualification of the workforce, especially in digital skills, makes it more difficult to boost investment in knowledge-intensive activities (Section 4.3). Investment gaps in infrastructure, particularly as regards transport and energy, make Portuguese firms less competitive (see Section 4.4). Other challenges to competitiveness include regulatory barriers in business services (see Section 4.4.2), and aspects of the business environment, in particular sector-specific barriers in licensing and inefficiencies in the justice system (see Section 4.4.4).

The EU supports investment in Portugal also via the European Fund for Strategic Investments (EFSI). By December 2019 total financing under the EFSI amounted to €2.7 billion, intended to trigger €10 billion in additional investments.

The current experience with the EU financial instruments and the EFSI budgetary guarantee demonstrated a need for simplification, streamlining and better coordination of the EU's investment support instruments during the next 2021-27 programming period. By the end of 2020, EFSI and other EU financial instruments will come under the roof of the new InvestEU programme that promotes a more coherent approach to financing EU policy objectives and increases the choice of policy implementation options and implementing partners to tackle country specific market failures and investment gaps. In addition, under InvestEU, Member States can set-up a national compartment by allocating up to 5% of their structural funds to underpin additional guarantee instruments supporting the financing of investments with a higher level of local specificities. InvestEU will be policy-driven and focus on four main areas: Sustainable Infrastructure, Research, Innovation, and Digitisation, Small Businesses, and Social Investment and Skills.

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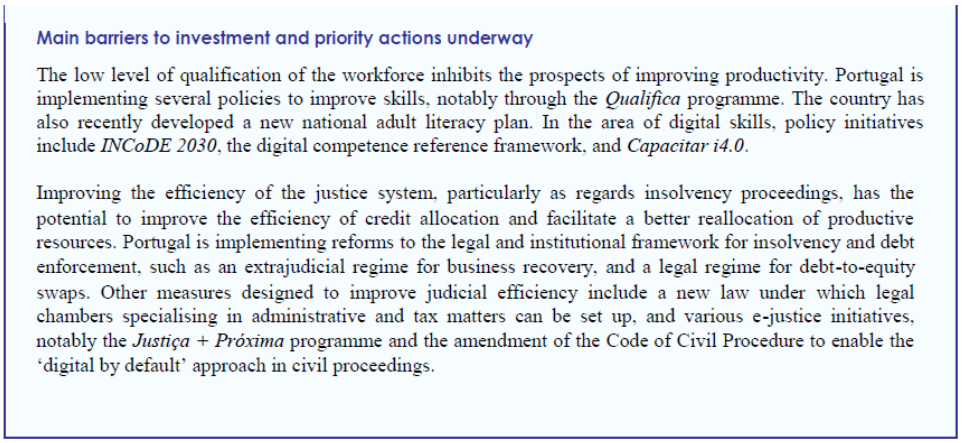


Main barriers to investment and priority actions underway

The low level of qualification of the workforce inhibits the prospects of improving productivity. Portugal is implementing several policies to improve skills, notably through the *Qualifica* programme. The country has also recently developed a new national adult literacy plan. In the area of digital skills, policy initiatives include *INCoDE 2030*, the digital competence reference framework, and *Capacitar i4.0*.

Improving the efficiency of the justice system, particularly as regards insolvency proceedings, has the potential to improve the efficiency of credit allocation and facilitate a better reallocation of productive resources. Portugal is implementing reforms to the legal and institutional framework for insolvency and debt enforcement, such as an extrajudicial regime for business recovery, and a legal regime for debt-to-equity swaps. Other measures designed to improve judicial efficiency include a new law under which legal chambers specialising in administrative and tax matters can be set up, and various e-justice initiatives, notably the *Justiça + Próxima* programme and the amendment of the Code of Civil Procedure to enable the 'digital by default' approach in civil proceedings.

[ANNEX D: Investment Guidance on Just Transition Fund 2021-2027 for Portugal p.85]

Building on the Commission proposal, this Annex presents the preliminary views of Commission services on priority investment areas and framework conditions for effective delivery for the 2021-2027 Just Transition Fund investments in Portugal (64).

These priority investment areas are derived from the broader analysis of territories facing serious socio-economic challenges deriving from the transition process towards a climate-neutral economy of the Union by 2050 in Portugal, assessed in the report. This Annex provides the basis for a dialogue between Portugal and the Commission services as well as the relevant guidance for the Member States in preparing their territorial just transition plans, which will form the basis for programming the Just Transition Fund. The Just Transition Fund investments complement those under Cohesion Policy funding for which guidance in the form of Annex D was given in the 2019 Country Report for Portugal (65).

In Portugal, there are two remaining coal-fired power plants: in the regions of Alentejo Litoral (municipality of Sines) and Médio Tejo (in Pego, municipality of Abrantes). These plants are the largest greenhouse gas emitters in Portugal, all sectors included. Highly polluting industries of manufacture of refined petroleum products and plastics are also located in Sines and Matosinhos. In line with the Portuguese Carbon Neutrality Roadmap 2050 targets reflected in Portugal's draft National Energy and Climate Plan, the Portuguese government has committed to decommissioning these two plants by September 2023.

Estimates suggest that the closure of the plants would affect around 650 jobs: 350 in Sines, 200 in Pego, and 100 in the port of Sines where coal is received. For the two municipalities (Sines and Abrantes), the jobs at stake correspond to almost 8% and 3% of the total number of people employed. Based on this preliminary assessment, it appears warranted that the Just Transition Fund concentrates its intervention on these regions.

In order to tackle these challenges, high priority investment needs have been identified to make the economies of these regions more modern and competitive based on sustainable investments and to help these regions to absorb the structural changes of the transition. Key actions of the Just Transition Fund could target in particular:

(...) investment in research and innovation activities and fostering the transfer of advanced technologies;

(...) productive investments in SMEs, including start-ups;

(...) The smart specialisation strategies of Centro and Alentejo (66) provide an important framework to set priorities for innovation in support of economic transformation. The economic diversification process that Centro and Alentejo could undergo to pave the way to their decarbonisation may take account of the sectors identified in their respective regional smart specialisation strategies referring, inter alia, to the development of the renewable energy sector (in particular, there is potential for wind, solar biomass and hydrogen) and energy efficiency as activities leading to new employment opportunities, from which the workers affected could benefit; they also refer to agribusiness, wood, biotechnology and sustainable tourism through the fostering of natural and cultural heritage, as sectors with high potential

24. ROMANIA

24.1. Executive summary

Insufficient investment hampers the potential of the economy to converge to EU levels. (…) Prioritisation, stabilisation and increases of public and private investment in research, development and innovation and in physical and digital infrastructure would contribute to reduce regional disparities and improve productivity and long-term growth.

The risks to Romania's competitiveness come from both cost and non-cost factors. (…) Furthermore, non-cost factors such as the poor quality of infrastructure, the economy's low innovative capacity and poor institutional quality hinder the country's ability to compete internationally.

Romania's weak research and innovation performance hampers the transition towards a knowledge-based economy. The country continues to have one of the lowest levels of public and private expenditure on research and development in the EU, negatively affecting scientific quality and the diffusion of technology amongst firms. Increasing R&D investment and quality and supporting innovative firms remain important challenges.

24.2. Research and Innovation

Romania has yet to start its transition towards a knowledge-based economy. The country's innovation performance is poor, ranking last in the EU in the 2019 European

Innovation Scoreboard (European Commission, 2019b). Investment in employee training and ICT solutions are lower than the EU average (EIB, 2019). R&D investment is very low, with an R&D intensity of 0.51% of GDP in 2018, well below the 2020 national target of 2% and the EU average of 2.12%. Public R&D investment was 0.2% of GDP in 2018. Private expenditure on R&D was only 0.30% of GDP, below the EU average of 1.41%

Scientific performance and academia-business links continue to be poor. The country still ranks at the bottom of the EU in terms of top scientific publications and international co-publications (European Commision, 2018a). Universities do not receive any institutional funding for R&D, despite their important role in producing relatively good research. Regulatory barriers (e.g. red tape, conflicting or unclear rules) hamper academia-business links, which tend to occur on an ad-hoc basis.

The ICT and automotive sectors show signs of innovation potential. Both sectors are predominantly export-oriented and well integrated into global value chains (ANIS 2018; NBR 2018), and are therefore exposed to competition and high technological standards. The ICT sector is leading in high growth enterprises[73] (Flachenecker et al, forthcoming), innovative start-ups and successful scales-ups (My-Gateway, 2019). The automotive sector accounts for some of the largest business R&D investment in the country. However, since foreign-owned firms operating in Romania tend to keep key R&D activities at their foreign headquarters (NBR, 2016), potential know-how or technology spill-overs remain limited (NBR, 2018). This is also visible in the R&D investment intensity of the ICT sector, which was among the lowest in the EU in 2016 (European Commission, 2019a), whilst in the automotive sector it is lower than in peer countries.

Policies supporting the transition towards a more knowledge-based economy remain limited. The economic competitiveness, research and innovation and smart specialisation strategies cannot achieve their stated objectives without a sufficient level of public R&D funding. Besides the tax exemption for ICT professionals, there are no targeted measures for innovative start-ups. The 'Start-up Nation' programme was not deemed well-tailored to the needs of innovative start-ups (World Bank, 2018). The scaling up of innovative domestic firms remains challenging due to the limited size of the local venture capital market (Invest Europe, 2018b). Most successful measures for start-ups and scales-ups (e.g. accelerators, business angels, venture capital) are bottom-up initiatives, with limited policy support (MyGateway, 2019).

Regional initiatives to enhance growth exist, but risk being hampered by a lack of a robust national innovation and entrepreneurship ecosystem. The Romanian regions have developed and are currently updating Smart specialisation strategies (S3), identifying key innovative sectors and projects pipelines. In 2019 they continued to

[73] Enterprises with an average annualised growth in the number of employees of more than 10% per year over a 3year period and at least 10 employees when the growth began. 7.7% of firms in the Romanian IT sector are high growth enterprises.

receive tailored expertise under the Commission's Catching up Regions Initiative in order to facilitate the transfer and dissemination of new technology between research organisations and businesses, better commercialise research projects, build capacity for technology transfer and promote innovation in local small and medium-sized businesses and start-ups. In 2019 the initiative led to the reallocation of EU Funds to innovation projects in two regions (Nord-Est and Nord-Vest) and will be carried out until end 2020. However, though very promising in terms of capacity and knowledge-building, these regional initiatives cannot achieve full potential and increase the country's performance and competitiveness unless a functional and robust national innovation and entrepreneurship ecosystem is set up.

24.3. Additional R&I references

[4.2. Financial sector 4.2.3. Capital Markets and Access to Finance, p.33]

Access to risk capital for innovative start-ups and scale-ups remains limited. Romanian firms operating in high tech knowledge-intensive services and manufacturing tend to be more finance constrained than firms active in less knowledge intensive sectors are (EIB, 2019a). This could be due to a lack of appropriate supply and financing instruments adapted to the needs of innovative start-ups and scale-ups. Romania was among the most attractive destinations in Central and Eastern Europe for private equity and venture capital funds (Invest Europe, 2018a) and venture capital investments have increased over the last four years. However, the size of the market and volumes are still relatively low and concentrated in few sectors, primarily in the Bucharest and Vest regions (Flachenecker et al., forthcoming). Efforts to support business creation with various financing options are initiated by national authorities, but lack a targeted approach and funds (OECD 2018b)

[4.4. Competitiveness, reforms and investment, 4.4.1. Competitiveness and External Position, p.48]

A number of non-cost factors also affect Romania's competitiveness negatively. The poor state of infrastructure hinders businesses' effectiveness in moving goods and services across borders, limits labour force mobility and aggravates regional disparities. The economy's low innovative capability is another key factor limiting competitiveness (see Section 4.4.2).

[Box 4.4.1: Investment challenges and reforms in Romania, p.49]

In terms of research and development, the country is amongst the worst performers in the EU, spending just 0.5% of GDP in R&D activities in 2018 compared to the 2020 country target of 2%. All peer countries in the region invest substantially more in R&D than Romania.. This underinvestment has resulted in poor scientific quality and performance. Academia-business cooperation occurs mainly on an ad-hoc basis and its development is hampered by regulatory barriers. Without significant regulatory and budgetary changes, current measures are insufficient to tackle the underfinancing and structural problems affecting the research and innovation sector.

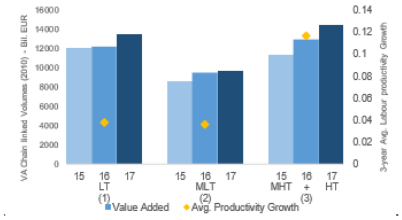
[4.4. Competitiveness, reforms and investment, 4.4.2. Productivity and Investment, p.50]

Labour productivity dynamics vary significantly across firms. Domestic firms are on average smaller, less productive and less innovative than larger, and mostly foreign-owned, firms (NBR, 2018). Despite a recent shift of manufacturing jobs towards more productive firms and increased allocative efficiency, there is scope for improvement. While foreign-owned firms represented less than 10% of all firms, they accounted for almost half of gross value added and more than two-thirds of the country's exports in 2016 (NBR, 2018).

Firm size and characteristics largely account for the low level of technology uptake. On average, small firms tend to invest less in new technologies and innovation (EIB, 2019). Even in knowledge-intensive sectors such as medium and high-tech manufacturing, firms invest less in R&D than their peers in the region. In addition, Romania has one of the lowest robot densities in the region (IFR, 2017) and SMEs are five times less likely to use robots than large firms (European Commission, 2019a).

Performance in the manufacturing sector has been mixed across technology classes. Whilst the low and medium-low technology sectors grew moderately in value added and labour productivity, medium-high technology production has been the largest contributor to growth (Graph 4.4.7). The foreign-dominated automotive industry and related sectors such as rubber and plastics are the driving forces behind this development and have also improved export quality. However, despite the presence of FDIs in R&D activities, spill-overs from foreign to domestic firms remain limited at best, with a positive effect between foreign-owned firms and domestic suppliers but a negative one between horizontal competitors (NBR, 2018).

Graph 4.4.7: **Value added and average labour productivity growth by manufacturing technology class**



(1) LT: Low technology sector;
(2) MLT: Medium-low technology sector;
(3) MHT + HT: Medium-high and high technology sector (merged due the low overall share of HT)
Source: European Commission

In services, labour productivity increased in the knowledge intensive and the low-knowledge intensive sectors. In terms of value added however, low-knowledge intensive sectors have a slightly higher growth rate (Bauer et al, 2020). The share of domestic firms in value added has also increased consistently since 2010. Amongst knowledge-intensive activities, the labour productivity gap between foreign and domestic firms has decreased in the ICT sector despite the smaller size of domestic

firms on average. Labour market tightness and financial constraints may constitute an obstacle to the scaling up of these domestic firms.

[4.4. Competitiveness, reforms and investment, Digitalisation, p.52]

Measures are in place to support investment in digital technologies. In terms of EU-coordinated programmes, Romania is a member of the EuroHPC73 Joint Undertaking, and signed the Declaration of the European Blockchain Partnership and the Declaration on Cooperation on Artificial Intelligence. During 2014 to 2020, under the European Regional Development Fund, Romania is also investing more than 75 million in the ICT innovation sector. The business sector showed a huge interest, responding to the calls for projects for five times higher than the available envelope. For the post-2020 EU Funds programming period, the intention is to put major emphasis on digitalisation and innovation.

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for Romania, p.83]

In order to tackle the related transition challenges, high priority investment needs have been identified to alleviate the socio-economic costs of the transition. Key actions of the Just Transition Fund could target in particular: (…)

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investment in the creation of new firms, including through business incubators and consulting services;
- investment in research and innovation activities and fostering transfer of advanced technologies

25. SLOVAKIA

25.1. Executive summary

Slovakia's growth opportunities lie in a more sustainable and higher value added economy. Slovakia has seen significant economic growth in recent decades and has been catching up with the EU average, thanks to important reforms and structural changes that have taken place. As convergence with the EU weakens, population ageing, climate change and the digital transformation pose long-term challenges to the country's economy and to fiscal sustainability. Maintaining productivity growth, the backbone of Slovakia's economic convergence, will thus require sustained structural reforms and targeted investment into infrastructure and research and innovation. Improving the quality and inclusiveness of the education and training system, reducing regional disparities and improving the quality of public institutions can help Slovakia to safeguard its competitiveness, move up the value chain and become more sustainable. A

smart and low-carbon transport and energy system can contribute to greening the economy. ([74])

The digital transformation could provide opportunities if the regulatory framework is made fit-for-purpose and R&D is improved. Future technological changes are likely to impact Slovakia's economy more than the economies of other countries. Yet, both public and private R&D investment remain low. The low quality of public research and limited cooperation with businesses, partly explained by inefficiencies related to a fragmented governance system, constrain the development and sharing of knowledge and skills.

25.2. Research and Innovation

R&D investment has increased in the last decade but depends on European Structural and Investment Funds (ESIF). About 39% of R&D investment relies on foreign funding sources, 89% of which are EU funds. Both figures are among the highest in the EU. Overall R&D investment has risen from 0.45% of GDP since 2007 to peak at 1.16% in 2015 and dropped again to 0.84% in 2018. These developments are mainly explained by fluctuations in public R&D funding due to the transition between EU funding periods. This illustrates Slovakia's over-reliance on ESIF funding and raises questions about the sustainability and adequacy of R&D funding.

The use of funds under the operational programme Research and Innovation (OP R&I) is slow, hampering R&D spending. The cancellation of various calls and administrative inefficiencies resulted in de-commitments ([75]) in 2017 and 2018, to be remedied by new calls to mobilise top researchers and support strategic research. Due to lengthy evaluation, selection and administrative procedures, the OP R&I will not have achieved its minimum spending targets again in 2019. The merger with the operational programme Integrated Infrastructure ensured that there was no de-commitment in 2019. Substantial improvements in the efficiency of the management and control system should follow to avoid another loss of EU funds earmarked for research and innovation.

A fragmented governance system renders public R&D investment inefficient. Policy development and implementation suffer from a lack of coordination between ministries and implementing agencies, and the lack of a comprehensive, long-term research and innovation strategy. Major reforms have been regularly postponed. No

([74]) This report assesses Slovakia's economy in light of the European Commission's Annual Sustainable Growth Strategy, published on 17 December 2019. In this document, the Commission sets out a new strategy on how to address not only short-term economic challenges but also the economy's longer-term challenges. This new economic agenda of competitive sustainability rests on four dimensions: environmental sustainability, productivity gains, fairness and macroeconomic stability.

([75]) 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'.

substantial policies were adopted to decrease the fragmentation of the public research system and the reform of the Slovak Academy of Sciences was stopped in its final stage. As a result, the whole R&I ecosystem is not performing well.

The low quality of public research constrains skills development, and knowledge production and diffusion. There is a vicious circle created by the low quality of the system ([76]) and the ability to attract students and researchers. Initiatives such as the ACCORD project to invest €111 million into Bratislava-based universities Comenius University and Slovak University of Technology could help break this circle and improve R&I capacity and infrastructure, as well as attracting students and researchers. Targeted measures to attract foreign talent can also increase the benefits of investing in infrastructure. The low quality of the science base also hinders science-business cooperation ([77]) and private R&D investment.

Business expenditure on R&D is too low to substantially boost innovation, particularly among small and medium enterprises (SMEs). Even though it has increased since 2009 to 0.45% of GDP in 2018, Slovakia's business R&D intensity remains one of the lowest in the EU. Despite the importance of the medium-high-tech manufacturing sector dominated by multinational firms, Slovakia has not been able to attract substantial R&D investment from these companies. Domestic technological development is low, as shown by patenting activity, which is among the lowest in the EU. In addition, at 0.14% of GDP in 2018, SMEs' business expenditure on R&D is at less than half the EU average of 0.3%. Various measures are underway to improve the SME research ecosystem, mostly financed by the European Structural and Investment Funds. However, SMEs' ability to draw on these resources is hindered by cumbersome and lengthy administrative processes. In 2018, 260 firms benefited from the R&D tax deduction (Section 3.1), saving around €72 million in income taxes (compared to 163 companies and €8 million in 2017; Slovak Credit Bureau, 2019). The increasing numbers and amounts as well as the involvement of micro and small enterprises in the scheme surpassed initial expectations.

Skills mismatches and regional disparities hamper Slovakia's capacity to benefits from smart specialisation. First, the smart specialisation strategy does not fully reflect differences between Slovak regions in terms of specialisation, economic performance or research and innovation potential. Second, the current skill-set and weakly developed policies for future skills hinder the technological transition of the economy. However, a revision of the strategy has recently started, with technical support from the EU Structural Reform Support Programme; the results should feed into the programming of

([76]) For instance, the proportion of Slovak publications that are highly-cited (scientific publications within the top 10% most cited scientific publications worldwide as percentage of a country's total scientific publications) remains very low.

([77]) Links between science and business remain limited, with public-private scientific co-publications only accounting for 2% of the total number of Slovak publications.

R&D investment for the post-2020 period. An important aspect of revising the strategy will be the setting up of an effective and continuous dialogue with entrepreneurs (entrepreneurial discovery process) to define new growth paths (the areas of smart specialisation where R&I could bring economic transformation), to identify measures to increase R&I performance and to strengthen the governance system.

25.3. Additional R&I references

[2. Progress with Country-Specific Recommendations, p. 18]

Limited progress has been made in focusing investment-related economic policy on research and innovation.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Slovakia, p.21]

EU Cohesion policy funding is contributing to major transformations of the Slovak economy by promoting growth and employment via investment, among others, in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility.

[3.Reform Priorities, 3.1.1. Taxation, p.23]

The ratio of tax expenditure to GDP is expected to increase from 1.4% in 2018 to 1.7% in 2021. (…) increases in extra deductions of the eligible R&D costs from 100% to 150% by the end of 2019 and to 200% in 2020 (…).

[3.4. Competitiveness, reforms and investment; 3.4.2. Regional disparities, p.43]

Economic and social disparities between regions in the East and in the West are significant. Despite a positive upward trend registered by all four NUTS 2 regions when comparing 2016 and 2019 values of regional competitiveness ([78]), the gap between Bratislava and Slovakia's other regions remains significant. A similar divide exists for levels of R&D expenditure, the proportion of the population with tertiary education, and employment in medium- and high-tech manufacturing (European Commission, 2019e). …

The capital region performs above EU average regarding higher education, labour market efficiency and innovation. (…) The Bratislava region performs better than the other regions on all R&I-related aspects, including innovation performance and tertiary

([78]) The 2019 European Regional Competitiveness Index

education. This might have an adverse effect on R&I development in non-capital regions, making efforts to attract talent to these regions more difficult…

[3.4.Competitivness, reforms and investment; 3.4.4. Institutional quality and business environment, p.46]

Support for entrepreneurship is below the EU average. (…) **However, innovation-driven high growth companies are performing relatively well.** In 2016, 19% of employees in companies with more than 10 employees worked for innovation-driven high growth companies, well above the EU average.

[3.4. Competitiveness, reforms and investment, 3.4.3. Innovation and Digital Transformation, p.45-46]

Digital economy, automation and connectivity

An increasing number of manufacturing companies are moving towards digital transformation. (…) Slovakia does not yet have a digital innovation hub and there is a shortage of employees with digital skills (see Section 3.3).

Automation can be an opportunity if the regulatory framework and education system support digital transformation. (…) The role of research and innovation must also increase if Slovakia is to be well equipped to adapt to these changes and move up the value chain. Slovakia scores particularly low on Industry 4.0 patent applications, with only four applications submitted between 1990 and 2016, compared to 33 in Czechia, 41 in Hungary and 86 in Poland (data from the European Patent Office for 2017). (…) The new Strategy for Digital Transformation of Slovakia 2030 and the related Action Plan 2019-2020 aim to make the country fit for the transformation by stimulating innovation, strengthening cybersecurity, supporting the job market, improving digital skills and building a strong institutional ecosystem. The effort could benefit from a broader involvement of initiatives such as the Digital Coalition or the new National Research Centre on artificial intelligence (Slovak.AI) as a platform for connecting everyone active and interested in AI.

[Annex A, Overview table, p.62]

Europe 2020 (national targets and progress)

Total R&D expenditure stood at 0.84 % of GDP in 2018 and it does not appear likely that the target of 1.2% will be reached. R&I ecosystem lacks a boost in both public and private expenditure. However, an increase in investment has to be coupled with appropriate reforms to set Slovak R&I on the right path.

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for Slovakia, p.72.]

In order to tackle the transition challenges and support the sustainable competitiveness of these regions, high priority investment needs have been identified. Key actions of the Just Transition Fund could target in particular:

- Investments in regeneration and decontamination of sites, land restoration and repurposing projects;
- Investments in research and innovation activities and fostering the transfer of advanced technologies;
- Upskilling and reskilling of workers;
- Investments in the deployment of technology and infrastructures for affordable clean energy, in greenhouse gas emission reduction, energy efficiency and renewable energy;
- Technical assistance.

26. SLOVENIA

26.1. Executive summary

Further investment in innovation and infrastructure (environmental, transport and energy) remains necessary to keep Slovenia on a sustainable growth path. The innovation potential of the economy is hampered by: rather low public investment in research and innovation, limited science-industry cooperation and uneven innovation and digital capacities among firms.

(…)

There has been **some progress** in the following areas:

- Focus investment-related economic policy on research and innovation – Slovenia has not fully implemented its research and innovation strategy, and there is little harmonisation among different policies and strategies.

Slovenia is making good progress towards its national targets under the Europe 2020 strategy. (…) However, the 2020 target for R&D and renewable energy are not likely to be reached.

26.2. Research and Innovation

Slovenian firms actively innovate, although certain indicators of innovation performance showed some decline in 2018. Slovenia has lost some ground on innovation performance: while Slovenia has ranked very high on the European Innovation Scoreboard since 2011, its performance fell in 2018 (European Commission, 2019 f). This fall can be attributed to decreases in specific indicators in areas like investment, human resources, linkages or sales of product innovations. As a result, Slovenia is no longer a ‘strong innovator’ but only a ‘moderate innovator’, a one-scale drop in the ranking. There is still a significant difference in innovation performance between the stronger western region and the weaker eastern region. However, there are innovation hubs not only in Ljubljana but also in the eastern cities of Celje and Maribor.

Both employment in high-tech ([79]) and knowledge-intensive services ([80]) sectors are concentrated in the western region (European Commission, 2019 d).

Domestic firms, notably SMEs, are on average less innovative than in the past. Half of Slovenian firms developed or introduced new products, processes or services in 2019. This is above the EU average and twice the share recorded in previous years. Furthermore, almost four in ten firms in Slovenia portray themselves as either active innovators or developers, more than the current EU average (28%). However, innovation activity of enterprises has declined across all size classes of company since 2010. In the past 3 years, small enterprises and the manufacturing sector recorded the largest decline (EIB, 2019; IMAD, 2019 a). Foreign-owned firms account for 39% of the country's total business enterprise expenditure on R&D. They perform innovation activities in the medium- and high-tech manufacturing sectors. More than half of the patent applications filed by Slovenian businesses with the European Patent Office in 2010-2018 were filed by large enterprises from these technological fields.

Business R&D intensity is relatively high but public R&D expenditure is modest and the 3% R&D intensity target seems out of reach. R&D intensity was 1.95% of GDP in 2018 (EU average: 2.11%), returning to its 2010 level, after peaking at 2.56% in 2013. This has been driven by business R&D expenditure which stood at 1.45% of GDP in 2018 (above the EU average of 1.41%), also returning to its 2010 level, after peaking at 1.96% of GDP in 2013. The peak in 2013 followed the introduction of substantial R&D tax reliefs in 2010 ([81]). The subsequent decline can be explained by stricter controls on business R&D reporting and the termination of the financing of R&D in centres for excellence, competence and development, which were co-financed by the EU (IMAD, 2019 a). Business investment in R&D still represents about 75% of total R&D expenditure in the country, around 10 pps more than the average in the EU. Business expenditure on R&D is mainly concentrated in pharmaceuticals, machinery, computer technology and technologies related to electrical energy. Public expenditure on R&D is modest (0.5% of GDP), but in 2018 the government increased it, partly boosted by EU structural funds. In addition, the Slovenian government planned a gradual increase in public R&D investment for the period 2019-2021. However, the 3% of GDP R&D intensity target seems out of reach by 2020. Slovenia ranked average among EU countries in international co-publications in 2018. Investment continues to be unevenly spread between the two regions with the R&D intensity at 2.27% in the western region and 1.4% in the eastern one, resulting also in an unequal share of human resources in science and technology in the active population (51% in Western Slovenia

([79]) 7.3% of total workforce in Western Slovenia against 4.3% in Eastern Slovenia.

([80]) 40.4% of total workforce in Western Slovenia against 31.2% in Eastern Slovenia.

([81]) The level of tax subsidy was increased in 2010 from 20% to 40% of allowed deduction of R&D expenses from corporate income tax with additional deduction in lower income regions. Since 2012, the research tax subsidy is 100%. In the case of insufficient tax liability, unused credits can be carried forward for 5 years. No ceiling applies to the amount of qualifying R&D expenditure or value of R&D tax relief.

against 40% in Eastern Slovenia in 2018). There is also regional discrepancy in co-publication activity, which is greater in the western region, both at public-private and at international level.

There has been an increase in the number of researchers and the share of PhD graduates is very high. Since 2008, the number of researchers employed by businesses ([82]) rose considerably. Slovenia still leads the OECD countries in the share of PhD graduates in the population ([83]) (OECD, 2019 d). In 2018, there was a net inflow of PhD students into the country. While 104 left Slovenia, 163 moved in.

More and better cooperation between science and industry could improve Slovenia's research and innovation capacity. Science-industry cooperation is limited mainly to the medium- and high-tech sectors (e.g. pharmaceuticals, machinery). The effectiveness of knowledge-transfer offices set up by research organisations and higher education institutions varies considerably.

Several structural reforms to improve the governance and effectiveness of public R&D investment are still pending. Approximately 87% of the structural funds' support measures are aimed at scientific and technological excellence; research infrastructures; and science-business cooperation. However, an effective governance structure still needs to be fostered for cooperation in research and innovation among different ministries and agencies as well as for closer collaboration between players in research and innovation. The draft R&D law, which lays the foundation for the implementation of the research and innovation strategy 2011-2020, is yet to be adopted by the Parliament. The introduction of institutional-performance-based funding could facilitate their development and growth. Although the government is committed to structural reforms in this area, it has yet to address the recommendations of the European Commission's policy support facility for Slovenia (European Commission, 2018 b) on the internationalisation of the science base and academia-business cooperation. The government also plans for the smart specialisation strategy to become an integral part of the research and innovation strategy and the R&D law.

([82]) Expressed as the number of full-time employees employed in R&D by businesses per thousand active population. The business sector employs nearly 2/3 of all researchers.

([83]) Percentage of 25-64 year olds with a PhD degree (3.8% in Slovenia, OECD average 1.1%).

Box 3.4.1: **Drivers of Slovenia's research and innovation performance**

The fourth industrial revolution, i.e. the convergence of digital, biological, and physical technologies, poses a challenge for the Slovenian research community and economic performance in general. The technological disruption brought about by big data, the internet of things, artificial intelligence and robotics will have a significant impact on the Slovenian economy, its productivity and competitiveness as well as on the workforce. According to some estimates, up to 40-70% of jobs could be affected by automation (OECD, 2018). Some jobs might be replaced, the nature of many others might change significantly and new ones might be created. The net effect will also depend on how well Slovenia prepares itself for the industrial transition, including with changes in the science, technology and innovation policy mix (see Section 3.3). The development and implementation of digital technologies and new business models calls for increased research activities, improved engineering, mathematics and digital skills (see Section 3.4.1), for efficient changes in public and private R&D as well as its integration into the economy (see Section 3.4.1).

While Slovenia's research and innovation performance remains below the EU average (ranked 'moderate innovator' in the 2019 European Innovation Scoreboard), the country has a competitive advantage in areas such as artificial intelligence and robotics (see Section 3.4.1). Slovenia has also an excellent track record in scientific and technological fields such as physics, materials, biochemistry and more recently in areas tackling climate-related challenges (e.g. development of new generation of batteries and cooling systems). The country has successfully conducted scientific research in artificial intelligence since the early 1970's. The first UNESCO-sponsored international centre for artificial intelligence will open in early 2020. The country is also aiming to develop a national artificial intelligence strategy, covering the entire innovative lifecycle and cross-sectoral up-take. While block-chain technologies are already used in the Slovenian FinTech sector (see Section 3.2), these technologies potentially have a much wider reach for the economy.

Slovenia's dynamic start-up ecosystem in information and communication technologies, backed by solid business support services, is an important driver for the country's industrial transition. Academia-business linkages are particularly important for the successful translation of knowledge into innovation in the first place, and in the second place into industry and higher productivity and improved competitiveness performance of Slovenian economy. Several examples of fruitful public-private cooperation can be found within the framework of the Strategic Research and Innovation Partnerships (SRIP). The academia-business partnership led by the public Jozef Stefan R&D Institute brings together key stakeholders involved in developing breakthrough innovations for the factories of the future. A project in the field of control technologies, tooling, robotics, and photonics constitutes another example of successful public-private cooperation, where innovative solutions for production facilities were jointly developed by 13 companies and 6 research organisations (GOSTOP). By building on previous projects, the faculty of mechanical engineering in Ljubljana successfully launched the first "smart factory demonstrator" in 2019 supporting the inclusion of innovative 'Industry 4.0' solutions in production processes. Building on the lessons learnt in successful projects as well as ensuring stability and continuation of R&I support will be key for improving the country's research and innovation performance and a key driver of economic growth.

To increase economic productivity and improve competitiveness of Slovene economy, the country should aim to approach the EU top performers in research and development. This would require an increase in public and private investments and a build-up of an adequate research infrastructure and research capacity, as well as to ensure that the potential is used to full capacity. In some sectors, this could be achieved relatively quickly as the infrastructure already exists and only needs to be upgraded and its usage optimised.

The funding of research and innovation should reward performance, while gaps in the innovation system will have to be addressed. Policy design might give attention to: (i) the strengthening of the capacities of responsible decision-making and executive bodies, (ii) the (re)introduction of schemes for public-private agenda-setting, (iii) the support of clusters, of collaborations between universities, public research institutes and the private sector (for example through doctoral candidates in companies) as well as of start-ups and scale-ups of SMEs.

26.3. Additional R&I references

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

Investment remains below the EU's and Slovenia's long-term average levels. Investment in R&D ('other investment') is growing at rather low rate. This is detrimental to the achievement of SDG 8 and 9. (…)

[Box 2.1 EU funds and programmes to address structural challenges and to foster growth and competitiveness in Hungary, p.18]

EU Cohesion policy funding is contributing to major transformations of the Slovenian economy. It is doing so by promoting growth and employment through investments in areas such as research, technological development and innovation, competitiveness of enterprises, in low-carbon economy, sustainable transport, employment, social inclusion and education. By 2019, investments driven by European Regional Development Fund and Cohesion Fund have already supported cooperation of 180 enterprises with research institutions, (…)

[3.2.2 Access to finance for small and medium-size companies, p.24]

Equity funding remains underdeveloped in light of the ambitions of the Capital Market Union. The limited availability of equity funding in Slovenia adversely affects its innovative start-up and scale-up environment. Slovenia lags behind other EU and central and eastern European countries (e.g. Czechia, Slovakia, Croatia) in the share of private equity funding for businesses (Invest Europe, 2019). Private equity is important for scale-ups, notably those that are looking for more than €500 000 of external funding. Venture capital remains scarce, partly due to an unfavourable regulatory environment and low inflows of venture capital from abroad. According to the European Investment Fund (EIF, 2019), venture capital investment in Slovenia as a share of GDP is one of the lowest in the EU. Slovenia also ranks low in terms of SMEs' confidence in talking about financing with equity investors and venture capital firms and in obtaining the desired equity, with only 9% of the respondents reporting that they felt confident doing this, which is significantly below the EU average of 22% (European Commission, 2019 c). Lack of financial and investment literacy among some types of SMEs and lack of trust in alternative financial sources and the continuity of public financial incentives are contributing to the challenge. (…)

After a period of rapid growth, Slovenia's FinTech markets have entered a calmer period. Slovenian companies have had a high success rate on several international crowdfunding platforms. Slovenian companies also raised significant funding through initial coin offerings. In 2017, around 5% of funds raised in global initial coin offerings went to Slovenian projects. More recently, the FinTech scene has seen a period of calm, with less projects initiated. Slovenia is preparing a new regulatory framework for block-chain technology. This could include the creation of a regulatory sandbox to facilitate further FinTech innovation.

Slovenia is actively beefing up its equity markets with the help of EU funds. According to the 2018/19 Global Entrepreneurship Monitor survey, Slovenia ranks above the average of high income countries in the support it gives to SMEs to access

finance. The government supports the development of the capital market in particular through studies and pilot projects aimed at improving capital market conditions for SMEs. In August 2019, the Slovene Enterprise Fund (SEF) launched a public call "Seed Capital – Co-investment with private investors", aimed at supporting innovative start-ups with high growth potential for equity capital, and at encouraging private investors to invest into the seed stage of company development. After favourable first experiences, the government plans to increase the scope of this investment fund in the coming years, mainly by using the EU cohesion policy funds. Furthermore, in 2018, the SEF invested €8 million in the Central European Fund of Funds with the aim of raising equity investment in SMEs. Slovenia's development bank (SID Bank) and the European Investment Fund (EIF) with EU guarantee (EFSI) back the Slovene Equity Growth Investment Programme, each providing €50 million. The programme supports Slovenian SMEs and midcaps (i.e. companies employing up to 3,000 employees), with equity investments aiming to support business growth and expansion, including internationalisation.

[3.4 Competitiveness reform and investment, Digitalisation, p.37]

(…) The digital transformation is strong in the automotive sector, e-commerce, tourism, innovation of composite materials and companies integrated into foreign value chains. Furthermore, Slovenia is strong in some niche areas such as robotics, fin-tech, cyber security and artificial intelligence (see Box 3.4.1). Slovenia is now implementing its national digital strategy ([84]) and currently drafting a comprehensive artificial intelligence strategy.

([84]) https://www.gov.si/assets/ministrstva/MJU/DID/Strategija-razvoja-informacijske-druzbe-2020.pdf.

[Annex A. Overview table, p.49]

CSR 3: Focus investment-related economic policy on research and innovation, low carbon and energy transition, sustainable transport, in particular rail, and environmental infrastructure, taking into account regional disparities.	Slovenia has made **limited progress** in addressing CSR 3.
Focus investment-related economic policy on research and innovation,	**Some Progress** Slovenia has not fully implemented its research and innovation strategy, and there is little harmonisation among different policies and strategies.

[Annex D: Investment guidance on Just Transition Fund 2021-2027 for Slovenia p. 60]

The smart specialisation strategy ([85]) provides an important framework to set priorities for innovation in support of economic transformation. In order to tackle these transition challenges, priority investment needs have been identified for diversifying and making the regional economy more modern and competitive, as well as alleviating the socio-economic costs of transition. Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in research and innovation activities and fostering the transfer of advanced technologies in line with the Slovenian smart specialisation strategy;
- investments in the deployment of technology and infrastructures for affordable clean energy;
- investments in digitalisation;

27. SWEDEN

27.1. Executive summary

Overall investment levels are high. Residential and equipment investment are declining due to the slowing economy. Investments in R&D, sustainable transportation and education and skills have been maintained tackling the continued investment needs in these areas.

Sweden has made some ([86]) progress in addressing the 2019 country-specific recommendations. (…) With its 2020 budget, Sweden focused investment-related

([85]) As defined in Article 2(3) of Regulation EU 1303/2013 (CPR)

([86]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a CSR is presented in the overview table in the Annex.

economic policy on education and skills, and research and innovation (see Sections 4.1 and 4.4).

On progress towards its national targets under the Europe 2020 strategy, Sweden has reached its targets for (…). Areas where the targets have not yet been achieved are early school leaving, energy efficiency and R&D.

Despite the favourable business environment, productivity growth has stalled recently and is expected to remain low in the short term. Productivity growth in the longer term will depend on the successful transformation of the production base and the introduction of further innovations in information and communication services and strategic value chains. 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, supporting productivity growth.

- **To achieve Sweden's ambitious climate objectives**, sizeable investments and adequate funding will be key. The country intends to be carbon-neutral by 2045. This will require investments in infrastructure, such as the electrification of transportation and industry, and close cooperation across society to support innovation, while maintaining competitiveness.

27.2. Research and Innovation

Sweden invests considerable resources in R&D and continues to be one of the most innovative economies in the EU. The country has been the top performer in the European Innovation Scoreboard since 2011 and has further increased its performance over time. It benefits from an innovation-friendly environment, highly skilled workers, attractive research systems and internationally competitive and innovative large companies. With 3.3% of GDP allocated to R&D in 2018, Sweden has the highest R&D spending in the EU. It has the highest business spending on R&D (2018: 2.35% of GDP) and the second highest public spending on R&D (2018: 0.96% of GDP) in the EU. Sweden's national goal for R&D expenditure in relation to GDP amounts to around 4% by 2020. Addressing these challenges would lead to progress on SDG 9.

Sustaining a high quality public research base is essential to keep the Swedish knowledge economy competitive. Sweden has the second highest number of scientific publications in relation to population in the EU ([87]). A strong increase in international scientific co-publications since 2011 has not led to an increase in scientific impact, however ([88]). The number of new doctoral graduates ([89]) has fallen over the past 7 years (European Commission, 2019e; Swedish Research Council, 2019). In 2019, the government launched a public enquiry (Steering and resource distribution of universities,

([87]) International scientific co-publications per million population.

([88]) As measured by highly cited scientific publications. Scientific publications among the top-10% most cited publications worldwide as percentage of total scientific publications of the country.

([89]) New doctoral graduates per 1,000 population aged 25-34.

STRUT) into a possible reform of government control and allocation of resources to higher education institutions (SOU, 2019a). The new Swedish research bill, with priorities and focuses for the next four years, is currently being prepared and will be presented in autumn 2020.

A sufficient supply of talent is essential to maintain Sweden's high innovation performance. A key challenge for SMEs in 2018 was the availability of skilled staff (European Commission/European Central Bank, 2019). Among Sweden's most R&D intensive companies, 4 out of 10 consider it difficult to recruit R&D personnel, and more than a third respond that it has become more difficult than 5 years ago. (Royal Swedish Academy of Engineering Sciences, 2019, see Section 4.3.2). A shortage of highly skilled personnel in science, technology and engineering might hamper investment in R&D and ultimately affect innovation performance.

Exploiting the full potential of SMEs can broaden and strengthen Sweden's innovation performance. So far, innovation has relied on a limited number of large and globally competitive companies. However, the innovation performance of SMEs has decreased since 2011 and could improve. SMEs could benefit from stronger collaboration between academia and the business sector. Although there are close links between the business sector and public sector researchers, which result in academic publications, the co-funding of public R&D expenditure has decreased in recent years, with Sweden ranked 8th in the EU (European Commission, 2019e). This shows further potential for privately co-funded university and government R&D to support the research needs of the business sector.

27.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 14/15]

Substantial progress and full implementation have been achieved in several policy areas, in particular fiscal governance and research and innovation.

Sweden has made some progress on the second CSR related to investment and on the third CSR related to anti-money laundering. (…) Investment in research and innovation and transport has been maintained.

[Box 2.1: EU funds and programmes to address structural challenges and to foster growth and competitiveness in Sweden, p. 17]

EU Cohesion policy funding is contributing to transformations of the Swedish economy by promoting growth and employment via investments, mainly in research, technological development and innovation, competitiveness of enterprises, sustainable transport, employment and labour mobility.

[4.4.Competitiveness, Reforms and Investment, 4.4.1. Productivity And Investment, Drivers of labour productivity growth, p. 46]

Total factor productivity (TFP) growth has been falling in recent years. TFP measures overall efficiency in the combination of inputs and it is often associated with innovation and intangible assets such as brands, organisational capital, management practices and other horizontal factors having a cross-cutting impact on efficiency.

[4.4. Competitiveness, Reforms and Investment, Reviving productivity growth, p. 47]

Embracing new technology has the potential to improve productivity in the long term. Artificial intelligence and robotics are widely expected to have a strong impact on societies and economies. While it is uncertain how and when current research will be converted into widely used technology that improves productivity, it is important to follow developments closely. The Swedish government adopted a roadmap for artificial intelligence in 2018, which aims to improve welfare and competitiveness and make the country a world leader in the field. The roadmap focuses on education, research, innovation, and frameworks and infrastructure. The Swedish Innovation Agency will invest €100 million over the next 10 years in AI-related projects. This matches the investment made by the Wallenberg foundation. In June 2019, the government announced an investment of SEK 40 million in professional education in AI.

[4.4. Competitiveness, Reforms and Investment, Box 4.4.3: The dynamics of labour productivity, p. 48]

In the event of a prolonged downturn, the new preference for labour hoarding could result in firms exiting the market instead of restructuring. Policy will have to anticipate these factors (see Section 4.3) in order to keep up employment and structurally raise productivity growth. Education, integration and a fostering environment for innovation are needed to achieve this.

[4.4. Competitiveness, Reforms and Investment, Green investments, p. 50]

Identifying investment needs and securing adequate funding will be key to delivering on Sweden's ambitious climate and energy objectives and transforming the Swedish economy to become sustainable and climate neutral by 2045 (see Section 4.5). Sweden will also need to support the decarbonisation of the economy using ambitious policies to promote innovation and competitiveness.

[4.4. Competitiveness, Reforms and Investment, Box 4.4.4: Investment challenges and reforms in Sweden, p. 52/53]

Barriers to investment in Sweden are overall low (European Commission, 2019e), but scope remains for measures in tackling barriers to construction (see Section 4.2.2) and in research and innovation (see Section 4.4.1) and construction investment.

Differences between urban centres and regions also exist in productivity and innovation. Similar disparities as for GDP per head are present in other economic dimensions. Productivity growth was higher in larger city regions with Stockholm well ahead, whereas North-Central Sweden, East-Central Sweden, Upper Norrland and Middle Norrland had low or even negative productivity growth ([90]) (Eurostat 2017). The larger city regions are all innovation leaders, with an innovation performance of 130%-155% of the EU average in 2018. The other regions are strong innovators (with a performance of 91%-115%), except for Mellersta Norrland, the only moderate innovator, with (89%).

([90]) European Commission calculations based on Eurostat regional accounts data released 2019.

Sweden uses regional smart specialisation strategies and intends to coordinate rural and regional policy better. Eighteen strategies are already in place, supported by the ERDF. The strategies focus on regions' comparative advantages to foster growth and innovation. Every region will need such a strategy to fulfil the enabling conditions for the upcoming ERDF programming period. In addition, the government announced in its 2020 budget bill that it wants to strengthen the innovation capacity of counties. Regional development strategies including innovation or smart specialisation should interact with national and international strategies and actions.

[4.4. Competitiveness, Reforms and Investment, Business environment, p. 55]

The public sector is digitally mature, but there is room for improvement on open data and the reuse of public data. E-government services are widespread in Sweden with 93% of internet users able to submit forms online. However, the country achieved only 52% of the maximum score on open data in 2018. The new agency for digital government (DIGG), set up in 2018, has the objective of increasing the use of data by the public administration. It has not yet implemented any changes. To advance, a focus on data as a strategic resource and better leadership might be required, together with work on trust and accessibility in digital services. This and the good conditions for using data could build citizen-related services, analyse complex societal changes and promote digital innovation.

[4.5. Environmental Sustainability, Policy and industry initiatives, p. 58/59]

The Industrial Leap programme to support low-carbon innovation in industry was scaled up during the year. In early 2019, the Swedish Parliament approved the allocation of SEK 300 million per year to the programme for the next 3 years, with a particular focus on the steel industry. In the government's climate action plan of December 2019, the government proposed doubling the funding of this programme. The intention is to continue annual funding until 2040. Other research programmes focus on areas where Sweden can have a competitive edge such as biofuels- and waste-based combined heat and power production, forest carbon sequestration and efficient use of bioenergy sources. (…)

The Just Transition Fund (see annex D) could help develop of new and innovative solutions bringing together academia, public authorities and industry in more innovative environments to help stimulate intersections between ideas from different industries and regions. A good example on how this could work might be the Transiton Lab on low carbon economy and resource efficiency in North-Central Sweden, which addresses the regional challenges in the areas of broadening and diffusing innovation (particularly in relation to SMEs) and building a more effective industrial ecosystem (to attract talent, research and innovation resources, and investments).

[Annex A, Overview table, p. 61]

(1) **CSR 2:** Focus investment related economic policy on education and skills, maintaining investment in sustainable transport to upgrade the different transport modes, in particular railways , and research and innovation, taking into account regional disparities. (3) Focus investment related economic	(2) Sweden has made **Some Progress** in addressing CSR 2 (…)

policy on education and skills, (4) maintaining investment in sustainable transport to upgrade the different transport modes, in particular railways, (5) and research and innovation, taking into account regional disparities.	• **Some Progress** Sweden continues to invest considerable resources in R&D and continues to be one of the most innovative economies in the EU. With 3.31% of GDP allocated to R&D (2018), Sweden remains the country with the highest R&D spending in the EU. However, there is a slight decrease in R&D Intensity (GERD as % of GDP) from 3.37 (2017) to 3.31 (2018), mainly due to a reduction in the business enterprise expenditure on R&D (BERD) as % of GDP from 2.4 (2017) to 2.35 (2018).

[Annex D: Investment Guidance on Just Transition Fund 2021-2027 for Sweden, P. 71]

The smart specialisation strategy ([91]) provides an important framework to set priorities for innovation in support of economic transformation. In order to tackle these transition challenges, investment needs have been identified for diversifying and making the regional economy more modern. Key actions of the Just Transition Fund could target in particular:

- productive investments in SMEs, including start-ups, leading to economic diversification and reconversion;
- investments in the creation of new firms, including through business incubators and consulting services;
- investments in research and innovation activities and fostering the transfer of advanced technologies;

28. UK

28.1. Executive summary

The United Kingdom has high employment but low, stagnant productivity. (…) There is scope to improve the effectiveness of education and training systems in areas such as basic and technical skills.

(…) **Labour productivity, which was already relatively low, has stagnated.** (…) There is scope to increase productivity by addressing broad-based problems such as low investment in equipment, infrastructure and R&D, and skills gaps (especially in basic and technical skills).

([91]) As defined in Article 2(3) of Regulation EU1303/2013 (CPR)

28.2. Research and Innovation

While the UK is considered a 'Strong Innovator' (see above), R&D investment intensity has remained flat, and below the EU average, for the past decade. In 2018, R&D expenditure reached £36.5 billion (€41.3 billion). However, research intensity (total R&D expenditure as a percentage of GDP) was still only 1.71%, below the EU average of 2.11%. In 2018, although the business sector spent £25.2 billion (€28.5 billion) – representing 69% of UK total R&D expenditure –business research intensity was at 1.18% of GDP also significantly below the EU average of 1.41% (Eurostat, 2019b).

R&D investment in the UK remains concentrated in a limited number of companies and regions. 400 firms account for the bulk of business R&D investment. The South East, the East of England and London regions undertook the majority of total UK research and innovation activity (ONS, 2019i).

Although UK universities are regarded as global research leaders, science-business linkages could be strengthened. UK universities are a leader in terms of highly cited publications ([92]), and the UK has improved in international rankings of knowledge diffusion ([93]). Nevertheless there is scope for the business sector to capitalise more on the UK's scientific strength.

The approach to future R&D funding in the UK was laid out in the December 2019 Queen's Speech. The UK plans to increase public R&D funding, with greater emphasis on high-risk, high-payoff research in emerging fields, a fast-track immigration scheme and reducing bureaucracy in research funding (HM Government, 2019a). Delivering on these ambitious proposals will be a challenge, as will the aim to increase R&D investment intensity to 2.4% of GDP by 2027.

28.3. Additional R&I references

[2. Progress with country-specific recommendations, p. 15-16]

The UK received a recommendation on investment in 2019 that encompasses areas covered by previous recommendations. (…) The UK's research base is excellent, but the diffusion of knowledge and process innovation across the economy is uneven.

(…) **The UK has made some ([94]) progress in addressing the 2019 country-specific recommendations (CSRs).** (…) There has been some progress on supporting research and innovation. UK universities remain global research leaders. However, UK research and development (R&D) intensity is flat and below the EU average. Delivering on the recent ambitious proposals for future research and innovation support will be a challenge.

([92]) In 2018, 14% of the total scientific publications in the UK ranked among the top-10% most cited publications worldwide.

([93]) According to the Global Innovation Index by Cornell university, INSEAD and WIPO, the UK has improved to 12th place in terms of knowledge diffusion.

([94]) Information on the level of progress and actions taken to address the policy advice in each respective subpart of a CSR is presented in the overview table in Annex A. This overall assessment does not include an assessment of compliance with the Stability and Growth Pact.

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

EU cohesion policy funding is contributing to transformations of the UK economy by promoting growth and employment via investment in: research; technological development and innovation; (…) and €6.1 billion (£5.35 billion) of EU funding from the Horizon 2020 programme has been allocated to Research and Innovation projects, of which €811 million (£711 million) has been allocated to 1 425 SMEs.

[3.4. Competitiveness reforms and investment, 3.4.1. Productivity and innovation, p. 34-35]

In some respects, the UK's low productivity is surprising. The UK economy has a number of characteristics that, in principle, tend to be associated with high average productivity. (…) It ranks eighth among 190 countries in the World Bank's classification of the ease of doing business (World Bank, 2019). In the 2019 European Innovation Scoreboard, the UK is considered a 'strong innovator' (European Commission, 2019g). The UK scores particularly well in human resources occupied in research, research networks, linkages with SMEs, venture capital expenditure (see Section 3.2), the sales impact of innovation activities and ICT training provided by firms, although it does less well in terms of R&D investment including in firms.

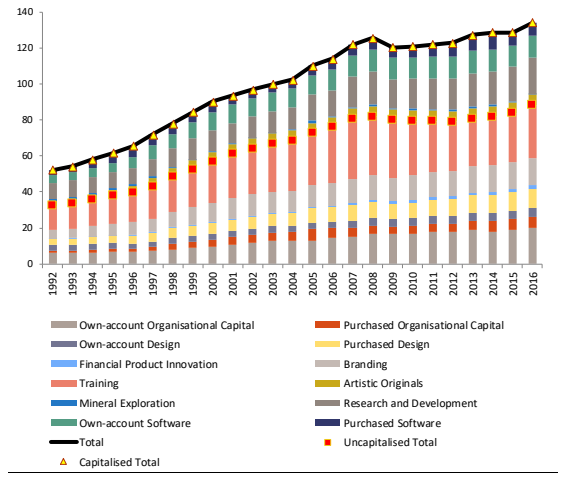
By some measures, the UK economy is less efficient than before the financial crisis. (…) The UK has issues with relatively low R&D (see Section 3.4.2) and a failure by many firms to effectively implement efficiency-enhancing technologies and processes that already exist.

[3.4. Competitiveness reforms and investment, 3.4.2. Investment, p. 38]

The level of UK investment looks better if all intangible investment assets are included. Intangible assets have growing economic importance, especially in a service-dominated economy like the UK. This has justified an extension of the capital assets considered in accounting beyond physical assets (Adarov and Stehrer, 2019, and ONS, 2019j). In addition to research and development, software and databases, intangible assets include artistic originals, mineral exploration, design financial innovations, branding organisational capital and firm-specific training. In the UK, the total volume of investment in intangible assets is estimated to match that in physical capital. Together, they account for about 25% of market sector gross value added.

Growth in investment in intangible assets has also slowed markedly following the financial crisis (Graph 3.4.4). Organisational capital has, however, been growing fast and, unlike financial innovations, the investment rate in this has not fallen. An additional exception is the continued growth of 'intellectual property products' as discussed above. The increasing proportion of intellectual property products and software in the capital-labour ratio could be positive for the UK's productivity prospects, though as discussed in Section 3.4.1 R&D intensity is still quite low. Spending on training per worker has also fallen (DfE, 2018b).

Graph 3.4.4: **Breakdown of intangible investment in the market sector (current prices)**



Source: ONS

[3.4. Competitiveness reforms and investment, 3.4.4. Regional disparities, p. 43]

Public sector investment has been concentrated in London and South East England. (…) As discussed in Section 3.4.1, there are significant regional imbalances in R&D funding which correlate with disparities in innovation performance. The three innovation leaders – London, the South East and the East of England (European Commission, 2019g) – accounted for half or more of public and private sector R&D expenditure in 2017. Per capita government expenditure on R&D ranges from £67 (€76.4) in South East England to less than £10 (€11.4) in Northern Ireland and Wales (ONS, 2019i). The new UK government has stated an ambition to "level up" poorer regions of the UK, including by allocating more public investment to these areas (HM Government, 2019a).

[3.5 Environmental sustainability, p. 48]

Access to finance will be a key enabler for the sustainability transition in both the public and private sectors. The UK is rich in scientific research and technical expertise and access to finance can facilitate research and development relating to energy efficiency, such as demand-side management, hydrogen and heat pumps. Through its Industrial Strategy Challenge Fund, the government is funding research and development related to eight 'challenges' to support clean growth. The UK is also channelling £505 million (€576 million) between 2015 and 2021 through the Energy Innovation Programme. This includes a series of competitions to provide the private sector with access to finance to research and develop low carbon technologies.

(1) Société Fédérale de Participation et d'Investissement / Federale Participatie- en Investeringsmaatschappij.

(2) Société Régionale d'Investissement de Bruxelles, Société Régionale d'Investissement de Wallonie/SOWALFIN, Participatie Maatschappij Vlaanderen.

(3) Detailed information on the QUEST model and applications is available at: https://ec.europa.eu/info/business-economy-euro/economic-and-fiscal-policy-coordination/economic-research/macroeconomic-models_en.

([4]) For detailed information on the QUEST model and applications, see: http://ec.europa.eu/economy_finance/research/macroeconomic_models_en.htm.

([5]) Burger et al. (2018) find evidence on the positive effect of functional upgrading on value capture. Studies showing gradual functional upgrading in the Hungarian and CEE auto industry include Éltető et al. (2015), Pavlínek and Ženka (2011). Stöllinger (2019) finds that even recent greenfield FDI flows show specialisation in fabrication activities. Belderbos et al. (2013) discuss home bias in R&D. The effect of industry characteristics on upgrading possibilities is described by Sturgeon et al. (2009).