Chapter 6

SEIZING THE POTENTIAL OF THE DIGITAL TRANSFORMATION OF THE ECONOMY AND SOCIETY

Unleashing digital innovation

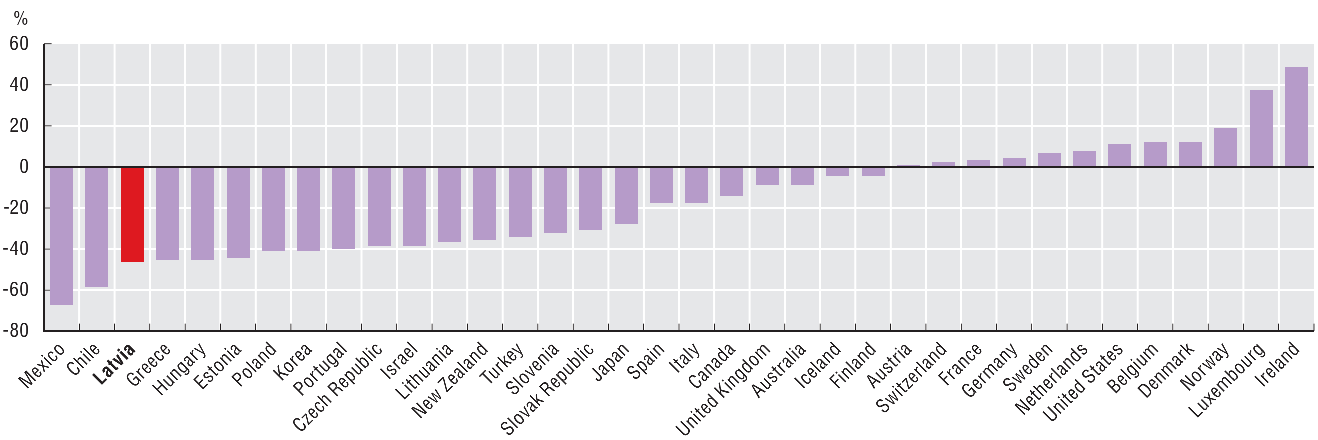
Latvia has made significant economic progress since the beginning of the millennium. The country's economy is growing faster rate than other EU and OECD countries. Productivity, however, remains significantly lower than in other OECD countries, while a declining working age population limits the prospects for further growth. Digital innovation is a key to increasing productivity and raising living standards. The Latvian government has thus taken measures to increase research and development (R&D) and innovation from its present low base. However, a more co-ordinated approach to implementing research and innovation policy, which treats ICTs as a transversal technology, could help Latvia raise its low innovation performance.

State of innovation and research in Latvia

Latvia is facing several challenges that may hinder future economic growth. The share of the working age population is shrinking due to an aging population and high emigration. In addition, while its small domestic market makes export-oriented growth a necessity, Latvia is distant from Europe's manufacturing hubs. Boosting innovation can help Latvia overcome these hurdles. Innovation can lift productivity from its current low level, thereby sustaining growth despite a falling population, and increasing wages, which can help to retain workers (Figure 6.1). In particular, digital innovation can overcome problems of distance and help Latvia boost exports.

Figure 6.1. Productivity gap in selected OECD countries, 2017

Percentage gap in GDP per hour worked against 17 richest OECD countries



Notes: Compared to the weighted average using population weights of the 17 OECD countries with highest GDP per capita in 2016 based on 2016 purchasing power parities (PPPs). Labour productivity is measured as GDP per hour worked.

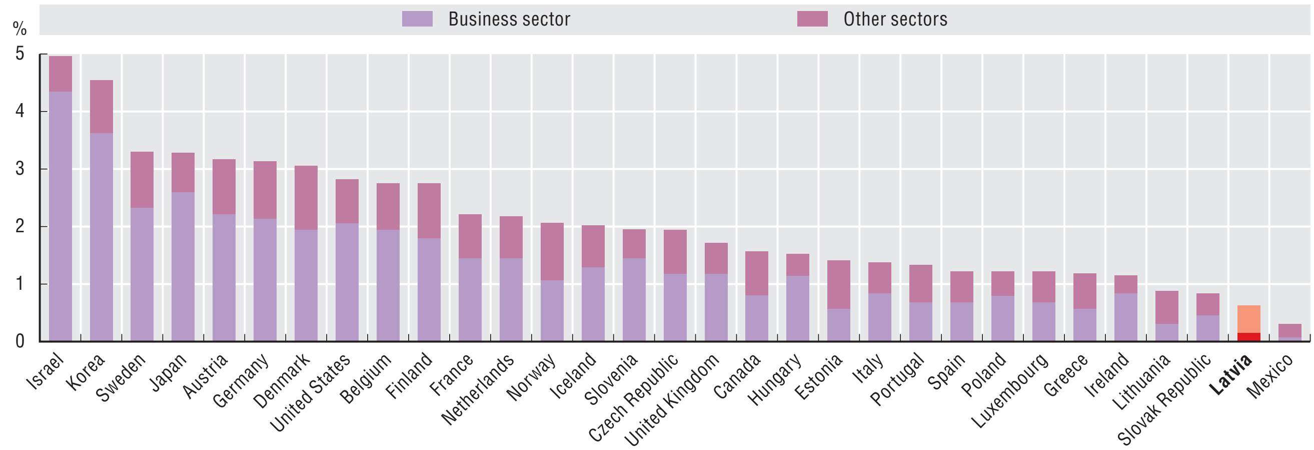
Source: OECD (2019a), *OECD Economic Surveys: Latvia 2019*, *https://dx.doi.org/10.1787/f8c2f493-en*.

At present, innovation plays a relatively minor role in the Latvian economy. R&D is particularly low, even compared to countries with similar GDP per capita. Furthermore, almost a quarter of R&D is funded by the European Union (Figure 6.2). In addition, Latvia has among the lowest shares of business enterprise expenditure R&D in GDP in the OECD.

Latvia also performs poorly along other measures of innovation (European Commission, 2018a). The country has among the lowest shares of innovative small and medium-sized firms (SMEs) in the European Union (Figure 6.3). In addition, much of the innovation performed by Latvian firms focuses on the adoption of existing technologies, rather than developing frontier innovation leading to the creation of intellectual property. As a result, patent applications per inhabitant in Latvia are among the lowest in Europe (Lauma Muizniece, 2017) (Figure 6.4). Latvia's innovation gap is confirmed by its export specialisation in low-value added and resource intensive products (OECD, 2017a). In part, this poor performance can be explained by a large proportion of micro and small firms (see Chapter 4), which tend to be less innovative, and a stock of FDI below the EU average, with FDI diverted largely to sectors that tend not to invest in R&D (European Commission, 2018a; OECD, 2020a).

Figure 6.2. Business R&D expenditure in Latvia and selected OECD countries, 2018

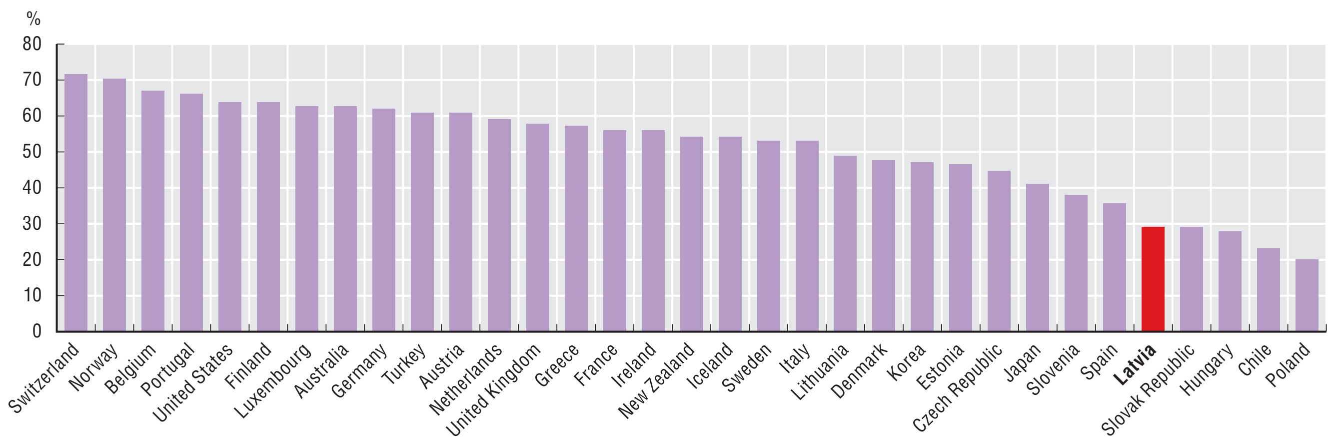
As a percentage of GDP



Source: OECD (2020b), *OECD Main Science and Technology Indicators* (database), *www.oecd.org/sti/msti.htm*.

Figure 6.3. Innovative SMEs[1] in Latvia and selected OECD countries, 2014-16

As a percentage of all SMEs

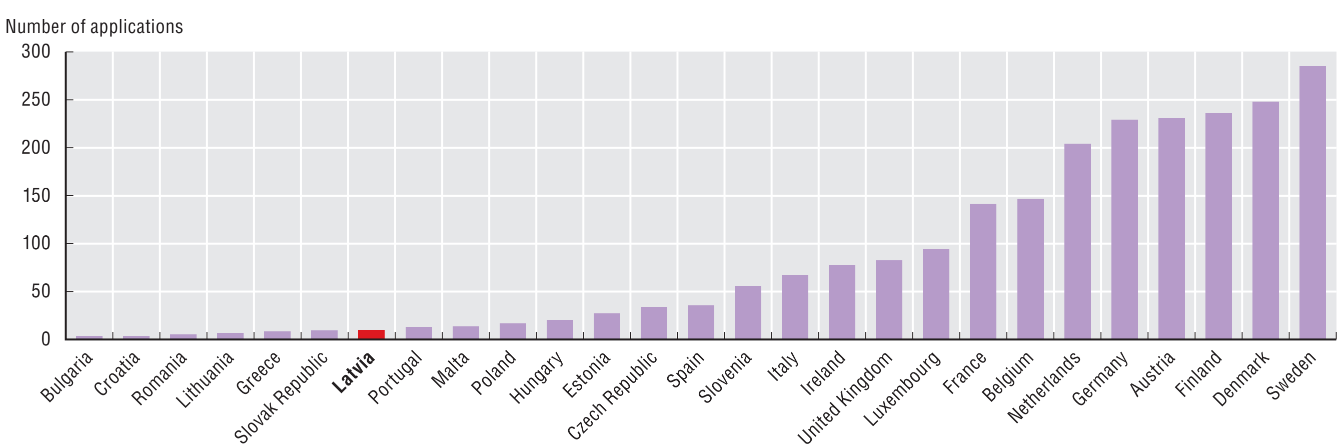


1. Innovative SMEs are those introducing product, process, marketing or organisational innovation.

Source: OECD, based on OECD (2019), *OECD Survey of National Innovation Statistics* and Eurostat, *Community Innovation Survey (CIS) 2016*, *http://oe.cd/inno-stats* (accessed on 20 January 2020).

Figure 6.4. Patent applications to the European Patent Office, 2017

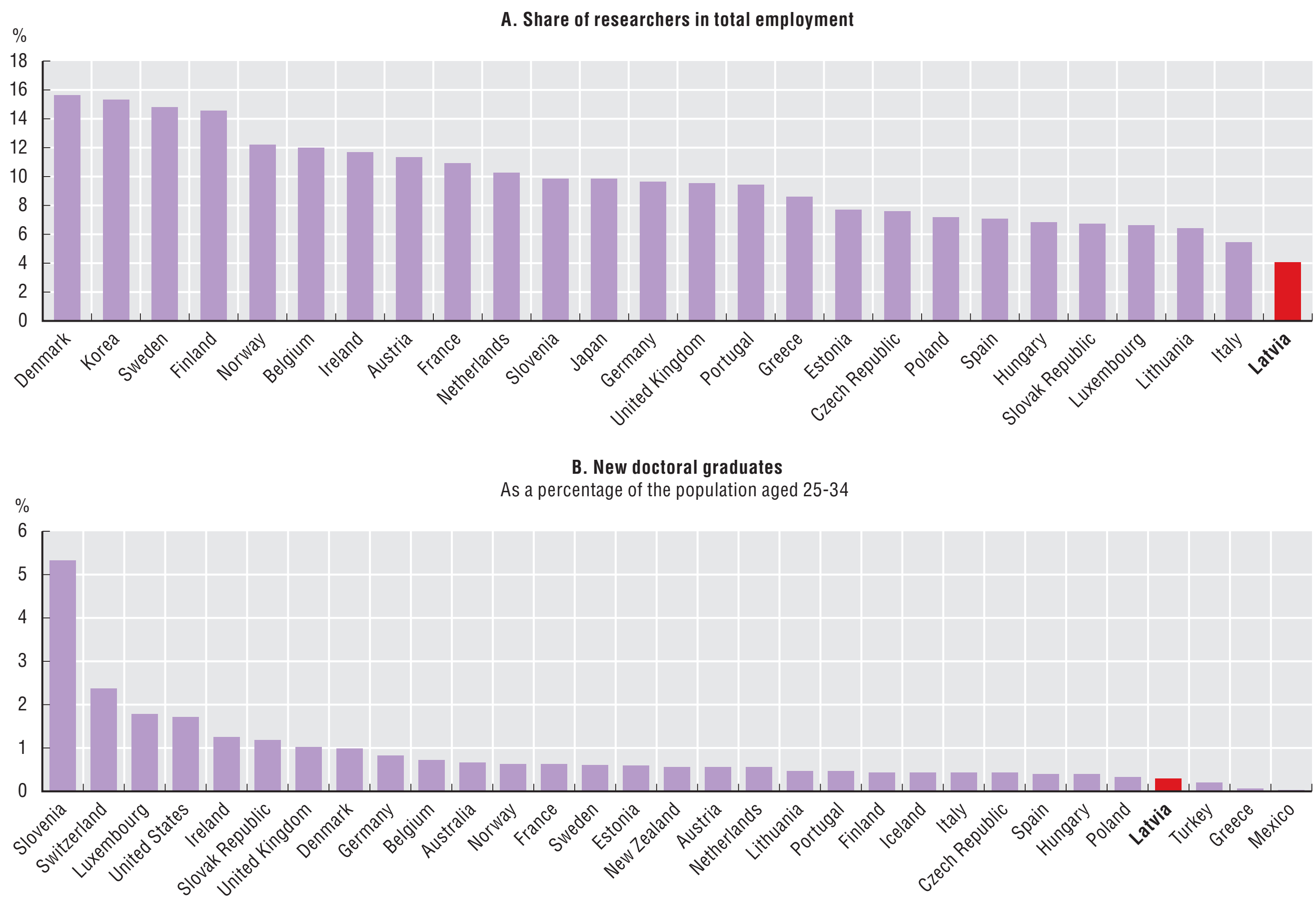
Per million inhabitants



Source: Eurostat (2020c), *Patent Applications to the EPO by Priority Year* (database), *https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=pat_ep_ntot&lang=en* (accessed on 6 May 2020).

The low innovation performance of firms is compounded by poor research performance in the higher education sector. Tertiary attainments for those aged 25-34 in Latvia are commensurate with the EU average, but the number of researchers and PhD graduates is particularly low (Figure 6.5) (OECD, 2019b). In addition, although the share of ICT specialists among all PhD graduates is in line with other European countries, it has shown some signs of decreasing in recent years (Figure 6.6) (Eurostat, 2019).

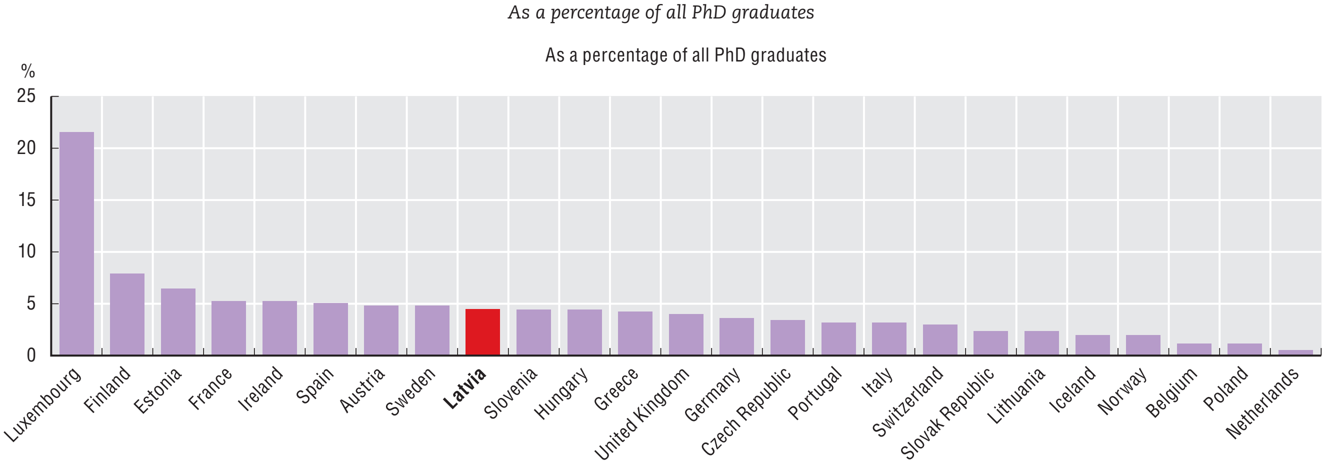
Figure 6.5. Researchers and new doctoral graduates in Latvia and selected OECD countries, 2018



Sources: OECD (2020b), *Main Science and Technology Indicators* (database), *www.oecd.org/sti/msti.htm*; OECD (2019c), *Education at a Glance*, *https://dx.doi.org/10.1787/f8d7880d-en*.

Figure 6.6. ICT PhD graduates in Latvia and selected OECD countries, 2013-17

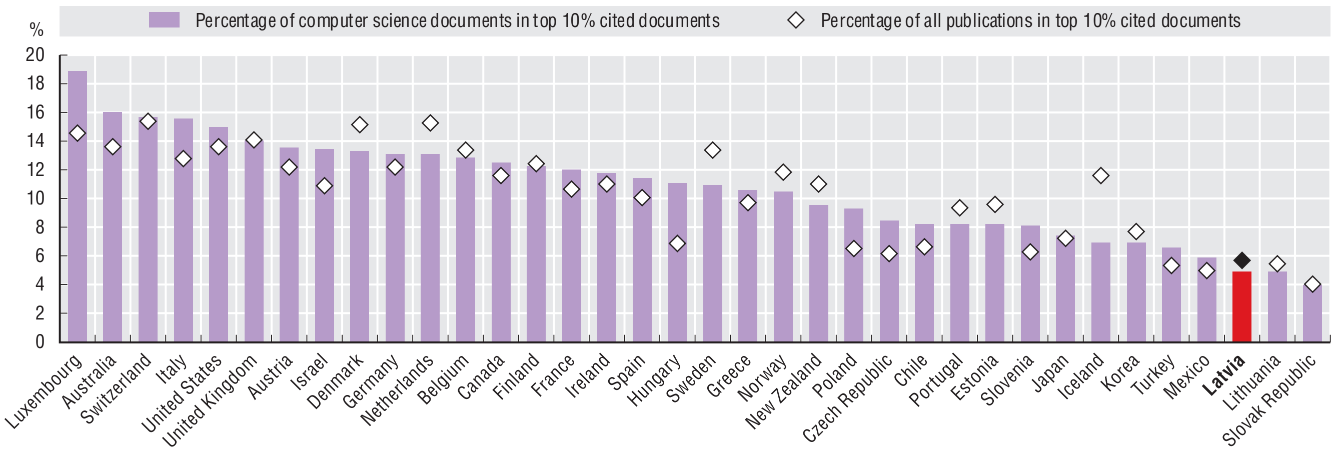
As a percentage of all PhD graduates



Source: Eurostat (2019), *Education Administrative Data from 2013 Onwards* (database), *https://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm*.

In addition, the quality of research is low relative to that of other EU countries (OECD, 2019a). Latvian publications in the field of ICT are under-represented in the top 10% most cited (Figure 6.7), and international collaboration is low (Figure 6.8).

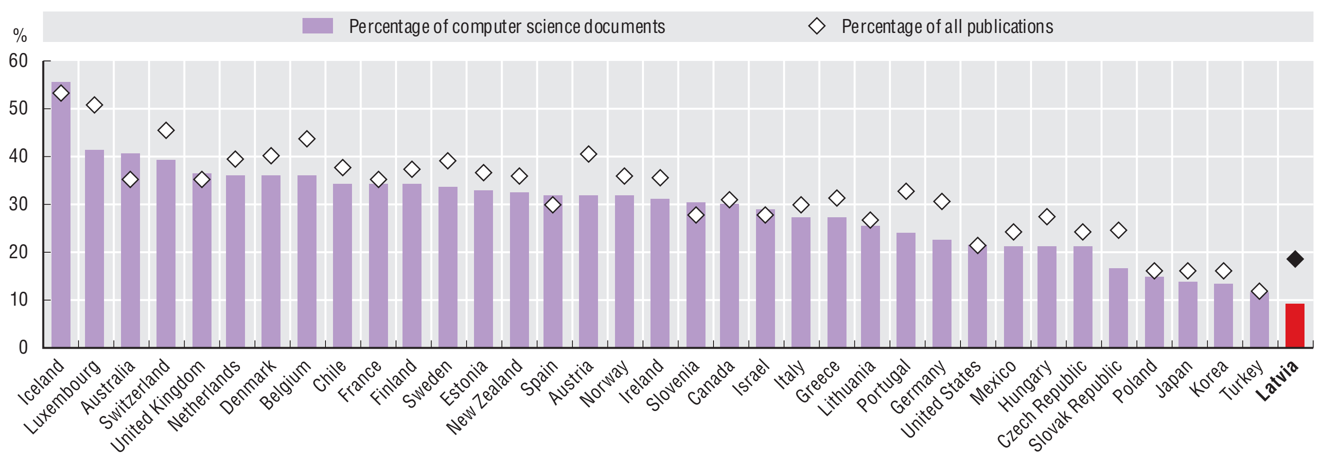
Figure 6.7. Top 10% most cited scientific publications in computer science in selected OECD countries, 2018



Note: Nationality is determined by the location of the institution to which the lead author is affiliated.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

Figure 6.8. Scientific publications resulting from international collaboration in selected OECD countries, 2018



Note: Nationality is determined by the location of the institution to which the lead author is affiliated.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

Innovation policy

Latvia's medium-term plans for innovation and entrepreneurship policy are set out in two sets of Guidelines: the *Guidelines for Science, Technology Development and Innovation for 2014-2020* (STDI) and the *Guidelines for National Industrial Policy 2014-2020*. These guidelines build on the long-term vision and direction put forward in the Latvia 2030 Strategy, which sets out medium-term objectives, defines the level of resources required and the tax initiatives to help achieve the objectives, as well as a set of indicators to monitor progress. Both Guidelines are consistent with the National Development Plan and the objectives of the Europe 2020 plan. Nevertheless, Latvia does not have a specific policy for the promotion of digital innovation, and the Guidelines do not single out ICTs as a key transversal technology for modernisation of the economy. In addition, digital technologies are not included as a key pillar of development in the draft National Development Plan 2021-2027 (Cross-Sectoral Coordination Centre, 2019).

The STDI Guidelines are based on Latvia's Smart Specialisation Strategy (also known as RIS3), which focuses on several high-value added sectors (see below) but lack provisions for the service sector (Box 6.1). Unlike previous guidelines, the R&D activities of firms and research institutions (e.g. universities) are now linked in a single planning framework. The Ministry of Education and Science (MoES), which sets policy for higher education and research, led the development of the Guidelines, with input from the Ministry of the Economy (MoE), various research institutes and the Latvian Information and Communication Technology Association (LIKTA) (Government of Latvia, 2013).

The STDI Guidelines and the Smart Specialisation Strategy acknowledge the ability of the ICT sector to help transform the Latvian economy. In addition, the development of a modern ICT system in the public and private sectors is listed as one of seven growth priorities. However, IT is not included as a stand-alone priority direction for science (Cross-sectoral Coordination Centre, 2017).

Box 6.1. Implementing the Guidelines for Science, Technology Development and Innovation

There are four lines of action for implementing the STDI Guidelines. These have specific associated tasks, such as tax measures or the introduction of innovation vouchers, as shown below.

- Increasing the competitiveness of the STI field:
  - Develop the human resource capital of the field.
  - Develop excellence in research.
  - Reduce STDI resource fragmentation.
  - Support the internationalisation of science and international co-operation.
- Linking science, technology and innovation with the needs of social and economic development:
  - Build the knowledge base and focus research on directions important for society's development.
  - Promote orders from industry ministries and municipalities.
  - Integrate education, the development of science, technology, innovation and business.
  - Strengthen innovation and knowledge absorption capacity in companies.
- Ensuring effective management of the STI industry:
  - Improving co-ordination.
  - Increase investment efficiency.
  - Increase state budget funding for STDI.
  - Calculate and allocate institutional or base funding in accordance with policy settings.
  - Gradually increase the level of R&D funding granted in tender procedures.
  - Create new financial instruments appropriate for the aims and tasks of STDI policy.
  - Support research in higher education (HE investments).
  - Develop a policy implementation, monitoring and impact assessment system.
- Raising public awareness and promoting science and innovation

The MoE has developed the *Guidelines for National Industrial Policy 2014–2020* (NIP). This set of guidelines relates largely to the manufacturing sector and recalls the EU target of raising Latvia's R&D expenditure to 1.5% of GDP – a target that is very unlikely to be met. They underline the importance of improving co-operation in innovation between research institutions and firms (European Commission, 2012a), but make no reference to digital technologies (unlike Sweden) (Box 6.2), despite discussing the importance of modernising the Latvian economy.

In addition, relatively little focus is placed on the development of digital services or service innovation, in spite of the strong link between digital innovation and the delivery of digital services. New business models have emerged, such as peer-to-peer accommodation (as with Airbnb), and new web-based business services have become a possibility. In addition, digitalisation blurs the line between goods and services, for example when sensors are incorporated into manufactured goods which can then be monitored as a service. (OECD, 2019d).

Box 6.2. Sweden's Innovation Strategy

Sweden's innovation strategy for 2017-2020 is set out in its research bill "Knowledge in collaboration – for society's challenges and strengthened competitiveness" (*Kunskap i samverkan – för samhällets utmaningar och stärkt konkurrenskraft*). The bill was elaborated to ensure Sweden becomes a world leader in research and innovation (OECD, 2018c; Swedish Ministry of Education and Research, 2019).

This strategy highlights the importance of Sweden's large ICT sector and ability of digital technologies to function as an enabler of innovation in other fields. The strategy includes:

- investment in digital research infrastructure (e.g. the Swedish University Computer Network) to facilitate data intensive research
- grants for data-driven research
- the promotion of open access to research data, such as through the use of personal identity numbers to connect different public registers and facilitate medical and social science research.

Latvia should undertake action to promote digital services, following the examples of several other OECD countries. In Austria, for instance, the Smart and Digital Services Initiative provides funding for non-technological innovations with the aim of promoting R&D in the service sector and encouraging firms in traditional industries to provide services (e.g. by including sensors in products and providing monitoring services as part of Industry 4.0). Small firms can avail themselves of non-repayable subsidies of up to 45% (FFG, 2015; OECD, 2020c). Meanwhile the Netherlands Enterprise Agency offers service design vouchers worth up to EUR 3 000 to SMEs in the manufacturing sector on condition that they also invest at least EUR 1 000. The vouchers can be used for consultancy advice with the intention of boosting co-operation between creative industries and manufacturing (OECD, 2019d; RVO, 2018).

Latvia's innovation strategy also lacks an emphasis on developing apps and software to address some of the country's societal and economic challenges. For example, Colombia's 2014-2018 Live Digital for the People (*Vive Digital para la Gente*) plan included the aim of making Colombia a world leader in developing apps to help the poorest in society. This goal helped the development of an agricultural app (Farmapp) to help pest control, which has been exported (OECD, 2019e). Meanwhile the United Kingdom has created the Centre for Acceleration of Social Technology, which has helped charities develop apps to meet their goals.

Promotion of R&D

Most of Latvia's government research funding goes to HEIs – and almost none to businesses (European Commission, 2018a) (Figure 6.9). Although Latvia used to provide a generous R&D tax allowance, this was abolished in 2018 as part of the reform of corporate income tax whereby only distributed income is taxed (e.g. payment of dividends). The majority of support for business R&D now takes the form of direct funding and tax incentives for hiring R&D staff (see below), in contrast to most OECD countries (Box 6.3) (OECD, 2019q; 2018a).

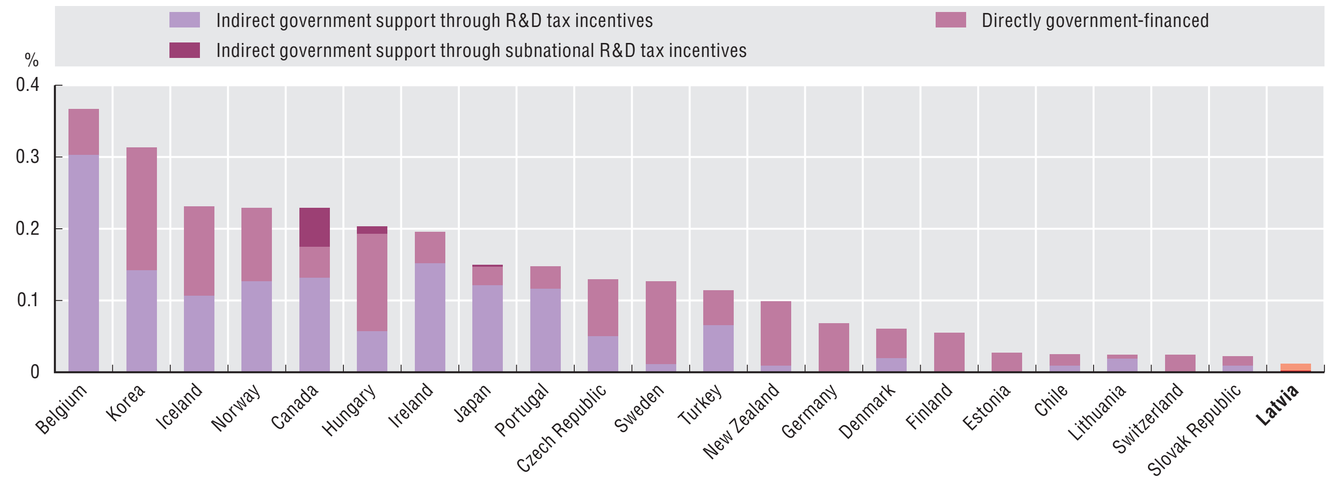
HEIs receive low levels of research funding

The Latvian HEI sector suffers from low levels and wide dispersion of funding. Public research funding amounts to EUR 73 million, half of which comes from the European Union; little of this funding is awarded competitively, with the majority allocated to finance the basic functions of institutions (see below) (European Commission, 2018a; OECD, 2019a). In addition, financial resources for research are thinly spread, with 21 public sector research institutions (including those based in universities) and scientific institutions receiving state and ERDF funding (European Commission, 2018a). Latvia also has more HEIs than Estonia or Lithuania; however, the University of Latvia (UL) and Riga Technical

University (RTU) account for over 40% of researchers and academic staff in the HEI sector (European Commission, 2018a). Latvia should therefore continue to concentrate research funding in a smaller number of institutions to allow the formation of institutions with a deeper pool of expertise.

Figure 6.9. Government funding and tax support for business R&D in Latvia and selected OECD countries, 2017

As a percentage of GDP



Note: R&D = research and development.

Source: OECD (2019f), *R&D Tax Incentives* (database), *www.oecd.org/sti/rd-tax-stats.htm*.

Box 6.3. Various approaches used to promote R&D

Governments can help support R&D directly (e.g. by providing grants or buying R&D services) or indirectly through fiscal incentives such as through preferential tax treatment of R&D expenditures or income. In the OECD area, almost 70% of all support for R&D is through indirect measures (Appelt et al., 2016).

A benefit of direct supports is that they can be targeted at areas that offer the highest social returns, but the administration of grants and the selection of projects can be costly. Direct support is considered most appropriate for research that will lead to public goods, and for riskier activities, such as helping firms to scale up. Market-based measures such as tax incentives have the advantage of not being dependent on the discretionary decisions of government officials, making them easier to administer and more likely to be compliant with international trade rules. Tax incentives are useful to stimulate an increase in R&D, especially in firms where R&D is already performed. However, they are not effective at directing research towards areas with higher social returns, and are more appropriate for the promotion of research that will lead to commercialisation. Loans are appropriate for diffusion-oriented R&D where there is also a need for capital expenditure.

Tax incentives can be calculated based either on expenditure on R&D or the income derived from R&D. Expenditure-based incentives include tax allowances, exemptions and deductions, which reduce the size of the tax base. In general, these rely on the firm having a sufficiently large tax liability (although tax credits can be refundable). An alternative approach (which is used in Latvia) is to reduce other R&D costs such as payroll taxes for research staff. These act as an upfront subsidy and are more attractive to riskier research, conducted in some cases by young firms, which are more likely to be loss-making or financially constrained. Finally, an alternative approach is to give preferential treatment to income from R&D (e.g. patent royalties). However, it can be more difficult to link income to R&D activities (Appelt et al., 2016; OECD, 2019q).

The lack of funding is compounded by the absence of an effective career structure for researchers, which can inhibit retention of skilled researchers and the development of research capacity. In addition, many university researchers are near retirement (European Commission, 2018a). Hiring is made more difficult by Latvian language requirements, as public universities must offer courses in Latvian, and academics must be fluent in Latvian (although an exception is made for visiting academics with a contract of less than two years) (The World Bank, 2018b). In addition, the government is setting up a database of Latvian researchers abroad to try to overcome hiring difficulties and encourage research and teaching collaboration (OECD, 2019a).

Latvia is also introducing new hiring criteria for professors, who will need a minimum number of academic publications, in order to increase the number of active researchers in HEIs (European Commission, 2018a). However, HEIs do not offer tenure, with contracts lasting for six years, which can make it difficult to attract talented researchers (OECD, 2016). The Latvian government is planning to ease the hiring of staff by merging career structures for research staff and academic staff. In order to encourage applied research and innovation (e.g. developing prototyping and patenting), the ability of researchers to attract external funding should be included as a criteria for promotion.

Funding of HEIs has been reformed to boost research orientation

To increase the emphasis on research in HEIs, the government has introduced a new funding model (European Commission, 2018a). There are now three pillars of funding in HEIs: basic funding, which depends on the average cost of teaching per student; performance-related funding, which is linked to the number of researchers who graduated no more than five years ago, the amount of international research funding attracted, the amount of funding attracted via R&D contracts, the amount of funding attracted from local governments, and the amount of funding attracted from creative and artistic projects; and innovation-oriented funding, which comes almost entirely from EU innovation projects (see below) (The World Bank, 2018a). In 2015, 60% of funding went to basic funding, 20% to performance-related funding and 20% to innovation-oriented funding (OECD, 2019g). However, in 2018, 90% of funding went to cover basic activities, with only 2% allocated to innovation-oriented activities.

Research funding is science focused rather than market-oriented

Latvia largely supports research through grants, and has two systems for administering funds for research and innovation depending on whether the source is the Latvian government or the European Regional Development Fund (ERDF). In 2017, each source accounted for an approximately equal amount of funding. National programmes tend to be smaller in scale but run over a longer period, while the opposite is true for structural funds programmes (i.e. they are bigger but run over a shorter time span) (European Commission, 2018a).

Latvian government research funding is administered by the MoES and its agencies (with the exception of research programmes of the Ministry of Agriculture), with the MoES also designing national funding programmes. The State Education and Development Agency (SEDA) administers funding from international sources such as ERDF-co-funded post-doctoral research programmes, international R&D co-operation programmes, and programmes funded by the European Economic Area and Norway. Meanwhile the Studies and Research Administration (SRA) administers fundamental and applied research programmes, student loans and research programmes that fall under the competence of the MoES. The Latvian Council of Sciences organises international peer review for state funded programmes (European Commission, 2018a). In addition, the Latvian Academy of Sciences provides small grants to senior scientists of repute.

EU-funded R&D and innovation programmes, including projects to modernise research infrastructure, are administered by the Central Finance and Contracting Agency (CFCA), which administrates all EUR 4.4 billion in EU funds made available to Latvia for the period 2014-2020 and is answerable to the Ministry of Finance (MoF). The CFCA has increased in importance since 2014, when it became the only co-operation institution for EU cohesion funds. The CFCA selects projects and administers them financially and scientifically (CFCA, 2020). As with SEDA, the CFCA selects peers from the European Commission's database for Horizon 2020 or other equivalent databases of international scientific peers. However, the role of the CFCA does not extend to supporting project leaders in the implementation of their projects (as is typically done by innovation agencies such as the Latvian Investment and Development Agency) (CFCA, 2019; European Commission, 2018a).

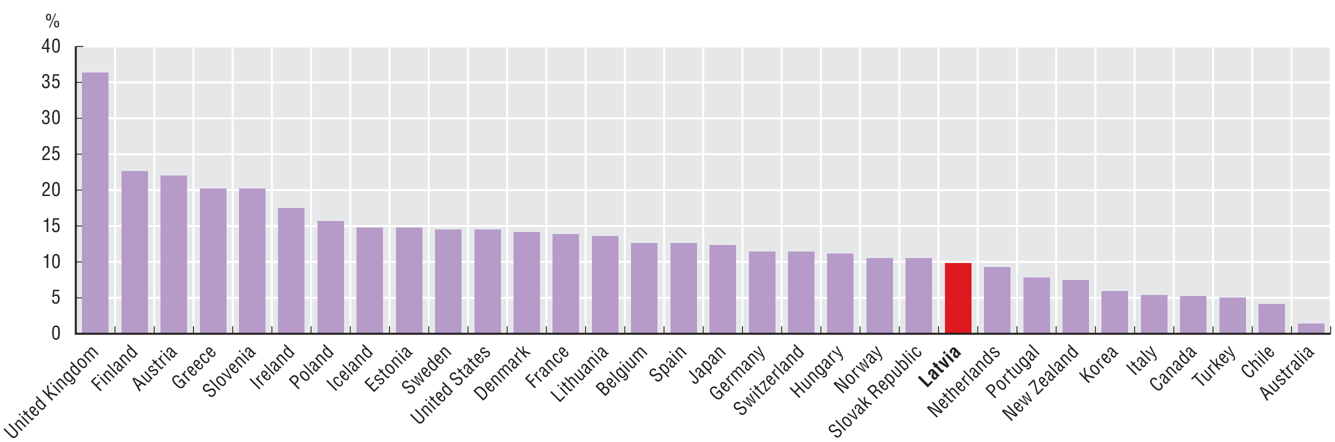
A benefit of the CFCA is the creation of a one-stop shop for applying for EU funds. However, the dual system results in implementation agencies answering to the MoF rather than to line ministries responsible for their policy. It also leads to agencies competing with CFCA reviewers of projects. From July 2020 onwards, a new Latvian Science Council will take over all the functions of implementing science policy from the current Latvian Science Council, SEDA and the SRA (MoES, 2020a). This should help improve programme efficiency in support of innovation.

Incentives to collaborate with firms are weak and ICT projects receive a small proportion of funding

Incentives for HEIs to collaborate with industry have been weak, however, with only a few SMEs collaborating with research institutions (European Commission, 2018a) (Figure 6.10). The new performance-related funding pillar for HEIs has changed these incentives, giving more funding to HEIs that collaborate with firms (OECD, 2019a). In addition, ERDF-funded applied research programmes, the Competence Centres programme and the Technology Transfer Programme (below) have served to boost links. Further increasing the proportion of HEI funding that depends on collaboration with firms could help to increase the market orientation of research conducted in HEIs.

Figure 6.10. SMEs co-operating on innovation activities with higher education or government institutions in selected OECD countries, 2014-16

As a percentage of innovative enterprises[1]



1. Innovative SMEs are those introducing product, process, marketing or organisational innovation.

Source: OECD, based on OECD (2019), *OECD Survey of National Innovation Statistics* and Eurostat (2016), *Community Innovation Survey (CIS) 2016*, *http://oe.cd/inno-stats* (accessed on 20 January 2020).

In addition, only a small proportion of EU research funding goes towards ICT-related projects in Latvia. The applied research ERDF funding stream, administered by the CFCA, aims to boost the research capacity of Latvian institutions. However, out of the 74 research projects running at the end of 2019, only two were in the field of ICT, with funding of EUR 750 000 (i.e. 1.9% of the total programme funding) (EsFondi.lv, 2020a; 2020b). The Postdoctoral Research programme, administered by SEDA, had 194 projects running at the end of 2019 (with almost EUR 25 million), out of which only one was in the field of ICT, with funding of approximately EUR 100 000 (i.e. 0.4% of total programme funding). Allocating a greater proportion of research funding to ICT-related projects should be a priority for Latvia to foster innovation capacity in this sector.

More funding should be awarded competitively and based on broad impact criteria

Latvia should raise the quality of research by increasing the proportion of funding awarded competitively. Competitive funding of projects can ensure projects reach a minimum level of quality, and gives researchers an opportunity to test ideas among peers, although there is mixed evidence that this can lead to shorter-term low-risk projects being selected, while increasing the administrative burden on researchers and hindering long-term planning. There is wide variation across OECD countries for the proportion of research funding awarded competitively, typically ranging from 25% to 50% (OECD, 2018b). Nevertheless, Latvia should increase the proportion of research funding allocated through a competitive process. Setting aside a proportion of more junior researchers would help overcome difficulties in attracting funding due to lack of a track record.

Latvia largely offers funding *ex ante* rather than rewarding successful research and innovation *ex post* (OECD, 2019g). If CFCA-funded projects have a negative *ex post* evaluation expenses must be refunded, though this has not occurred to date (MoF, 2020). Part of research funding should be based on the impact of research. For example, Science Foundation Ireland has gone beyond the use of bibliometric citations and introduced research impact evaluations, whereby experts in the commercialisation and development of research evaluate the impact of research *ex post*. In addition, for many projects international experts conduct a mid-term review to assess progress against the original proposal (OECD, 2018b).

Promotion of innovation within firms

Innovation does not play a large role in Latvian firms (see above). However, Latvia is taking steps to increase the number of firms involved in innovation through regional and ERDF-funded programmes. Nevertheless, lack of clarity about the role of ICTs in national planning documents has led to programmes with overlapping and, at times, inconsistent aims.

The Latvian Investment and Development Agency (LIDA) plays an important role in managing support programmes for entrepreneurs. The LIDA is the main state agency for innovation and forms part of the MoE. It manages innovation programmes funded by EU structural funds such as the Technology Transfer Programme, the Innovation Motivation Programme and the Business Incubators Programme (although the CFCA administers funding). The LIDA's main role is to support foreign direct investment (FDI), although FDI flows largely towards sectors that do not tend to invest in R&D (European Commission, 2018a).

Latvia has sought to increase public awareness of the benefits of innovation and has taken measures to encourage those with innovative ideas to pursue them to commercialisation. For instance, the Innovation Motivational Programme aims to raise awareness among the general public of the importance of innovation and to encourage entrepreneurship. The programme receives ERDF funding (EUR 0.5 million in 2018) but is run by the MoE and LIDA. Activities to date have included a "brainstorming" competition to generate business ideas, networking events, management innovation training for merchants (e.g. a week-long Mini-MBA in Innovation and Leadership course) and competitions such as the Ideas Cup for innovative business ideas (Cross-sectoral Coordination Centre, 2017; LIDA, 2019a).

There are overlapping programmes to link firms with HEIs and research institutes

Several programmes exists to boost innovation by diffusing expertise across Latvian firms. However, these programmes do not regard digital technologies as key enablers of innovation. Introducing a strong digital focus in these programmes is crucial for Latvian firms to seize the innovation opportunities arising from the digital transformation.

In 2010, Latvia launched the Competence Centre Programme, managed by the LIDA, to raise the competitiveness and innovation of firms. These centres aim to promote applied research and frontier innovation in sectors aligned with the Smart Specialisation Strategy (see below) and, thereby, help develop new products and technologies by fostering co-operation between the research sector and industry. However, in this regard the centres overlap with the Technology Transfer Programme (above). Although the competence centres receive grant funding from the ERDF, they are majority owned by the private sector, and at least a quarter of their funding must be earmarked for experimental development. By the end of 2018, support was given to almost 150 firms to create or improve 174 products, with almost 500 jobs created, 175 master and doctoral students involved in research, and over 200 academic articles published.

The IT Competence Centre began operating in April 2011 and focuses on the areas of natural language technologies and business process analysis technologies, with previously conducted studies leading to publication in academic journals. The centre received EUR 7.8 million in ERDF funding plus private funding of EUR 5.2 million for the period 2014-20. Over the period April 2019 to December 2021, 20 research projects are being implemented with the intention of assisting 20 firms to develop new products (Esfondi.lv, 2020c). Given that ERDF funding is due to expire in 2021, alternative sources will be required. Increasing the proportion of funding from private co-financing could help ensure that incentives are geared towards generating commercial innovations, rather than academic research.

In contrast, the Technology Transfer Programme aims to boost innovation in SMEs by diffusing existing technology and expertise (rather than engaging in frontier innovation) from research institutions and promoting the commercialisation of research. The programme is administered by the LIDA but receives funding from the ERDF. Entrepreneurs are directed towards potential research organisations by "technology scouts" who work for the LIDA.

The Technology Transfer Programme mainly offers support to established SMEs in the form of innovation vouchers, although it also helps to finance visits with potential investors and participation in trade fairs for start-ups, and assists research institutes with commercialising their research. Innovation vouchers are available for any business that develops new products or technology in sectors outlined in the Smart Specialisation Strategy. Vouchers are co-financed 85% up to the value of EUR 25 000 and can be used for feasibility studies, experimental development, prototyping, industrial design, strengthening intellectual property, and for testing and certification (LIDA, 2019b; 2019c). Support of up to EUR 300 000 is also available to research organisations for feasibility studies and for developing commercialisation strategies. By the end of 2018, the programme had spent EUR 2.7 million and 36 new products or technologies had been developed, 48 firms had received grants to launch new products on the market (e.g. by visiting potential investors and exhibitions), and 15 projects of research organisations had financed for commercialisation. The project will continue to the end of 2022 (Esfondi.lv, 2020d).

Latvia has sought to foster innovation by boosting co-operation among firms

Technology diffusion can also be boosted by increasing co-operation among innovating firms and multinational enterprises (MNEs), an approach that has been lacking in Latvia (OECD, 2017a). The Cluster Programme aims to increase the competitiveness export capacity of SMEs by increasing co-operation among firms within the same sector. The programme supports 14 clusters, as defined by the Smart Specialisation Programme (MoE, 2018a). The Latvian IT Cluster includes both firms and HEIs as members, and provides services to assist in exporting, for example by providing firms with information about international networking events and market research. However, these activities overlap with the export promotion work of the LIDA. In addition, the IT Cluster organises events to promote digitalisation in other sectors, ranging from workshops for individual firms to highlight the benefits of digitalisation to larger networking events. These activities appear to duplicate those of the ICT sector association LIKTA.

The Latvian IT Cluster is also one of three Digital Innovation Hubs (DIHs) in operation, with a fourth being established in Riga. The aim of these hubs is to boost cross-sectoral collaboration. The second DIH, the Ventspils High Technology Park (VHTP) (based in Ventspils, almost 200 km from Riga), focuses on developing hardware such as smart materials, technology and engineering within the manufacturing sector, and offers services to assist firms in their digitalisation efforts. The third, the Institute of Electronics and Computer Science (EDI), is a state research institute originally established in 1960 that develops software (e.g. signal and image processing) and embedded hardware (e.g. remote sensors and wearable devices) (European Commission, 2018b). An additional DIH, TechHub Riga, will be based in Riga. However, the proliferation of various hubs can potentially limit the development of a critical mass of expertise. Latvia should therefore consider instead concentrating funding within fewer organisations.

The presence of the Latvian IT Cluster in both the Cluster Programme and the DIHs can lead to conflicting aims, creating a critical mass of expertise, on the one hand, and diffusing such expertise, on the other. Given the overlap between the IT Cluster, LIKTA, LIDA and the IT Competence Centre, the Latvian government should review the activities of these organisations, assess their relative strengths and weakness, and clearly define their respective roles based on this assessment. In addition, these programmes should focus on promoting digitalisation within firms, rather than innovation within the IT sector.

To some extent, this duplication among programmes is an outcome of the *Guidelines for National Industrial Policy*, which do not recognise digital technologies as a key transversal enabler of innovation, and make no distinction between the adoption of existing technologies and the promotion of frontier innovation. Placing digital innovation at the core of the *Guidelines for Science, Technology Development and Innovation* and the *Guidelines for National Industrial Policy* will allow Latvia to set clear priorities for its programmes, reduce overlap and increase efficiency.

Adapting intellectual property and regulatory regimes could boost digital innovation

Measures have also been taken to improve the protection of intellectual property rights (IPRs), which can help develop frontier innovation. Latvian IPRs policy is fragmented across the Ministry of Justice (MoJ), the Ministry of Culture (MoC) and the Ministry of Agriculture (MoA), with different agencies responsible for copyright, patents and trademarks (Cross-sectoral Coordination Centre, 2017). This can be particularly problematic for digital innovation, which frequently spans several IPRs mechanisms (Beckerman-Rodau, 2011). Latvia has improved the situation by establishing an Intellectual Property Council as an advisory body and a single Intellectual Property Information Centre to provide information and consulting services regarding the different forms of intellectual property (Patent Office of the Republic of Latvia, 2019). Meanwhile, Latvia's Patent Office (LRPV) offers search reports, which can help reduce costs for those applying for a European patent. In addition, the LRPV and the LIDA are increasing awareness among firms of the importance of IPRs through events such as seminars and trade fairs. Modules on IPRs will also be incorporated into tertiary courses on graphic design and technical subjects.

Developing an Intellectual Property Strategy, as has been done in some Nordic countries, could help Latvia increase investment in IPRs. For example, Finland published its first IPRs strategy in 2009 (currently under review) to overcome problems such as lack of knowledge among SMEs regarding potential IPRs, lack of ability to establish contracts capitalising on their IPRs and an inability to monitor whether their IPRs are being violated (OECD, 2011). This strategy included steps to improve the efficiency of IPRs protection in the court system through the establishment of a dedicated court and tax incentives for R&D (Takalo, 2013).

Finally, navigating regulations can be a challenge for new digital firms (see below). In response, Denmark has created a one-stop shop (Nye Forretningsmodeller) for regulatory inquiries about new business models, which may be impacted by new regulations administered by different public authorities. This agency also analyses the demands of new businesses and the ways in which regulations are implemented in neighbouring countries, in order to develop new solutions to regulatory challenges (Nye Forretningsmodeller, 2019).

Promotion of start-ups

Latvia has also expanded its efforts to support start-ups along all stages of their life cycle. Latvia has 400 registered start-ups, which are mostly concentrated in Riga, although the city has been described as a start-up community rather than a start-up ecosystem (European Commission, 2018a; LIDA, 2019d). In 2018, StartupLatvia.eu was launched as a portal listing the services offered to start-ups. In addition, creating a favourable environment for innovation and start-ups was made a central tenet of Latvia's innovation policy. The MoE is also implementing an Action Plan for Enhancing the Environment for Entrepreneurship (OECD, 2019g). In recent years, Latvia has taken further measures, such as easing access to finance and reforming tax laws, which can be of particular benefit to digitally innovative firms (see below).

The Business Incubator Programme, which runs from 2016 to 2023, offers training and mentoring for later stages of the innovation process (OECD, 2019h). Incubators are located across Latvia, with a Creative Industries Incubator in Riga (LIDA, 2019e). In total, there are 15 incubators across Latvia (with two in Riga) run by the LIDA, which offer training, mentorships and grants for a maximum of four years. The incubators offer training in the use of digital tools, and some of the incubated firms now sell digital products (e.g. VRDEV developed virtual and augmented reality). However, the aim of these incubators is to foster entrepreneurship across Latvia rather than developing digital technologies (LIDA, 2019f). Latvia should therefore reorient the efforts of one of its hub towards digital start-ups.

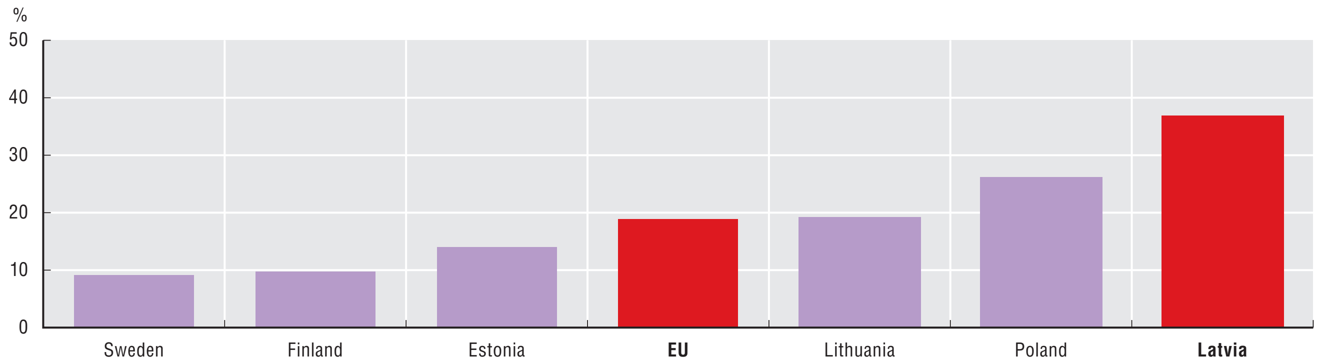
Finally, in 2019 the MoES approved five HEIs to provide grants to students as part of the ERDF-funded Innovation grants for students programme. This programme aims to develop the entrepreneurship and innovation skills of students through training in product development, commercialisation and the establishment of business incubators for students (EsFondi.lv, 2020e; RTU, 2019). Total funding of EUR 14.25 million was approved, with a quarter coming from the private sector.

Measures have recently been taken to ease access to finance

Firms face obstacles accessing finance which can act as a barrier to innovation. Almost half of firms report financing as an obstacle to investment (Figure 6.11). SME lending has remained low since the financial crisis, with smaller firms getting most of their funding from equity and non-bank short-term liabilities such as trade credit (OECD, 2019h). This has led the government to take measures to increase financing.

Figure 6.11. Firms declaring that availability of finance is a major obstacle to long-term investment, 2018

As a percentage of all firms



Source: European Investment Bank, *EIB Investment Survey 2019*.

ALTUM is Latvia's sole development finance agency. It was created in 2013 out of the merger of the Latvian Guarantee Agency, Lavijas Hipotēku un Zemes Banka and the Rural Development Fund (OECD, 2019i). It is owned by the ministries of Agriculture, Economics and Finance (European Commission, 2018a). ALTUM implements state aid programmes, such as microfinance, credit guarantees and loans to start-ups, some of which are funded by the European Union (Cross-sectoral Coordination Centre, 2017; OECD, 2019a). The agency initiated micro-loans in 2016 for start-ups followed by loan guarantees in 2017 (OECD, 2019h).

Four acceleration funds operate in Latvia, all of which have demonstrated considerable attention to digital innovation. In 2018, 15 million EUR (with funding provided by the ERDF but administered by ALTUM) was provided to three acceleration funds, two of which fund the development of digital technologies. Overkill Ventures focuses on business-to-business software start-ups and BuildIT focuses on hardware and the Internet of Things (LIDA, 2019d). In 2019, the first 18 start-ups advanced past the accelerator stage (ALTUM, 2019).

In addition, seven new venture capital funds (backed by the European Union) were launched in 2018 (OECD, 2019h). Venture capital funds have expanded due to an increase in public funding, though the venture capital market remains small due to a lack of good investment opportunities (OECD, 2019a). The Baltic Innovation Fund (BIF) is part of the European Innovation Fund (EIF) and combines funding from the three Baltic governments (OECD, 2019g).

Improving the environment for start-ups

Latvia has also taken measures to ease migration for those working for or who have founded start-ups, and also to protect IPRs.

In May 2017, a special visa programme for those launching start-ups was introduced. Latvia offers temporary residence permits (referred to as the "start-up visa") for up to three years to non-EU start-up founders that base themselves in Latvia. Each start-up can have up to five founders availing themselves of a residence permit. Permit holders are not allowed to be an employee or board member of another company in Latvia and must attract an investment of at least EUR 30 000 from a venture capital fund or 15 000 from an accelerator or business angel within 12 months (LIDA, 2019g).

In 2017, a Start-up law also came into effect, offering eligible firms two options for reducing the cost of hiring highly skilled R&D staff, including ICT specialists. The first option allows firms to pay a lump-sum social insurance contribution of EUR 302 per month for each employee regardless of the salary paid as an alternative to the overall 35% social security rate. This option is more convenient for firms where staff are paid at least double the minimum wage. In addition, start-up employees are exempted from personal income tax on their salary. Alternatively, firms can opt for a 45% rebate on the labour cost of highly qualified staff who hold a MSc or PhD degree (in information technology, natural sciences, mathematics, engineering and technology, manufacturing and processing, or design) or at least three-year's work experience in a relevant field. Eligible firms can receive these benefits for one year initially and can continue for a maximum of five years (Magnetic Latvia, 2019).

Total funding for assistance under the Start-up law has been capped at EUR 1.6 million and is available via ERDF and national sources (LIDA project No. 1.2.1.2/16/I/001) (LIDA, 2019d). Nevertheless, it is unclear whether it is more beneficial for Latvia's scarce ICT specialists to work in start-ups rather than in more established firm. In addition, Latvia lacks other market-based incentives to promote R&D. Latvia should therefore consider making the tax incentives for R&D staff in start-ups less generous but available to all firms.

Conclusion and policy recommendations

There is considerable overlap among Latvia's efforts to boost innovation. In part, duplication is a result of digital technologies not being included as a transversal enabler of innovation across several sectors. The duplication of efforts among the LIDA, competence centres, clusters and hubs can hinder the development of institutional expertise within a single organisation. In addition, projects have seemingly been chosen because of their ability to attract EU funding, rather than based on a clear set of national priorities. As EU programmes tend to be short term in length, this further hinders the development of institutional capacity to support innovative firms. Therefore, creating a new innovation strategy, with digitalisation at its heart can help Latvia reduce such duplication. Key recommendations are presented in Box 6.4.

Box 6.4. Policy recommendations

Boosting research

- Review the *Guidelines for Science, Technology Development and Innovation* and the *Guidelines for National Industrial Policy* for the next planning period and:
  - put a strong focus on digitalisation as a key transversal enabler of innovation and growth
  - promote digital service innovation
  - promote digital innovation to address Latvia's societal and economic challenges.
- Increase the level of public support to business R&D and diversify its composition towards greater use of tax allowance for R&D expenditures.
- Increase incentives for HEI staff to engage in applied research and innovation, by incorporating their ability to raise private funding among the criteria for promotion.
- Allocate a greater proportion of research funding to ICT-related projects (including cross-disciplinary projects), which are currently underfunded.
- Raise the quality of research by increasing the proportion of funding allocated through competitive processes.
- Introduce a system of *ex post* evaluation of research projects similar to that used by the Science Foundation Ireland.

Box 6.4. Policy recommendations *(cont.)*

Boosting innovation in firms

- Raise the proportion of private co-financing of competence centres to ensure that they are geared towards commercial innovations.
- Review the activities of the IT Cluster, LIKTA, LIDA and the IT Competence Centre to assess their relative strengths and weakness, and clearly define their respective roles based on this assessment.
- Clearly focus the mission of the IT Cluster on promoting digitalisation among firms to avoid duplication with other programmes.
- Develop an intellectual property rights (IPRs) strategy, based on the successful example of Finland, and establish a specialised court for all IPR issues.
- Raise business incentives to invest in R&D by making existing tax incentives for R&D staff in start-ups less generous but available to all firms.

Latvia's Smart Specialisation Strategy

In 2013, the Latvian government adopted a National Research and Innovation Strategy for Smart Specialisation (RIS3), which defines national priorities for a knowledge-based structural transformation. RIS3 is part of the EU Cohesion Policy for 2014-2020 and a precondition for receiving financial support from the European Union's Regional Development Fund (ERDF).[1] In particular, RIS3 largely determines the distribution of ERDF funds across different areas. The European Union considers the Digital Agenda a core instrument for the implementation of a RIS3.

Latvia's Smart Specialisation Strategy sets three directions for economic transformation: 1) change in the production and export structure of traditional economic areas; 2) future growth areas where products and services with high added value exist or may appear; and 3) areas with significant horizontal impact contributing to national economy transformation. The strategy also determines several key priorities including more efficient use of raw materials, the creation of new materials, wider use of non-technological innovations, the development of a modern ICT system in the private and public sector, and an advanced knowledge base and human capital in areas where Latvia has a comparative advantage of importance to the process of transformation (MoES, 2013a).

The government identified five Smart Specialisation areas in line with three directions. **Knowledge-intensive bioeconomy** is a strategic area for the transformation of traditional sectors. **Biomedicine, medical technologies and biotechnology** and **Smart materials, technology and engineering** are areas with high value added and high growth potential. **Advanced ICTs** and **Smart energy** are horizontal enablers of structural transformation across economic sectors.

Several niches of competitiveness were highlighted within each of the specialisation areas (Table 6.1). Table 6.2 summarises the distribution of available funds across the different Smart Specialisation areas and funding mechanisms for the years 2014-18.

The selection of Smart Specialisation areas followed several rounds of discussions with entrepreneurs, industry associations and academia in June and July 2013. An initial assessment found that a strong product portfolio and a skilled labour force already existed in forestry and wood processing, agriculture and food as well as metalworking and mechanical engineering. High export potential was identified for woodworking, the food industry, manufacture of metal and its products, and the chemical industry, as well as information and communication services. The export of health services, while small at the time, was also considered promising. Significant patent activities were identified in the fields of surface technologies and coatings, materials, engines, turbines pumps, nano-science, audio-visual technology, health, pharmacy, and chemistry and wood chemistry, as well as selected fields of IT and management methods. Finally, the assessment highlighted research specialisation in the material sciences, biotechnology, ICT, energy and transportation technology (MoES, 2013a).

Table 6.1. Latvia's Smart Specialisation areas

Specialisation area (RIS3)	Potential specialisation niches (as of 2014)	Related industries (NACE Rev. 2)
Knowledge-intensive bioeconomy	Sustainable and productive forest growing in changing climatic conditions; Full use of wood biomass for chemical processing and energy; Innovative, risk-reducing plant and animal breeding technologies; Development of innovative high-value added niche products from wood, traditional and unconventional agricultural plant and animal raw materials; Technological solutions for the use of plant and animal breeding and processing by-products; Food safety	A – Agriculture, forestry and fishing: A.01 – Crop and animal production, hunting and related service activities; A.02 – Forestry and logging; A.03 – Fishing and aquaculture C – Manufacturing: C.10 – Food products; C.11 – Beverages; C.16 – Manufacturing of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials; C.17 – Paper and paper products; C.20 – Chemicals and chemical products; C.23 – Other non-metallic mineral products; C.27 – Electrical equipment; C.28 – Machinery and equipment n.e.c. M – Professional, scientific and technical activities: M.74 – Other professional, scientific and technical activities
Biomedicine, medical technologies and biotechnology	Chemical and biotechnological methods for the production of pharmaceutical and bioactive substances; Development and research of human and veterinary medicinal products; Molecular and individualised treatment and diagnostic methods and cell technology; Functional foods, therapeutic cosmetics and bioactive natural substances	C – Manufacturing: C.10 – Food products; C.20 – Chemicals and chemical products; C.21 – Basic pharmaceutical products and pharmaceutical preparations; C.26 – Computer, electronic and optical products; C.26.6 Manufacture of irradiation, electromedical and electrotherapeutic equipment; C.32.50 Manufacture of medical and dental instruments and supplies Q – Human health activities
Smart materials, technology and engineering	Implant materials, composite materials, thin layers and coatings, equipment, machinery and working machines, glass fibre products and smart glass-based materials	C – Manufacturing: C.20 – Chemicals and chemical products; C.23 – Other non-metallic mineral products; C.25 – Fabricated metal products, except machinery and equipment; C.28 – Machinery and equipment n.e.c., C.32 – Other manufacturing
Advanced ICT	Innovative knowledge management, system modelling and software development methods and tools; Innovative sectoral ICT hardware (hardware) and software (software) applications; Cyber-physics systems, language technologies and the semantic web; Bulk data and knowledge infrastructure; Information security and quantum computers; Computer system testing methods	J – Information and communication technologies: J.61 – Telecommunications; J.62 – Computer programming, consultancy and related activities; J.63.1 – Data processing, hosting and related activities; web portals; J.58.1 – Software publishing; C.26.1 – Manufacture of electronic components and boards; C.26.2. Manufacture of computers and peripheral equipment; C.26.3. Manufacture of communication equipment; C.26.4. Manufacture of consumer electronics; C.26.8. Manufacture of magnetic and optical media
Smart energy	Development of smart grids and demand-supply systems, smart buildings, home, appliances and home automation systems; Development of next-generation technologies for energy from renewable energy sources; Increasing energy efficiency – energy efficiency of building structures, energy efficiency of residential infrastructure elements; Sustainable energy for transport – new technologies, accelerating their implementation, electric mobility	C – Manufacturing: C.27 – Electrical equipment; C.28 – Machinery and equipment n.e.c.; C.29 – Motor vehicles, trailers and semi-trailers D – Electricity, gas, steam and air conditioning supply: D.35 – Electricity, gas, steam and air conditioning supply F – Construction: F.41 – Construction of buildings; F.43 – Specialised construction activities J – Information and communication technologies: J.62 – Computer programming, consultancy and related activities

Note: ICT = information and communication technology; n.e.c. = not elsewhere classified.

Source: European Commission (2018c)¸ "Latvia – S3 priorities as encoded in the 'Eye@RIS3' Tool", *https://s3platform.jrc.ec.europa.eu/regions/LV/tags/LV* (accessed on 30 September 2019).

Latvia's selection of Smart Specialisation areas has a rather strong focus on manufacturing activities. Services are explicitly considered only as IT services in the ICT specialisation area. Services related to well-being or social innovation are not considered. This differs from many other EU countries, including Denmark and Estonia, which have explicitly included health services or social work activities as Smart Specialisation areas, and makes Latvia's Smart Specialisation Strategy appear somewhat one-sided (European Commission, 2012b).

Each Smart Specialisation area is supported by a number of competence centres and clusters (Table 6.3). Competence centres are commercial entities founded by enterprises and research organisations, which manage and finance R&D activities with potential commercial value. They play a crucial role in improving the potential for exchange between firms and research organisations. Clusters are membership organisations in particular economic fields that aim to create positive externalities for members through network activities. In the context of innovation systems, clusters usually include three types of members (triple-helix), namely private, academic and public entities (e.g. universities and research institutions). Clusters and cluster policies are considered to be among the key building blocks in developing and implementing RIS3 (European Commission, 2013).

Table 6.2. Funding instruments for Smart Specialisation, 2014-18

In EUR

Source			Funding instruments of the Ministry of Education and Science		EU Innovation and research programme	Funding instruments of the Ministry of Economics		Total
	National government		ESIF (e.g. ERDF, ESF)		Horizon 2020	ESIF (e.g. ERDF, ESF)		
	ERA-NET	Fundamental and applied research programme	Post-doctoral research	Practical-oriented research	Horizon 2020	Research results commercialisation	Competence centres	
Bioeconomy	..	3 003 297	3 255 695	3 349 101	4 456 544	778 245	9 752 819	**24 595 701**
Biomedicine	2 539 607	4 996 572	6 155 076	19 683 916	2 329 968	2 302 933	7 871 315	**45 879 387**
Smart energy	..	5 378 043	12 404 929[1]		12 419 688	4 050 0081[1]		**34 252 668**
Smart materials	..	8 012 905	5 352 240	15 722 087	2 994 482	3 713 511	16 399 223	**52 194 448**
ICT	..	3 494 203	3 813 470	5 238 442	7 511 618	2 095 685	10 780 921	**32 934 339**
Total	**2 539 607**	**24 885 020**	**74 974 956**		**29 712 299**	**57 744 660**		**189 856 543**

1. This number refers to total funds from ESIF.

Note: .. = not available; ICT = information and communication technology.

Source: OECD, based on data from the MoES.

Table 6.3. Smart Specialisation: Competence centres and clusters

Specialisation area (RIS3)	Competence centres	Clusters (launched since 2017)
Knowledge-intensive bioeconomy	Latvian Food Competence Centre (LFCC), Forest Sector Competence Centre (FSCC)	Food Products Quality Cluster, Latvian Wood Construction Cluster, CLEANTECH Latvia (cross-sectoral), Smart City Cluster (cross-sectoral)
Biomedicine, medical technologies and biotechnology	Pharmacy, Biomedicine and Medical Technology Competence Centre (PBMTCC)	Life Science Cluster of Latvia
Smart materials, technology and engineering	Mechanical Engineering Competence Centre (MECC), Smart Materials and Technology Competence Centre (SMTCC)	Metal working Cluster, Green and Smart Technology Cluster (cross-sectoral), Printing and Media Technology Cluster
Advanced ICT	IT Competence Centre (ITCC), LEO Research Centre (LEO)	Information Technology Cluster
Smart energy	Smart Engineering, Transport and Energy Competence Centre (SETECC)	Latvian Electronics and Electrical Engineering Cluster

Source: OECD, based on MoES (2018), *Informative Report: Monitoring of Smart Specialization Strategy*, *https://s3platform.jrc.ec.europa.eu/documents/20182/0/RIS3_progress+report_LV_2018.pdf/940176c6-b886-4213-9f18-75c20251bfb9*.

In 2018, the government conducted an initial assessment of the implementation of the Smart Specialisation Strategy, and concluded that Latvia's competitive advantage still relies largely on low labour costs and natural resources. Investments in research and development as a percentage of GDP declined slightly between 2010 and 2016, while labour productivity in manufacturing increased slightly, but remained below expectations. In addition, Latvia moved from the modest to the moderate performance group in the European Innovation Index, although this result was based largely on EU support during the previous funding round (2007-13). The assessment reported positive developments with regard to science publications, the educational attainments of young adults (aged 30-34), research fragmentation and export of high technology goods (MoES, 2018). However, the assessment did not address the performance of particular specialisation areas or research fields.

To better assess the effectiveness of invested funds, an RIS3 monitoring system was put in place in 2016. The results will be used to shape the next iteration of the Smart Specialisation Strategy (2021-2027), which will shift the focus from fostering loosely related product niches (Table 6.1) to developing a smaller selection of ecosystems with potential for comparative advantages. An important difference is that the new approach better accounts for the crucial role of different ecosystem players as well as upstream and downstream activities (i.e. the value chain).

At present, the Latvian government has identified three ecosystems for development: biomedicine, smart materials and smart cities.[2] Out of these, the Smart City is the only ecosystem currently not explicitly linked to any of the existing specialisation areas. However, there are significant overlaps between the Smart City concept and the specialisation areas of Smart Energy (including mobility) and Biomedicine (including remote healthcare monitoring). Sustaining clear links to existing Smart Specialisation areas can be critical to ensure continuity. As the Latvian definition of the Smart City concept explicitly highlights measures that allow for timely anticipation and prevention of potential challenges, such as energy shortages, heat losses or sewer leaks, the following sections, which provide an assessment and recommendations for different Smart Specialisation areas, treat the Smart City ecosystem within the area of Smart Energy. Overarching policy recommendations that arise from the following sections can be summarised as follows.

First, public support for Smart Specialisation should be better targeted at ecosystems with high growth potential, taking into consideration the whole value chain, from research to commercialisation. In the past, the Smart Specialisation Strategy has provided support to too many distinct product niches without prioritisation. This has resulted in funds being spread too thinly. The new ecosystem approach can help to improve targeting, and the following sections provide some indications of where potential might lie.

Second, Latvia should better leverage the ICT Smart Specialisation area as an enabler of innovation in other specialisation areas. As digital technologies generate positive spill-overs across all economic activities, the share of spending on ICTs in total spending on Smart Specialisation (Table 6.2) should be increased significantly.

Third, while fostering innovation is at the core of the Smart Specialisation Strategy, encouraging the uptake of existing technologies is an important complementary strategy. In particular, wider dissemination of general purpose technologies such as ICTs is crucial, because it enables more firms to innovate (OECD, 2019j). This is particularly important for services firms, which should be accorded a more prominent role in Latvia's Smart Specialisation Strategy.

Box 6.5. Smart Specialisation: Overarching recommendations

- Concentrate funding for Smart Specialisation on ecosystems with high potential.
- Increase the share of RIS3 funding devoted to ICTs and target applications of high relevance for other Smart Specialisation areas.
- Complement the Smart Specialisation Strategy with measures to broaden and diffuse innovation, in particular by fostering the uptake of digital technologies.

Latvia's bioeconomy strategy

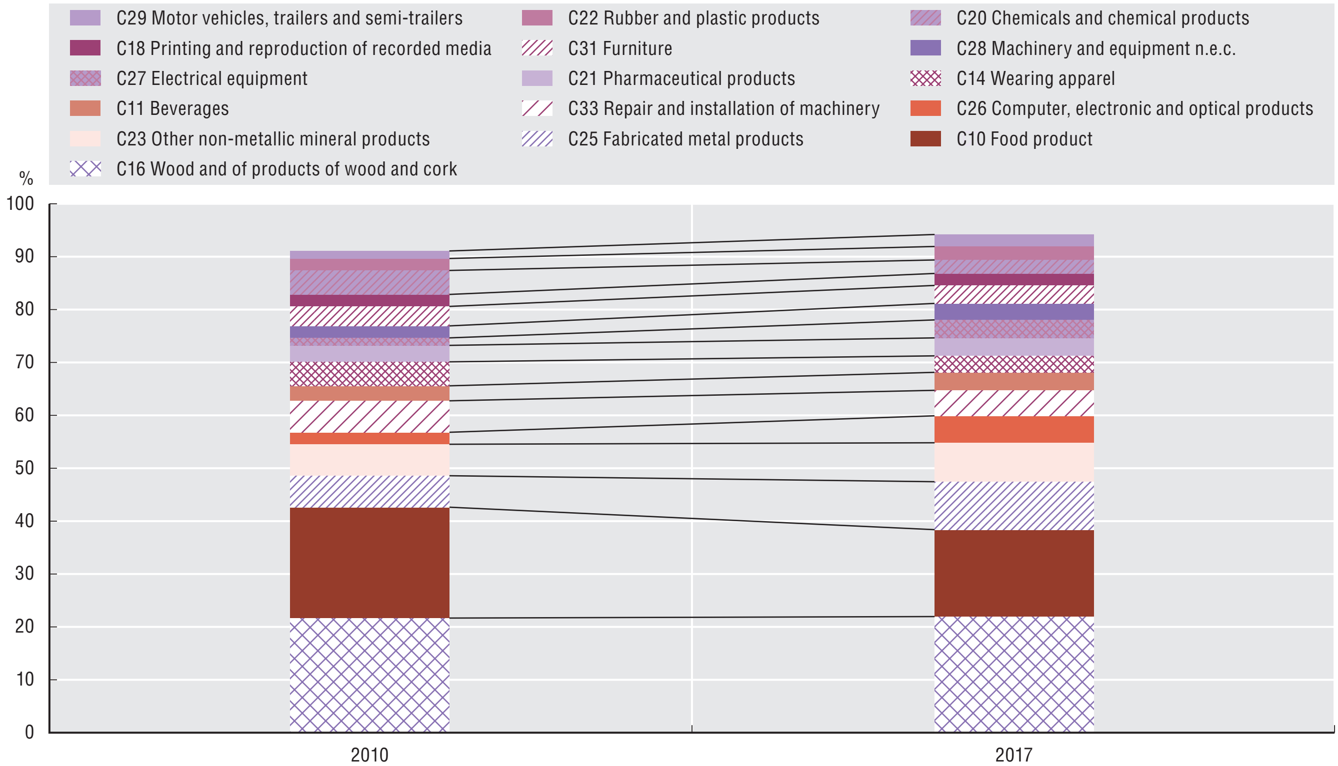
The bioeconomy involves the use of renewable feedstock to produce goods and services. It encompasses a wide range of sectors and activities, including chemicals, food, agriculture, dairy, forestry, pulp and paper, waste management and others. Accordingly, the term "bioeconomy" does not necessarily convey a particular notion of technological intensity. Traditional forestry is as much a part of the bioeconomy as the genetic manipulation of biomass and synthetic biology. In Latvia's Smart Specialisation Strategy (RIS3), the knowledge-intensive bioeconomy relates to some of the more traditional sectors, including agriculture and forestry, as well as related manufacturing sectors such as food or products made from wood. This specialisation area also includes some knowledge-intensive activities such as chemical wood processing or renewable energy from bio-resources. For these sectors, RIS3 emphasises an extension of the product space and a gradual upgrade towards higher value-added products.

Comparative advantages in the bioeconomy are based on abundant resources rather than innovation

In 2017, agriculture, forestry and fishing, with manufacturing activities related to food and wood products, accounted for close to 9% of Latvian total value added. Traditional bioeconomy sectors thus form an important part of the economy. The significance of the bioeconomy is particularly pronounced in the manufacturing sector, where products made of wood and cork (excluding furniture but including straw and plaiting materials) as well as food and beverages account for 43% of total value added (Figure 6.12). Over time, the contribution of wood and related manufacturing activities increased slightly, from 21.6% in 2010 to 22.1% in 2017, but declined significantly for the food sector, from 20.9% to 16.4%.

Figure 6.12. Contribution of the bioeconomy to manufacturing value added, 2010 and 2017

As a percentage of total manufacturing value added



Note: n.e.c. = not elsewhere classified.

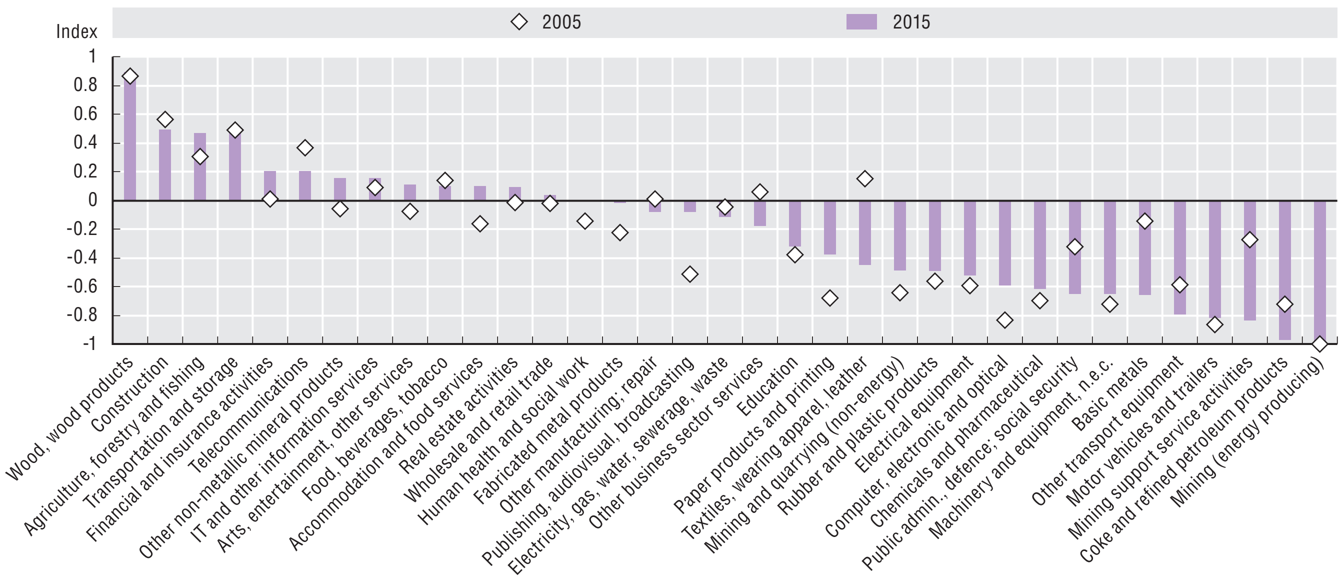
Source: CSBL (2020a), *IKG10_060 Total Gross Value Added by Kind of Activity (NACE Rev. 2)* (database), *https://data1.csb.gov.lv/pxweb/en/ekfin/ekfin__ikp__IKP__ikgad*.

Latvia has substantial revealed comparative advantages (RCAs) in traditional bioeconomy sectors.[3] In 2015, the share of wood and wood products in Latvia's total exports was 14 times higher than the corresponding share in world exports. This accounts for both direct exports of wood and wood products, as well as indirect exports of wood products embedded as intermediates in other products (Figure 6.13). Furthermore, compared to 2005, the RCA has become larger over time, implying increasing specialisation. RCAs for agriculture, forestry and fishing are also significant, with the sector's share in total exports in 2015 being over 2.8 times higher than in other countries.

However, while Latvia is still exporting more food products than other countries, and labour productivity has kept increasing, food exports have suffered substantially from a Russian embargo that began in 2014 (MoE, 2018b).

Latvia's traditional bioeconomy exports concentrate on low-value added products. In the food sector, high-value added exports are stifled by a lack of processing capacity and value chain inefficiencies (OECD, 2019g). For example, the Latvian food processing industry today includes fewer large businesses and more numerous small ones than a decade ago, and a large share of the increasingly organic production is being sold to conventional processors (e.g. more than half for organic milk and eggs and one-third for meat and cereals). For the forestry value chain, a significant share of exports is still determined by products such as sawn wood, fuel wood, wood in the rough or wood charcoal, while products higher up the value chain, including furniture or paper, remain more limited. However, over time there has been a significant increase in the export of products higher up the value chain, such as wood panels or wooden houses, implying that the value of exports has increased compared to total wood production (Figure 6.14).[4]

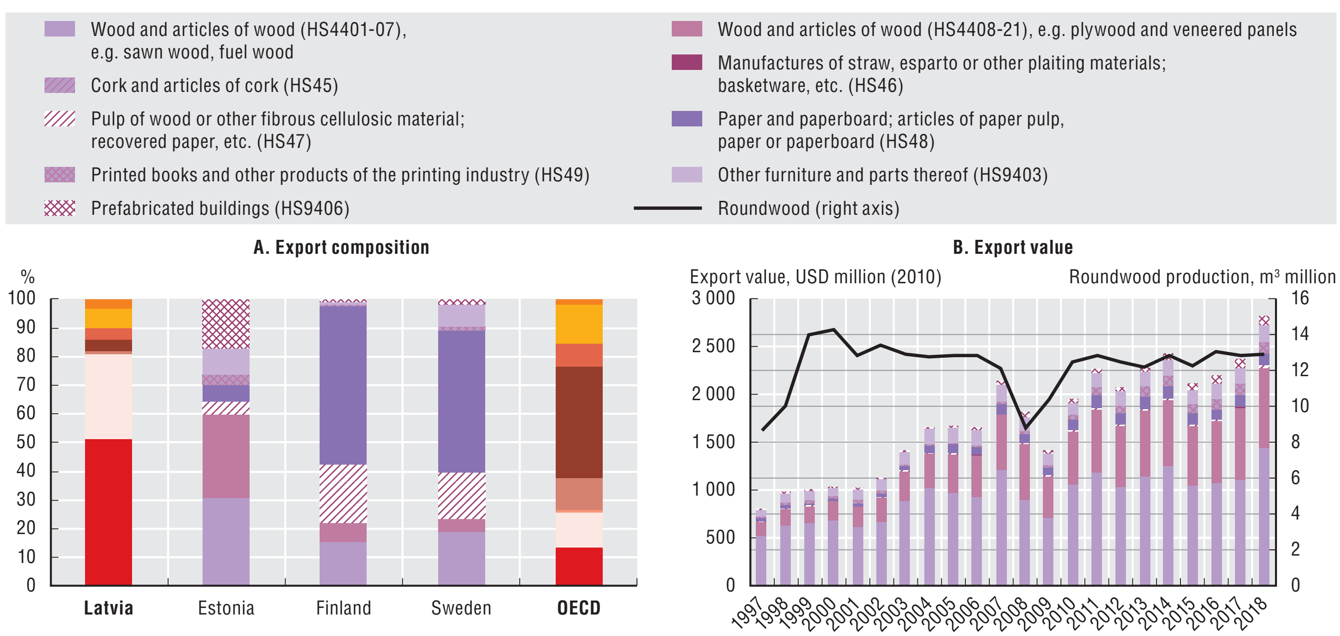
Figure 6.13. Latvia's revealed comparative advantage, 2005 and 2015



Notes: n.e.c. = not elsewhere classified. Revealed comparative advantage (RCA) of exports in value-added terms. The calculation in value-added terms takes into account GVC linkages. In particular, exports of a given sector are considered irrespective of whether they are directly exported or embodied in the exports of downstream sectors. See Miroudot and Cadestin (2017) for details. The RCA in the figure is normalised to [-1;1]. To obtain the original RCA values referred to in the text, the formula (x+1)/(1-x) needs to be applied.

Source: OECD (2020d), "Trade in value added", *https://dx.doi.org/10.1787/data-00648-en* (accessed on 27 February 2020).

Figure 6.14. Value added of forestry products in Latvia and selected OECD countries



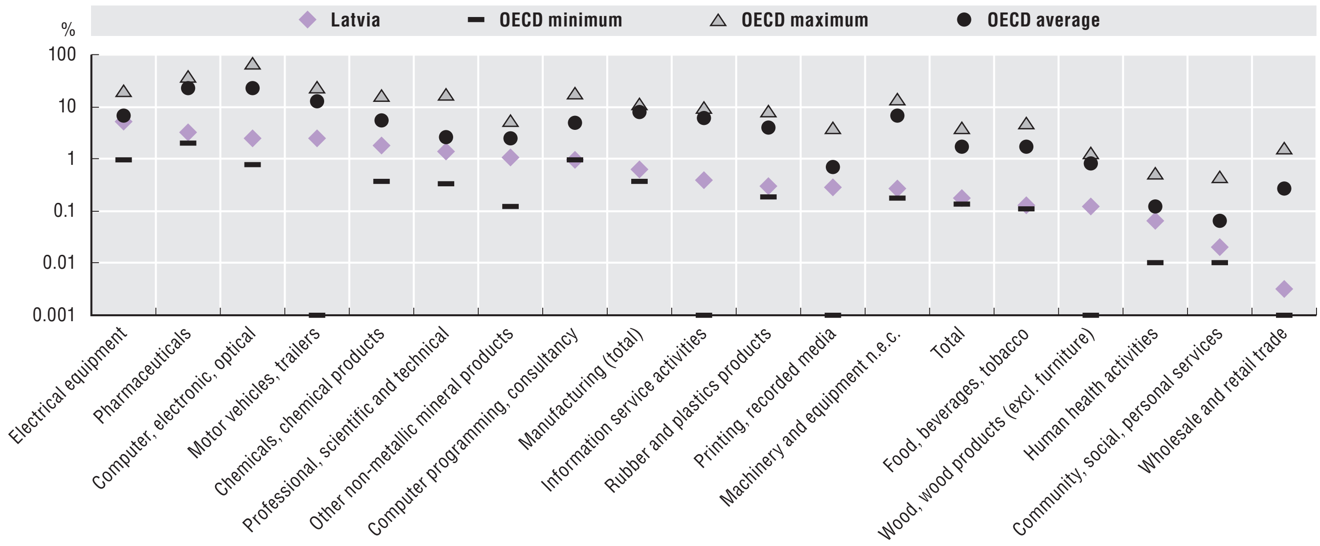
Note: The export values (current USD) in panel B have been deflated with US CPI index (2010).

Sources: WITS/UN Comtrade (2020), *UNSD Commodity Trade* (database), *http://wits.worldbank.org* (accessed on 4 February 2020); FAO (2020), *Forestry Production and Trade* (database), *www.fao.org/faostat/en/#data/FO/visualize* (accessed on 20 May 2020).

Latvia's bioeconomy significantly trails OECD countries with regard to R&D. In 2015, R&D expenditures of Latvian firms as a share of value added were equal to 0.13% in food manufacturing and 0.12% in the wood products industry, compared to an OECD average of 1.76% and 0.81%, respectively (Figure 6.15). This seems to confirm the assumption that output and export growth in these sectors is based on an abundance of natural resources rather than innovation and productivity.

Figure 6.15. R&D expenditure by industry in Latvia relative to the OECD, 2015

As a percentage of each industry's value added



Note: Logarithmic scale. Averages are weighted using value added in purchasing power parities (GDP). Data for Chile, Estonia, Hungary, Japan, Lithuania, Portugal and the United States are from 2014. Data for France are from 2016.

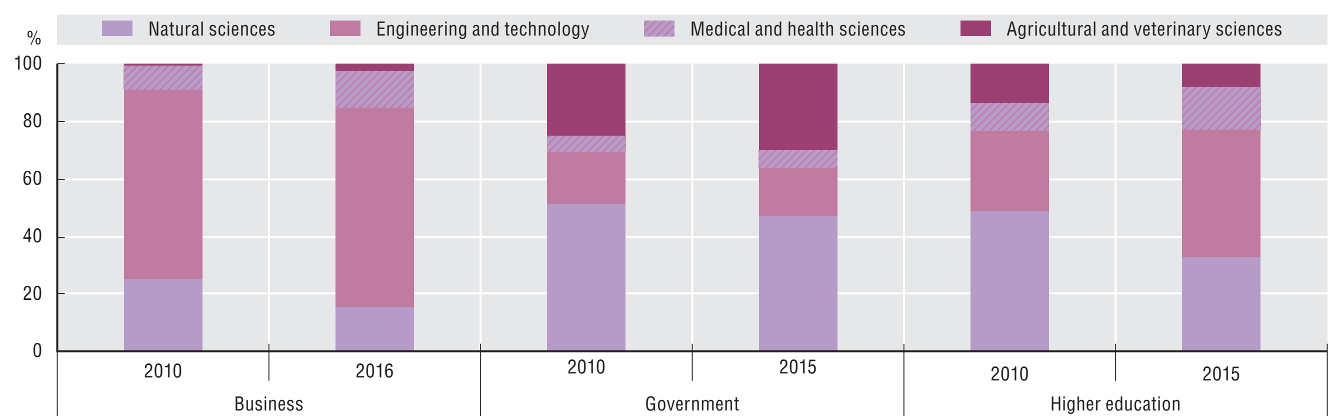
Sources: OECD (2020e), "Research and development statistics: Business enterprise R-D expenditure by industry – ISIC Rev. 4", *https://dx.doi.org/10.1787/data-00668-en* (accessed on 13 March 2020); OECD (2020f), "STAN Industry ISIC Rev. 4", *https://dx.doi.org/10.1787/data-00649-en* (accessed on 24 February 2020).

The government has strengthened research in the bioeconomy but technology transfer to smaller firms remains weak

Over the past decade, the government has made substantial efforts to enhance innovation in traditional bioeconomy sectors. Between 2010 and 2015, government R&D expenditures on agricultural and veterinary sciences increased by close to EUR 5 million, (i.e. from 25% to 30% of government R&D expenditure in the natural sciences and engineering) (Figure 6.16). However, government spending increases (e.g. on public research facilities) were not accompanied by additional funding for HEIs. Potentially, this could negatively impact on availability of scientific talent in the future.[5]

Figure 6.16. Latvia's R&D expenditure in natural sciences and engineering, by performing sector

As a percentage of total R&D expenditure in natural sciences and engineering performed by each sector



Source: OECD (2020g), "Research and development statistics: Gross domestic expenditure on R-D by sector of performance and source of funds", *https://dx.doi.org/10.1787/data-00189-en* (accessed on 26 February 2020).

The government has also taken steps to enhance co-ordination among research institutions. In 2014, 14 scientific institutions in agriculture, food, forestry and related sectors, including woodworking and wood chemistry, formed the Strategic Association for Bioeconomy Research. Following a consolidation process in 2015, the association now consists of eight institutions. These include: the Latvian University of

Life Sciences and Technologies (LLU); three independent institutions under the university's supervision, namely the Institute of Horticulture, the Institute of Agricultural Resources and Economics, and the Latvian Plant Protection Research Centre; the Institute of Food Safety, Animal Health and Environment (BIOR); the Latvian State Forest Research Institute (Silava); the Institute of Wood Chemistry; and the Forest and Wood Products Research and Development Institute (MeKA).

Over time, the association has seen a substantial increase in the number of research personnel, from 242 in 2013 to 359 in 2016 (MoA, 2018). The share of cited publications in the field of agricultural and food science in all Latvian publications increased significantly from 11% in 2007-12 to 16% in 2013-16 (OECD, 2019g). However, revenues from the transfer of intellectual property rights or other research services provided to third parties, decreased in 2016-15 from EUR 4.7 million to EUR 4.2 million, below their level in 2013. This suggests that there is room for Latvia to enhance knowledge transfer from publicly funded research into commercial applications. The critical role of more knowledge transfer mechanisms has been explicitly acknowledged in Latvia's Bioeconomy Strategy 2030, which the government published in 2018. In particular, the strategy highlights slow and fragmented knowledge transfer as a main obstacle to value-added upscaling in production (MoA, 2018).

An important step towards better collaboration between scientific institutions and firms has been the creation of competence centres in different research areas. By the end of 2018, 149 firms had benefited from one of the eight competence centres, of which 31 were supported by the Latvian Food Competence Centre and 13 by the Forest Sector Competence Centre. Private investment complementing state aid for R&D projects totalled EUR 1.9 million for the food sector and EUR 2.3 million for the forest sector. However, industry stakeholders have noted that the limited capacity of competence centres represents a bottleneck for potential new projects. More importantly, the high research intensity of the projects makes the programme unsuitable for SMEs.

The government should strengthen mechanisms for the commercialisation of applied research results that are better suited for SMEs, such as the Technology Transfer Programme. Instruments to promote research commercialisation received only 3.2% of total spending in the Smart Specialisation area (Table 6.2). Additionally, the Technology Transfer Programme has only a single contact point for the bioeconomy, at the Latvian University of Life Sciences and Technology (LLU). The Technology Transfers Offices Flanders, a joint initiative by five Flemish universities, provides a good example of how different universities and research institutes can co-operate to provide online access to all the available knowledge and technology within different institutions (Box 6.6).

Box 6.6. Technology Transfer Offices (TTO) Flanders

TTO Flanders is a joint initiative of five Flemish universities: Ghent University, the University of Antwerp, KU Leuven, Vrije Universiteit Brussel and Hasselt University. The technology transfer offices (TTOs) of these universities are responsible for the transfer of knowledge and technology from universities and associated university colleges to private and public partners. This includes establishing contact with industry, offering legal support related to contracts, promoting education activities for engagement, offering protection of intellectual property and supporting start-ups and spin-offs.

The joint initiative provides a unique point of contact (*www.ttoflanders.be*) for industries looking for research expertise and licensing opportunities, aimed at better valorisation of available knowledge and technology. It fosters collaboration between the five different TTOs and strengthens their performance by developing common means and sharing best practices. The universities and university colleges involved hope that the initiative will help the Flemish TTOs become a more effective player on the European and international innovation scene.

TTO Flanders offers technologies in areas such as food and agriculture, health, materials and chemistry, ICT and electronics, and cleantech and energy, and provides links to the relevant centres of expertise. The website is available in English and directs customer questions to the right person or research centre. The estimated budget expenditure per year ranges from EUR 1 million to 5 million.

Sources: OECD (2019k), Benchmarking Higher Education System Performance, Higher Education, *https://dx.doi.org/10.1787/be5514d7-en*; European Commission/OECD (2020), STIP Compass: International Database on Science, Technology and Innovation Policy (STIP), *https://stip.oecd.org*.

Latvia should target high-value added forestry products and exploit synergies with material sciences

The wood processing sector has outperformed the food sector along several dimensions in recent years, including value-added contributions, revealed comparative advantage and R&D spending by the private sector (see above). Taken together with the absolute advantage of vast amounts of forest areas, this suggests high potential for a competitive ecosystem within the wood processing sector in Latvia.

In order to remain competitive on international markets, Latvia's forestry sector needs to move up the global value chain. With the global use of paper falling, competition from topical and sub-tropical regions rising, and increasing automation along the value chain, traditional wood product manufacturers in Latvia, Finland or Sweden will find it increasingly difficult to compete without innovation (OECD, 2017b).

For Latvia, signs of positive dynamics are emerging in areas where material science and new technologies are being used to transform raw material into exportable products. For example, in a recent research collaboration, commissioned by the Forest Sector Competence Centre, the Latvian State Institute of Wood Chemistry (IWC) and joint-stock company Latvjas Finieris, a producer of birch plywood, have developed a new method to obtain Betulin – a substance responsible for the white colour of birch bark – on an industrial scale. The unrefined Betulin is aimed at the cosmetics market and by-products of the process can be used to replace formaldehyde as a glue for wood composites or as mineral fertilisers.

The case of Betulin, which is known for its positive health effects, is an example of potential synergies not only with the Smart Materials specialisation area, but also with the Biomedicine ecosystem. For example, Riga Technical University (RTU) and Rīga Stradiņš University (RSU) have been co-operating since 2016 to obtain a bioactive chemical compound with anticarcinogenic properties from Betulin. RTU and LLU are researching additional applications of the refined form of Betulin, including its use in medical cosmetics to support skin regeneration or as an additive in food to prolong the storage life of milk or meat products (Vaivare, 2018a).While it is currently unknown how marketable these products will be, Latvia is likely to benefit from the knowledge created across these different projects.

Latvia's Bioeconomy Strategy should have a stronger digital focus

Latvia's Bioeconomy Strategy 2030 does not have a digital focus in spite of the fact that the whole ecosystem, from the extraction of raw material to food and wood manufacturing, is ripe for digitalisation. While there is no plan at present to update the strategy, consideration of how best to govern the digital transformation in agriculture, forestry and food will become increasingly important. As a first step, Latvia should measure the digital transformation in the bioeconomy, starting with an analysis of access and use for basic digital technologies, as well as more advanced tools specific to agriculture, forestry or food production. Recent experience in the food manufacturing sector suggests that digital readiness remains low, with firms in the sector experiencing significant difficulties navigating even basic digital management tools (PPKK, 2019).

Several recent initiatives are trying to fill these gaps. For example, the Latvian IT Cluster and the Food Product Quality Cluster form part of DIGICLUSTERS, a European Cluster Collaboration Platform sponsored by the European Union, which focuses on enhancing the competitiveness of SMEs in the agro-food packaging sector. Latvia also participates in SmartAgriHubs, a EUR 20 million EU Horizon 2020 instrument fostering the development and adoption of digital solutions in farms across Europe. The project, which runs from 2018 to 2022, envisages the establishment of an innovation portal and catalogue for farmers and agribusiness to map existing digital technologies and facilitate the exchange of best practices among network participants (e.g. start-ups, SMEs, business and services providers, technology experts, etc.).

LIKTA runs a project entitled Training of Small and Micro Entrepreneurs for Development of Innovations and Digital Technologies in Latvia (Project 1.2.2.3/16/I/002) under the responsibility of the Ministry of Economics. The initiative, co-funded by the European Union (EUR 2 001 937) and the private sector (EUR 762 600), provides training in three areas: digital technology (e.g. cloud services or security), digitalisation of internal company processes (e.g. financial management and marketing), and digital tools for production and service development (e.g. CRM). The project aims to reach 6 200 managers and employees by December 2020.

There are, however, no specialised training courses offered on digital tools for the bioeconomy. In the agricultural sector, the Latvian Rural Advisory and Training Centre (LLKC) offers several courses for rural entrepreneurs via its distant learning platform (LLKC Talmaciba). However, none of the courses currently has a digital focus. The government should use LLKC to provide more specialised training on the use of digital technologies in agriculture, such as precision agriculture or drones. For example, the National Service for Rural Apprenticeship (SENAR) in Brazil has offered free courses on drone use in agriculture since 2016, including on regulation (SENAR, 2016).

The government should foster open data policies to enhance digital transformation in the agro-food sector

The government could also further leverage existing information systems to disseminate advanced applications and data tools among farmers and other rural entrepreneurs, as well as in fisheries. Two systems that seem particularly promising in this regard are the Electronic Application System (EAS) of the Rural Support Service and the Latvian Fisheries Integrated Control and Information System (LFICIS).

The EAS was developed in 2007 to simplify the application process for EU and state support. Over time, additional features were added and use of the system became obligatory in 2016. EAS now also links to services from other agencies with access to geospatial data provided through the Web Map Service (WMS) and the Web Feature Service (WFS). In 2015, the programme received the UN Public Service Award for the category "Promoting Whole of Government Approaches in the Information Age" and was also the winner of the 2017 World Summit on the Information Society (WSIS) Prize in the field of e-agriculture. The LFICIS is operated by the MoA and links several databases and data tools. Since June 2018, the system also contains a product traceability module, which tracks fisheries products from landing to retail and export. It currently provides information to several government agencies, including for fisheries and food safety control and customs, as well as private sector market participants, including fishermen, wholesalers and consumers.

Enabling the private sector to openly access selected data available in the EAS and the LFICIS, and to develop and append additional value-added services, could also help Latvia attract innovative service providers. For example, in 2014 the French co-operative InVivo acquired a majority stake in SMAG, an agricultural software provider, to develop farm management applications based on shared data from its members.

Fostering online platforms in the bioeconomy can also bring benefits in other areas, such as in the case of open software platform FIspace. Created by a consortia of universities and firms with the support of EU funding, FIspace fosters the sharing of farming and food supply chain data in order to enhance business-to-business collaboration (Paunov and Planes-Satorra, 2019). In Brazil, the online platform Uller offers a peer-sharing solution for agricultural machinery and constitutes an interesting example of how digital technologies can help overcome the financial restrictions facing agricultural producers. Applications for the delivery of better policies are also viable (Box 6.7).

The Latvian government should also speed up the digitisation of spatial data, including the plant, agrochemical and soil data of the State Plant Protection Service. In the context of Latvia's Data Driven Nation (DDN) Memorandum of Understanding, the Information Society Development Council has agreed to make available a limited number of geospatial datasets for fee-free usage. However, the business model for data sharing should be reconsidered (Ozols, 2018). An important barrier to the wider release of public data is that a significant budget share of some public institutions (e.g. the State Land Service) is derived from the provision of data. The Australian Productivity Commission in 2017 issued a detailed report examining the benefits and costs of different options for sharing data between public entities, individuals and the private sector, which could serve as guidance, including on regulatory approaches and principles to address the concerns of data owners and enhance trust in data sharing initiatives (Productivity Commission, 2017). With regard to funding support for public sector data releases, the report considers several options, including a re-prioritisation of existing agency budgets, additional earmarked funding through the government or a reward system where agencies are rewarded for data releases that result in research outputs of public interest. The report further recommends that agencies provide annual reports on the proportion of datasets made publicly available, shared and not available for release. It suggests that a central office (National Data Custodian) could take overall responsibility for the implementation of data management policy and accredit other entities to enhance linkages between different datasets. The OECD (forthcoming) provides additional examples and best practices with a particular focus on the regulatory aspects of data governance in agriculture, which could be informative for the discussion in Latvia.

Box 6.7. Leapfrogging potential: Big data for better policies in agriculture and forestry

Recent digital innovations provide opportunities to deliver better policies for the agriculture sector by helping to overcome information gaps and asymmetries, lower policy-related transaction costs, and enable people with different preferences and incentives to work better together (OECD, 2019r).

In Latvia, the research project "Evaluation of land use optimisation opportunities in Latvia in the context of climate policy" has raised the prospect of better-targeted policies. Researchers from the Latvian University of Life Sciences and Technologies (LLU) aggregated spatial data from various sources to assemble fine-grained maps (parcel level) of both agricultural and forestry land use in Latvia. The data contain a range of information including soil type, farm size or melioration status in the case of agriculture, and species, age group or site quality in the case of forestry. The specific characteristics of each parcel can be linked to data on economic (e.g. profit), social (e.g. labour input), climate (e.g. greenhouse gas emissions) or biodiversity (e.g. bird habitat quality) measures to better understand and potentially forecast performance relationships. The study has aimed to optimise the use of agricultural and forest land capacity assessments, and could help policy makers devise more coherent land-use related policies, including financial incentives that simultaneously address different policy objectives (e.g. environmental and social).

Latvia's State Forests (LVM), the publicly owned company that administers Latvia's state-owned forests, has provided financial support for the research and is already using the tool to maximise profits while keeping the forest inhabitable. However, additional uses seem viable, for example to enhance the targeting of other policy measures (e.g. to achieve reduction in greenhouse gases). LVM, through its informatics division, has proven quite successful in the development of innovative software solutions. For example, LVM GEO provides flexible access to geospatial information via desktop, browser or mobile apps (online and offline). The database integrates land and forestry data with other data sources, including the drainage cadastre, state road services or the nature conservation agency. The platform, which was initially developed for in-house usage, is now open to other companies and organisations, and due to its modular structure allows for several stand-alone solutions and integration with other proprietary systems.

Access to spatial data is also important for the wider adoption and usage of remote monitoring systems, including Latvia's planned pilot project on technologically enhanced fire monitoring towers or drones. In the case of drones, many agricultural and forestry applications are inhibited by current regulation which prohibits the use of drones beyond the line of sight (500 m) (Regulation No. 737). New European regulation, which entered into force in July 2019, could soon allow for more flexible uses, but will be fully applicable only after a two-year transition period. In particular, the new regulation describes a category for "specific" usage, eliminating restrictions concerning the visual line of sight, mass or altitude of operation. Most usage scenarios in agriculture would likely fall into the specific category. The Latvian government should foster fast adaptation of the new regulation. A positive signal in this regard was a drone flight conducted by Latvia's president and the president of Latvijas Mobilais Telefons (LMT) beyond the visual line of sight via the mobile network as a demonstration of the potential of the 5G ecosystem.

Biomedical research and health innovation

Biomedicine, as a Smart Specialisation area, covers medical technologies and links to sectors such as chemical and pharmaceutical industries, manufacturers of electrical and optical products as well as medical and dental instruments, and human health activities.

Box 6.8. Policy recommendations: Bioeconomy

- Strengthen the capacity of the Forest Sector Competence Centre and enhance knowledge transfer towards smaller firms by upscaling the Technology Transfer Programme and creating a single digital point of entry.
- Encourage public support for research on products high up the forestry value chain, and exploit synergies with smart materials or other Smart Specialisation areas.
- Measure digital uptake in the agro-food sector and leverage existing digital platforms, such as the Electronic Application System (EAS), by disseminating advanced applications and data tools among rural entrepreneurs and farmers. Invite private sector service providers to deliver relevant value-added services through public platforms.
- Leverage the Latvian Rural Advisory and Training Centre (LLKC) to provide specialised training on digital agriculture.
- Foster open data policies and provide easily accessible information via the relevant normative environment (e.g. via a website).

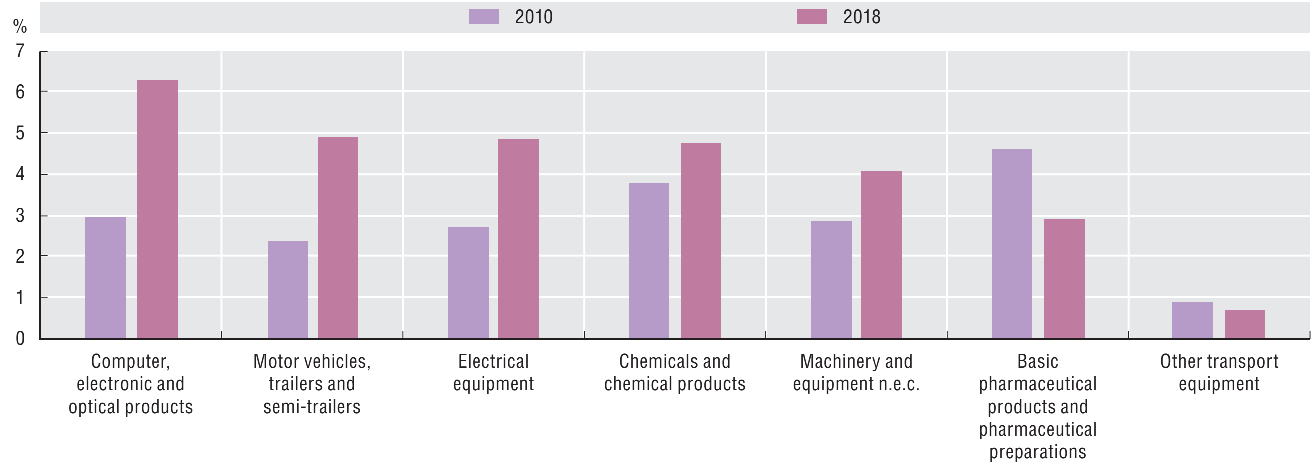
Latvia appears to be losing ground in pharmaceuticals and medical technologies

Between 1945 and 1991, Latvia emerged as one of the major producers of new drug designs and medical products in the former Soviet Union (LIDA, 2019h). Important drivers of this success were public research institutes, such as the Institute of Organic Synthesis, established in 1957, and large pharmaceutical producers such as Grindeks (1946) or Olainfarm (1972).

In 2017, the pharmaceutical sector still accounted for 3.3% of total manufacturing value added, slightly up from 3.0% in 2010 (Figure 6.12). However, over the same period the share of pharmaceuticals in total manufacturing exports diminished from 4.6% to 2.9% (Figure 6.17). Furthermore, a broader sector aggregate, encompassing also chemical industries, revealed no comparative advantage in 2015 (Figure 6.13).

Figure 6.17. Latvia's exports of high-tech and medium-high tech products, 2010 and 2018

As a percentage of total manufacturing exports



Note: The figure shows the share of high-tech and medium-high tech products in total manufacturing exports. High-tech products encompass computer, electronic and optical products as well as basic chemical products and chemical preparations. Classification based on Galindo-Rueda and Verger (2016).

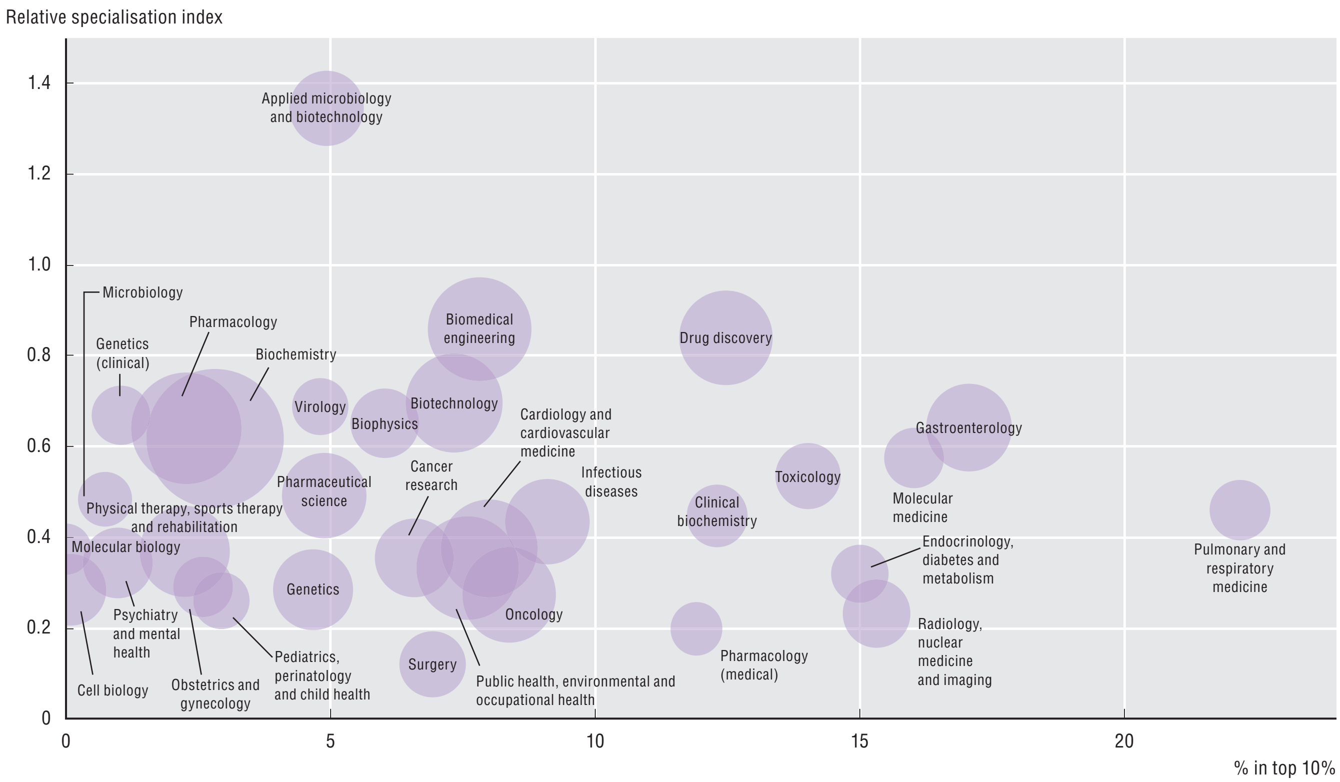
Source: CSBL (2020b), *Exports and Imports by Commodity Section and by Economic Activity (NACE Rev.2) of the Importer (thsd euro) – ATG015* (database), *www.csb.gov.lv/en/statistics/statistics-by-theme/foreign-trade/ft-nace-bec/tables/atg015/exports-and-imports-commodity-section-and*.

Several indicators point to weakening innovation in the sector. In 2015, Latvia's R&D in the pharmaceutical industry accounted for only 3.3% of value added, compared to an OECD average of 23.4% (Figure 6.15). The number of patents in pharmaceuticals and medical technologies fell from about 32% of all Latvian patents in the period 2007-11 to 19% in 2012-16.[6]

In 2014-18, the share of Latvian scientific publications in pharmaceuticals and pharmacology among the global top-10% most cited publications was 8.5%, compared to a (definitional) world average of 10%. Research excellence (i.e. more than 10% among the top-cited publications) was reached for particular subfields like toxicology (14% among the top 10% cited) and drug discovery (12.5%) (Figure 6.18).

Figure 6.18. Latvia's publications in the top 10% most cited documents

Average, 2014-18



Notes: The percentage of publications in the top 10% most cited documents is an indicator of excellence. It indicates the amount (in percentages) of a unit's scientific output included in the group of the 10% most cited papers in their respective scientific fields. The world average is 10% for the period. The Relative Specialisation Index measures relative specialisation. This index is calculated by dividing all papers in a field from country a by total production in all fields for country a. This proportion is then divided by the corresponding proportion for the world. The world average is 1. A threshold has been set and the index has only been calculated for countries with 50 or more documents.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

Taking into account other fields related to the Smart Specialisation area, such as medicine, immunology, biochemistry or genetics, further suggests research excellence in areas such as pulmonary and respiratory medicine (22.2% among the top 10%), gastroenterology (17.1%) or molecular medicine (16%). However, Latvia specialised in none of these fields, implying that the contribution of the sub-field to all Latvian publications remained below the share of this field in all (world) publications.

Applied microbiology and biotechnology are the only fields related to the Smart Specialisation area for which Latvia exhibits specialisation. However, the share of excellent publications remained low (4.9% in top 10%). Additionally, while Latvian patent applications in biotechnology have been increasing from 0.2 in 2007-11 to 2.1 in 2012-16, the number is too small to determine a trend.

The government should promote innovation diffusion in the public health system while strengthening research skills

The share of medical and health sciences in total R&D expenditures in the field of natural sciences and engineering rose from 8.4% to 12.1% between 2010 and 2016, increasing from EUR 8.1 million to EUR 11.7 million, respectively. By far the largest increase can be attributed to HEIs, which increased spending from EUR 3.6 million to EUR 6.8 million. Relative to other fields in the natural sciences and engineering, spending on medical and health sciences also grew in importance for the business sector and the government (Figure 6.16). However, expenditures for both actors remained rather stable in absolute terms (EUR 3.2 million and likely below EUR 2 million, respectively).[7]

In 2014-18, biopharma and biotechnologies and translation medicine accounted for 40% and 25%, respectively, of the EUR 46 million in funds allocated under the Smart Specialisation framework. A large share of the funds for biopharma and biotechnologies was channelled through the Pharmacy, Biomedicine and Medical Technology Competence Centre (PBMTCC), where the sub-field accounted for around 95% of total spending, or around EUR 7.5 million. Translational medicine, which aims to better link laboratories, hospitals and patients, received over 62% of the H2020 funding distributed to the Smart Specialisation area.

Two of the largest H2020 grants received by Latvia not only illustrate the country's recent contributions in this area, but also highlight the relationship with digital technologies, the critical role of international co-operation and potential routes towards research commercialisation. The University of Latvia received close to EUR 1.6 million in EU contributions spread across three joint projects led by the Israel Institute of Technology (European Commission, 2017). The first of these projects, "Smart Phone for Disease Detection from Exhaled Breath" (SNIFFPHONE), ran from 2015 to February 2019. It integrated heterogeneous micro and nanotechnologies into a smart device that attaches to a mobile phone and analyses disease markers from exhaled breath. The data are then transmitted to a cloud platform for evaluation and a clinical report is sent to the designated receiver (e.g. a specialist) in the event of a positive test result. SNIFFPHONE received the 2018 Innovation Award from the European Commission. The second project, A-Patch, or the "Autonomous Patch for Real-Time Detection of Infectious Disease", applies the science of volatile organic compounds to the analysis of skin data. The technology builds upon a wearable, equipped with an intelligent hybrid sensor array. VOGAS, the third project, runs until December 2021 and aims to develop a new breath analysing device to be used as a non-invasive gastric cancer screening tool.

Repeated involvement in high-profile international research projects suggests that Latvia has established itself as a trusted partner with regard to the testing of medical innovations. The Latvian government should build upon this success by formally integrating industry partnerships and device testing into the public health care system. For example, the National Health Service (NHS) in the United Kingdom introduced a Test Beds Programme in 2016 to allow for the testing of new digital devices and new forms of health service delivery in specific hospitals and for particular groups of patients. Successful innovations can then be scaled up to the entire health system. Several learning handbooks, for example on how to set up data sharing and information governance arrangements, are available and could help Latvia design a similar system (Paunov and Planes-Satorra, 2019).

Latvia should further foster the judicious use of real-world healthcare data to inform biomedical research and evaluation. A "learning healthcare system" based on electronic health records and other routinely collected data holds large promises for making medical research, including with regard to pharmaceuticals, more effective and efficient (e.g. Eichler et al., 2019; OECD, 2019p). However, Latvia stands out from other OECD countries in terms of the absence of national standards for clinical terminology within electronic clinical records and the lack of a national plan or policy to extract data from electronic clinical records systems (e.g. to facilitate clinical trials or monitor patient safety). There is currently also no process to evaluate the usability of electronic health records for dataset creation and healthcare data are mostly not used for research (Oderkirk, 2017).

The testing of medical innovations aside, significant dynamics are also apparent in the area of genomics-based precision medicine and biotechnology. Continuous improvements in digital technologies, including data storage capacities and algorithmic capabilities, have significantly enhanced the feasibility of genetic sequencing. This progress has re-awakened interest in the analysis of genome data and shifted the focus in medical research towards big data and artificial intelligence (OECD, 2020c).

In Latvia, a first physical biobank, the Genome Database of the Latvian Population (LGDB), was established in 2006, legally supported by the Human Genome Research Act of 2004 (Rovite et al., 2018). Since then, several large multinationals, including the Chinese genome sequencing company BGI, Microsoft and Roche, have begun investing in Latvian genomics. For example, in September 2017 Microsoft established LUMIC at the University of Latvia (UL), the first Microsoft Innovation Centre (MIC) of its kind in the Baltics and Eastern Europe. LUMIC focuses on the education of young IT professionals and cloud-based solutions for interdisciplinary IT projects involving students, scientists, industry and government. Genomics-based cancer research is one of the first big data applications to use the new infrastructure. The project is supported through the LIDA initiative Support for Commercialization of Research Results (Vaivare, 2018b).

The push towards digitally enabled genomics in Latvia is partly the result of strong political commitment. In 2017, Latvia signed a Memorandum of Understanding with the Chinese genome sequencing company BGI to promote the creation of the Latvia-Biolake-BGI Life Science and Technology Centre. In November 2019, MGI, a subsidiary of the BGI Group, which produces DNA sequencing instruments, opened the China-Europe Life Health Innovation Centre and a R&D and manufacturing facility in Riga. The same day, BGI Research and MGI announced in Latvia the 10 Million Single-Cell Transcription Project (scT10M), a collaboration with scientists around the world, aiming at sequencing and analysing 10 million cells in an effort to build a comprehensive single-cell transcriptome map to be shared with the scientific community (MGI, 2019).

In May 2019, the Minister of Economics and the Minister of Health jointly launched a conference on precision medicine, with a clear focus on big data analytics and ICTs in health. The conference also addressed the national system of precision medicine in countries such as Sweden, a possible framework for precision medicine research in Latvia and the ethical challenges of using big data in medicine. The MoE is currently developing a common strategy for the biomedicine ecosystem covering the 2021-2027 planning period together with relevant stakeholders from the public sector, industry and academia.

To leverage these dynamics, Latvia should strengthen research in genetics (including clinical) and health informatics. The current number of publications (2014-18) does not suggest research specialisation in these fields and only a small number of publications featured among the 10% most cited publications. Building excellence in these fields requires forming and attracting skills, and the LUMIC innovation centre can be a critical enabler in this regard. LU also offers a doctoral school in translational medicine, partly in co-operation with Rīga Stradinš University (RSU). However, the faculty of computing currently does not form part of the programme and no specialisation is available in health informatics at LU. In addition, while the RSU has established a bioinformatics research group, the master's programme currently offered in biomedicine is only available in Latvian, severely restricting the attraction of foreign talent. To foster the biomedicine ecosystem and leverage investment by large multinationals, Latvia should further enhance the offer of academic courses at the overlap between medical and computer sciences.

Latvia should broaden the scope of innovation policies for the biomedical ecosystem

Latvia should concentrate more resources in the area of digital health to support the commercialisation of private sector health innovations. Between 2014 and 2018, only 2.5% of all Smart Specialisation spending on biomedicine was devoted to the commercialisation of research results (MoES, 2020). Additionally, funding channelled through competence centres is focused predominantly on pharmaceuticals, cosmetics or nutrition. While private sector e-health solutions, and in particular software, are promoted through the Riga IT Demo Centre (established by the Latvian IT Cluster in 2012), the main focus of the centre seems to be the domestic market. That Latvian health care solutions can also have international appeal is illustrated by the start-up Anatomy Next. The firm developed a Software-as-a-Service (SaaS) solution relying on augmented reality and interactive 3D anatomical models to enhance the spatial awareness of medical students with regard to the human anatomy. The solution won the 2017 Technological Innovation of the Year Award of the Swedish Trade and Investment Council and received EUR 50 000 funding through the H2020 framework's SME instrument.

To foster more innovative firms like Anatomy Next, the government could also provide more support to SMEs and start-ups that apply for H2020 funding. While some support seems to be available for the early stages of the process, many start-ups rely on expensive foreign consultancy firms to manage the application in later stages. To promote the identification of additional niches of excellence and respond swiftly to newly arising market opportunities (e.g. vaccines, diagnostics or medical technologies in the context of the COVID-19 crisis), support should not be limited to particular fields. However, firms in specific sectors such as health informatics could be targeted through cluster initiatives.

The government should further consider adjacent sectors as part of the biomedicine ecosystem. For example, significant export potential for health services was recognised during an initial evaluation of potential Smart Specialisation areas (MoES, 2013b). Thus, between 2005 and 2015, Latvia came close to developing an RCA in exports of human health activities (Figure 6.13); and while firms in the sector spent only 0.07% of total value added on R&D, the distance to the OECD average (0.13%) was lower than in many other sectors (Figure 6.15).

Providing a testbed for healthcare innovations, as suggested above, could be a promising way for Latvia not only to enhance the moderate quality of its public health care system (OECD, 2019a), but also to establish itself internationally as an innovative provider of health services. For example, Latvia could extend its participation in the ProVaHealth network. ProVaHealth is one of 39 approved Interreg Baltic Sea Region projects, and aims to establish the region as a single test site for the development of new health care products and services. Currently, Latvia's participation is limited to well-being, with the Latvian Resorts Association as the only participant. However, other companies, research institutes or universities could enter the project to benefit from the project's Living Labs, providing a real-life testing ground for innovative healthcare solutions.

Synergies could also be created with regard to the national e-health initiative, which since 2018 has made use of the national e-health portal mandatory for prescription and sick leave services. Despite this significant progress, the launch of the third phase of the strategy, an extension of the system, is advancing relatively slowly (MoH, 2019). To improve population health and reduce the significant disparities that still exist in terms of access and outcomes in the public health care system, the government should advance the e-health agenda, including with regard to health data (see above) and telemedicine. Areas such as prevention, primary care, home care or community-based services seem especially promising areas for applications that could reduce the current high reliance on hospital treatments (OECD, 2019l).

Box 6.9. Policy recommendations: Biomedicine

- Build upon research excellence in translational medicine by developing industry partnerships and test beds for new medical devices in the public health care system.
- Leverage private investments in digital research infrastructure by strengthening academic outputs in the area of health informatics and genomics.
- Enhance spending in the field of digital health and commercialisation of digital health products, including software. Support start-ups and SMEs in applications for H2020 funding to promote clusters of excellence.
- Leverage national e-health initiatives and existing collaborations with other countries (e.g. ProVaHealth) to test and promote innovative health care services and enhance the quality of the public health care system.

Improving targeting of innovation policies

Increasing the rate of discovery and development of new and improved materials is key to enhancing product development and facilitating mass customisation based on emerging technologies such as 3D printing. Acceleration of the discovery and development of materials has been enabled by advances along multiple fronts, including data analytics, the capabilities of scientific instrumentation, high-performance computing and predictive computational methods applied to material structure and properties (OECD, 2017b). Latvia's RIS3 considers Smart Materials a core area for research specialisation.

In addition to new materials, such as implant materials, composite materials, glass fibre and glass-based materials, or thin layers and coatings, the Smart Specialisation area also covers a wide range of manufacturing activities related to technology and engineering. These include, among others, equipment and control systems for manufacturing activities, medical engineering and biotechnology. These different activities are reflected in several manufacturing industries, such as fabricated metal products, non-metallic mineral products, machinery and chemical products.

Smart materials and engineering can rely on a robust research environment and successful industry performance

Many of the above sectors have grown in importance in recent years. The contribution to total manufacturing value added of fabricated metal products, such as those related to engineering and coatings, grew from 6% in 2010 to 9% in 2017. Over the same period, the contribution of other non-metallic mineral products, including glass. fibre-based materials, grew from 6% to 7.4%. Rubber and plastic products, which are not listed under the relevant sectors for smart materials in the Latvian strategy, but link to new packaging materials such as bioplastics and composite materials, also increased, from 2.2% to 2.5%. The contribution of machinery and equipment (not otherwise considered), related to technology and engineering, increased from 2.2% to 3.3%. However, the contribution of chemical products diminished significantly from 4.5% to 2.5% (Figure 6.12).

Export performance has also improved significantly in recent years. Manufacturing activities related to motor vehicles, electrical equipment or machinery has contributed considerably to the increasing share of medium-high and high technology goods in exports (Figure 6.17). Although Latvia had no RCA in these industries as of 2015, the country developed an RCA in non-metallic mineral products over the years 2010-15, and came close to an RCA for fabricated metal products (Figure 6.13).

Business R&D as a share of value added in non-metallic mineral products (1.1%) was below the OECD average (2.5%). However, the distance from the OECD average, both in absolute and relative terms, was significantly lower than in most other manufacturing sectors. Investments in research were also relatively high for electrical equipment (5.3% compared to 6.8%). Distances from the OECD average for R&D intensity were larger for other manufacturing industries, including chemicals (1.8% compared to an OECD average of 5.4%), rubber and plastics (0.3% compared to 4.1%), and machinery and equipment (0.3% compared to 6.8%) (Figure 6.15).

R&D activities in the area of smart materials and engineering were also reflected in several patent applications between 2012 and 2016 in the fields of (other) special machines, surface technology and coatings, electrical machinery, apparatus and energy, materials in metallurgy and chemical engineering. The number of patent applications (including fractional counts) in the above fields increased from 10.0 (9% of all Latvian applications) in 2007-11 to 26.1 (20%) in 2012-16.

Scientific publications confirm Latvia's strong specialisations in engineering and materials. While the number of Latvian publications in 2014-18 was highest in electrical and electronic engineering, the strongest specialisation relative to other countries was found in automotive engineering, industrial and manufacturing engineering, and biomaterials. Furthermore, Latvia contributed more than 10% (the global average) to the top 10% most cited publications in fields such as the mechanics of materials, metals and alloys or mechanical engineering (Figure 6.19).

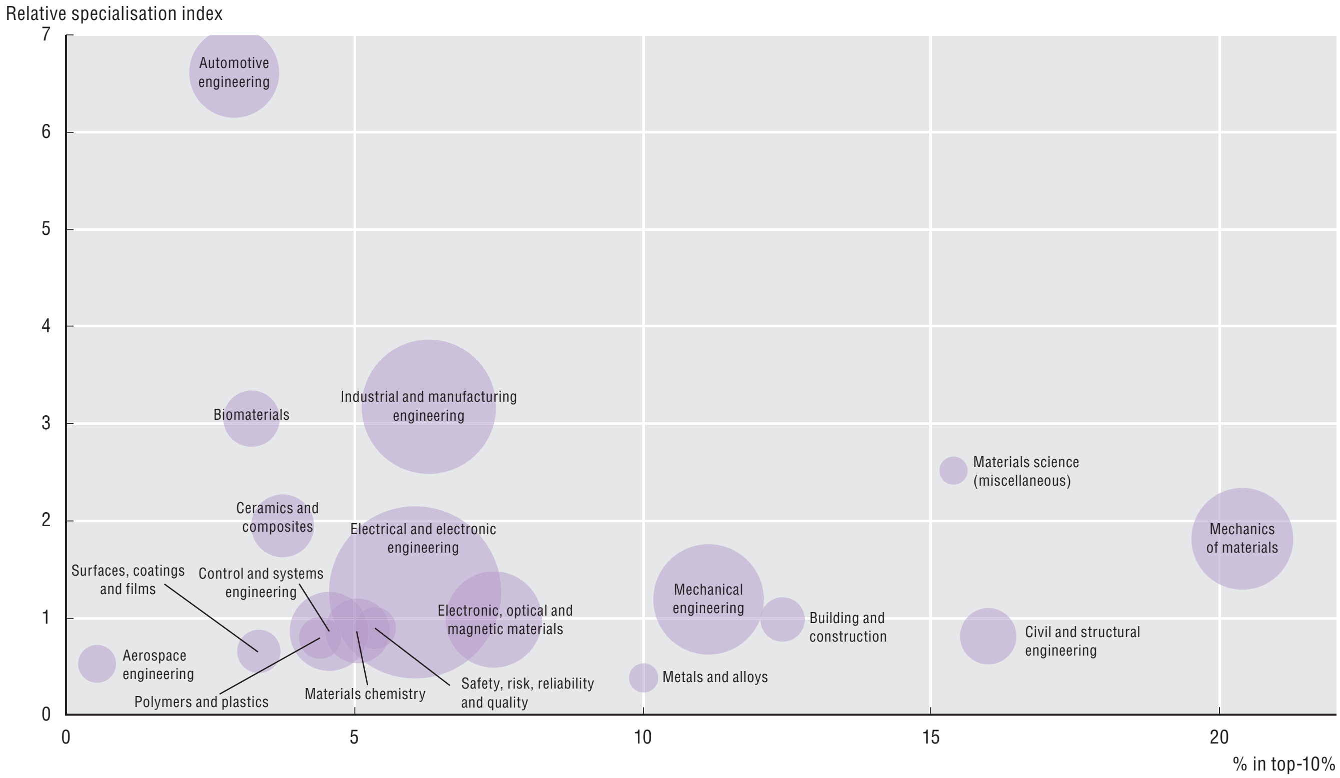
Government support for material sciences needs to be better targeted and should be complemented by general support mechanisms for innovative firms

Research in the smart materials specialisation area has been fuelled by significant public funding through the Smart Specialisation Strategy. The area received the largest share of funds among all Smart Specialisation areas with over EUR 52 million in funding (27.5%) (Table 6.2).

However, allocation of funding was spread too thinly across a large number of research topics. In the best cases (e.g. for fields such as thin layers and coatings or composite materials and polymers), several million euros were allocated to support different stages of maturity, from basic technology research (TRL 1) up to demonstrations in a relevant environment (TRL 6). However, other research topics, such as medical engineering or implant materials, received only EUR 340 000 and EUR 600 000, respectively, focusing on particular stages of technological maturity.

Figure 6.19. Latvia's publications in the top 10% most cited documents on material sciences and engineering

Average, 2014-18



Notes: Size of shapes represents number of publications, ranging from 7 (Materials – miscellaneous) to 281 (Electrical and Electronic Engineering). Number of publications are totalled over the years 2014-18. See Figure 6.18 for more details.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

To increase effectiveness of spending, Latvia should concentrate funding on a smaller number of selected ecosystems that allow for close linkages between materials discovery and product development. The development of a more comprehensive material innovation ecosystem, involving research universities and manufacturers, is key to reducing the lag between these stages. Digital technologies, including computational material science and digital twins, are crucial enablers in this regard, as they help to connect the different stages of the materials production life cycle (OECD, 2017c). For example, Integrated Computational Materials Engineering (ICME) uses data science, computational modelling and simulation to link the development of materials to the certification of properties and product deployment more efficiently. The Laboratory of Magnetic Soft Materials at the University of Latvia, in co-operation with the Institute of Experimental Physics SAS (the Slovak Republic), Cordouan Technologies and LCPO (France), is currently involved in an ICME project focusing on the properties and applications of magnetic filaments in areas such as energetics, textiles and medicine. The project is financed through M-ERA.NET (see below).

A positive example of increasing linkages between research and manufacturers is the Excellence Centre of Advanced Material Research and Technology Transfer (CAMART). Originally established in 2001, CAMART is run by the Institute of Solid State Physics (ISSP) of the University of Latvia in co-operation with two Swedish partners, the KTH Royal Institute of Technology and Acreo Swedish ICT. The Centre receives funding from the Horizon 2020 framework (EUR 15 million) and ESIF funds (EUR 16.3 million). In 2018, CAMART launched Materize, a brand and platform to foster the transfer of new materials and technology to commercial products. Materize provides services ranging from proof-of-concept in the laboratory environment to prototyping and small-scale production in industrial test beds provided by partners.

Latvia should seek to actively enhance linkages between materials discovery and product development by making funding available for different technological maturity levels (TRL 1-6) within a selected materials ecosystem, from basic technology research to technology demonstration and the commercialisation of research results. The Baltic Biomaterials Centre of Excellence (BBCE) is an example of an ecosystem where such an approach is already underway. Latvia could also focus export support on firms that have previously benefited from publicly funded R&D (e.g. through competence centres).

For research fields with less developed innovation ecosystems, Latvia should focus on more general support mechanisms that can help to improve linkages between firms and public research institutes or universities. In particular, Latvia should strengthen its Technology Transfer Programme and foster incubators at universities. At present, there also seems to be no overarching strategy to promote co-operation between start-ups and research facilities, with many start-ups reporting difficulties identifying suitable research partners (MoE, 2018c). With the launch of the website StartupLatvia.eu, the Latvian government has recently introduced a centralised one-stop shop for start-ups. However, relevant information on technology transfer offices and opportunities for research collaboration are not currently available.

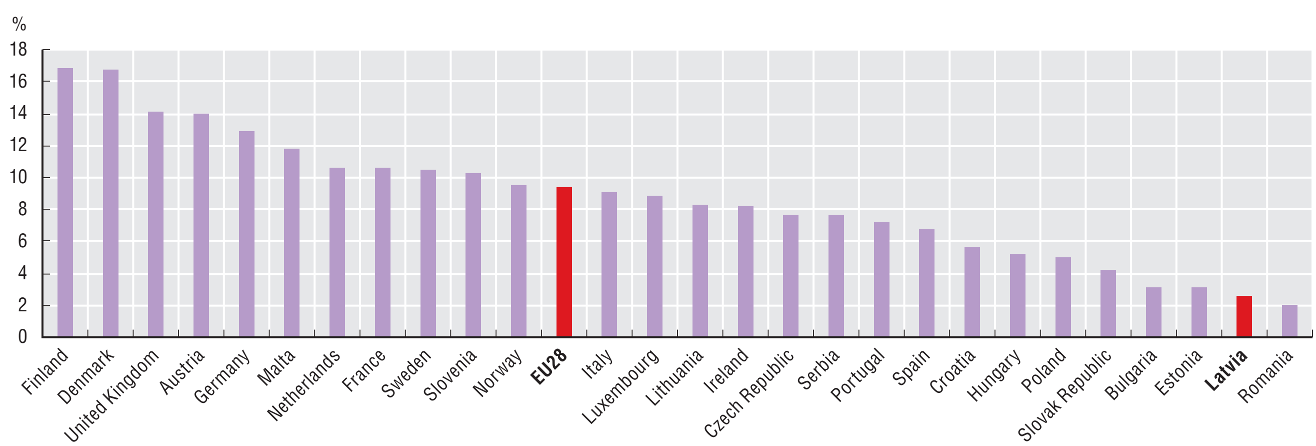
The Latvian government should also provide more support for excellence-based innovation calls such as Horizon 2020. Through its national contact points (e.g. SEDA), the government could provide targeted training workshops for applicants (e.g. in co-operation with universities, cluster initiatives or competence centres) or more actively approach innovative private sector stakeholders. Indeed, a collaboration involving several institutions, including SEDA and the MoEs as well as external experts, has helped to increase significantly the success rate of Latvian research proposals to M-ERA.NET, an EU-funded network issuing annual calls for transnational R&D projects on materials sciences. In particular, the percentage of proposals that were accepted for funding increased from 5% in 2012-14 to almost 20% in 2017-18.

Latvia should foster uptake of advanced manufacturing technologies in downstream sectors

The Latvian government should foster wider uptake of digital manufacturing technologies in downstream sectors. For example, Latvian manufacturing firms are lagging behind in the use of 3D printers (Figure 6.20).

Figure 6.20. Business use of 3D printers in manufacturing in Latvia and selected OECD countries, 2018

As a percentage of all manufacturing firms



Source: Eurostat (2020a), *ICT Usage in Enterprises – E-business (isoc_eb)* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/database*.

Latvian stakeholders are beginning to actively promote the uptake of digital production technologies in core manufacturing industries. In 2016, the industry association for firms in mechanical engineering and metalworking industries (MASOC) engaged in the cross-country co-operation programme Empower Metalworkers for Smart Factories of the Future (4CHANGE). The project, which was co-funded by the "EU Erasmus+" programme and ran until November 2019 with a budget of about EUR 1.2 million, aimed to enhance vocational education and training (VET) programmes, with a focus on the use of computer numerically controlled (CNC) machines. However, as of 2018, about half of firms in mechanical engineering and metalworking industries still perceived themselves as low digitally intensive (Grinfelds, 2018).

In order to foster and extend similar projects to other industries, the government, together with several competence centres and the German-Baltic Chamber of Commerce (AHK), has recently signed a Memorandum of Understanding on Development and Implementation of the Platform Industry 4.0 (Box 6.10).

Box 6.10. Platform Industry 4.0

To increase the use of digital technologies in the manufacturing sector, Latvia is developing an Industry 4.0 Implementation Package which aims to improve links between Latvian manufacturing firms and enterprises developing smart technologies. In February 2019, a Memorandum of Understanding on Development and Implementation of the Platform Industry 4.0 was signed by the Ministry of the Economy, the Ministry of Environmental Protection, eight competence centres and the German-Baltic Chamber of Commerce (AHK), which includes companies such as SAP and Bosch. Platform Industry 4.0 aims in particular at strengthening co-operation and co-ordination between stakeholders, advising Latvian firms with regard to new technologies for the manufacturing sector and designing policies to promote digital technologies. The Ministry of Economy is currently developing a strategy to implement the Memorandum.

The government aims to leverage DIH as a physical platform for the implementation of Platform Industry 4.0. These hubs would serve as a one-stop shop where firms and, in particular, SMEs, as well as public sector organisations, could access services related to testing, attracting investors, skills and training, networking and the innovation ecosystem. According to the government, Platform Industry 4.0 will be established formally through the Digital Europe Programme (2021-2027), which proposes to make available EUR 9.2 billion for areas such as supercomputing, artificial intelligence, and the build-up and strengthening of the European DIH network.

For the implementation of the Latvian Platform Industry 4.0, which is currently still in the planning phase, Latvia should consider some of the approaches used by other countries to foster the uptake of digital tools, in particular among SMEs. For example, the SME 4.0 Competence Centres in Germany offer demonstrations of new technologies and industry applications to SMEs. These demonstrations are often performed at universities and are tailored to specific sectors. In Denmark, the MADE programme organises visits to industry leaders willing to share their experience with evolving state-of-the-art solutions (Paunov and Planes-Satorra, 2019). Latvia could also consider opportunities beyond the Digital Innovations Hubs (of which only three are currently active) to promote interactions with new technologies among SMEs. For example, Latvian clusters, potentially in co-operation with clusters in other countries, could organise visits for SMEs to local or international industry leaders. Additionally, competence centres could offer targeted demonstrations of relevant new technologies for SMEs.

The programme Brasil Mais Productivo provides another example that could help foster Industry 4.0 in Latvia. The programme offers targeted consultancy services to help generate process innovation in small and medium-size manufacturing firms. The programme involves about 120 hours of technical training on lean manufacturing, energy efficiency practices and digitalisation of the production process. The focus on consultancy limits the cost of the programme. Additionally, companies are required to pay a share of the costs, which helps to ensure active participation. A specific credit scheme helps entrepreneurs with limited funds to overcome the financial burden of the programme. In the absence of an institutional structure to provide such consultancy services across Latvian regions, specialised courses on lean manufacturing and the use of advanced technologies could also be incorporated into the business training courses provided by LIDA within the framework of the Innovation Motivation Programme.

Box 6.11. Policy recommendations: Smart materials and engineering

- Target funding from the Smart Specialisation Strategy towards a smaller number of selected ecosystems allowing for closer links between materials discovery and application. Support innovation in selected ecosystems along the full innovation cycle, from early stage research to marketing and internationalisation.
- Support excellence in other research fields through broader innovation support mechanisms, including technology transfer programmes, university incubators and training for H2020 applications (e.g. by SEDA).
- Finalise and implement the Industry 4.0 Implementation Package to foster digital uptake in manufacturing firms, in particular SMEs. Leverage clusters and competence centres to disseminate knowledge about advanced manufacturing solutions and promote consultancy services and training (e.g. through LIDA).

Smart Energy technologies and Smart City solutions

The Latvian Smart Specialisation Strategy considers smart energy and ICTs as sectors with significant horizontal impact on transformation in other manufacturing sectors. The Smart Energy specialisation area, in particular, underscores the role of improved energy efficiency and clean technologies for enhanced productivity and environmental sustainability across economic sectors (MoES, 2015).

Smart Energy is highly dynamic in Latvia but uptake of energy saving technologies remains low

Sectors producing Smart Energy technologies are growing. In particular, the share of electrical equipment in total manufacturing rose from 1.5% in 2010 to 3.3% in 2017, while the contribution of machinery and equipment increased from 2.2% to 3.3%. Other related industries, such as manufacturing of motor vehicles and trailers, also increased in importance (1.5% to 2.5%) (Figure 6.12).

All three industries also contributed significantly to an increase in the share of high and medium-high tech goods in total manufacturing exports (Figure 6.17). However, in neither did Latvia reveal a comparative advantage (Figure 6.13).

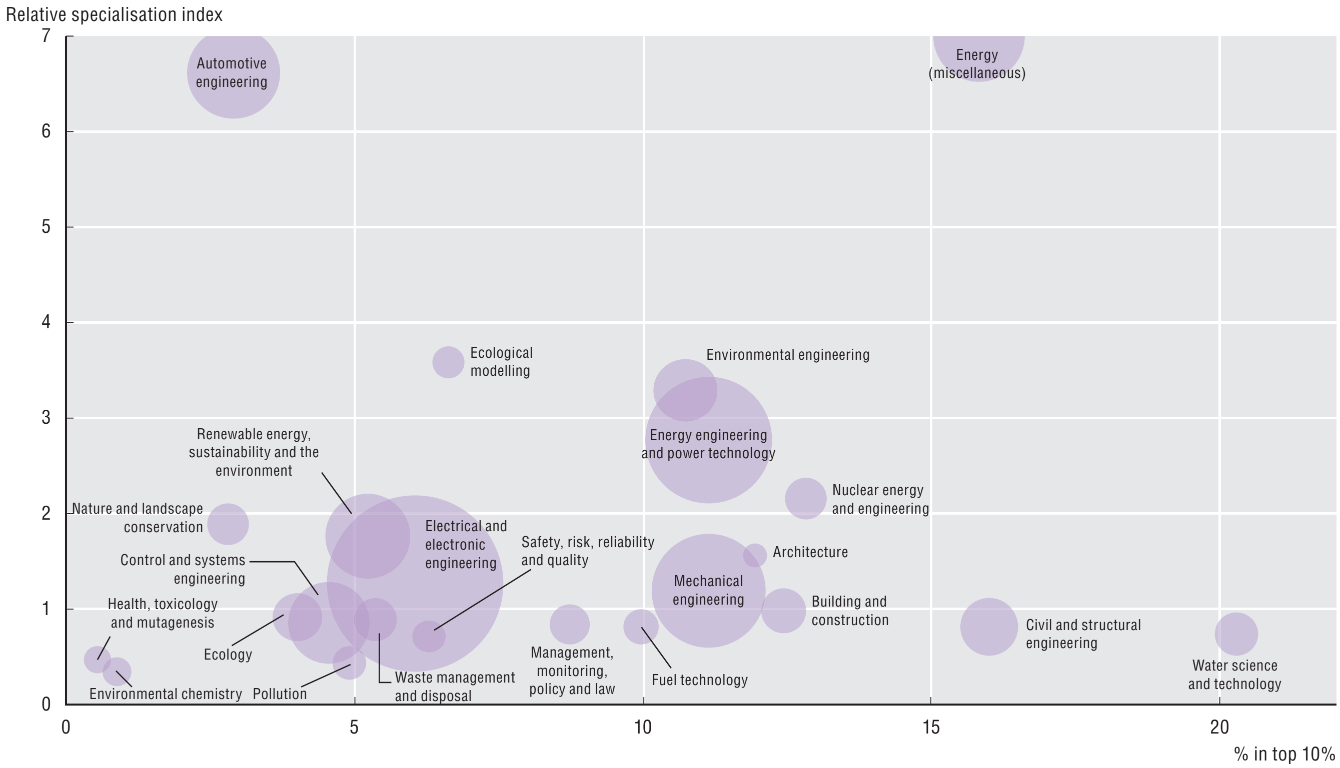
Business R&D on electrical equipment, however, was far higher than in any other manufacturing industry (5.3%), and came relatively close to the OECD average (6.8%) (Figure 6.15). Similarly, the number of patents in electrical machinery and apparatus, transport and environmental technology increased from 2007 to 2016.[8]

The energy and environmental sciences are among the most successful research areas in Latvia. According to the European Eco-Innovation Index, in 2018 academic output in the field of eco-innovation was greater in Latvia than in any other EU country. Publications in related fields of research were published relatively more frequently than in other countries (i.e. compared to the world average), and the share of frequently cited documents was also higher. In particular, over the years 2014-18 around 17.3% of Latvian publications in the field of Energy were among the top 10% most cited publications worldwide (Figure 6.21). In the environmental sciences, research performance was highest for environmental engineering and water science and technology, where 17% of Latvian publications were among the top-10% most cited worldwide. Publications in other related engineering fields, such as civil and structural engineering (16%) or building and construction (13%), were also frequently among the top 10%.

Between 1990 and 2016, Latvia more than doubled energy production, from 1.2 million tonnes of oil-equivalent (Mtoe) to 2.5 Mtoe. Over the same period, net energy imports declined from 7.5 to 2.2 Mtoe, implying significantly lower dependency on foreign suppliers (IEA, 2019a). Biofuels and waste have become key sources of energy supply – as of 2018, Latvia had the third highest share of energy from renewables in gross final energy consumption (40.3%) among all EU countries, after Finland (41.2%) and Sweden (54.6%) (Eurostat, 2020b).

Figure 6.21. Latvia's publications in the top 10% most cited documents on smart energy

Average, 2014-18

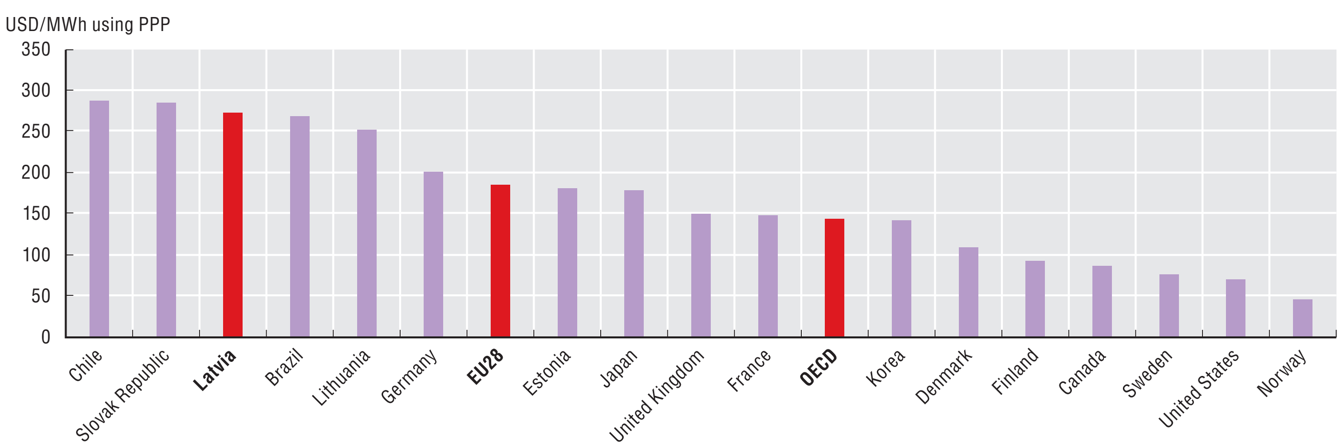


Notes: The size of shapes represents the number of publications, ranging from 5 (Architecture) to 281 (Electrical and Electronic Engineering). The number of publications is totalled over the years 2014-18. See Figure 6.18 for more details.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

However, while Latvia is on track to achieve its 2020 energy efficiency target, energy consumption is on the rise, driven by the transport and the residential sectors. Furthermore, energy production from biomass remains highly inefficient and, together with growing urban transport and low energy efficiency in housing, threatens the achievement of Latvia's 2030 energy efficiency targets (European Commission, 2020; OECD, 2019a). The country also still needs to improve sustainability in waste management, as the recycling rate in municipalities remains low. Additionally, Latvia has some of the highest industrial electricity prices in the world (Figure 6.22), which are regarded by many firms as a major challenge to competitiveness (e.g. Grinfelds, 2018).

Figure 6.22. Industrial electricity prices in Latvia and selected OECD countries, 2017



Note: MWh = megawatt-hour.

Source: IEA (2019b), *World Energy Prices*, *http://data.iea.org/payment/products/121-world-energy-prices-2019-edition.aspx*.

Commercialisation of innovative clean technologies needs stronger policy support

With about EUR 34 million in funding in 2014-18, Smart Energy accounted for less than one-fifth of total support to Smart Specialisation. Most of R&D funding has been invested in developing technologies and solutions for improving energy efficiency in buildings and industry (30%) and energy management, including smart grids (29%). Alternative fuels, including electro mobility, received 22%. Over one-third of the total R&D funding for Smart Energy was provided through the Horizon 2020 framework (36%), a share significantly higher than in all other RIS3 areas, where the share of H2020 ranged from 5% (Biomedicine) to 23% (ICT) (Table 6.2).

The largest projects funded under this scheme are SUNShINE and SUNShINE Accelerate, each of which benefits from EU contributions of close to EUR 1.3 million. The projects target the renovation of residential buildings, and are co-ordinated by Riga Technical University. While they promote energy efficiency in Latvian housing and foster demand for energy services, there are no conditions regarding the technologies used by projects, implying that the effects on innovation remain uncertain.

Digital innovation, in particular, can be a crucial enabler of energy savings. According to the International Energy Agency (IEA), the use of digital technologies such as smart thermostats and smart lighting in buildings has the potential to create global energy savings of around 65 PWh up to 2040 – the total final energy consumption of OECD partner economies in 2015 (IEA, 2017). Similarly, the use of digital technologies in transport (e.g. smart charging of electric vehicles, shared and automated mobility) and industry (e.g. additive manufacturing, digital twins) could unlock significant energy savings and emission reductions. Latvia should therefore specifically foster *smart* energy innovations, including the application of digital technologies in buildings, transportation and industry, to help achieve energy and cost savings.

Two H2020 projects that highlight successful research activity in this regard are MORE-CONNECT and RealValue. MORE-CONNECT focused on the design and piloting of modular, prefabricated renovation elements that communicate through wireless sensors and control components for performance diagnostics and control. The project represented a collaboration between RTU (EUR 330 450), the Latvian Wood Construction Cluster (EUR 56 875) and the Zemgales Technological Centre (EUR 78 925) along with 15 other participants from seven countries, and was completed in May 2019. RealValue demonstrated the potential of Smart Electric Thermal Storage (SETS) as a replacement for existing electric thermal storage heaters and water tanks. The project involved RTU (EUR 632 318) along with 11 partners from Finland, Germany, Ireland and the United Kingdom, and was completed in May 2018. SETS devices were deployed together with smart plugs, sensors and smart meters in 1 250 homes in Germany, Ireland and Latvia. A gateway connects the devices to a cloud optimisation engine, which links to the electricity grid in each country to calculate and implement optimised charging schedules. RTU was also involved in the energy system modelling exercise, which helped demonstrate the potential of technical and commercial deployment in millions of homes across representative EU regions.

Innovation in smart energetics is also picking up in the private sector, where a number of start-ups with a focus on digital technologies have been emerging. For example, Citintelly, founded in 2016, has developed a multifunctional cloud-based Street Lighting Central Management System (CMS), including sensors and controllers, and has to date implemented projects in Israel, Latvia and Malta. Meanwhile, Route4Gas is developing software solutions for better gas routing in the European natural gas market. Additionally, Marine Digital, one of the first international start-ups settling in Latvia in the context of the country's start-up visa programme is offering an automated port and bulk-terminal management system (see the first section of this chapter).

To support start-up dynamics and private sector innovation, the government should increase funding for research commercialisation and competence centres. Smart Energy is the Smart Specialisation area with the least spending in these areas, which fall under the responsibility of the MoE. Together, they account for only 12% of total spending (EUR 4 million) in the Smart Energy specialisation area, compared to 22% in biomedicine and around 39-43% in other areas (EUR 10-20 million) (Table 6.2).

Latvia should specifically target eco-innovation, in order to better exploit synergies between Smart Specialisation and measures that support cleaner production, waste prevention or bioenergy (OECD, 2019m). While eco-innovation cuts across several Smart Specialisation areas, including Smart Energy, Bioeconomy and Smart Materials, it is not currently the focus of any one area. Accordingly, environmental innovators are represented in four different clusters, namely: the Latvian Electronics and Electrical Engineering Cluster, the CLEANTECH Cluster, the Green and Smart Technology Cluster, and the Smart City Cluster. Stakeholder interviews with cluster representatives seem to confirm that some firms in these clusters have faced significant difficulties in locating appropriate support mechanisms within the Smart Specialisation framework.

The government could, for example, replace or revive the Green Industry Innovation programme, which provided pre-incubation and incubation services to start-ups engaging in the development and commercialisation of environmental technology. The initiative, which started in 2014, was run by the MoE as part of the Norwegian Financial Instrument Programme. As of April 2017, 152 teams had received pre-incubation advice from a specialised green technology incubator and 23 project implementers had benefited from co-funding totalling EUR 2.4 million (MoES, 2018). The programme is currently inactive in Latvia due to a lack of funding.

Smart Energy and environmental technologies stand to benefit substantially from Smart City initiatives

One promising concept that provides significant potential for the Smart Energy specialisation area in the context of digital transformation is Smart Cities. Smart cities are closely linked to the emergence of new digital technologies in areas such as energy efficient buildings, smart grids, smart mobility solutions, and sustainable waste and water treatment solutions.

For example, the "Riga Smart City Sustainable Energy Action Plan for 2014-2020" (SEAP), through which the city of Riga has committed to reducing CO_2 emissions by at least 20%, is based on a 20% increase in energy efficiency and an increase in the share of renewable energy in total consumed energy to 20%. The integration of innovative ICTs into energy and transportation systems is a core component of the programme. SEAP was developed within the EU Seventh Framework programme "Strategies towards Energy Performance and Urban Planning" (STEP-Up) in collaboration with municipalities in Belgium and Sweden and the United Kingdom.

One of the actions foreseen under the programme is an upgrade of the city's lighting system to programmable LED lamps. However, progress has been rather slow since the programme's launch in 2012, with "smart" control of LED streetlights currently restricted to a limited number of neighbourhoods. This includes Maras Park, which in 2017 was equipped with smart lighting technology by the Latvian start-up Citintelly. In 2019, an agreement was signed worth over EUR 4.7 million for three new projects to advance the implementation of smart lighting solutions in Riga. The projects involve remote control systems with presence radar detection for light and traffic control.

Further investments are also required in the transport system. Most transport-related investments in the past have focused on the road network, with cars still accounting for the vast majority of passenger travel in Latvia. Currently there is no integrated public transport system linking Riga to neighbouring municipalities, implying that services such as route planning, pricing and ticketing are separated across several providers and municipalities (OECD, 2019m). Developing an integrated public transport system with a metropolitan transport authority, such as those in Madrid, Prague or Warsaw, could make travel easier and more affordable, and allow for the digital integration of ticketing and route planning systems. Fostering alternative shared and active mobility solutions, such as bicycles, electronic cars or scooters, could further incentivise commuters to leave their car at home and make transport more inclusive and sustainable.

Among smaller municipalities, the city of Jelgava has been one of the earliest adopters of a Smart City vision. Since 2016, critical infrastructure in the city has been monitored by a Joint Municipality Operative Information Centre (JMOIC), which includes real-time monitoring of traffic flow data, traffic optimisation through smart traffic lighting, and automated monitoring of meteorological stations and flood protection gates, as well as smart energy management solutions for district heating. Additionally, citizens were provided with e-cards (NFC technology) that can be used to pay for public transportation and receive social benefits. In 2017, the investment research department of the *Financial Times* ranked Jelgava 6th among European micro-cities in the category "connectivity" (Strods, 2017).

The Smart City concept is gaining traction across Latvia following the identification of Smart Cities as a core value chain for the revised version of the Smart Specialisation Strategy. The MoE is currently defining the details of the value chain, in consultation with public, private and academic stakeholders, as well as in co-ordination with the ministries of Transport and Environmental Protection and Regional Development. MoE representatives and other stakeholders have also engaged with international peers to learn more about the realisation of Smart City concepts in countries such as the Netherlands or at the Smart City Expo in Barcelona.

One indication of increasing dynamism is the initiative VEFRESH, an open innovation movement launched in 2019 by technology companies, real estate developers and the Riga municipality. The movement aims to transform Riga's VEF district – which hosts a large share of Latvia's IT sector and accounts for over 40% of the country's IT exports – into a testbed for smart city solutions. The national government can play an enabling role in support of innovative solution delivery, capacity building and upscaling in the context of smart cities (OECD, 2020i), and has signalled its direct support for Smart City developments in the VEF neighbourhood through a recent MoU signed between the MoE and Riga City Council.

The town of Cesis has also begun to develop a digital strategy and is organising seminars and workshops for business people on variety of data tools, including artificial intelligence. The Cesis district municipality has received support from the private sector-driven initiative Valsts#196, which provides a platform for dialogue between municipalities and providers of technological solutions. The Latvian IT Cluster is one of the co-founders of the initiative.

Latvia should further integrate the smart city concept into national and regional development strategies to leverage complementarities and enhance co-ordination with other policies which aim to increase quality of life and investment opportunities across the country, including in small municipalities. The existence of a national framework for smart city solutions is important as it can empower and guide local governments to identify their main needs and opportunities. The Canadian government, among others, is actively fostering smart city solutions in smaller municipalities through the Smart Cities Challenge. This competition, which is open to municipalities, regional governments and indigenous communities, encourages participants to adopt innovative technologies to improve the lives of their residents. Four initiatives will be selected and receive federal funding. An important requirement is that projects are scalable and replicable.

An increasing number of good practices worldwide could inspire smart city policies in Latvia. For example, Finland's Six City Strategy (6Aika), launched in 2014, includes the development of an open innovation platform where stakeholders in the six largest cities can share smart solutions. Participating stakeholders can freely experiment with innovative solutions in all six cities. In France, the public investment bank has created a special fund (*Ville de Demain*) to provide financial support to start-ups offering smart city solutions. In addition to financial support, Japan grants regulatory exceptions to cities prepared to implement smart city projects. These and other examples are discussed in (OECD, 2020i; 2019n), which take stock of a decade of experimentation, uptake and proliferation of smart city initiatives across the globe (Box 6.12).

Latvia should make more extensive and strategic use of public procurement to promote innovation among regions and municipalities.[9] The OECD Framework to Promote the Strategic Use of Public Procurement for Innovation discusses several action areas that could guide Latvia in efforts to strengthen procurement for innovation (OECD, 2017d). Removing financial and regulatory barriers to the participation of SMEs in public procurement bids will also be crucial (see Chapter 4). Many countries have developed integrated procurement plans with explicit targets for innovative projects at the municipality level. In Sweden, for example, some municipalities have incorporated innovation targets into procurement procedures, while VINNOVA, the Swedish Innovation Agency, provides support to contracting authorities that wish to procure innovation in the form of financing possibilities (OECD, 2017d). The Latvian Ministry of Finance is currently analysing the potential for greater usage of public-private partnerships, which have been used successfully in other countries to finance smart city projects (Deloitte, 2018).

Box 6.12. Enhancing the contribution of digitalisation to smart cities of the future

Digital transformation brings opportunities for ground-breaking innovations in urban design, policy making and infrastructure. Cities are already tapping this potential, often with the close involvement of the private sector. Municipalities are using data and digital technology to help tackle climate change, foster inclusive growth or improve administrative processes by searching for efficiencies, cutting red tape or engaging citizens. Sector-driven technologies have also contributed to new social initiatives, actions to combat climate change and green growth in cities.

A search on Google Trends suggests that worldwide interest in smart cities has increased significantly since 2013, making "smart" the most popular adjective in relation to cities, surpassing others such as sustainable, healthy, liveable, green and resilient. The smart city concept itself is evolving and is still subject to debates. Highlighting the crucial role of citizens' well-being, the OECD has defined smart cities as "initiatives or approaches that effectively leverage digitalisation to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process" (OECD, 2020i). This definition as well as recent OECD discussions stress in particular:

- the need to design, implement and monitor smart city policies, to ensure that the rapid diffusion of new technologies improves well-being for all people
- the enabling role that national governments can and should play to support innovative solution delivery, capacity building and upscaling
- the critical role of a comprehensive, multi-sectoral and flexible framework that helps advance the measurement agenda and is aligned with local and national strategic priorities, and embraces efficiency, effectiveness and sustainability dimensions
- the need for holistic and smart governance, which sometimes requires re-regulation rather than simple de-regulation, leverages public procurement, and employs business and contractual models that able to adapt rapidly to changing urban environments.

The central role of citizens not only as recipients, but also as actors of smart city policies, implies the co-construction of policies throughout the policy cycle. Policy makers, however, still often lack a clear understanding of the challenges, risks and trade-offs of digital innovation in cities. Indeed, digital transformation can either improve the public policy response to other transformative megatrends, such as globalisation, demographic shifts and climate change, or reinforce their destabilising effects. In the absence of an integrated, multi-sectoral and whole-of-government perspective, digital innovations can upend legal and regulatory frameworks that safeguard affordability objectives, consumer protection, taxation, labour contracts or fair competition. They can also jeopardise citizen data, privacy and safety, thus generating trade-offs between data disclosure and the perceived impacts of smart city services.

To ensure that digitalisation does not widen social inequalities or contribute to further citizen discontent and a backlash against public institutions, public and private actions must be evaluated in terms of their value to society, and smart city applications should be well connected with inclusive growth objectives. Investment in human resources, for example through life-long learning, and efforts more generally to ensure that people have the skills they need for future work, including digital literacy, must be implemented in all cities and regions, and should be viewed as an investment and not a cost.

Source: OECD (2020i), *Smart Cities and Inclusive Growth*, *www.oecd.org/cfe/cities/OECD_Policy_Paper_Smart_Cities_and_Inclusive_Growth.pdf*; OECD (2019n)¸ *Enhancing the Contribution of Digitalisation to the Smart Cities of the Future*, *www.oecd.org/cfe/regional-policy/Smart-Cities-FINAL.pdf*.

Latvia should also develop regulatory sandboxes to help overcome the regulatory challenges and uncertainties related to smart city initiatives. The British Office of Gas and Energy Markets (Ofgem) provides an interesting model in this regard. Ofgem has created a one-stop shop for the *energy* sector, offering rapid advice on energy regulation to businesses. When regulatory barriers prevent the launch of a product or service that would benefit consumers, a regulatory sandbox can be granted to permit a trial (Paunov and Planes-Satorra, 2019).

Box 6.13. Policy recommendations: Smart energy

- Target eco-innovation by broadening the scope of the Smart Energy specialisation area to include environmental technologies (e.g. for waste and water treatment).
- Re-allocate Smart Specialisation funds towards research commercialisation and competence centres.
- Re-establish a Green Industry Innovation programme with an adequate level of resources.
- Integrate the smart city concept into regional development policies to promote eco-innovation and increase the quality of life and investment opportunities in all regions.
- Foster smart city solutions through financial support to innovative municipalities, open innovation platforms, smart procurement and regulatory sandboxes.

Improving synergies within RIS3 areas

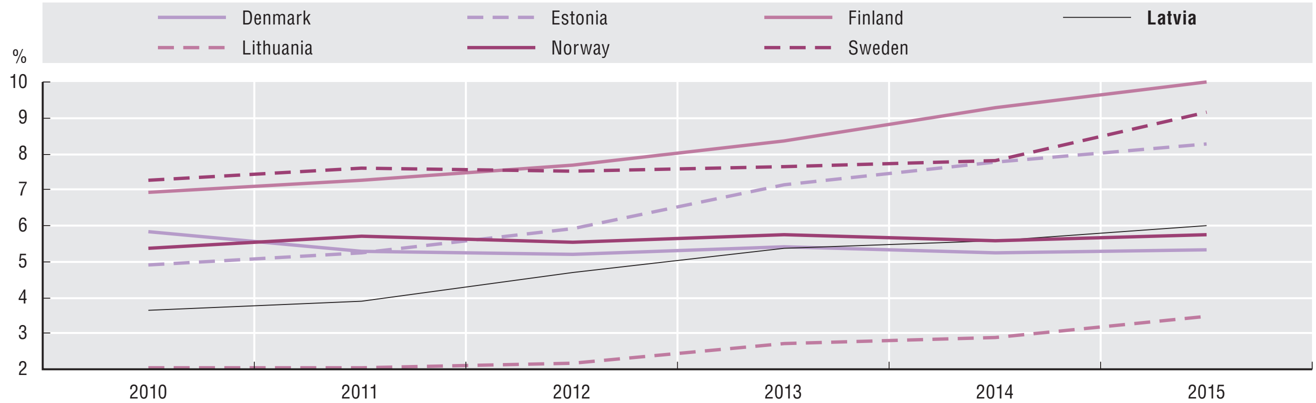
As noted earlier, the Latvian Smart Specialisation Strategy considers smart energy and ICTs as sectors with significant horizontal impact on transformation in other manufacturing sectors (MoES, 2015). This section considers ICT goods and services, including related manufacturing industries such as consumer electronics.

ICT goods and services account for an increasing share in Latvian exports but research capabilities remain low

The share of ICT services in total business services exports increased significantly between 2010 and 2015, rising from 3.6% to 6%. While ICT services export intensity was higher in neighbouring Estonia (8.3%), Latvia overtook both Denmark (5.3%) and Norway (5.7%) (Figure 6.23). Between 2010 and 2015, Latvia also further developed an RCA in value-added exports of IT and other information services (Figure 6.14). However, research and development expenditures as a share of total value added (0.5% in 2015) remained significantly below the OECD average (4.8%) for ICT services.

Figure 6.23. ICT services[1] exports from Latvia and selected OECD countries, 2010-15

As a percentage of all business sector[2] exports



1. ICT services relate to D62-D63 (ISIC, Rev.4), IT and other information services.

2. Business sector services (D45-D82) exclude real estate.

Source: OECD (2020f), "STAN Industry ISIC Rev. 4", *https://dx.doi.org/10.1787/data-00649-en* (accessed on 24 February 2020).

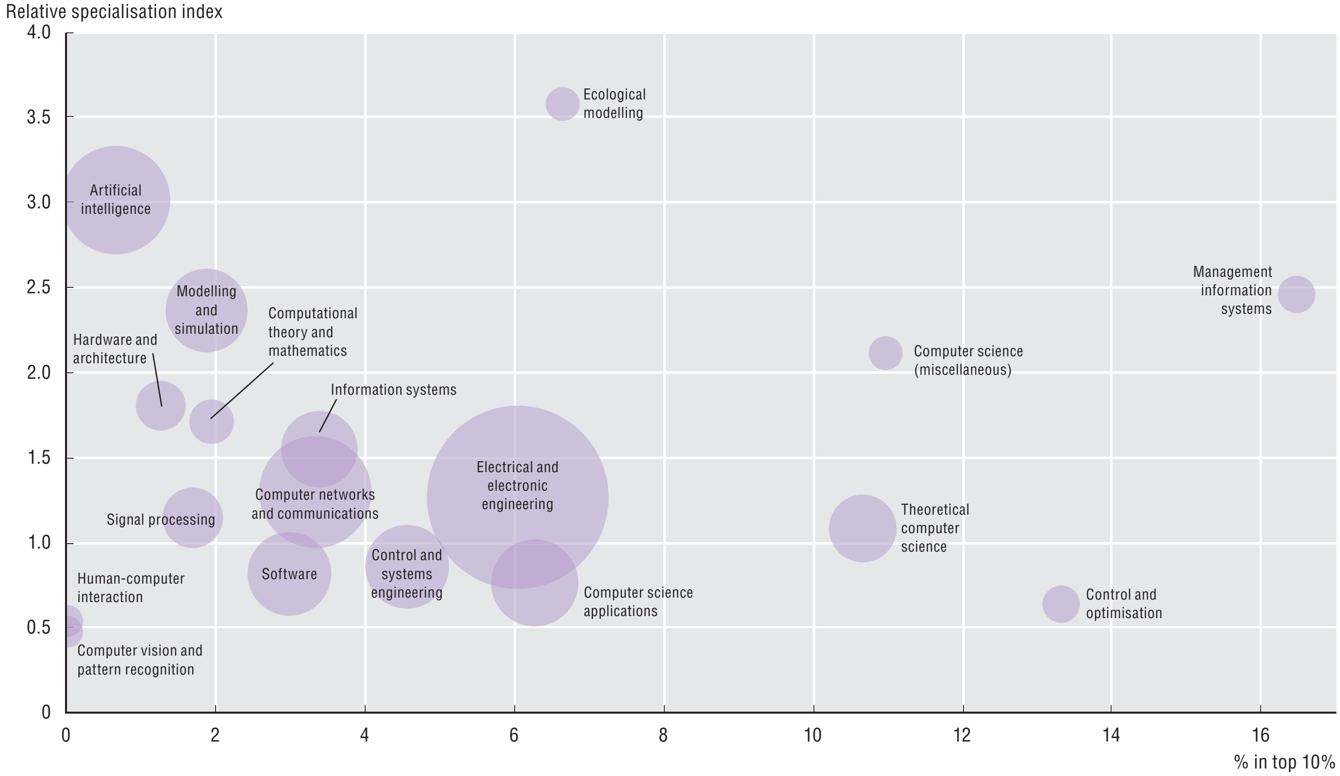
The ICT and electronic goods sector has also grown rapidly over recent years. Between 2010 and 2017, the share of Computer, electronic and optical products in total manufacturing value added more than doubled, from 2.2% to 4.9% (Figure 6.12). A similar increase can be observed for manufacturing exports, where the share of the sector aggregate grew from 3% to 6.3% between 2010 and 2018 (Figure 6.17).

Large increases in exports were observed for product categories such as transmission apparatus (radio, telephone or TV), monitors and projectors, microphones and printed circuits. Jointly, these products accounted for over three-quarters of total ICT goods exports in 2018.[10] However, despite progress since 2010, Latvia had not attained an RCA for the sector aggregate in 2015 (Figure 6.13). Additionally, research and development expenditures for computer, electronic and optical products as a share of value added (2.5%) also remained significantly below the OECD average (23.7%) (Figure 6.15).

Patent applications nevertheless suggest increasing research activity in areas related to audio-visual technologies and computer technology. Together, these patent classes accounted for 8.9% of all applications in 2012-16, up from 1.9% in 2007-11. Applications in related areas (e.g. telecommunications, basic communication processes, semi-conductors or digital communication) declined (from 5.4% to 2.4%).[11]

Figure 6.24. Latvia's publications in the top 10% most cited documents on computer science, electronic engineering and related fields

Average, 2014-18



Note: Excludes fields with less than five publications between 2014 and 2018. Number (fractional) of publications ranges from 8.8 (Human-computer interaction) to 281 (Electrical and electronic engineering). See Figure 6.18 for more details.

Source: OECD calculations based on Elsevier, Scopus Custom Data, Version 5.2019.

The share of top-cited scientific publications in most fields of computational science and electronic engineering remained below 10%, the global average across countries (Figure 6.24). The exception consisted of a small number of highly cited publications in theoretical computer science (e.g. quantum computing or management information systems). Specialisation is strong in the field of artificial intelligence, with around 100 publications in 2014-18. However, only 0.7% were among the top 10% in terms of citations. As mentioned above, a large number of publications were published in the field of electronic engineering, but only 6% were among the 10% most cited documents, below the global average (10% by definition).

These findings suggest room to further strengthen research capacity and specialisation, both in general fields, such as artificial intelligence, and fields with clear applications in other Smart Specialisation areas, such as health informatics or ecological modelling.

Government support lacks a focus on Smart Specialisation areas

The ICT Smart Specialisation area accounted for about 17.4% of funding from instruments available under the Smart Specialisation Strategy (Table 6.2). As the area is considered to have a substantial cross-sectoral impact – like Smart Energy, which received 27.5% of the total funding – the low share of resources allocated is surprising. Programmes fostering research commercialisation and the competence centres for ICTs accounted for a relatively larger share of the available funds for the area, whereas funding for fundamental and applied research, post-doctoral research or practical research was relatively low. Thus, while ICT research in the early stages (TRL 1-3) received only EUR 12.5 million in 2014-18, funding reached EUR 29.1 million for Smart Materials and 33.4 million for Biomedicine (Table 6.2).

Funding has also been scattered across many fields. Around 32% of the total ICT funds available were distributed among ICT goods, including smart sensors and the Internet of Things (11.1%), robotics and computer vision (4.6%), and a wide array of electronics (16.3%) ranging from smart screens, semi-conductors and microchips, to smart cars, 3D printers, audio devices and precision instruments (Table 6.4). More targeted funds went to computational linguistics and machine translation (14.5%). The remainder was distributed among a diverse set of research areas, including education technologies, quantum research, space technologies, business process management, big data and cyber security. As a result, specific fields of high relevance to Smart Specialisation value chains received rather limited funding. For example, medical informatics and bioinformatics were considered jointly with other big data applications, which taken together received only 8.6% of the available funds.

Table 6.4. Support for ICTs does not align with needs of other Smart Specialisation areas

Funds for Smart Specialisation in the area of ICT, 2014-18

Research areas	Funding instruments of the Ministry of Education and Science			EU Innovation and research programme	Funding instruments of the Ministry of Economics	
	National/ government funding	EU funds (e.g. ESIF, ERDF)	EU funds (e.g. ESIF, ERDF)	Horizon 2020	EU funds (e.g. ESIF, ERDF)	EU funds (e.g. ESIF, ERDF)
	Fundamental and applied research programme	Post-doctoral research (1.1.1.2.)	Practical research (1.1.1.1.)	Horizon 2020	Research results commercialisation (1.2.1.2.)	Competence Centres (1.2.1.1.)
	TRL 1-2	TRL 1-2	TRL 2-3	TRL 4-8	TRL 3-5	TRL 4-6
Computational linguistics	495 446	133 806	1 338 661	1 375 750	x	1 419 752
Algorithms	698 910	802 836	921 276	x	23 572	1 134 227
Machine learning	699 874	267 612	x	17 339	x	830 155
Education technologies and digitalisation	200 000	401 418	1 837 020	x	x	x
Business process management systems	x	x	x	533 663	x	1 647 396
Electronics	x	x	517 036	1 064 329	x	3 778 490
Smart sensors and Internet of Things	300 000	1 070 448	x	1 553 216	730 743	x
Robotics	300 000	267 612	x	550 560	332 936	62 500
Big data	x	401 418	x	1 669 115	681 584	x
Data storage, transmission and systems	x	401 418	x	246 561	x	1 835 455
Space technologies and remote sensing	799 973	66 903	624 449	100 000	326 850	x
Public and cyber security	x	x	x	401 085	x	72 946
Total	**3 494 203**	**3 813 470**	**5 238 442**	**7 511 618**	**2 095 685**	**10 780 921**

Notes: x = not applicable. Computational linguistics includes research in the area of machine translation. Algorithms includes quantum research. Robotics includes computer vision research. Big data includes medical informatics/bioinformatics research. Electronics includes research in several fields, including smart screens, semi-conductors, microchips, smart cars, 3D printers, and audio or precision devices.

Source: OECD, based on data from the MoES.

The current funding structure, therefore, does not sufficiently support the role of applied ICT research as a fundamental enabler for other specialisation areas. In particular, more targeted funding could help support emerging ecosystems in other Smart Specialisation areas, including specialised research on Integrated Computational Materials Engineering (ICME), environmental modelling, bioinformatics or health informatics. Fostering modular programmes (see Chapter 4) and more strongly involving engineers and ICT specialists in the research projects of applied institutes, such as the Laboratory for Genomics and Bioinformatics at LU or the Faculty of Materials Science and Applied Chemistry at RTU, could assist in this regard. Additionally, newly installed infrastructure, such as the Microsoft Innovation Centre (LUMIC), should be leveraged to foster emerging Smart Specialisation ecosystems. Bringing international researchers to Latvia, including through conferences such as the 15th International Conference on Agricultural Informatics and Communication (2021 in Riga), would also support this approach.

The IT sector requires broad-based policy support

Particular clusters of excellence in the Latvian ICT sector have attracted significant Horizon 2020 funding. Currently, 36 signed grants benefit from H2020 funding of almost EUR 7.9 million. After Food and Energy, ICT projects were the third most important area of H2020 funding for Latvia. Several projects have arisen in the area of computational linguistics and machine translation. These include SUMMA (Scalable Understanding of Multilingual Media), which received contributions of EUR 1.2 million, making it the largest H2020 project with a focus on ICTs. The project ran from 2016 to 2019 and involved the Latvian Information Agency (LETA) along with research institutions in four other European countries.

Together with 12 other firms and research institutions, LETA was also one of the founders of the first IT Competence Centre (IT CC) programme in 2010, one of the main focuses of which was language technology. Tilde SIA, another co-founder of IT CC, was also involved in several H2020 projects focused on machine translation. The two most recent projects, co-ordinated in France and Germany, respectively, received funding of EUR 935 000 up to 2021. Tilde's machine translation technology, which specialises in Baltic languages, has outperformed solutions from key players such as Google and Microsoft in the translation of Lithuanian, Estonian and Latvian (LSM, 2019). The technology is freely available for the three Baltic languages as well as Arabic, English, Finnish, Polish and Russian.

Other successful deep-tech firms have also benefited from the Competence Centre programme. For example, as part of the IT CC, the company Squalio developed a deep-tech solution for vehicle licence plate recognition and applied it to speed cameras in a pilot with the Latvian Traffic Safety Directorate (CSDD). According to the CSDD, the solution has already reduced the number of car accidents and is a good example of how smart procurement can be used to foster technological innovation. In another example, Tilde was awarded a tender in 2017 by a Directorate (G3) of the European Commission for the provision of tools and resources for automated translation and language processing services.

Latvian deep tech is likely to evolve further in the future, with firms like Tilde or Squalio generating awareness of particular technological niches. In addition, the Latvian IT Cluster has recently attracted additional H2020 funds for a programme to help deep-tech start-ups improve products and sell more effectively (STARTUP3). However, while H2020 or competence centres can help develop particular technological niches, they need to be complemented by more comprehensive policy measures to support innovation.

Countries have introduced several measures to support the growth of ICT sectors, including loans, export or innovation subsidies, training, and ICT specific incubators and accelerators (OECD, 2019o). Measures to foster the adoption of digital technologies (see Chapter 4) also play an important role in creating demand for domestic solutions. Latvia should consider strategies to ease the demand for skills and enhance productivity in the sector. In addition to making adjustments to the education system, such strategies could involve measures to attract ICT specialists from abroad. In Belgium, a special tax regime for foreign executives and specialists has provided benefits to foreigners with particular skills on a temporary basis since 1983. In Germany, the government has recently agreed a plan with business leaders to ease entry into the country for foreign workers. The resulting Memorandum of Understanding foresees support from the German bureaucracy, assistance with the search for housing and faster visa processes.

The design and implementation of regulatory adjustments will be crucial in particular sectors. For example, ICT firms developing Fintech solutions are likely to benefit significantly from the creation of regulatory sandbox environments or the swift and coherent implementation of emerging regulation. For example, the Alternative Financial Services Association of Latvia, which represents several Latvian

Fintech firms, has joined forces with associations in Denmark, Poland and Spain to voice concerns over the increasing difficulties associated with small sum, cross-border lending. The coalition, which represents over 100 digital lenders, argues that the implementation of existing EU rules, such as the Consumer Credit Directive, varies widely across different member states and is stifling market entry by foreign competitors. In response, the European Commission is currently evaluating the need to revise the Consumer Credit Directive. In this and other similar cases, the Latvian government should foster ongoing dialogue with sector representatives and – in the case of EU regulation – with other countries, to determine how regulation can be implemented without creating unnecessary friction.

Box 6.14. Policy Recommendations: ICT

- Re-allocate Smart Specialisation funding towards the ICT specialisation area to better account for the positive spill-over effects ICTs generate across the economy, including in other Smart Specialisation areas.
- Concentrate funding in selected niches of excellence (e.g. machine translation, audio technology), as well as research fields complementary to other Smart Specialisation areas (e.g. health informatics).
- Complement targeted instruments with broader support for ICT innovation and adoption, and consider the introduction of special tax regimes or relocation support to attract foreign ICT specialists.
- Foster dialogue with sector representatives to ensure that emerging regulation is implemented without creating unnecessary friction.

References

ALTUM (2019), "The first 18 startups financed by the ALTUM accelerator programs graduate most promising teams will qualify for 250 thousand euro investment", *www.altum.lv/en/news/veiksmigi-nosledzies-pirmais-posms-altum-akceleratoru-programma-daudzsolosakie-jaunuznemumi-pretende-uz-250-tukstosu-eiro-ieguldijumu* (accessed in March 2020).

Appelt, S. et al. (2016), "R&D tax incentives: Evidence on design, incidence and impacts", *OECD Science, Technology and Industry Policy Papers*, No. 32, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlr8fldqk7j-en*.

Beckerman-Rodau, A. (2011), "The problem with intellectual property rights: Subject matter expansion", *Yale Journal of Law and Technology*, Vol. 13/1, pp. 36-89.

Cross-Sectoral Coordination Centre (2019), *National Development Plan of Latvia for 2021-2027*, first version summary, Riga.

Cross-Sectoral Coordination Centre (2017), *National Development Plan 2014-2020 Annual And Sustainable Development Strategies For Latvia Up To 2030. Annual Implementation Monitoring Report*, Riga.

CSBL (2020a), *IKG10_060 Total Gross Value Added by Kind of Activity (NACE Rev. 2)* (database), Central Statistical Bureau of Latvia, Riga, *https://data1.csb.gov.lv/pxweb/en/ekfin/ekfin__ikp__IKP__ikgad*.

CSBL (2020b), *Exports and Imports by Commodity Section and by Economic Activity (NACE Rev.2) of the Importer (thsd euro) – ATG015* (database), Central Statistical Bureau of Latvia, Riga, *www.csb.gov.lv/en/statistics/statistics-by-theme/foreign-trade/ft-nace-bec/tables/atg015/exports-and-imports-commodity-section-and*.

CFCA (2020), "History", Central Finance and Contracting Agency, Riga, *www.cfla.gov.lv/en/about-us/history* (accessed on 20 May 2020).

CFCA (2019), "General information," Central Finance and Contracting Agency, Riga, *www.cfla.gov.lv/en/eu-funds-2014-2020/general-information* (accessed on 20 May 2020).

Deloitte (2018), *Using Public-Private Partnerships to Advance Smart Cities. Part 2: Funding and Financing Smart Cities Series*, Deloitte Center for Government Insights, New York, NY, *www2.deloitte.com/content/dam/Deloitte/global/Documents/Public-Sector/gx-ps-public-private-partnerships-smart-cities-funding-finance.pdf*.

Eichler, H-G. et al. (2019), "Data rich, information poor: Can we use electronic health records to create a learning healthcare system for pharmaceuticals?" *Clinical Pharmacology and Therapeutics*, Vol. 105/4, pp. 912-922, *doi:10.1002/cpt.1226*.

EsFondi.lv (2020a), "Informācijas sistēmu modelēšanas principu piemērošana strukturētai un mērķtiecīgai kompetenču pārvaldībai" [Application of information systems modeling principles to structured and purposeful competence management], *www.esfondi.lv/es-fondu-projektu-mekletajs/project?number=1.1.1.1%2F16%2FA%2F252* (accessed in March 2020).

EsFondi.lv (2020b), "Neironu tīkli fleksīvo dabisko valodu apstrādei" [Neural networks for processing flexible natural languages], *www.esfondi.lv/es-fondu-projektu-mekletajs/project?number=1.1.1.1%2F16%2FA%2F215* (accessed in March 2020).

EsFondi.lv (2020c), "Informācijas un komunikācijas tehnoloģiju kompetences centrs" [Information and Communication Technology Competence Centre], *www.esfondi.lv/es-fondu-projektu-mekletajs/project?number=1.2.1.1/18/A/003* (accessed in May 2020).

EsFondi.lv (2020d), "Tehnoloģiju pārneses programma" [Technology transfer programme], *www.esfondi.lv/es-fondu-projektu-mekletajs/project?number=1.2.1.2%2F16%2FI%2F001* (accessed in May 2020).

EsFondi.lv (2020e), "RTU inovāciju granti studentiem" [RTU innovation grants for students], *www.esfondi.lv/es-fondu-projektu-mekletajs/project?number=1.1.1.3/18/A/001* (accessed in May 2020).

European Commission (2020), *Country Report Latvia 2020*, Commission Staff Working Document, Brussels, *https://eur-lex.europa.eu/legal-content/EN/TXT/?qid=1584543810241&uri=CELEX%3A52020SC0513*.

European Commission (2018a), *The Latvian Research Funding System*, Brussels, *https://op.europa.eu/en/publication-detail/-/publication/f631a55b-bbba-11e8-99ee-01aa75ed71a1*.

European Commission (2018b), *Digital Innovation Hubs – Smart Specialisation Platforms, Brussels*, *https://s3platform.jrc.ec.europa.eu/digital-innovation-hubs-tool/-/dih/13295/view* (accessed in February 2020).

European Commission (2018c), "Latvia – S3 priorities as encoded in the 'Eye@RIS3' Tool", Smart Specialisation Platform, Version: 1.0.47, Brussels, *https://s3platform.jrc.ec.europa.eu/regions/LV/tags/LV* (accessed on 30 September 2019).

European Commission (2017), *Latvian Research Funding System Background Report: Horizon 2020 Policy Support Facility*, European Commission, Brussels, *http://dx.doi.org/10.2777/4162*.

European Commission (2013), *The Role of Clusters in Smart Specialisation Strategies*, European Commission, Directorate-General for Research and Innovation, Brussels, *https://ec.europa.eu/research/evaluations/pdf/archive/other_reports_studies_and_documents/clusters_smart_spec2013.pdf*.

European Commission (2012a), *Latvia: National Industrial Policy Guidelines for 2014-2020*. Digital Transformation Monitor, European Commission, Brussels, *https://ec.europa.eu/growth/tools-databases/dem/monitor/sites/default/files/DTM_Latvia_vf.pdf*.

European Commission (2012b), *Guide to Research and Innovation Strategies for Smart Specialisation (RIS 3)*, Regional Policy, European Commission, Brussels, *http://s3platform.jrc.ec.europa.eu/documents/20182/84453/RIS3+Guide.pdf/fceb8c58-73a9-4863-8107-752aef77e7b4*.

European Commission/OECD (2020), *STIP Compass: International Database on Science, Technology and Innovation Policy (STIP)*, European Commission, Brussels, OECD, Paris, *https://stip.oecd.org*.

Eurostat (2020a), *ICT Usage in Enterprises – E-business (isoc_eb)* (database), *https://ec.europa.eu/eurostat/web/digital-economy-and-society/data/database*.

Eurostat (2020b), "Renewable Energy Statistics", Eurostat Statistics Explained, *https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Renewable_energy_statistics#Share_of_renewable_energy_almost_doubled_between_2004_and_2018* (accessed on 10 June 2020).

Eurostat (2020c), *Patent Applications to the EPO by Priority Year* (database), *https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=pat_ep_ntot&lang=en* (accessed on 6 May 2020).

Eurostat (2019), *Education Administrative Data from 2013 Onwards* (database), *https://ec.europa.eu/eurostat/cache/metadata/en/educ_uoe_enr_esms.htm*.

Eurostat (2016), *Community Innovation Survey (CIS-2016)* (database), *https://ec.europa.eu/eurostat/web/microdata/community-innovation-survey*.

FAO (2020), *Forestry Production and Trade* (database), *www.fao.org/faostat/en/#data/FO/visualize* (accessed on 20 May 2020).

FFG (2015), *Service Innovations – Funding Guidelines*, Austrian Research Promotion Agency, Vienna, *www.ffg.at/en/programme/service-innovations* (accessed in March 2020).

Galindo-Rueda, F. and F. Verger (2016), "OECD taxonomy of economic activities based on R&D intensity", *OECD Science, Technology and Industry Working Papers*, No. 2016/4, OECD Publishing, Paris, *https://dx.doi.org/10.1787/5jlv73sqqp8r-en*.

Government of Latvia (2013), *Guidelines for Science, Technology Development, and Innovation 2014-2020*, Riga, *https://s3platform.jrc.ec.europa.eu/documents/20182/227021/Guidelines+for+Science+Technology+and+Innovation+2014-2020.pdf/d96566cd-e61b-471b-9f80-4d06236037b4*.

Grinfelds, T. (2018), "Industry trends and challenges in Latvia", presentation for Digital Transformation of the Engineering Industries in the Baltic Sea region – Conference in the framework of "Tech Industry 2018", *https://veca.likta.lv/EN/Documents/TomsGrinfelds-MASOC.pdf* (accessed on 3 October 2019).

IEA (2019a), *World Energy Balances* (database), International Energy Agency, Paris, *www.iea.org/statistics/?country=LVA&isISO=true*.

IEA (2019b), *World Energy Prices*, International Energy Agency, Paris, *http://data.iea.org/payment/products/121-world-energy-prices-2019-edition.aspx*.

IEA (2017), *Digitalisation and Energy*, International Energy Agency, Paris, *www.iea.org/reports/digitalisation-and-energy*.

Lauma Muizniece, A. (2017), "Supporting university technology transfer-struggles and barriers in Latvia", *Ekonomska misao i praksa*, Vol. 26/1, pp. 321-342.

LIDA (2019a), "Inovāciju motivācijas programma" [Innovation motivation programme], Investment and Development Agency of Latvia, Riga, *www.liaa.gov.lv/lv/fondi/2014-2020/inovaciju-motivacijas-programma*.

LIDA (2019b), "Innovation Voucher Program: Financial boost for empowering innovation", Investment and Development Agency of Latvia, Riga, *https://startuplatvia.eu/innovation-voucher*

LIDA (2019c), "Inovāciju vaučeru atbalsta pakalpojumi" [Innovation voucher support services], Investment and Development Agency of Latvia, Riga, *www.liaa.gov.lv/lv/fondi/2014-2020/inovaciju-vauceru-atbalsta-pakalpojumi*.

LIDA (2019d), "Start-up ecosystem", Investment and Development Agency of Latvia, Riga, *www.liaa.gov.lv/en/invest-latvia/start-up-ecosystem* (accessed in October 2019).

LIDA (2019e), "Incentives for R&D", Investment and Development Agency of Latvia, Riga, *www.liaa.gov.lv/en/invest-latvia/investor-business-guide/incentives-investors/incentives-rd* (accessed in October 2019).

LIDA (2019f), "Magnetic Latvia business incubators", Investment and Development Agency of Latvia, Riga, *https://startuplatvia.eu/magnetic-latvia-business-incubators* (accessed in October 2019).

LIDA (2019g), "Startup visa application process", Investment and Development Agency of Latvia, Riga, *https://startuplatvia.eu/files/resources/editor/LV%20Startup%20Visa%20Application%20Process%202019.10.09.pdf*.

LIDA (2019h), "Life sciences", Investment and Development Agency of Latvia, Riga, *www.liaa.gov.lv/en/invest-latvia/sectors-and-industries/life-sciences* (accessed on 5 December 2019).

LSM (2019), "Latvia's Tilde beats Internet giants in machine translation battle", *LSM.lv*, *https://eng.lsm.lv/article/society/education/latvias-tilde-beats-internet-giants-in-machine-translation-battle.a327904* (accessed on 18 October 2019).

Magnetic Latvia (2019), "Startup law benefits", *https://startuplatvia.eu/startup-law-benefits*.

MGI (2019), "BGI Group and European Partners launch project to sequence and analyze 10 million cells", *MGI News Center*, *https://en.mgitech.cn/news/108* (accessed on 17 February 2020).

MoA (2018), *Latvian Bioeconomy Strategy 2030 – Informative Report,* Ministry of Agriculture, Riga, *www.zm.gov.lv/public/files/CMS_Static_Page_Doc/00/00/01/46/58/E2758-LatvianBioeconomyStrategy2030.pdf*.

MoE (2018a), "Clusters", Ministry of Economics, Riga, *www.em.gov.lv/en/sectoral_policy/industrial_policy/clusters*.

MoE (2018b), *Economic Development of Latvia*, Ministry of Economics, Riga, *www.em.gov.lv/files/tautsaimniecibas_attistiba/leap/leap_2018-en.pdf*.

MoE (2018c), "Assessment of Latvian start-up ecosystem, description of the current situation and recommendations for further improvements", Ministry of Economics, Riga.

MoES (2020a), "Latvijā tiek veidota vienota un spēcīga zinātnes politikas ieviešanas iestāde" [A unified and strong science policy implementation institution is being established in Latvia]", Ministry of Education and Science, Riga, *www.izm.gov.lv/lv/aktualitates/4002-latvija-tiek-veidota-vienota-un-speciga-zinatnes-politikas-ieviesanas-iestade* (accessed on 14 May 2020).

MoES (2020b), *RIS3 Info on Investments in RIS3 by Instrument (2014-2018),* Ministry of Education and Science, Riga.

MoES (2018), *Informative Report: Monitoring of Smart Specialization Strategy*, Ministry of Education and Science, Riga, *https://s3platform.jrc.ec.europa.eu/documents/20182/0/RIS3_progress+report_LV_2018.pdf/940176c6-b886-4213-9f18-75c20251bfb9*.

MoES (2015), *Analytical Description of the Ecosystem of Smart Specialization Area "Smart Energetics",* Ministry of Education and Science, Riga, *https://cfla.gov.lv/userfiles/files/1111_Ecosystem%20-%20Smart%20energetics.docx*.

MoES (2013a), *About the development of Smart Specialisation Strategy*, Ministry of Education and Science, Riga, *www.izm.gov.lv/images/zinatne/RIS3_ENG/The_Informative_Report_Development_of_RIS3.pdf*.

MoES (2013b), *Assessment of Export Potential of Economic Sectors*, Appendix 2 to the informative report "On the Development of Smart Growth Strategy and Determination of Specialisation", Ministry of Education and Science, Riga, *www.riseba.lv/sites/default/files/inline-files/Appendix_2_Assessment_of_Export_Potential_of_Economic_Sectors.pdf*.

MoF (2020), *Vadlīnijas par finanšu korekciju piemērošanu, ziņošanu par Eiropas Savienības fondu ieviešanā konstatētajām neatbilstībām, neatbilstoši veikto izdevumu atgūšanu 2014.-2020.gada plānošanas period* [Guidelines on the application of financial corrections, reporting on discrepancies identified in the implementation of European Union funds, recovery of irregularly incurred expenditure in the 2014-2020 programming period], Ministry of Finance, Riga, *www.esfondi.lv/upload/Vadlinijas/vadlinijas_10022020.zip*.

MoH (2019), "Veselības ministre uz laiku apturējusi e-veselības trešās kārtas uzsākšanu", [Minister of Health Temporarily Suspended the Launch of the Third Round of e-Health], Ministry of Health, Riga, *www.vm.gov.lv/lv/aktualitates/preses_relizes/5946_veselibas_ministre_uz_laiku_apturejusi_eveselibas_tresas_kar* (accessed on 14 October 2019).

Miroudot, S. and C. Cadestin (2017), "Services in global value chains: Trade patterns and gains from specialisation", *OECD Trade Policy Papers*, No. 208, OECD Publishing, Paris, *https://dx.doi.org/10.1787/06420077-en*.

Nye Forretningsmodeller (2019), "One Stop Shop for new business models", Copenhagen, *https://nyeforretningsmodeller.dk/english* (accessed in February 2020).

Oderkirk, J. (2017), "Readiness of electronic health record systems to contribute to national health information and research", *OECD Health Working Papers*, No. 99, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9e296bf3-en*.

OECD (forthcoming), *Regulatory Aspects of Data Governance for the Digital Transformation of Agriculture*, OECD Publishing, Paris.

OECD (2020a), *FDI Stocks* (indicator), OECD Publishing, Paris, *https://dx.doi.org/10.1787/80eca1f9-en* (accessed on 28 February 2020).

OECD (2020b), *Main Science and Technology Indicators* (database), OECD, Paris, *www.oecd.org/sti/msti.htm* (accessed on 28 February 2020).

OECD (2020c), *The Digitalisation of Science, Technology and Innovation: Key Developments and Policies*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/b9e4a2c0-en*.

OECD (2020d), "Trade in value added", *OECD Statistics on Trade in Value Added* (database), OECD, Paris, *https://dx.doi.org/10.1787/data-00648-en* (accessed on 27 February 2020).

OECD (2020e), "Research and development statistics: Business enterprise R-D expenditure by industry – ISIC Rev. 4", *OECD Science, Technology and R&D Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/data-00668-en* (accessed on 13 March 2020).

OECD (2020f), "STAN Industry ISIC Rev. 4", *STAN: OECD Structural Analysis Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/data-00649-en* (accessed on 24 February 2020).

OECD (2020g), "Research and development statistics: Gross domestic expenditure on R-D by sector of performance and source of funds", *OECD Science, Technology and R&D Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/data-00189-en* (accessed on 26 February 2020).

OECD (2020h), "Patents by main technology and by International Patent Classification (IPC)", *OECD Patent Statistics* (database), OECD, Paris, *https://dx.doi.org/10.1787/data-00508-en* (accessed on 17 March 2020).

OECD (2020i), *Smart Cities and Inclusive Growth*, OECD, Paris, *www.oecd.org/cfe/cities/OECD_Policy_Paper_Smart_Cities_and_Inclusive_Growth.pdf*.

OECD (2019a), *OECD Economic Surveys: Latvia 2019*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f8c2f493-en*.

OECD (2019b), *Business Innovation Statistics and Indicators* (database), OECD, Paris, *http://oe.cd/inno-stats*.

OECD (2019c), *Education at a Glance 2019: OECD Indicators*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/f8d7880d-en*.

OECD (2019d), *Digital Innovation: Seizing Policy Opportunities*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/a298dc87-en*.

OECD (2019e), *OECD Reviews of Digital Transformation: Going Digital in Colombia*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/781185b1-en*.

OECD (2019f), *R&D Tax Incentives* (database), OECD, Paris, *www.oecd.org/sti/rd-tax-stats.htm*.

OECD (2019g), *Innovation, Agricultural Productivity and Sustainability in Latvia*, OECD Food and Agricultural Reviews, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264312524-en*.

OECD (2019h), *OECD SME and Entrepreneurship Outlook 2019*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/34907e9c-en*.

OECD (2019i), "Country Snapshots: Latvia", in *Financing SMEs and Entrepreneurs 2019: An OECD Scoreboard*, OECD Publishing, Riga, *https://doi.org/10.1787/fin_sme_ent-2019-en*.

OECD (2019j), *Regions in Industrial Transition: Policies for People and Places*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/c76ec2a1-en*.

OECD (2019k), *Benchmarking Higher Education System Performance, Higher Education*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/be5514d7-en*.

OECD (2019l), *Latvia: Country Health Profile 2019, State of Health in the EU,* OECD Publishing, Paris/European Observatory on Health Systems and Policies, Brussels, *https://dx.doi.org/10.1787/b9e65517-en*.

OECD (2019m), *OECD Environmental Performance Reviews: Latvia 2019*, OECD Environmental Performance Reviews, OECD Publishing, Paris, *https://dx.doi.org/10.1787/2cb03cdd-en*.

OECD (2019n), *Enhancing the Contribution of Digitalisation to the Smart Cities of the Future*, OECD Publishing, Paris, *www.oecd.org/cfe/regional-policy/Smart-Cities-FINAL.pdf*.

OECD (2019o), "ICT investments in OECD countries and partner economies: Trends, policies and evaluation", *OECD Digital Economy Papers*, No. 280, OECD Publishing, Paris, *https://doi.org/10.1787/bcb82cff-en*.

OECD (2019p), "Harnessing data to manage biomedical technologies", in *Health in the 21st Century: Putting Data to Work for Stronger Health Systems*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/1df03c3b-en*.

OECD (2019q), "Innovation support in the enterprise sector", *OECD Science, Technology and Industry Policy Papers*, OECD Publishing, Paris, *https://doi.org/10.1787/4ffb2cbc-en*.

OECD (2019r), *Digital Opportunities for Better Agricultural Policies*, OECD Publishing, Paris, *https://doi.org/10.1787/571a0812-en*.

OECD (2018a), "R&D tax incentives: Latvia, 2017", OECD, Paris, *www.oecd.org/sti/rd-tax-stats-latvia.pdf*.

OECD (2018b), "Effective operation of competitive research funding systems", *OECD Science, Technology and Industry Policy Papers*, No. 57, OECD Publishing, Paris, *https://dx.doi.org/10.1787/2ae8c0dc-en*.

OECD (2018c), *OECD Reviews of Digital Transformation: Going Digital in Sweden*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264302259-en*.

OECD (2017a), *OECD Economic Surveys: Latvia 2017*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/eco_surveys-lva-2017-en*.

OECD (2017b), *OECD Territorial Reviews: Northern Sparsely Populated Areas*, OECD Territorial Reviews, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264268234-en*.

OECD (2017c), *The Next Production Revolution: Implications for Governments and Business*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264271036-en*.

OECD (2017d), *Public Procurement for Innovation: Good Practices and Strategies*, OECD Public Governance Reviews, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264265820-en*.

OECD (2016), *Education in Latvia, Reviews of National Policies for Education*, OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264250628-en*.

OECD (2011), "Nordic countries: Matching exceptional design and creativity with progressive policy", in *Intellectual Assets and Innovation: The SME Dimension,* OECD Publishing, Paris, *https://dx.doi.org/10.1787/9789264118263-6-en*.

Ozols, G. (2018), "Cooperation on data driven nation development in Latvia", *Joinup*, Brussels, *https://joinup.ec.europa.eu/collection/egovernment/document/cooperation-data-driven-nation-development-latvia* (accessed on 22 August 2019).

Patent Office of the Republic of Latvia (2019), "Intellectual Property Information Centre", Riga, *www.lrpv.gov.lv/en/patent-and-technology-library/patent-and-technology-library* (accessed on October 2019).

Paunov, C. and S. Planes-Satorra (2019), “How are digital technologies changing innovation?: Evidence from agriculture, the automotive industry and retail”, *OECD Science, Technology and Industry Policy Papers*, No. 74, OECD Publishing, Paris, *https://dx.doi.org/10.1787/67bbcafe-en*.

PPKK (2019), “Digitalisation is at the base of growth – new digitalisation workshops are launched, specifically designed for the food industry”, PPKK.lv, *www.ppkk.lv/en/international-activities* (accessed on 2 October 2019).

Productivity Commission (2017), *Data Availability and Use*, Productivity Commission Inquiry Report, No. 82, Australian Government, Canberra, *www.pc.gov.au/inquiries/completed/data-access/report/data-access.pdf*.

Rovite, V. et al. (2018), “Genome Database of the Latvian Population (LGDB): Design, goals, and primary results”, *Journal of Epidemiology*, Vol. 28/8, pp. 353-360, *http://dx.doi.org/10.2188/jea.je20170079*.

RTU (2019), “RTU Innovation Grants for Students”, rtu.lv, *www.rtu.lv/en/university/rtu-projects/open?project_number=3912* (accessed on 13 May 2020).

RVO (2018), Service Design Vouchers, Agency, N. (ed.), *www.rvo.nl/subsidies-regelingen/service-design-vouchers* (accessed in March 2020).

SENAR (2016), “SENAR-MT Lança Treinamento Sobre Operação de Drones na Agropecuária” [SENAR-MT Launches Training on Drone Operation at Agropecuári], Agro de Precisão.

Strods, J. (2017), “Smart city solutions for small city”, Jelgava City Council presentation, *www.norden.lv/Uploads/2017/09/11/1505122734_.pdf* (accessed on 23 February 2020).

Swedish Ministry of Education and Research (2019), *Swedish National Roadmap for the European Research Area 2019–2020*, Stockholm, *www.government.se/4adab0/contentassets/514bde7beb4d423ea7b7b1f2c50f470f/swedish-national-roadmap-for-era-2019-2020.pdf*.

Takalo, T. (2013), “Rationales and instruments for public innovation policies”, *Bank of Finland Research Discussion Papers*, Vol. 1/2013, *http://dx.doi.org/10.2139/ssrn.2217502*.

Vaivare, L (2018a), “Miracle tree”, *Innovation*, Vol. 3/Summer, Magnetic Latvia, *https://startuplatvia.eu/sites/default/files/resurs_file/InnovationMag3_2018_0.pdf* (accessed on 10 October 2019).

Vaivare, L. (2018b), “Life with a plastic bag on your head”, *Innovation*, Vol. 5/Autumn/Winter, Magnetic Latvia, *https://startuplatvia.eu/files/resources/resource_file/innovation_journal.pdf* (accessed on 15 October 2019).

WITS/UN Comtrade (2020), *UNSD Commodity Trade* (database), *http://wits.worldbank.org* (accessed on 4 February 2020)

The World Bank (2018a), *Focus on Performance – World Bank Support to Higher Education in Latvia, Volume 2: Internal Funding and Governance*, The World Bank, Washington, DC.

The World Bank (2018b), *Focus on Performance –World Bank Support to Higher Education in Latvia, Volume 3: Academic Careers*, The World Bank, Washington, DC.

Notes

Israel

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.

1. The ERDF is one of five European Structural and Investment Funds (ESIF). The other funds are: the European Social Fund (ESF), the Cohesion Fund (CF), the European Agricultural Fund for Rural Development (EAFRD) and the European Maritime and Fisheries Fund (EMFF).
2. The OECD defines smart cities as “initiatives or approaches that effectively leverage digitalisation to boost citizen well-being and deliver more efficient, sustainable and inclusive urban services and environments as part of a collaborative, multi-stakeholder process” (OECD, 2020i). The smart city definition of the Latvian Ministry of Environmental Protection and Regional Development can be found in the same document.

3. The (value-added) RCA is defined as the share of value-added originating from a given sector in a country's exports divided by the share of value-added originating from this sector in world exports. In a world without any trade distortion, the RCA would be a good proxy for what economists define as comparative advantage. A country has a comparative advantage in a sector when this share is above 1 (i.e. when the value-added coming from this sector represents a higher share for this country as compared to the world average) (see Miroudot and Cadestin, 2017).
4. Changes in the export value over time do not fully account for specific price changes of products within the export basket. Possible developments in wood chemistry and new biomaterials (see below) are not captured in these figures.
5. R&D expenditure directed towards the bioeconomy also arises in fields such as engineering and technology, for example in relation to process innovations or new machinery.
6. Calculations are based on OECD (2020h) and consider patent applications filed under the Patent Cooperation Treaty (PCT), using the priority data and the inventor's country of residence as defining characteristics. Counts are based on the list of IPC codes given in each patent document, and use fractional counts.
7. Precise data for the government sector are not available for 2016 due to confidentiality reasons.
8. OECD calculations based on OECD (2020h).
9. The strategic use of public procurement for innovation is defined as any kind of public procurement practice (pre-commercial or commercial) that is intended to stimulate innovation through research and development and the market uptake of innovative products and services (OECD, 2017d).
10. OECD calculations based on WITS/UN Comtrade (2020).
11. OECD calculations based on OECD (2020h).

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