European Commission

JRC SCIENCE FOR POLICY REPORT

RIO COUNTRY REPORT 2015: Latvia

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2016

EUR 27867 EN

Joint Research Centre

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JRC Science Hub
https://ec.europa.eu/jrc

JRC101203

EUR 27867 EN

PDF ISBN 978-92-79-57802-1 ISSN 1831-9424 doi:10.2791/917332 LF-NA-27867-EN-N

How to cite: Gundars Kulikovskis, Diana Petraityte, Blagoy Stamenov; RIO Country Report 2015: Latvia; EUR 27867 EN; doi:10.2791/917332

Abstract
The 2015 series of RIO Country Reports analyse and assess the policy and the national research and innovation system developments in relation to national policy priorities and the EU policy agenda with special focus on ERA and Innovation Union. The executive summaries of these reports put forward the main challenges of the research and innovation systems.

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Foreword

The report offers an analysis of the R&I system in Latvia for 2015, including relevant policies and funding, with particular focus on topics critical for EU policies. The report identifies the main challenges of the Latvian research and innovation system and assesses the policy response. It was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites etc. The quantitative data is, whenever possible, comparable across all EU Member State reports. Unless specifically referenced all data used in this report are based on Eurostat statistics available in February 2016.

Acknowledgments

The report draft has benefited from comments and suggestions of Zane Ozola from the Ministry of Education and Science.

Comments from DG RTD are gratefully acknowledged.

Peter Fako, Lorenzo Isella and Athina Karvounaraki produced the statistics and the analytical assessments for sections 3.2 and 3.6 of the report.

We would like to thank Sophie Bodart and Françoise Gandrey for their assistance in preparing this report for publication.

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Executive summary

The report offers an analysis of the R&I system in Latvia for 2015, including relevant policies and funding, taking into account the priorities of the European Research Area and the Innovation Union. The report was prepared according to a set of guidelines for collecting and analysing a range of materials, including policy documents, statistics, evaluation reports, websites, etc. The quantitative and qualitative data is, whenever possible, comparable across all EU Member State reports.

Context

Latvia, like its Baltic neighbours, was heavily affected by the 2009 recession, when real GDP per capita fell by 14%. However, since 2010, the economic downturn in Latvia was replaced by growth. In 2011 and 2012, GDP increased by close to 5%, in 2013 by 3%, and in 2014 by 2.4%. Exports of Latvian goods and services (mostly in the sectors of machinery production, wood and timber products, agriculture and food products) have been the driver of the economic growth in the recent years. So far the global competitiveness of indigenous firms has been achieved mainly due to low labour costs, but further improvement of competitiveness will depend on the readiness of business for technology absorption. Businesses in Latvia still rely heavily on the acquisition of machinery as one of the most important mechanisms for knowledge acquisition. This strategy has been successful so far if one looks at real labour productivity per person employed where Latvia fares very well with an average growth rate in the last 5 years among the highest in the EU (together with Bulgaria, Romania and Lithuania). However, this also signals that the Latvian economy is in an efficiency-based rather than knowledge-based growth mode.

The economic crisis hit Latvia very hard and it was under extreme pressure to pursue fiscal austerity measures. Those measures were implemented across the board, including R&D allocations (cut by almost a half). The public R&D expenditure started recovering after 2010 but overall R&D spending (both public and private) remains one of the lowest in the EU. It is largely thanks to the EU Structural funds that Latvia continued to fund its R&I policy mix in the post-crisis period.

The R&I system of Latvia is characterised by very low R&D intensity (low figures of gross expenditure on R&D (GERD) as percentage of GDP in comparison to other EU member states), both in the public and in the private sector, and a strong dependence on European funding. Public R&D spending was 0.44% of GDP in 2014 and private R&D expenditure (BERD) was 0.24% of GDP (Central Statistical Bureau of Latvia) – both among the lowest in the EU-28. Public R&D budgets suffered significant cuts after the crisis due to austerity measures and GERD (in absolute numbers) has stagnated in the recent years. The current R&I policy mix in Latvia is mainly funded by the European Regional Development Fund (ERDF) and the European Social Fund (ESF). Data for 2014 shows significant improvement in overall R&D intensity. Overall GERD improved by 13.3% compared to 2013 from 0.6% of GDP in 2013 to 0.68% of GDP in 2014. BERD also increased from 0.17% to 0.24%. In order to fulfil its research, development and innovation targets, however, Latvia still has to significantly improve the pace of R&D expenditure growth.

The comparison of the number of R&D jobs in the three Baltic States also reveals big differences. In 2014 in Latvia R&D personnel was 0.58% of the whole active population, as reported by Eurostat. In the same reference year, Lithuania's share of R&D personnel was 0.76%, Estonia's – 0.86% and the EU-average stood at 1.14%. In fact, in R&D personnel numbers the difference between Latvia and its neighbouring countries and the EU average seems to be as extensive as the gap in total funding.

According to the Innovation Union Scoreboard 2015 (IUS) Latvia belongs to the group of "modest innovators" together with Bulgaria and Romania and its relative performance is about 50% of the EU average.

Key developments in the R&I system in 2015 included:

- The Ministry of Education and Science introduced a new approach to higher education financing - financing of HEIs is tied to their institutional evaluation score and is expected to stimulate attraction of external financing to research and signals to institutions that research is important part of the education process;
- Paying taxes was made easier for companies by simplifying the VAT return, enhancing the electronic system for filing corporate income tax returns and reducing employers' social security contribution rate;
- Changes in the Law of Public Procurement regarding innovation and research projects started to be discussed with the aim to simplify procurement procedures and to make it easier to purchase services of external experts for evaluation of research projects.

The national policy mix is, to various degrees, aligned with the ERA pillars. Most of the ERA objectives are addressed, though with variable rates of performance. Almost all national policy measures to support research are targeted to research organisations registered in Latvia and foreign partners could be involved only on a subcontract basis. While research grants are portable to another national research institution, the current law does not regulate the portability of grants to another country. National grants are open to non-residents if they are employees of a contracting institution.

With the aim to promote cooperation between academia and industry in the recent years a plethora of measures have been continued or introduced. However, support for new innovative companies is sparse, with underdeveloped financial instruments. Demand-side instruments are also not developed which significantly influences innovation performance of both public and private sectors. The main supporting measures providing incentives for businesses to invest in R&D are direct support schemes and tax incentives are very recent. The country scores poorly in IUS rankings, but is on the path of important reforms which are expected to bring more efficiency in the system.

The identified challenges for Latvia's R&I system are:

1. Encouraging private sector innovation capacity, investment and collaboration with science;
2. Continuing the reform in the public research system (the new HEI funding model and the consolidation of research institutions) and strengthening public R&D capacity.

R&I Challenges

Challenge 1: Encouraging private sector innovation capacity, investment and collaboration with science

Description

BERD in Latvia is very low. In 2013 it was just 0.17% of GDP compared to the 1.29% EU-28 average. Even taking into account the growth of BERD in 2014 (to 0.24% of GDP), the level of BERD remains low compared to the benchmark. Moreover, the Innovation Union Scoreboard output indicators for Exports of medium and high-technology products as a share of total product exports as well as Sales of new-to-market and new-to-firm innovations as percentage of turnover are at the bottom, which signals very low innovation capacity of local companies. Another indicator of low innovation performance of the private sector is the share of innovative companies in Latvia - just 29.9% (for comparison, in Lithuania it is 34.5%, in Estonia – 56.8%, EU average - 52.9%)[1]. The Council Country Specific Recommendations for Latvia in the framework of the European Semester 2015 include an R&I recommendation connected to this challenge: "Better target research financing and incentivise private investment in innovation on the basis of the Smart Specialisation Framework".

The low innovation capacity both in terms of low technology absorption and investment readiness is rooted in several reasons. The first one is the industrial structure itself: the competitiveness of the Latvian economy is based on cheap labour force and processing of natural resources. The most prominent sectors in the Latvian economy are still the traditional ones (e.g. food, wood and timber) accounting for the largest share in value added and employment. The export structure is dominated by low or medium technology segments (more than 82% of total processing industries [2]) and the share of manufacturing industry sectors is low[3].

In addition, competitiveness of the private sector is hampered due to a lack of collaboration with research institutes and universities. Evidence for weak knowledge transfer could be inferred by the low level of privately-funded public R&D expenditure (0.046% of GDP in 2014), by the low number of public-private co-publications per million of population (in 2013 Latvia had only 6.4 compared to 29 for the EU-28)[4] and by the low number of researchers employed in business (the 0.09% value in 2014 locates it among the bottom in EU-28)[5].

Finally, the 5 sectors that the RIS3 Strategy and the Industrial policy guidelines identify as future growth sectors are: (1) knowledge-based bio-economics), (2) bio-medicine, medical technologies, bio-pharmacy and biotechnologies, (3) advanced materials, technologies and engineering systems; (4) smart energy; (5) information and communication technologies (ICT). These sectors could be viewed as "guidelines" that have the potential to lead towards structural changes in Latvia's economy under proper conditions. These specific areas were identified as they possess not only observable export value gaps, but also have the potential for knowledge and competence development that could close the gap. However, solely focusing financing and development activities in these fields might not be enough as improvement in the absorptive capacity of the industry requires a big enough pool of qualified R&D specialists. Thus, the RIS3 in Latvia is focusing more on the development of human capital, and the strategy's success in the priority development areas will be measured by the increase in the total number of R&D jobs (especially in the business sector) as well as investment as a percentage of GDP.

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[1] Partnership Agreement for the EU Funds Programming Period 2014 – 2020, based on Eurostat
[2] National Industrial Policy Guidelines for 2014-2020. http://polsis.mk.gov.lv/view.do?id=4391, pp.6-11
[3] National RTDI Guidelines for 2014-2020. http://polsis.mk.gov.lv/view.do?id=4391, p. 17
[4] RIO elaboration based on Scopus data.
[5] Eurostat: Total R&D personnel (FTE) by sectors of performance, occupation and sex as % of total employment

Policy response

Latvia has introduced policy initiatives aimed at addressing the challenge of low business innovation capacity. The Council gave Latvia a CSR on the issue for the first time in 2012: "Design and implement an effective research and innovation policy encouraging companies to innovate, including via tax incentives and upgrading infrastructure". As a result, some policy instruments geared towards the industrial sector were launched in the end of 2012 and carried out in 2013 - 2015 (funded to a significant extent by the SFs)[6]:

- *Development of New Products and Technologies* – implementation of 116 projects for the total financing of €37.6 m;
- *High Value-Added Investments* - 107 supported projects with total financing of €134.4 m;
- *Introducing New Products and Technologies in Production* – 107 projects for the total amount of €32.9 m were completed by the end of 2013;
- *New Product and Technology Development Programme in SMEs* – innovation vouchers, total SF financing €2.85 m;
- *Competence Centres* – 6 competence centres, acting as platforms for collaborative projects, are supported with total public financing in the amount of €53.2 m by 2015[7]

In addition, the *Innovation Motivation programme* ("Measures to Encourage Innovations and Business Start-ups") was also launched and as a result several educational, training and information measures have been implemented (e.g. a training course "Become an Entrepreneur in 5 days", the innovative business idea competition "Idea Cup 2014", etc.)[8].

The Innovation vouchers and the Motivation programmes will be continued in the new programming period 2014-2020 and new ones are being planned, e.g. *Conquering external markets* (budget: €31.8 m) and a set of measures to increase the number high-growth enterprises (total budget €75 m)[9]. The *Cluster programme* will also be continued with a budget of €6.2 m with the aim to promote the collaboration between so far unconnected enterprises and research institutions, to improve the competitiveness of enterprises, to boost export volumes, and to promote the development of new products. As of 2014, the programme supports 11 cluster projects which involve at least 300 enterprises, more than 20 educational and research institutions, as well as several non-governmental organisations and local governments.[10]

Last but not least, in 2013 the Saeima (Parliament) adopted amendments to the Law on Corporate Income Tax, which stipulates that from 1 July 2014 a new tax incentive is in force with the aim to encourage the investment of private sector in R&D, providing that certain corporate R&D costs are written off the year in which they arise with the application of value-enhancing coefficient of 3. Eligible costs are compensation of scientific and technical personnel, costs of services received from research institutions, costs of certification, testing and calibration services.

[6] National Reform Programme 2015
[7] National Reform Programme 2015
[8] RIO Country Report Latvia 2014
[9] The measures listed by the Economics Ministry addressing this goal are:
Seed and start-up capital funds (€30m budget);
https://em.gov.lv/lv/es_fondi/atbalsta_pasakumi_2014_2020/seklas_un_sakuma_kapitala_fondi/
Growth capital funds (€30m budget);
https://em.gov.lv/lv/es_fondi/atbalsta_pasakumi_2014_2020/izaugsmes_kapitala_fondi/
Technology accelerator (€15m budget);
https://em.gov.lv/lv/es_fondi/atbalsta_pasakumi_2014_2020/tehnologiju_akselerators/
[10] RIO Country Report Latvia 2014

As regards knowledge transfer, relevant measures that have been implemented (and will be continued in the next programming period) include:

Technology Transfer Programme – two-tier program: first tier is focused on local HEIs/PROs and 8 TTOs were established in the main universities, the other is centralized and aims at commercialization in international markets; total budget in the new programming period is €24.5m[11].

Assessment

The 2007 – 2014 policy mix consisted of a plethora of measures, some of them too fragmented and small-scale to effectively tackle the challenge. The key shortcomings remain the low level of government financing for R&D&I, the overreliance on structural funds and the lack of strategic focus. Moreover, the majority of projects described in the previous section were implemented mostly by firms with only few cases of collaborative research with PROs[12]. From the intended two-tier Technology transfer program only the first tier was implemented in the previous programming period, cutting off international competence building and grants for IPR portfolio building[13]. Even the first tier hasn't been very successful because it takes a very long time and a quite good university to build up a portfolio that is good enough to be profitable (on the quality of Latvian science base see Challenge 2). As regards the recent tax incentive scheme, it's still too early to evaluate its effectiveness. The first impact evaluation of the tax incentive was scheduled in the second half of 2015.

Public procurement for innovation and other demand-led policy instruments are largely absent in Latvia. According to the results of the Global Competitiveness Report 2014-2015[14] government procurement of advanced tech products in Latvia with the evaluation of 3.2 points takes the 92nd place in the total evaluation of 144 countries.

International markets tend to be more demanding of innovation than domestic ones, so as a small open economy (with exports contributing nearly a third of GDP) Latvia should orient its policy towards them (the new programme *Conquering external markets* is a step in this direction). However, according to the Latvian Innovation System Review and Research Assessment Exercise by Technopolis Group (2014) raising the level of absorptive capacity in individual firms is a precondition for them to be able to recognise and respond to (external) market signals demanding innovation. The report mentions two kinds of interventions that can be undertaken in this respect: helping companies to understand improvement opportunities through awareness raising, training and pilot-testing, and "injecting" additional qualified human resources into firms. However, human resource availability has been a long-standing problem for Latvia due to ageing of the STI workforce, uncompetitive wages, and brain drain[15].

The key for structural reforms is based on Latvia's capability of restructuring traditional sectors and supporting emerging new innovating companies on the way to become mature innovators. To that end, Latvia should take advantage of its smart specialisation strategy and use it as a basis to steer investments into those sub-areas with the highest economic potential and to leverage private investment. RIS3 was taken as an economic transformation agenda where building up R&I human capital across the spectrum to gain critical mass was identified as a precondition. The selected areas were based on the needs of the industries with biggest value gaps based on export volume prices. It is expected that the build-up of critical mass of R&I human capital will allow for firms to exploit their existing production factors and move gradually up on the product ladder to more complex and value added products. Given the current stage of economic development and economic structure (multiple niches with room for improvement),

[11] Latvian Ministry of Economy
[12] Latvian Ministry of Economy
[13] RIO Country Report Latvia 2014
[14] http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf
[15] OECD STI Outlook Latvia 2014

many improvements in the business sector innovation capacity do not necessarily require narrow, specific frontier research for the next several years and a broad focus could be justified[16]. However, there is also a risk that the identified S3 priorities are too broad. In any case, the implementation of RIS3 should avoid spreading resources too thinly across all areas of identified needs, risking a continuation of the policy fragmentation characterizing the 2007-2014 period[17].

Challenge 2: Continuing the reform in the public research system and strengthening public R&D capacity

Description

A small country like Latvia until recently used to have a total of 150 registered research institutions. The practice of registering any qualifying, self-defined small group of researchers as a research unit results in a structure that is fragmented and duplicative across all areas of research. None of the country's universities is among the top universities in Europe. Various reports state that the main challenges in the Latvian public research system are an inadequate public funding system, low levels of internationalisation, insufficient human resources and a lack of internationally-approved accreditation[18]. Public expenditure per student is among the lowest in the EU, and the financing model until recently lacked performance-based components[19].

The Council CSR 2014 included a recommendation worded as follows: "Step up implementation of the higher education reform, in particular through the establishment of an independent accreditation agency and a financing model that rewards quality. Take steps for a more integrated and comprehensive research system also by concentrating financing towards internationally competitive research institutions."

Inadequate public funding in a fragmented research and innovation system (fragmentation makes an increase in public financing ineffective) is naturally leading to a lack of scientific excellence (for example, the share of scientific publications in the top 10% of the most cited is 4% and falling and the licence and patent revenues are very low[20]). An adequate quality of the science base is a necessary precondition for improving knowledge transfer and for addressing the needs of local industry (see challenge 1). In that context, the fact that public R&D intensity reached only 0.44% of GDP in 2014 and remains excessively dependent on EU structural funds signals the existence of a clear challenge.

The scientific excellence challenge is exacerbated by the lack of human capital and low level of internationalisation. The number of new doctoral graduates per thousand population aged 25–34 in Latvia is among the lowest in the EU (0.95 in 2012, EU average: 1.81)[21]. The proportion of foreign university students and professors in Latvia is also low and the national requirement that most teaching and research must be done in Latvian ("Official Language Law"[22]) is a further obstacle[23].

Policy response

Large-scale reforms of HEIs and PROs are currently under way to improve the quality and relevance of public R&D. As part of this process, research institutions have been assessed by international experts (in co-operation with the Nordic Council of Ministers and NordForsk, undertaken by Technopolis[24]) and the results came out in 2014.

[16] Focusing on narrow areas of excellence can break the link between R&I and the capacity of the production base to absorb the results of R&I.
[17] Technopolis, Expert assessment of RIS3 ex-ante conditionality compliance, 2014
[18] EC Staff Working Document 2015
[19] Ibid.
[20] Innovation Union Progress at Country Level Latvia 2014
[21] Eurostat
[22] Originally "Valsts valodas likums". Available at: http://likumi.lv/doc.php?id=14740
[23] Technopolis, Latvia Innovation System Review and Research Assessment Exercise
[24] Technopolis, Latvia Innovation System Review, and Research Assessment Exercise

According to the assessment, only 15 out of 150 evaluated research institutes and research groups in HEIs received the highest evaluation and were recognized as international players.

As a result, the first step after amendments in the Regulation on "Order of calculation and allocation of institutional funding to research institutes"[25] was to reduce the number of registered research groups to 90. The reform is currently continuing with further consolidation by merging the weaker institutions with excellent ones, by consolidating similar research structures and by limiting financial support only to PROs which after the consolidation process will have more than 25 FTE of research personnel (in several specific sectors 10 or 5).[26] In addition, the government provided (on limited competition basis) additional €9.9 m of funds to support excellent institutes to develop their strategy and to integrate weaker institutions until November 2015.[27] The reform also entails an increase by 10% of the calculated basic infrastructure grant to those research institutions which received an evaluation score 4 or 5 (i.e. are among excellent science organisations) since 1 January 2015 and excludes those whose evaluation marks are 1 or 2 (starting from 1 January 2016).

In addition, a reform of the way universities are financed is taking place. A new quality-targeting financing model has been developed, based on the recommendations from a recent World Bank study[28], and some performance-oriented funding will be piloted in 2015-2016. The WB recommendations suggest a three pillar model which foresees a combination of stable financing (basic funding – pillar 1) with performance based component using a formula with performance indicators (pillar 2), and an innovation component based on three mission target agreements with the Ministry of Education and Science (pillar 3). The legal acts regarding the above-described model have been adopted by the end of 2015.

In terms of relevant policy measures aimed at increasing the scientific excellence, in the 2014-2020 programming period some of the programs are: *Strengthening the institutional capacity of scientific institutions* (€15.25 m), *Grants for post-doctoral research* (€64 m), *Practically oriented research* (€76.5 m), *Development of the R&D infrastructure* (€100 m).

Assessment

Latvia has embarked on ambitious and large-scale reforms to address the problems in the public research system. It's currently on track to finalize the process of consolidation of research institutions although the pace could be faster. The country has also made gradual progress in setting up an internationally approved accreditation system and the plans to introduce a new financing model are indicatively foreseen for 2016. The financing and the consolidation processes are slowed down by a lot of vested interests – a reluctant big part of the research community whose funding would be cut as a result of the reforms.

Notwithstanding the ambitious reforms, the most fundamental problems of the Latvian public research remain the very low level of research funding across the whole system and the lack of orientation of research objectives towards the needs of industry.

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[25]Related normative acts: (1) Informative Report of the Cabinet of 19 August 2014 *"On Implementation of the Structural Reforms of Science of Latvia until 1 July 2015"*; (2) Conceptual Report of the Cabinet of 9 June 2015 *"Introduction in Latvia of a New Model for Financing of Higher Education in Latvia"*; (3) Cabinet Order No. 331 of 26 June 2016 *"On the Plan for 2015-2017 for Implementation of the Education Development Guidelines 2014-2020"*; (4) Cabinet Order No. 333 of 29 June 2015 *"On Introduction in Latvia of a New Model for Financing of Higher Education in Latvia"*; (5) Amendments to the Cabinet regulation No. 994 of 28 July 2015 *"Procedures for the Financing of Institutions of Higher Education and Colleges from the Funds of the State Budget"*.

[26] Information Report on State research structural reforms implementation till July 1st, 2015 from September 11th, 2014, p.20

[27] RIO Country Report Latvia 2014

[28] World Bank Report on introduction of the new financing model for Higher Education in Latvia. More on http://viaa.gov.lv/lat/izglitibas_petijumi/petijums_ai_finansesana/

Demographic trends of migration and brain drain exacerbate the issue further although the number of PhD graduates has been steadily rising in the recent years.

Last but not least, the entrepreneurial culture is still underdeveloped in Latvian universities and thus requires more effective incentive systems, e.g. modifications to the career criteria for researchers, university IPR policies, critical evaluation of the effectiveness of the existing knowledge transfer offices, and entrepreneurial training. Instead of encouragement for researchers to spin off and convert their knowledge into products, there is a tendency to unnecessarily complicate such activities, for example by requiring all research costs to be covered upfront, before the attempt to convert research into product shows any signs of commercial viability.

1. Overview of the R&I system

1.1 Introduction

Latvia is a small country that covers an area of 64,573 km². As of January 1st, 2015, its total population stood at 1,986,173 and constituted 0.39% of the EU-28 population. Latvia's population has been steadily decreasing since 1990 and in 2014 the population dropped by 15,400 (Eurostat, 2015c).

Latvia's Gross Domestic Product (GDP) per capita in Purchasing Power Standards (PPS) in 2012, 2013 and 2014 was 60%, 64% and 64% of the European Union (EU) average, respectively. Economic indicators had slightly declined in Latvia after the crisis in 2008, but quickly recovered and surpassed the pre-crisis levels by 2013. As indicated in Table 1, Latvia's GDP per capita in current prices increased from €10,800 in 2012 to €11,300 in 2013 and €11,800 in 2014. Yet at the end of 2014, the absolute GDP per capita in Latvia was still less than half of the EU average of €27,400. The real GDP growth rate in Latvia has been slowing over the past three years (4% in 2012, 3% in 2013 and 2.4% in 2014). However, growth is still above the EU-28 average of 1.4% in 2014.

Latvia's total unemployment rate spiked by almost 10% as a result of the financial crisis. At the time, it was the biggest rise in unemployment in the EU. Beginning in 2011, the unemployment rate started to decrease and rapidly converged with the EU average. In 2014, as a percentage of the labour force, the unemployment rate was 10.8% in Latvia and 10.2% in the EU on average (data for 2012 and 2013 are presented in Table 1).

Over the past three years, Latvia's public finances have been quite stable with both GDP per capita and GDP growth rate indicators being below the EU average. Budget deficit figures presented as a percentage of the public budget were 0.8%, 0.9% and 1.5% in chronological order, while the average EU budget deficit in 2014 was 3%. Government debt as a percentage of GDP remained around 40% in Latvia (Table 1), whereas the EU average has been increasing from around 80% since 2011 on a year-to-year basis. In 2014, the EU average general government gross debt was 86.8% of GDP (Eurostat, 2015a).

Decomposition of the value added as a percentage of GDP by sector of origin, provided by the World Bank, indicates that the service sector accounted for 80.2% of Latvia's value added in 2014. Two other sectors that have been steadily losing their relative weights are the industrial and the agricultural sectors, accounting for 16.4% and 3.4% of GDP in 2014, respectively (World Bank, 2015). The country's medium-low and low-tech industries, however, still account for around 82% of the entire manufacturing industry.

Table 1. Main R&I indicators 2012-2014.

Indicator	2012	2013	2014	EU average (2014)
GDP per capita, EUR, current prices	10,800	11,300	11,800	27,400
GDP growth rate	4.0%	3.0%	2.4%	1.4%
Budget deficit as % of GDP	-0.8%	-0.9%	-1.5%	-3.0%
Government debt as % of GDP	41.4%	39.1%	40.6%	86.8%
Unemployment rate as percentage of the labour force	15%	11.9%	10.8%	10.2%
GERD in €m[29]	145.4	139.5	162.8	9714.3 (2013)[30]
GERD as % of the GDP	0.66%	0.6%	0.68%	2.03%
GERD (EUR per capita)	71.7	69.1	81.9	558.4
Employment in high- and medium-high-technology manufacturing sectors as share of total employment	1.5%	1.8%	1.6%	5.7%
Employment in knowledge-intensive service sectors as share of total employment	36.5%	36.1%	35.7	39.8%
Turnover from innovation as % of total turnover	5.9% (2008)	3.1% (2010)	5% (2012)	11.9% (2012)
Value added of manufacturing as share of total value added	20.3%	19.6%	n.a.	26.2% (2012)

Source: Eurostat.

With Gross Expenditure on Research and Development (GERD) at 0.68% of GDP (2014), Latvia is among the EU member states with the least Research and Development (R&D) intensity in terms of the total costs of its research and development activities. Moreover, R&D intensity in Latvia is surpassed significantly by its neighbouring Baltic states (Eurostat, 2015b). Given its R&D intensity growth rates, the European Commission (EC) assigns Latvia to the group of member states that need to substantially increase their R&D intensity growth in order to reach the intended target (European Commission, 2013). Meanwhile, in 2014, Latvia experienced significant (13%) annual growth of GERD, from 0.60% to 0.68% of GDP. The increase can mostly be attributed to the business sector, the R&D expenses of which grew from €39.5m in 2013 to €57.8m in 2014. The business enterprise sector (BES) also added a significant amount of R&D jobs in the same year – the number of R&D personnel in full-time equivalent (FTE) in the BES increased from 981 in 2013 to 1,382 in 2014.

The absolute figures for GERD in Latvia decreased from €145.4m in 2012 to €139.5m in 2013. In 2014, the absolute figure corresponding to the aforementioned 0.68% of GDP was €162.8m. Taking an overview of the years prior to 2014, the same trend was seen

[29] Latvian absolute GERD data source: Central Statistical Bureau in Latvia; http://www.csb.gov.lv/en/statistikas-temas/science-key-indicators-30753.html
[30] A total of 272 billion EUR in EU-28 in 2013 divided by 28. Source: Eurostat; http://ec.europa.eu/eurostat/statistics-explained/index.php/R_%26_D_expenditure

in R&D intensity (GERD as % of GDP) figures – from its peak of 0.7% in 2011 it decreased to 0.66% and then dropped to 0.6% in 2012 and 2013. The fall of the R&D intensity figures in these years were mainly caused by the decrease in Business Expenditure on R&D (BERD) in 2012 and the expenditures in the Higher Education Sector (HES) during both 2012 and 2013. The expenditures in the government sector as a fraction of GDP only slightly fluctuated at around 0.17% over the period 2011-2014 (Table 3).

Latvia's 2020 R&D objective is set at 1.5% of GDP. The National Reform Programme[31] of Latvia (NRP) forecasts the total R&D financing to be €500m in 2020. The private sector investment in R&D, according to the National Development Plan of Latvia for 2014-2020,[32] is set to reach at least 48% of the total investment in R&D by 2020. This corresponds to BERD/GDP target of 0.72% by 2020.

Given the ambitious target of 48% of total R&D funds, or 0.72% of GDP, coming from the private sector, it is important to analyse the historical performance of the country's business sector funding. Here, a familiar pattern emerges – the total funding figures in Latvia seem to be falling behind those of both the reference countries and the EU-average; this is even more apparent when it comes to the number of R&D personnel employed in the BES. The number of people employed in R&D in the business sector in Latvia in 2013 (981 in FTE terms) was less than half of Lithuania's (2,401) and Estonia's (2,069) totals.[33] While BES R&D personnel accounts for 0.19% of the economically active population in Lithuania, 0.27% in Estonia and 0.62% on average in the EU, in Latvia they only comprise 0.14% of the active population (2014 figures).

In terms of total BERD, the gap between Latvia and the EU28 is quite wide. In parallel with the underdeveloped human resources problem in the business sector R&D activities, another explanation could be that R&D activity in the Latvian business sector is underreported. Only recently has Latvia developed legislation that would create incentives for businesses to separate R&D costs from their other costs. Given that before 2014 no benefit was granted to companies performing R&D, some of their R&D activities might have been reported with other types of costs instead. While purely hypothetical since the actual numbers of such companies would be difficult to obtain, this idea is supported by ample anecdotal evidence. If the underreporting of the level of R&D activity carried out by businesses is actually proven, the introduction of the planned R&D tax incentive might contribute to increasing BERD by not only stimulating actual expenditures but also by improving the accuracy and frequency of their reporting. The tax incentive providing a tax relief for companies performing R&D was decided upon in the middle of 2014. More information on the tax incentive and other measures to encourage R&D investments in Latvia is presented in section 3.5.

1.2 Structure of the national research and innovation system and its governance

1.2.1 Main features of the R&I system

Research and innovation (R&I) policy in Latvia is predominantly developed, funded and implemented at the national level. The institutional role of the regions in research governance is comparatively limited. The country as a whole is categorised as a single region at the Nomenclature of Territorial Units for Statistics 1 (NUTS) level. The five existing planning regions have neither the necessary level of responsibility nor the funding capacity to develop their own explicit R&D policies. At the level of regional planning, the main bodies are the Planning Region Development Councils, which are elected by the municipalities of the respective planning regions. They are responsible for

[31] http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_latvia_en.pdf
[32] http://www.pkc.gov.lv/images/NAP2020%20dokumenti/NDP2020_English_Final__.pdf
[33] At the time of the report, only the data for 2013 was available for Estonia with respect to its R&D personnel numbers. Thus, for comparison purposes, 2013 data was used here for all three Baltic states.

setting the main principles, objectives and priorities of long-term development, drafting the regional development programme and undertaking territorial planning in compliance with the national development strategy.

The national "Guidelines for Development of Science and Technology for 2014-2020" draw attention to the promotion of R&I activities in regions where they are less developed than they are in the capital city. The capital Riga is the centre for research activities since this is where most of the public research and higher education institutions are located. The need for regional R&D policies should be considered carefully, however, given the low population density outside of Riga. 66.8 % of GDP (2012)[34] is produced in Riga or in the surrounding area and more than half of the country's population[35] lives or works within this zone as well. In order to reach R&D critical mass, the centralisation of the policies and the concentration of R&D promotion in Riga seem rational. Riga is the only region in Latvia with a critical mass in place, thus, it is more likely to attract new players and capital in R&D. There are, of course, some exceptions where specialised R&D infrastructure is found outside of Riga. One such example is the huge radio telescope that is found in the Ventspils region.

Latvia belongs to the group of EU member states whose research and innovation systems are dominated by the public sector (more than 60%). This group is referred to as public-sector-oriented and is characterised by its low level of business sector R&D and patenting activities, especially when it comes to high-tech patents. However, public research is commonly quite active in these countries, which usually results in greater publication intensity (Erawatch, 2010). In 2014, Latvia's GERD breakdown by source of funds was the following: business enterprise sector – 27.8% of total GERD; government and higher education sectors – 28%; foreign financing, the majority of which comes from the EU Structural Funds administered by governmental agencies – 44.2%. The importance of striking a funding source balance has been acknowledged in the Lisbon Agenda. It specifies that an appropriate split for R&D would be one-third financed by public funds and two-thirds by private.

According to the Central Statistical Bureau (CSB) of Latvia, 490 institutions and 3,748 researchers (FTE) were involved in R&D activities in 2014. The number of institutions engaged in R&D had increased by 68 since the end of 2013. The number of researchers in R&D had been decreasing since 2011, falling by 1% and 7% in 2012 and 2013, but it began to increase in 2014 when the annual growth equalled 3.4%. However, the increase was not sufficient to restore the number of researchers to what it had been in 2011. 12.2% of the institutions engaged in R&D in 2014 were affiliated with the higher education sector, 3.9% with the government, and 83.9% with the business enterprise sector. The shares of the institutions engaged in R&D have decreased in the HES and the governmental sector since 2013. However, that does not mean that fewer institutions are currently engaged in R&D in these sectors. Rather, the numbers have remained almost constant, thus indicating that a greater number of companies in the BES (69 in total) are now engaged in R&D. Researcher distribution across sectors, however, reveals a different pattern. 61% of researchers come from higher education institutions, 18% come from the public sector, and almost 21% come from the business enterprise sector (Central Statistical Bureau of Latvia, 2015). Compared to the pre-2013 figures, it appears that after a long period of time the number of business sector researchers now exceeds the number of governmental sector staff.

[34] http://data.csb.gov.lv/pxweb/lv/ekfin/ekfin__ikgad__ikp/IK10_0110.px/table/tableViewLayout1/?rxid=073f5e9f-0c35-49b3-8288-f030e2e1580a

[35] http://data.csb.gov.lv/pxweb/lv/tautassk_11/tautassk_11__tsk2011/TSG11-01.px/table/tableViewLayout1/?rxid=073f5e9f-0c35-49b3-8288-f030e2e1580a

1.2.2 Governance

The Parliament of Latvia and the Cabinet of Ministers of the Republic of Latvia set the state's policy on the development of science and technology in broad terms. As indicated in the Law on Research Activity,[36] the responsibilities of these bodies when it comes to research, development and innovation (R&D&I) include setting the evaluation criteria for the assessment of research institutions' efficiency as well as allocating the science and technology policy budget. Furthermore, Parliament determines and the Cabinet approves the prioritised scientific directions on a national level, along with the state's research programmes. This also includes determining the procedures that control the use of the financial resources that are allocated for specific national directions and programmes (The Parliament of the Republic of Latvia, 2013). As pointed out in the Technopolis Group's report assessing the R&I system in Latvia, R&I policy has been a relatively low priority for Parliament (Technopolis Group, 2014). The relatively low R&I budget allocation indicators in comparison to other EU countries further demonstrate this.

The Cross-Sectoral Coordination Centre (CSCC) has been in operation since 2011 and is directly subordinate to the office of the Prime Minister. The Centre is in charge of the development and coordination of planning documents at the national level and their consistency and compliance with regulatory requirements. The CSCC was tasked with preparing the National Development Plan of Latvia for 2014-2020, which includes, among other things, an outline of the strategic objectives related to research, development and innovation. Developing such central documents of national importance gives the CSCC the power to coordinate the priorities of various ministries, at least in the medium-term.

The Ministry of Education and Science (MoES) has a pivotal role to play in building R&I policy. MoES designs and coordinates public policies when it comes to research and education and supports project financing instruments and the Smart Specialisation Strategy (RIS3). Two departments within MoES work on R&I policy planning:

1. The Department of Higher Education, Science and Innovations – responsible for policy design and monitoring in the fields of higher education, science, research, and innovation.
2. The Department of Structural Funds – together with the State Education Development Agency (VIAA), it is responsible for the implementation of Structural Fund (SF) programmes.

Its subordinate institution, the State Education Development Agency (SEDA), often implements the programmes designed by the MoES.

The Ministry of Economics (MoE) is responsible for developing policies related to business support and innovation as well as the design, introduction and supervision of Structural Fund programmes and projects pertaining to enterprise support and innovation. In the previous EU programming period (2007-2013), the Latvian Investment and Development Agency (LIDA), which is one of the institutions that is overseen by the MoE, implemented these policies and programmes. However, the interviews conducted with representatives of the MoE indicate that the human resources allocated to the field of innovation within this ministry might currently be insufficient and unsustainable in the future. This is based on the relatively low involvement of the Ministry of Economics in R&I activities when compared to the involvement of the Ministry of Education and Science. Moving forward, this appears to be signalling that the Ministry of Education and Science will henceforth take a leading role in the design of innovation policies.

[36] The Law on Research Activity (orig. Zinātniskās darbības likums); approved by the Cabinet of Ministers on 14.04.2005, last amended on 10.04.2013. Available at: http://m.likumi.lv/doc.php?id=107337

Other ministries may have input on the R&I policy development in their respective fields. Even though most Latvian universities answer to the Ministry of Education and Science, some of them along with respective research units in Higher Education Institutions (HEIs) answer to other ministries. For instance, the Ministry of Agriculture oversees the University of Agriculture, while the Ministry of Finance (MF) is in charge of the development and coordination of financial policy and budget allocation as well as the administration of EU Structural Funds and the Cohesion Fund.

The Central Finance and Contracting Agency (CFCA) has had a more influential role with respect to the governance of R&D funds since the start of the new EU programming period of 2014-2020. CFCA supposedly had to replace some of the functions of two main government funding agencies – the State Education Development Agency and the Investment and Development Agency of Latvia. CFCA is a state agency that is subordinate to the Ministry of Finance. With the aim of improving funding absorption, minimising costs and bureaucracy, the Ministry of Finance initiated concentration of EU fund allocation and oversight in the hands of one institution. Given the increased importance of the organisation, the CFCA has set out rather ambitious plans to increase its capacity and adjust its structure.

The State Education Development Agency (SEDA) is the largest agency under the Ministry of Education and Science, which is the main body to implement R&I policy. The role of this agency includes the implementation of the national policy in the fields of education, science and research. SEDA also implements and monitors projects financed by EU Structural Funds, along with other financing programmes and initiatives. In fact, from 2007 to 2013, SEDA played a central part in EU fund governance and allocation of SF programmes related to education, science and research, along with some of the programmes targeting innovation. The role of SEDA in the governance of EU funds for R&D is expected to decrease in the period 2014-2020 due to the planned consolidation of the system. However, this agency will still play an essential role in policy planning and policy design as it is commonly recognised as an efficient organisation with a "business-like" internal culture that places the focus on results rather than on the implementation process.

The Investment and Development Agency of Latvia (LIDA) is a direct administration institution under the Ministry of Economics. The main objectives of the agency are the facilitation of foreign investment and increasing the competitiveness of Latvian entrepreneurs, thus promoting business development. In 2004, LIDA became one of the funding agencies responsible for administering EU funds, implementing state support programmes and advancing grants to entrepreneurs. The agency is also involved in the implementation of national programmes regarding export and innovation, EU Horizon 2020 projects and the implementation of EU SF co-financed programmes, like the Competence Centres Programme or the Micro, Small and Medium-Sized Businesses New Product and Technology Development programme.

The JSC Development Finance Institution Altum (henceforth referred to as Altum) is a financing institution that is fully owned by the state and has three ministries as its shareholders. The new unified institution was created in April 2015 when the Latvian Guarantee Agency (LGA) merged with the State Joint Stock Company Latvian Development Financial Institution Altum (ALTUM) and the State Joint Stock Company Rural Development Fund (RDF). Like the LGA, the newly created Altum will provide alternative risk capital funding for businesses in the event of insufficient collateral. The objective of Altum is to use state support financial instruments in order to provide efficient and professional support to certain target groups in the form of financial instruments (such as loans, guarantees, investments in risk capital funds, etc.) that are supplemented by non-financial support (consultations, training, monitoring, etc.). The support is intended to aid in the establishment, growth and expansion of business operations.

The Administration of Study and Research (ASR) is another institution responsible for the implementation of R&I policy under the Law on Research Activity. Subordinate to the Minister of Education and Science, the ASR is, among other things, obliged to supervise the use of financial resources in research and administer the state budget resources allocated to fundamental and applied research projects. Moreover, the law requires this organisation to supervise Latvian scientific co-operation with the European Union and other international organisations as well as prepare and publish information related to the activities thereof.

The Council of Higher Education (HEC) of Latvia is an advisory body for higher education policy making, as indicated by the Law on Scientific Activity. HEC is an independent institution comprised of twelve members: representatives of the Latvian Academy of Science, the Council of Creative Unions, the Association of Leaders of Education of Latvia, the Chamber of Commerce and Industry, and delegates from organisations of rectors, professors and students. This council was set up to help develop the national strategy on higher education, to encourage cooperation between HEIs, state institutions and the general public, and to oversee the quality of higher education guarantees.

The Research and Innovation Council (RIC) is a new advisory body that was established at the end of 2013. RIC is chaired by the Prime Minister and is comprised of Ministers, representatives of higher education institutions (HEIs), representatives of the regions, Chamber of Commerce, Confederation of Employers, Baltic Innovative Research and Technology Infrastructure (BIRTI - an NGO), the Academy of Science and the Cross-Sectoral Coordination Centre. The task of this council is to advise the Cabinet of Ministers on important matters concerning research and technology investments and the evaluation of policy proposals. Ever since its establishment, the RIC has become a platform through which different stakeholders can communicate and reach consensus regarding potential decisions to be made by the Cabinet, thus making the R&I decision-making process more inclusive.

The Latvian Council of Science, created in 1991, had the task of formulating and coordinating science policy as well as assessing applications for research funding and allocating money granted through competition. Today, the role of this Council is slightly reduced since its policy making function was transferred to the Ministries. It continues, however, to advise on science, R&D and higher education policy formulation and implementation as well as act as a research funding council. According to the Law, the Council is a collegial body of scientists supervised by the Ministry of Education and Science. The Council consists of representatives of 14 institutions and operates through five expert commissions. The expert commissions are responsible for the assessment of scientific research projects and programmes, formulation and constant improvement of evaluation criteria for projects and institutions, and the evaluation of the general situation in each of Latvia's relevant scientific fields.

1.2.3 Research performers

The Law on Scientific Activity differentiates between research institutes by dividing them into four categories: a public agency, a derived public person, a structural unit of an HEI, or a private legal entity. A recent innovation-related policy focus in Latvia is on the involvement of business entities in innovation. Business enterprises are chiefly responsible for, and able to convert, the stock of knowledge into commercially viable innovations, namely through the creation of products, services and technologies. Governmental bodies, the government itself and NGOs may also implement social innovations. However, the authors did not find evidence of NGOs playing a significant role in Latvia at the time of preparation of this report (2015).

Governmental research organisations

Before the start of 2015, of a total of 91 scientific institutions listed in the Scientific Institute Register of the Ministry of Education and Science, around 46 were classified as public research organisations (PROs).[37] The Ministry of Education and Science of Latvia lists 29 state research institutes[38] that received the base financing in 2015. Some of the state institutes, like the Latvian Institute of Organic Synthesis, are more active and internationally recognised, participating not only in European Union Structural and Investment Funds (ESIF) but also in the Framework and Horizon 2020 Programmes. The CSB provides figures that in general, 3.2% of institutions and 18.2% of researchers engaged in R&D in 2014 were associated with the government sector. This relatively small R&D sector used almost 24% of the available research and development and innovation (R&D&I) funding in 2014. This included €18.7m in foreign funding, €14.2m in government funding and €6.1m from the business enterprise funds. An assessment of the Latvian research and innovation system points to the excessive fragmentation of the public research organisation system (Technopolis Group, 2014). Based on this assessment, consolidation of the scientific institutes with regard to base financing has already been undertaken. The number of state research institutes that receive the base financing is planned to be reduced from 29 to 20 by 2020. According to the consolidation plans, the state will only allocate the base financing to the institutes that have received high scores in international evaluations. Already for the year 2016, the base financing will only be given to 21 state scientific institutions.[39]

Higher Education Institutions

As reported by the Ministry of Education and Science of Latvia, 57 institutions of higher education and two branches of foreign universities were operational in Latvia in 2015. This number includes 17 state HEIs and 17 state colleges, and 14 HEIs and nine colleges established by juridical persons.[40] HEIs play an important role in the Latvian R&I system with more than 60% of researchers being concentrated in this sector. Three Latvian universities, namely the University of Latvia, Riga Technical University and Riga Stradins University, are internationally recognised due to their research institutes and scientific groups. The research activities of smaller and private HEIs, on the other hand, are not yet that developed. The main research performers at the universities are research institutes with various degrees of autonomy and legal statuses. The MoES Scientific Institution Register includes 10 public HEIs and two HEIs established by private persons as well as agencies and research institutes that are subordinate to these HEIs. The 60 HEIs that operated in Latvia in 2014 constituted approximately 12.2% of all the institutions engaged in R&D in Latvia. Since 2007, the HEIs also consume the largest portion of the funding allocated to R&D on an annual basis. In 2013, the higher education sector performed GERD worth 0.26% of GDP, while the GERD performed by the government and private sectors were equal to 0.17% of GDP each. In 2014, HES was still performing most of the R&D in expenditure terms, although after some significant advancement the private sector almost caught up. In particular, the HES performed R&D worth 0.28% of GDP, while the business sector and the government sector contributed 0.24% and 0.16% of GDP, respectively.

According to CSB, HEIs in 2014 used 40.5% of the available R&D funding in Latvia, including €30.8m from foreign funding, €26.7m from the state budget, €4.7m from the private sector and €3.8m of the institutions' own money.

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[37] Research organisations associated with state HEIs are also considered to be PROs; http://www.ikvd.gov.lv/zinatnisko-instituciju-registrs.html

[38] http://www.izm.gov.lv/lv/zinatne/zinatniskas-darbibas-bazes-finansejums/2015-gada-zinatnes-bazes-finansejums

[39] List available at: http://www.izm.gov.lv/images/zinatne/BF2016/BF_ZI_gala_rik_2016.pdf

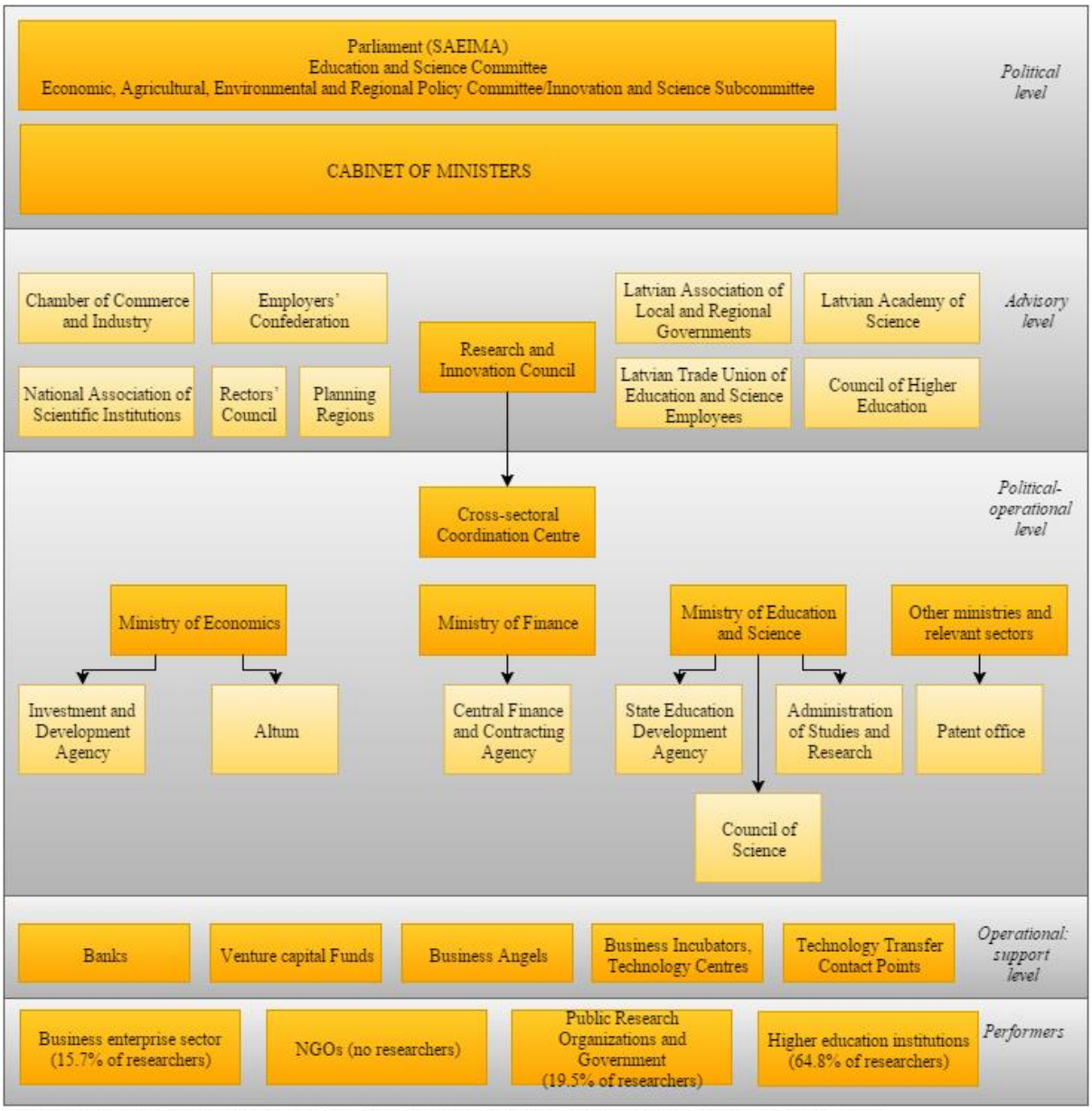
[40] List available at: http://www.izm.gov.lv/lv/izglitiba/augstaka-izglitiba/augstakas-izglitibas-iestades

The higher education system in Latvia also demonstrates problems related to excessive fragmentation. Higher education institutions located in the regions are needed to keep the regional population from leaving elsewhere. However, such an approach is expensive, as it disrupts the integrity of the higher education system and makes it disperse. As it has been pointed out in assessments of Latvia's higher education system, this might also contribute to lowering the quality of education (Arnold et al., 2014).

Private sector research community

During 2014, a rapid increase in R&D activities in the Latvian business sector was observed. BERD increased by 13% from €39.4m to €57.8m in 2014. Growth was also experienced with respect to another indicator – the number of full-time employees (total R&D personnel in FTE) in research and development in the business sector, which went from 981 in 2013 to 1,382 in 2014. While the numbers are still small when compared to the EU average, the dynamics are promising. In 2014, the total number of business sector enterprises performing R&D activities was 411, whereas the Scientific Institution Register had 45 entries for scientific institutions established by the private sector as of January 2015. Researchers employed in the private sector in FTE) amounted to 776 in the same year. Despite the fact that the institutions performing R&D that come from the private sector amounts to approximately 84% of the total, they usually employ very few researchers, as the private sector share of researchers is only 20.7%. The predominant source of funding for the business enterprise sector was internal funds – €34.5m came from the business enterprises themselves, €0.8m from the government and €22.5m from abroad.

The relatively small figures might be explained by the fact that it is mostly small- and medium-sized enterprises (SMEs) that are engaged in R&D. As reported by CSB, in 2013, 86.5% of economically active enterprises in Latvia were micro enterprises and 93% were classified as small- and medium-sized enterprises. Moreover, the accounting principles and underreporting of R&D activities by enterprises could also explain the seemingly low expenditure on R&D. In the Latvian BES, enterprises rarely pay much attention to the classification of R&D activities. Such a culture might be in place due to the aforementioned lack of R&D tax incentives as well as the lack of recognition of R&D in the expense reports of the enterprises that actually perform a great deal of R&D. These circumstances are starting to change and they might lead to at least a partial correction of the underreporting. Together with certain scientific and environmental factors, this could contribute to an increase in R&D spending by the private sector.



Source: Adapted from RIO Country Report 2014 (Avotiņš and Resele 2014) reflecting changes in 2015 compiled by author.

Figure 1. Organisational structure of the research and innovation system in Latvia.

2. Recent Developments in Research and Innovation Policy and systems

2.1 National R&I strategy

Latvia's national R&D&I strategy highlights are set out in the "Guidelines for National Industrial Policy for 2014-2020" [41] and the "Guidelines for Science, Technology Development, and Innovation 2014-2020"[42] (the latter of which will be referred to as STDIG), among others. The guidelines include the areas and goals that Latvia prioritises, along with guidance for their implementation and policy objectives. STDIG was developed on the basis of the Smart Specialisation Strategy for Latvia and the "Guidelines for National Industrial Policy".

The strategic objective, according to these documents, is to develop the Latvian science, technology and innovation sector into a sector that is competitive on a global scale and capable of satisfying the development needs of the economy and society. A special focus is placed on transforming the economy to support knowledge- and technology-driven growth and catching up on the development of knowledge-based skills. In line with the European standard, the guidelines focus on the period leading up to 2020. The R&D investment target corresponding to this time frame, as was previously mentioned, is set at 1.5% of GDP, and the guidelines identify the measures and indicators required to achieve the target. Specifically, the strategy builds on the priorities corresponding to the current primary challenges of the national R&D&I system: it aims at improving human resources, skills and capacity building; encouraging innovation in firms; and supporting entrepreneurship, SMEs and enabling conditions for starting new businesses, including providing better access to financing. It also aims to reform the public research system by strengthening public R&D capacity and infrastructure and improving returns to, and the impact of, science. Moreover, the guidelines emphasise Latvia's ambition to improve the technology transfer between academics and entrepreneurs, to support commercial entities' investments in innovations, and to encourage high value-added product development.

Following the principle of Smart Specialisation, Latvia's research and innovation resources are prescribed to be focused according to two principles. The first is that resources should be allocated in the fields of knowledge where the state has a relative advantage or a basis to create one. The second is that selected fields of knowledge should have the potential to improve the value added in industries with significant export volume and significant value gaps between their export unit price in Latvia and their export unit price in more developed countries (FIDEA SIA, 2013). Namely, the chosen Smart Specialisation fields are: (1) knowledge-based bio-economy; (2) biomedicine, medical appliances, bio-pharmacy and bio-technology; (3) advanced materials, technologies and engineering systems; (4) smart energy; and (5) the Information and Communication Technologies (ICT).

The National Reform Programme 2015 also outlines the planned allocation of EU funds (which, so far, is the main source of R&D&I funding) according to the thematic objectives within the field of R&D&I and education. Taking into account the development level and the economic needs of Latvia, investments are expected in all thematic objectives, and the planned allocation is presented in Table 2.

[41] Latvian version available at http://polsis.mk.gov.lv/view.do?id=4391;
English version available at https://www.em.gov.lv/files/nozares_politika/finl_en%20(1).pdf
[42] Available at https://www.em.gov.lv/files/nozares_politika/2014ino.pdf

Table 2. Allocation of EU funds for R&D&I and education for the period 2014-2020 (in millions of Euros).

Thematic objective	ERDF	ESF	EAFRD	EEF	Total	Link with national objectives in the context of the Europe 2020 Strategy
Strengthening research, technology development, and innovation	467.5	0	13.4	0	480.9	**Objective of the NRP:** investments in R&D – 1.5 % of GDP. **NRP challenges:** a small number of people are employed in science and research, underdeveloped infrastructure of science and research, insufficient number of advanced laboratories for the implementation of technology projects, weak commercialisation potential of research results, weak cooperation between the science and industry sectors, and the structure of Latvian business is mainly composed of small- and medium-sized enterprises which have no R&D investment.
Investing in education, skills and lifelong learning	277.5	238.5	16.2	0	532.2	**Objectives of the NRP:** The share of early school leavers (aged 18–24) is 13.4 %. The share of residents aged 30–34 with higher education is 34–36%.
Enhancing the competitiveness of SMEs	296.2	0	370.3	95.2	761.6	**NRP challenges:** improvement of the business environment, provision of merchant access to finances with the aim of supporting productive investments, the small share of SMEs in the export structure, sophisticated implementation of marketing activities abroad, incompatibility of knowledge and skills of those employed in SMEs with the labour market needs.

Source: Adapted from the National Reform Programme 2015.

2.2 R&I policy initiatives

One of Latvia's important long-term R&I policy measures was its re-introduction of mandatory state exams in natural science in high schools. This policy change came as a result of a public discussion that took place between different stakeholders over the years 2013–2015. Such a policy measure is very important in the context of the Latvian education and R&D&I systems, as it has the potential to help tackle some of their current structural challenges. Namely, it might improve the quality of education provided in the fields of chemistry, biology and physics and contribute to the training of more high-quality R&D staff in the future. The debate over the introduction of mandatory state exams in natural sciences was rather extensive due to a clash of opinions. Businesses supported the introduction of such exams with the aim of better preparing pupils for further studies in engineering and the natural sciences. Many schools took the opposing side by claiming that the HEIs' resources, including their teachers, were insufficient to provide high quality teaching in the natural sciences to everyone. The policy measure is not expected to bear fruit for at least another decade; nevertheless, the business community has welcomed this change with great enthusiasm. Universities teaching the natural sciences had also highlighted high school graduates' low levels of preparedness in the subjects of engineering, mathematics and natural sciences due to the voluntary nature of the state exams in the natural sciences.

The business community has correctly pointed out that innovation in Latvia is limited due to its inadequate supply of potential R&D personnel. This is especially true in the fields of engineering, ICT and the natural sciences. The supply of workers in these fields is insufficient when compared to what would be required if the businesses were to fully exploit their desired opportunities.

Another important policy measure incentivising innovation and private sector participation in R&D&I activity is the Corporate Income Tax incentive providing a tax break to companies for their R&D costs. The government approved this measure in 2014 and it has led to two changes in the Latvian environment: (1) businesses now have greater incentives to reinvest their profits in R&D as opposed to investing in extending their existing production capacity; (2) businesses have the incentive to report all their R&D activities. In fact, the increase in business investment in R&D in the year 2014 produced three effects: (1) the creation of the Competence Centres Programme (further discussed in section 2.3); (2) greater investment in R&D as a result of tax incentives; and (3) better reporting of R&D activities due to the tax incentives (more information on the tax incentive is found in section 3.5).

Evaluations, consultations, foresight exercises

What was probably one of the most comprehensive evaluations of Latvia's research and innovation system was carried out by the Technopolis Group in 2014. Their report, "Innovation System Review and Research Assessment Exercise: Latvia", is based on a literature review, interviews with key Latvian stakeholders, incorporates previously conducted panels of international peer reviewers, and considers self-assessment reports prepared by research groups. This paper overviews the development of production and innovation capabilities in Latvia, the situation in the R&D sector at that time, emphasises the human resources dimension, and discusses the country's knowledge infrastructure, R&D&I governance and policy. Then, based on the main findings, Technopolis Group experts put forward recommendations to reform aspects of the R&D&I system (Arnold et al., 2014).

Considering the historic trends and specifics of Latvian production and exports, the authors found that the majority of companies operating in the Latvian market are SMEs and little initiative has been taken to support the formation of clusters, effectively resulting in diminished possibilities to exploit scale economies, share knowledge or build on national or local specialisation advantages. Moreover, the trends in Latvian export composition revealed that the export expansion was mostly oriented towards the already established markets and the exports themselves became more fragmented, product-wise. The assessment authors conclude that the lack of new market penetration can be associated with the lack of innovation in the Latvian enterprise sector – companies still choose to export to neighbouring price-sensitive markets and compete mostly in the same established industries, mainly because of labour cost advantages. However, the authors also note that product diversity has been increasing over the years. It is mainly viewed as an upside signalling a shift away from raw materials and a low value-added product-centred focus. The downside of fragmentation is also discussed, namely, the question is raised as to whether a small economy like Latvia's would not be better off if the emphasis was less on the diversity of products and more on specialisation in areas where the country's competitive advantages lie. Nonetheless, the research did not perform an analysis of whether the diversification is related or not related. Latvia is at a disadvantage when it comes to scale intensive production, therefore, related diversification might be a by-product of the positive movement towards more value-added products and services.

The assessment of Latvian innovation and the overall business environment presented in the study points to the high rate of new company formation in the country, however, it also indicates that this is mostly "need driven" – start-ups created due to a lack of other opportunities. Innovation in the Latvian enterprise sector is concluded to be low, and the same applies to patenting activity, especially when it is compared with the European average. The authors suggest that the country's competitive advantage in less demanding markets where quality and innovation are less crucial and where the emphasis is put on lower input costs and prices may be a potential explanation for this situation.

The main problems regarding research, development and human resources in Latvia include an ageing researcher base and a potential shortage of professionals in Information and Communication Technologies (ICT) and engineering in the near future. Moreover, low performance indicators for R&D outputs regarding both the quantity of publications and co-publications and the quality and impact of the outputs have been pointed out.

Latvian science and industry structures are, according to the authors' assessment, still affected by the Soviet period. The governance of the research and science system is overly bureaucratic, lacks a central overview and coordination, and is constrained by hierarchical rigidities. Consequently, the system is unresponsive to feedback and inflexible in its consideration of emerging opportunities or needs. As for the national strategy, or, more precisely, the R&D intensity targets, the authors of this report conclude that it is possible that they can be reached, however, the goal is also very ambitious.

The authors also put forward multiple policy recommendations for the Latvian R&D&I system, as follows:

1. Increase enterprise innovativeness:
- Increase the demand for innovation by raising the standards of quality and performance as well as by putting more emphasis on the international markets where demand for innovation is already higher;
- Increase the use of innovative procurement (discussed in more detail in section 3.5);
- Raise awareness about the importance of innovation and the benefits it can bring to individual companies, provide training to find such opportunities through campaigns and programmes for entrepreneurship and innovative company training;
- Revise the cluster policies and policies that develop companies along supply chains;
- Combat the shadow economy, possibly through revision of corporate tax laws;
2. Tackle the human resource shortage and the skills gap in the R&D sector:
- Offer differential fees or other incentives to students studying science, engineering and the like;
- Develop vocational education and training, especially in the shortage areas;
- Introduce programmes to foster inward mobility of researchers in order to generate more internal competition in the research community and to increase the currently limited number of international research relationships (includes altering the current restriction on the use of foreign languages in Latvian university teaching);
3. Research infrastructure and governance:
- Increase the level of institutional funding to 50%, introduce periodic revisions of quality and relevance, and allocate it on the basis of performance. This should be done, according to the authors, to ensure continuity and provide funds for implementing longer term strategies;
- Continue competitive project support, allowing the state and industry to influence the pattern of research as well as its quality and relevance.

This assessment exercise was one of two carried out in Latvia, the previous one (a peer review) taking place over 5 years ago. Thus, this report is of high relevance to research performers and the Latvian system as a whole, especially given its wide issue coverage and excellent quality. The research assessment exercise has been prepared as a component of a larger assessment of research in the Republic of Latvia for the Ministry of Education and Science, thus, it is taken into account by one of the key R&D policy making bodies in Latvia. The report authors advised MoES on some initiatives that have already been started, such as the research system consolidation, and also provided multiple other recommendations for consideration.

The assessment received a mixed response, however. Some representatives of the public research sector and higher education institutions disagreed with the findings and argued that the assessment lacks an understanding of local realities. Moreover, they argued that the real problem is the funding level, not the structural problems that were mentioned in the report. The business community, on the other hand, mostly agreed with the findings and are actually asking to solve the structural problems identified in the report and focus the policies on innovation capacity human component.

Other assessments related to the R&I system in Latvia include two reports published in 2014: "Higher Education Financing in Latvia: Analysis of Strengths and Weaknesses"[43] and "Assessment of Current Funding Model's 'Strategic Fit' with Higher Education Policy Objectives".[44] These reports aim at evaluating the strengths and weaknesses of Latvia's higher education funding system in the light of European developments and with a view to comparing it against general criteria for good funding models. The latter paper considers the 'strategic fit' of the funding mechanisms in the Latvian higher education system by evaluating it with respect to its compatibility with the government's explicit strategic priorities. Latvian R&D&I performance is also assessed in the "Latvia Competitiveness Report"[45] which was prepared in 2013 with the goal of assessing the overall competitiveness of the Latvian economy. Moreover, the audit report "The Efficiency and Compliance with the Requirements of Regulatory Enactments of the Activities of the Ministry of Education and Science in Developing and Organising the Implementation of the National Science Policy" was released by the State Audit Office in 2012. It highlighted the need to improve the management of the national R&I system with regard to aligning research and technology development (RTD) policy with the main objective of moving towards a knowledge-based economy and creating sustainable growth.

Finally, the previous "Policy Mix Peer Review: Latvia Peer Review Outcome Report", prepared by Technopolis in 2010, provided an expert assessment of the Latvian innovation system and innovation policy based on outcomes of a visit made by the members of the Peer Review in 2009. The report put forward multiple recommendations for improvements, some of which have successfully been addressed since then. The recommendations included the need to establish the importance of innovation, the need for strategic innovation policy and governance system, setting thematic priorities based on the actual and potential strength of the economy and aligning research and innovation policy as well as the science-funding rules with these priorities, implementing reforms in higher education, increasing efforts to encourage FDI and others.

2.3 European Semester 2014 and 2015

The European Council's (EC) country-specific recommendations (CSR) for Latvia in the framework of the European Semester 2015 include the following R&I suggestion: "Better target research financing and incentivise private investment in innovation on the basis of the Smart Specialisation Framework". The Council's CSR 2014 recommended that Latvia "Step up implementation of the higher education reform, in particular through the establishment of an independent accreditation agency and a financing model that rewards quality. Take steps for a more integrated and comprehensive research system also by concentrating financing towards internationally competitive research institutions."

The NRP 2015 aims for the R&D investments in Latvia to reach 1.5% of GDP, or €500m in absolute terms, by 2020. This goal is equivalent to an annualised growth of around 20% per annum in R&D investments during the period. The NRP also identifies the approaches and measures that will be taken in order to achieve the required growth, and thus, the raised objective. Firstly, a shift in the economy is said to be required by turning

[43] http://www.izm.gov.lv/images/izglitiba_augst/03.pdf
[44] http://www.izm.gov.lv/images/izglitiba_augst/04.pdf
[45] http://www.bsr2013.eu/wp-content/uploads/latvias_competitiviness_report_eng-1.pdf

to higher value-added goods and services. Complementarily, it indicates the need to increase the role of manufacturing, modernise manufacturing and services, develop export complexity, and focus on specialisation as planned in the Smart Specialisation Strategy (RIS3). In addition, there are several key policy measures that will be undertaken that were highlighted and described in detail in the NRP.

The first measure, under the responsibility of the MoES, is development of scientific activity potential. In 2014, the smart consolidation of the actors in the research system was initiated with the goal of only 20 competitive scientific institutions being awarded with base financing in 2020 (as opposed to the 44 that were awarding this funding before the initiative). The consolidation policy will allow resources to be concentrated in the best, most efficient, research institutes. This initiative is supported by regulations drafted by the Cabinet of Ministers as well as by adjustments that have been made to the funding system.

Secondly, the measures specified in the NRP 2015 aim at tackling the lack of cooperation between enterprises and public research institutions by developing a long-term cooperation platform. This will be achieved through the continued support of the EU SF Competence Centres Programme (CC). This programme was planned to be implemented by the end of 2015 with its total public financing being in the amount of €53.2m. It will also attract at least €10m in co-financing from the private sector. The programme will continue in the next programming period as well.

The Competence Centres Programme also has the goal of being a platform of cooperation and project management for enterprises. The biggest difference between this programme and other support measures is the decision-making approach to choosing the projects to support. When it comes to the CC programme, a board consisting of business representatives makes these decisions and it makes them quickly. The Competence Centres also promote the idea that the research activity should only be continued as long as there are prospects for commercially viable results, thus encouraging R&D performers to shift their efforts immediately if the current direction of their research loses its technological or commercial feasibility.

The third highlighted target focuses on innovation and it is specifically aimed at "Supporting the development of innovative enterprises". This action assumes the form of continued funding for development and the production of new products and technologies, including the establishment of new enterprise production units and a new focus on the development of environmentally friendly technologies.

The progress made with regard to some of these goals has been acknowledged in Latvia's 2015 European Semester Country Report prepared by the EC. The report also includes the following challenges that threaten the Latvian R&I and education system:

1. Low proportion of university graduates in the fields of science, technology, engineering and mathematics (below the EU average - 18.8% compared with 22.8% in 2012)[46];
2. Low adult participation in lifelong learning;
3. Lack of skilled employees faced by enterprises;
4. Bottleneck vacancies in sectors such as metal processing, machinery, IT, road hauling, food processing, health care and textiles;
5. Low proportion of employment in knowledge-intensive sectors;
6. Economy is dominated by SMEs that are, to a large extent, concentrated in sectors with low and medium-low research intensity, such as metal processing and machinery, wood products and food processing (82%);

[46] The figure in the report differs from the data compiled during 2014 by FIDEA from the MoES sources (in section 5.3). Due to Latvia's decreasing population, the total number of students in natural sciences and engineering is almost the same as it has been over the last three years (22.2, 22.0, 22.2 thousand in 2011, 2012, 2013 respectively, according to the data compiled by FIDEA) and is insufficient to meet the needs of the economy despite relative growth.

7. Little involvement of SMEs in innovative activities;
8. Very limited co-operation between businesses and academia;
9. Low efficiency of public spending (public R&D intensity stood at 0.43% of GDP in 2013, and remains excessively dependent on EU Structural Funds).

In response to the identified challenges in the field of education, a new higher education financing model was developed in 2014 during an inclusive procedure involving representatives of the higher education sector and social partners. The Cabinet regulations for performance-based financing of higher education institutions were issued in July 2015. Namely, as described in the NRP 2015 of Latvia, a three-pillar financing model was proposed as the most suitable solution to resolve Latvia's socio-economic situation. The three pillars are the three funding forms, specifically:

1. Base financing (institutional financing to ensure the functioning of education and research);
2. Performance-based financing (financing that is allocated when study outcomes and research results are achieved);
3. Innovation financing (future development-oriented financing that promotes the specialisation of institutions and their profile development).
   The new financing model is aimed at developing research-based higher education, contributing to closing the labour gap in the industry, and establishing performance management of HEIs. The new conceptual model also paves the way for optimising the higher education sector, launching strategic specialisations of higher education institutions and performance-based financing, as well as supporting research excellence and innovation. The reform aims to address the main challenges in the Latvian education system - declining enrolment in STEM fields, underfunding, demographic factors and emigration, dispersed institutional capacity, and fragmentation of budget resources.

€11.9m support from the ERDF will be available for the consolidation and reorganisation of the research institutions as well as the management of the competitive scientific institutions' activities. In order to ensure the efficient use of public funds by competitive research performers alone, the Procedure for the Calculation and Allocation of Base Financing to Scientific Institutions was amended in 2014 by the Cabinet of Ministers. According to the amendments, 10% of the additional base financing will be allocated to competitive scientific institutions that have received an evaluation of "4" and "5" in the international assessment of science,[47] while the scientific institutions that have received a low evaluation ("1" and "2") will not receive the base financing in 2016.

In November 2015, the second pillar was introduced - performance based financing has been allocated to HEIs, taking into account results achieved in 2014 that show the HEI's ability to attract young researchers, research projects, local government research funding as well as implemented and realized art and creative projects. The second pillar's implementation has been supported by the new budget sub-programme which allocated €5.5m in 2015 and will allocate a further €6.5m in both 2016 and 2017. A set of criteria for the performance-based financing of scientific activity has also been developed. It is expected to direct the financing in order to facilitate an increase in human resources in the research and development of technologies and increase the international competitiveness of Latvian research.

The 3rd pillar funding will supposedly be partly constituted by the support activities within the European Union Structural Funds Operational Programme "Growth and Employment". Additionally, MoES is meeting the challenge to develop various solutions of how to attract funding for higher education to implement the third pillar – innovation financing.

[47] http://izm.gov.lv/images/zinatne/ZISI/Latvia-systems-review_2014.pdf

With regard to the second part of the EC's country-specific recommendation on higher education in 2014, the new high school, college and study program licensing and accreditation procedure was approved by the Cabinet of Ministers on July 14, 2015. It stipulates that the National Accreditation Agency will be established on the basis of the Academic Information Centre (AIC), an institution currently responsible for the expertise and recognition of foreign diplomas and recognition of professional qualifications in regulated professions. The amendments of the Law on Higher Education Institutions were made in the December 2014 delegating the accreditation functions to the AIC starting from July 2015. The independent accreditation agency established on the basis of the AIC must be included in the European Quality Assurance Register for Higher Education (EQAR) by 2018. The next comprehensive accreditation phase is foreseen in 2019.

2.4 National and regional R&I strategies on Smart Specialisation

The Smart Specialisation Strategy of Latvia puts an emphasis on supporting economic transformation and was developed by taking into account the structural challenges (as illustrated in Figure 2) to enable the transformation and sustainable development of the Latvian national economy. The RIS3 of Latvia is laid out in one of the central R&D&I documents, the "Guidelines for Science, Technology Development and Innovation for 2014-2020" (STDIG). Due to the current economic advantage of Latvia being within a low-income sector, having export structures mostly consisting of low or medium-low technology industry production, and the competitiveness of the country relying on low labour costs, the strategy is founded on an economic transformation agenda.

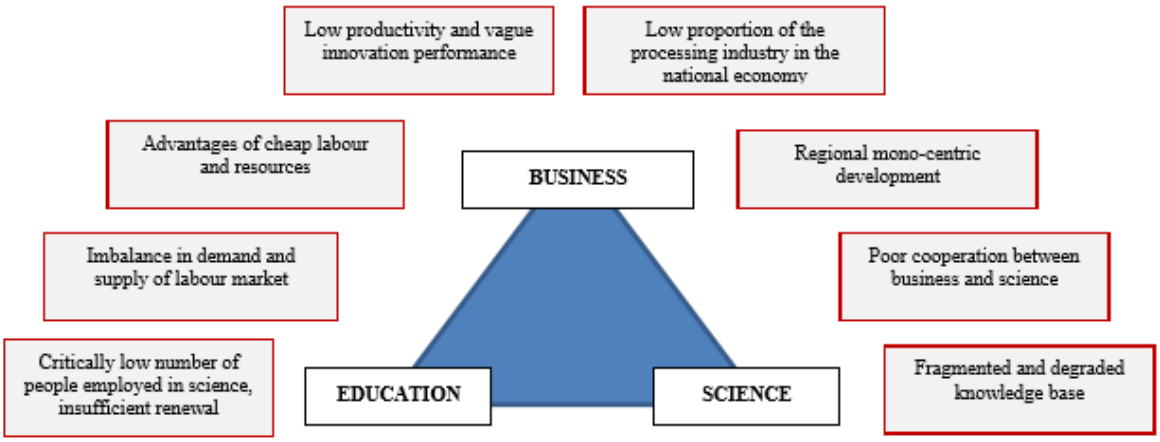


Figure 2. Structural challenges faced by the Latvian R&D&I system taken into account when developing RIS3 in Latvia.

Source: STDIG.

Thus, stakeholder consultations on selecting the national priorities began in late 2013, involving both entrepreneurs and research communities. As of 2014, the priorities of the national transformation and Latvia's corresponding fields of specialisation were specified in the STDIG and are as follows:

1. More efficient use of primary products for greater value-added production, creation of new materials and diversification of application;
- **Specialisations corresponding to this priority:** "knowledge-intensive BioEconomy", "Biomedicine, medical technologies, bio-pharmaceuticals and biotechnology" and "Smart materials, technologies and engineering systems";
2. The creation of an innovation system that provides support for the creation of new products and technologies within the framework of the existing sectors and cross-sectors, as well as new sectors with high growth potential;

- **Specialisations corresponding to this priority:** "Smart materials, technologies and engineering systems" and "Biomedicine, medical technologies, bio-pharmaceuticals and biotechnology";

3. Improvement of energy efficiency, which includes the creation of new materials, production process optimisation, technological innovation, the use of alternative energy sources and other solutions;

- Specialisations corresponding to this priority: "Smart Energy";

4. Development of a modern and contemporary ICT system in the private and public sectors;

- **Specialisations corresponding to this priority**: "Information and communication technologies";

5. A modern education system that corresponds to the future labour market demand, facilitates a transformation of the national economy and the development of competences that are necessary for the implementation of RIS3 priorities, an enterprising spirit and creativity at all levels of education;
6. Advanced knowledge base (basic science and scientific infrastructure) and human capital in areas of knowledge in which Latvia has a comparative advantage and which are important in the process of transforming the national economy. Namely, the areas of knowledge related to the Smart Specialisation fields (1) knowledge-intensive bio-economy; (2) biomedical, medical technology, bio-pharmacy and biotechnology; (3) intelligent materials, technologies and engineering systems; (4) smart energy; and (5) ICT. This priority also includes an advanced knowledge base and human capital in nanotechnology, micro- and nano-electronics, photonics, advanced materials and manufacturing systems, and biotechnology;
7. Studying the existing resources of territories and specialisation, proposing the prospective economic development opportunities and directions (among others) and leading prospective business directions in the municipal territories.

The transformation directions of Latvia's national RIS3, corresponding priorities and fields of specialisation are summarised in Figure 3.

Directions of the transformation of economy	Growth priorities	Smart specialization areas
1. The change of production and export structure in the traditional sectors of the economy	***1st priority:*** More efficient use of primary products for the production of products of higher added value, development of new materials and technologies and diversification of their application. More extensive use of non-technological innovations, the potential of the Latvian creative industry for the production of products and services with a higher added value in the economic sectors.	**1. Knowledge-intensive bio-economics** **2. Biomedicine, medical technologies, biopharmacy and biotechnologies** **3. Smart materials, technologies and engineering systems** **4. Smart energetics** **5. Information and communication technologies**
2. The sectors of future growth, where products and services with a high added value exist or could appear	***2nd priority:*** Constant search for new products/services that requires creation of an efficient identification system that could find and provide support for the development of new products within the framework of the existing sectors and cross-sector areas, as well as creation of new sectors with a high growth potential.	
3. Sectors with a significant horizontal impact and contribution to the transformation of economy.	***3rd priority:*** Increase in energy efficiency, including the development of new materials, optimization of production processes, introduction of technological innovations, use of alternative energy resources, and other solutions.	
	4th priority: State-of-the-art ICT system in the private and public sector that meets today's requirements.	
	5th priority: A modern education system that meets the requirements of the future labour market and facilitates the transformation of economy and the development of competencies, undertaking and creativity necessary for the implementation of the RIS3 priorities at all levels of education.	
	6th priority: Developed knowledge base and human capital in the areas of knowledge, where Latvia has comparative advantages and that are significant for the process of transformation of economy: areas of knowledge related to the development needs of knowledge-intensive bio-economics, biomedicine, medical technologies, biopharmacy and biotechnologies, smart materials, technologies and engineering systems, smart energetics and ICT areas, and the key technology areas identified by the EC (nanotechnologies, micro- and nanoelectronics, photonics, advanced materials and production systems, biotechnologies).	
	7th priority: Identification and specialization of the existing resources of the territories, proposing the possibilities and directions of potential economic development, including the leading and prospective business directions in municipal territories.	

Figure 3. Summary of transformation directions of the Latvian Smart Specialisation Strategy, growth priorities and areas of specialisation. Source: Science, Technology Development and Innovation Guidelines for 2014-2020.

In 2015 descriptions of ecosystems of each specialization area were developed to introduce policy makers, R&D sector, entrepreneurs and the general public to the main actors who create and use knowledge and, by doing so, generate added value. Descriptions of ecosystems provide a snapshot of the current context in which knowledge is created including the scale of each knowledge area, core challenges, public funding and regulations. However, ecosystem descriptions as such do not have the capacity to fully express the complexity of interactions between ecosystem players and to highlight all the opportunities that exist in R&D&I (for instance, ones that are out of the proposed specialisation strategy range or ones that arise in the "overlap" areas of several specialisation fields). Thus, the conclusion following the ecosystem analyses made it clear that such descriptions should not replace evaluation of the activities and projects following three key criteria (described later in this section).

The chosen specialisation areas seem to be somewhat generalised by the policy makers. For example, Latvia has a strong competence in organic synthesis and pharmacology, but the area of specialisation is presented as biomedicine, medical technologies, bio-pharmacy and biotechnologies. Neither biotechnology nor biomedicine are fields in which Latvia's industry or scientists have the greatest competences, however. This raises concerns that some specialisations listed in RIS3 might not be selected based on

evidence but rather on the general compromise between what fields of science are perceived to be the most promising and by making at least some correlation with business needs.

Moreover, as discussed in the Stairway to Excellence Country Report for Latvia, small economies like Latvia's may have difficulties fully covering such broad research areas. Thus, cooperative specialisation, for instance in the Baltic Region, could allow the entire region to focus on one field (or a few) while each country could fully exploit their narrower niches within it.

The specialisation strategy described was formulated in 2014 and, as of 2015, some policy changes related to the Smart Specialisation Strategy had either already been implemented, or were anticipated, for the period 2014-2020. Namely, the development of RIS3 has contributed to:

1. A transparent and comprehensive policy-building process;
2. A focus on peer-review and international expertise in evaluation and monitoring of the projects;
3. A greater focus on building human capacity in the area of research and innovation;
4. A focus on consolidation of fragmented higher education and research systems;
5. A new approach to policy design - fewer objectives and goals, more focus on innovation and closer to market approach;
6. A greater focus on building excellence in science;
7. Entrepreneurial discovery as part of the policy cycle;
8. More experimentation in policy building.

It is expected that the process started by the Smart Specialisation Strategy will continue and provide constant feedback on policy successes and issues.

To concentrate public R&D investment in programs that create future domestic capability the strategy has defined three core criteria for allocation of public resources:

- Growth of R&D human capital (knowledge and networks), expressed as increased competence of individuals engaged in projects;
- Scientific excellence, characterized by the level of usefulness of new knowledge for future or present economic and societal challenges;
- Net economic value or today's financial and social benefits that the project will create.

According to the "Smart Specialisation Strategy Monitoring System"[48] report, the RIS3 monitoring system in Latvia revolves around three monitoring levels: the overall goals of the specialisation strategy, and macro- and micro-level indicators. It was designed in such way so that it would be more likely to, at least partly, capture the broad scope of the potential impact of public investment in science, technology development and innovation. The overall goals include an increase in investment in R&D as a percentage of GDP, a better position on the EU Innovation Union Scoreboard and greater efficiency in the processing industry. The macroeconomic level indicators, among others, include private sector investments in R&D as a percentage of total investments, proportion of innovative companies, the number of R&D personnel and graduates in R&D related fields. Micro-level indicators are the indicators contributing to the achievement of the macro-level indicators and include many factors.

However, a couple of problems associated with this approach are apparent in the Latvian R&D&I context. Firstly, the focus of the monitoring and evaluation system is still on R&D spending in monetary terms rather than on an increase in the volume of R&D activity, which does not account for the possibility of inefficient fund usage. Secondly, the results

[48] Report by the Ministry of Education and Science of the Republic of Latvia; accessible at: http://tap.mk.gov.lv/lv/mk/tap/?pid=40334802&mode=mk&date=2014-10-21

of the policies regarding human capital development will only become apparent in the long term and the monitoring system lacks scope to define and track any progress in the short term that would indicate a gradual improvement.

2.5 Main policy changes in the last five years

Main Changes in 2011

Latvia introduced a mechanism for out-of-court settlement of insolvencies to alleviate the pressure on the courts and tightened some procedural deadlines.

The National Reform Programme of Latvia for the implementation of the "EU 2020" strategy was adopted by the Cabinet of Ministers.

A decision on the international evaluation of the Latvian science, public research organisations, science and innovation policy to be carried out in 2012 was taken by the government.

Extraordinary Parliamentary elections and the formation of a new government. The declaration of the newly formed government envisaged a transfer of responsibility for innovation policy to the Ministry of Education and Science.

The Cabinet of Ministers took a decision on the elaboration of the National Development Plan for 2014–2020.

Main changes in 2012

Launch of the development of the Basic Guidelines for Science, Technological Development, and Innovation for 2014–2020.

Reduction of the minimum capital requirement and introduction of a common application for value added tax and company registration, making it easier to start a business.

Adoption of a new insolvency law that streamlines and expedites the insolvency process and introduces a reorganization option for companies.

Introduction of a competitiveness-driven procedure for the distribution of state-funded research grants.

Launch of policy instruments managed by LIDA and the offering of support for the development of new products and technologies, support for establishing industrial property rights, support for the introduction of new products and technologies for production.

Notable changes took place in the structure of the Ministry of Education and Sciences, int. al. having a direct effect on the field of science with two departments joined into a single Department of Higher Education, Science, and Innovation.

For the first time, an international evaluation of fundamental and applied research projects funded by the Latvian Council of Science was undertaken by foreign experts. The majority of the 370 project applications submitted were assessed to be of high quality.

The National Development Plan for 2014–2020 was adopted by the Parliament of the Republic of Latvia.

Main changes in 2013

MoES underwent significant structural and staff changes with the aim of reforming the education, science and research sectors; policy planning became more inclusive and transparent.

The CM approved the Guidelines on Research, Technology Development, and Innovation for 2014–2020.

Amendments were made to the Cabinet of Ministers (CoM) regulation 1316. Performance-based financing rules were developed based on attracting external financing and publications.

Main Changes in 2014

A review of the institutional funding allocation system was undertaken with the aim of cutting support to the two lowest levels of research institutions.

Further policy measures were introduced to consolidate and merge research institutions with the aim of integrating the weak ones into the excellent ones, thus reducing the overall number to approximately 30.

Strengthened the approved state research programme's projects by allocating additional funding to the best proposals in priority research areas.

Creation of the National Innovation and Technology Council under the Prime Minister's Office.

Creation of a corporate income tax incentive to promote research and development spending – introduction of tax deductible costs of R&D (Latvijas Republikas Ministru Kabinets, 2014).

It became possible to file applications for company registration and value added tax registration simultaneously at the commercial registry.

The credit information system was improved by adopting a new law regulating the public credit registry.

The introduction of mandatory high school exams in physics, chemistry or biology with the aim of improving the level of teaching is expected to focus school managers' attentions on the quality of teaching of these subjects.

Main Changes in 2015

The Latvian presidency of the Council of the European Union 2015 made the country the hub of an important set of events regarding R&D&I. During the Latvian presidency, Riga hosted several international conferences[49]:

International Conference on the 'Smart Specialization Strategy: New Approaches for Partnerships among Education, Research and Industry in Regions' in February, and the 6th edition of the Week of Innovative Regions in Europe (WIRE 2015) Conference in June 2015.

The Baltic Sea Science Congress (BSSC), held on 15–17 June in Riga, focused on effective dialogue and cooperation between science, policy makers, industry and society, to promote better and more sustainable management of the seas.

The largest nanotechnology event in Europe – 'EuroNanoForum 2015' was an international conference which brought together more than 1200 participants from 50 countries.

Paying taxes was made easier for companies due to simplified VAT return, enhanced electronic system for filing corporate income tax returns and reduced social security contribution rate for employers.

The MoES introduced a new approach to higher education financing. Financing of HEIs is expected to stimulate external financing of research and will signal to HEIs that research is an important part of the education process.

The law of public procurement was reformed by several changes regarding innovation and research projects: a) to make it easier to purchase the services of external experts for an evaluation of the research projects; b) to decrease the level of bureaucratic costs of R&I performers by simplifying the procurement procedure where possible. The expected changes in the law represent an important step towards a peer-review based evaluation of the innovation projects that is expected to decrease the level of bureaucracy while increasing the quality of the projects selected for financing.

The Latvian University opened a new Academic Centre of Natural Sciences on September 7, 2015. It is the first of the new buildings that will be part of a larger university campus that is expected to be finished in 2023.

In April 2015, the Latvian Guarantee Agency (LGA) merged with the State Joint Stock Company Latvian Development Financial Institution Altum (ALTUM) and the State Joint Stock Company Rural Development Fund (RDF).

[49] https://eu2015.lv/images/news/EU2015LV_results_en.pdf

3. Public and private funding of R&I and expenditures

3.1 Introduction

The National Reform Programme and the National Development Plan of Latvia have set the national target for GERD at 1.5% of GDP for the year 2020. Even though this target is half of the European R&D intensity goal and well below the current average GERD level in the EU (Table 3), the EC has indicated that it is still ambitious. This perspective is based on the downward trends of this indicator in Latvia in the period leading up to 2014. GERD as percentage of GDP figures fell from 0.7% in 2011 to 0.66% in 2012 and 0.6% in 2013. This indicator was decreasing due to somewhat stagnant GERD funding levels in times of GDP growth. After an increase in GERD over the period 2010-2011 that was linked to European Union allocations (EU SFs, the Seventh Framework Programme [FP7], etc.), R&D funding from abroad as a percentage of GDP has been steadily declining.

However, the decrease in foreign funding was not the only factor that contributed to the overall drop in R&D expenditure – the funding coming from the business enterprise sector had also been declining over the course of the years leading up to 2014. According to data from Eurostat, in 2013 business expenditure on R&D (BERD) in Latvia was the third lowest in the EU. Such low levels of business sector participation are unsustainable, since business innovations are the most effective in increasing the commercialisation of products, thus improving value added and inducing growth. Therefore, the National Development Plan of Latvia for 2014-2020 specifies the target of a 48% share for private sector investments – a composition that is very different from the one observed in 2013 and the years preceding it.

2014, however, was a very promising year in the light of the raised funding targets and the experiences of the past. Since the end of 2013, the gross expenditure on R&D increased at a rate of 16% to reach €162.8m. Although, as has been mentioned, an annualised rate of approximately 20% is required to meet the objective of €500m invested in R&D in the year 2020, when compared to past GERD growth rates, the 2014 numbers remain promising. The breakdown of GERD by funding source is also positive in 2014 – the biggest increase was seen in GERD funded by the business sector, witnessing an increase from 0.13% of GDP in 2013 to 0.19% of GDP in 2014. The government funding as a percentage of GDP also increased from 0.14% to 0.17%. While foreign funds are still the biggest source of GERD in Latvia (0.3% of GDP in 2014), their share is decreasing and, for the first time since 2010, account for less than a half of the total GERD. Thus, some movement towards reaching the objectives aspired to can be observed.

If achieved, the new structure with 48% of GERD funded by the private sector would rely on more effective private investments rather than foreign investments that are mostly comprised of European funds. The current situation is depicted in the recent Operational Programmes (OPs) of Latvia, for instance the OP "Growth and Employment".[50] The total budget indicated in the programme is approximately €5,193m, €4,418m of which is covered by the EU fund contribution. As for the R&D&I priority, the budget includes €467.5m of EU support (85%) and €82.5m of national funding (15%).

The business sector participation in research and development had also been diminishing in terms of R&D performance up until 2014. After a decline in 2012, R&D funds performed by the business sector slightly picked up in 2013 and stood at nearly a third of all funds. However, this still raised concerns when compared to pre-crisis levels, for instance, the stake of R&D performed by the business sector accounted for half of the total in 2006. For reference, the average business sector input in the EU in 2013 was 64%. In 2014, the Competence Centres initiative, together with tax incentives for

[50] http://www.esfondi.lv/upload/14-20_gads/DP/OP_Growth_and_Employment_eng_FINAL_04.03.14.pdf ;

companies performing R&D, boosted the R&D levels performed by the BES. During 2014, BERD jumped from 0.17% of GDP in 2013 to 0.24% of GDP.

In recent years, R&D performed by the governmental sector has shown increasing volumes, accounting for the same 28.3% as the business sector R&D in 2013 and decreasing by 1% to 0.16% of GDP in 2014 (23.5% of the total GERD in 2014). The share of R&D carried out by the higher education sector is still the most significant contributor to the R&D activity in Latvia, consuming nearly a half of the total R&D funds (41.2% in 2014).

The Latvian government budget appropriations or outlays for R&D (GBAORD) increased from nearly €30m in 2011 to about €38m in 2014. The EU average GBAORD, standing at much higher levels than those in Latvia, has been growing at an average rate of 2% over the past decade. This suggests that the government's support to R&D in Latvia is still modest.

Table 3. Basic indicators for R&D investments.

Indicator	2011	2012	2013	2014	2015	EU average (2014)
GERD (as % of GDP)	0.7	0.66	0.6	0.68	n.a.	2.03
GERD (Euro per capita)	67.8	71.7	69.1	81.3	n.a.	558.4
GBAORD (€m)	29.59	32.84	32.46	38.2	n.a.	92,828.15 (Total for EU28)
R&D funded by BES (% of GDP)	0.17	0.16	0.13	0.19	n.a.	1.12 (2013)
R&D funded by GOV (% of GDP)	0.16	0.16	0.14	0.17	n.a.	0.66 (2013)
R&D funded by HES (% of GDP)	0.01	0.01	0.02	0.02	n.a.	0.02 (2013)
R&D funded from abroad (% of GDP)	0.36	0.33	0.31	0.30	n.a.	0.2 (2013)
R&D performed by HEIs (% of GERD)	50	50	43.4	41.2	n.a.	23.5
R&D performed by government sector (% of GERD)	22.9	27.3	28.3	23.5	n.a.	12.5
R&D performed by business sector (% of GERD)	27.1	22.7	28.3	35.3	n.a.	64

3.2 Smart fiscal consolidation[51]

3.2.1 Economic growth, fiscal context[52] and public R&D

Latvia has been extremely strongly hit by the crisis, losing around 20% of its real GDP throughout 2008-2010. Rapid export driven growth followed during the next three years (cumulated 14%) thanks to successful reforms resulting in competitiveness gains. Growth weakened to 2.4% in 2014 partially due to the steep depreciation of the Russian rouble. In 2015 it has slightly picked up to 2.7% on the back of private consumption supported by rising income and cheaper energy. In 2016-17 growth is expected to accelerate to 3.1-3.2% driven mainly by private consumption and productivity gains.

Public finances in Latvia were strong before the crisis. The headline deficit was below 1% and the less than 10% public debt was one of the lowest in the EU (Figure 4). In spite of fiscal contraction the deficit increased to around 9% of GDP during 2008-2009 due to the even steeper fall in the GDP. Due to strong political commitment towards the euro immediate implementation of the financial assistance program and reinforced by economic recovery, the deficit shrank rapidly during 2010-13. The authorities demonstrate strong commitment to the medium-term fiscal target of a structural deficit of 1% of GDP and also to reducing the headline deficit to below 1% of GDP over the coming years. Due to some issues both on the revenue and the expenditure sides of the budget (high labour tax burden, amount and quality of financing of healthcare, education and public administration) the Commission expects a 1% headline deficit throughout 2016-17. Public debt (36.7% in 2014) is moderate and the Commission expects it to remain stable even until 2030 (2016: 39.9%, 2017: 37.7%) assuming no further policy changes are made. Age-related public expenditure is expected to fall due to increases of the share of funded pension schemes.

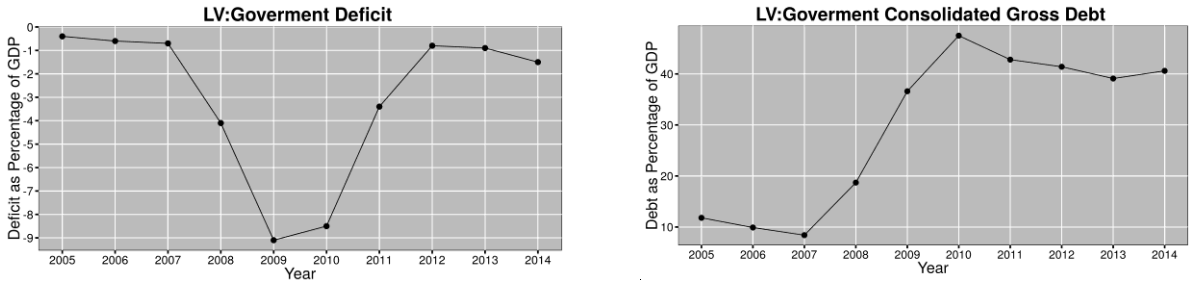


Figure 4. Government deficit and public debt

Data source: Eurostat

Total GERD in Latvia was 140 MEUR in 2013. There are three main sources of R&D funding: the business sector (31 MEUR), the government (34 MEUR), and foreign funding (72 MEUR[53]). Direct funding from the government goes to R&D institutes in the business enterprises (0.6 MEUR), the government (12.4 MEUR) and the higher education sector (20.4 MEUR).

[51] Smart fiscal consolidation is defined as public budget cost-cutting programmes aimed at establishing a foundation for long-term growth. This public policy strategy is based on a trade-off between the need to safeguard growth enhancing elements (including R&D) from budgetary cuts and the need to reduce public spending in a context of economic crisis. For reference see Kolev, G. and Matthes, J.: Smart fiscal consolidation a strategy for achieving sustainable public finances and growth, Centre for European Studies, 2013; Veugelers, R.: Undercutting the future? Bruegel Policy Contribution Issue 2014/06, June 2014). The conclusions in our analysis focus only on the R&I aspect of Smart Fiscal Consolidation.

[52] Sources: DG ECFIN, Country report for Latvia
http://ec.europa.eu/europe2020/pdf/csr2015/cr2015_latvia_en.pdf, RIO

[53] In 2012 EU funding was 61 MEUR out of total foreign funding of 74 MEUR

Table 4. Key Latvian Public R&D Indicators

	2007	2009	2013
GBAORD, % of gov. exp.	0.82	0.47	0.39
GERD, % of GDP	0.56	0.45	0.60
out of which GERD to public, % of GDP	0.37	0.29	0.43
Funding from GOV to, % of GDP			
Business	0.01	0.01	0.00
Public (GOV+HES)	0.27	0.19	0.14
Total	0.28	0.20	0.14
EU funding, % of GDP	n.a.	n.a.	0.24

Source: Eurostat

3.2.2 Direct Funding of R&D activities

The sources of R&D funding according to the Frascati manual are: Government sector (GOV), Higher education sector (HES), Private non-profit sector (PNP) and Abroad (including EC). In this analysis the public sector as source of funds is given by the GOV part of the total intramural R&D expenditure (GERD), whereas the public sector as a sector of performance is the aggregation of GOV and HES. Figure 5 below shows the historical evolution of GERD financing in current prices in Latvia.

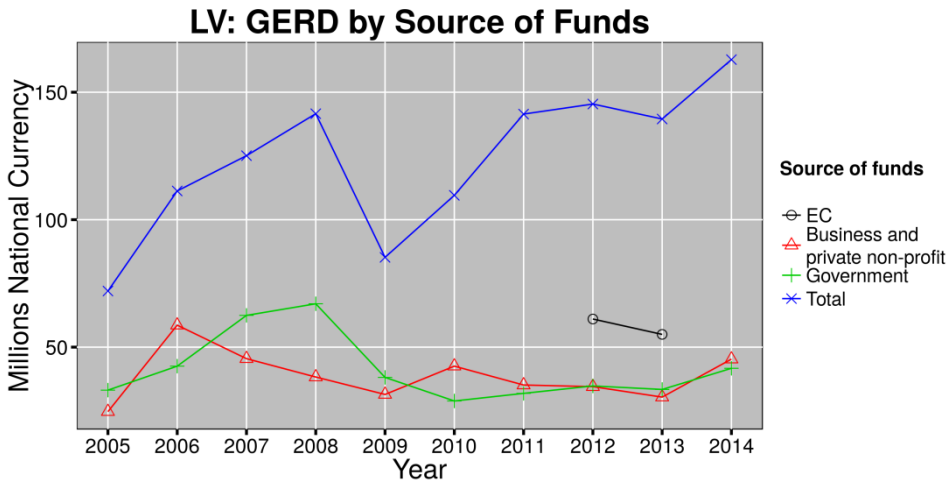


Figure 5. Developments in the funding of the total GERD

Data source: Eurostat

The total Latvian R&D expenditure (GERD) experienced a severe drop in 2009 due to the crisis but it recovered and even grew in 2011 and 2012 in absolute volume (mainly due to the use of structural funds, as explained later in the section). A small drop in 2013 could be associated with the drop in the private R&D expenditure as well as the life cycle of the EC support. In 2014 the picture changes again with the total GERD increasing sharply as a result of the increase in both public and private contributions. From 2009 the government is no longer the major funder of GERD. The private sector became more or at least equally important. Although it is not evident from Figure 5 due to the lack of data on the subcategories of the category "Abroad" as source of funding, the country is overly reliant on EU funding. Table 5 (see below) shows that from 2009 the external funding accounts for more than 50% of the total GERD. Assuming that the shares of the different subcategories are stable over time and based on data for 2012 and 2013 it can be concluded that the European funding is responsible for the significant increase in the overall GERD from 2010 and on.

3.2.2.1 Direct public funding from the government

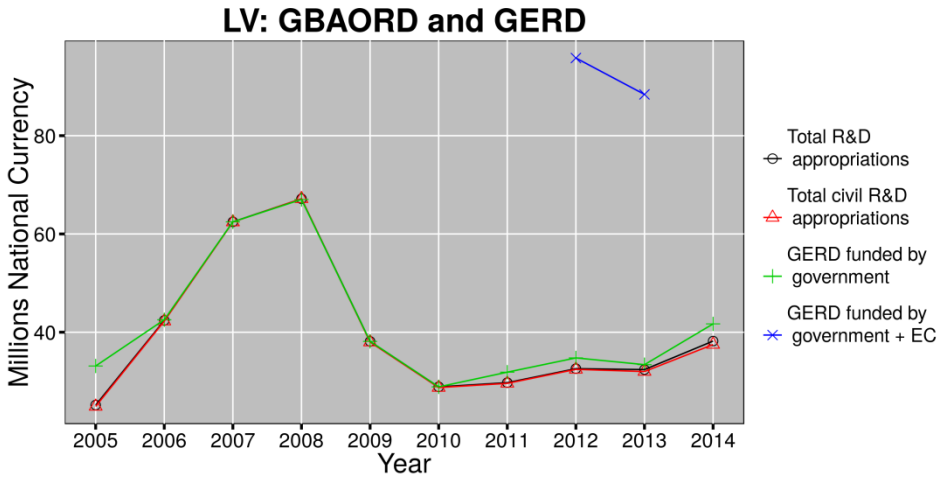


Figure 6. R&D appropriations and government funded GERD in millions of national currency
Data source: Eurostat

Figure 6 shows that there is hardly any difference between the total and civil R&D appropriations which is not surprising for a small country without extensive military base.

A strong similarity in expenditure and allocations measured in millions of national currency is also observable. In fact, government financed GERD and GBOARD are almost identical in terms of absolute values. Both have been increasing until the economic crisis of 2008. The crisis hit Latvia very hard and the country experienced a negative growth rate of -17.7%. At the backdrop of rapidly increasing foreign debt and outflow of foreign private capital the country was faced with very strong fiscal consolidation pressure and pursued pro-cyclical austerity measures across the board. The adopted restrictive fiscal policies were among the most severe in Europe bringing severe cuts in the government expenditure. This led to a drastic decrease of R&D spending and appropriations both in absolute and relative terms (Figure 6). Government budget for R&D decreased by 50% and government R&D spending dropped with nearly 40% between 2008 and 2009. The public R&D expenditure started recovering after 2010 and in 2014 has reached the level of 2009. Still, overall R&D spending (total GERD) remains one of the lowest in the EU.

3.2.2.2 Direct public funding from abroad

Latvia provides data only on the category "abroad" as a total not allowing for the assessment of the EC contribution to R&D expenditure through Structural Funds and Framework Programmes. Data are available only for 2012 and 2013, therefore trend analysis cannot be performed. It can be seen, however, that the European Commission is the major source of external funding. In both 2012 and 2013, the EC contribution represented over 70% of the total funding from Abroad (about 40% of the total GERD) and over 160% of the direct public funding provided by the government. As a Bruegel policy contribution[54] highlights, in countries such as Latvia (and for that matter for most Central and Eastern European states) "Structural Funds for research and innovation are of the same magnitude as national R&I budgets, meaning that Structural Funds (almost) double the volume of government R&I funding included in GBAORD data for the country".

[54] Reinhilde Veugelers (2014), "Undercutting the Future? European Research Spending in Times of Fiscal Consolidation"

This observation is also relevant for the other 2 Baltic States – Estonia and especially Lithuania, but Latvia is the most extreme case with Structural Fund allocations.

Table 5. Public Funding from Abroad to Latvian R&D (in millions of national currency)

Source from abroad	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Total	13.30	8.40	15.94	32.73	13.09	36.57	72.14	73.25	72.00	72.00
BES								7.8	14.7	
EC								61.03	55	
International Organizations								0.6	1.5	
Total as % GERD	18.47	7.54	12.74	23.12	15.36	33.38	51.01	50.39	51.61	44.23
EC as % GOVERD								175.49	164.67	

For implementation of activities planned in the Latvian Guidelines for the Development of Science Technology and Innovation 2014-2020[55] the required total state budget for the 2014-2020 periods is 603 million EUR. Total financing from the Structural Funds for this period is planned to be 548 million.

Distribution of public funding

Figure 7, below shows how the distribution of public funding to sectors of performance evolved over time. It is clear that publicly funded R&D is ***almost entirely*** performed by the public sector. After 2005 direct public support to private R&D diminished. The recent introduction in 2014 of a 300% super deduction fiscal incentive scheme is aimed to stimulate business R&D indirectly (see Sections 3.2.3 and 3.5). The effect of this measure is yet to be seen.

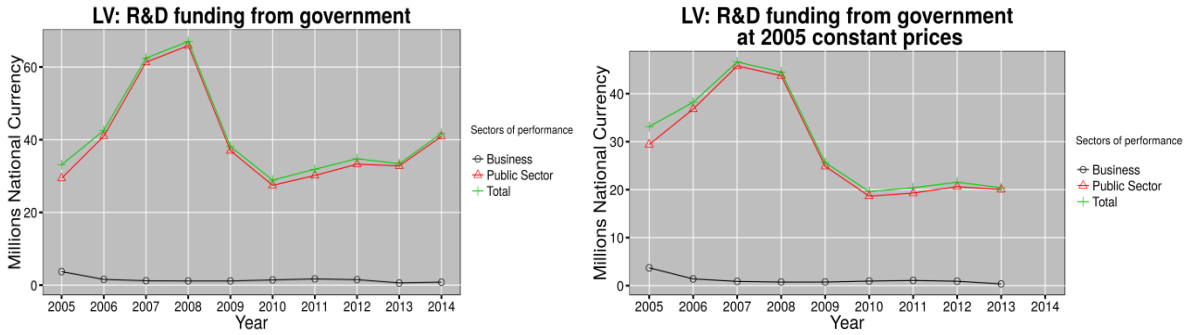


Figure 7. Government intramural expenditure by sectors of performance
Data source: Eurostat

[55] http://polsis.mk.gov.lv/view.do?id=4608

3.2.3 Indirect funding – tax incentives and foregone tax revenues

Until now Latvia has been a selective and marginal user of R&D tax incentives, mainly targeting the acquisition of technology from outside the country and via foreign investors and entrepreneurs. A new enhanced allowance scheme was recently introduced (in July 2014). The new scheme will offer a 300% super deduction of the following R&D expenditures:

• Remuneration of the scientific staff or scientific technical staff;

• Remuneration of the research services provided by the specialised scientific institutions (member state residents of EU or EEA);

• Remuneration of the accredited certification, test and calibration institutions (member state residents of EU or EEA) for the test, certification and calibration services.

Since the measure was recently introduced, no assessment of its effectiveness is available and no data on forgone tax revenue exists. The first impact evaluation of the tax incentive is scheduled in the second half of 2015. Moreover, Latvia is not yet an OECD member and it does not participate in the OECD data collection on tax incentives in support to R&D.

3.2.4 Fiscal consolidation and R&D

As visible in Figure 6, after a sharp drop in 2009, the country maintained and even increased slightly the nominal levels of its budgetary appropriations for R&D since 2010 but on a lower than the pre-crisis level. Similarly, GERD funded by government dropped in 2009 but has not decreased further since 2010. However, due to the rapidly recovering economic growth, their share as a percentage of GDP show a decrease for GBAORD, or stagnation for government funded GERD. This is depicted in Figure 8, below, that shows the scatterplot of the structural balance and a relevant measure of the R&D (GBAORD as % GDP, first panel and GERD as % GDP, second panel)[56]:

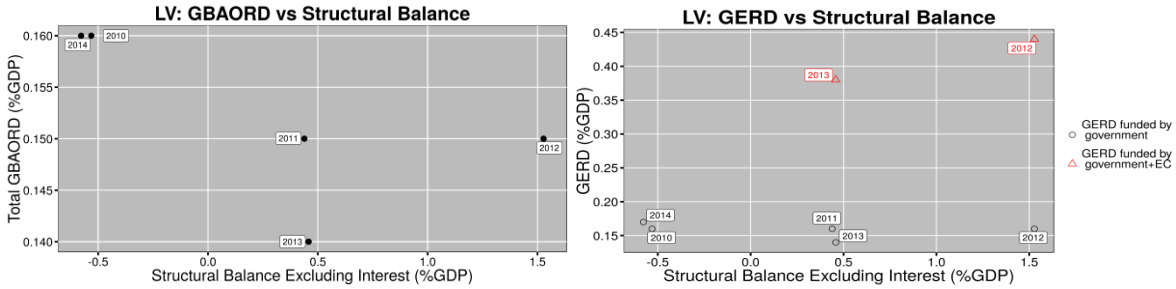


Figure 8. Fiscal consolidation and R&D

Data source: AMECO, Eurostat

Based on Figure 8, fiscal consolidation had a small negative impact on R&D appropriations in terms of GDP between 2010 and 2012, translating into a small loss of around 0.01% of GDP (i.e. the difference between 2012 and 2010 data for GBAORD). However, in terms of government expenditures (Figure 8, right) direct public funding practically has not come at the expense of R&D investments in 2010-2012 (there is no evident correlation between the two variables). The decisive role of EU funding can be observed.

It needs to be mentioned that the quality of data concerning indirect financing through R&D tax incentives is not sufficiently good in order to be able to take it into account in this analysis.

[56] Structural balance data comes from the AMECO database the other indicators were taken from Eurostat.

Based on the analysis performed in this section, we can argue that although negatively affected in terms of appropriations, direct public funding to R&D in Latvia during the post-crisis fiscal consolidation period was maintained on a fairly constant (albeit very low) share of the GDP. It is largely thanks to the EU Structural funds that Latvia continued to fund its R&I policy mix in the post-crisis period.

3.3 Funding flows

3.3.1 Research funders

As indicated in section 1.2.2, the Ministry of Education and Science of the Republic of Latvia is the main body in charge of R&D funding programme design, including the formulation of the eligibility criteria. Alongside it, the Ministry of Economics is responsible for the programmes related to innovation and business support. The same section identified the State Education Development Agency (subordinate to MoES) and the Latvian Investment and Development Agency (MoE) as the main funding agencies that are responsible for the implementation of these programmes, funding allocation and funded projects' supervision. Since 2014, the implementation and administration of R&I funds coming from the EU, which constitute a vast majority of the total R&I funds in Latvia, has been in the hands of the Central Finance and Contracting Agency (subordinate to the Ministry of Finance).

The funding of research in the higher education sector in Latvia, for example, can be divided into three branches. Firstly, there is the basic research funding upon which the distribution of funds is based on a formula that takes into account a number of scientific outputs, like scientific papers, patents and doctorates. The second type is academically oriented research funding administrated by the Council of Science of Latvia. It consists of five sub-councils that evaluate the proposals submitted after calls for projects and allocate the funding based on the quality of the proposals. The success rate of those applying to this funding source is around 15%. When it comes to state research programmes in more applied areas, applications received during calls for proposals are reviewed by the Council of Science, but the final funding decisions are made by the MoES.

The authors of this report did not identify any source of private not-for-profit funding of public research performers in Latvia. The role of such funding is still very small or non-existent.

3.3.2 Funding sources and funding flows

EU SFs play an essential role in the financing of R&I in Latvia – 10% of the total European Regional Development Fund (ERDF) and Cohesion Fund (CF) allocations for the 2007-2013 period were used for R&I. In 2010, R&I financing from the SFs far exceeded the national public funding. Overall, last 10 years have witnessed considerable growth in the share of EU SFs (ERDF/ESF) in Latvia's total R&D funding, reaching 50.99% in 2011 (EU SFs and FP7 contributions taken together) and 50.45% in 2012. The same dominance was present in 2013 with a gradually decreasing trend in late 2013 and in 2014 due to a decrease in the funds available from both SFs and EU Framework Programme projects due to the transition period between the programme and planning cycles. As of 2015, SF funding represents a third of the total R&D expenditure in Latvia.

Overall, 21.8% of GERD in 2013 originated from the business sector (0.13 % of GDP) and government financing amounted to 23.9% (0.14% of GDP), whereas foreign funds, including the EU Structural Funds, constituted 51.6% of the total expenditure on R&D (0.31 % of GDP). The share of foreign funds for R&D in Latvia increased significantly in 2010 (to reach a third of all expenditure on R&D) and between 2011 and 2013, it has accounted for more than a half of total GERD. Such statistics point to the extensive dependence of the Latvian R&D&I system on foreign financing, mostly on EU funds. 2014 showed promise with regard to decreasing the country's dependency on foreign funds since 44.2% (0.3% of GDP) of all funds came from abroad that year. Both the share of

business financing (27.8% of GERD or 0.19% of GDP) and the government financing of R&D (25.6% of GERD or 0.17% of GDP) increased in 2014.

According to data from the EC, the overall absorption rate of EU SF in Latvia stood at 92.8% in 2015 and it was among the highest in Europe. In recent years, it has been above both the EU-28 and the Central and Eastern Europe averages. However, neighbouring countries like Estonia and Lithuania are ahead of Latvia with regard to not only the absorption rate but also the payment ratio and contracting ratio (as for the latter, only Lithuania exceeds the Latvian contracting rate). Specifically, the contracting ratio in Latvia was 96% in 2013 while the payment ratio was 70%. The difference between contracts and payments could be an indicator of efficiency in the administration of fund absorption. According to the KPMG progress report on EU funds in Central and Eastern Europe,[57] the gaps between grants contracted and paid out in 2013 in the three Baltic states were smaller than in the rest of the region. However, when it comes to R&D&I fund absorption capacity, there are still some important factors hindering its success.

For instance, when considering its human resources, the R&D sector in Latvia is insufficiently developed. The number of jobs in research and engineering is low and less knowledge-intensive industries prevail (low-middle tech industries constitute 82% of manufacturing).[58] The "Informative Report on Medium and Long-term Labour Market Forecasts",[59] prepared by the Ministry of Economics, notes that the issue is unlikely to be resolved in the next five years. Businesses lacking motivation to gradually shift to more knowledge-intensive industries and to create more permanent R&D jobs technically limits Latvia's ability to absorb the available SF/ESIF funds in R&D&I activities.

The use of EU SFs in Latvia in the period 2007-2013 was directed more towards investments in infrastructure, production equipment purchases or replacement, construction and other capital goods. Less tangible R&D&I investments, such as R&D&I activity, education, human resources, social investments and the like, were not as popular. Data provided by LIDA indicates that during 2008-2014, only in 2010 did SF support given to less tangible R&D&I investments exceed those meant for capital replacement or extension or similar. In all other years, the use of these funds to promote innovation, enhance human resources and improve R&D&I activity capabilities was much lower. Such fund usage prevailed due to the relatively safe nature of the projects that were supported – they were typically aiming at already known products with few minor changes, had an existing market ready for the product, had a high likelihood of success, and used reliable business plans based on prior experience and a mutual experts' and policy makers' agreement on high probability of success.

As for the EU Framework Programme (FP) funding, Latvia's participation in these initiatives has not been very active. Latvia's participant success rate in the EC Seventh FP was 21.6%. The successful participants received a total EC financial contribution of €48.19m. As indicated in the sixth FP7 monitoring report, during 2007-2012, Latvia was the country with the second lowest number of EU financial contributions per applicant in the retained proposals for FP7 calls.

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[57] http://www.kpmg.com/CEE/en/IssuesAndInsights/ArticlesPublications/Documents/EU%20Funds%20in%20Central%20and%20Eastern%20Europe%202013.pdf

[58] The share is measured as the value added of low and low-medium technological intensity manufacturing as a percentage of total manufacturing value added in 2013; Data source: http://data.csb.gov.lv/pxweb/en/rupnbuvn/rupnbuvn__ikgad__uzndarb/SB0240_euro.px/table/tableViewLayout1/?rxid=562c2205-ba57-4130-b63a-6991f49ab6fe

[59] Ministry of Economics of the Republic of Latvia, "Informative Report on Medium and Long-Term Labour Market Forecasts" (Riga: Ministry of Economics of the Republic of Latvia, 2014. gada 12. jūnijā), 84. Retrieved from: https://em.gov.lv/files/tautsaimniecibas_attistiba/DT2014_1.pdf.

3.4 Public funding for public R&I

3.4.1 Project vs. institutional allocation of public funding

Funding for science, research and development comes from three main sources in Latvia: state (public) budget funding, European Structural Funds allocated nationally, and international performance-based project funding. At present, the funding available to Latvian scientists from the state budget is channelled to research institutions through several funding schemes.

As of 2014, research funding in Latvia is organised with a new approach. The newly proposed three-pillar higher education financing model also extends to research funding. The model and its three pillars - base financing, performance-based financing and innovation financing – are described in section 2.3 and summarised in Figure 9 presented below.

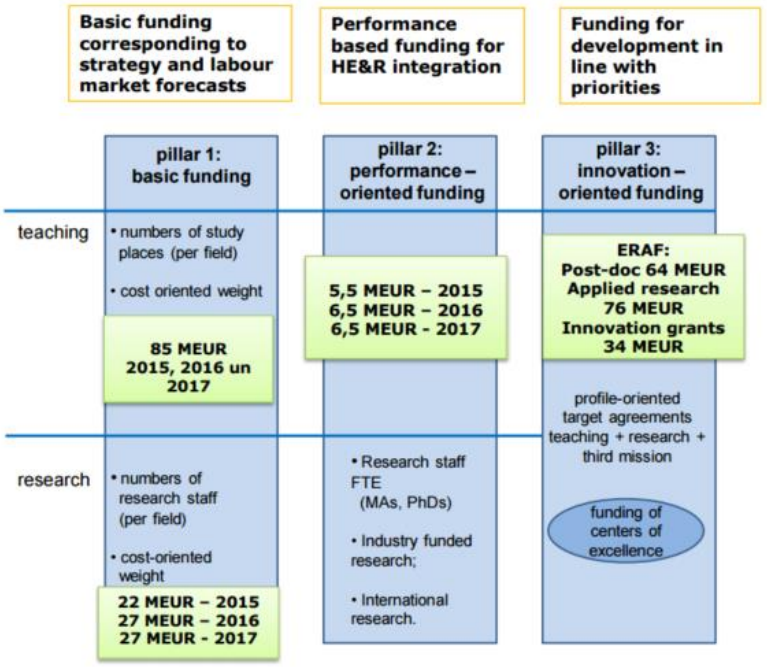


Figure 9. The new higher education and research funding model.
Source: Ministry of Education and Science.

The balance between project-based funding and institutional funding in Latvia leans more towards project-by-project funding. Only 17% of research funding is institutional. Low relative levels of institutional funding can commonly disrupt continuity, affect the ability to invest in facilities and equipment, impede the ability to carry out institutional challenges and, consequently, damage quality. As pointed out in Latvia's research and innovation system assessment exercise undertaken by the Technopolis Group, the optimal – or at the least minimum – level of institutional funding should be somewhere around 50%.

Nevertheless, the extensive share of Structural Funds in R&D funding and the design of the funding programmes serve to further widen the gap between these two types of resource allocation. Namely, they cause the share of project-based funding to grow. They also increase the share of competitive funding as opposed to non-competitive funding. This is significant in the Latvian context, since Latvia experienced a severe financial crisis that led to budget cuts to public research organisations in 2008-2009. As a result of the budget cuts, SFs were distributed mainly on a needs basis. Despite the fact that taking such an approach was rational and beneficial at the time, it effectively created a system in which PROs and HEIs became heavily reliant on continued funding from SFs. To rectify this, increasing the share of performance-based project funding is

considered conductive to yielding higher returns in terms of knowledge creation, research output and making research organisations more responsive to socio-economic needs.

However, as the above mentioned assessment report by Technopolis Group (Arnold et al., 2014) points out, an increase in performance-based institutional funding would help change the incentives under which Latvian researchers and groups operate. For instance, it could be an incentive for the research institutions to consolidate into fewer, but more excellent, organisations. The institutes might be encouraged to merge their groups and activities, build scale, and pool their researchers. Moreover, the lack of institutional funding might be considered a contributor to the dilution of thematic priorities, for instance, in the state research programmes. Some incentives encouraging this could be observed in 2014, when additional government financing (€2.8m) was allocated to fund scientific institutions and changes were made to the provisions governing the allocation of their base financing.[60]

3.4.2 Institutional funding

According to the Law on Scientific Activity, the state shall allocate base financial resources to state scientific institutions, state institutions of higher education and the scientific institutes of state institutions of higher education that are registered in the Register of Scientific Institutions. The amount is allocated in accordance with the procedures specified by the Cabinet and includes resources for:

- the maintenance of scientific institutions (buildings and equipment maintenance, payment of public utility services, remuneration of administrative and support staff);
- payment to the scientific staff;
- development of the scientific institutes to support them in achieving the aims set out in their operational strategies.

According to the law (last amended in 2010), scientific institutes that receive the base financing shall have their activities evaluated every six years. Institutional base financing is calculated and administered by the Ministry of Education and Science based on the data submitted to it annually by the research institutions.

The amount of base research funding that is granted to the research organisations is calculated according to a formula that considers three variables from the previous year: the sum of the average operation costs and research personnel costs multiplied by the development coefficient. The first variable reflects the office space operating costs that are obtained by taking the amount of fixed space (15 m^2 per each individual employed in research) and multiplying it by the number of FTE researchers, then multiplying it by a standard calculation of the premises' fixed operation costs and further multiplying it by a coefficient of 2.0 (in the case of natural and engineering sciences) or 1.3 (for social sciences and humanities). The second variable in the formula reflects the number of FTE personnel employed by the organisation in the previous year multiplied by half of a professor's minimum annual income as set by state regulations. The development coefficient varies in the interval from 1 to 12 and includes the contribution of last year's outputs, such as peer-reviewed scientific papers in various categories, monographs, patents and doctorates produced, as well as the number of international research and development projects generated.

Large-scale reforms of HEIs and PROs are currently under way to improve the quality and relevance of public R&D. In 2013, the Cabinet of Ministers accepted amendments in Regulation No. 1316's "Order of calculation and allocation of institutional funding to research institutes". The amendments intend to revise and approbate new criteria for granting base financing to scientific institutes in order to reduce institutional

[60] National Reform Programme of Latvia for the Implementation of the "Europe 2020" Strategy, page 46; http://ec.europa.eu/europe2020/pdf/csr2015/nrp2015_latvia_en.pdf

fragmentation, achieve scientific excellence and ensure that innovation and technology transfers take place. Namely, changes to provisions on allocating the base financing to scientific institutions took place in 2014. The changes stipulate that additional financing will be granted to the scientific institutions that have received an evaluation of "4" and "5" in the international assessment of science, while those that have been evaluated with "1" and "2" and do not participate in the consolidation processes of scientific institutions will not receive the base financing as of 2016. Fostering the consolidation process, the scientific institutions with the lowest marks are asked to seek out opportunities to integrate with stronger institutions.

Another new development is that since July 1st, 2015 MoES will subtract from the available in the Law on State Budget financing to cover costs of full science paper data bases, operational costs of access to GEANT, costs to maintain local academic network, costs of joint data centre and national research web-site, thus reducing the share of overall institutional financing.

According to the information provided by the Ministry of Education and Science, the budget foreseen for the science base funding for the period 2014-2017 is €99.16m. The annual base funding amounts are dependent on the MoES' calculated allocations for the funded research institutions and they are corrected proportionally to the amount of available funding in the State Budget Law for the next year. The base financing distributed to the state scientific institutions amounted to €15.98m in 2014, €18.38m in 2015 and is estimated to amount to a total of €19.95m in 2016. While the base financing was distributed to 40 institutions in 2014, as a result of the consolidation process, this number decreased to 29 in 2015 and to 21 in 2016.

3.4.3 Project funding

According to the Law on Scientific Activity, the state research programmes that have been operational since 2005 are the state commissions for the performance of scientific research in a specific economic, educational, cultural or other sector of priority to the state with the purpose of promoting the development of such sector. The Cabinet implements the programmes according to the scientific priority directions that it approves. The specific purposes and tasks of the state research programmes are set by the relevant ministries as well as the Latvian Council of Science and the Latvian Academy of Sciences. As set in the Law, the Cabinet of Ministers is responsible for determining the application, evaluation and financing procedures of the programmes, and the Ministry of Education and Science is in charge of allocating the financing from the state budget resources provided for the financing of science to the programmes in accordance with competition procedures.

The implementation period of the state research programmes is four years. According to MoES data, the total budget planned for the state research programmes for the period of 2014-2017 is approximately €25.7m. During the first round of financing (2014) around €4.4m were distributed, whereas €6.15m were allocated for the implementation of the second round financing (2015) of the state research programmes.

CoM order No. 558,[61] adopted on 7 October 2014, approved 10 state research programmes for the period 2014-2017. CoM order No. 559[62] approved four additional state research programmes for this period. The current state research programmes for 2014-2017 and their financing in the first and second rounds are presented in Table 6.

[61] http://likumi.lv/doc.php?id=269406
[62] http://likumi.lv/doc.php?id=269407

Table 6. 2014-2017 State research programmes and their financing.

Programme name	Abbreviation	Total financing 2014-2017	1st round financing (2014)	2nd round financing (2015)
Energy-efficient and low-carbon solutions for safe and sustainable energy supply	LATENERGI	€2.25m	€333,502	€543,730
Latvian ecosystem evaluation and its dynamic climate effect	EVIDEnT	€2.25m	€332,249	€558,600
Multifunctional materials and composites, photonics and nanotechnologies	IMIS²	€2.25m	€364,137	€530,300
Cyber physical systems, ontology and biophotonics for safe and smart cities and society	SOPHIS	€2.25m	€429,704	€533,160
Biomedicine for public health	BIOMEDICINE	€4.5m	€878,682	€1,077,970
Forest and subsoil resource research, sustainable use – new products and technologies	ResProd	€2.25m	€425,502	€532,600
Agricultural resources for sustainable high quality, healthy food production in Latvia	AgroBioRes	€2.245m	€385,000	€542,490
Innovative solutions for social tele-rehabilitation in the context of inclusive education in Latvian schools	INOSOCTEREHI	€0.6m	€73,355	€151,920
Economic transformation, smart growth, governance and regulatory framework for public and socially sustainable development - new approaches to sustainable knowledge society building	EKOSOC_LV	€1.65m	€259,146	€397,900
Sustainable and innovative environment for Latvian cultural traditions	Habitus	€0.2m	€34,829	€41,090
Innovative materials and smart technologies for environmental safety	IMATEH	€1.1m	€175,654	€254,830
Next generation information and communication technology (ICT) state research programme	NexIT	€1m	€131,575	€220,430
Innovation and sustainable development: Latvia's post-crisis processes in the global context	SUSTINNO	€0.9m	€122,592	€231,460
Letonika – Latvian history, language, culture, values	Letonika	€2.25m	€437,302	€532,330

Source: Ministry of Education and Science.

This financing can be considered the only state-ordered medium-term applied research funding aimed at meeting and exploring challenging areas that are important for society. It also aims to catalyse structural reforms in the Latvian economy by resolving the problems identified in the specific priority directions based on RIS3.

Project funding comes in the form of grants for fundamental and applied research projects (operational since 1991) from the Latvian Council of Sciences. Five sectoral

councils distribute funds in response to peer-review-evaluated calls for proposals in the state research programme's five thematic areas: energy and environment, innovative materials and technologies (ICT and signal processing and nanotech), national identity, public health, and sustainable use of natural resources (food; forestry). The success rate is about 15% and the average amount distributed annually is €4.3m. As reported by the Latvian Council of Science, in both 2014 and 2015, the distributed financing was approximately €4.4m, out of which around €3.2m went to thematic research projects and €1.2m to research cooperation projects.

Several problems are present in the project-oriented funding schemes. Project funding programmes are usually heavily reliant on an exhaustive list of quantitative and qualitative criteria. Even though the project selection process and determination of eligibility criteria are generally perceived as being transparent and free of corruption, in some cases they have proven to be inappropriate, especially regarding innovation projects. The excessive bureaucracy and documentation in the selection of projects, administration and control processes might not only be time- and resource-consuming, but may also be practically impossible to fulfil by innovative projects. This is due to the nature of such projects, the outcomes of which are commonly valuable but may not necessarily completely match the outlined development schedule and anticipated results. The design of the funding programmes should, therefore, take a slightly different approach by including fewer objectives and goals, placing a greater focus on innovation and by being closer to the market. More emphasis should also be put on peer-review-based projects in combination with evaluating the project results according to the eligibility criteria.

Some progress can already be seen regarding the funding programme design. For instance, new programme proposals by the Ministry of Education and Science have fewer goals and objectives, international experts are involved in the evaluation of the applications and they are now based on fewer criteria. Some national funding programmes are also designed to give priority to proposals that have already proven to be of high quality, for instance, during their participation in Horizon 2020. Such programme design features are significant improvements, even when compared to the more recent ones that were given approval last year.

3.5 Public funding for private R&I

Indirect financial support for private R&I

It is notable that up until the middle of 2014, the indirect government R&D incentives promoting R&D&I in Latvia, such as R&D tax credits, R&D allowances, reductions in R&D workers' wage taxes and others, were either insignificant or absent.

Even though Latvia has much to overcome in this context, some progress has taken place recently. In order to encourage private sector investments in R&D, as of 1 July 2014, enterprises making investments in R&D are eligible for tax relief, providing for a possibility to write off certain R&D costs in the year when such costs are incurred by applying a value-increasing coefficient of 3. The eligible R&D costs, to which the tax incentive can be applied, include the company's scientific and technical personnel costs in relation to R&D work, costs of research services received from scientific institutions, as well as costs of certification, testing, and calibration services when receiving the services from accredited certification, testing, and calibration institutions. Previously, the amount that was allowed to be written-off was 1.5 times the R&D expenditures.

According to information provided by LIDA, to avoid any misinterpretation of the tax code, the new legislation provides definitions of R&D activities and guidance on their evaluation. Therefore, a company's R&D activities have to meet the following criteria:

1. The purpose of the R&D activities is industrial or experimental production; this stipulation also includes industrial research or experimental production in the service industry;

2. The anticipated result of the R&D activities is innovation or furthering insight into scientific or technological problems;
3. The recommended solution to the problem is not obvious to the respective industry's experts who have knowledge or experience in the field;
4. The innovation or the scientific and technological problem that is addressed is connected to the current business operations of the taxpayer or business operations that the taxpayer is about to undertake.

For the taxpayer to apply the tax break, s/he needs to evaluate the eligibility of the planned R&D activities and produce an R&D project that explains its objectives – in short, produce a new product or technology that neither the company nor anyone else has ever made before. Exceptions for non-innovative products can be made in cases when the taxpayer proves that the company was not aware of such a pre-existing product or research or if the product or research was not available at the time. The exception rule applies, for instance, in cases when the production is economically beneficial or if the company has a patent for the product or its research.

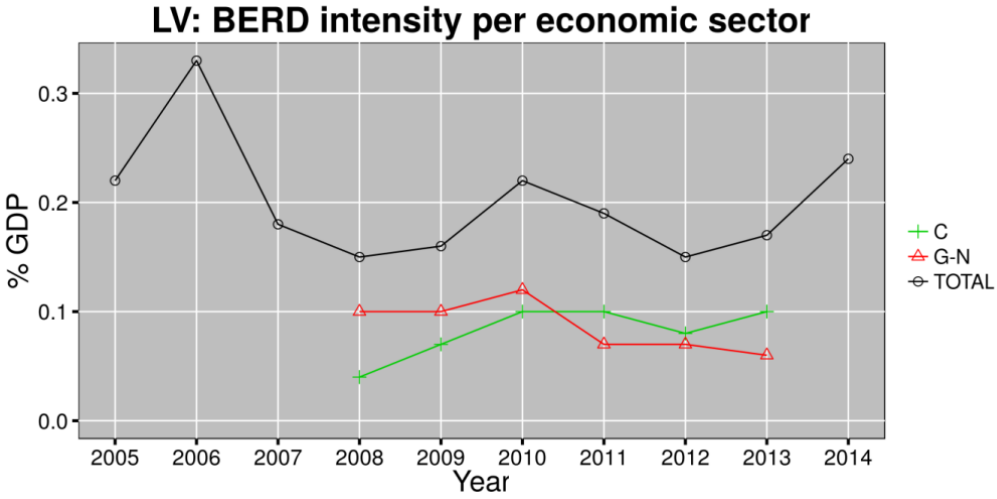
Regarding the demand-side policy instrument related to public procurement, Latvia does not have plans in the field of innovation procurement. Such a measure could potentially encourage the development of specific innovations in the delivery of public services, which in turn could benefit the companies developing, or having the potential to develop, the innovations and encourage them to innovate further by seeking other national and international markets. Nevertheless, the government's current level of support given to innovation performers appears to be weak and is mostly led by supply rather than demand. The only measure which is so far only informally discussed and is supported by the industry is a "lead market" initiative, whereby the government could provide a one-time grant covering the risk of participation in markets/value chains that are difficult to enter, such as in the area of nanomaterials with non-tested products.

3.6 Business R&D

3.6.1 The development in business R&D intensity

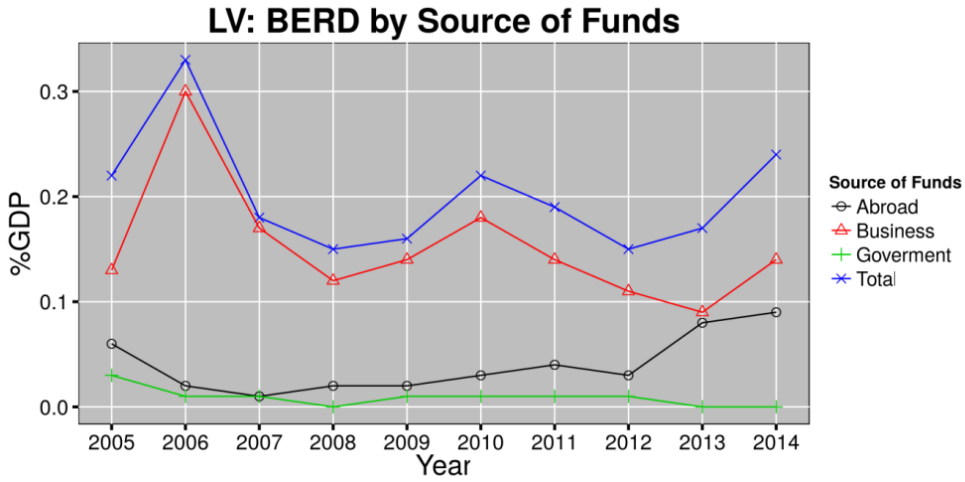
As one can see from Figure 10, BERD intensity in Latvia has stagnated in the recent years. It peaked in 2006 but then went back down to values of around and below 0.2% of GDP. The value for 2014 (0.24% of GDP), although marking an increase from 2013, is still one of the lowest in the EU. The highest BERD spenders have been the manufacturing and business services sectors. In 2011 business services BERD intensity dropped and manufacturing became the most important sector in this respect. Figure 13 shows that BERD in ICT and in professional, scientific and technical activities both decreased significantly in 2011 but the latter managed to recover somewhat, unlike the former. In the manufacturing top sectors (in terms of BERD) the pharmaceutical industry and the manufacture of computer, electronic and optical products are responsible for the increase in manufacturing BERD since 2011 (Figure 12).

Figure 10. BERD intensity broken down by most important macro sectors (C= manufacture, G_N=services).



The private sector is the main funder of the Latvian BERD, but since 2013 external resources (mostly EU structural funds) are almost as important a source of funds as the private sector (Figure 11). Indeed, in 2012-13 a significant drop of funding from domestic private resources has been compensated by external resources, notably EU funding that has gradually gained importance since 2008-9, when a number of SF-funded measures targeting the business sector were introduced. Funding from government sources was of marginal importance throughout the whole period under scrutiny.

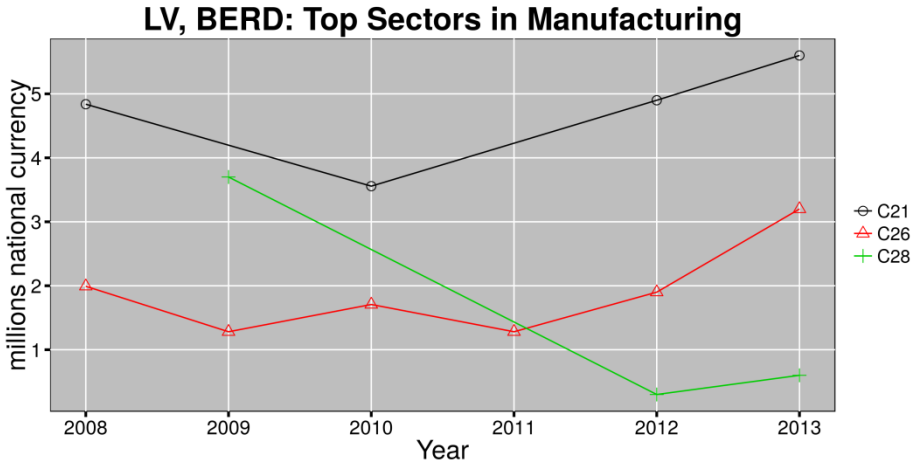
Figure 11. BERD by source of funds



3.6.2 The development in business R&D intensity by sector

Based on Figure 12, below, the highest BERD spenders in manufacturing are pharmaceuticals and computer, electronic & optical products. BERD spending was negatively affected by the crisis in all these sectors but has recovered. Interestingly, the manufacture of machinery and equipment n.e.c. (for example, agriculture and forestry machinery, engines and turbines, machinery for food, textile and paper processing) completely lost its leading role in terms of R&D intensity after 2009 and today it is quite marginal.

Figure 12. top sectors in manufacturing (C26=manufacture of computer, electronic and optical products; C21=Manufacture of basic pharmaceutical products and pharmaceutical preparations; C28=manufacture of machinery and equipment n.e.c).



The pharmaceutical industry has been the most R&D intensive manufacturing sector in the period under scrutiny. Latvia's pharmaceutical and biotechnological industries have a long history and the sector continues to be a cornerstone of today's economy. Pharmaceuticals is the largest industrial sub-sector, creating 32% of its total turnover.[63] Some of the biggest Latvian pharma companies are Grindeks[64] and Olainfarm[65]. The sector's importance was reaffirmed by the 2009 decision of the Latvian Cabinet of Ministers to include the chemical and pharmaceutical industries in the list of priority sectors essential for the country's economic development.[66] In addition, one of the country's smart specialisation priorities is "biomedicine, medical appliances, bio-pharmacy and bio-technology".

Thanks to long-standing traditions, Latvia has a strong manufacturing base in fine chemicals and pharmaceuticals. The country was the principal location for these sectors in the former Soviet Union, with 25% of new Soviet-era drug technology designed here. One out of every four medical preparations manufactured in the former USSR and intended for the USSR market was actually made in Latvia.[67] The country has a competence centre on pharmaceuticals and chemistry.

The country produces and exports a diverse array of pharmaceuticals and chemical goods, from unique anti-influenza medicine to household chemicals and paints. The core export markets are Latvia's Baltic neighbours Lithuania and Estonia, as well as Russia, Denmark, Germany, Sweden and the Netherlands. Latvia has been traditionally successful in establishing a solid scientific base that is necessary for the sector development going forward.[68]

The sector's BERD suffered a contraction during the crisis but returned to a growing path after 2010.

[63] http://scanbalt.org/press/news+archive/view?id=3317
[64] According to its website, every year the company allocates significant resources (8-10% of the net sales) in R&D that is mainly oriented towards development of cardio vascular, neurological, anti-cancer and virus preparations. 4-5 research projects are carried out annually and about 70 employees are involved in the R&D activities of the company. http://www.grindeks.lv/en/research-and-development
[65] JSC Olainfarm has distinctive experience in the development and manufacturing of adamantane, quinuclidine, and nitrofurane-line APSs. http://olainfarm.lv/en/research
[66] http://www.lakifa.lv/en/about-industry/
[67] http://www.liaa.gov.lv/trade/industry-profiles/chemistry-pharmacy-and-biotechnology-industry
[68] http://www.lakifa.lv/en/about-industry/

The other significant sector, manufacture of computer, electronic and optical products, has also strong historical tradition from Soviet times and today more than 200 companies comprise the Latvian electrical engineering and electronics industry.[69] Its companies manufacture products such as advanced acoustic systems and related accessories, wireless data-transmission equipment and other telecommunication systems, industrial optics, nuclear electronics, electronic control and monitoring devices used in industrial and scientific applications. The sector has a high proportion of exports (80%) and a variety of export destinations.[70] One of the 6 competence centres in Latvia is the competence centre on electrical and optical manufacturing industry.

In the business services sector professional, scientific and technical activities, ICT, as well as the financial and insurance activities sector are the top BERD spenders (Figure 13).

Due to data limitations the performance of the financial sector cannot be analysed but the country is similar to its Baltic neighbours in attracting mostly Scandinavian banking and insurance investors. FDI inflows in Latvia are the highest in this sector - about 25% of total FDI.[71]

The Latvian ICT sector is less developed than in the neighbouring Baltic countries and for a while its R&D spending was quite small but in 2013 an increase is clearly visible. Within the latest Operational Programme "Growth and Employment" (2014), the priority axis "Availablity of ICT, e-government and services" is among the top priorities.

In addition, the ICT sector exhibits the highest number of high growth enterprises and of scientists and engineers in 2013 among the most innovative sectors. Today the ICT sector (outside e-government initiatives) develops fast and is becoming more competitive. A strong informal cluster for services for the global gaming industry is emerging - developing live game experience technologies to international online gaming operators.

As far as telecommunications are concerned, despite high mobile and broadband penetration, Latvia remains a lacklustre market as the mobile market has long been saturated and there is little incentive for operators to innovate in terms of services.[72]

The top sector in terms of BERD remains professional scientific and technical activities and in particular sector M72 – Scientific research and development. It has had a strong performance throughout the whole period under discussion.

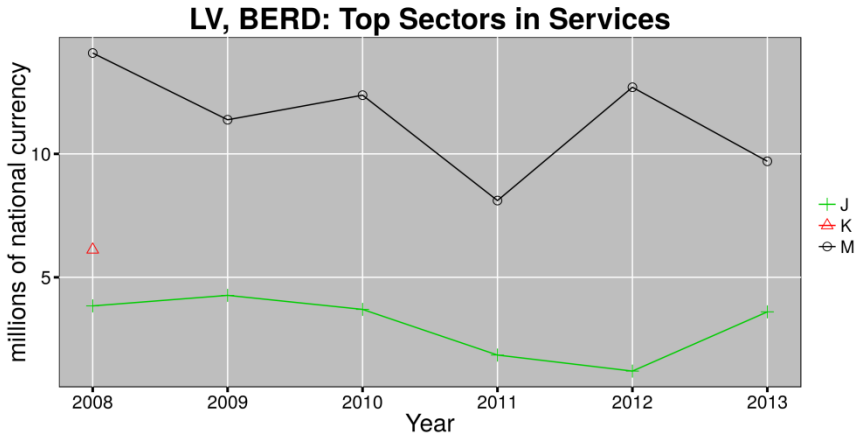
[69] A list of companies in the sector can be found here: http://www.liaa.gov.lv/files/liaa/attachments/k_2014_electrical_engineering_and_electronics_industry_companies.pdf

[70] http://www.liaa.gov.lv/trade/industry-profiles/electrical-engineering-and-electronics-industry

[71] http://www.liaa.gov.lv/invest-latvia/investor-business-guide/foreign-direct-investment

[72] Latvia Telecommunications Report 2015. http://www.marketresearch.com/Business-Monitor-International-v304/Latvia-Telecommunications-8591935/

Figure 13. top service sectors (J=information and communication, K=financial and insurance activities, M=professional, scientific and technical activities).



3.6.3 The development in business R&D intensity and value added

Figure 14 shows the contribution of each economic sector to the total Gross Value Added (GVA) in 2012 compared with the EU-28 as a benchmark. Wholesale and retail trade, real estate activities and manufacturing are the sectors with the highest GVA, which account for about 40% of the total GVA of Latvia. The percentages of GVA from wholesale and retail and real estate exceed the EU-28 figures but the manufacturing GVA is below the EU average. However, the R&D expenditure of these sectors is very limited. The pharmaceutical and the professional, scientific and technical activities sector, although being the biggest R&D spenders, have quite small GVA contribution (less than 5% for scientific and technical activities and about 0.5% for pharma, see Figure 15). Therefore, there is no correlation between R&D intensity and GVA contribution.

Figure 15 focuses on the economic sectors under Manufacturing. Sectors C16 - Manufacture of wood and of products of wood and cork and C10-C12 - Manufacture of food products, beverages and tobacco products are much beyond the EU-28 levels and contribute the most in the manufacturing GVA of Latvia, followed by sectors C25 - Manufacture of fabricated metal products, except machinery and equipment and C23 - Manufacture of other non-metallic mineral products. This is not surprising as the leading manufacturing branches in Latvia have traditionally been wood products, such as plywood and paper, and food products, particularly goods made from milk and sugar refined from beets.[73] It can be seen that the wood sector has a much higher share of national GVA in Latvia than the EU average.

It is noteworthy that the manufacturing sectors with the highest R&D investments, C21 - Manufacture of basic pharmaceutical products and pharmaceutical preparations and C26 – Manufacture of computer, electronic and optical products, account for less than 1% of the total GVA. The relatively high – compared to other industrial sectors – value added of low-tech sectors and, simultaneously, the relatively lower importance of many of the R&D-intensive sectors in Latvia can partially explain the low intensity of the Latvian business R&D.

[73] http://www.countriesquest.com/europe/latvia/economy.htm

Figure 14. economic sectors as percentage of the total GVA. Top 6 sectors in decreasing order: 1) wholesale and retail trade; repair of vehicles and motorcycles, 2) real estate activities, 3) manufacturing, 4) public administration and defence, compulsory social security, 5) construction, 6) education.

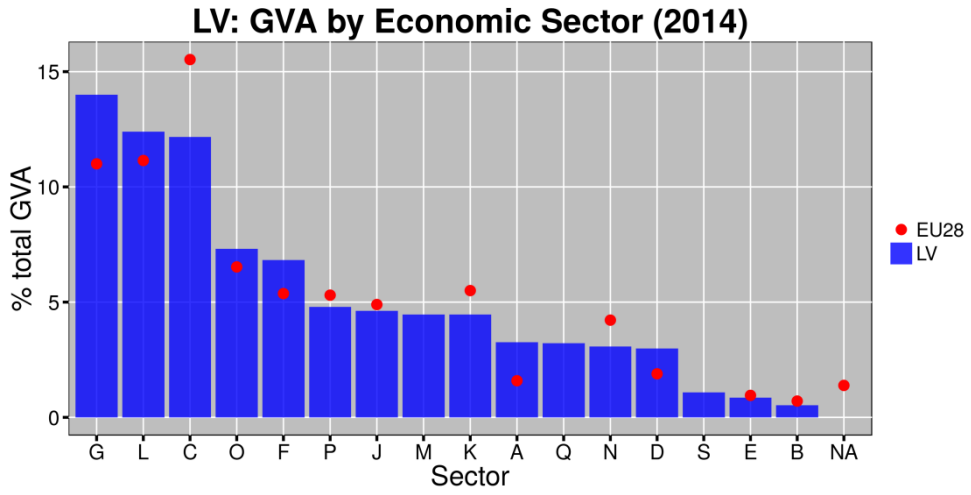
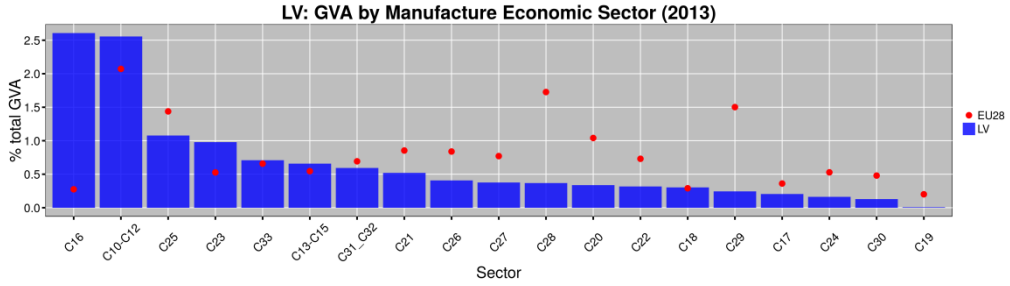


Figure 15. GVA in manufacturing. Top 6 manufacturing sectors

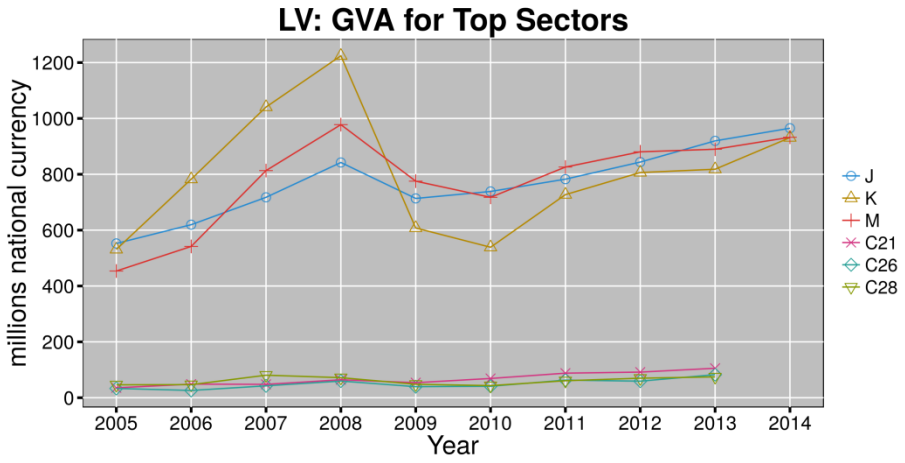
1) Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials; 2) Manufacture of food products, beverages and tobacco products; 3) Manufacture of fabricated metal products, except machinery and equipment; 4) Manufacture of other non-metallic mineral products; 5) Repair and installation of machinery and equipment; 6) Manufacture of textiles, wearing apparel, leather and related products.



Wholesale and retail trade is by far the top sector in terms of VA at factor cost (Figure 16). The VA of this sector and all the other depicted in the figure sectors show a similar behaviour throughout the analysed period. Interestingly, they don't seem to have been significantly affected by the crisis.

ICT (J), banking and insurance (K) and professional, scientific and technical activities (M) are the top sectors in terms of VA at factor cost (Figure 16). The VA of these sectors shows a similar behaviour throughout the analysed period. They were all significantly affected by the crisis but have been on a recovering path since 2010 (slightly less so in the hardest hit financial and insurance sector).

Figure 16. Value added at factor cost for the leading manufacture and service sectors in Figures 12 and 13.



3.7 Assessment

In the years following the financial crisis of 2007-2008, public R&D funding in Latvia has undergone a significant shift from largely needs-based R&D funding towards a more performance-based approach. The increasing share of performance-based funding is considered conducive to yielding higher returns in terms of knowledge creation, research output and making research organisations more responsive to socio-economic needs. Changes in the base financing model of the higher education system should further improve the efficiency of public R&D resource allocation.

Despite the fact that there is no hard evidence on the effective leveraging of business expenditures in R&I, the authors' estimation is that the BERD increase in 2014 is partially attributable to leverage effects. For instance, one of the signs of the presence of a leveraging effect could be that the increase of the business expenditure on R&I financed by the business sector is almost three times higher than the increase of public funding provided. Business R&I expenditure is still limited by the number of R&I jobs. One of the ways to rapidly increase the number of R&I jobs is to mobilise the existing production personnel to R&I activities. Tax breaks are believed to provide such incentives and contribute to leveraging R&I expenses. However, no assessment has yet been done on this and the authors do not possess proof of the additionality effects of R&D tax breaks. As a side note, it should be mentioned that it is difficult to exclude double accounting of the same expenses from any of these estimations and that the benefits of tax breaks for R&I expenses are delayed in time. Companies performing R&I will benefit from the tax break only in the future, not at the time of R&I activities.

According to experts from several commercial banks, Latvia should expect to have moderate to high growth in the next two to three years. The effect of the counter-cyclicality of R&I expenses in the business sector makes it more difficult for the government to effectively stimulate an increase in R&I in the business sector. If incentives and public funding are extensive, the government risks diverting business efforts from capturing growing markets in a growth period to the kind of long-term investment in R&D that is more appropriate for periods of low growth. However, in current Latvia's case growth is still export-led and targeting stagnating external markets, thus, it could be hypothesised that growth is related to introduction of new products and occupation of new niches. In such case, increase in R&D&I activities might be the driver and not the obstacle for growth in the short-term as well.

A general change in the policy making approach is increasing level of involvement by different stakeholders into the policy development process. Such a commitment was made by the Latvian government in 2013 and the policy has been enacted by most levels of government. As a result, the general perception regarding the transparency of the R&I policy making process has shifted. Since most of the actual changes in the policies have yet to be implemented, it is difficult to assess their quantitative effects.

4. Quality of the science base and priorities of the European Research Area

4.1 Quality of the science base

When considering the publication productivity of Latvian science, even when including both co-publication and citation statistics, it is clear that the country lags behind not only other European countries, but also the other Baltic states. In 2013, the number of publications per thousand people was 0.71 in Latvia while it was 1.82 in the EU. In Estonia and Lithuania, the quantity and quality of scientific publications in the last decade have rapidly increased, whereas Latvia's output has stagnated. Latvian scientific publication is dominated by physics, chemistry and materials science. In the top 20 publication categories in the period 2001 to 2013, it stands at 17th place (with 196 publications). The most publication intense categories in the same period, according to data from Web of Science, were Physics Condensed Matter, Materials Science Multidiscipline and Organic Chemistry.

The quality of the research output can also be indicated by the citation statistics. According to Eurostat data, the percentage of Latvian papers in the top 10% of the most cited publications from 2000 to 2013 was 5.94%. Once again, this number is nearly half of the European average of 10.63%.

Scopus data on the numbers of citations of papers published in the Baltic states (1996-2012) indicates that Latvian performance is lagging behind when compared to the two other Baltic states.

Latvia's main partners in terms of cooperating in scientific research are large countries. Based on data from the Web of Science, the main Latvian partners in co-publications, at least during 2008-2010, were Germany, Sweden and the USA. The numbers of co-publications with these partners, however, are low, almost half of Estonia's and approximately a quarter less than Lithuania's co-publications. Therefore, the absolute numbers of papers written in collaboration with Latvian authors are small when compared to those of their neighbours and the EU. The number of international publications per thousand population in 2013 was 0.24 in Latvia and 0.92 in the EU. These numbers represent the Latvian and the European shares of international co-publications of, respectively, 34.4% and 47.5%.

Finally, the share of public-private co-publications is also low when compared to the EU, which points to an issue of science-business cooperation in Latvia. This indicator, according to SciVal data, was equal to 0.8% in Latvia in the period 2011-2013 (for reference, the corresponding value for the EU-28 was 1.8%). Latvian public-private co-publications per million population, as reported in the IUS database, amounted to 2.2 in 2011 (whereas it was 52.8 for the EU-28).

Some concerns with respect to the quality of the Latvian science base stem from the fragmentation of its research and higher education systems. Given the small population in the regions and the fragmented higher education system, an important question is whether there is even a possibility of reaching critical mass. If the goal is to achieve excellence, then data taken from the Top 100 universities of the world per 100 million population in 2012 reveals that Latvia, with a population of 2 million, can expect to have 0.6 top-class universities. Thus, the impact of fragmentation on the efficient use and development of human resources should be analysed in more detail. Namely, regional universities competing with the Riga Technical University and the University of Latvia might be the source of economic activity in the regions at the cost of the effective use of the country's scarce human resources in science and technology. During public discussions regarding innovation, multiple high-ranking representatives of HEIs have openly pointed out that they clearly understand that Latvia has the capacity to be home to one university of the highest quality. However, this sentiment is not shared by the rectors of the HEIs.

It is notable that in keeping with the consolidation of the state-supported research institutes, the Latvian Council of Ministers' regulations were drafted to implement the sub-activity "Institutional Capacity Development of Research Institutions of the Operational Programme 'Entrepreneurship and Innovation'". The sub-programme allocates ERDF financing in the amount of €11.9m, including support for not only the aggregation of resources in fewer and more excellent research institutes, but also to encourage excellence and output from the most competitive research performers.

Table 7. Scientific output indicators for Latvia and the EU.

Indicator	Value	EU
Number of publications per thousand population (2013)	0.71	1.82
Share of international co-publications (2013)	34.4%	47.5%
Number of international publications per thousand population (2013)	0.24	0.92
Percentage of publications in the top 10% most cited publications (2000-2013)	5.94%	10.63%
Share of public-private co-publications (2011-2013)	0.8%	1.8%

Source: JRC IPTS RIO elaboration on Scopus data collected by Sciencemetrix in a study for the European Commission DG RTD (Campbell, 2013). The share of public-private co-publications is derived from the Scival platform and is also based on Scopus data (September 2015). SciVal ® is a registered trademark of Elsevier Properties S.A., used under license. The data on public-private co-publications is not fully compatible with the data included in the IUS, due to differences in the methodology and the publication database adopted.

4.2 Optimal transnational co-operation and competition

4.2.1 Joint programming, research agendas and calls

In order to facilitate greater participation of Latvian scientific and research institutions in the EU's research and innovation basic programmes and to promote international cooperation in the field of research and technologies, in 2014, the CM supported provisions to implement the "Support to International Cooperation Projects in Research and Technologies" with the total eligible financing of €2.1m. Furthermore, the programme Baltic BONUS, which was established in 2013 and covers project elaboration costs for the participation of scientists of the Baltic states in the Horizon 2020 competitions, has also been launched. A total of €139,000 was allocated to this measure in 2014.

As for cooperation on a Baltic state level, starting with the trilateral meeting of representatives from Latvia, Estonia, and Lithuania on the further development of research infrastructure in the Baltic region, consultations between Latvian, Estonian and Lithuanian scientists were repeatedly held throughout 2012.

Before 2015, Latvia had never been a member of any of the 10 Joint Programming Initiatives (JPI). Latvia is an observer, however, when it comes to four of these initiatives: (1) A Healthy Diet for a Healthy Life; (2) Cultural Heritage and Global Change: A New Challenge for Europe; (3) Urban Europe - Global Urban Challenges, Joint European Solutions; and (4) Water Challenges for a Changing World.

4.2.2 RI roadmaps and ESFRI

Currently, Latvia is one of the few members of the European Strategy Forum on Research Infrastructures (ESFRI) that does not have a developed national research infrastructure (RI) roadmap. In April 2015, however, an order to prepare an informative report "On the Territorial Mapping of the Concentration of Science and Innovation Infrastructure and Research Activity" was placed. According to the NRP 2015 of Latvia, this report should also include the ESFRI roadmap.

The Network of National Research Infrastructures includes three RIs that are located in Latvia and are funded by the EC to provide transnational access to researchers. As reported on the EC's website, these infrastructures are part of networks that are supported through the Integrating Activity projects with a view to making the most out of existing facilities by optimising their use for the benefit of the scientific community. Two of these three projects are related to the physical sciences and astronomy and have provided support for the RI of Ventspils University College, namely in the form of the radio telescopes of the Ventspils International Radio Astronomy Centre. Under the project RadioNet-FP7 (2009-2012), the EU's contribution amounted to almost €10m, and under the project RadioNet3 (2012-2015), the contribution was equal to €9.5m. The project SeaDataNet II (2011-2015) aimed at establishing a pan-European infrastructure for ocean and marine data management. Within the framework of this project, a total of €6m was contributed to the Latvian Institute of Aquatic Ecology.

Latvia is also a part of multiple international research infrastructures that aim at strengthening coordination and collaboration within particular areas. For instance, two Latvian institutes belong to the fusion research network established under the European Fusion Development Agreement (EFDA). EFDA's activities include coordinating physics and emerging technology activities across fusion Association laboratories, promoting training and career development opportunities for researchers, the collective use of the Joint European Torus (JET) facilities, and more. The EFDA Associations are affiliated with the Institute of Solid State Physics and the Institute of Physics of the University of Latvia.

Latvia is one of the countries that has co-operation agreements with the European Space Agency (ESA). Consisting of 22 members, the ESA is responsible for drawing up the European space programme and carrying it through. With the aim of stimulating relations with interested European countries, expanding the overall European scientific and industrial base and enriching the ESA as an R&D organization, in 2001, the ESA created a new agreement to open up opportunities for European states to work more closely with ESA programmes. The new agreement allows the partner country to participate indirectly in all ESA procurements and activities. Latvia entered this cooperation agreement in March 2013.

4.3 International cooperation with third countries

Almost all national policy measures to support research are targeted at the research organisations registered in Latvia and foreign partners could only be involved on a subcontracting basis (not usually welcomed because of the co-financing requirement). The cross-border cooperation programmes, along with the Norwegian Government Financial Facility and the Switzerland Government Financial Facility, include measures available for joint research activities. At the same time, the research sectors and activities are restricted by the rules and criteria of particular programmes.

Latvia has taken part in some international cooperation programmes involving third countries within the European Neighbourhood and Partnership Instrument 2007-2013, such as the Estonia-Latvia-Russia Cross-Border cooperation Programme (ESTLATRUS) and the Latvia-Lithuania-Belarus Cross-Border Cooperation Programme. These programmes have similar strategic objectives to promote joint development activities for the improvement of the region's competitiveness and to make the wider border area an attractive place for both its inhabitants and businesses through activities aimed at improving living standards and the investment climate. Specific priorities include the promotion of sustainable socio-economic development, addressing common challenges, and the promotion of people-to-people cooperation. The cross-border cooperation programme ESTLATRUS had a budget of €65m for the period 2007-2013, whereas the Latvia-Lithuania-Belarus programme had a budget of €46.7m. However, both cross-border programmes were mainly focused on regional, municipal or local government interests and only few of them had RTD as a core priority during the period 2007-2013.

The bilateral programme between Lithuania and Latvia with Taiwan primarily promotes the scientific co-operation between the three countries. The programme's goals include the initiation and promotion of joint research projects and the associated mobility programme (especially for young researchers), promotion of joint symposiums that should help scientists to find future collaborators for joint research projects, and support for guest lecturers with the aim of providing access to a mutual understanding of regional science. Such bilateral programmes (Latvia – Lithuania – Taiwan; Latvia – Belarus) support few projects and represent a small share of an organisation's financing.

Key to the integration of transnational research cooperation are the FP7/H2020, Bonus, Life, and Erasmus+ programmes where the rules are pre-determined by the EU and not by the Latvian government or PROs. Since institutional funding is often insufficient, these programmes are used to pre-finance and co-finance approved projects, and are sometimes also used to pay for external consultants, but are not used for transnational cooperation.

4.4 An open labour market for researchers

4.4.1 Introduction

For researchers, Latvia's labour market is characterised by a high level of institutional autonomy. The total number of active researchers in FTE in 2013 in Latvia was 3,625, which represented a slight decrease from 2012 (3,904). In 2014, the number of researchers rose to 3,748, mainly due to the contribution of the business sector. The researchers are mostly concentrated in the higher education system where the level of autonomy is also the most apparent. This is determined by the Law on Research Activity and the Law on Higher Education Institutions which provide similar levels of autonomy to universities and HEIs as in the EU. HEIs are in charge of deciding their own curricula and governance structures, while the academics, students and staff elect the rectors.

4.4.2 Open, transparent and merit-based recruitment of researchers

Since 2013, vacancies in academic positions and top-level positions (e.g. directors) in publicly-funded scientific institutions and publicly-funded higher education institutions have been advertised in the online newspaper *Latvijas Vestnesis* (*Latvian Herald*). Research institutions in Latvia have the autonomy to publish job vacancies on relevant Europe-wide online platforms and choose the language of the advertisement. Publishing on national platforms is not up to the research institution and the job advert must be published together with the selection criteria (or with a link to a notice listing these criteria). The establishment of a recruitment selection panel is regulated by the Law on Institutions of Higher Education (1995) and the Law on Scientific Activity (2005). Minimum time periods between the publication of the vacancy and the deadline for applying are also regulated by the same laws, and they ensure that the applicants have the right to appeal a decision. The hiring institutions, however, have the right to choose whether to offer applicants feedback. The burden of proof is on the institutions as employers to prove that the recruitment procedure was open and transparent.

In 2013, the number of posts for researchers that were advertised through the EURAXESS jobs portal per thousand researchers in the public sector was 1.8 in Latvia compared with 9.0 among the Innovation Union reference group and an EU average of 43.76.

The Law on Immigration and the Law on Research Activity regulate the employment of foreign researchers in Latvia. The Law on Research Activity also includes legal norms for admitting third-country researchers for the purposes of scientific research. Scientific institutions are entitled to recruit third-country nationals to participate in scientific research projects.

Foreign job seekers, irrespective of the duration of their stay, are required to have a temporary residence permit. EU researchers and third-country nationals with a permanent residence permit and/or the status of a long-term EU resident may apply for any research position in Latvia. The recruitment of non-national applicants is limited in practice by the requirements on knowledge of the Latvian language contained in the Official Language Law (1999) and the related regulations.[74] While foreign scientists with residence and work permits can be employed as guest-scientists, they cannot be elected without Latvian language skills and the ability to participate in the administrative activities of their research institutions. Despite this, the main barrier to recruitment are the low, unattractive and capped salaries that are offered, especially when compared to the EU average.

4.4.3 Access to, and portability of grants

Portability of grants

While research grants are portable to another national research institution, the current law does not regulate the portability of grants to another country. In practice, however, there are a few signs of grant portability. Contracts are signed with the grant programme administrating agency both for state budget and EU SF grants, and if a researcher is relocating because of a career opportunity, the responsible research institution is obliged, according to the contract with the administering agency (as a lead partner) or with a lead partner (in case of being a minor partner), to replace the retired or departing researcher with another that corresponds in terms of quality and competencies.

Access to cross-border grants

Contracts on publicly-financed research activities are concluded between the funding agencies and the research institutions or higher education institutions. Therefore, national grants are also open to non-residents provided that they are employees of a contracting institution (Deloitte, 2014). Therefore, a foreign national may come to Latvia and become a student in a doctoral study programme and, when approved, receive scholarships on the same basis as local students according to the CoM Regulations on Scholarships (CoM Reg. No.740 from 24.08.2004). National fellowships are also open to non-residents if they are students of the same study programme that provides the fellowship. A limited number of Latvian scholarships are open to non-residents to study in Latvian HEIs, for research work in Latvian HEIs and to participate in summer schools in Latvia.

4.4.4 Doctoral training

The Guidelines for the Development of Science and Technology for 2009-2013 stated that the number of PhDs awarded annually should be increased from 230 in 2010 to at least 425 by 2013. The number of doctoral candidates has, in fact, increased in the last couple of years, with a 7.5% average annual growth percentage in the number of new doctoral graduates per 1,000 inhabitants aged 25-34 in Latvia. This is partly due to the increased investment of ERDF funds in doctoral level education.

However, if compared to the European standards, PhD production appears to still be small and the proportion of PhDs in the population is among the lowest in Europe. This not only affects the organisations performing research, but may also undermine the ability of the business sector to innovate technologically. Latvian PhD production per thousand population was 0.4 in 2010, compared with an EU average of 1.4, i.e. it is 30% of the European rate.

[74] Deloitte. Researchers' Report 2014. Country Profile: Latvia

Funding for scientific work in Latvia has gradually been increasing since 2005 when doctoral students were given the opportunity to receive scholarships within the context of EU structural funding. The Research, Technological Development and Innovation Guidelines for 2014-2020 also anticipates the continued support for doctoral studies, specifically by increasing the number of doctoral students in the following scientific areas: nature, life, information technologies, forestry, agriculture and engineering.

In particular, the Guidelines foresee the establishment of a grant system for doctoral degree study programmes.

The ESF co-funded activity "Support for the Implementation of Doctoral Study Programmes (2007-2013 programming period)" covered the full expenses of doctoral studies for students on a competitive basis. There is no formal bar on foreign students applying for state-funded PhDs in Latvia; although, in practice, language barriers could be considered one.

The form and content of doctoral studies vary from one institution to another. Each university should, however, license their doctoral study programs. To increase the quality of their doctoral training, in 2009/2010 the University of Latvia and the Riga Technical University set up doctoral schools.

Post-doctoral researchers appear to be mainly funded through the ESF and ERDF as well as by the Framework Programmes. The planned budget of the Grants for Post-Doctoral Research for the years 2014-2017 is €64.03m.

4.4.5 Gender equality and gender mainstreaming in research

In 2010, the percentage of women in R&D academic staff was 32.1% in Latvia compared with 31.2% among the Innovation Union reference group and an EU average of 19.8%. As of 2011, the Latvian government had not introduced any new measures aimed at supporting women in top-level positions. The activities co-funded by the ESIF aim to promote gender equality in the research profession. Gender balance in award proposals is considered desirable, but is not a criterion to which a score is attached. In practice, the proportion of women working in science in Latvia is among the highest in the European Union. Parental leave, provisions for maternity leave and childcare leave depend on the status of the employee. For employees, leave is covered by the regulation of labour and social security terms and conditions, but national grants given on the basis of research contracts between funding agencies and research institutions or universities do not carry any special provisions on maternity or childcare leave. Employees with permanent employment contracts may return to their previous work after pregnancy and/or parental leave. For fellows, including those receiving ESIF fellowships for postgraduate study programmes, there are no special provisions on parental leave.

4.5 Optimal circulation and Open Access to scientific knowledge

4.5.1 e-Infrastructures and researchers' electronic identities

Riga Technical University's (RTU) Electronics and Telecommunications faculty announced the beginning of Latvian e-science in 2005 when the European funded FP6 project "BalticGrid" was launched. The aim of the project was to create e-infrastructures for the Baltic countries and give local researchers access to grid computing and data storage resources on a European and global level. A major effort was devoted to the attraction of new users and raising awareness of the usefulness of the grid. In 2008, the FP7 project "BalticGrid II" ensured the continuity of the work. After the end of the project in 2010, users gained access to thousands of processors and 100 TB of disk memory resources that were located in major universities in the Baltic countries. The Latvian academic institutions were also ensured access to the European single e-infrastructure, the European academic network GEANT, and the Latvian Academic Network SigmaNet. In the course of the project, a grid computing centre and a specialist support team were created (RTU Elektronikas un telekomunikaciju fakultate, n.d.).

The universities continue to explore and seek out opportunities to introduce other additional services related to e-science, such as cloud, high performance computing, sensor grids and others. Part of the capacity of e-science and its infrastructure in grid development, data repositories, cloud and high performance computing are developed within State Research Consortia in ICT and signal processing, the "Iksa Centre" and two state research programmes at the Institute of Mathematics and Computer Science at the University of Latvia and RTU.

By 31 August, 2015 the implementation of the ERDF funded project "Establishment of unified national importance academic network in Latvia for provision of research activities" was expected to finish. The network was intended to connect the main education and research centres and ensure the full and effective participation of Latvian researchers in the European and global research arenas, as well as to improve scientific communication. Virtual laboratories, the availability of digital libraries, online discussions and conferences, research integration in the higher education system, integrated learning solutions, interoperable and integrated administrative systems of research, academic institutions, and universities are some of the benefits.

Project activity number 2.1.1.3.2 of the EU SF Second Operational Plan "Entrepreneurship and Innovation" (2007-2013 planning period), entitled "Improvement of IT infrastructure and information systems for scientific activity" was implemented directly by the MoES and foresaw:

1) The creation of an academic network;
2) The creation of main campus subnetworks and the provision of access to the main research institutions;
3) Access to the main full text scientific publication databases;
4) Licences for the key software applications commonly used in research.

Weak management has delayed the coordination and agreement on priorities among the key players involved and has led to the postponement of the design of the project's technical specifications and the announcement of public procurement. All the partners in this project had access to the international scientific literature database Science Direct and the citation index Scopus.

Within the latest Operational Programme "Growth and Employment" (2014), specifically the priority axis "Availability of ICT, e-government and services", the following investment priorities and activities are planned with regard to e-infrastructures and researchers' electronic identities:

- **Investment Priority 2.1; objective 2.1.1: Improved access to the electronic communication infrastructure in rural areas.**

Investment priority is to be implemented in close connection with the priority axis No. 1 "Research, technological development and innovation" as well as with respect to the competitiveness of SMEs. The objective's target group is households and other users of information systems and e-services, including entrepreneurs and institutions.

- **Investment Priority 2.2. "Strengthening ICT applications for e-government, e-learning, e-inclusion, e-culture and e-health", objective 2.2.1: Ensuring an increase in the re-use of public data and efficient interaction of the public administration and the private sector.**

The data that is available to the administration is expected to be accessible for commercial use, including for the development of new and innovative business ideas and products, and business automation products that will contribute to the economic transformation processes described in RIS3. In addition to the existing services, the availability of new electronic services that are deemed necessary to residents and entrepreneurs is also planned.

Another aim of this investment priority is to ensure the integration of Latvia into the single European market and ensure cross-border cooperation by providing the

interoperability of national e-solutions with the EU solutions, including the creation of a technological base for machine translation.

Investments planned for the digitisation of public administration include development in the areas of e-health, e-education, e-inclusion, e-welfare, e-justice and e-skills, and will introduce the necessary preconditions for the development of e-commerce. They are meant to reduce the fragmentation of the digitised processes as well as support the transition into "only electronic", where possible.

4.5.2 Open Access to publications and data

Although Open Access (OA) policies on either a regional or institutional level have yet to be adopted in Latvia, the country is starting to develop Open Access initiatives.

As of 2015, there are six Open Access journals indexed in the Directory of Open Access Journals (DOAJ) and three digital repositories registered in OpenDOAR:

Journals:

- Latvian Journal of Physics and Technical Sciences;
- Proceedings of the Latvian Academy of Sciences. Section B: Natural, Exact and Applied Sciences;
- Environmental and Experimental Biology;
- Baltic Journal of Modern Computing;
- Complex Systems Informatics and Modeling Quarterly;
- Transport and Telecommunication;

Repositories:

- E-resource repository of the University of Latvia;
- Riga Technical University Repository;
- SciRePrints (Science and Religion Dialogue Prints), University of Latvia.

Many researchers in Latvia publish their papers in Open Access journals and deposit their papers in subject repositories because they recognise that their studies will be accessible to a larger audience than they would be if they published in conventional journals. Latvian scientists publish individually in subject repositories such as PubMed Central, ArXiv, Cogprints and in Open Access journals (Gudakovska, Lapsa, & Rozenberga, 2014).

As in many other states, in Latvia, dissertations and theses are systematically digitised. For instance, at the University of Latvia, works defended since 2006 are available in the database "Theses of the University of Latvia". The University Library is also digitising the theses and dissertations that were defended before 2006 and, along with staff publications, is depositing them in the repository of the e-resources of the University.

The country's national policies and policy documents cover only some of the aspects related to publication and access to scientific research and list some future actions that are planned in this regard:

One of the directions in the National Reform Programme of Latvia for the Implementation of the "Europe 2020" strategy, approved by the Cabinet of Ministers in 2011, is the "Digital Agenda for Europe" initiative, which aims for determination of cultural digital content and services high-availability standards.

One of the central laws on R&D in Latvia, the Law on Scientific Activity, specifies that information on scientific research financed by the state or municipality has to be made publicly available, and access to the research outcomes (if access to this information is not limited by the law) should be provided by the institution that commissioned the research.

The Law on Higher Education Establishments states that the academic staff of HEIs has to publish their research results and that HEIs have to publish informative research summaries on their websites.

In Latvia, researchers' copyright on scientific articles is covered by the Copyright Act, and together with the issue of researchers' rights over their inventions and the rights of scientific institutions to use the patents invented by public foundations is a topical matter (European Commission, 2011).

The Guidelines for Science, Technology Development and Innovation for 2009-2014 (STDIG) have the objective of supporting excellence in research. Some of the future actions planned apply to Open Access. These include:

- The requirement to publish research results in high-quality scientific editions in the criteria for funding instruments (both on a base and on a competitive basis);
- Support for the involvement of international editors in publications of Latvian scientific institutions and their issue and inclusion in databases of international scientific publications;
- Provision of acquisition and maintenance of national licences for international scientific databases (with allocated financing of €2m annually from the state budget to implement the action).

The Ministry of Culture of the Republic of Latvia has established a working group to develop guidelines for digital cultural heritage. One of the main objectives described in these guidelines is the development of infrastructure for any kind of digital content, including scientific publications and research data, their long-term preservation and online availability. It is expected that implementation of these guidelines will facilitate the preservation of scientific information and promote the planning and implementation at the national level as well as the depositing, identification and fair use of materials.

Few initiatives that focus on the increased availability of scientific information are initiated by Latvian scientific institutions. However, the University of Latvia Library (UL Library) supports Open Access principles and creates and shares knowledge about Open Access in the academic and scientific environment. The UL Library does so by organising annual thematic conferences, by serving as the local Open Access contact point and by helping researchers to deposit their publications. Institutions like the Centre for Culture Information Systems and Riga Technical University also work to promote Open Access in Latvia.

At the moment, all Latvian initiatives are focused solely on the implementation of the "green open access" model, [75] creating institutional repositories and practising collaboration on a national scale. However, based on the data gathered for the report "Proportion of Open Access Papers Published in Peer-Reviewed Journals at the European and World Levels—1996–2013" (European Commission, 2014), publishing in "Gold" journals as opposed to "Green" journals is more common in Latvia. Out of the sample size of 387 articles, 232 (or 60%) were Open Access in the period of 2008-2013. The majority of these articles were published in other OA journals (156 articles or 40%), 57 articles (or 15%) in Gold OA journals and only 21 (or 5.4%) in Green OA journals. After the adjustment for true and false positives and negatives, the percentage of OA articles in Latvia was finalised as 69%.

[75]Open Access types:
(i) 'Gold' Open Access (Open Access publishing): payment of publication costs is shifted from readers (via subscriptions) to authors. These costs are usually borne by the university or research institute to which the researcher is affiliated, or by the funding agency supporting the research.
(ii) 'Green' Open Access (self-archiving): the published article or the final peer-reviewed manuscript is archived by the researcher in an online repository before, after or alongside its publication. Access to this article is often delayed ('embargo period') at the request of the publisher so that subscribers retain an added benefit. The Green access model allows for certain variations: the length of the embargo period and the version that may be archived at different moments in time vary, e.g. depending on the agreements between publishers and the authors.
(iii) 'Hybrid' Open Access refers to a publishing model in which subscription-based journals allow authors to make individual articles open access upon payment of an article publication fee.

5. Framework conditions for R&I and science-business cooperation

5.1 General policy environment for business

The 2014 Innovation Union Scoreboard prepared by the EC ranks Latvia's innovation level as low – together with Bulgaria and Romania, Latvia forms the EU Modest Innovators Group. While part of the country's low innovation and lack of competitiveness can be attributed to its underdeveloped R&D sector and weak links between academia and industry, the overall business environment faced by Latvian entrepreneurs seems to be positive. In 2015, the World Bank's "Doing Business Index" (DB) ranked Latvia 22nd when it comes to the ease of doing business there. Latvia ranked the same in the beginning of 2016. The "Doing Business Index" is an indicator revised on an annual basis for 189 economies worldwide and takes into account the various aspects that contribute to shaping the overall business environment in the countries. The World Bank positions the other Baltic states at a similar level – in 2015 Lithuania ranked one place above Latvia (21st) and Estonia was the leader among the Baltic states taking 16th place in 2015. Two other economies that are also in the Modest Innovators Group, Bulgaria and Romania, had worse business environments – they occupied the 36th and 37th places on the list, respectively. Latvia's absolute level of regulatory performance, measured by the distance to frontier (DTF)[76] indicator, has been quite steady over recent years; however, it is also displaying an upward trend even if it is slow paced. The DB ranks and DTF scores for Latvia and comparable countries for the years 2015 and 2016 are summarised below.

Table 8. World Bank's Doing Business indicators for Latvia and comparable countries. Years 2015 and 2016.

	DB Rank 2016 (2015)	Distance To Frontier 2016 (2015)
Latvia	22 (22)	78.06 (77.51)
Lithuania	20 (21)	78.88 (78.19)
Estonia	16 (16)	79.49 (79.27)
Bulgaria	38 (36)	73.72 (73.62)
Romania	37 (37)	73.78 (73.59)

Source: Doing Business.

Compared to 2014, Latvia's 2015 ranking and DTF scores fell the most with regard to the starting a business[77] indicator, as reported by the World Bank. The ease of starting a business was downgraded due to recent policy changes, namely the increase in registration fees, bank and notary fees. Nevertheless, recently Latvia's placement on the list increased by 9 positions resulting in 27th place in 2016. In this sphere, with regard to four aspects of starting a business,[78] Latvia was outperforming the averages of Europe and Central Asia as well as the OECD member average. Among the DB indicators, Latvia receives its highest ranking in terms of getting credit. This is due to the relatively strong

[76] The distance to frontier score aids in assessing the absolute level of regulatory performance and how it improves over time. This measure shows the distance of the economy to the "frontier", which represents the best performance observed on each of the indicators across all economies in the *Doing Business* sample since 2005. An economy's distance to frontier is reflected on a scale from 0 to 100, where 0 represents the lowest performance and 100 represents the frontier. For example, a score of 75 in DB 2015 means an economy was 25 percentage points away from the frontier constructed from the best performances across all economies and across time. A score of 80 in DB 2016 would indicate the economy is improving. Measured in % points.

[77] Starting a business and other indicators discussed in this paragraph are all included in the overall Doing Business Index and scores.

[78] The ease of starting a business is evaluated by looking at four indicators - the number of procedures, average time, costs and minimum paid-in capital required to start a business

legal rights index and high credit registry coverage. According to the authors of the "Doing Business Index", credit information system improved and getting credit became easier between 2015 and 2016 when a new law governing the licensing and functioning of credit bureaus was introduced. Due to a recent tax reform, companies found it easier to pay their taxes due to a simplified VAT return, enhanced electronic system for filing corporate income tax returns and a reduction in employers' social security contribution rates. These changes resulted in Latvia's ranking climbing up by four places in 2015 (1.59% improvement in DTF). In the beginning of 2016 the ease of paying taxes in Latvia was slightly downgraded as the possibility of deducting bad debt provisions was eliminated. The evaluation of Latvia's business environment is quite positive when it comes to registering property, enforcing contracts and trading across borders, with the latter being explained by the country's lower import and export costs when compared to the benchmarked groups.

Other DB indicators deal with construction permits, protection of minority investors and getting electricity. Latvia's rankings when it comes to these indicators are 30, 49 and 65, respectively. Getting electricity has the worst ranking among the indicators (65th place in the beginning of 2016).

In 2015, Latvia was the 39th most favourable economy for resolving insolvency, in 2016 – 43rd. Most Latvian indicators under this aspect are very close to the OECD average. An exception might be the rate of recovery – while in the OECD member states the creditors could recover on average around 72.3% of their investment from the insolvent firm at the end of insolvency proceedings, in Latvia this number was 48.1%. Latvia has recently modified its Insolvency Law[79], which was changed to benefit the enterprises.

5.2 Young innovative companies and start-ups

The Global Entrepreneurship Monitor (GEM) study indicates the rate of new company formation in Latvia. This rate is high when compared to both European countries and Latvia's neighbouring countries. Latvia's relatively positive scores in the DB Index, especially the ease of starting a business in the country, support such an assertion. However, the same GEM study also states that the high level of entrepreneurial trends is need-driven (e.g. due to people not seeing appealing employment opportunities elsewhere) in Latvia rather than originating from an actual entrepreneurial spirit or a good idea for a business. Unsurprisingly for a small country, Latvian start-ups are commonly internationally oriented. It is also notable that the Innovation Union Scoreboard 2015 does report that Latvia was among the innovation growth leaders in the recorded period of 2007-2014.

In the 2007-2013 programming period, the MoE administered programmes targeting young innovative enterprises and start-ups as follows:

1. Business Incubator Programme, implemented in the period 2009-2014, financed by the ERDF. Total budget LVL 20m (approx. €28.83m);
2. Motivation Programme for Entrepreneurship and Innovation, 2009-2014, financed by the ERDF. Total budget LVL 2.02m (approx. €2.88m).

New firms may also benefit from a loan guarantee scheme, aimed at providing access to loans without collateral, and a mezzanine loan scheme, seed and expansion risk capital, and an export credit guarantee scheme (all provided by Altum). After a few unsuccessful attempts, the Latvian Business Angel Network (LATBAN) was established in 2014.[80] LATBAN, the Latvian Private Equity and Venture Capital Association, TechHub Riga, Seed Forum Riga, and the Commercialization Reactor organise a number of investor forums which are events where new nascent or new business idea holders can present their ideas to risk capitalists.

[79] http://likumi.lv/doc.php?id=214590
[80] http://www.vatp.lv/en/association-latvian-business-angel-network-announcing-first-meeting-new-entrepreneurs

The STDIG reports one of the aims for future development of R&D&I in Latvia to be to encourage the formation of new innovative companies with rapid growth potential and facilitate the attraction of funds in their early stages of development. Specific actions that are pending for implementation in this field include extending the early phase investment instrument spectrum and its volume that are specifically meant for new business ideas and business extension ideas with the potential for rapid growth. With regard to SMEs, their approach to new product and technology development services (innovation "vouchers") will be improved by providing support for the purchasing of services related to research and product development, while expanding the range of service providers. Moreover, the planned activities include ensuring pre-incubation and incubation services for newly established companies both by developing a network of business incubators in the regions and by developing technology incubators, which focus on the commercialisation of research results, through start-up companies. Specific planned funding allocation figures for these activities are presented in Table 9 below. The implementation time frame of all these programmes is 2 January 2015 - 30 December 2020.

Table 9. Planned indicative funding for future actions under the direction "Strengthening of innovation capacity in the companies".

Task	Responsible institution	Participating institutions	Indicative funding (Source)
Provide support to SMEs in research and product development, including development of nontechnological innovation, purchasing of services (innovation and design vouchers)	ME	LIAA	€5m (EU SF)
Ensure pre-incubation and incubation services for newly established companies within the framework of business incubators	ME	LIAA	€25m (EU SF)
Create a support tool that is focused on commercialisation of research results by creating start-up companies, providing incubation services and facilitating the fund attraction in their early phase of development	ME	LIAA, LGA	€20m (EU SF)
Provide funding for the implementation of technologically intensive business ideas with rapid growth potential in their early stage of development ("seed" and start-up risk investment instruments)	ME	LGA	€40m (EU SF)
Implement measures to raise public awareness and involvement in innovation and entrepreneurial activity (motivational program)	ME	LIAA	€5m (EU SF)

Source: STDIG.

5.3 Entrepreneurship skills and STEM policy

In general, Latvia is facing a lack of human resources employed in R&D&I activities. However, there are some positive trends emerging in the R&D sector's human resources base in Latvia in the longer term. For example, the proportion of students choosing to study natural sciences or engineering is slowly, but consistently, increasing. University admissions data shows the relative popularity of natural sciences and engineering studies as a percentage of the total number to have increased from approximately 20% to almost 30% (Figure 17).

However, the increase in the relative popularity of R&D studies does not solve the issue, since the overall number of students in Latvia has been decreasing since 2004. In the academic year 2014/2015, the total number of students in HEIs was 85,900, which is 4% less than a year ago. However, in 2012, when Latvia still had 97,000 students, the students in tertiary education comprised 4.85% of the total, compared to a 4% average in the EU. The factors that have caused a reduction in the number of students are demographical and economic crises that have reduced the ability of the population to pay for higher education and have caused a high number of young people to emigrate to other countries.

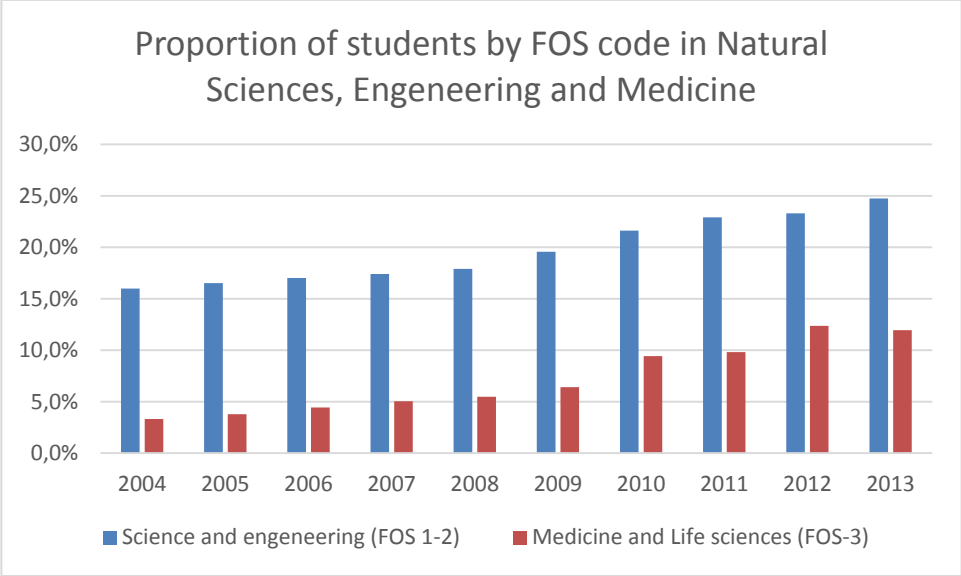


Figure 17. Number of students in different fields of science and technology by Fields of Science (FOS) codes. Data: MoES, compiled by FIDEA.

The report on "Entrepreneurship in Education in the Baltic Sea Region" evaluates to what extent the entrepreneurship skills agenda is incorporated into the government's education policies. Out of the nine evaluated countries, Latvia was one of the two that has education policies that explicitly mention entrepreneurial education as an objective; however, there are no practical activities being undertaken in this regard. Although entrepreneurship is an integrated part of the general curriculum of HEIs, Latvia does not have an updated system for the assessment of students' entrepreneurial skills.

As the STDIG indicates, sufficient and high-quality human capital, along with other favourable conditions, is necessary for the effectiveness of the investments in research and innovation. The guidelines acknowledge that it is important that investments in the STDI infrastructure are balanced by investments in human capital development, without creating expensive laboratories and other stocks of expensive technological equipment that are not used due to lack of appropriate specialists.

Given the current issues faced by the Latvian R&D&I sector, the renewal and development of human resource capital by increasing the number of people employed in the field is the top priority of the sector. Within the framework of the Smart Specialisation Strategies, the focus of the upcoming efforts is on the human resource capital needs (including support for doctorates) in the natural sciences (physics, chemistry, biology), engineering (computer science, materials science, biotechnology), medicine (int. al. pharmacy), agricultural science (int. al. forestry), social sciences in the areas which study human development and its challenges, and the humanities and arts.

The specific tasks to be undertaken in order to tackle the problems associated with the human resource shortage in R&D and to improve its competence include:[81]

1. Improvement of the dissertation process;
2. Involve doctoral students from state budget-funded programmes and projects;
3. Grant excellence scholarships to doctoral candidates who demonstrate high research potential;
4. Prepare master's students and PhD students for employment with specific industry partners;
5. Include safeguarding of PhD jobs as part of the assessment criteria for doctoral studies programme development and improvement projects;
6. Support research-driven, third-cycle studies in art and design, and their association with industrial innovation;
7. Include a doctoral thesis developer job in scientific group projects.

5.4 Access to finance

A report by the Ministry of Economics[82] acknowledges that the provision of access to finance in the form of equity is needed to achieve an increase in investments in research and innovation (with the goal being 1.5% of the GDP in 2020). However, the current venture capital market in Latvia is still underdeveloped; according to the same report, venture capital investments in 2012 in Latvia stood at 0.009% of GDP, while the EU average was 0.040 %.

Currently, there are seven active venture capital (VC) funds in Latvia, of which six are co-financed by the ERDF and private funding and only one is a fully private fund (ABLV). The VC funds operating in Latvia are summarised in Table 10. Recently, as reported by the MoE, Latvia has become a co-investor in the Pan-Baltic venture capital fund the Baltic Innovation Fund, which provides funding based on market principles. The international pan-Baltic venture capital fund invests from €3m up to €15m. The Baltic Innovation Fund is providing large-scale investments to Latvian, Estonian and Lithuanian companies that are willing to expand their businesses on an international level.

Table 10. Venture capital funds in Latvia.

Fund management company	Name of the fund	Fund size	Focus
BaltCap Management Latvia, Ltd	BaltCap Latvia Venture Capital Fund	€30m	Expansion
Imprimatur Capital Fund Management, Ltd	Imprimatur Capital Seed Fund (including pre-seed fund)	€6.3m	Early stage
	Imprimatur Capital Start-up Fund	€6.02m	Early stage
Expansion Capital, Ltd	Expansion Capital	€10.5m	Expansion
ZGI, Ltd	ZGI-3	€10.5m	Expansion
FlyCap, Ltd	FlyCap	€10.5m	Expansion
ABLV Private Equity Management	ABLV Private Equity Fund	€15m	Expansion

Source: MoE report "Access to Finance: Market Gap Assessment".

[81] Tasks identified in "Guidelines for Science, Technology Development, and Innovation 2014-2020" with regards to development of human resources in R&D

[82] Ministry of Economics of the Republic of Latvia (2014). *Access to Finance. Market Gap Assessment*; http://www.lga.lv/fileadmin/dokumenti/Iepirkumi/Access_to_Finance_Market_Gap_Assessment_30_06_141_Pielikums_4.pdf

In order to develop a common investment culture in Latvia and provide more complete information about investment opportunities to both companies and professional private investors, in April 2014, the new Latvian Business Angel Network, or "LATBAN" was established. The association will bring together private investors and raise their capacity and understanding of the venture capital investments, challenges and opportunities available to them in Latvia. The training of project managers will be managed as well in order to present the highest quality and most complete business projects to investors.

In general, the business angels market in Latvia is underdeveloped. There is a lack of information about business angels, especially invisible ones. Furthermore, no public support for the development of business angels' activities has thus far been provided by the government. In 2007, the "Latvian Private Investors Association" was established to unite private investors that exclusively make only equity investments. Amber Sea Business Angels Club, which was established in 2011, provides investments in any development stage of a company; however, it has very precise requirements for the company's geographic location.

5.5 R&D related FDI

Foreign direct investment (FDI) has overall grown quite rapidly since Latvia regained its independence (with the exceptional slowdown experienced due to the financial crisis) and in 2013 reached the cumulated amount of €11.6 billion. Historically, most of Latvia's FDI inflow has come from neighbouring countries in the Baltic Sea region and other EU member states. Sector-wise, the largest share of FDI stock is attributable to services, for instance, most investment is attracted by financial intermediation (25%). FDI in real estate operations, manufacturing and trade makes up 13%, 12% and 11% of total FDI, respectively. [83]

The main factors fostering FDI inflows to Latvia are new market opportunities for foreign investors, inexpensive workforce, legislation that is harmonized with the European Union and favourable to investments, a simple and attractive taxation system, low taxes, Latvia's advantageous geographic location between the EU and CIS countries, and its well-developed transport infrastructure. Due to extensive austerity measures in the aftermath of the financial crisis, foreign investor confidence and FDI levels are recovering.

According to the Investment and Development Agency of Latvia, incentives aimed at facilitating foreign direct investment in Latvia in general include multiple tax incentives, like special economic zones or corporate income tax rebate for large-scale investment projects, labour-related incentives for finding, training and raising qualification of employees, access to capital opportunities, credit guarantees and others.

While the above listed incentives may be relevant for the R&D oriented investments as well, some already discussed policies are aimed specifically at R&D investments, including R&D intensive FDI in Latvia. This includes the tax breaks for R&D activities discussed in section 0, access to finance discussed in section 5.4, European and state funding programmes (see Annex 2). Another notable incentive is the beneficial depreciation ratio for new technological equipment**,** following which taxpayers may calculate tax depreciation from a higher initial value of fixed assets (new technological equipment bought in 2009-2013) and intangible investments (patents and trademarks registered after 1 January 2009) using a coefficient of 1.5.

One of the papers from the OECD Global Forum on International Investment (Guimón, 2008) concludes, however, that an efficient promotion of R&D-intensive FDI requires a close coordination between innovation policy and inward investment promotion.

[83] Investment and Development Agency of Latvia, Bank of Latvia.

5.6 Knowledge markets

The central institution of the intellectual property protection system is the Patent Office of the Republic of Latvia, namely the Department of Examination of Inventions and the Department of Trade Mark and Design.

Patent applications can be submitted to the Patent Office by following the national procedure, and a patent can be obtained under the Patent Law. The law regulating patent procedures was adopted and entered into force in 2007. It was last amended on 1 January 2015. As of November 2015 a patent will also be valid in the Republic of Latvia, if it is granted in accordance with the European Patent Convention, and this patent application must be submitted to the European Patent Office (EPO).

In 2014, the Patent Office received 107 national patent applications, which was less than in 2013 (233) due to the end of the acquisition period for European funding. In the same year, the Patent Office granted 1,288 Invention Patents, including 144 patents for national applications, 1,034 validated European patents, and 110 extended European patents. The total amount of patents that entered into force in 2014 was 4% greater than in 2013 when 1,242 patents were granted. According to the Patent Office, most of the applicants were universities and institutes (about 50%) which confirms the ability of these HEIs to seek out new solutions and underscores their interest in protecting these solutions as inventions.

Trade mark and design protection in Latvia is regulated by the Law on Trade Marks and Geographical Indications and the Law of Designs. The Law on Trade Marks and Geographical Indications has been in force since 1999, whereas the Law on Designs came into force in 2004; both were last amended on 1 January 2015. Since 1 May 2004, when Latvia joined the EU, all legislative acts of the European Union that regulate trademarks and designs are binding in the Republic of Latvia, including Council Regulation 6/2002/EC 26 February 2009 on Community trademarks and designs.

In 2014, 1,474 trade mark registration applications were received through national procedure and 1,234 trade marks were registered. Most of the trade mark registration applications were submitted by Latvian companies. As for the design registrations, 36 applications, including 103 designs, were received through the national procedure in 2014. Thirty-three design applications were registered in 2014, covering 75 designs altogether. In 2014, Latvian applicants applied for 111 trade marks for international registration through the Patent Office.

The average time from receiving trade mark application to registration through national procedure in 2014 was 198 days. The average time for registering a national design was 78 days, in accordance with the data for 2014 (Latvijas Republikas Patentu valde, 2015).

In the period 2009 to 2014, the bulk of patents that were in force in the Republic of Latvia were European patents. Most of these European patents, in accordance with the International Patent Classification (IPC), were submitted under section C (chemistry; metallurgy) and section A (human necessities), which in most cases are related to pharmaceuticals. These results reflect the interest of foreign applicants in these two spheres, however there is also competition from Latvian companies and applicants due to the fact that these areas are relatively well developed in Latvia. The few Latvian applicants for European patents in electronics, telecommunications and the transport industry highlights the lack of Latvian competitiveness in these industries that needs to be addressed in the future.

5.7 Public-private cooperation and knowledge transfer

5.7.1 Indicators

Funding: BES-funded/publicly-performed R&D

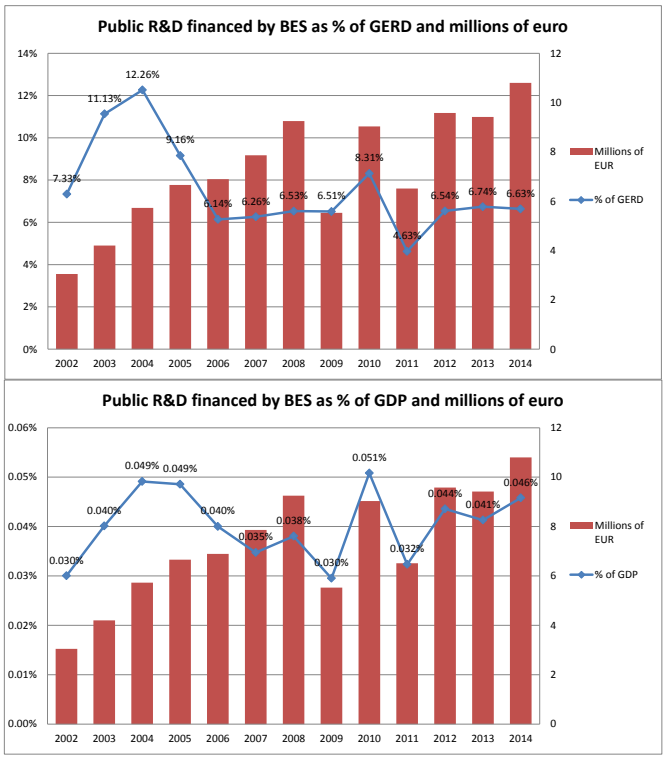


Figure 18. BES-funded public R&D in Latvia as % of GERD (in €MLN) and % of GDP

The level of privately-funded public R&D expenditure in Latvia is relatively low, especially in absolute terms and as a share of GDP. In 2014 it was €10.8m, i.e. 6.63% of the total GERD but only 0.046% of GDP. Figure 18 also shows significant drops in private funding in 2009 (from €9.25m to around €5.5m) and in 2011 (from €9m to €6.5m). The 2009 drop reflects the drop in all the private investments as a result of the crisis and therefore in private investments in publicly performed R&D that is depicted on the graph. The second decrease in private funding, however, was accompanied by an overall increase in GERD (2009-2011, from 0.46 to 0.66%) which was however based mostly on the growth of abroad funding of R&D (mostly from EU structural funds). This increase in overall R&D expenditure has triggered an only modest increase of the private funding of R&D performed by the public sector after 2012. Since 2012 it has remained stable around the €10m value (i.e. 6.5-6.7% of total GERD).

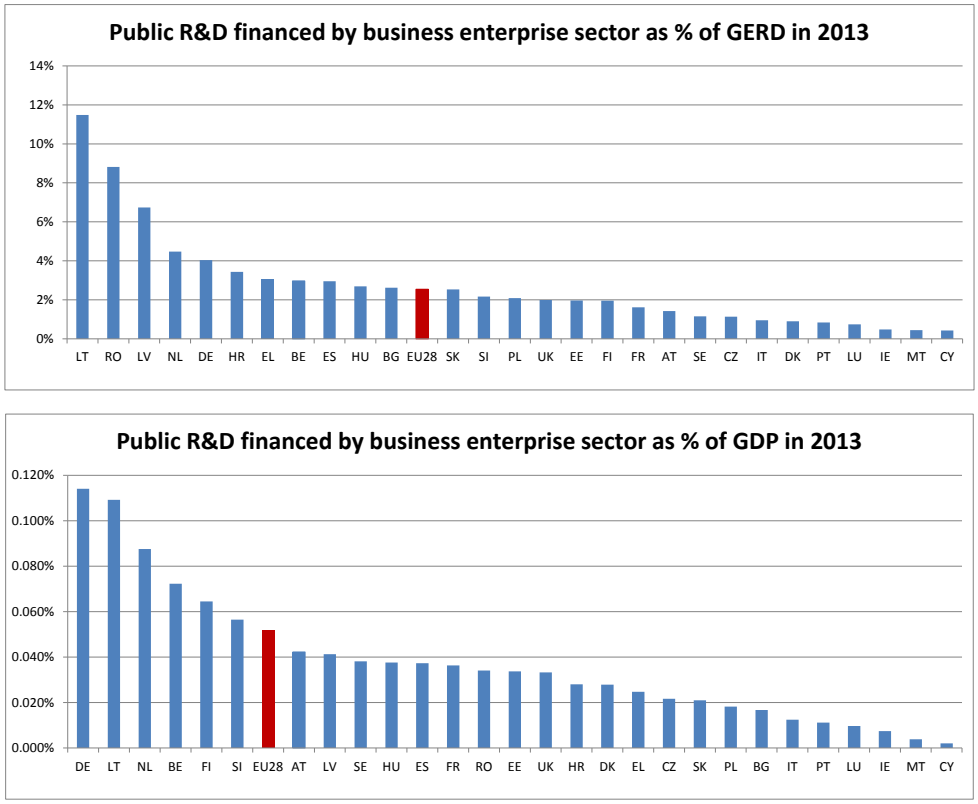


Figure 19. BES-funded public R&D as % of GERD and as % of GDP in 2013 in Member States[84]

From Figure 19 one can see that Latvia is above the EU-28 average of BES-financed public R&D when measured as percentage of GERD but not when measured as a share of GDP.

The fact that Latvia's BES-funded public R&D is above the EU-28 average as % of GERD shouldn't be overestimated because the general GERD level is low and because of the fact that private sector co-financing in projects funded by EU structural funds is required in some policy instruments (e.g. Competence centres). Lack of cooperation between science, academia and industry is mentioned as one of the main weaknesses in the Latvian innovation system[85]. The general low level of public-private cooperation is rooted in several reasons. The first is the industrial structure itself - the competitiveness of the Latvian economy is based on cheaper labour force and processing of natural resources and the export structure is dominated by low or medium technology segments (more than 82% of total processing industries[86]). Therefore, the real needs of very few local companies require frontier research outputs or intervention of up-to-date advanced knowledge or competence[87]. Another important factor may also be the lack until very recently of a well-designed system of R&D targeted tax incentives.

On the supply side, the academia seems neither skilled nor motivated enough in R&D commercialisation partially because a lot of highly qualified researchers are migrating abroad due to poor career prospects and a fragmented institutional system. Moreover, individual researchers have little motivation for commercialisation of their findings as HEIs often have uncoordinated and poorly managed IPR policies. Legislative inefficiencies make it harder to attract quality private investments for bringing inventions and their respective inventors closer to the market. If the HEI does not use its rights to

[84] 2013 was chosen as the latest data series providing a full comparison within EU-28.
[85] National Guidelines for the Development of Science, Technology and Innovation for 2014-2020, p.19
[86] National Industrial Policy Guidelines for 2014-2020. http://polsis.mk.gov.lv/view.do?id=4391, pp.6-11
[87] See also Watkins A., Agapitova N. Creating a 21st Century National Innovation System for a 21st Century Latvian Economy. World Bank Policy Research Working Paper 3457, November 2004, p. 95

commercialise IP, the researcher has little resources to get a commercial return from his/her invention[88]. Finally, the Latvian higher education system has until recently[89] supported career performance indicators such as teaching hours, number of scientific publications and internal organisational responsibilities, but not the development or management of spin-offs or the development of project proposals for industry, which are usually not additionally remunerated[90].

Funding: Structural funds devoted to knowledge transfer

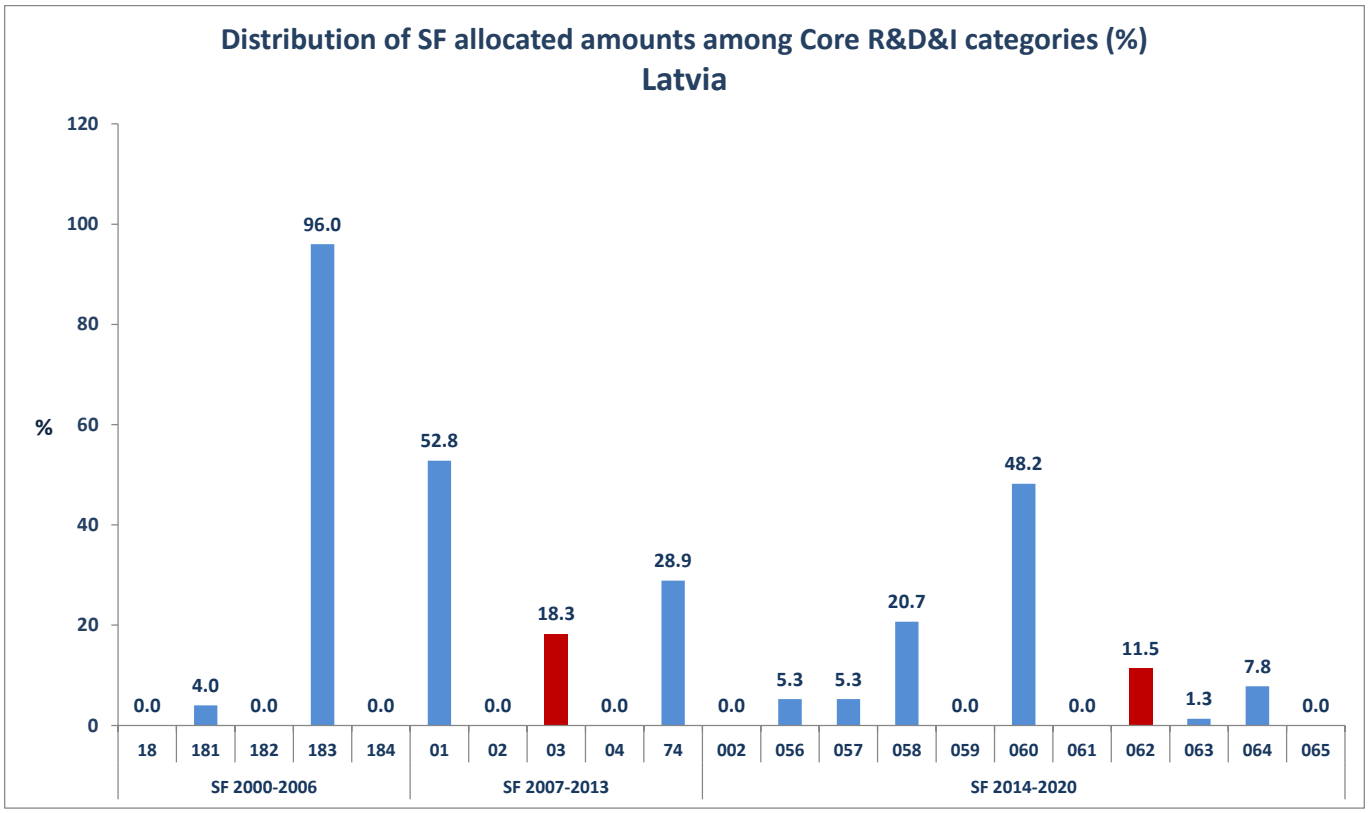


Figure 20. Structural Funds for core R&D activities 2000-2006, 2007-2013 and 2014-2020[91]. We use the categories: 182 (2000-2006), 03 and 04 (2007-2013) and 062 (2014-2020) as proxies for KT activities.

[88] For example, the University of Latvia has an IPR policy stating that individual employees are rewarded in the amount of 50% of income generated from commercialisation of IP after paying all incurred costs within the commercialisation process unless the Commercialisation Agreement with UoL or funding program regulations do not foresee a different distribution model. See: http://www.lu.lv/fileadmin/user_upload/lu_portal/par/strukturvienibas-un-infrastruktura/departamenti/attistibas-un-planosanas/inovaciju-centrs/rupnieciska_ipasuma_noteikumi.pdf

[89] A major reform in the way universities are funded is currently underway, see World Bank Report on introduction of the new financing model for Higher Education in Latvia. More on http://viaa.gov.lv/lat/izglitibas_petijumi/petijums_ai_finansesana/

[90] RIO Country Report Latvia 2014

[91] Figure 20 provides the Structural Funds allocated to Latvia for each of the above R&D categories. The red bars show the categories used as proxies for KT. Please note that the figures refer to EU funds and they do not include the part co-funded by the Member State. The categories for 2000-2006 include: 18. Research, technological development and innovation (RTDI); 181. Research projects based in universities and research institutes; 182. Innovation and technology transfers, establishment of networks and partnerships between business and/or research institutes; 183. RTDI infrastructures; 184. Training for researchers.
The categories for 2007-2013 include: 01. R&TD activities in research centres; 02. R&TD infrastructure and centres of competence in specific technology; 03. Technology transfer and improvement of cooperation networks; 04. Assistance to R&TD particular in SMEs; 74. Developing human potential in the field of research and innovation.
The categories for 2014-2020 include: 002. Research and Innovation processes in large enterprises; 056. Investment in infrastructure, capacities and equipment in SMEs directly linked to Research and Innovation activities; 057. Investment in infrastructure, capacities and equipment in large companies directly linked to

Latvia has allocated 11.5% of its structural funds for core R&D activities to "Technology transfer and university-enterprise cooperation primarily benefiting SMEs" (compared to none for 2000-2006 and 18.3% in the 2007-2013 programming period). The figure for the 2014-2020 period is lower than the EU average of 15.7% (the EU average was 26.1% for 2000-2006 and 30.1% for 2007-2013).

Cooperation: Share of innovative companies cooperating with academia

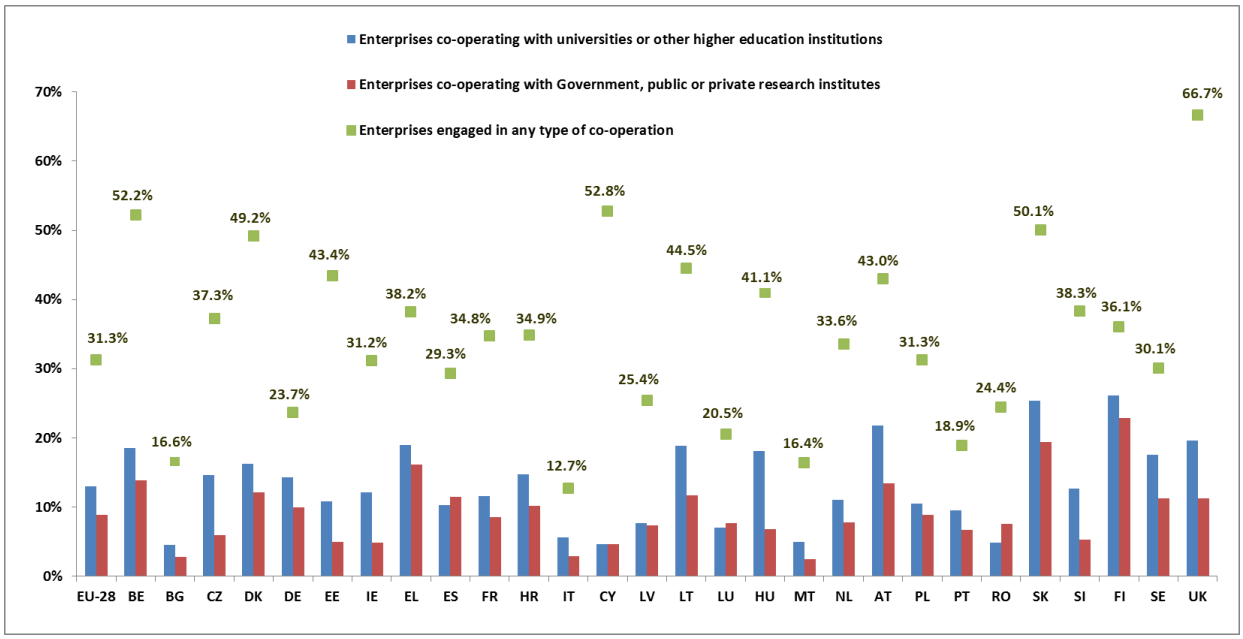


Figure 21. CIS survey 2012 – share of enterprises cooperating with academia

According to CIS 2012, in Latvia 25.4% of innovative companies engaged in any type of cooperation, which is below the EU average of 31.3%. In addition, less than one third of them (7.7%) cooperate with universities and higher education institutions compared to almost 11% in EE and 19% in LT. A bit less – 7.4% cooperate with government or public or private research institutes (compared to 5% in EE and 11.7% in LT). Looking at the impressive rate of cooperation of Finland – one of the innovation leaders (26% of innovative companies that work with higher education institutions and 23% with government or public or private research institutes) – or even Slovakia (with 25.4% and 19.4% respectively), one can see the space for intensifying cooperation between innovative Latvian enterprises and academia.

Cooperation: Technology Transfer Offices (TTOs), incubators and technological parks

Latvia has 8 Technology transfer contact points[92] and 4 Science and Technology Parks (Latvian Technological Centre, Latvia Technology Park, Ventspils High Technology Park, Latgale Machinery and Technology Centre)[93] which also offer business incubation services.

Research and Innovation activities; 058. Research and Innovation infrastructure (public); 059. Research and Innovation infrastructure (private, including science parks); 060. Research and Innovation activities in public research centres and centres of competence including networking; 061. Research and Innovation activities in private research centres including networking; 062. Technology transfer and university-enterprise cooperation primarily benefiting SMEs; 063. Cluster support and business networks primarily benefiting SMEs; 064. Research and Innovation processes in SMEs (including voucher schemes, process, design, service and social innovation); 065. Research and Innovation infrastructure, processes, technology transfer and cooperation of enterprises focusing on the low carbon economy and on resilience to climate change.

[92] Full list here: http://www.liaa.gov.lv/lv/tehnologiju-parneses-kontaktpunkti

[93] http://www.spica-directory.net/associations/?id=40

The Latvian Technological Centre was established in 1993 by the Riga City Council, the Latvian Academy of Sciences, the Institute of Physical Energetics and the Latvian Society for Quality. It hosts about 30 knowledge-based companies and is active in transnational technology transfer - it is a partner organization of the Enterprise Europe Network. *The Latvia Technology Park* was established by the Riga Technical University with the goal of re-organizing some 8 ha of available land and barracks of a former Soviet Union's army base in Riga into a technologically developed area. It has approximately 30 tenant companies. *The Ventspils High Technology Park* was founded in 2005 and specialises in information and communication technologies, electronics, mechanical engineering and space technologies providing infrastructure and services to high technology companies.

Latvia has 6 regional incubators and 1 creative industries incubator (*RISEBA*) [94]. Recently, with the support of the Norwegian Financial Instrument (90% of financing, €11.2m) and state budget (10%, €1.2m) a *Green Technology Incubator*[95] was launched in July 2014 in Riga. The aim of the Incubator is to help green innovation ideas to enter the market, and also to promote co-operation between the private and academic sectors in the area of green technology businesses between Latvia and Norway[96]. The incubator is a joint project of Riga Technical University, the University of Latvia and the Norwegian Industrial Development Corporation SIVA.

These facilities have been mainly financed from the Norway grants [97] and from EU Structural funds in the last programming period but at the end of October 2015 the funding for some of them ends[98].

Cooperation: Share of public-private co-publications

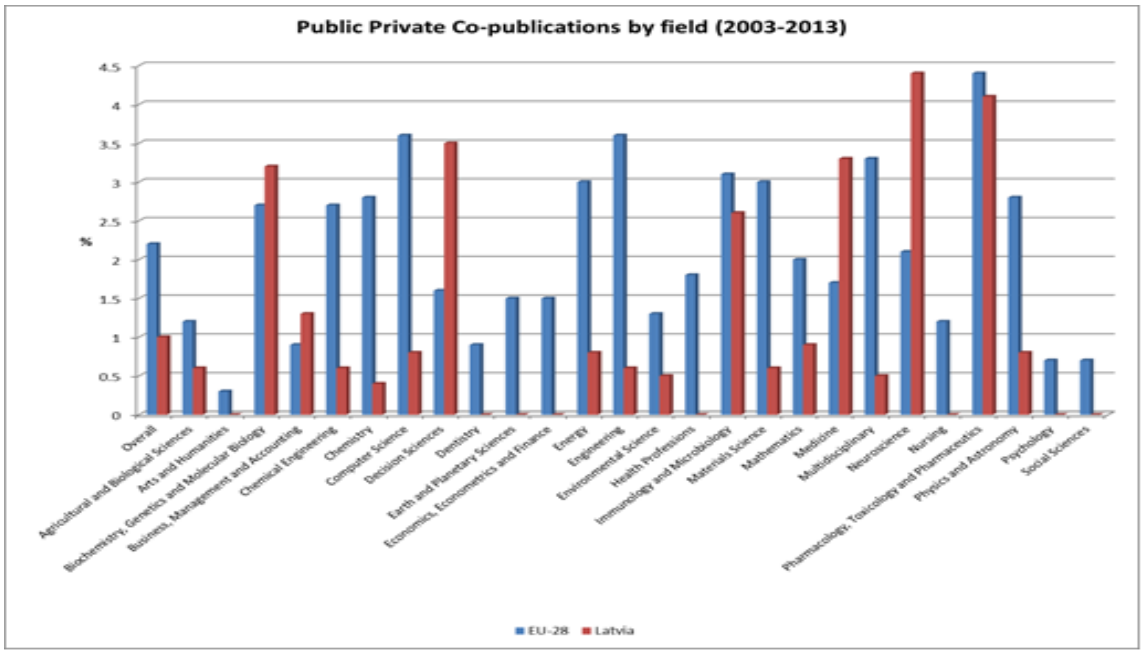


Figure 22. Co-publications by field 2003-2013 in Latvia.
Scopus database

[94] http://www.labsoflatvia.com/news/business-incubation-in-latvia-2015-20-creating-the-future-2
[95] http://www.giic.lv/en/
[96] http://eeagrants.org/News/2014/Green-Technology-Incubator-launched-in-Riga-Latvia
[97] http://eeagrants.org/Who-we-are/Norway-Grants
[98] http://www.labsoflatvia.com/news/business-incubation-in-latvia-2015-20-creating-the-future-2

Figure 22 shows the 2003-2013 average percentages of academia-industry co-publications by field in Latvia compared to the European average. Scopus data indicate also that the percentage of co-publications has almost not changed in the last five years (2009-2013), with 1% of academia-business co-publications in 2013 (compared to 2.2% for the EU-28). Moreover, in 2013 Latvia had only 6.4 public-private co-publications per million of population compared to 29 for the EU-28 (and 5.7 for LT, 28 for EE)[99]. The domains with highest percentage of co-publications are neuroscience, pharmacology, medicine and decision sciences.

Cooperation: Patenting activity of public research organisations and universities together with licensing income

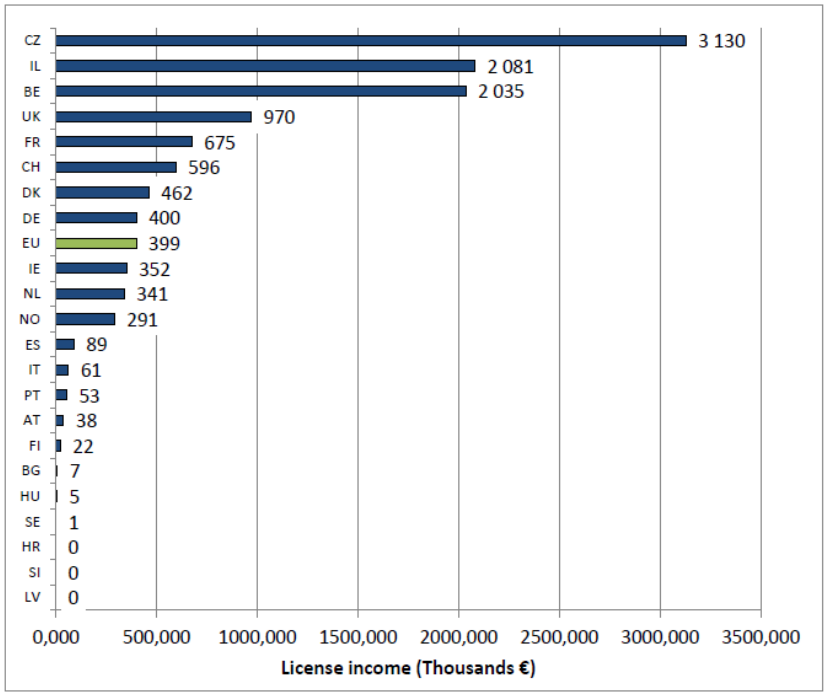
According to the Latvian Patent Office, in 2014 most of the patent applicants are universities and research institutes (about 50%, the other 50% being the business and individuals). According to the 2014 National Reform Programme, the 8 Technology Transfer Contact Points prepared in 2013 67 research output commercialisation offers, submitted 55 patent applications (incl. 5 international patent applications) and 2 other industrial property design or prototype applications.

The European Knowledge Transfer Indicator Survey 2011 and 2012[100] indicates that the patent applications from the public sector are filed but rarely used. For example, according to the Survey, Latvia ranks second in number of patent grants per thousand research staff (26.7) but the country is at the bottom in terms of number of license agreements per thousand of research staff (1.0). In other words, the main purpose of patent filing seems to be to increase the rating of a given PRO and very rarely patents are licensed to business. As noted earlier, on the supply side this might be due to poorly managed IPR policies of Latvian PROs and on the demand side it might stem from the industrial structure of the Latvian economy (very low share of hi-tech manufacturing and high knowledge intensive economic sectors).

According to the data available, Latvian PROs report no licensing income from their patents, which is hardly surprising considering the low level of license agreements.

[99] RIO elaboration based on Scopus data.
[100] http://knowledge-transfer-study.eu/

Exhibit 3-35: Thousands Euros of license income per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



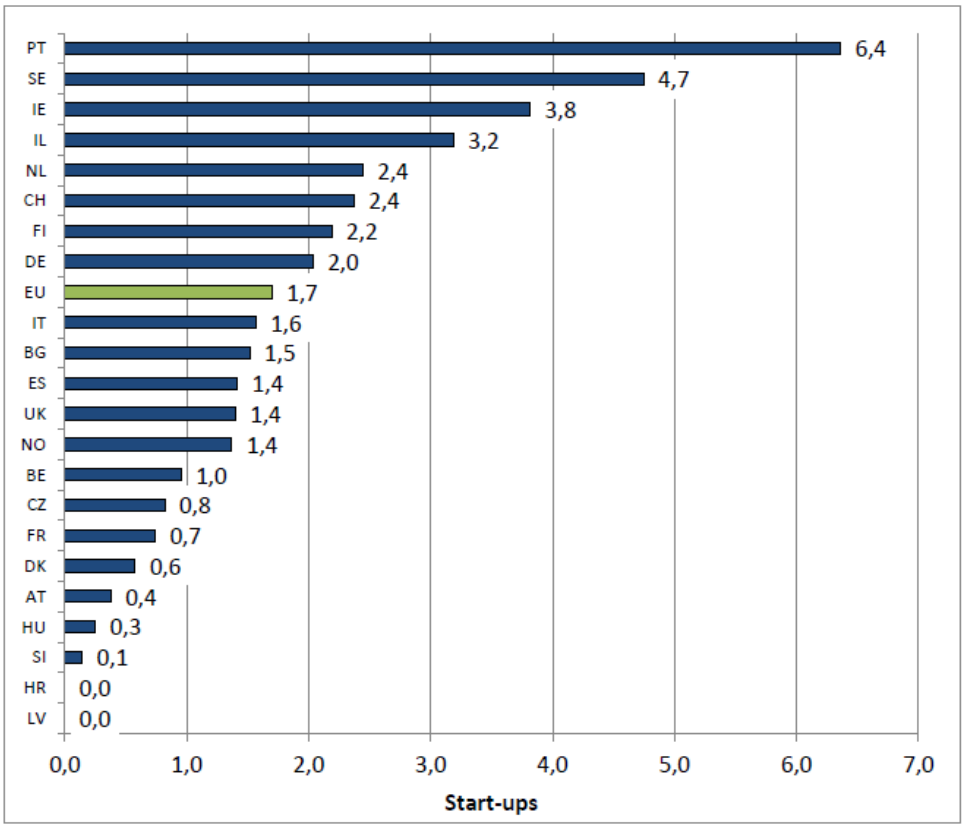
Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 23. License income per 1,000 research staff by country. EKTIS survey 2011-2012

Cooperation: Companies

According to the Knowledge Transfer Study 2010 - 2012 Latvia has zero start-ups per thousand of research staff. The Latvian "Guidelines for the Development of Science, Technology and Innovation 2014-2020" also report a very low number of spin-off as well as start-up companies that stem from the public research sector. This is due to both legislative and cultural barriers. As already mentioned above, the full research commercialization costs should be paid in advance by the researcher whenever he/she wants to spin off. It is important for an inventor to be able to attract the best private investors in the field with a motivation to achieve positive results as fast as possible. This type of investors need clear rules of IP ownership.

Exhibit 3-33: Number of start-ups per 1,000 research staff by country, EKTIS 2011 and 2012 results combined



Source: MERIT, European Knowledge Transfer Indicator Survey 2011 and 2012.

Figure 24. Number of start-ups per 1,000 research staff by country. EKTIS survey 2011-2012

5.7.2 Policy Measures

The Latvian government has introduced a number of policy measures in the recent years that are aimed at strengthening the cooperation between business and academia and facilitate knowledge transfer. The 2007-2013 Operational Programmes were the main source of funding for most of the measures.

The main activity to create better environment for generating commercial return and foster long-term cooperation between scientists and industry is the state support program Competence Centres. In the programming period 2007-2013 within the activity "Competence Centres" 6 contracts have been concluded with NGOs representing Competence centres as established legal entities: IT Competency Centre, Forest Sector Competency Centre of Latvia, Pharma and Chemistry Centre of Latvia, "LEO Pētījumu centrs" (competency centre for Latvian Electrical and optical manufacturing industry), Transport and Machinery Competency Centre and Environment, Bioenergetics and Biotechnology Competency Centre. The Program is administrated by the Investment and Development Agency of Latvia (IDAL) and financial support is provided by the European Regional Development Fund for general industrial research and for projects dealing with new product and technology developments. The programme started in 2010 with opportunity to prolong current ongoing projects until December 2015[101] with total public funding of €53.2m, plus additional co-funding of at least €19m expected to be attracted from the private sector.

[101] See Amendments in Regulations of CoM http://likumi.lv/doc.php?id=269855

- 197 production research and new product and technology development projects are implemented in the 6 competence centres, out of which 42 projects have been completed by June 2014.
- A total of 140 enterprises and 15 scientific institutions are involved in the competence centres, while over 323 researchers are involved in the conduct of research[102].

The Competence Centre initiative is a successfull example. The programme is believed to be the source of the latest growth of the R&D spending in the business sector. Competence centre initiative also allows cooperation between Latvian businesses and foreign research organisations. The competence centre measure will be continued in the 2014-2020 programming period with a planned budget of €72.3m.

Within the programme Commercialisation of science and transfer of technologies (launched in 2010) 8 TTOs were established in the main universities. In 2013 they prepared 67 research output commercialisation offers, submitted 55 patent applications and 2 other industrial design or prototype applications.

However, the existing technology transfer support model is limited as it provides no financing for technical and economic feasibility studies of research results or for developing the commercialization potential of intellectual property created by scientists. In addition, no tools were put in place for the development of new innovative spin-off companies in collaboration with providers of incubation services and venture capital investors[103]. Technology Transfer Offices, which work in individual universities, show mediocre results partly because the legal framework of the intellectual property is incomplete, which does not stimulate the universities to patent their inventions and partly because of the skill gap they are facing (lack of experts that would be capable of both understanding the research results and creating a vision for their commercialisation). The Technology transfer programme will be continued in the 2014-2020 programming period with a planned budget of €24.5m.

To support facilitation of the cooperation between science and business, the Ministry of Education and Science (MoES) financed the implementation of Market oriented research projects (MORP). Within the framework of market-oriented projects scientists and manufacturers cooperate to develop new products and technologies. In this way, scientists do research in close collaboration with manufacturers, receiving state budget funds for scientific work, while manufacturers get new competitive products. However, on the basis of the Law "On State Budget for 2013" applications for market-oriented research projects were not accepted in the year 2013[104]. In the year 2014 financing of the program was reduced by €160,658 with the aim to ensure the payment of Latvia's membership fee in the European Research Infrastructure Consortium and participation of Latvian researchers in the 7th stage of the European Social Survey in 2014[105]. In 2013-2014 MoES gradually replaced the MORP financed purely from the state budget with the EU SF program 2.1.1.1. Support to science and research,[106] the third call of which aimed to support research and industry collaboration and commercialisation of research outputs (mainly licensing) in five priority science areas: energy and environment; innovative materials and ICT and signal processing and nanotechnologies; national identity; societal health, local resource sustainable usage. The available ERDF financing for this program was €18 million Euro, minimal project size €42,700, maximal ceiling €569,000.

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[102] Ministry of Economy (2014). Report "Economic Development of Latvia". https://www.em.gov.lv/files/tautsaimniecibas_attistiba/2014_jun_eng.pdf
[103] Guidelines for the Development of Science, Technology and Innovation for 2014-2020, p.88
[104] RIO Country Report Latvia 2014
[105] http://likumi.lv/doc.php?id=269832
[106] http://esfondi.izm.gov.lv/projektu_iesniedzejiem/konkursi/2_1_1_1_aktivitates_tresa_projektu_iesniegumu_atlases_karta

By June 2014, 695 internationally recognized scientific papers were published and 125 international patent applications have been submitted[107].

Another example of support in terms of the commercialisation of technologies, is the Commercialization Reactor. It is involved in business innovation, helping businesses to develop fast growing and internationally competitive high technology start-ups by commercialising the technological developments created by Latvian and CIS scientist. The Commercialization team organises meetings for scientists and potential entrepreneurs, helps to create a prototype and prepares them step-by-step for the attraction of investments. The Commercialization Reactor focuses on nano, bio, green, security and other high technologies.

The Cluster Programme co-funded by the EU funds and administered by IDAL has also promoted the collaboration between mutually unconnected enterprises, research, educational and other institutions, to improve the competiveness of sectors and enterprises, boost export volumes, promote innovation and new products. As of 2014, the programme supports 11 cluster projects which involve at least 300 enterprises, more than 20 educational and research institutions, as well as several non-governmental organisations and local governments. A maximum of €0.42m can be granted to one cluster[108]. From the 11 supported clusters[109], 8 represent smaller groups of respective national association (e.g. tourism, pharmaceuticals, etc.) members which continues the tradition that associations are drivers also of cluster development. The Cluster programme will be continued in the 2014-2020 period with a budget of €6.2m.

In addition, IDAL has continued implementing the EU structural funds programme Innovation Motivation Programme. The total budget for the planning period 2009-2014 (implementation until June 2015) was €2.9m. Within the framework of the Motivation Programme, several training and information measures are implemented, for instance, series of practical seminars for authors of innovative business ideas and seminars on commercialization of technologies, innovation days for students, the innovative business idea competition Idea Cup 2014, networking seminars, mentoring programmes for new entrepreneurs, as well as TV competitions for new entrepreneurs. The programme will be continued in the new programming period with a planned budget of €4.8m.

A dedicated support for start-ups in Latvia has been available from the Business Incubator Programme, implemented in the period 2009-2014 and financed from ERDF. The programme aims to provide favourable conditions for new small and medium sized enterprises not older than 2 years. The total budget of the measure was approx. €28.8m. The programme will be continued in the new programming period with a planned budget of €31m.

In order to promote development of technology intensive products and services, with the support of the Norwegian Financial Instrument (90% of financing, €11.2m) and state budget (10%, €1.2m) the Green Technology Incubator[110] was launched in July 2014 in Riga. The aim of the incubator is to help green innovation ideas to enter the market, and also to promote knowledge flows and co-operation between the private and academic sectors as well as the exchange of experience and competence in the area of green technology businesses between Latvia and Norway[111]. The incubator is a joint project of the Riga Technical University, the University of Latvia and the Norwegian Industrial Development Corporation SIVA. In 2014, two calls for small amount grant scheme project applications were announced and as a result 10 project applications for the total financing of €1.1m were supported.

[107] Report "Economic Development of Latvia", 2014, p.137
[108] Ministry of Economics. Report "Economic Development of Latvia". Riga, June, 2014
[109] http://www.liaa.gov.lv/lv/ar-11-klasteru-starpniecibu-veicinas-latvijas-ekonomikas-izravienu
[110] http://www.giic.lv/atbalsts
[111] http://eeagrants.org/News/2014/Green-Technology-Incubator-launched-in-Riga-Latvia

Furthermore, the DEMOLA project in Latvia was launched in 2013 by the Latvian IT Cluster with the support of the Ministry of Economy and the Investment and Development Agency of Latvia (from the Motivation Program). DEMOLA is an innovation platform with Finnish roots, supporting cooperation of students, universities and companies. DEMOLA Latvia has set cooperation with the Latvian Electrical Engineering and Electronics Industry Association, the Association of Mechanical Engineering and Metal-working Industries of Latvia, the Association of Latvian Travel Agents and Operators, and some major universities in Latvia. In 2014 DEMOLA planned to implement 12 projects[112].

Another measure which could indirectly support knowledge transfer is the decision of the Ministry of Education to introduce a **performance based** research institution funding model with higher score at evaluations given to applied science and to institutions that have contract, collaborative or sponsored research projects with industry (see section 2.3 for more details).

5.8 Regulation and innovation

The regulation impact on innovation in Latvia is not overviewed by a single separate governmental institution. Impact monitoring is carried out to some extent at the implementation level, by the agencies subordinate to the respective ministries (more information in section 1.2.2), and assessment exercises can be ordered by the ministries in charge.

Specifically, the main responsible bodies are the MoE Innovation Department, two MoES departments - Higher Education, Science and Innovation Department and Department of Structural Funds, the MoES agency State Education Development Agency (SEDA; VIAA in Latvian) and the MoE agency Investment and Development Agency of Latvia (since 1st of April 2016 – the agency's Technology Division). Strategic monitoring is the responsibility of the Strategic Research and Innovation Council subordinate to the Prime Minister of Latvia.

Most R&I system assessments do not focus solely on the impact of specific policies and legislation. They cover the broader view of the research and innovation system or several aspects of it, thus, they touch upon the regulation impact indirectly. An overview of assessment reports on the Latvian research and innovation system is available in section 0.

5.9 Assessment of the framework conditions for business R&I

As supported by the low comparative numbers of business R&D&I investment, the respective framework conditions for business in Latvia are lacking both in terms of supply-side policies and demand-side policies. The Corporate R&D Survey in Latvia[113] shows that in 2013, 47% of Latvian companies spent less than 1% of their turnover on R&D, of which 7% spent nothing, and only 33% of companies spent more than 3% of their turnover on R&D. In Central Europe, on average only 26% of companies invested less than 1% and 45% of companies invested more than 3% in R&D. The survey found that the companies see the availability of qualified R&D personnel and the means of financing R&D projects as the main factors that encourage increased future R&D spending.

Latvian government funding for the R&D&I performed by business enterprises equalled €0.8m (0.003% of GDP) in 2014 and the foreign funds largely administered by the governmental agencies equalled €22.5m (0.09% of GDP). Almost a half of the Latvian companies that participated in the abovementioned R&D survey were familiar with the available national and EU provided support measures for business R&D, and around 20%

[112] http://www.liaa.gov.lv/lv/par-liaa/liaa-zinas/ziema-2014/atklata-inovaciju-platforma-demola-latvia
[113] Deloitte (2014 July). "Latvia. Corporate R&D Report 2014." Available at: http://www2.deloitte.com/content/dam/Deloitte/global/Documents/About-Deloitte/CE_RD_Latvia_2014.pdf

of them were actually using it. As already mentioned, the indirect government measures for business R&D and innovation incentives, such as public procurement of innovation or advanced technologies or tax incentives, are absent in Latvia to a large extent. The tax incentive discussed in section 3.5 has already been approved, thus indicating some progress, however, public procurement in general might benefit from multiple revisions (as supported by various assessment reports).

For instance, the Foreign Investors Council in Latvia's (FICIL) position paper on public procurement makes multiple recommendations aimed at improving the Latvian public procurement procedures in general. The report indicates the need for the public service providers' "below-threshold" procurement to be regulated according to the same principles that are specified in the law (the same way that the "above-threshold" procurement is regulated). It also suggests that the "Procurement Guidelines for Public Service Providers", prepared by the Procurement Supervision Bureau in 2011, be more extensively and thoroughly implemented. The Council notes that realising these suggestions might contribute to not only improving the business environment in Latvia but also to combating the issue of the shadow economy. In line with the insights of the Technopolis Group's assessment of the Latvian R&I system, the adjustments of public procurement could also bring great value if reviewed with regard to stimulating innovation.

The conditions for starting a business in Latvia are of a moderate level compared to the overall situation in the EU. The Doing Business ranking for 2016 places Latvia in 27th place in the world (out of 189 economies). The assessment of the situation in Latvia shows that the rate of new company creation is mediocre, while recognising that many of the companies are created out of a need rather than based on opportunity and entrepreneurial spirit. The Global Entrepreneurship Monitor 2013-2014 Latvia Report[114] indicates that the fear of failure when starting a business was estimated at 41.6%[115] in Latvia in 2013, which was above the EU average of 39.8% and ranked 8th in the EU-28. The insolvency framework in Latvia is, however, generally evaluated quite positively. One of the DB components is the insolvency framework index strength that can be given a value of 0 to 16. The strength of this index in Latvia was assigned a value of 12 in 2016, which is almost the same as that of the OECD high-income country average (12.1). Moreover, as previously mentioned, in 2015, Latvia amended its Insolvency Law for the benefit of enterprises.

The ease of obtaining start-up financing from VCs or business loans is ranked under one of the pillars of the Global Competitiveness Index by the World Economic Forum.[116] In Latvia, the respective Financial Market Development pillar was assigned a value of 4.6 out of 7 and ranked 33rd out of 144 economies. One of the pillar's component elements, Venture Capital Availability, specifically the accessibility of VC to start-up entrepreneurs with innovative but risky projects, was ranked 48th in Latvia (with a value of 3 out of 7). However, the other two means of business financing evaluated within the scope of this pillar – namely, Ease of Access to Loans and Financing Through Local Equity Market – received much lower rankings (both took 96th place out of 144).[117]

With regard to intellectual property protection rights, the ease with which businesses can secure rights to property, including the number of steps, time, and costs involved, is ranked 23rd out of 189 in the DB 2016 rankings. Such a ranking is due to the low costs of obtaining and maintaining patents and copyrights, along with Latvia having recently made transferring property easier by introducing a new application form for transfers, thus reducing the time and number of procedures required in the transaction.

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[114] Krūmiņa, M., & Paalzow, A. (2014). Global Entrepreneurship Monitor. 2013-2014 Latvia Report. Retrieved from Biceps website: http://www.biceps.org/assets/docs/gem/GEM2013_2014

[115] Percentage of adult population aged 18-64

[116] The Global Competitiveness Report 2014-2015 is available at: http://www3.weforum.org/docs/WEF_GlobalCompetitivenessReport_2014-15.pdf

[117] http://reports.weforum.org/global-competitiveness-report-2014-2015/economies/#economy=LVA

An important obstacle in the general business conditions in Latvia, which also affects the levels of Foreign Direct Investment (FDI), is the prevalence of the shadow economy. As reported in the "Shadow Economy Index for the Baltic Countries 2009-2014"[118] report, the estimated extent of the shadow economy as a percentage of GDP in Latvia in 2014 was 23.5%. The proportion of the estimated shadow economy in Latvia has decreased significantly since 2010, for instance, when it was 38.1%, however, it still remains well above those of its neighbouring countries (Lithuania's shadow economy was 12.5% in 2014; Estonia's was 13.2%). As described in the international assessment of the Latvian R&I system prepared by the Technopolis Group, the shadow economy can create frictions in trading between firms (formally and informally operating), has a negative effect on the collection of taxes, discourages investment (especially FDI) and hampers the development of efficient supply chains involving smaller firms. The Foreign Investors Council in Latvia (FICIL) also draws attention to this issue in several of their position papers highlighting the reduction of the shadow economy as a necessary means of increasing tax revenues and thereby improving the economic flexibility needed for structural reforms. The FICIL points to the same adverse effects in addition to emphasising the negative impact on the country's economic and social development, distortion of fair competition, and safety and welfare concerns for unregistered employees.

Research-backed innovation and firm-level technology absorption in Latvia are also limited due to the lack of knowledge regarding transfer mechanisms (discussed in section 5.7) and acute gaps of R&D personnel (discussed in section 1.1).

[118] http://www.sseriga.edu/files/content/sseriga_baltic_shadow_index_2009_2014.pdf

6. Conclusions

6.1 Structural challenges of the national R&I system

One of the main structural challenges that Latvia is facing is a high level of fragmentation in the R&D and higher education systems (see also R&I Challenge 2 in the beginning of the report). In 2014, Latvia was home to 88 scientific institutions and 60 higher education institutions. That equates to 44 institutions engaged in R&D and 30 HEIs per million population. These numbers are lower in some of the more highly-developed EU Member States and in Latvia's neighbouring countries. For instance, in 2014, Lithuania had 15.7 higher education institutions per million population, while Estonia had 19.

The excessive number of institutions leads to the inefficient use of financial and administrative resources, and causes problems for knowledge management. Latvian R&D&I and education systems are not only fragmented with regard to their large number of institutions, but also from a geographic standpoint. There are views expressing concerns about the mono-centric development of the research infrastructure in Latvia. A well-developed research infrastructure should enable more efficient cooperation between the stakeholders in the system and attract new competitive talent and capital; in the case of Latvia, centring the infrastructure around Riga could be an efficient option. As already mentioned, Riga is the region where the majority of the population live and the country's economic activity is concentrated. Other regions do not have the ability to attract a critical mass of people and capital to further sustain their development. Thus, trying to artificially induce growth in the regions by building scientific facilities and higher education institutions and allocating more funding to them might instead further increase the dispersion and fragmentation of the R&D&I system.

In the context of the R&D&I system in Latvia insufficient supply of human resources is one of the biggest issues. This is true for both the business and the public sector, and human capital capacity in both cases relates not only to the number of people, but also to the relevance of their knowledge. Thus, the infrastructure should be developed in a way that increases researchers' productive time spent on actual R&D and favours their convenience. This also suggests that it would be sensible to locate most of the research institutes or HEIs around Riga where most of the talent is gathered. In the light of the recently initiated consolidation of the research system, when decreasing their number it might make sense to take into account not only their excellence and their contribution to the development of society and the national economy, as pointed out by the national R&D&I strategies, but also the geographic location of the research institutes and their development potential.

In its summary of the structural challenges to the Latvian R&D system, the STDIG point to the low number of people employed in science and the insufficient renewal of scientists. While it explicitly refers to the issues in higher education, it is important to also take into account the problems existing at an earlier stage in the education system. The quality of the provision of education in natural sciences is insufficient in high schools, which results in low numbers of students taking the state exams in biology, chemistry and physics as compared to the other subjects. The differences indicate that schools are not doing enough to generate their pupils' interest in the natural sciences. Moreover, for a long time, it was not mandatory to sit the state exams in either of the natural sciences, and there was a lack of initiative to make them mandatory. Recently, an improvement was made in this sphere as the introduction of mandatory state exams in at least one of the three natural sciences was approved in 2014. It is expected that this reform could focus the attention of school managers on the quality of teaching in these subjects.

To summarise, the authors of this report point out the three most acute issues that affect the development of the Latvian R&D&I system:

1. Too much emphasis is placed on R&D expenditures in monetary terms, whereas the focus ought to be on R&D activity volume as measured by the number of R&D jobs available and filled (the challenge includes addressing the low number of R&D human resources);
2. Excessive fragmentation of the Latvian R&D and education systems in terms of the number of institutions and their geographic dispersion;
3. Lack of focus on the quality of education in the natural sciences and teachers' training in general education.

The Science, Technology Development and Innovation Guidelines for 2014-2020 discuss more of the weaknesses, along with the opportunities, that need to be addressed to increase the performance level of the national R&D&I system in Latvia. The challenges are closely related to the ones outlined in the beginning of the report. They are presented in a tabular form along with the tasks to be implemented to address them.

Table 11. Challenges and issues faced by the Latvian R&D&I system and respective tasks planned for implementation. Table compiled based on the weaknesses and tasks identified in the Science, Technology Development and Innovation Guidelines for 2014-2020.

Challenges and weaknesses	**Tasks to be implemented**
Fragmentation and inefficiency of the R&D&I management: • Fragmented scientific institutions causing obstacles for efficient coordination and cooperation • Overlapping management functions of some institutions in the R&D&I system • Insufficient cooperation and coordination between science, higher education and industry • Lack of transparency in evaluation of grant applications and funding allocation	Fragmentation reduction: • Creation of excellence centres in the areas of Smart Specialisation; • Complete the existing and to be purchased or established common infrastructure database in the structure of an academic base network, and ensure that it is accessible to all interested parties; • Analysis and assessment of infrastructure creation or purchase purposefulness; • Research infrastructure improvements; • Increase the minimum criteria for the existence of a scientific institution according to the specifics of the science sector (number of PhDs, turnover, percentage of applied research) and stop financing those institutions that do not achieve the established results; • Combine research institutes for grant applications, as well as reinforce the use of the existing infrastructure (by stimulating the purchase of research equipment and by giving priority in evaluation criteria to institutions that have joined together, thus demonstrating an enhanced use of existing equipment within projects). • Developing monitoring and assessment systems for implementation of R&D&I and Smart Specialisation Strategy policy.
Financing problems: • Insufficient funding by the industry, heavy reliance on EU SF in R&D&I • Purchases of new buildings, laboratory equipment and other infrastructure element investments are not balanced by investments in human resources • Excessive bureaucracy associated with the science financing instruments	Increasing investment efficiency: • Increase state financing of R&D, gradual increase of R&D funding granted through tender procedures; • Design instruments that would encourage private sector and foreign investments (including attraction of funding from the EU FP Horizon 2020); • Calculate and allocate institutional or base funding in accordance with policy settings (increase in scientific institution base funding in accordance with the volume established in the legislation).

Challenges and weaknesses	**Tasks to be implemented**
Human resource problems in the R&D&I system: • Low numbers of people engaged in R&D, and low numbers of students damage the prospects of the renewal of high-quality scientific personnel • Lack of mechanisms to attract or maintain industry scientists, e.g. lack of accessible financial support for post-doctoral and young researchers • Non-competitive remuneration of employees in science • Heavy workload of scientists potentially harms the quality of the research conducted • Ageing scientist base	Young scientist attraction and career development: • Dissertation process improvement; • Improve state budget-funded programmes and projects for doctoral students; • Grant excellence scholarships for doctoral candidates who demonstrate high research potential; • Preparation of master's students and PhD students for specific industry partners; • Provide support for infrastructure renovation and move towards unified science quality standards; • Include safeguarding of PhD jobs as assessment criteria for doctoral studies programme development and improvement projects; • Support research-driven, third-cycle studies in art and design and their association with industrial innovation. Support for new R&D careers in science and the industry: • Create national post-doctoral grant system; • Support for applied research in development of innovative solutions for practical industries or addresses societal challenges, providing jobs for young scientists within the framework of the projects; • Support for implementation of individual post-doctoral R&D projects, including the establishment of a grant scheme for the creation of post-doctoral jobs in enterprises. Competitive researcher salaries funded from the state budget: • Provide 100% allocation of the estimated base funding; • Task execution linked to the progressive increase in the science base funding; • Introduce the unity principle of pedagogical and research work, which provides involvement of academic staff in research and involvement of scientists working for scientific institutes in the teaching of certain subjects. Raising of public awareness, promotion of science and innovation: • Development of a communication plan for R&D&I; • Include contributions to the promotion of scientific research performance evaluation and calculation of the base funding; • Provide support to the professional scientific organisations for the implementation of science promotion measures; • Provide support for measures aimed at improving science, math and reading skills of the pupils and increasing the appeal of math, science, engineering and IT studies; • Development of interactive science centres in Riga and regions of Latvia.

Challenges and weaknesses	**Tasks to be implemented**
Science competitiveness problems: • A small number of international scientific articles are produced which is caused by a lack of human resources, funding and open access not ensured • Insufficient funds of research institutions (reduced base funding) for the registration and maintenance of patents, which negatively affects the amount of registered intellectual property • Insufficiently developed environment to promote international cooperation	Development of research excellence: • Continued implementation of programmes that reinforce the importance of research excellence focused criteria in the allocation of funding; • Ensure support for the research and development of unique/practically applicable products for the needs of Latvia; • Draft a plan of measures for the development of Latvian science sectors taking into account international assessments (still to be completed); • Requirement to publish research results in high-quality scientific publications as one of the criteria for funding instruments; • Support the integration of Latvian scientists in international scientific networks of excellence and integration into the European research area, using joint mobility projects; • Support involvement of international editors in publications of Latvian scientific institutions, their issue and inclusion in databases of international scientific publications; • Provide acquisition and maintenance of national licences for international scientific literature databases. Internationalisation and international cooperation support: • Support of Latvia's participation in the research and technology development programmes of the EU and the Baltic state region (H2020, EUREKA, Eurostars, ECSEL, COST, Bonus, KIC, etc.); • Improve operation of the National Contact Points; • Create financial instruments for the support of project preparation and provision of co-financing, including additional incentives for collaborative projects that involve partners in Lithuania and Estonia in the technology development spheres with other countries; • Support participation in the European Space Agency projects, in international scientific cooperation organisations and associations; • Ensure recognition and competitiveness of research conducted in Latvia in the international arena; • Provide opportunities to young scientists who obtained doctoral degrees abroad to participate in the scientific projects in Latvian scientific institutions and companies and vice versa.

Challenges and weaknesses	**Tasks to be implemented**
Knowledge transfer and commercialisation related problems: • Insufficient cooperation between the scientific institutions and businesses • Underdeveloped skills and competences in the scientific institutions with regard to the commercialisation of research • Lack of development of the technology transfer and innovation infrastructures • Weak performance of innovation and limited capacity of the companies to invest in research and innovation • Domination of low-technology sectors; low productivity	Integration of education, science development, technology, innovation and business: • Prioritising research associated with tackling of scientific or technological problems identified by the industry; • Creation of forecast study courses of future market products and incorporate them into science and technology development related programmes; • Develop an institutional integration model for provision of internship placements and collaboration with universities in state and municipal companies; • Create innovation grants for students and academic staff, particularly in the STEM areas; • Create a single technology transfer platform which includes the formation of 2-3 technology transfer centres and widened technology transfer services, protection of Intellectual Property, and support for research aiming to create new commercialisable knowledge and technology; • Continued development of technology transfer contact points; • Establish a Centre for Creative Industries; • Ensure wider accessibility of the scientific infrastructure for entrepreneurs, develop the scientific infrastructure in areas identified by the demand that would form after Open Access principles are achieved; • Continued development of Competence Centres as a long-term platform for cooperation of scientific institutions and entrepreneurs. Innovation and knowledge absorption capacity strengthening Latvian companies: • Introduction of corporate income tax discounts on investments made in R&D, especially if the research was carried out in cooperation with scientific institutions; • Extend the early phase investment instrument spectrum and volume; • Improve the SMEs approach to new product and technology development services (innovation "vouchers"), ensure pre-incubation and incubation services for newly established companies both by developing a network of business incubators in the regions and by developing technology incubators; • Facilitate the potential of non-technological innovations and the Latvian creative industry; • Implement measures for the general public in order to inform and motivate people to engage in innovation and entrepreneurial activities.

6.2 Meeting structural challenges

The changes and policy initiatives aimed at addressing the structural challenges mentioned in this report were only begun in 2013. The Ministry of Education and Science, the main policy making body regarding R&D&I in Latvia, is constantly facing strong opposition to most of its proposed changes. Therefore, the progress being made towards solving the challenges and overcoming the weaknesses is slow and rather complicated, and is likely to persist in the future. The current pace of the structural changes might appear to be a compromise between the necessity of reacting and political possibilities. However, given the complexity of the structural challenges, the fact that the respective policy actions were initiated only recently and that the last independent assessment was carried out in 2014, as of 2016 it is still too early to assess the effectiveness of the actions that have been undertaken. The effectiveness of the policy measures in addressing the structural challenges, for instance, can only be speculated upon, although it is expected that EU funding accessibility will help to address the fragmentation issues since funds will be available for the consolidation of the institutions.

Significant progress can already be observed with respect to the consolidation of the R&D system – from 44 institutions receiving the institutional base financing before the start of the consolidation process, the number decreased to 40 institutions in 2014, 29 in 2015 and 21 in 2016. The goal of the consolidation is to have only 20 research institutions receive the base financing by 2020.

Latvia's R&D investment indicators already showed promising tendencies in 2014, especially given the country's ambitious 2020 targets for R&D intensity and BERD. Increased business sector investments in R&D are the main source leading to the annual growth rate of GERD of more than 13%.

Due to counter-cyclicality forecasts and hypotheses about the progress of R&D investments in the future, business sector investments in particular should be approached with caution since they are in many cases associated with a high level of uncertainty.[119] A potential way to overcome the counter-cyclicality of R&D activities is to encourage the creation and expansion of companies that engage in R&D as their primary field of operation. Given that Latvia is a small country and cannot compete on a scale-intensive basis with large economies, turning to innovation and R&D&I intensive activities could be a sustainable source of growth. Specifically, companies where R&D&I is a product itself could be one of the sources of Latvia's sustainable economic growth.

[119]As discussed by Kadri Männasoo and Jaanika Meriküll in their paper "R&D in Boom and Bust: Evidence from the World Bank Financial Crisis Survey" (2011), R&D investments are susceptible to broader macroeconomic conditions. In times of a booming economy, firms are more focused on capturing market share rather than making long-term investments in R&D. At the same time, deep recession times are marked by cost cutting and company priorities are often elsewhere other than R&D. That is why expectations for a big increase in R&D investments could be characterised by a high level of uncertainty.

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Abbreviations

BERD	Business Expenditure on Research and Development
BES	Business Enterprise Sector
CC	Competence Centre
CFCA	Central Finance and Contracting Agency. Agency under the Ministry of Finance (Latvian - Centrālā finanšu un līgumu aģentūra [CFLA])
CoM	Cabinet of Ministers of the Republic of Latvia (Latvian – Ministru kabinets [MK])
CSCC	Cross-Sectoral Coordination Centre (Latvian - Pārresoru koordinācijas centrs [PKC])
DOAJ	Directory of Open Access Journals
EC	European Commission
EFDA	European Fusion Development Agreement
ESA	European Space Agency
ESFRI	European Strategy Forum on Research Infrastructures
ESIF	European Structural and Investment Funds
EU	European Union
FDI	Foreign Direct Investment
FPs	Framework Programmes for research and technology development; FP7 is referring to the 7th Framework Programme carried out in the period of 2007-2013
FTE	Full Time Equivalent
GDP	Gross Domestic Product
GERD	Gross Expenditure on Research and Development
H2020	Horizon 2020 – the 8th EU Framework Programme for the period 2014-2020
HEI	Higher Education Institution

HES	Higher Education Sector
ICT	Information and Communications Technology
IP	Intellectual Property
IUS	Innovation Union Scoreboard
JET	Joint European Torus
JPI	Joint Programming Initiative
LATBAN	Latvian Business Angel Network
LIDA	Latvian Investment and Development Agency. Agency under the Ministry of Economics (Latvian - Latvijas Investīciju un Attīstības Aģentūra [LIAA])
MoE	Ministry of Economics (Latvian – Ekonomikas Ministrija [EM])
MoES	Ministry of Education and Science (Izglītības un Zinātnes Ministrija [IZM])
MS	Member States of the European Union
NCP	National Contact Point
NDP	National Development Plan of Latvia
NGO	Non-Governmental Organisation
NRP	National Reform Programme of Latvia
OA	Open Access
OP	Operational Programme
PPP	Purchasing Power Parity
PRO	Public Research Organisation
RI	Research Infrastructure
RIC	Research and Innovation Council
RIS3	Research and Innovation Strategies for Smart Specialisation

R&D	Research and Development
R&I	Research and Innovation
R&D&I	Research, Development and Innovation
SEDA	State Education Development Agency. Agency under the Ministry of Education and Science (Latvian - Valsts Izglītības Attīstības Aģentūra [VIAA])
SF	Structural Funds
SME	Small-Medium Enterprise
STDI	Science, Technology Development and Innovation
STDIG	Guidelines for Science, Technology Development, and Innovation 2014-2020
STEM	Science, Technology, Engineering and Mathematics - curriculum based on the idea of educating students in the four disciplines in an interdisciplinary and applied approach.
TTO	Technology Transfer Office, alo referred to as Technology Transfer Centres

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Annex 1 – List of the main research performers

Table 12. List the top 10 private R&D performers based on R&D expenditures

Top 10 public R&D performers (2013) by total research funding[120] (Source: Ministry of Education and Science)	Top 10 private sector R&D performers in 2014 (by expenditures on R&D) (Source: Ministry of Economics)
Latvian University (€16m); Riga Technical University (€8.7m); Institute of Organic Synthesis (€5.2m); Latvian State Forest Research Institute "Silava" (€2.9m); Latvian Biomedical Research and Study Centre (€2.7m); Riga Stradiņš University (€2.3m); LU Institute of Solid State Physics (€2m); Latvian University of Agriculture (€2m); Daugavpils University (€1.8m); Latvian Institute of Wood Chemistry (€1.4m).	Aviācijas Pētniecības Centrs, SIA; Grindeks, AS; Latvijas Finieris, AS MNKC, SIA; Pharma and Chemistry Competence Centre of Latvia, SIA; Quintiles Latvia, SIA; Rīgas Elektromašīnbūves Rūpnīca, AS; SAF Tehnika, AS; Sidrabe, AS; Vides Bioenerģētikas un Biotehnoloģijas Kompetences Centrs, SIA.

[120] Includes the 2013 external funding, such as FP7 funds, government funding and industry funding

Annex 2 – List of the main funding programmes[121]

Table 13. List of the funding programmes

Name of the funding programme	Timeline	Budget	Target group[122]
Science base funding	2014-2017	€99.16m	State scientific institutions
State research programmes	2014-2017	€25.7m	Researchers, scientific institutions
Practically oriented research	Launched 09.2015	€76.51m	Scientific institutions, businesses
Innovation grants to students	Launched 12.2015	€34m	Students, HEIs, research institutes within HEIs
Grants for post-doctoral research	Launched 09.2015	€64.03m	Researchers, scientific institutions, businesses
Development of R&D infrastructure	Launch 2nd quarter of 2016	€98m	Registered scientific institutions
Support to International Cooperation Projects in Research and Technologies	Launched 12.2015	€27.7m	Research institutions, universities, researchers
Competence Centres (including purchase of research and innovative equipment)	2016-2021 (including multiple rounds)	€72.3m	Companies, agricultural co-operative societies, research institutions
Technology Transfer System	To be launched on the 1st quarter of 2016	€24.5m	Scientific institutions, enterprises
Implementation of new products into production	To be launched on the 3rd quarter of 2016	€60m	SMEs and large enterprises
Innovation vouchers for SMEs	To be launched on the 2nd quarter of 2016	€7m	SMEs
Support for training of employees	To be launched on the 1st quarter of 2016	€24.9m	SMEs and large enterprises
Access to Finance (guarantees, loans)	2016-2017	€51.4m	SMEs, large enterprises, agricultural co-operations (depends on the specific instrument)
Business Incubators	To be launched on the 1st quarter of 2016	€31m	Individuals, SMEs
Cluster programme	To be launched on the 2nd quarter of 2016	€6.2m	SMEs, businesses
Technology Accelerator	31.03.2016 - 31.01.2017	€30m	SMEs and agricultural co-operations

[121] Sources: Ministry of Economics, Ministry of Education and Science, Ministry of Finance, Central Finance and Contracting Agency. The budget figures might not be final.
[122] Refers to end beneficiaries (the funding might not receive them directly from the agency administering the funds, e.g. through competence centres, co-operations, etc.)

Annex 3 – Evaluations, consultations, foresight exercises

Swedbank macroeconomic research "The Latvian Economy" (June 30, 2014) – highlighting the challenges faced by the manufacturing sector. The main challenges identified – lack of investment for technological development, capped capacity and labour market constraints, domination of low tech manufacturing and the need to move towards more technologically advanced manufacturing.

Swedbank macroeconomic research research "The Latvian Economy" (May 8, 2014) – assessment of the business innovation. The main takeaways discussed – research conducted concludes that the Latvian companies cite the high innovation costs and the lack of funds as the main obstacles to innovation activity; the poor innovation performance, as indicated by the companies overviewed, is also attributable to the lack of cooperation amongst companies, the government, and academia. The government's steps to address the issue, such as establishing Competence Centres and a cluster programme and introducing a tax allowance for R&D expenditures in mid2014, are acknowledged, but it is concluded that further actions are needed to overcome the lagging of the Latvian RDI performance. According to the report, if government measures remain short-term oriented with a heavy administrative burden, companies are unlikely to see this as an inviting strategy for R&D investments, which, by definition, are associated with uncertainty and risk.

The Research Assessment Exercise by the Technopolis Group (discussed in section 2.2.1.) and panel reports in multiple discipline categories, complementary to it. The latter assess the excellence and competences of the Latvian scientific institutes regarding multiple criteria and ranks them.

07.03.2012. Audit report "The Efficiency and Compliance with the Requirements of Regulatory Enactments of the Activities of the Ministry of Education and Science in Developing and Organising the Implementation of the National Science Policy" released by the State Audit Office – highlighted the mismanagement of the national R&I system, especially with regards to RTD policy not being aligned with the main objective – moving towards a knowledge based economy and sustainable growth.

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doi:10.2791/917332

ISBN 978-92-79-57802-1