European Commission

Specific Support to Latvia

The Latvian Research Funding System

Horizon 2020 Policy Support Facility

Research and Innovation

The Latvian Research Funding System

European Commission
Directorate-General for Research and Innovation
Directorate A — Policy Development and Coordination
Unit A4 — Analysis and monitoring of national research and innovation policies

Contact (H2020 Specific Support for Latvia):
Diana Ivanova-Van Beers, Policy Officer: diana.ivanova-van-beers@ec.europa.eu
Contact (H2020 PSF coordination team):

Román ARJONA, Chief Economist and Head of Unit A4 - Roman.ARJONA-GRACIA@ec.europa.eu
Stéphane VANKALCK, PSF Head of Sector, Unit A4 - Stéphane.VANKALCK@ec.europa.eu
Diana SENCZYSZYN, PSF Team Leader, Unit A4 - Diana.SENCZYSZYN@ec.europa.eu

European Commission
B-1049 Brussels

Manuscript completed in January 2018.

Luxembourg: Publications Office of the European Union, 2018

PDF ISBN 978-92-79-79921-1 doi: 10.2777/3392 KI-AX-18-002-EN-N

EUROPEAN COMMISSION

Specific Support to Latvia

The Latvian Research Funding System

Independent Experts

Dorothea Sturn (Chair)

Erik Arnold (Rapporteur)

Susana Borrás

José-Ginés Mora Ruiz

National Peers

Indrek Reimand (Estonia)

Philip Sinclair (UK)

Directorate-General for Research and Innovation

2018 EN

Table of Contents

List of Figures

List of Tables

List of Abbreviations

Abbreviation	Full name
BERD	Business expenditure on research and development
CERN	European Centre for Nuclear Research
CFCA	Central Finance and Contracting Agency
CSB	Central Statistical Bureau
DG RTD	Directorate-General for Research and Innovation
EC	European Commission
EEA	European Economic Area
EIS	European Innovation Scoreboard
EQAR	European Quality Assurance Register
ERA	European Research Area
ERC	European Research Council
ERDF	European Regional Development Fund
ERIC	European Research Infrastructure Consortium
ESA	European Space Agency
ESF	European Science Foundation
ESFRI	European Strategy Forum on Research Infrastructures
ESIF	European Structural and Investment Funds
EU	European Union
EUR	Euro
FDI	Foreign direct investment
FFG	Austrian Research Promotion Agency
FP	Framework Programme
FTE	Full-time equivalent
FWF	Austrian Science Fund
GDP	Gross domestic product
GERD	Gross expenditure on research and development
GOVERD	Government expenditure on research and development
GTS	Approved Technological Service Provider (DK)
H2020	Horizon 2020
HE	Higher education
HEI	Higher education institution
HERD	Higher education expenditure on research and development

Abbreviation	Full name
ICT	Information and communications technology
IMF	International Monetary Fund
IPR	Intellectual property rights
JRC	Joint Research Centre
KNAW	Royal Netherlands Academy of Arts and Sciences
LCS	Latvian Council of Sciences
LIAA	Investment and Development Agency of Latvia
LIIA	Latvian Institute of International Affairs
LIKTA	Latvian Information and Communications Technology Association
MA	Master of Art
MoE	Ministry of Economics
MoES	Ministry of Education and Science
MoF	Ministry of Finance
NTNU	Norwegian University of Science and Technology
OECD	Organisation for Economic Co-operation and Development
PRFS	Performance-based research funding systems
PSF	Policy Support Facility
RAE	Research Assessment Exercise
RCN	Research Council of Norway
R&D	Research and development
R&I	Research and innovation
RIO	Research and Innovation Observatory
RIS	Research information system
RIS3	Research and Innovation Strategies for Smart Specialisation
RTO	Research and technology organisation
RTU	Riga Technical University
SEDA	State Education and Development Agency
SRA	Studies and Research Administration
STEM	Science, Technology, Engineering and Mathematics
TAFTIE	The Association For Technology Implementation in Europe
TNO	Organisation for Applied Scientific Research (NL)
TRL	Technology readiness level
TTP	Technology Transfer Programme

Abbreviation	Full name
UL	University of Latvia
VTT	Technical Research Centre of Finland
WB	World Bank

THE PSF SPECIFIC SUPPORT PANEL

Dorothea Sturn, Chair, was Managing Director of the Austrian Science Fund (FWF), Austria's central funding organisation for basic research. In this context, she was involved in different international projects comparing peer review practices in national funding bodies. Her main areas of expertise revolve around research funding and proposal assessment by peer-review as well as strategy building and evaluation of research performance. Previously, she worked at the University of Vienna as Head of the Quality Assurance and Evaluation Unit where she developed an informed peer review scheme for the assessment of research quality in different institutional settings. At the Austrian Research Promotion Agency (FFG), she was responsible for various schemes fostering the co-operation between research and economy and earned her particularly strong experience in programme management. She holds an MA and a PhD in Economics and has lectured on public economics and on political economy.

Erik Arnold, Rapporteur, is co-founder and Chairman of the Technopolis Group, Adjunct Professor in Research Policy at the Royal Institute of Technology, Stockholm, and a Visiting Academic at the University of Manchester. He is a Trustee of the Fraunhofer-ISI institute and a member of the editorial board of the journal Research Evaluation. He has worked in research and innovation policy and evaluation since 1980, covering work in a wide range of disciplines handling research and innovation policy. His work spans over 30 countries as well as the European Commission and a range of international organisations including the OECD, World Bank, Nordic Council of Ministers, ESF and COST.

Susana Borrás, Expert, is a professor of innovation and governance at Copenhagen Business School. As a social scientist expert on public policy, two of her leading questions are, what governments can do to foster and to improve socio-technical innovation in the economy, and what makes some decisions regarding socio-technical and innovation change to be democratically legitimate and others not. Her main focus is on the European Union, both at the supra-national level as well as national and regional levels. She regularly advises innovation policymakers, is member of the editorial board of 5 scientific journals, and has non-executive leadership responsibilities seating in several boards.

José-Ginés Mora Ruiz is an expert on higher education systems and management, especially on European higher education and its recent developments. Currently he is Visiting Fellow at OxCHEPS, University of Oxford. Earlier, he was Visiting Professor at the UCL Institute of Education and professor and director of the Centre for Higher Education Management at the Technical University of Valencia. He has been president of the European Higher Education Society (EAIR), vice-president of the Governing

Board of the IMHE programme (OECD), member of the Bologna Follow-Up Group and a member of the Steering Committee of the ENQA (European Network of Quality Assurance).

Indrek Reimand, Peer Expert, is Deputy Secretary General for Higher Education and Research, Estonian Ministry of Education and Research. Prior to this, he was the head of Research Policy Department (2004-2012) in the ministry, a position he moved to from Estonian Information Technology.

Philip Sinclair, Peer Expert, until recently was Head of Innovation and Growth in the UK Cabinet Office, leading inward innovation in government, with a focus on making public sector business more accessible to SMEs. Prior to joining the Civil Service, he worked in management consulting, corporate finance, and law. As an entrepreneur he has founded two businesses, most recently in the education sector for the Asia Pacific region. As a non-executive director, he has advised several others on strategy, growth, and intellectual property. He has mentored entrepreneurs, executives, and students in the UK and abroad. Philip is a Fellow of the Royal Society for the encouragement of Arts, Manufacturers & Commerce.

The expert team was supported by Elina Griniece and Reda Nausedaite who prepared the background report based on a structure proposed by the rapporteur then revised based on comments from the expert team. The experts were also supported by the PSF Team comprising the PSF contractor (represented by Bea Mahieu, project manager at Technopolis Group) and the Commission services (DG Research and Innovation, Unit A4 – 'Analysis and monitoring of national research policies') with Diana Ivanova-van-Beers as the contact point from DG Research and Innovation, who coordinated the exercise and ensured liaison with the Latvian authorities. Bea Mahieu, Technopolis Group, acted as the quality reviewer.

The Latvian authorities provided available data and background documentation useful for the panel's work, and also supported the visits to Latvia (i.e. inviting the representatives of government institutions and stakeholders; providing meeting facilities and interpretation, as required). The Ministry of Education and Science provided coordination for the Latvian authorities, ensuring the involvement of other relevant ministries, agencies or bodies. The Ministry and the EU Representation in Latvia made available facilities for meetings and workshops.

POLICY MESSAGES AND SUMMARY

This study has been produced at the request of the Latvian authorities by an expert panel funded under the European Commission (DG RTD) Policy Support Facility. It is based upon document analysis as well as interviews with key stakeholders conducted during two visits by the panel to Latvia during the course of 2017. It has subsequently been discussed with the Latvian authorities.

The task of the expert panel was to

- Review the funding allocation systems and processes (for both project funding and institutional funding) and propose any improvements required to correspond to best practice while being adapted to the Latvian situation
- Propose an overall institutional/organisational structure for managing the funding system, tailored to the specificities of the Latvian situation
- Propose the fundamental elements of the organisational model for each of the organisations to be part of this structure, including its possible competences, governance, and relationships with government, industry and research communities

Context

This report relies on two important ideas, both of which are orthodox in the study of research and innovation. The first is the idea, which is strongly supported by empirical evidence, that R&D is a crucial driver of economic development and growth. The second is the heuristic of 'national research and innovation systems', which involves a systemic approach to understanding the need for and the development of policy – recognising the complexity of system performance and refraining from single-factor explanations. A consequence of this systemic perspective is a search for balance among different policy objectives and instruments.

Latvia was among the European countries worst affected by the financial crisis starting in 2008 and was rescued by an IMF loan. The government put in place a programme to alleviate liquidity pressures and restore long-term stability and make it possible to repay the IMF loan, which involved austerity in the state budget. As a result, state spending on research fell dramatically and has not fully recovered. For the time being, European structural funds have gone some way to closing the gap. Gross expenditure on R&D was 0.52% of GDP in 2005 and after falling back has risen to only 0.63% in 2015, compared with an EU average of 2.03%. For 2016 the percentage was even lower (0.44%). Latvia's industrial competitive advantage is based on low labour costs. Industry barely does any R&D. The

European Innovation Scoreboard listed Latvia in 2016 and 2017 as one of the EU's 'moderate innovators'. Production of graduates is strong but there are continuing problems of brain drain and population loss.

Governance

The Latvian system of agencies involved in implementing research and innovation policy is fragmented, making it difficult to build a critical mass of capacity, quality and scale. Budget restrictions mean that few ministries beyond the Ministry of Education and Science and the Ministry of the Economy develop and fund their own research strategies. Except when structural funds periods are being planned, coordination about research and innovation across government is limited.

The Latvian Council of Sciences (LCS) performs peer review for parts of the state R&D funding system. However, it has no staff of its own so it has to work with others who implement its funding decisions. It is also not fully independent of the Latvian Academy of Sciences. The Investment and Development Agency of Latvia (LIAA) has established a 'technology transfer' group that is beginning to function as a small innovation agency. However, overall the roles and functions of different agencies in implementation, monitoring, project selection etc. are overlapping, unclear and complicated. This makes it difficult to build effective policy implementation capacity across the whole funding system.

Policy

The state has developed guidelines for science, technology and innovation as well as for industry. These jell well with the National Development Plan and the Smart Specialisation Strategy and together these comprise a coherent framework for the economic development of the country. Recent reforms of especial importance to this review include

- Structural reform of the research sector, 2014-5, aiming to reduce the previous extreme fragmentation of the state's research-performing system
- Reform of the public funding system for higher education and research (also in 2014-5), setting up a 'three-pillar' system for institutional funding, performance-based funding and incentives for universities' 'third mission'

However, research and innovation funding continues to have low priority compared with other policy areas.

Performers

The great majority of research in Latvia takes place in higher education institutions and research institutes. Funding levels are well below those in

other developed countries and there is an unhealthy dependence upon structural funds for research and innovation funding. Despite significant reductions in recent years, there is still a need further to reduce the fragmentation among the higher education and research institutions. Universities' governance is largely collegial, limiting their ability to act strategically. There are too few people doing research in the university sector and, despite areas of strength, the overall quality of the research produced needs to improve. Funding incentives have therefore been introduced to address these problems. The proportion of the already small research workforce that is coming up to retirement is high and while there is a new generation of young researchers there are few people in the middle age-groups. Research careers are insecure and poorly structured.

Business expenditure on R&D was 0.15% of GDP in 2015 (and only 0.10% in 2016), compared with an EU average of 1.3%. Latvian firms tend to be smaller than the European average and 6% of them are foreign-owned, compared with 1% in the EU as a whole. FDI is not concentrated in fields where foreign owners will tend to encourage R&D in Latvia. Some 30% of GDP is produced by state-owned firms, most of which also do little R&D. There are growing numbers of firms that are becoming more competitive by internationalising and investing in newer production technologies, but these also do little R&D. Riga has a small technology start-up community but not yet a well-developed start-up ecosystem.

There are relatively few research-industry links, in no small part because the industrial side is technologically weak. Companies generally spend little on research or innovation and lack significant technical staff that could undertake R&D. The competence centres programme is widely seen as providing a large and positive contribution to such links. Except at Riga Technical University (RTU) there is a limited entrepreneurial culture within the universities though a small number of institutes work very actively with industry. There are few 'boundary organisations' – such as the research and technology organisations like Fraunhofer that are seen in other countries. To some extent, RTU, the competence centres and some of the institutes provide corresponding functions.

Funding

In 2017, total annual public funding for research was €73m, of which half came from structural funds. Most of the money from the national budget was devoted to institutional funding, leaving little for competitive, project-based programmes. Thanks to the structural funds, there is a growing portfolio of research funding instruments that either build research capacity or support young researchers. Following the research assessment exercise of 2014, the government has decided to make some of research-performing organisations' institutional funding dependent on past performance. This is being done as part of implementing a 'three-pillar' funding model comprising

- Institutional funding for higher education and research and competitive project funding for research
- Funding dependent upon past performance in higher education and research
- Funding to promote institutional development and innovation – which has largely yet to be implemented

Internationalisation of research is promoted through a number of bi- and multi-lateral arrangements, including the Framework Programme.

Innovation funding programmes for industry amount to some €40m in 2017, entirely paid for by structural funds and including the competence centres, technology transfer, innovation vouchers, innovation promotion and a range of investment and training incentives. The portfolio is ambitious but has some missing elements and is inherently unstable, owing to the dependence on structural funds.

Policy implications

Based on a background report, two missions to Latvia, and analysis of these main challenges the expert team has identified **five** key policy messages that underpin the more detailed recommendations presented in the report.

Funding for research and innovation should increase, especially from national sources

- **State expenditure on research and innovation needs to grow in order to drive performance and growth**. This should be supported by improved communication to achieve a clearer national understanding and vision and to upgrade the visibility and priority of research and innovation policy. The line ministries should allocate a certain share of their budget to research and innovation in their respective areas.
- **The current high dependence on structural funds is not sustainable in the longer term** so Latvia should seek a better balance between national and European funding.

The structure and governance of state organisations should be streamlined to meet national needs

- A **national exercise is needed to restructure and improve coordination** and the division of labour in the structure and governance of research and innovation policy. The ministries need to build a platform for cooperation on research and innovation questions. In principle the Research Council should be able to do this. However, the political acceptability of this solution would have to be explored and the analytic capacity available to the Council would have to be increased.

- **There should be a clear separation between policymaking in the ministries and implementation in agencies**. The Ministry of Education and Science as well as the Ministry of Economics as main players in research and innovation policy should act as owners of the agencies (or the unified agency). Furthermore, other ministries such as the Ministry of Health, the Ministry of Agriculture or the Ministry of Transport should develop their own research strategies with a view – in the longer term – to funding their own research.
- **The implementation of structural funds programmes should be re-integrated with national funding** in order to build capacity and scale. In a small country such as Latvia, a unified implementation agency for research and innovation funding can build scale and capacity while implicitly coordinating the various policies and instruments it implements. This should include both research and innovation funding in a single organisation. Latvia should build such an organisation by bringing together relevant functions from existing agencies. This should incorporate part of, or work in close partnership with, CFCA.
- **Peer review proposal assessment in Latvia should be centralised in a way that builds on existing experience and capabilities** (for example, at the Latvian Council of Science) and should ideally form part of the unified implementation agency. This capacity can then be used by others, as needed. Processes used should follow good international practice.
- **Latvia should develop a strengthened and more integrated innovation agency function**, with good links to research as well as business innovation.
- **The Latvian authorities should consider the role and function of the Latvian Academy of Science and support their efforts to turn into a learned society. The Latvian Academy of Science should no longer have the right to determine the governance of the Latvian Council of Sciences**, which should form part of the unified implementation agency or, failing that, be governed by an independent board.
- An incidental bugbear is the perceived complexity of **procurement rules** that impede project implementation. These **should be clarified.**

<u>Higher education structure and governance should further be modernised</u>

- **There should be further consolidation among research-performing organisations**, though this should respect individual circumstances and the opportunities for some to act as 'boundary organisations'.
- **Universities should be run by boards that have a majority of external, societal representatives and the power to appoint the rector**.

- **The Latvian authorities should consider reforming the research career system,** for example by introducing a tenure track.
- **The national higher education accreditation agency should engage in the main European networks** in its area, both to obtain recognition and in order to learn.

Competitively-won research funding should increase, in order to meet national needs

- **The next research assessment exercise** should be directly coupled **to performance-based funding**, though care should be taken to ensure that this does not accidentally undermine the incentives for other vital functions such as teaching and the third mission. The next exercise should continue to use peer review, in order to generate institution-specific feedback.
- **Both the scale and the scope of competitive, external research funding schemes should increase**, in order to meet national needs for both 'bottom-up' and thematically orientated research.

Investment by private and public businesses in innovation should be increased and broadened

- **The innovation funding portfolio is incomplete and needs to be strengthened with additional measures** that foster innovation and the creation of absorptive capacity in firms.
- **The state-owned firms represent a significant lever over the performance of industrial R&D and should be required to spend a certain minimum of their revenues on doing or commissioning R&D.**
- This study was not able to go into the detail needed to make specific recommendations about creating or strengthening 'boundary organisations between research and industry. **The Latvian authorities should conduct or fund further investigation into the opportunities to strengthen the 'boundary' function**.

1. INTRODUCTION, SCOPE AND METHOD

1.1. The PSF Specific Support Actions

The Horizon 2020 Policy Support Facility (PSF) is an instrument aimed at supporting Member States and countries associated to Horizon 2020 in improving the design, implementation and evaluation of their national R&I policies and systems. The PSF was set up by the European Commission, DG Research and Innovation (DG RTD), under Horizon 2020.

Specific support services provide tailored advice, expertise and good practice to help Member States and Associated Countries in the design or implementation of a specific reform or topic concerning R&I strategies, programmes or institutions. This is carried out by an international and independent expert panel which formulates concrete and operational recommendations for the national authorities on the reforms necessary to address the specific objectives.

1.2. Scope and methodology

This report reviews the Latvian research funding system. It has been produced at the request of the Latvian authorities through the Horizon 2020 Policy Support Facility of the European Commission's Directorate General for Research and Innovation.

Specifically, the task of the expert panel producing this report was to

- Review the funding allocation systems and processes (for both project funding and institutional funding) and propose any improvements required to correspond to best practice while being adapted to the Latvian situation
- Propose an overall institutional/ organisational structure for managing the funding system, tailored to the specificities of the Latvian situation
- Propose the fundamental elements of the organisational model for each of the organisations to be part of this structure, including its possible competences, governance, and relationships with government, industry and research communities

Research and innovation need to be embedded in the wider society in order to drive development and growth, which in turn creates the ability to fund more research and innovation. The panel has therefore chosen to interpret 'research' in a broad sense, to include the production and use of knowledge in innovation as well as the role of the state in the governance of the national research and innovation system.

To support the work of the panel, a background report was produced, summarising and synthesising available policy documents and studies. The expert panel made two three-day visits to Latvia in 2017, in order to

interview relevant policymakers and stakeholders, to discuss issues concerning the funding system and to reflect on potential reforms.

The PSF panel drafted this independent report on the basis of the documents analysed, the Latvia's feedback on the panel's preliminary findings, as well as by drawing on discussions with stakeholders and experts and comments received during the field visits.

Chapter 2 of this report provides a diagnosis for the research funding system. It sets out basic concepts and offers a short analysis of the Latvian research and innovation systems (updated summary of the background report) as well as of Latvian research and innovation policy.

Chapter 3 discusses the way the national research and innovation system is governed. The Chapter is completed with recommendations and proposals concerning two governance scenarios. An additional proposal addresses the improvement of the peer review system.

Chapter 4 deals with the higher education and research institutions, industrial innovation and research-industry links. Here again, conclusions and recommendations, based on the foregoing material, are formulated. The question about whether there are adequate 'boundary organisations' to promote the creation of absorptive capacity and exploitation of knowledge in industry is addressed.

Chapter 5 analyses research funding and innovation funding by the state. General recommendations are followed by a discussion of the implications for the coming national research assessment.

Chapter 6 summarises the conclusions of the report and makes recommendations for improvement.

This report presents the views of the expert panel. These are not necessarily the same as those of the European Commission, which makes its views known through other channels.

2. THE CONTEXT

Here we set out some basic concepts and ideas upon which we rely in the report. These reflect current orthodoxy in analysis of research and innovation systems and their performance. We then describe the Latvian research and innovation system and current policy relating to it.

2.1. Basic concepts and ideas

Three ideas are central to the way in which we currently understand and analyse national research and innovation performance.

- First, the idea that R&D and innovation are crucial drivers of economic development and growth
- Second, the concept of a 'national innovation system' or, in our view, more properly a 'national research and innovation system'
- Third, the implication of the 'national research and innovation system' view that countries need to maintain a balanced policy mix and not focus all policy attention only on one or a small number of components of the research and innovation system

R&D as a driver of economic development and growth.

There is now a large literature about the returns from R&D and the links between R&D, the economy and wider society. Useful reviews and summaries can be found in (Martin & Tang, 2007) (Hall, Mairesse, & Mohnen, 2010) (Becker, 2015) (David, Hall, & Toole, 2000).

Much of the literature tries to calibrate production functions using economic data so as to estimate the contribution of technology or knowledge to output. A simple production function is an equation that relates economic output or productivity to inputs such as labour, capital and proxies for technology. More refined versions are dynamic rather than static, add other variables and distinguish between the stock of existing knowledge available to companies and the input of new knowledge (typically from R&D). Variations deal with growth and productivity, especially total factor productivity. A long-standing area of interest has been quantifying spill-overs from R&D. New knowledge 'leaks' from R&D performers to others, so the social rate of return is typically two to three times larger than the private rate of return to R&D performers. There are also spill-overs from private R&D through labour mobility, imitation, licensing and so on despite firms' attempts to monopolise the results.

Available studies find large and positive returns to private R&D. Rates of return vary among industries. Product R&D seems to have a higher rate of return than process R&D, though of course the two are complementary: it is often difficult to make new products without new processes. A considerable number of studies find that the returns to publicly-funded

business R&D are lower than those for private (i.e. company-funded) R&D. This appears to be because the work on privately-funded R&D focuses on manufacturing while a lot of government R&D is in services (where output is harder to measure) and because government funding focuses on higher-risk areas (where private money fears to tread), the production of public goods and areas of existing policy focus.

Some earlier studies suggest that publicly funded R&D tends to crowd out privately funded R&D, but most and more recent studies find the opposite: that public funding 'crowds in' private R&D. University research, the availability of high-skilled human capital and R&D co-operation also typically increase private R&D (Becker, 2015).

Rates of return to government-funded basic research are high because basic work tends to have long-term benefits and because the amount of spill-over is higher than that from applied research or development. The traditional 'market failure' argument (Nelson, 1959) (Arrow, 1962) for state funding of R&D is precisely that the high risk, high rate of spill-over and the public good character of basic research (i.e. the impossibility of appropriating and monopolising the results) makes it an unattractive investment to private enterprise. There is some evidence that academic-industry cooperation increases the rate of return to the companies involved because they access more basic knowledge than would otherwise be the case without having to pay the full economic price or take on the risks associated with basic research.

The concept of "innovation systems" adds a "system failure" argument to the classical "market failure" argument. Systems failures, eg the lack of proper links between actors and institutions or insufficient knowledge flows among them, can occur even in absence of pubic good problems. As a consequence, public interventions may also be beneficial in more applied contexts of research.

The key channels through which the benefits of public research flow through into the economy are (Martin & Tang, 2007).

- Increase in the stock of knowledge
- Supply of skilled graduates and researchers
- Creation of new scientific instrumentation and methodologies
- Development of networks and stimulation of social interaction
- Enhancement of problem-solving capacity
- Creation of new firms
- Provision of social knowledge

The literature is therefore unequivocal in indicating that investment in research produces large economic benefits, that state investment has an

especially high return when it funds work that private industry would not do or stimulates the private sector to increase its R&D effort. Martin and Tang's 'channels' provide important clues about where government can fruitfully devise policies to increase the effectiveness with which state research investment translates into economic benefit.

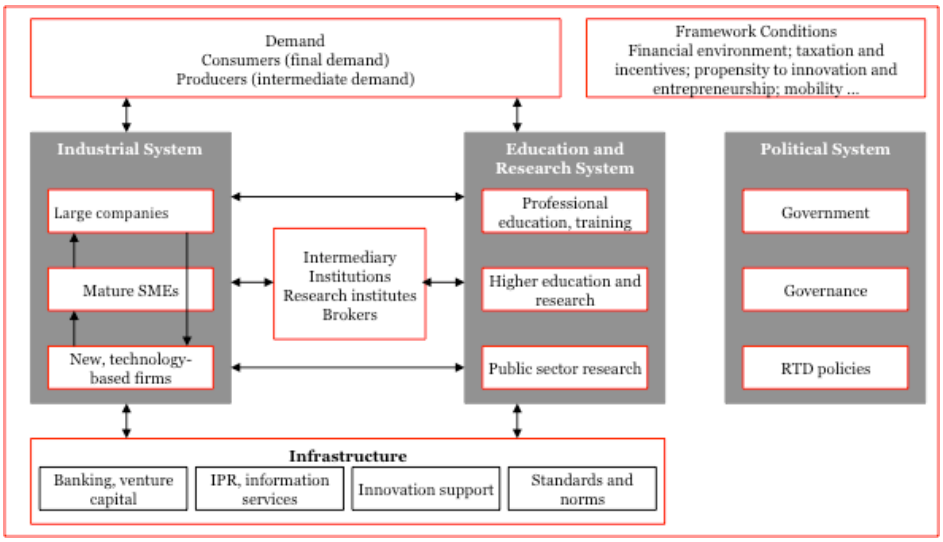
National Research and Innovation Systems

The concept of a 'national innovation system' emerged in the late 1980s and early 1990s in opposition to the idea that traditional (neoclassical) economics alone provided an adequate description or theory of how technological change happens in and affects society. It is now the dominant heuristic in analysis of research and innovation performance and is used, for example, in the OECD's Reviews of Innovation Policy as well as various European Commission Policy Mix reviews. Systemic approaches gave new insight into innovative and economic performance by focusing on the interaction among actors and not just inputs (such as research expenditures) or outputs (such as patents). (Freeman, 1987) (Lundvall, 1992) (Nelson, 1993) (Patel & Pavitt, 1994) (OECD, 1997). Key elements of the idea include

- Economic actors have 'bounded rationality', so they do not always make optimal decisions. Past decisions, skills and resources affect decisions, so future decisions and behaviour can become 'path dependent' rather than being objectively rational
- Hence, knowledge, learning and institutions become key to how economies innovate
- The smooth operation of innovation systems depends on the fluidity of knowledge flows – among enterprises, universities and research institutions. Both tacit knowledge, or know-how exchanged through informal channels, and codified knowledge, or information codified in publications, patents and other sources, are important.
- Firms and other institutions on the one hand and their economic and social context on the other are interdependent. These co-evolve and therefore their relations often differ among countries
- As a result, policies have to be tuned to the national systemic context – they cannot simply be copy-pasted from one place to another
- Good system performance (eg growth) results from a combination of the level of performance at multiple points in the system – policy development has to take account of bottlenecks in the system and can rarely improve performance by intervention at a single point

Because research is a key component of innovation systems, we prefer to refer to 'research and innovation systems'. Figure 1 is a widely-used illustration of the major components of a research and innovation system. Our analysis takes account of many of these components.

Figure 1 A national research and innovation system heuristic



Source: (Kuhlmann & Arnold, 2001)

A balanced policy mix

While individual national systems have unique characteristics, a universal principle, however, is the need for **balance** among the different components of the research and innovation system and therefore in the mix of policies and instruments employed by the state. For example, the further and higher education systems need to produce roughly the quantity and type of people needed in the labour force; some of the research effort funded by the state needs to be orientated towards specific economic and social needs; but there also needs to be a balance between the amount of such orientated research and 'bottom-up' or investigator-initiated research (which is a source of unexpected ideas, of research-capable human capital and of the ability of the system to learn from global advances in science and technology).

The balance of R&D effort between the state and business and the balance between 'basic' and more applied research performed overall tend to change with development. In low-income countries, business tends to do little R&D. Most research is done in the state sector: universities and government laboratories. As industrial capacity and capability grow, so the balance typically swings the other way, so that business does the majority of R&D. (This is reflected in the EU's goal to spend 3% of GDP on R&D, of which 2% should be funded by business and 1% by the state.) Because the state system is the source of the human capital used by business, it has to grow over time in order to support the growing needs of the whole system

– though business' expenditure on R&D should grow faster than that of the state if development is taking place.

Links between the research and industry matter. The Community Innovation Survey (available from EUROSTAT) has consistently shown over the years that successful innovators make more use of knowledge from external research organisations such as universities than unsuccessful ones. These links operate also in relation to human capital. Research tends to inform the pattern of education in universities. As a result, companies make use not only of ideas from the research system but of relevantly-skilled people. It is essential therefore that aspects of research policy are in balance with the actual and potential needs of industry – and society more widely – for new ideas and educated people.

In most countries, there is a struggle between different factions about the amount of resources that should be devoted to basic versus more applied research[1]. There is no single 'right' balance. Arguably, the structure of industrial and societal need should be one determinant. Thus, Norway – which has a lot of process industry and engineering – devotes a large part of its research effort to rather applied topics. In the other side of the Scandinavian peninsula, Sweden – which has strong engineering traditions but also a lot of science-based industry – spends a great deal on basic research. Different points of balance make sense in the context of different national needs. At the more general level, those advanced economies that report their R&D effort in basic versus applied research to the OECD devote on average about 20% of their R&D expenditure to basic research – a proportion that has been very slowly rising over the last twenty years or so. Developing countries often devote far less. China, for example, has devoted roughly a 5% share of the national R&D effort to basic research since the start of the 1990s, a period in which total R&D expenditure has grown at an enormous rate, in line with China's industrialisation. For economies in catch-up, the needed trajectory is defined by the leading countries, so they need lots of applied work to absorb, localise and improve technologies. In contrast, countries near to the technological frontier cannot just rely on others – they need sources of completely new ideas and therefore need to devote more effort to basic research (Arnold & Giarracca, 2012). (That said, the crucial role of basic research in human capital formation should not be forgotten. It can be argued that this is actually more important than its role in idea generation, especially in smaller countries.)

In relation to the national research and innovation system, policymakers can be thought of as doing 'bottleneck analysis' (Arnold, 2004) to identify weaknesses in the boxes and links shown in Figure 1, above. A balanced

1 These definitions are themselves problematic (Stokes, 1997). Arguably, the category of basic research would not continue to be used were it not for the fact that the OECD published statistics about it (Godin, 2000)

policy mix is one that addresses these weaknesses and helps the system to function in a balanced way.

2.2. The Latvian research and innovation system

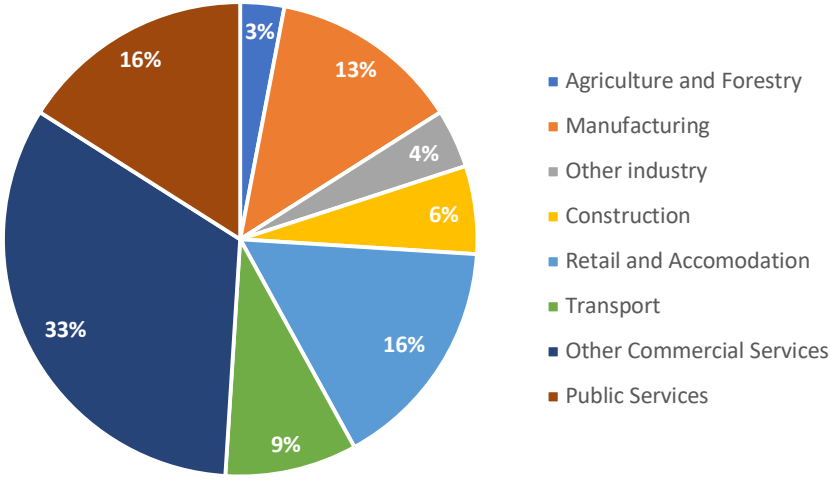
The Latvian research and innovation systems has been reviewed a number of times (Arnold, et al., 2010) (Arnold, et al., 2014) (Kulikovskis, Petraityte, & Stamanov, 2016) (Kuļikovskis, Petraitytė, & Stamenov, 2017) (European Commission, 2017), so the main lines are relatively well known. This section summarises key issues at a fairly high level. More detailed analysis and data may be found in the background report to this review (Griniece & Nausedaite, 2017).

Following a period of rapid growth, driven by credit expansion and consumer demand, the Latvian economy was among the worst affected by the financial crisis, which was followed by a 25% decrease in GDP between 2007 and 2009. The government adopted a severe austerity policy in order to repay the IMF loans that had been provided to help the country weather that crisis and managed to rebalance the state budget in 2012 (Kuļikovskis, Petraitytė, & Stamenov, 2017; European Commission, 2017). Since then the national budget has been close to being balanced but the government struggles to maintain the levels of expenditure on research seen in other EU countries. In fact, much of that low level of spending is supported by Structural Funds and will eventually need to be substituted by national money as the Structural Funds are phased out.

In Latvia's economic structure the service sector remains the biggest contributor to the national GDP, while manufacturing and other industry comprise only 17% (see Figure 2).

The goal is to transform the economy towards sustainable development underpinned by strong export-led growth and increasing attractiveness for foreign direct investment. Export of goods constitutes around 2/3 of the overall income from export. It is dominated by five major product groups that constitute more than 70% of the total export of goods. These product groups are: 1) wood and wood products (17.5% in 2016); 2) agricultural and food products (19.2%); 3) machinery and electric equipment (17.3%); 4) products of the chemical and allied industries (11.1%) and 5) metals and metal articles (8.3%) (MoE, 2016). While these five product groups stand out in the overall export structure, there are only two distinct industry clusters – forestry and woodworking and agriculture and food – that show concerted knowledge and skills base between science and industry (Ministry of Economics, 2013). Around 15% of the total income from export comes from transport services, of which 1/3 is connected with transit.

Figure 2 Economic sector contribution to GDP



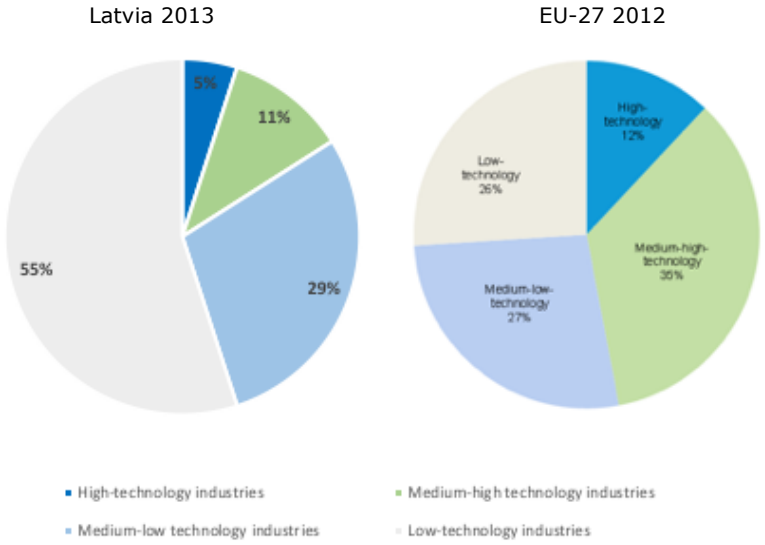
Source: (Ministry of Economics, 2016)

Much of Latvian business' competitiveness is driven by low labour costs, but this advantage is constrained by a long-standing pattern of economic emigration and brain drain, as a result of which the total population has now fallen to just below two million people. Manufacturing productivity is still much lower than in the rest of the EU. Productivity increases are needed to support higher wages and improved competitiveness. Businesses in Latvia rely heavily on the acquisition of machinery for technological upgrading. In a developed knowledge-based economy, however, research and innovation as well as a skilled labour-force should be the driver of productivity increases and technological development. There is a low share of medium-high and high-tech companies in the overall structure of the manufacturing sector (Figure 3) though there appears to be some growth in the medium-low technology industries at the expense of the low-technology ones.

Productivity and competitiveness will only improve if industry can engage more deeply in technological development as well as inward technology transfer and if the economy can restructure towards higher value-added (meaning, usually but not always, higher technology) sectors. This implies focusing on knowledge- and not just efficiency-based growth and hence on making and using a greater investment in innovation and research. Latvia's growing number of start-up companies are often knowledge-intensive and internationally orientated. They can contribute to this, but their aggregate contribution is likely to be small – there also needs to be significant transformation within existing companies of which about 30% is government owned. While innovation and research are not currently high on the political agenda, they need to be policy priorities if Latvia is to grow

and stop losing people (especially the very valuable people who are attractive in international labour markets).

Figure 3 Structure of the Latvian manufacturing sector by technology level in 2013 (left-hand graph) versus EU27 in 2012 (right-hand graph)



Source: Ministry of Economics, 2015 (EUROSTAT, 2013)

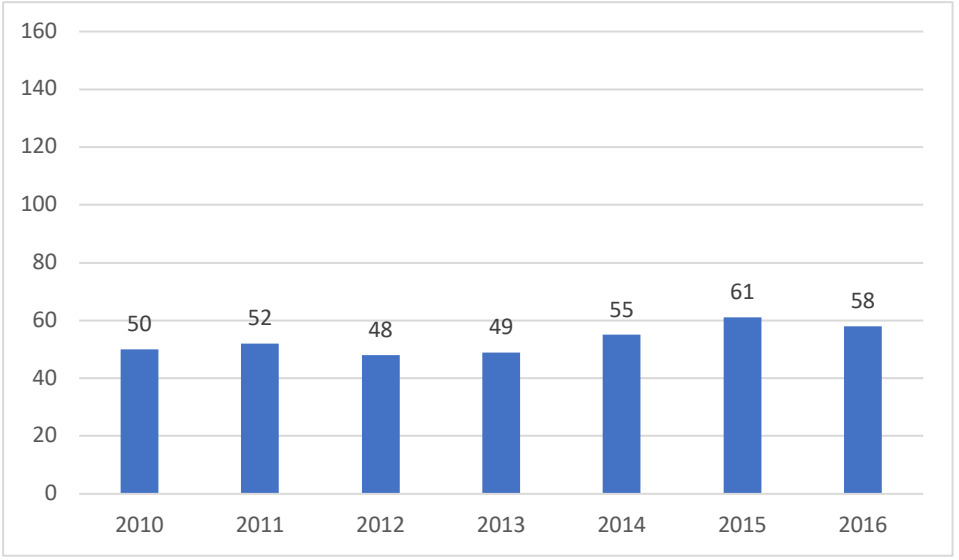
Higher public and political priority of research and innovation is important as research plays a critical role in the innovation process. It is essentially an investment in technology and future capabilities which is transformed into new products, processes, and services. In industry and technology sectors research is a crucial component of innovation and a key factor in developing new competitive advantages and economic growth.

Since 2008 Latvia has belonged to the group of 'Modest innovators' according to the European Innovation Scoreboard (EIS) classification. The EIS 2016 reclassified Latvia for the first time as belonging to the group of 'Moderate innovators' with a similar overall performance to that of Lithuania and Croatia. Latvia maintains its EIS position as a moderate innovator also in 2017. In the period 2010-2016, the innovation performance of Latvia has increased by 8.5% relative to that of the EU (see Figure 4).

The performance of the Latvian research and innovation system is increasing for about two-thirds of the indicators. The innovation dimensions where Latvia scores close to the EU average in 2010 are *Human resources* and *Innovation-friendly environment* (due to good scores in *broadband penetration*).

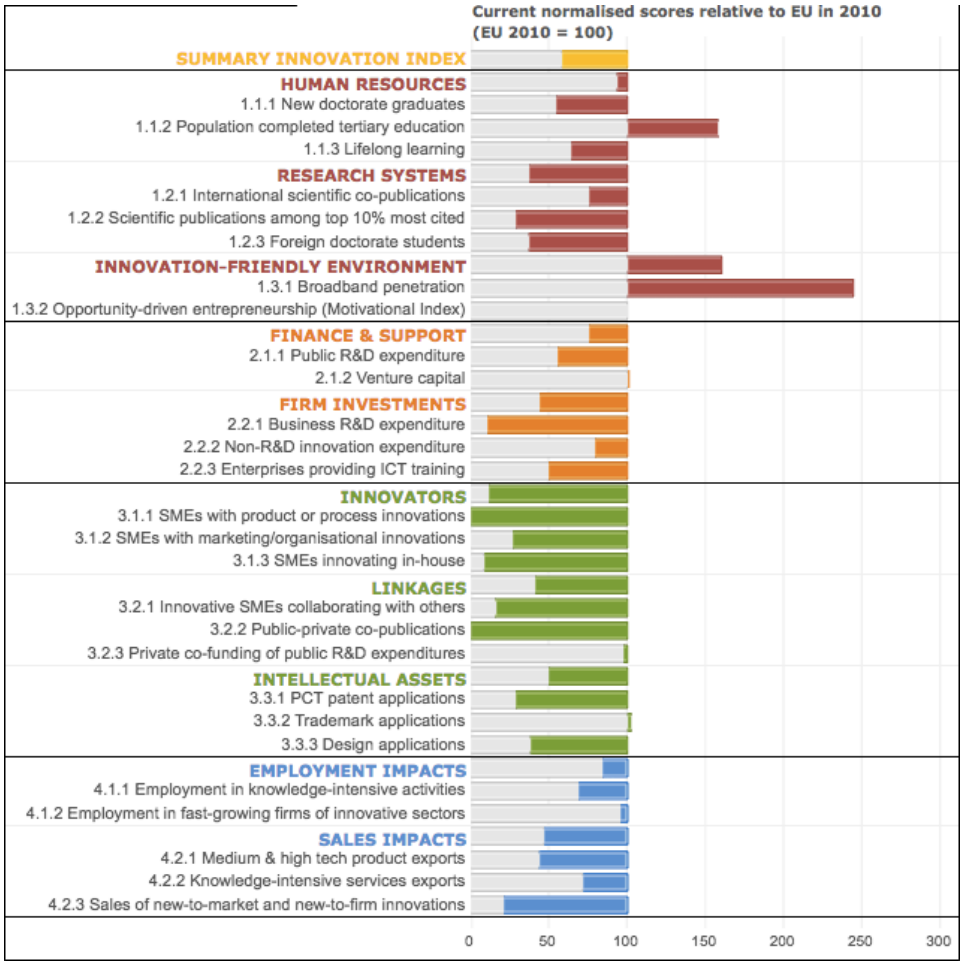
In other innovation dimensions Latvia performs well below the EU average. Particular attention should be paid to areas like *Linkages* and *Innovators (*worst score of the indicator - *Public-private co-publications* and *SMEs with product or process innovations)*, *Research systems (low international co-publications, top cited publications and foreign PhDs),* and *Firm investments* (for details see Figure 5). As research and innovation are closely related, many of the lags in the innovation indicators can be explained by the weakness of the research sector.

Figure 4 Performance of Latvia in EIS 2010-2016 relative to EU average



Source: EIS, 2017

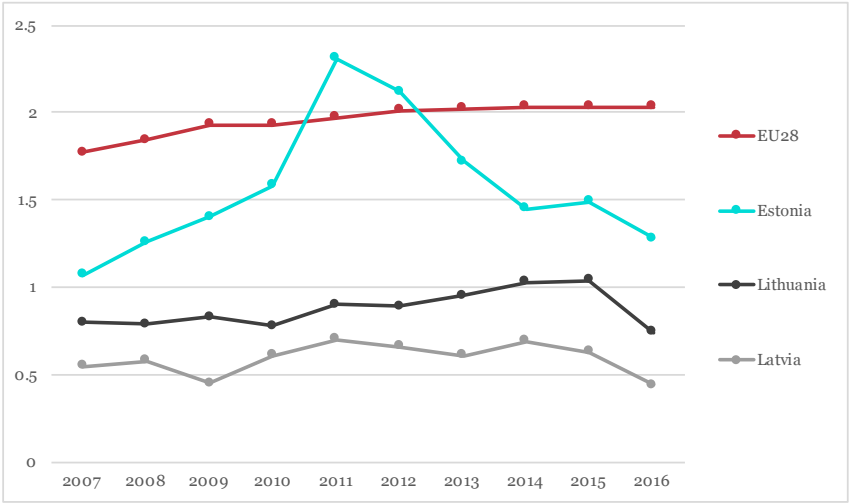
Figure 5 Performance of Latvia in EIS 2017 relative to EU in 2010



Source: EIS, 2017

While the gross domestic expenditure on R&D (GERD) as a percentage of GDP had marginally increased from 0.55% in 2007 to 0.63% (or €152.2m in absolute terms) in 2015, it decreased again in 2016 to 0.44% and remains well below the EU average of 2.03% and also lags behind the expenditure rate in Estonia and Lithuania (Figure 6). The significant reduction in national public R&D budgets due to fiscal austerity measures during the crisis years has partly been off-set by a relatively substantial use of EU Structural Funds, leading to dependence on foreign funding for research system development.

Figure 6 Gross R&D expenditure as % of GDP, 2007-16



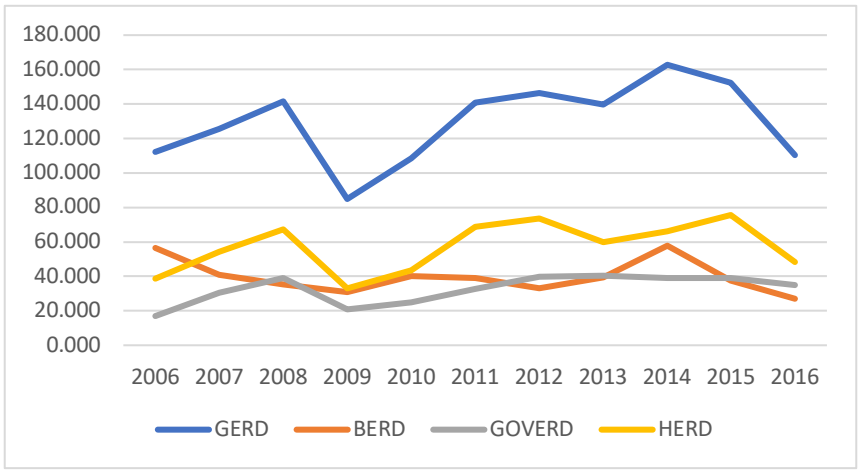
Source: Eurostat, 2017

Public funding for R&D in 2015 represented around 0.5 % of GDP, of which 0.28 % came from international funding sources. Private-sector R&D expenditure (BERD) constituted around 0.12 % of GDP (CSB, 2017) and has been stagnating in recent years. This reflects the structure of the Latvian economy where private innovative and high added value firms are largely missing. The accounting principles and underreporting of R&D activities by enterprises could also partially explain the very low expenditure on R&D.

Figure 7 breaks down Latvian GERD into BERD, Higher Education Expenditure on R&D (HERD) and Government Expenditure on R&D (GOVERD) over time. It reflects the cost of the R&D performed in each of these sectors and is expressed in current money. It shows that the dip in GERD after the financial crisis was driven by drops in HERD and GOVERD rather than BERD but that BERD itself has been stagnating (despite a short-lived peak in 2014)[2].

2 Note, however, that BERD is thought to be under-reported in Latvia

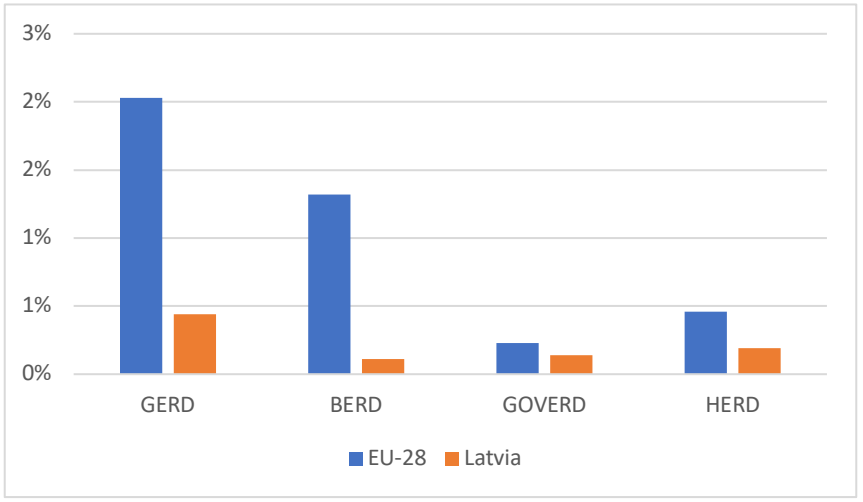
Figure 7 Latvia expenditure on R&D by performing sector, 2006-16



Source: EUROSTAT, 2017

Figure 8 compares Latvia's expenditure on these four categories of R&D in 2016 with that of the EU-28. Latvia spent 0.44% of GDP on R&D – some 22% of what the EU as a whole spent. The major part of this discrepancy is caused by the low level of BERD.

Figure 8 Latvian and EU-28 R&D spending as a percentage of GDP, 2016



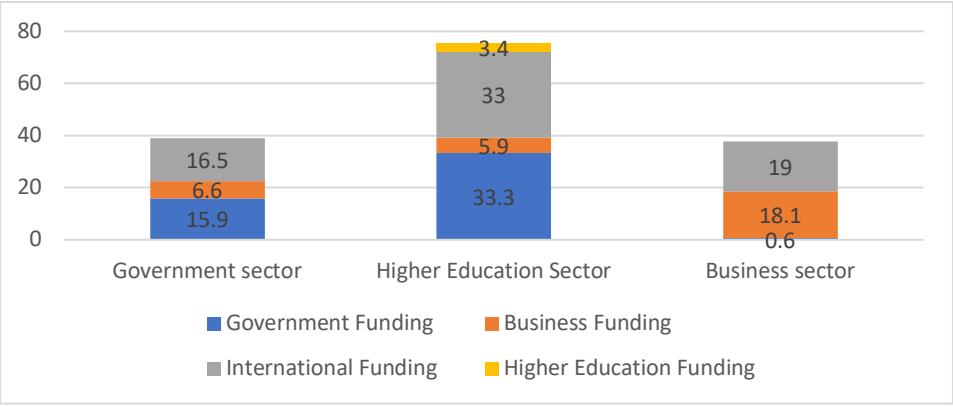
Source: EUROSTAT, 2017

Breaking down R&D expenditure in each sector of activity to show who pays for it (Figure 9) shows that the largest share of state funding goes to the HE sector. State-funding allocations to the business sector are negligible. While there is a funding stream from industry to government research (in the institutes) and the HE sector, the share of this funding is relatively small. All three sectors, but most especially the Higher Education sector,

are heavily dependent on international funding, mostly from European Structural Funds.

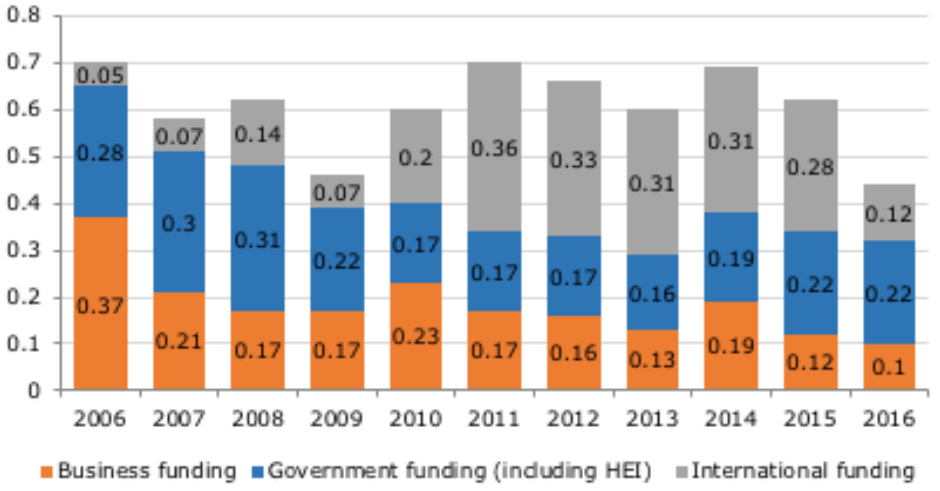
Figure 10 finally shows that research funding dropped dramatically in 2016, mainly due to reduced international funding.

Figure 9 R&D funding per sector of activity, 2015 (in €m)



Source: Eurostat, 2017 Note: Data for private non-profit sources are not available

Figure 10 Structure of R&D funding, 2006-2016 (% of GDP)



Source: CSB (Centralas statistikas parvaldes datubazes), 2017 ; Note: There are some small discrepancies between international (Eurostat 2017) and national (CSB 2017) statistics. According to Eurostat, GERD amounts to 0.63% and BERD to 0.15% in 2015; numbers for 2016 are 0.44% for GERD and 0.11% for BERD. CSB reports 0.62% (GERD) and 0.12% (BERD) in 2015. In 2016 the corresponding percentage for GERD is 0.44% and for BERD 0.10%.

2.3. Research and innovation policy in Latvia

Main strategic frameworks

The main strategic frameworks in which the country operates are

- The Guidelines for Science, Technology Development and Innovation (2014-20) – they are based on the National Development Plan 2014-2020 and include The Smart Specialisation Strategy (RIS3, 2014-20)
- The Guidelines for National Industrial Policy 2014-20

Other important documents that establish the framework for research are the "Law on Research Activity" and the "National Reform Programme of Latvia for the Implementation of the 'Europe 2020' strategy". These documents emphasise Latvia's priorities and serve as a roadmap to transform the economy towards higher added value, productivity and more efficient use of resources.

The strategic objective, according to these documents, is to develop Latvian science, technology and innovation into a system that is competitive on a global scale and capable of satisfying the development needs of the economy and society. A particular focus is placed on transforming the economy to support knowledge- and technology-driven growth and catching up on the development of knowledge-based skills.

The following quantitative targets are intended to be achieved by 2020.

- Increase gross R&D investment to 1.5% of GDP in 2020
- Increase private R&D investment by 11% (2010 as a baseline)
- Increase the number of researchers employed in the private sector by around 6.8% (2010 as a baseline)
- Double the 2011 number of European patents granted to inventors residing in Latvia
- Maintain the number of people graduating for the higher education sector per year and thus slightly increase the share of the population that holds a higher education degree

The first of these targets involved raising state investment in R&D by 0.15% of GDP annually, an intention which the government has not consistently been able to fulfil.

Eleven principles are set out in the **Guidelines for Science, Technology Development and Innovation** (2014-20).

- Priority of human resource capital and talent
- Excellence and quality

- Integration with industry
- Sustainability and balance
- Cooperation
- Integration of humanitarian and national culture and identity-related science fields
- Complementarity between public, private and EU investments Participation by broad involvement of public and private research institutions, scientists, industry and interested private sector organizations
- Openness and transparency
- Knowledge transfer
- Polycentric development

Targets, sub targets, four lines of action and a multitude of tasks and measures were defined, ranging from overall goals to very small, fragmented and limited tasks. The strategy 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 increase technology transfer between academics and entrepreneurs, to support commercial entities' investments in innovation, and to encourage high value-added product development. Based on five general priorities, the six "Priority Directions in Science for 2014-2017" had been defined[3]:

1. Environment, climate and energy.

2. Innovative and advanced materials, smart technologies.

3. Public health.

4. Research on and sustainable use of local resources.

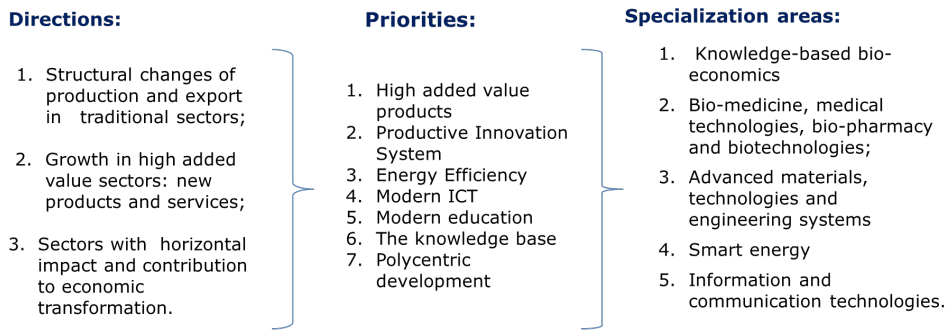
5. Sustainable development of the state and the public.

6. Letonica

Finally, the Smart Specialisation Strategy (RIS3) sets the following Directions, Priorities and Specialisation areas (Figure 11).

[3] These Priority Directions will be redefined shortly.

Figure 11 Smart Specialisation Strategy



Source: Ministry of Education and Science

Latvia's RIS3 pursues a 'hybrid strategy' as it emphasises both general investments in the knowledge base and specific research activities in the five areas of smart specialisation. It builds upon existing capabilities and seeks to expand these into the domains of traditional industries. It emphasises the role of universities as "knowledge hubs" to provide modern education and knowledge base for the economy.

EU Structural Funds have been allocated to strengthen the research infrastructure and human resources for public research, attract foreign academic staff to Latvian HEIs and promote innovation grants for students (especially in STEM fields). The Initiative for Research-oriented Education (2015-25) ensures that universities receive funding for employing graduates at Masters or PhD level as researchers, including the development of joint degree PhD programmes and post-doctoral research laboratory networks. The National-level infrastructure development initiative, launched in 2016, identifies research infrastructure of national importance to be publicly funded.

The Guidelines on National Industrial Policy for 2014-20 identify innovation as a key pillar for improving competitiveness, productivity and exports. Initiatives include support for co-operation between industry and academia and commercialisation of research results, new product and technology development and the expansion of innovative and technology-oriented companies as well as new financial instruments (e.g. seed and venture capital) for innovative companies. Several other initiatives aim to improve Latvian industry´s ability to innovate (eg the Micro-loan support for start-ups, several incubators, the innovation voucher programme, the tax incentive scheme and the introduction of a new procurement procedure called Innovation Partnership).

Policy measures and recent reforms

- **Structural reform of research sector 2014 – 2015:** The concentration of research resources in internationally competitive

Research Institutes and Universities as Knowledge Hubs was an important step towards a competitive R&D and higher education system. According to the RIS3 strategy, the number of Research Institutes will be reduced to 20 by 2020. This reduction is planned to be accompanied with an increasing number of researchers per unit as well as the establishment of new cooperations between research and industry.

- **Reform of higher education and research public funding system 2014 – 2015:** By the end of 2015 Latvia had adopted a '3 pillar' model, that accounted for basic funding, performance oriented funding and innovation funding tied to the universities 3rd mission (see section 4.1). As in the case of the structural reform of the research sector, the reform is still in the making. Further policy developments are needed in order to integrate higher education and research better and align them with the needs of the economy.

Two more reforms are currently in the implementation phase.

- The modernisation of infrastructure, strengthening of institutional capacity and development of institutional strategies.
- The introduction of specific mechanisms that change the behaviour of research institutes and industry organisations

All the strategy papers are well designed and address important issues and challenges. Nevertheless, the number of strategies and the large number of tasks and measures involved runs a risk of losing track of the central theme. Some of the papers, especially the Guidelines for Science, Technology Development and Innovation (2014-20), the National Development Plan and the Smart Specialisation Strategy, harmonise which each other. Indeed, the Guidelines are a part of Latvia's Smart Specialisation Strategy and therefore contribute to the achievement of the goals set out in the country's long-term and medium-term policy planning documents, such as the National Development Plan. Others are written with different emphases and Leitmotifs. The Guidelines for National Industrial Policy focus on the restructuring of production and export in traditional fields of the economy and the support of future areas of growth.

The resulting measures address a research and innovation system with very limited availability of state funding and a fragmented institutional structure, leading to a complex division of labour (funding, evaluation, reporting) with many overlaps. Underfunded measures often strain the absorptive capacity of the potential beneficiaries. Both firms and researchers appear to have limited knowledge about the details of the different instruments, and are not able to see how the schemes would influence their performance.

This leads to the conclusion that the main problems of current R&I strategy and policy relate to a failure to prioritise research in national policy, a lack of sufficiently large and stable research funding programmes and insufficient capacity to communicate and run the programmes as well as to

absorb or use their results. Additional effort is needed on communication, coordination and capacity building.

3. GOVERNANCE

In this section we discuss some general models of research and innovation system governance and discuss the Latvian system against this background. We conclude with recommendations and propose two governance scenarios. A second proposal addresses the improvement of the peer review system.

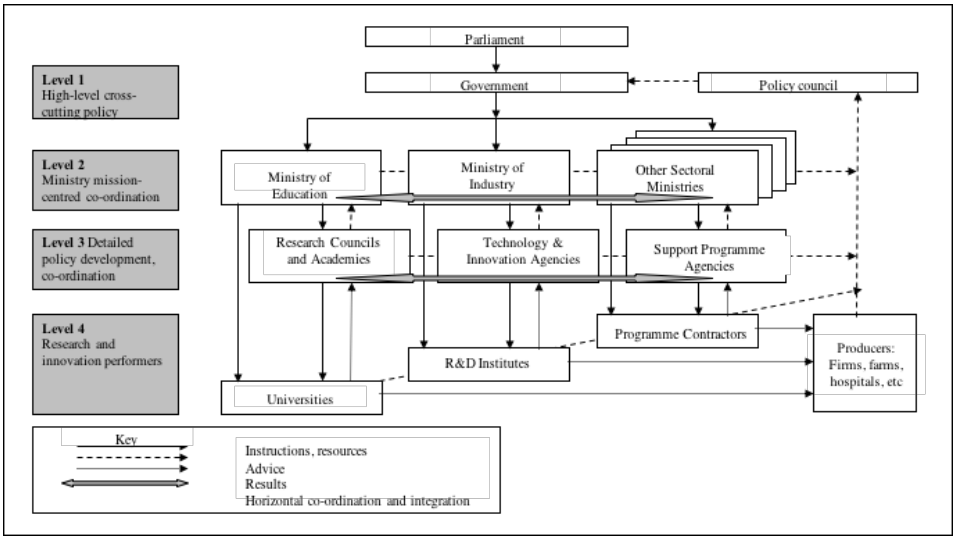
3.1. Research and innovation system governance

Research and innovation funding are key parts of the overall system of research and innovation governance. That overall system has to span all the significant state actors involved in research and innovation so that it is possible to understand the national innovation system as a whole and make policy for it. Figure 13 describes in generic terms the kind of governance model used in many countries. In order to make balanced and coherent policy, there has to be coordination across the organisations involved. Many countries have some sort of high-level council that advises the government on overall policy (Schwaag-Serger, Wise, & Arnold, 2015). In some cases, government ministers are members, together with other stakeholders. To some degree this also takes place by peer-to-peer contact at levels 2 and 3. Some countries have specific coordination committees at one or both of these levels, but these are typically less effective that government-level coordination.

A strength of the type of governance shown in Figure 12 is that – via the ministries – the interests of all sectors of society can be involved. In most cases, the education and industry ministries devote the most resources to research and innovation. The responsibilities of the other ministries for research and innovation vary from country to country. In the USA, Departments of State responsible for 'missions' such as energy, defence and transport spend massively on research and innovation. At the other end of the spectrum (including Latvia), the other ministries have few resources and little practical power to use the research and innovation system to solve their problems. Norway and Sweden have an explicit 'sector principle': that is, that each ministry is responsible for securing the research and research capacity needs of its own sector of society. In the last 20 years, Norwegian governments have required each ministry to develop and explicit research strategy, in the belief that it is better for those who understand the sectors to define strategy than to centralise strategic responsibility in a science ministry that necessarily lacks this kind of intimate understanding. (In practice, many countries implicitly employ the sector principle. The strength of the Norwegian example is that it is **explicit**). Norway has also established a single organisation (the Research Council of Norway, RCN) to act as a research and innovation funder. Each ministry (except defence) uses RCN as its funding agency, so needs are

articulated close to the relevant sector of society while Programming and funding can be done through common, co-ordinated funding instruments, reaping scale and coordination benefits.

Figure 12 Generic research and innovation governance model



Source: (Arnold, Bell, Bessant, & Brimble, 2000)

The use of funding agencies

It has become increasingly normal in recent decades for ministries to use agencies to implement policy. Some of the major reasons for this are

- It creates a division of labour, where the agency can focus on implementation and the ministry on policy
- It enables the agency to professionalise, to build scale, specialist skills and capabilities, generally employing people with skills different to those of traditional civil servants
- It creates a separation between the political and policymaking level on the one hand and implementation, reducing the opportunities for the political level to interfere in individual funding allocation decisions and to over-ride the rule-based manner in which they are made. The degree of separation varies. For example, in some cases Austrian ministries approve (but do not propose) individual funding decisions while others are delegated. Sweden is at the other end of the spectrum. There, it is formally illegal for a minister to tell an agency to fund or not to fund a particular project

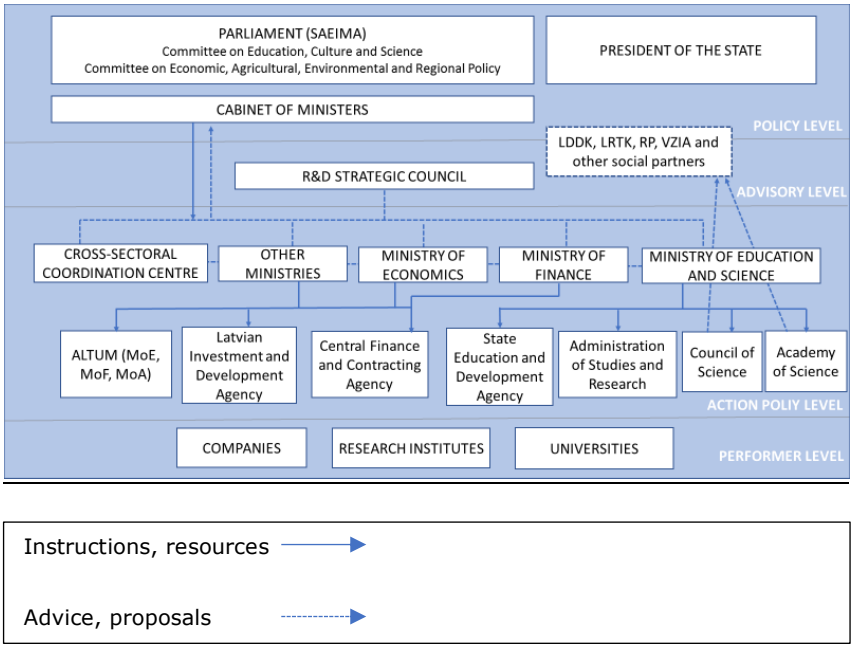
In a small number of cases, funding agencies have more than one principal. RCN is the most extreme example, currently meeting the implementation needs of fifteen ministries. FFG in Austria answers to two ministries but

also manages funding schemes for other national and international bodies. RANNIS in Iceland answers to two ministries. A strength of such multi-principal agencies is that they can build greater skills and scale in areas such as peer review, Programming, funding administration and project monitoring than would be available to an agency with only a single principal. They may be especially useful in small countries, where fragmenting such skills militates against quality and can lead some organisations to be under-critical in key skill areas. Latvia already has such an agency in the form of Altum, whose principles are MoE, MoF and the Ministry of Agriculture.

3.2. Latvia´s system of governance

The Latvian research and innovation funding system involves fewer ministries and fewer funding instruments but more agencies than is typically the case in West European systems. It also involves the Ministry of Finance (MoF) and its Central Finance and Contracting Agency (CFCA) in a manner that is unusual elsewhere, also among countries that like Latvia make heavy use of structural funds in research and innovation policy. The line ministries do not have a responsibility for research relevant to their sector of society or to have their own research strategies and tend to procure only extremely small research projects to support policy needs. As a result, there is little research culture embedded in much of the government apparatus. The following Figure shows the structure of Latvia's system of governance for research and innovation.

Figure 13 Governance of the Latvian R&I system



Main actors involved: ministries and agencies

The R&I Strategic Council was set up in 2014. It is chaired by the prime minister and contains a number of other ministers as well as representatives of a wide range of research and innovation stakeholders. Its function is to advise the government on priorities. While it was very effective at the start of the current Structural Funds planning period it has since not been so active. It has little analytic capacity of its own and only experiences a political drive to be active at times then there are large amounts of budget to be allocated.

The Cross-Sectoral Coordination Centre in the State Chancellery prepared the National Development Plan 2014-20 and is charged with ensuring alignment among national and EU funding lines in order to support the implementation of that plan. It also functions as a secretariat for the R&I Strategic Council and undertakes some background research and consultations to that end. In principle, it therefore plays a large role in policy coordination. However, its practical influence seems to be limited except at times of budget allocation.

The **Latvian Academy of Sciences** no longer plays a formal role in system governance, although it can be called on for scientific advice by the government. In its current form, it was established in 1991/2. Unlike its Soviet-era predecessor, it has no institutes. It is funded by MoES. Its tasks are to promote excellent science, provide science policy advice to government, host the LCS, maintain the terminology commission for the Latvian language, provide small grants to excellent senior scientists and publish two volumes of proceedings (scientific journals), one of which is in English and is indexed while the other is in Latvian and is not. The Academy supervises two of the 14 sub-programmes of the state research programme. It has 100 full, 100 corresponding and 100 foreign members, as well as a number of honorary members. The office is staffed by a secretary general (25%) and three full-time secretaries, two of whom handle international cooperation. The Academy's degree of influence over policy is in practice unclear. Its ability to influence public opinion is equally so. It appears not effectively to undertake the role of promoting and communicating science in that way that some other academies (such as the Royal Society in the UK or KNAW in The Netherlands) do.

MoES articulates policy for higher education and research, interacts and negotiates with the research performing institutions in the course of providing institutional and performance-based funding and planning the development of research infrastructure. The ministry also developed and oversees the national RIS3 smart specialisation strategy and a number of structural funds programmes. It coordinates research needs among the spending ministries and manages the state research programmes intended to meet these.

The MoES has two agencies: **The State Education and Development Agency (SEDA)**, which corresponds to the higher education funding agencies seen elsewhere; and the **Studies and Research Administration (SRA)**, whose main task is student loan administration, but which also has a department of four people to administer and monitor research funding using national funds. The MoES designs and oversees national funding programmes. It manages institutional funding of research in-house. For competitive, project-based programmes, it uses LCS and (in the case of the post-doc programme) SEDA to manage peer review of proposals while either SEDA or SRA undertakes financial monitoring. It services a Monitoring Committee, which monitors the scientific progress of the projects. SRA also provides administrative support to the Latvian Council of Science (LCS).

The Latvian Council of Science (LCS) is in effect a research council, comprising five expert commissions elected by the research community from fourteen research performing institutions in Latvia. Five of the council members are appointed by the Academy of Science, and the chair has to be elected from among these. Most other members are also members of the Academy. LCS has almost no staff of its own, hence the need for administrative support from SRA. It is responsible for peer review and selection of research proposals in the bottom-up fundamental and applied research programme and in the thematic state research programme. In the basic and applied research programme, funding has been allocated to different disciplines based on simple bibliometric indicators. In future, money will be allocated based on demand, pro rata the number of above-threshold grant applications received per field. LCS maintains its own database of peers. Since 2013, these have been exclusively international. All peer review is done remotely, normally by two peers. In cases of disagreement, a third peer is appointed. In the basic and applied programme, LCS' five commissions are presented with lists of proposals ranked on the average scores given by the peer reviewers and validates these. In the state research programme, an international panel makes the final funding decisions, based on the peer reviewers' average scores.

The LCS is attached to the **Academy of Sciences**, which currently serves mainly as a discussion and lobbying platform for the research community. The Council does proposal assessment and project selection work for the MoES and also plays a role in homologating new PhD courses. Neither the Academy nor the Council retains its earlier significant role as policy advisor to the government.

MoE is responsible for developing policies related to business support and innovation.

MoE has two agencies: The **Investment and Development Agency of Latvia (LIAA)**, which promotes foreign direct investment and business development in indigenous industry; and **Altum**, which provides loans (Altum is co-owned by MoE with MoF and the Ministry of Agriculture.) LIAA

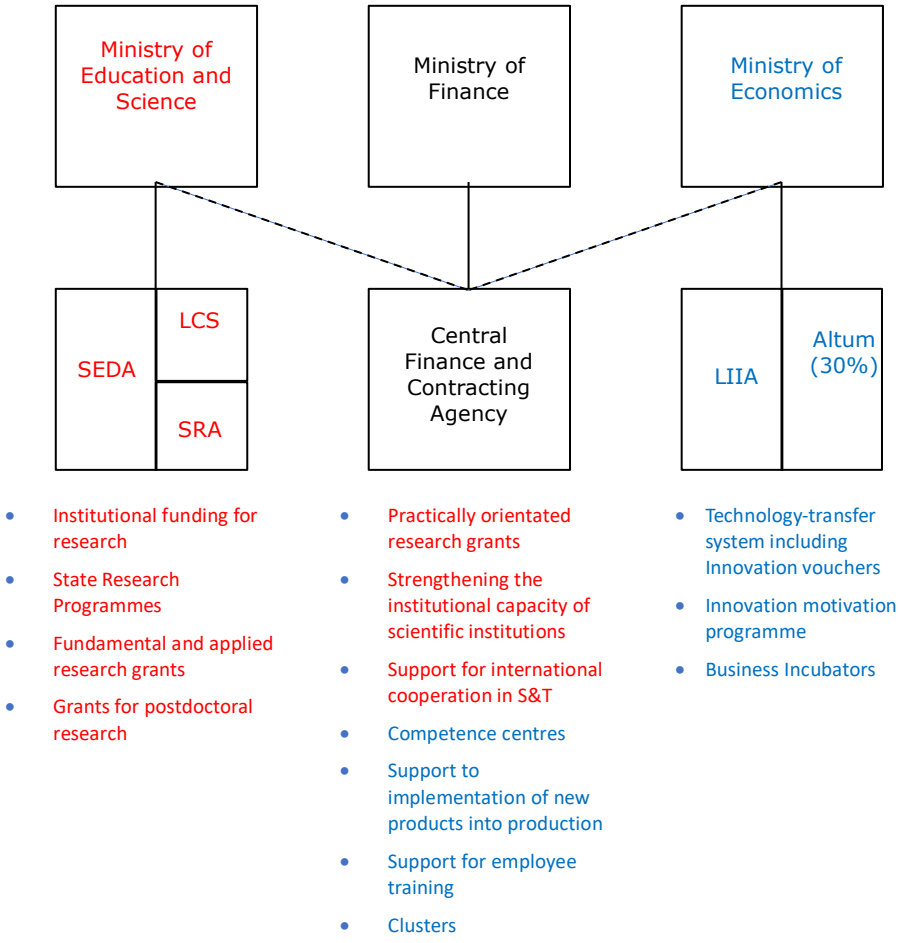
implements and manages several innovation programmes financed by structural funds as Technology Transfer, Motivation programme, and Business incubators programme. These programmes are administered by CFCA, which is responsible for the administration of all structural funds programmes and selected LIAA as programme manager within a limited tender. Furthermore, LIAA distributes funding and provides a point of entry for firms participating in these programmes (see 5.2)

Unlike in many countries, the **other ministries** largely do not fund research. Instead, the Ministry of Education and Science (MoES) consults the other ministries about their research needs and then designs the state research programmes on their behalf. As a result, not all the other ministries feel that their research needs are fully met. The level of funding available to satisfy the ministries' research needs is also, in total, woefully inadequate. An exception is the Ministry of Agriculture which maintains two research institutes and a university. It also manages two programmes of the European Agricultural Fund for Rural development that support science-industry links and knowledge exchange in agriculture and forestry.

The key development at the level of the agencies is the strengthening of the role of the **CFCA** since 2014. This effectively takes the implementation of structural funds programmes out of the hands of the ministries and agencies operating in the respective policy area, leaving them only with implementation responsibility for nationally-funded programmes. In a number of cases, this means that CFCA selects projects to be funded and has therefore had to build up capabilities which duplicate those already existing in LCS, MoES and its agencies and which are used for nationally-funded programmes. It also means that the implementation agency CFCA is not responsible to the ministry responsible for policy but to the Finance Ministry.

Figure 14 shows the organisations involved as well as key programmes. The programmes of each ministry are colour-coded and are arranged vertically below the ministry responsible for implementation. The number of ERDF-funded programmes is increasing and CFCA's role in research and innovation funding is expanding considerably. A more normal arrangement would be for those who implement programmes to be in the sphere of the ministry that controls the relevant policy domain, or at least for them to be agents of that ministry. That maintains integrity of policymaking and implementation and allows each ministry to build both administrative capacity and strategic intelligence in its own sphere.

Figure 14 Structure of the research and innovation funding system



The structure shown in Figure 14 militates against capacity building, organisational learning and high quality in funding processes because it imposes fragmentation on an already very small system. The CFCA exists in order to ensure that structural funds are correctly administered and has to build competences in research and innovation programme implementation. It selects and administers projects. It monitors projects quarterly in financial and scientific terms but does not appear to have the kind of domain understanding needed to manage and develop programme or to offer the kind of support to project leaders elsewhere seen in research councils and (especially) innovation agencies. It has a say in who implements programmes that rely on Structural Funds. CFCA uses peer review in the selection of research and innovation projects. The peers who were involved in the selection of successful projects are asked to conduct mid-term and final project evaluations. The mid-term evaluations can result

in a requirement that the project be modified or terminated. However, the final evaluations do not appear to have consequences.

Peer review is done in the LCS, SEDA and the CFCA. None of these organisations alone has sufficient critical mass to manage a good network of peers. The latter two organisations select experts from the European Commission's database of experts for Horizon 2020. All appear to lack sufficient capacity to make good choices of experts or to manage peer review processes. The LCS maintains permanent panels of national peers and its own database of international peers, who are used for assessing proposals for the panels. The continuing role of nationals is problematic in a small country such as Latvia.

The governance system therefore suffers from a number of problems.

- Low social and political commitment to the idea that research and innovation drive economic development mean that these have limited priority in government policy and hence receive little budget or attention. There is still insufficient public awareness as well as recognition in political and policymaking circles concerning the importance of research and its central role for innovation, economic development and solving societal challenges. The communication plan, foreseen by the "Science, Technology and Innovation Development Guidelines" never was put in place. Even commitments laid down in its own legislation are not always delivered by government
    - Commitment to research and innovation at the political level increases when there are opportunities to allocate structural funds but is then not sustained
    - Something of a parallel system has developed for planning and spending structural funds that lives alongside the national system. This leads to institutional fragmentation, undermining the effects of the funding that is available. It also means that nationally-funded programmes tend to be sub-scale, while structural funds backed programmes can be more substantial but temporary
    - A further consequence of the parallelism in the system is that the Ministry of Finance has taken on some of the operative responsibilities of spending ministries, undermining the spending ministries' capabilities and trying to assume responsibilities that go beyond its own sphere of expertise
    - The lack of research budget in most of the spending ministries undermines their ability to make policy as well as their opportunities to contribute to both the planning and implementation of a holistic national research and innovation policy. It correspondingly forces the MoES to take on a proxy customer role for the other ministries in planning the state

research programmes, reducing the likelihood that the research done is the research that is actually needed

- The lack of coordination mechanisms across the ministries means that national strategies and plans have a top-down character. This is compounded by the fact that such strategies tend to be overly detailed rather than leaving strategy deployment to ministries and agencies closer to the objects of policy

- One more problem lies in the capacity of ministries and agencies. There are too few people to run these massive reforms and even fewer people who are educated or trained properly.

At the level of research-performing institutions, governance remains out-dated. Compared to more modernised systems, the collegiate body has too much power, hampering institutions' ability to act strategically.

3.3. Recommendations

The central conclusion we draw is, that **the structure and governance of state organisations should be streamlined to meet national needs.** This can be broken down to a more specific level with the following recommendations:

- Most of the ministry staff interviewed agreed that more regular meetings could be an opportunity to promote closer cooperation between the ministries, especially between the Ministry of Education and Science and the Ministry of Economics. Some countries have built such platforms at the level of ministers (Finland, Norway, Ireland), at the level of ministries (Norway) and at the level of agencies (Sweden, Norway, Ireland). Experience is that minister-level platforms such as the Finnish Research and Innovation Council are the most effective at setting policy directions. Platforms at ministry level are more consultative, enabling coordination in the implementation of policy. Agency-level platforms focus on exchange of information and experience. **The Latvian authorities should seek to build platforms for routine cooperation among the ministries on research and innovation, starting at the level of ministers**.

- There should be a clear separation between the policymaking function of the ministries and the implementation tasks of the agencies. The Ministry of Education and Science as well as the Ministry of Economics as main players in research and innovation policy should act as owners of the agencies (or the unified agency). Furthermore, other ministries such as the Ministry of Health, the Ministry of Agriculture or the Ministry of Transport should develop their own research strategies with a view – in the longer term – to funding their own research.

- All spending ministries should be making policy based on knowledge and should therefore be empowered to ensure that they can obtain the knowledge needed as well as to contribute to national research and

innovation policy. **A first step would be to require the ministries to develop research strategies and to provide with their own research budgets or failing that to increase the size of the state research programmes to the point where they are large enough to meet policy needs and reinforce the consultation and coordination process through which the MoES currently programmes them.**

- Research and innovation funding is fragmented across multiple organisations, in part as a consequence of the way structural funds are administered. This undermines the development of critical mass, organisational learning and quality improvement in the process of devising and implementing research and innovation policy. A particular problem is the fragmentation of peer review across the funding system, which undermines its quality and consistency. One more problem lies in the capacity of ministries and agencies. There are too few people to run these massive reforms and even fewer people who are educated or trained properly. Building up the capacity of involved parties needs an agreement with the Ministry of Finance that the administration of research programmes can be covered from the funds of the programme (which is common international practice). Furthermore, staff should be offered training and retraining on topics including research policy, evaluation and governance.
    - **Latvia should reduce the number of organisations involved in research and innovation funding and to allow a smaller number to develop capacities that at present are lacking or in small supply**
    - **Operationally, there is a need to stop separating nationally resourced and structural funds-based policies and instruments**
    - **Agencies need to be able to tackle their tasks in an holistic way and to build capacity, otherwise they will be inefficient and ineffective. Thus, tasks should not be fragmented across two or more agencies**
    - **Given Latvia's small size, peer review should be centralised into a single competent organisation that can provide a peer review service to others as necessary**
- Peer review is currently fragmented within the small Latvian funding system. **Peer review should be centralised in order to build scale and capacity, building on the competence of the LCS.**
- LIAA's decision to set up an internal group to act as an 'innovation agency' is a good one, bringing specialist skills to innovation and creating a small team of people able to focus on the subject. Its range of instruments and its scale are both too small. There is also a need for an agency to be given a role in supporting applied research that links the research ad business sectors in the style of Vinnova and Tekes. **Latvia needs a stronger and more integrated innovation agency.**

We argue in the next section that there is value in combining this function with research funding – especially if Latvia decides to take up the important challenge of funding research as well as innovation activities relevant to industry.

- The Academy of Science plays a limited and partly unclear role in the institutional system. **The Latvian authorities should consider the role and function of the Latvian Academy of Science and support their efforts to turn into a learned society.** The symbiosis between the LCS and the Academy seems unhealthy. LCS needs at once to be responsive to policy priorities and to make use of best international peer review and panel practice to assure the quality of the research it selects. **The Academy should no longer have the right to determine the governance of the LCS. Rather, the head of the LCS should be appointed by an appropriately staffed board and should in turn recruit panel members and peers from the research community.**
- A specific bugbear associated with Structural Funds is the use of inappropriately demanding procedures for procurement, even in the case of small expenditures. There is a need to simplify or clarify procurement **procedures so that small purchases are not subject to the same stringent rules and documentation requirements as large pieces of infrastructure**.

3.4. Proposal 1: A revised institutional and governance structure

Our analysis suggests that the problems of the Latvian research and innovation system stem both from a lack of resources and a number of governance failures. Here, we propose two governance scenarios for discussion.

- A unitary implementation agency
- A 'two-pillar' structure

This scenario does not involve institutional restructuring but should involve some reallocation of tasks among institutions.

1. A unitary implementation agency

In small systems like Latvia, it can be difficult to reap economies of scale in funding (including learning as well as economic benefits) but economies of scope can become important. A single implementation agency that executes both research and innovation policy and therefore shares aspects of administration is therefore attractive. This would combine the advantages of the administrative centralisation achieved by CFCA with the domain and policy knowledge of the responsible ministries. It would have MoES and MoE as its principals. It should be led by a PhD-holder with both academic research experience and understanding of innovation in business

as well as having demonstrated their ability to run an organisation of equivalent size. This person should be a good communicator, politically independent and be able to demonstrate that they will not have any conflict of interest in overseeing state funding decisions. In the long term, when the structural funds fade away, it would automatically put the needed research and innovation implementation capacity in the right place.

In the medium term, as the research policy responsibilities of the other spending ministries grow, it would also be possible for them to delegate implementation to the agency. A unitary implementation agency is well positioned not only to implement programmes that sit wholly within individual principals' area of expertise but also the hybrid programmes that are becoming increasingly normal as policymakers take a more systemic approach to research and innovation policy (as with the competence centres, which are research/innovation policy hybrids) and as cross-cutting issues such as climate change and the other societal challenges need to involve multiple sectors and a mix of research and innovation activity.

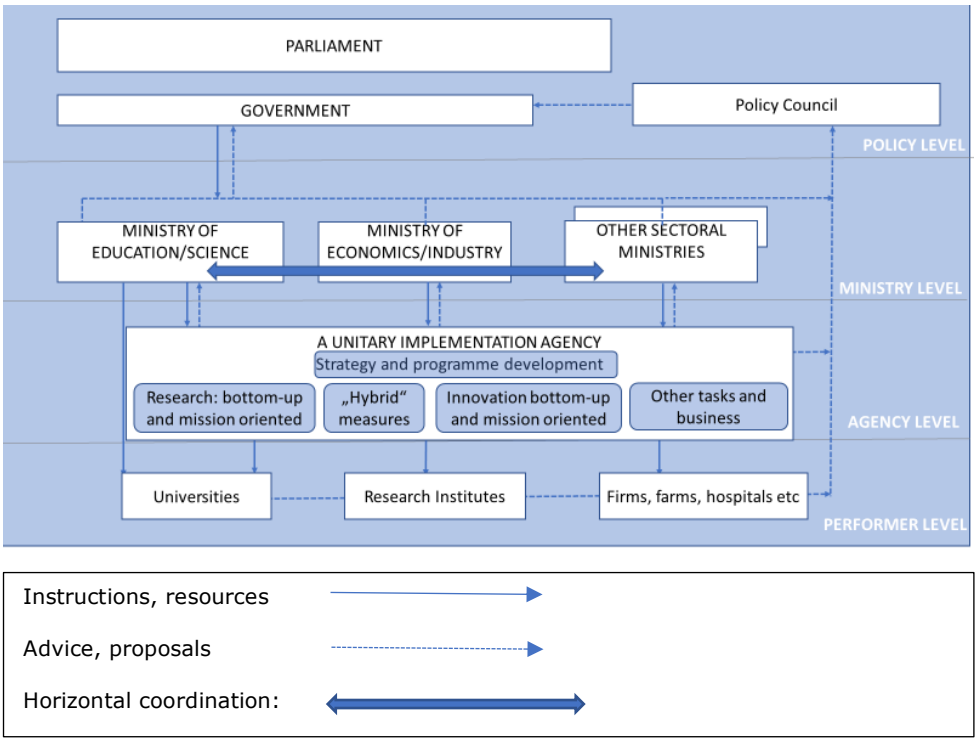
In the first instance, MoES and MoE would establish a joint research and innovation implementation agency, using parts of existing organisations and complementing these with additional skills as necessary. The parts of the CFCA that deal with research and innovation programmes would be integrated into the new agency, though it could be expedient still to use CFCA 'back office' functions in order to continue to benefit from economies of scale.

As long as the unitary agency is solely concerned with implementation while programme design remains with the ministries, its management should be directly appointed by MoES and MoE. In the longer term, the ministries may want to delegate programme design to the agency, leaving the ministries free to focus on policy rather than being involved in operations. In that case, a governing body comprising relevant stakeholders should be created and the ability of the agency to collect and analyse strategic intelligence should be strengthened.

The internal organisation of the agency should be driven by its tasks. It will need a research funding function able to handle peer review as well as programme administration. LCS should therefore be integrated into the agency and should form the core of its research division. It will also need a group with innovation funding skills, which it can acquire by absorbing LIAA's internal 'innovation agency'. Care should be taken to focus on innovation and technology and not to absorb aspects of LIAA's work that rely mostly on business and FDI skills. It will need mechanisms for exploiting the combination of research and innovation skills across programmes that address both, such as the competence centres.

The following picture shows a possible structure of a research and innovation governance model with a unitary agency:

Figure 15 A unitary implementation agency



This proposal has the advantage that it collects implementation work in one place while maintaining the connection between the domain expertise of the ministries and the work of implementation. This means not only that the implementation is likely to be better but also that strategic intelligence about the use of the instrument in practice and the needs of beneficiaries can more easily be connected to policymaking. The agency provides a unique arena in which hybrid and cross-cutting programmes can be devised and implemented, providing opportunities for policy coordination. It reintegrated structural funds programmes with nationally-funded ones. And it takes a form that allows additional principals to be added over time, further supporting the design and implementation of a balanced research and innovation policy.

In order to make best use of the experience of other research and innovation funders, the agency should join the TAFTIE network of European innovation agencies and Science Europe, which networks research funders.

2. A 'two-pillar' structure

The "two-pillar" structure offers an alternative to a unitary implementation agency. It is strongly associated with Finland but is widely used elsewhere. In these systems, the education/research and industry/economics ministries and their agencies take primary responsibility respectively for research and innovation policy. While they are seen as the two pillars, the

other ministries also play important roles in research and innovation policy, primarily in areas relevant to the 'sector' of society for which they have responsibility. The extent to which this sector responsibility is made explicit and to which it covers more fundamental research in addition to short-term, policy-relevant research varies.

This scenario involves 'mainstreaming' the structural funds administration into the national ministers and their agencies and adopting the structure that Latvia most likely would have used in the absence of Structural Funds.

- The CFCA would be relieved of its responsibilities in connection with the use of Structural Funds for research and innovation funding, which would revert to MoES and MoE and their agencies, reducing the systemic fragmentation and empowering these ministries fully to develop and perform their intended roles
- As in the case of a unitary implementation strategy, Latvia would more explicitly adopt a sector principle, in which other spending ministries are required to develop explicit plans for acquiring the knowledge they ned to make good policy.

The research agency should be led by a PhD-holder with academic research experience as well as having demonstrated their ability to run an organisation of equivalent size. The innovation agency should be led by a PhD-holder with experience of industrial innovation and links to academia. Both should be good communicators, politically independent and able to demonstrate that they will not have any conflict of interest in overseeing state funding decisions.

The following picture shows a possible structure of a research and innovation governance model with a 'two-pillar' structure:

Figure 16 A ´two-pillar´ structure

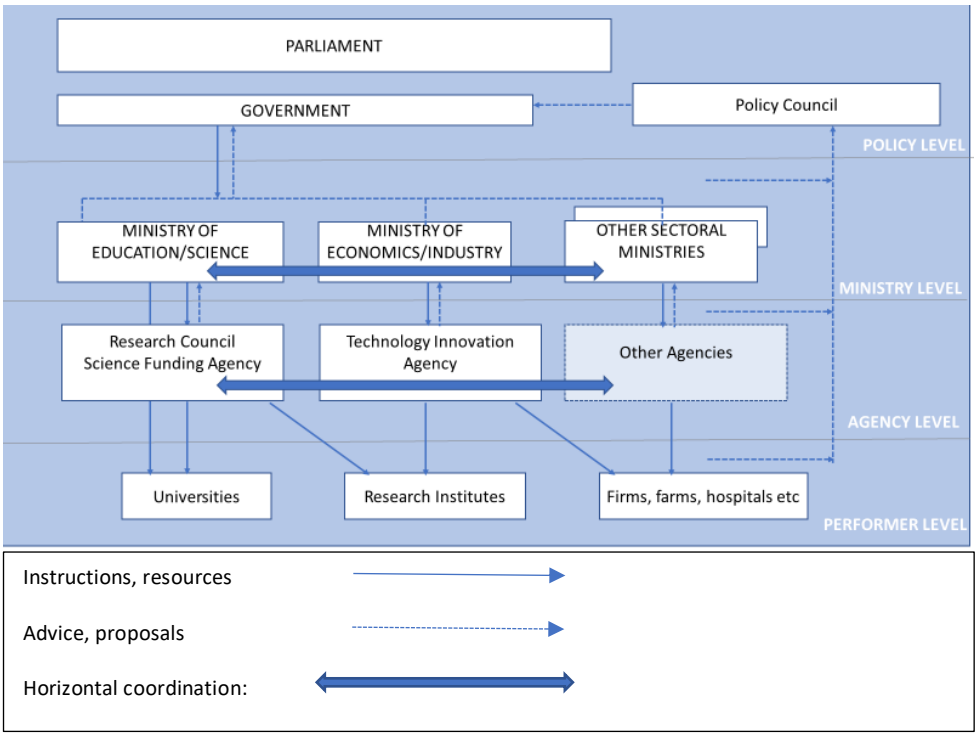


Table 1 shows the existing division of tasks among organisations that fund research and innovation.

Table 2 shows the division of tasks under the two proposed reforms described above.

Table 1 Existing tasks in research and innovation funding

Organisation	Programming	Research Project Selection	Innovation Project Selection	Monitoring and funding administration
MoES	√	√		√
MoE	√			
MoF	√			
LCS		√		
SEDA		√		√

SRA		√		√
LIIA			√	
CFCA		√	√	√

Table 2 Proposed tasks in research and innovation funding

Organisation	Programming	Research Project Selection	Innovation Project Selection	Monitoring and funding administration
MoES	√			
MoE	√			
MoF	√			
Proposal 1				
Unitary implementation agency		√	√	√
Proposal 2				
Research agency		√		√
Innovation agency			√	√

3.5. Proposal 2: An improved peer review system

Excellence in research depends largely on the quality of the procedures used to assess and select the proposals for funding. Research councils and funding organisations face the challenge of establishing stable, transparent and fair assessment systems which meet international standards.

Peer review is perceived as the gold standard for assessing academic achievements, scholarly publishing and communication. It gives rigour and legitimacy to new ideas, improves the trustworthiness and clarity of academic work and determines whether research can be viewed as scientifically valid.

The use of international peers is quite a new phenomenon in Latvia. Nevertheless, during recent years both the agencies and the Ministry made a considerable effort to implement international peer review routines.

- The CFCA selects international peers from the European Commission's database of experts for Horizon 2020 by using bibliometric indicators (mainly h-indices according to Scopus; different disciplines are treated differently). The team of experts in charge of the selection of the peer reviewers as CFCA´s stuff must be experienced researchers and satisfy additional requirements for project management and communication skills
- The LCS has made some use of international peers since 2009. During the 2014-2020 funding period, LCS introduced international peer review based evaluations for the most the funding schemes in the Council´s responsibility
- Further, the MoES has decided mainly to use international experts in the proposal assessment for most of the activities of the research programmes financed by structural and state budgets funds. In addition, for the evaluation of the research quality of the projects submitted within the framework of the structural funds activities, it is planned to apply the assessment principles and criteria of the "Horizon 2020" programme's practical research projects. Currently, 8 out of 14 research support programmes have already been either provided with international expertise or it has been planned to provide it. It has also been planned to use international expertise in evaluating state research programmes and fundamental and applied research projects

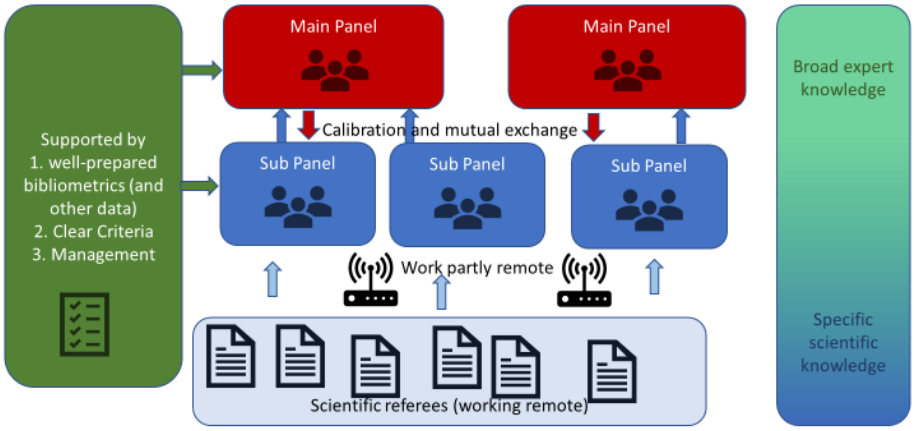
These existing pieces should be put together and centralised into a single competent organisation that can provide a peer review service to others as necessary.

Following international practice, which has been well described by the ESF (2011), some elements can be identified as necessary ingredients for a professional international peer review system.

- To establish and maintain confidence in the system, the core principles of excellence, transparency, integrity and impartiality must be defined and strictly applied. This includes clear rules about how to deal with conflicts of interests (both real and perceived ones)
- Different and discipline-specific search strategies should be followed when recruiting appropriate peers: Traditional techniques like discipline matching and key word matching can be supplemented by the use of information systems and tools (eg Elsevier Reviewer Finder and Expert Lookup or ScholarOne and Reviewer Locator from Thomson Reuters or disciplinary tools like Peer2Ref). European databases like H2020 or ERC can serve as an additional useful source of further information, though it should be noted that the H2020 database relies on people to enter their own data and is not quality-assured. To assure quality, funding institutions should carefully evaluate the qualification of the experts
- Assessment results from remote international peers have to be combined with and calibrated by panel evaluations. Bibliometric indicators ("informed peer review") can make peer review more transparent and may offer additional insight especially in cases of divergence among panel members´ opinions. Both high quality of the bibliometric indicators and transparency in the use by peers or panels are important in this context
- The composition of different panels as well as their appropriate staffing seems to be one of the biggest challenges in the design of peer review based research assessment approaches. In order to ensure consistency some kind of calibration between different disciplines, interest groups and different panels is needed, and social dynamics should not be ignored
- Sufficient and sufficiently-qualified internal personnel with both a scholarly and a management background are needed for the proper implementation and application of these routines

The following picture shows a possible architecture for evaluation panels.

Figure 17 Panel architecture



Costs are one of the most important issues when it comes to the decision of implementing an international peer review system. Internal and direct cost estimates for the applicants as well as for the funding organisations are high, and if the opportunity costs of refereeing and panel membership are included into the estimation, the total costs increase dramatically. Therefore, the use of international peers and panels should be done with a sense of proportion. In the context of small subsidies which are difficult to assess by international peers (e.g. Innovation grants for students), the funding decisions could be make internally. For medium-sized grants (e.g. Fundamental and applied research grants) it should be sufficient to work with one single panel or few main panels in combination with written international reviews and to relinquish sub-panels.

As a traditional evaluation tool, peer review plays an important role in scholarly research and communication and is used by Research Councils as a central mechanism to allocate research funding. Today, peer review is widely used in nearly all research assessment exercises such as programme evaluations, field studies, national and institutional investigations.

With a few modifications concerning the criteria, the selection of the referees and the staffing of the panels, such assessment models can also be applied to innovation funding programmes.

4. PERFORMERS

In this Section, we discuss the higher education and research institutions, industrial innovation and research-industry links. We draw conclusions and make general recommendations, based on the foregoing material. Finally, we raise a question about whether there are adequate 'boundary organisations' to promote the creation of absorptive capacity and exploitation of knowledge in industry.

4.1. Higher education and the research institutes

Higher Education Structure

Latvia has a complex and extended higher education system: public and private, university (meaning research oriented) and non-university. Currently according to the Study in Latvia web site (2017)[1] there are 6 universities (all of them public), 10 public and 10 private higher education institutions. In addition, there are schools offering post-secondary vocational education. The non-university sector is highly specialised in specific fields (music, sport, business, etc.) and only few have a more comprehensive scope. The two main universities - the University of Latvia (UL) and Riga Technical University (RTU) – account for more than 40% of the researchers and academic staff working within the higher education sector. This large number of institutions (in relation to the size of the country) has consequences. On the one hand, there is a positive consequence, the territorial distribution of HEIs spread throughout the country makes access to higher education easier and affordable for a large share of the population: the proportion of people in the age group 30-34 who have a higher education degree is high (42.8% in 2016), above the Europe 2020 target of 40% (Eurostat, 2017). On the other hand, a negative consequence is a considerable fragmentation of higher education institutions and consequently of university-based research. This militates against the formation of critical mass, despite recent reductions in the number of research-performing institutions.

Universities have a reasonable level of autonomy and have a collegial form of governance. The Senate, elected by staff and students, is the governing body. Rectors are acting on behalf of the senate to implement its decisions and strategy. Lower-level units such as faculties have similar collegial structures.

Nevertheless, governance of HEIs seems to be a weakness both in terms of leadership and distribution of power. This traditional collegial model is not the most efficient for a modern and dynamic system of higher education (World Bank, 2014, 2016). Most European governments pursue policies that reduce the amount of direct influence they exert over higher education

[1] http://www.studyinlatvia.eu/en/studies/universities

institutions in favour of less direct approaches that focus on setting objectives and providing incentives but leaving the institutions themselves with the task of deciding how to react to these. This means that universities need to be autonomous, albeit embedded in systems of accountability, and capable of acting strategically as integrated entities. Most European higher education systems are therefore moving to more entrepreneurial models of governance. Hence the involvement of external stakeholders in universities' decision-making bodies should be increased, universities are being required to establish governing bodies with a majority of external representatives that are responsible for appointing rectors and handling key budgeting and strategic functions. These can be observed in many European countries but are particularly pronounced in some. This shift has been strongly promoted by actors on the supranational level, among them the European Commission as part of its Modernisation Agenda (European Commission, 2006) (European Commission, 2011) and the European University Association (Estermann & Nokkala, 2009).

An autonomous system requires strong accountability. This is still work in progress in Latvia. The national accreditation agency was created very recently, and it is not member of the European Association of Quality Assurance Agencies (ENQA) or the European Quality Assurance Register for Higher Education (EQAR). Both networks provide a kind of legitimation to quality procedures in European higher education system. Being part of these networks should be a priority in Latvia, both to ensure that the Latvian universities are held to account against international standards and to enable international recognition of national degrees.

Regarding the working conditions of academic staff, Latvia has a particularity compared with most European countries: there are no tenure positions (European Commission, 2017). Professorial contracts have a fixed term of six years. The resulting instability may have a negative effect on the long-term behaviour of academic staff. The rules for assessing professors' qualifications are being amended in order to improve the quality of academic staff. Under the new compulsory criteria, professors will have to have a minimum number of international publications and an adequate knowledge of foreign languages. It should be borne in mind that international publications are relevant, but they are only one indicator of research productivity and should be considered together with other indicators such as research quality and its impact on the economy and on the society at large. The number of publications alone does not measure these aspects and, if used as the only quality indicator, would introduce a perverse incentive into the system. Reforms therefore aim to increase research performance but need to be matched by a system of incentives in the form of a clear career structure. International experience is that such a structure provides a better incentive for performance improvement than individual monetary incentives.

Many experts agree, e.g. World Bank (2014), and it is obvious from the data, that higher education in Latvia receives too little funding to be able

to offer the needed quality of service to Latvian society. Public expenditure per student is among the lowest in the EU, and until recently the funding model lacked performance-based components. Nevertheless, recent reforms in the funding model (the three-pillar model, still in process of implementation) try to solve some of the funding problems (WB, 2014).

National authorities and HEIs leaders are conscious of the main problems in the system and are engaged in a process of reform, especially in the areas of funding and staff. Nevertheless, it would be necessary to speed up these reforms in order to reduce the lag behind other European higher education systems.

Our interviews with stakeholders in Latvia tend to substantiate issues already evident from available documentation (World Bank, 2014) (World Bank, 2016) such as the following.

- It is obvious to all parties (authorities, stakeholders and university staff) that the level of investment in higher education is very low. It is difficult to develop a high-quality higher education and research system with the current level of investment. The relevant weight of structural funds for financing the system makes the sustainability of the model problematic in the long run
- Governance of HEIs seems to be a problem. Accountability needs to be further increased, strategy planning at all institutional levels should be developed and the system would improve substantially with a strong system of individual and unit incentives for excellence in teaching, research or closer cooperation with firms
- The average age of academic staff is high. This, too, constrains performance and modernisation. New generations have had difficulties entering the system because of the lack of new positions and the low attractiveness of academic careers in Latvia compared with opportunities in other countries. Only a long-term policy can change this situation but shorter-term measures such as the creation of 'new blood' positions can mitigate the problem. The postdoc programme recently implemented is a good step in this sense., Although some performance-based incentives have been introduced recently in the new funding system, the system overall lacks sufficient stimulus for improving quality and productivity or to develop links with industry

Latvia is implementing a set of higher education reforms, aiming to make the system more efficient. For instance, merging of universities and research institutes, the implementation of a new funding model, many small programmes for developing human resources and so on. A critical change in the governance model has also recently been proposed (World Bank, 2016). These Higher Education reforms are likely to move the system in the right direction. However, authorities should be careful in the implementation of the reforms. Two examples in this sense:

1. Reforms emphasise the need to increase the proportion of tertiary graduates in science, technology, engineering and mathematics (STEM), although the Latvian proportion (19% in 2012) is only slightly lower than the OECD average (22%) and greater than some highly industrialised countries such as the US (16%) or The Netherlands (15%) (OECD, 2017a).
2. Reforms emphasise the need to increase the number of scientific publications in international journals. In principle, this seems positive but focusing only on "academic publications" (the easiest to assess) set aside other relevant activities: applied research, cooperation with industry, knowledge transfer and, of course, teaching. A balanced set of incentives is needed that takes account of all three university missions: teaching, research and supporting social and economic development.

Research Structure

The system of research performers has some specific problems. According to the Central Statistical Bureau (CSB) of Latvia, 3,152 (FTE) researchers and 1,968 other scientific personnel were involved in R&I activities in 2016. In the public sector, Latvia has 29 public research institutions (university based and independent). Currently a total of 71 scientific institutions are listed in the Scientific Institute Register of MoES. Twenty-one receive institutional and ERDF funding. This represents a remarkable reduction, but the research system is still fragmented, with efforts dispersed across many areas of research. Bearing in mind the size of the country, this dispersion of efforts has negative effects for the funding of these units, for the quality of outcomes and for the overall performance of the system. Following the recommendations of recent reports on the situation of R&I in Latvia (World Bank, 2014) (Kuļikovskis, Petraitytė, & Stamenov, 2017) (Arnold, et al., 2014), consolidation of research institutions is an ongoing process that clearly needs to continue.

The great majority of research in Latvia takes place in higher education institutions and research institutes. Funding levels are well below those in other developed countries and there is an unhealthy dependence upon Structural Funds for research and innovation funding.

Three important facts emerge.

1. The low level of R&D investment in Latvia. This is a serious barrier to the future social and economic development of the country
2. The low proportion of private investment in R&D. In a mature research and innovation system, it is industry that does the lion's share of R&D. This is not the case in Latvia. Policies for correcting this situation should be a priority as we will detail in next section

3. The fragmented structure of the research-performing institutions, which – despite reform – continues to be a serious obstacle to more efficient use of resources

The combination of limited funds and an inefficient funding model has led to low scientific performance low levels of public-private cooperation, and low levels of internationalisation and international relevance.

Increasing the priority of and amount of funding for R&D may be politically difficult at the moment but is nonetheless a necessary condition for economic development and growth. It is also necessary to allocate funding so as to increase the effectiveness and efficiency of the system. Existing measures aiming to consolidate research structures, finance research based on quality and internationalise the research system are important. Nevertheless, it may be necessary to introduce more incentives at the institutional and individual career levels.

4.2. Industrial innovation

The innovation that is taking place within the industrial sector in Latvia is rather limited. As in other small and post-communist economies, a rapid transformation into a market economy during the past decades has not been easy. The crisis in 2008 clearly showed the vulnerability of the Latvian economy, and the challenges its industry continues to face in relation to globalisation. Exposure to international competition has accelerated the development of Latvia's industrial sector.

According to Eurostat, the overall gross domestic expenditure on R&D in 2015 was 0.63% and declined to 0.44% in 2016. Latvia remains one of the countries in the EU with the lowest total domestic expenditure on R&D activities. This is also reflected in the level of business expenditure on R&D, as Latvia is the lowest among EU28 member states after Cyprus: In 2016 Latvian Business Expenditure on R&D (BERD) was 0.11% of GDP, whereas the Euro area average was 1.3% (Eurostat, 2017)[4]

Some 45% of Latvian R&D activities in 2015 were funded from foreign sources. Only Bulgaria with 50.9% has a higher share. This indicates that Latvian R&D expenditure, overall, is highly dependent on public funding and highly dependent on foreign sources. The weakness of the business expenditure on R&D is remarkable, even in the context of weak levels of R&D expenditure overall: the share of business expenditure in Latvia is only 25%, whereas the EU average is 55% (Eurostat 2017). This is a weakness in a weakness, and it can only be understood by looking at the traits of the Latvian industrial structure.

[4] Compare the note in 2.2 concerning discrepancies between different statistical sources.

The Latvian industrial structure is mainly characterised by low-tech firms. The proportion of medium-high and high-tech firms is rather limited compared to other European countries. In Latvia, the share of both medium-high and high-tech firms is 15% of the total manufacturing sector, while the corresponding EU average is 47% (compare Figure 9). Given that, it is unsurprising that Latvian business expenditure in R&D is among the lowest in the EU28. In a similar vein, the percentage of full time equivalent researchers in the labour market is rather low. These indicators (prominence of low-tech firms, low business R&D efforts, and few researchers in the labour market) suggest that the level of absorptive capacity and capacity to do R&D are modest.

Latvia's industrial and export specialisation is mainly in five areas: wood products, agro-food, machinery and electrical equipment, chemical products, and metal products. This follows from the economic structure, where agriculture and mining represent more than 8% of employment, compared to 5% in the rest of the EU. It seems that the two first sectors, wood products and agro-food, have a good knowledge-base in the country, with well-embedded research institutions and skills development. These two sectors are related to the smart specialisation strategy.

Latvian firms tend to be far smaller than the EU average. Micro-enterprises (0-9 employees) generate 26% of total business turnover, whereas this is 17% in the rest of the EU countries. Likewise, Latvian SMEs represent 51% of turn over, as against an EU average of 38%. Yet, the most significant difference is with large enterprises (+250 employees), which are only 22% of turnover (44% in the EU). Hence, Latvian firms are far smaller than the EU average. This poses problems to issues of critical mass in terms of business R&D expenditure and business innovation intensity. Another relevant feature of the business structure is the fact that Latvia has a relatively large share of foreign controlled enterprises. Whereas the EU has on average a 1% share, Latvia has more than 6%. This indicates interesting levels of foreign direct investment. The question is what type of FDI this is, and whether it is supportive of enhancing innovative activities by using and developing new technologies in Latvia.

Latvia continues to have a medium to high level of inward FDI, compared to other central and eastern European countries. Latvia is, after Estonia, Bulgaria, the Czech Republic and Slovakia, the central and eastern European country with the most stable and highest percentage of inward FDI during the years after the financial crisis. The major investing countries are neighbours. The Bank of Latvia's statistics show that by 2016, about 16% of FDI had come from Sweden, 10% from each of Russia and Cyprus, about 7% from each of The Netherlands and Estonia and about 5% each from Lithuania, Norway and Denmark. One quarter of the total investment was in finance and insurance, 15% in vehicle retailing and repair, 13% in real estate and 12% in manufacturing. Agriculture, forestry and fishing attracted about 4%, as did construction and transportation. Energy supply

and professional and technical services accounted for about 3% each. Thus, about 30% of FDI has ended up in sectors clearly related to production.

A large proportion of GDP (about 30%) is produced in state-owned firms in Latvia. Their R&D effort appears to be minimal. These firms share with others concerns about the lack of adequate skills of mid-level and technical employees, and about the need to develop more business-oriented knowledge and skills in the Latvian educational system that serves the needs of the labour market in the coming years. A few of the large state firms have developed framework agreements with universities, creating some internships and jobs for university students. However, this is far from being a widespread practice.

The competitive advantage of Latvian firms in the international context is currently based on low labour costs, and they are specialised in low-tech industrial sectors. This is not necessarily a problem but sustaining competitiveness in such industries requires constant effort to improve productivity. Productivity levels continue to be below the EU average, even if they have improved recently.

In spite of these weaknesses, during the past few years there seems to be an increasing number of examples of firms improving their added value. Private firms with business-to-business products in the wood sector seem to have been developing higher added value products in close collaboration with external partners and customers. These firms have small portfolios of product development-oriented projects, in collaboration with customers. The projects tend to be oriented towards incremental product improvement rather than more radical innovation. Nonetheless, those projects seem to be having a positive impact on competitiveness and the companies' positions within international value chains.

Latvia has a small biomedical and pharma industry, as well as a relevant biomedical research base which is located in universities, university hospitals, and research centres (see Section 4.3).

There is a dynamic but small entrepreneurship scene emerging in Riga, particularly in the IT-sector and around some specific universities - Riga Technical University in particular (interview with entrepreneur representatives and Riga Technical University leadership). Some Latvian entrepreneurs are participating in accelerators abroad (primarily in Finland), and are increasingly able to attract foreign investment. However, the start-up ecosystem in Latvia is still small and faces important barriers, like considerable red tape, lack of venture capital at national level, limited and fragmented public support and, above all, small scale.

Some recent policy interventions appear to have positive effects on industrial innovation in Latvia. The competence centres created under the auspices of the Smart Specialisation Strategy using EU Structural Funds are perceived very positively by the different actors in the Latvian innovation

system, firms in particular. Apparently, these competence centres have managed to bring the industry together, making investment in R&D projects more efficient. They seem to have developed a model that is suitable for the needs of private firms' industrial innovation. Thus, firms see the competence centres as valuable partners and look forward to the continuation of the scheme by the national authorities, when EU funding phases out.

In terms of developing human capital skills and training, different firms seem to be involved in the definition of standards for professional training at the national level. Public and private firms are equally engaged when discussing these matters. There is a widespread consensus in the country about the need to improve substantially the skills of graduates and of the specialised labour force. Such engagement in the debate and wide consensus among stakeholders is crucial to make the necessary investments to improve the knowledge competences in Latvia, as a way of boosting the currently low innovative capacity of the production sector.

4.3. Research-industry links

The structure of the Latvian economy does not facilitate research-industry links. The low proportion of technology companies, the weight of the informal economy (which the Stockholm School of Economics in Riga's Shadow Economy Index for the Baltic Countries puts at about 20% of GDP) and the high number of state-owned companies are not the best environment for developing innovation and cooperation between companies and research institutions. Nevertheless, the very limited total volume of research performed in research institutions as well as the lack of cultural tradition are probably important obstacles for these interactions.

The degree of university-industry collaboration in Latvia, and of interactions between public and private innovation performers more generally, is rather low. The weakness of those ties is perhaps one of the most obvious legacies of the Soviet past of the country, as other post-communist countries tend to exhibit similar patterns. University-industry collaboration is of crucial importance for the future development of the Latvian innovation system and in particular is key for any effort to build up its industrial innovation capacities.

There are nonetheless some individual cases of university/public research organisations and firms' interactions in Latvia. These are mostly associated with the competence centres, some small incubators and a few successful examples of spin-offs and entrepreneurship activities related mostly to Riga Technical University.

Another successful example is the Latvia bio-bank, which is co-owned by the University of Latvia and a university hospital, in what seems to be a very strong institutional collaboration among both organisations and is funded by the EU ERIC scheme. The biobank collects data and conducts

biomedical research. It also collaborates with industry, undertaking clinical trials of pharmaceutical products. Although clinical trials are in the late phases of product development rather than in the first steps of research, an incipient interaction with industry - both national and international - is clearly emerging around the biobank. This is one strong performer of R&D activities in the country.

However, these examples are rather limited in scope, and are far from being universally embedded in the research activities around the country. In other words, research and innovation collaboration is spotty and far from being routine practice in Latvia.

Entrepreneurial culture is still underdeveloped in Latvian universities. Studies developed in several higher education systems (EUREK, 2011) (Shattock, 2008) show that university entrepreneurialism, that is, the capacity of universities to develop external links and connect with the needs of the economy and the society at large, strongly depend on the entrepreneurial capacity of some individuals inside the institutions. These entrepreneurial individuals need at least two conditions for developing their activities: first, a certain level of institutional freedom (or at least, an institutional governance model that is not too bureaucratic); and second, incentives for their activities that should be part of their personal academic CV and considered in relation to promotion, salaries, prestige and so on. The Latvian model of governance and human resources in research institutions should thus be prepared to allow individuals to engage in entrepreneurial behaviour. This requires modifications to the career criteria for researchers, critical evaluation of the effectiveness of the existing knowledge transfer offices, and entrepreneurship training (Mora & Vieira, Managing university-business partnerships, 2011).

Research-industry links, however, do not only depend on the willingness and ability of the research side to engage with industry but also on the extent of industry's 'absorptive capacity', that is its ability to identify new, external scientific and technological opportunities and to internalise and exploit them. Typically, that means that it must have people able to do – and preferably already doing –R&D. A strong supply of relevantly skilled labour is an enabling factor here, but it is also possible to take more active measures such as placement subsidies for engineers or tax incentives for employing R&D personnel in order to bootstrap absorptive capacity.

The extremely low levels of interaction in Latvia appear to be linked to at least five bottlenecks currently present in the innovation system.

- The limited amount of public funding sources that target collaborative projects or multi-actor consortia
- The lack of incentives in HEIs for external collaboration. Publicly employed researchers at universities do not seem to have any relevant

set of incentive mechanisms to stimulate the creation and their engagement in collaboration with industry

- The weakness and scarcity of 'boundary organisations' in Latvia like Technology Transfer Offices, Research and Technology Organisations or other types of innovation promotion units, whose function is to actively build bridges between different actors in the innovation system.
- The limited absorptive capacity of industry, which may partly be explained by the high share of medium- and low-tech industries in the economy, and which is reflected in the low level of BERD discussed in Section 2.2, above.
- One more barrier that might explain low levels of collaboration and interaction is the red tape that comes from the low-risk, low-trust and process-oriented/bureaucratic administrative culture in public institutions

European researchers and the EC through the programme Higher Education Modernisation Agenda, have developed since 2008 forums and other activities for supporting university business cooperation[5]. There is a good amount of experiences and cases of good practices that could be a model for Latvian universities. Based on these experiences, next is a short list of main traits shared by successful experiences of university business partnerships (Goddard, 2011) (Mora, Detmer, & Vieira, 2010).

- Governance. Successful partnerships need institutional flexibility and some personnel flexibility in regard to internal duties and activities.
- Funding. Initial support from public or private sources is relevant at the beginning. Later, fiscal incentives to partnerships and personal incentives to individuals help to maintain the partnership.
- Individual entrepreneurialism and leadership. Most initiatives (even institutional ones) are to a great extent based on individuals or networks of people with an entrepreneurial vision. Only after reaching a certain stage of development, these individual initiatives become institutional. Then, it is important to promote entrepreneurialism at institutional level and not slow down initiatives.
- Mutual trust. Mutual trust of institutions with local/regional authorities and enterprises is a key factor. In many cases, this trust comes initially from personal contacts and other relationships.
- Object of the partnership. Obviously, partnerships should be based on some strong and innovative points of the institution, but not necessarily on high level research or high technologies. In a country like Latvia medium level technologies could be very successful.

[5] http://ec.europa.eu/education/policy/higher-education/university-business-cooperation_en

- Internal marketing. To overcome certain reluctance of academic staff to participate in external partnerships it could be necessary to develop a more favourable vision to links with industry remarking that these links not only provide financial benefits, but also help to develop research and teaching more focused on social needs.

AN EXAMPLE OF UNIVERSITY-BUSINESS PARTNERSHIP

The Istituto Superiore Mario Boella (ISMB)

Founded in Turin in 2000 by the private foundation Compagnia di San Paolo and the university Politecnico di Torino. Since 2001 several other corporations such as Motorola, SKF, STMicroelectronics and Telecom Italia Lab joined the partnership. Additional contributions to the income of the Institute are made by the Ministry of University Education and major public and private, National and European organisations that provide funds for research and postgraduate education programmes.

The ISMB can be considered as structured, long-term, university-enterprise-partnerships, comprising different type of collaboration and a large number of projects on a specific issue carried out in shared research facilities.

The main activities developed are: Technology transfer, joint applied research laboratories, spin-offs, programmes on higher education, post-graduate and master programmes, exchange of academics and human resources, creation of jobs.

The partnership aims at the mutual benefit by generating business in the region of Piedmont and applied education and job opportunities for the Politecnico's researchers.

The ISMB's labs employ researchers from the Institute, the Politecnico, industrial partners and customers. This working method allows adapting scientific ideas produced by academic researchers to the requests of skilled industrial research partners in real time. It matches feasible forefront technology with the exigent and challenging demand of enterprises, i.e. fine-tuning engineering prototypes that enable the companies to inject innovation directly into their production activities.

It provides young academics with the chance to research in their field of interest by connecting facilities, funding and knowledge in educational programmes.

ISMB processes around 100 projects at the same time, most of them in advanced technologies but also runs higher education and postgraduate activities integrating academic studies with applied research activities. It starts educational programmes in accordance with the requirements of the labour market in its most advanced segments and tries to involve the most brilliant students in research teams of the institutes. The Institute supports doctorate dissertations, both by granting scholarships to be used within the Institute and by having doctorate students at its premises which are supported by other organisations. In other quite different area, the "Mario Boella Chair" of Cinema and Communication Media Engineering was established in 2006.

4.4. Research and Technology Organisations (RTOs)

Latvia does not have any well-developed research and technology organisations (RTOs, although it does have other kinds of applied research institutes. RTOs are 'boundary organisations', working between the research sector and industry. There are other kinds of boundary organisations such as the Latvian competence centres, so this boundary function can be provided in different ways. However, such organisations can be crucial to industrial development and the weakness of this function in Latvia appears to us to be an important lacuna.

At the cost of some simplification (since some multidivisional institutes can inhabit more than one category) there are three categories of research institute.

- Scientific research institutes
- Government laboratories
- RTOs

Internationally, some **scientific research institutes** have their origins in Research Councils or Academies of Science, which were simultaneously research-funding and research-performing organisations. Such institutes tend to do fundamental or applied science and to have a very high proportion of core funding in their income. In many parts of Western Europe, the funding and performing functions of Research Councils have been separated some decades ago. In the former Soviet bloc, Academies of Science tended still to control their own institutes up to the end of the 1980s. Since then, some of these countries have separated out the institutes as independent organisations or transferred them to universities; in others, the Academies continue the old integrated model. Scientific research institutes, such as the Max Planck institutes in Germany, CNRS in France or the institutes of the national academies of science in various of the new member states, largely do the same kind of research as universities and correspondingly get a high proportion of their income in the form of block grants.

A second category of research institutes – often but not always referred to as '**government laboratories**' – focuses on producing public goods to meet knowledge needs of the state or wider society. Sometimes referred to as 'sector' institutes, they are generally owned by the state and their main function is normally to deliver services and policy-relevant information to government. Examples include nuclear research, marine institutes (which mix counting fish stocks with more fundamental work in marine biology) and metrology. Generally, the bulk of their income comes from the ministry whose policy mission they support.

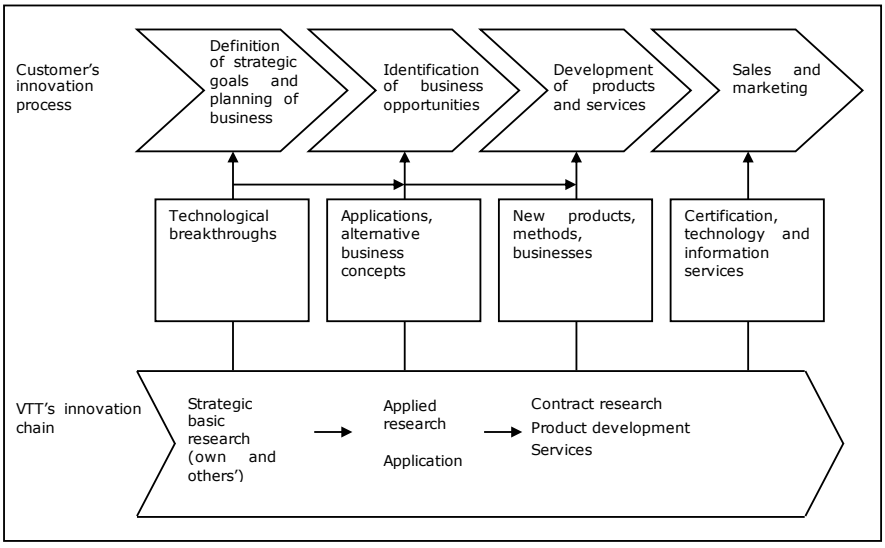
A third category of **Research and Technology Organisations** or 'applied research institutes' tackles the needs of industry for knowledge and a range

of knowledge-related services. Large-scale examples include VTT Finland, the Fraunhofer Society in Germany or TNO Netherlands but there are also smaller and more specialised institutes. Their origins are often as testing laboratories, product and process developers for industry or branch-based research associations, but they focus on user- or problem-oriented research for the benefit of society and normally win the greater part of their funds competitively. Typically, their role is to assume some of the risks of industrial innovation, helping companies to go beyond what they would be able to do, based on their own technological capabilities. RTOs tend to operate with a three-stage model that involves

- Exploratory research and development to develop an area of capability or a technology platform
- Further work to refine and exploit that knowledge in relatively un-standardised ways, often in collaborative projects with industry
- More routinised exploitation of the knowledge, including via consulting

Figure 18 shows VTT's version of this model. (VTT is the main Finnish RTO.) In principle, RTO core funding is primarily intended to pay for the first, exploratory stage, where the RTO develops knowledge and capabilities needed to support its industrial customers. This is the key thing that distinguishes an RTO from a technical consultancy. The public money is used to create the capabilities the institute needs to take companies 'one step beyond' what they could otherwise do, thereby providing social returns by de-risking innovation (Sörlin, et al., 2009).

Figure 18 VTT's Innovation Model



Source: VTT

What individual RTOs do, has to change over time. In many countries, RTOs were set up with the idea that they would develop products and processes for industry. But as companies' technological capabilities increase, so the mission changes to become supporting those capabilities by tackling problems that are out of their reach. Industrial development means therefore that over time the work of the RTOs becomes increasingly scientific. In some cases, RTOs develop a separate set of services (often with additional state subsidy) to SMEs, which can have very different needs to those of larger companies.

It is rather difficult for universities to perform the functions of RTOs. RTO people need some industrial experience, an understanding of how industry works, understand industry (and project management, and deadlines, and how to use existing technology if you don't need to invent something new …) Normally, these people are very different from academic types. At least some of the RTO researchers should have industrial backgrounds. But the RTO still needs close relations with one or more universities in order to understand longer-term scientific and technological opportunities (as is illustrated in the symbiotic relationship between SINTEF and the NTNU university on the same campus in Trondheim).

Suggestion: A role for boundary organisations?

In our brief study of the Latvian research and innovation funding system, it has not been possible to explore in any detail the characteristics and capabilities of individual research-performing institutions that play the role of boundary organisations or to assess the extent to which those which are easily identifiable – notably the competence centres, parts of LIAA, technology transfer offices – collectively cover national needs. It would clearly be expensive to set up new boundary organisations, so the first question is the extent to which the existing institutional structure is adequate – or can easily be modified so as to make it adequate – to the task.

We therefore suggest that the Latvian authorities carry out a study of the boundary function in Latvia. This should explore the extent to which important industrial sectors are adequately served by the current institutions and what current and near-future needs are not met. This should be done using a combination of survey or mapping of industry and its needs on the one hand and scientific/technical expertise on the other. Since the essence of this kind of boundary organisation is that it can work slightly beyond the capabilities of existing industry, existing companies will not always be able to specify technical capabilities they do not yet possess. Hence, it is important to counterbalance their perceptions with the views of scientific/technical experts.

4.5. Inefficiencies in procurement processes as barriers to research and innovation

Procurement appears as a complicating factor in many discussions with researchers and authorities but the evidence presented to us is conflicting. The Ministry of Finance points out that there is a procurement limit of €10 000, below which formal, competitive procurement procedures are not required. Yet people in the competence centres complain that they have to launch a competitive procurement in order to buy even inexpensive items such as consumables or small instruments. Some of those involved with peer review are under the impression that unless they use an 'official' database of experts such as that maintained by the European Commission, they are obliged to recruit peers via a formal, competitive process. It is not clear to us what the underlying issue is. Use of Structural Funds seems to be associated with perceived procurement problems, but similar issues were also raised in relation to national funds. It appears that Latvia has developed an extremely risk-averse procurement culture that encourages excessive timidity, for example by building extremely risk-averse interpretations of the law into universities' own procurement regulations. While that is not a central issue for this report, it is clear that both efficiency and effectiveness are compromised by such an approach to procurement and that Latvia would be well served by, say, an educational exercise for relevant institutions led by the Ministry of Finance.

4.6. Summary

Latvia's investment in R&D – both by business and by government – is among the lowest in Europe and is completely inadequate to the task of generating growth and maintaining a healthy national research and innovation system. The current funding pattern is over-dependent upon European Structural Funds and in the longer term unsustainable. While increasing the national investment in R&D may be financially and politically difficult, there is no alternative if Latvia is to secure economic development.

While the level of higher educational attainment is high by EU standards, the higher education and research institutes continue to be under-funded and fragmented, despite considerable consolidation since the 2014 Research Assessment Exercise. The high level of university autonomy, however, is not matched by modern governance systems able to develop and implement clear strategies. The degree of collegial control needs to be reduced and rectors appointed by university boards that contain a majority of external stakeholders. At the same time, there is a need to address the low wages and lack of tenure or predictability of income of academic teachers and researchers. Measures to reduce the average age of researchers (as eg the postdoc programme) are of specific importance because the age distribution is bimodal: once the older researchers retire, there is not a strong middle generation to take over the reins.

The inadequacy of R&D funding applies as much to the business sector as to the research sector. The low level of R&D in Latvian companies overall has two consequences. First, they tend to lack sufficient ability to identify, understand and absorb technology in pursuit of their business strategies. Second, they are hampered in their efforts to innovate internally. A strand of policy is needed that is aimed at building these internal capacities. A wide range of instruments is available to help do this including R&D subsidies, graduate placement schemes, requiring or encouraging FDI to be accompanied by some R&D activity, supply chain development schemes or fiscal incentives – though the latter appear not to have enjoyed much success in Latvia for local reasons. The state-owned firms that account for 30% of GDP do little R&D and should be required to do so: either internally or by purchasing contract research and services. While there is an exciting start-up scene (though not yet, in reality, a developed ecosystem) in Latvia, the rate at which this can produce growth and structural change remains low. It needs to be accompanied by stronger measures that affect more of the economy, for example through increasing productivity.

Research-industry links are weak, in part because both the research system and the business system are weak. Latvia has started to put in place various linking instruments based on international practice, such as the competence centres, TTOs and so on. However, these cannot succeed without a parallel effort to strengthen the state and business research systems. A strong bridge cannot be built on weak foundations.

Furthermore, procurement rules and processes are widely cited as barriers to doing research and innovation projects.

4.7. Recommendations

Based on this analysis we make the following recommendations.

Higher education structure and governance should be further modernised

- MoES needs to continue to drive the process of institutional consolidation in the research sector, reallocating resources from weak to strong performers as necessary in order to achieve this. Despite considerable rationalisation since the 2014 Research Assessment Exercise, Latvia still has too many research performing organisations to be efficient. The quality and productivity of Latvian research are improving but there is still a considerable distance to go before it is comparable even to the average EU level. The Latvian research community remains insufficiently integrated into world science. **Since the Research Assessment Exercise, there have been many institutional mergers and other changes among research performers that have significantly reduced fragmentation. Such consolidation can only sensibly be done on a case by case basis. However, it needs also to take into account the legacy of a**

system bifurcated between research institutes and teaching universities. Currently, all Latvian universities are formally research oriented by law. I**f university teaching is to be research-based, then it is important that the universities do a reasonable amount of research and that is a strong reason to integrate institutes, especially where they are relatively small and work in the same areas as university researchers. At the same time, larger and well-performing institutes with critical mass may be better off outside the confines of a university, especially when university membership entrails extra bureaucracy and restrictions. Such institutes may be fundamental, applied or even RTOs.**

- Institutional governance in the research performing institutions remains out-dated. MoES should continue the process of modernisation of institutional governance in tandem with promoting rationalisation. The involvement of external stakeholders in universities' decision-making bodies should be increased. Universities should be required to establish governing bodies with a majority of external representatives and the responsibility for appointing rectors and handling key budgeting and strategic functions.
- The lack of well-defined and well-funded academic career paths in Latvia makes such careers relatively unattractive and therefore undermines the quality of both teaching and research. **The Latvian authorities should consider making academic appointments permanent and introducing a tenure track system in the universities.**
- The national accreditation agency was created very recently, and it is not member of the European Association of Quality Assurance Agencies (ENQA) or the European Quality Assurance Register for Higher Education (EQAR). Both networks provide a kind of legitimation to quality procedures in European higher education system. **Being part of these networks should be a priority in Latvia for the international recognition of national degrees.**

Investment by private and public businesses in innovation should be increased and broadened

- There are encouraging signs both of improved innovation performance among some established companies and that a small but lively technology-based start-up scene is beginning to emerge in Latvia. Nonetheless, the overall level of research and innovation activity remains low and many companies lack both absorptive capacity and the vision to want to take a more knowledge-based approach to development and growth. Their development is impeded by skill shortages, especially in IT but also in STEM subjects more generally. Without an improvement in absorptive capacity, much of Latvian industry will remain trapped in a vicious circle of low productivity and low wages. New knowledge is also needed to support the restructuring of industry towards higher-technology and higher value-added lines of

business. At present, there are many programmes in place that encourage cooperation between research and industry (e.g. Support to development of new products and technologies within competence centres; Technology-transfer system and innovation vouchers) but only few that directly target innovation in companies or the development of absorptive capacity. **The competences and skills need to be better aligned to industrial and societal needs. Measures are needed that address the development of absorptive capacity in industry, in addition to direct stimuli to in-company innovation. These could include instruments such as graduate placement schemes, technology audits, R&D partnership programmes and support to firms' close-to-market R&D.**

- The state-owned firms do relatively little R&D, yet they are a significant fraction of Latvian enterprise and provide a source of leverage over the development of absorptive and technological capacity in business. **The Latvian authorities should consider requiring the state-owned firms to spend an appropriate portion of their income on R&D, alone or in partnership with the research system and with other firms.**
- Research-industry links are limited in scope and not well embedded in the practices or incentive systems of the research-performing institutions. Most of the successful examples focus on the competence centres or are at RTU. Incubator and industrial liaison/technology transfer office functions in Latvia are at an early stage of development. There is no explicit Research and Technology Organisation (RTO) in the system, with a specific remit to work at the boundary between research and innovation in the way that, for example, the Fraunhofer Society works in Germany. **Measures to strengthen absorptive capacity need to be matched by increasing the amount of 'boundary work' done by the research performing organisations with a view to maintaining research-industry links. The government should explicitly consider how to create an organisation or network that provides innovation-related translational work, such as that done by RTOs in other countries. Existing organisations which already fulfil some RTOs´ functions such as the competence centres, as LIAA or technology transfer offices should be part of the creation of such an organisation or network. This could involve redefining the funding of certain applied industrial research institutes, strengthening industrial extension services of universities or both.**

5. FUNDING

In this section, we discuss separately research funding and innovation funding by the state, then go on to consider policy measures that promote internationalisation. Finally, we formulate general recommendations and discuss different performance-based funding systems.

5.1. Research funding

The main funding lines for the research system include:

- Institutional research funding: funds to enable universities to have and maintain internal research facilities and resources, which the universities are able to spend as they themselves decide, in line with the principle of university autonomy
- Nationally financed grants: academically orientated competitive research funding and competitive funding for more applied research in the national Priority Directions in Science
- International funding: EU Structural Funds, EU Framework Programme, other international funding

Table 3 lists funding instruments that support research and scientific competitiveness. More detailed information about these is provided in the Appendix. The programmes are translated from Latvian to English in the following way.

Table 3 Instruments supporting research and scientific competitiveness

Funding instrument and source	Annual funding (€)	Policy	Project selection proposal assessment	Administration and monitoring	status
National budget					
Institutional funding for research	27m (2017) 27m (2016) 22m (2015)	MoES	MoES	MoES	running
State Research Programmes	8.9m (2017) 5.7m (2016) 6.2 m (2015)	MoES	MoES (with LCS)	SRA	running
Fundamental and applied research grants	1m (2017)	MoES	LCS	SRA	running

Funding instrument and source	Annual funding (€)	Policy	Project selection proposal assessment	Administration and monitoring	status
	4.4m (2016) 4.4 m (2015)				
ERDF					
Practically orientated research grants	14.3m (total 86.1 m)	MoES	CFCA	CFCA	running, 2nd call 2017
Support of Post-doctoral Research	10.6 m (total 64 m)	MoES	SEDA	SEDA	running, 2nd call 2018
Innovation grants for students	5.6 m (total 34 m)	MoES	CFCA	CFCA	in development, 1st call 2018
Support for international cooperation projects in science and technologies	5.4 m (total 32.5 m)	MoES	CFCA	CFCA	call opened 2017
Development of the R&D Infrastructure in Fields of Smart Specialisation and Strengthening of Institutional Capacity of Scientific Institutions	20m (total 120 m)	MoES	CFCA	CFCA	call opened 2017

NB: Indication of the ERDF as a funding source means the total funding, which also includes national (incl. private) co-financing (in most cases 15 %)

Translations
Institutional funding for research (Bāzes finansējums)
State Research Programmes (Valsts Pētījumu programmas)
Fundamental and applied research grants (Fundamentālie un lietišķie pētījumi)
Practically orientated research grants (1.1.1.1. Praktiskas ievirzes pētījumi)

Support of Post-doctoral Research (1.1.1.2. Pēcdoktorantūras pētniecības atbalsts)
Innovation grants for students (1.1.1.3. Inovācijas granti studentiem)
Support for international cooperation projects in science and technologies (1.1.1.5. Atbalsts starptautiskās sadarbības projektiem pētniecībā un inovācijās)
Development of the R&D Infrastructure in Fields of Smart Specialisation and Strengthening of Institutional Capacity of Scientific Institutions (1.1.1.4. P&A infrastruktūras attīstīšana viedās specializācijas jomās un zinātnisko institūciju institucionālās kapacitātes stiprināšana)

In 2017, total annual funding for scientific research is €73.5m. €36.6m is provided by the ERDF and the remaining €36.9m comes from national sources. The Ministry of Education and Science (MoES) is responsible for setting policy in all cases and controls the implementation of those programmes that are funded entirely using national money. It implements the funding instrument itself in the cases of institutional research funding and while it initiated the closely related programme for strengthening the capacity of the scientific institutions (which is a temporary programme that supports strategy development and restructuring in the research and higher education sector, aiming to reduce fragmentation and increase quality), CFCA has now taken over responsibility for implementation.

MoES allocates institutional funding for research to those research institutions, HEIs, their structural units, and institutes that are listed in the Register of Scientific Activity. Public financing is gradually being limited to institutions that have achieved a certain critical mass and that received high scores in the 2014 Research Assessment.

The fundamental and applied research grants programme provides bottom-up, research-council style funding for science while the Sate Research Programmes address the knowledge needs of the various ministries. For these, the Latvian Council for Science (LCS) organises peer review of proposals and selects projects for funding but the contracting, administration and monitoring of the projects is then done by the Studies and Research Administration (SRA), which is an agency of the MoES.

MoES defines the themes for the state research programmes, based on consulting the other ministries about their needs for policy-relevant research. The ministries we consulted have little capacity to define or manage research and little or no money to fund it. The Ministry of Agriculture is an exception, since it provides institutional funding for the Latvia University of Agriculture and a programme of ten PhDs per year, but its own budget for research is only some €100 000 and is subcritical in scale.

Other programmes rely on ERDF funds and are mostly implemented by the Central Finance and Contracting Agency (CFCA), which is an agency of the Ministry of Finance (MoF).

- The practically oriented research grants fund innovation-related research projects in public institutions and in companies and are implemented by the CFCSA, which manages the use of structural funds.
- The post-doctoral research grants scheme, on the other hand, is implemented by the MoES' State Education Development Agency (SEDA), which handles the implementation of higher education policy. Its target group are new scientists, who obtained their PhD 5 years ago or less for career start-up opportunities at research institutions and enterprises, connected with the RIS3 strategy. This measure is currently in its implementation stage.
- "Innovation grants for students" is aimed to provide students with innovation and entrepreneurial skills during their studies and to raise private funds for R&D based student innovation and entrepreneurship education. Currently the regulatory framework is under development and a call is planned to be open in 2018.
- "R&D infrastructure" ("The modernisation of infrastructure, strengthening of institutional capacity and development of institutional strategies") is directly targeted to research institutions and universities to develop their research capacity by improving infrastructure and institutional capacity. This call is recently opened and currently evaluation is in progress.
- "Programme for international cooperation projects in research and innovation" is targeted to promote the participation of Latvian researchers in the European Research Area, thereby promoting international cooperation in research and technology. The regulatory or legal framework has been approved. Calls for this programme have been opened.

In addition to these main streams there are some other international cooperative sources such as the EEA and Norway grants that provided in the period 2009-14 €5.5m for research and scholarships and €11.3m to innovation in green industry.

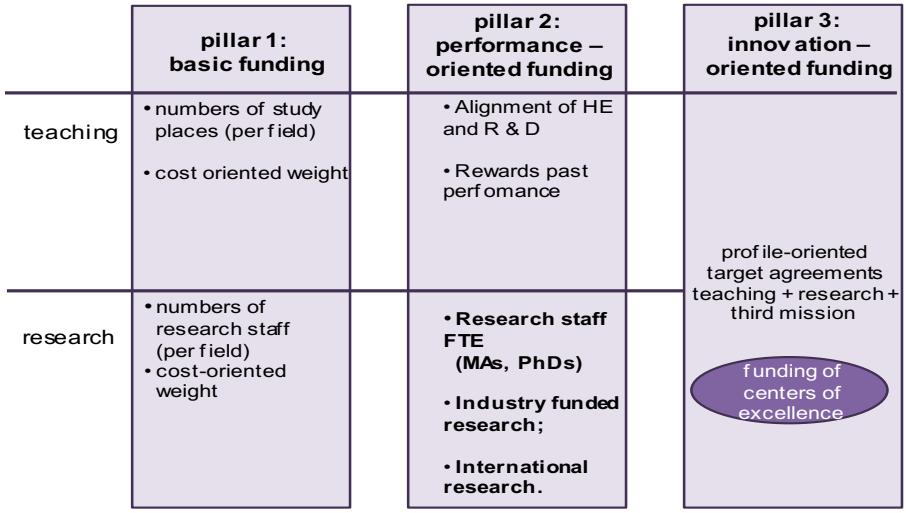
In the past, Latvia's model for financing higher education and institute research lacked performance-oriented components. It was a model based exclusively on inputs where outputs were not considered. A new higher education financing model was developed in 2014 following the recommendations of a World Bank report (WB, 2014). A three-pillar financing model was proposed (Figure 19). The three pillars are: 1. Base financing (institutional financing to ensure the functioning of education and basic research); 2. Performance-based financing (that is allocated based on study outcomes and research results, mainly publications); 3. Innovation financing (development-oriented financing that promotes the specialisation of institutions and their profile development. Still not

implemented). The new financing model is aimed at developing research-based higher education and establishing performance management of HEIs.

The second pillar is performance and growth oriented funding. Funding is awarded after ex-post assessment of results achieved, compared against the planned performance criteria established in the negotiation procedure between HEIs and Ministry. Core and specific performance indicators are included in the funding mechanism. Most indicators are related to research and internationalisation. In 2017 the budget for this pillar was €6.5m. It appears problematic that this pillar focuses mainly on research productivity and not the broader set of performances expected of the universities. If productivity and quality of teaching are not considered in this type of performance-based funding, then HEIs and especially academic staff get the message that teaching and learning are secondary missions. Over-focusing performance-based funding on research has proved to be a problem in the UK, where additional instruments to reward teaching and the third mission have now been implemented as corrective measures.

The third pillar aims to foster innovation-oriented activities. This pillar has not been fully designed yet and no additional funding was allocated in 2017, due to budget restrictions. In the future, funding will be awarded on a competitive basis taking into account the alignment of initiatives with national priorities. Using this funding stream, the government expects to stimulate R&I activities in HEIs, signalling the importance of connecting R&I to education and pursuing universities' 3rd mission. This third pillar is a very interesting proposal that needs to be properly developed.

Figure 19 Outline of the new HEI funding model



Source: Ministry of Education and Science

In summary, the new model is a positive step, although the absolute amounts of money involved are lower than those required for the improvement that Latvian higher education needs. Further development of this model should involve considering several factors.

- The need to increase the total funds committed to HEIs. These funds, mostly those for current expenditures, should be national. Structural Funds should be used for closing gaps that are constraining the development of the system, but using European money for permanent current expenditures will not be sustainable in the future
- The use of appropriate performance criteria and indicators. On the one hand, assessing the performance of HEIs should include the assessment of learning. On the other hand, it is important to choose the indicators that are relevant for the system, not only those which are easy to measure
- Flexibility for adapting funding programmes to different and changing contexts

5.2. Innovation funding

There are a number of instruments supporting and funding industrial innovation in Latvia. Table 4 summarises the most important of them. (More detail is available in the Appendix, where ERDF-funded schemes for business support are also shown.) It is worth noting that many of them have been created very recently, and therefore there is still a steep learning curve for the Latvian government and agencies about what works best.

Table 4 Instruments supporting industrial innovation

Funding instrument and source	Annual funding (€m)	Policy	Project selection Proposal assessment	Administration and monitoring	Status
National budget					
CIT R&D Tax allowance	0.78 (2014) (OECD calculation)	MoF/ MoE	-	State Revenue Service*	Will be cancelled in 2018 (tax reform)
Support to technology-oriented start-ups (Tax relief)	-	MoE	LIAA	State Revenue Service	running

Funding instrument and source	Annual funding (€m)	Policy	Project selection Proposal assessment	Administration and monitoring	Status
ERDF (2014-2020)					
Support to development of new products and technologies within competence centres	9.18m (total funding: 64.3m, 3 calls for proposals)	MoE	CFCA	CFCA (Financial framework) MoE (Strategic framework)	running
Support to implementation of new products into production	8.57m (total funding: 60m, 2 calls for proposals)	MoE	CFCA	CFCA MoE	running
Technology-transfer system and innovation vouchers; Support to technology-orientated start-ups – attraction of highly skilled workers	5.80m (total funding: 40.6m) +3.5m	MoE	CFCA (Technology-transfer) LIAA (start-up)	LIAA MoE	running
Innovation motivation programme	0.81m (total funding: 5.7m)	MoE	CFCA	LIAA MoE	running
Support for employee training to increase business competitiveness and innovation	2.50m (total funding: 18m, 2 calls for proposals)	MoE	CFCA	CFCA MoE	running
Support for training to improve ICT skills, capacities for non-	1m (total funding: 6.9m)	MoE	CFCA	CFCA	running

Funding instrument and source	Annual funding (€m)	Policy	Project selection Proposal assessment	Administration and monitoring	Status
technological innovation and attracting foreign investment				MoE	
Clusters	(total funding 6.2m)	MoE	CFCA	CFCA	running

NB: Indication of the ERDF funding source means the total funding also includes national co-financing (in most cases 15 %)

* The State Revenue Service (SRS) controls the eligibility of the expenditures. Single cases can be decided by the R&D Assessment Commission of the MoE.

Translations
Support to development of new products and technologies within competence centres (1.2.1.1. Atbalsts jaunu produktu un tehnoloģiju izstrādei kompetences centru ietvaros)
Support to implementation of new products into production (1.2.1.4. Atbalsts jaunu produktu ieviešanai ražošanā)
Technology-transfer system and innovation vouchers; Support to technology-orientated start-ups – attraction of highly skilled workers; (1.2.1.2. Atbalsts tehnoloģiju pārneses sistēmas pilnveidošanai)
Innovation motivation programme (1.2.2.2. Inovāciju motivācijas programmema)
Support for employee training to increase business competitiveness and innovation (1.2.2.1. Atbalsts nodarbināto apmācībām,)
Support for training to improve ICT skills, capacities for non-technological innovation and attracting foreign investment (1.2.2.3. Atbalsts IKT un netehnoloģiskām apmācībām, kā arī apmācībām, lai sekmētu investoru piesaisti)
Clusters (3.2.1.1. Klasteru programmema,)

Tax incentive instruments

As it can be seen in the table above, the Latvian government has primarily developed innovation policy instruments based on tax incentives. The most important is the general R&D tax allowance instrument, which provides tax incentives to R&D activities of Latvian firms. The scheme targets as well

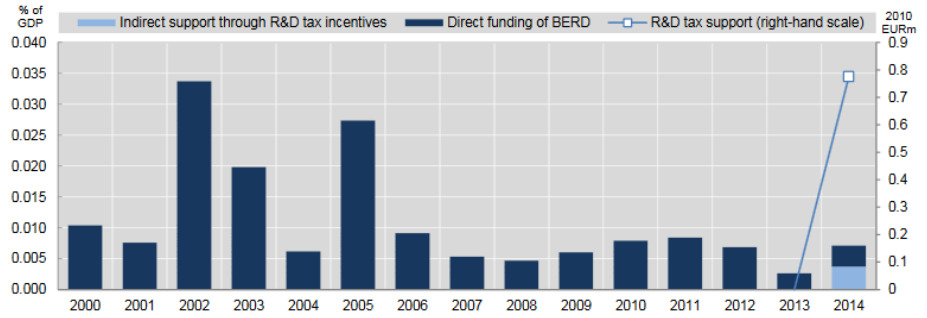
the acquisition of technology from outside the country and via foreign investors and entrepreneurs. Furthermore, in 2014, the scheme was enlarged, offering a deduction for other R&D expenditures such as remuneration of scientific and technical staff and research services provided by scientific institutions. Apart from that general tax incentive to R&D activities, a new scheme directly focusing on start-up companies has been created. The new scheme came into force on January 1, 2017, and it gives a special employee taxation regime to start-ups. For that reason, as can be seen in table 2, at the time of writing there are two main Tax incentive policy instruments in Latvia.

The overall target of the general tax reduction scheme is to increase business expenditure in R&D in the country, because Latvia has one of the lowest levels in Europe. However, this scheme has had a very little take-up among firms. One of the practical problems with the scheme is that firms – especially those that do no R&D – generally do not know about it. Another of the practical problems is that among the firms which knew about the scheme, many decided not to participate. The reason for the non-participation is, either because the firms were uncertain about what exact type of activities are to be considered R&D, or because the practice of the tax authorities was to inspect any firm claiming the tax incentive.

Like most R&D tax incentives, the Latvian scheme allows beneficiaries to offset allowable expenses against corporation tax (tax on company profits). Latvia's rate of corporation tax is only 15%. At that level, the incentive is not very attractive, given the administrative complexity of obtaining it. It is only of value to companies making fairly substantial profits. For others, there is little or no corporation tax against which expenses can be offset. The Dutch scheme addresses this problem by offsetting R&D expenses against social charges, so that even companies that are not in profit can benefit. The Norwegian scheme sets expenses against corporation tax but allows corporation tax to become negative. In the majority of cases, the Norwegian tax authorities in fact pay negative corporation tax to the companies. The policy focus of R&D tax incentives is often on small and new firms, aiming to enable or encourage the creation of in-house R&D capacity. Schemes are capped, to limit free-riding by larger R&D performers. Therefore, it is crucial that those schemes become attractive and relevant for small and new firms; otherwise most likely they will have limited effect.

According to the OECD, the cost of Latvia´s R&D tax allowance amounted to 0.78m € which was equivalent to 0.004% of GDP in 2014. In contrast to this, direct funding of BERD reached only 0.003% of GDP. However, it has to be noted that most schemes supporting R&D and innovation in companies have been introduced only recently (OECD, 2017b). The figure shows direct funding of business R&D and tax incentives for R&D between 2000 and 2014.

Figure 20 Direct funding of business R&D and tax incentives for R&D 2000-2014



Source: OECD, R&D Tax Incentive Indicators, http://oe.cd/rdtax, March 2017.

Given the limited success of the general R&D tax incentive scheme, the Latvian government has most recently changed the approach, moving away from tax exemptions for specific R&D activities, towards a more generic scheme that supports the capitalisation of firms. Many firms in Latvia have very low levels of equity[6] and therefore have difficulty in borrowing from external sources. The Latvian scheme follows the model of Estonia, which has shown that company owners tend to capitalise their firms to a higher degree than before. This higher capitalisation in turn, allows companies to engage in further collaboration and/or R&D activities. This generic tax incentive scheme is easier to manage for the companies and the state. The new scheme will be implemented in the beginning of 2018. Time will tell whether this works as well for Latvia. However, to the extent that Latvia needs specific measures to encourage firms to start doing R&D, it is clear that these will have to be grant- or subsidy-based. Such measures can also be more carefully targeted to the development of absorptive capacity, for example through graduate placement schemes, technology audits to make companies aware of the opportunities available from R&D and partnerships with research-performing organisations or even other firms.

Competence centres

Following the table above the next group of policy instruments in Latvia are related to the EU structural funds, more particularly the ERDF. It is worth noting that the Central Finance and Contracting Agency (CFCA) is the Cooperation Institution in the administration system of the EU Funds, and therefore it is involved in various functions in the implementation process of ERDF schemes, mainly project selection, proposal assessment, monitoring and administration (all programmes, except the Start-up programmes). LIAA has also important functions in these areas. (see table above).

[6] Shareholders' funds or Eigenkapital

Among the EU-funded programmes, the competence centres, mentioned in section 2.3.1, seem to be the most successful instruments promoting innovation in Latvia at the moment. The ERDF provides about €40m per year in innovation funding, from which those centres are financed. The competence centres are based at universities and connect companies with research relevant to their product and process development. The competence centres have proven to be the most successful instruments in Latvia so far in terms of creating bridges between research centres and industry. Among the eight competence centres, it seems that the centre dedicated to forestry and wood processing is an example of good practice, as it has managed to bring together and generate synergy between different types of actors in this industrial and technological area. Concrete projects were put forward by some private woodwork firms in Latvia, which have been using the competence centre to interact with other organisations and develop further their own knowledge competences.

Another important programme supported by Structural Funds is financial support for the acquisition of new products into production. This is among the largest funding programmes in Latvia. It is designed by the Ministry of Economy and implemented and monitored by the CFCA. The overall aim of the programme is the modernisation of industry.

Technology transfer, innovation motivation, and attracting FDI

The Investment and Development Agency of Latvia (LIAA) is the central state actor in issues of innovation. While most of LIAA's activities are traditional inward investment support services, it established an internal group of about a dozen people with a 'technology agency' function in 2016. Many of the concrete initiatives of the TTP programme are still in an early phase, and are still suffering from limited or uncoordinated funding. LIAA is a very important player in terms of supporting and funding instruments towards industrial innovation. The most relevant programme it manages is the recently created technology transfer programme (TTP), which addresses three dimensions: technology push, market pull, and boosting the ecosystem. Regarding technology push, the programme focuses on commercialisation by providing grants to research organisations conducting technology projects to scale them up from TRL level 3 onwards. The TTP programme also includes an innovation voucher scheme, which supports SMEs collaborating with universities. The TTP programme also has some soft support measures addressing the start-up ecosystem by stimulating networking, engaging in brokerage activities, and organising scouting for firms which seek specific knowledge specialisation and expertise in university or research centres in Latvia.

In addition to the technology transfer activities, LIAA also manages a programme for 'innovation motivation', which promotes innovation to society, focusing on awareness raising in the media and among children and young people. The aim is to promote an entrepreneurial and innovation-orientated mind set.

LIAA's primary purpose, however, is to promote and support inward investment. This is of course a large area. In order to attract higher added value activities to Latvia, the agency manages another programme which supports training of employees in order to improve overall skills and capacities for technology and non-technological innovation. This small programme provides customised training to address the specific needs of an inward investor if the foreign direct investment (FDI) investment brings significant elements of new technology. It is part of a slightly larger training programme whose aim is to promote the productivity and efficiency of SMEs by increasing their qualifications and skills in the field of ICT. It helps companies to obtain an appropriately qualified labour force to facilitate the introduction of non-technological innovations (marketing, logistics, organisational and manufacturing processes, management of product and process innovation etc.), as well as to provide support for training, which would encourage the attraction of investors. The scheme is open to small and large companies and also to the self-employed. The Latvian Information and Communications Technology Association (LIKTA) delivers the ICT training; the Latvian Chamber of Commerce and Industry does the training for non-technological innovation; and the Investment and development Agency of Latvia (LIAA) itself handles the training of employees in Latvian firms in order to attract FDI.

LIAA's traditional role is reactive, supporting companies that approach the agency. However, it is taking a more proactive stance and approach to clients in innovation and technology. This is particularly the case with the new scouting activities and the other soft support measures that aim at building an innovation ecosystem in the country. Keeping a balance between the two approaches (the service oriented approach and the proactive oriented approach) will be key for the success of the agency in terms of stimulating more innovation activities in the country. More challenging for the success of the agency in achieving its goals is however the question of economic and manpower resources. It seems that there has been some instability in the funding of the agency's activities, particularly the TTP, which puts at risk the success of the programme. Likewise, developing the highly needed proactive approach requires that LIAA gets the best possible human resources in the form of employees that are able to speak the language of industry and the language of technology, as well as being good at English.

As Table 4 indicates, Latvia has other policy instruments and programmes which support the training of employees in order to increase the competitiveness and innovativeness of Latvian business. These are not related to FDI. One programme supports the efforts of companies to invest in employee training to facilitate innovation and its adoption into their business models. Funding is available for companies operating in the manufacturing industry, ICT and tourism. The ERDF is funding two calls for proposals, each with a budget of €9m. The target group is the employees from SMEs and large companies. The direct beneficiaries are industry associations, which, at the request of companies, provide appropriate

training. There are other, smaller training instruments outside the realm of the MoES.

When looking at this portfolio of innovation related policy instruments, it is worth noting, that Latvia does not yet seem to be using public procurement as an instrument for supporting and funding innovation although the Guidelines on Industrial Policy 2014-20 state an intention to do so. Areas in which Latvia could actually have such an innovation oriented public procurement include those of the Ministry of Health and the Ministry of Transport, which are areas with large public procurement budgets. These ministries are not currently making any active use public procurement for innovation purposes. Naturally, it is important that procurement is done in a way that does not conflict with state aid regulations. However, the opportunities offered by EU procurement rules do not seem to be used in Latvia due to a combination of factors. First, small budgets limit the opportunities to spend in a proactive way, and conservative and known solutions are preferred. Second, an extreme culture of blame avoidance is reinforced by a very risk-averse approach to legal interpretation. Third, a lack of knowledge and technical competence in the procuring agencies may limit the capacity to identify potential innovation opportunities in concrete exercises of public tenders. We were unable to find any example of public procurement being used (successfully or unsuccessfully) for innovation purposes.

The current portfolio of policy instruments supporting innovation in Latvia is ambitious and is clearly pointing in the right direction. However, it is nonetheless incomplete, under-funded and unstable.

The most relevant policy instruments in the field of innovation seem to be: the competence centres (which seem to be rather successful so far and supported by the Smart Specialisation Strategy), the technology transfer programme managed by LIAA; and the recently reformed tax incentives to boost the levels of capitalisation in firms (and indirectly of R&D activities too) following the Estonian model. There is no doubt that these are highly relevant instruments for promoting innovation activities in the Latvian innovation system. However, taken together, they fall short of covering the needs of the innovation system, in particular, the need to boost the low levels of business investment in R&D and industrial innovation more generally. Important aspects of the innovation system need more active policy intervention, for example via

- Support to start-ups and innovative entrepreneurship through a series of more ambitious and targeted instruments such as the creation of accelerators (the hands-on training of entrepreneurs, and their active networking with potential investors), support and encouragement of private venture capital formation in Latvia, or the creation of spaces for location of start-ups like start-ups hotels or incubators near the competence centres, technical university or similar incipient hotspots

- Support for private firms' close-to-market R&D activities through more sector-targeted innovation funding, particularly by sectoral ministries or specialised public agencies (not always and necessarily in collaboration with HEIs) but perhaps in collaboration with competence centres
- Graduate placement schemes, to inject absorptive capacity into companies
- R&D partnership schemes, to enable companies to do R&D together with universities and institutes, thus going beyond the technology transfer and advice services currently offered by the competence centres
- Technology audit schemes, that alert companies to technical and innovative opportunities
- Proactive use of public procurement to foster innovation

The overall levels of public funding of the current instruments in place do not seem to match the scale of the challenges that the innovation system in Latvia currently faces. In some cases, the scale of programmes does not seem to correspond to the size of the challenges addressed. For example, the programmes supporting the training of the innovation related skills of Latvian employees, seem to be underfunded and highly fragmented in their implementation.

A portfolio of innovation policy instruments requires a certain level of stability through time. The dramatic downturn of the Latvian economy in 2008 put severe constraints on public expenditure during the years that followed. While the economy has since recovered, levels of public expenditure are still not back to pre-crisis levels and are dependent upon the temporary supply of ERDF money.

5.3. Policy measures addressing internationalisation

The current low level of internationalisation and international recognition is less the result of a lack of effort or policy instruments than a direct consequence of the very limited funding made available. Nevertheless, Latvia made enormous improvements in the last six years. For example, according to the European Innovation Scoreboard, Latvia´s international scientific co-publication rose from 21.4% of the overall level in 2010 to 75.5% of the EU level in 2016. The indicator for foreign doctoral students points in the same direction. In 2010 Latvia stood at 2.3% of the overall EU level but this rose to 36.9% by 2016 (European Commission, 2017).

According to the Guidelines for Science, Technology Development and Innovation 2014-2020, internationalisation of science and international cooperation is one of the top priorities in Latvian research and innovation policy. MoES addresses this strategic goal by implementing a large number

of activities and programmes in order to support research internalisation and deeper integration into the European Research area.

- "Support to international cooperation projects in research and innovation" (€4.6m per year – see section 5.1.) promotes Latvia's participation in the EU research and technology development programmes (HORIZON 2020, Joint Programming initiatives, and activities under Article 185 and 187). Furthermore, state budget programme was designated to support the participation of Latvian entities in the EU research and development programmes with annual funding of €1,5-5m.
- Bilateral collaboration has been implemented with Belarus and Taiwan, Lithuania. In the beginning of 2016, a collaboration programme with Ukraine in the fields of science and technology was launched
- The participation of Latvian groups in European Space Agency (ESA) projects receives €1.4m in funding per year
- The Cabinet of Ministers has approved Latvia's participation in eight prior consortia and platforms of the ESFRI Roadmap
- Future plans include joining five EU Joint Programming Initiatives, CERN and ESA as well as the enhancement of bilateral co-operations (China, Baltic states).

Apart from these concrete support schemes, peer review, project selection and monitoring have largely been aligned to European standards (mainly H2020) both in terms of criteria and processes and in terms of experts involved. Moreover, internationalisation is made through support of Horizon 2020 projects with seal of excellence under ESIF if the project proposal has reached threshold but was not financed due to insufficient funds.

All the activities and programmes point in the right direction, and should be continued and strengthened. The national scientific community needs stable and comprehensive incentives to cooperate in international consortia, to open their doors for researchers from abroad and to promote mobility at different career levels. Therefore, future efforts should include

- The development of a well-functioning and trusted international peer review system
- The simplification of the rules for involvement of international scientists in teaching and research
- The attraction of foreign students and researchers by offering more work and study environments in English

Further, Latvia could consider fostering international, inter-sectoral and interdisciplinary research training, as well as transnational mobility by applying under the EU COFUND scheme.[7]

5.4. Recommendations

Against the background of the presented evidence, we draw the following conclusions and recommendations:

Funding for research and innovation should increase, especially from national sources

- Latvia's research and innovation system is small and under-funded, as a result of which its performance is not only poor in international comparison but also inadequate to national needs for knowledge and skills to support economic and social development. While we recognise the economic constraints, state expenditure on research and innovation policy should increase in order to drive performance and growth.

  The problem of lack of resources is closely connected with the lack of public awareness and recognition in political and policymaking circles of the importance of research and its central role for innovation and economic development and the low political priority of research and innovation policy is an important factor limiting Latvia's development and growth. A clearer national understanding and vision is needed in order to upgrade the visibility and priority of research and innovation policy. This includes a broad understanding that R&D is a crucial driver of economic development and growth as well as the awareness that public investment in R&D will induce further private investment ("crowding in"). Furthermore, this vision should be strengthened by communication, explanation and awareness raising. The Ministry of Education and Science is currently defining the research priorities for the period from 2018 to 2021 and intends to use this process for communication with other ministries, stakeholders and the general public. This could be a starting point for a comprehensive communication and awareness-raising campaign as a joint and coordinated task of all ministries and policy making circles. **The communication plan foreseen in the "Science, Technology and Innovation Development Guidelines" should be put in place. The Latvian authorities should consider the best way to generate and promote an overall vision articulating the role of research and innovation in future development. This should include a specific national exercise to improve policy coordination, obtain a better balance among instruments and to adjust the division**

[7] See MSCA-COFUND-2017 http://ec.europa.eu/research/participants/data/ref/h2020/wp/2016_2017/main/h2020-wp1617-msca_en.pdf)

of labour in the structure and governance of research and innovation policy.

- In our view, the scale of the research and innovation activities funded respectively using national and Structural Funds are seriously out of balance. Nonetheless, Structural Funds are in principle under the control of the national authorities and should be used in part to support the development of the research and innovation system. The separation in Latvia is extreme and detrimental, especially when it is complicated by the presence of the CFCA that adds to the fragmentation of implementation and its disconnection from policy. **The national authorities should aim to achieve a better funding balance between national and Structural Funds, bearing in mind the fact that money is fungible and that structural funds are a temporary expedient.**

Competitively-won research funding should increase, in order to meet national needs

- **A new RAE is due soon and should this time explicitly be connected to resource allocation.** At the same time, there is a need to ensure that such research-related incentives do not unbalance the system by taking attention away from education or the 'third mission'.
- **Both the scale and the scope of competitive, external research funding schemes should increase**, in order to meet national needs for both 'bottom-up' and thematically orientated research.

5.5. Proposal 3: A performance-based research funding system (PRFS)

The 2014 research assessment exercise (RAE) was launched on the initiative of the education and science minister, in part to generate a 'map' of national research assets and their quality. The RAE was based on panel reviews and considered all registered research units. This was the first time such a comprehensive exercise had been undertaken in the recent period. For each group it addressed

- Scientific quality
- Impact on science
- Economic and social impact
- The quality and adequacy of the research environment
- The development potential of the unit

The exercise was based in part on extensive self-reporting and self-evaluation by the individual units. In many cases, it served as an introduction to the process of being evaluated and it therefore helped establish an evaluation culture in the Latvian research sector. The exercise

used peers in order to generate not only ratings of performance but also feedback on how to improve it. After the exercise, MoES decided to focus institutional funding on those groups that had achieved high scores in the RAE.

Some design pointers from international experience

MoES now intends to run a new exercise, using similar criteria. This time it will directly link RAE results to institutional funding. We offer here some pointers based on international experience of PFRS that may be useful to MoES in the process of designing and implementing the new RAE.

A PRFS is one among a number of options policymakers have at their disposal for increasing the quality and relevance of research. Others include: adjusting the ratio between institutional funding and external competitive project funding; fostering international collaboration; governance reforms in the research-performing institutions; varying the overall level of expenditure on research. The potential interaction of the PRFS and these other factors needs to be considered in designing both the method of assessment and the way assessment is connected to funding.

A further, crucial systemic aspect is that a PRFS is only one of the means through which university performance should be measured or understood. UK experience is that a strong PRFS in the absence of significant incentives for teaching quality or performing the third mission has distorted the university system, making teaching a second-class activity and discouraging interaction with society or anything else that does not generate credit in the PRFS. As a result, in the last few years a teaching excellence assessment has been introduced and the PRFS itself has been adjusted to reward not only research quality but also its impact, as well as the quality of the environment in which research is conducted. It is important therefore to design and implement a PRFS as part of a wider strategy for improving university performance. These issues are less acute in institutes that do not teach though there is reason to foster their societal impact in addition to their research quality.

Peer review has strong advantages over metrics-only methods of assessing research, especially in small countries that use a language not widely spoken elsewhere and where the research system needs further development. It enables direct interaction between the peers and those evaluated. Given the much reduced number of research units in Latvia compared with 2014, it would be possible for the peers to make site visits, increasing the quality of the interaction, their judgements and the feedback needed in order support development.

As the Latvian research system matures, there should be a declining need for the high level of personal interaction between peers and those assessed that is currently appropriate. In the longer term, a national research information database (RIS) - based on the already existing "National

Science Information System" ttps://sciencelatvia.lv/#/pub/home - could be used as an important source of information for research assessments (like the Norwegian CRIStin system). Entries in CRIStin are classified by the 'level' of the publication. National experts determine how to classify journals and outputs in the national language so that they can be counted and weighed together with publications indexed in the commercial bibliometric databases. This would support a transition to a metrics-supported approach in the future approach though, of course, there are many methodological issues associated with the use of metrics that need to be understood and taken into account.

Self-evaluation is itself a useful learning exercise and certainly should be a component of a development-orientated PRFS. However, the use of self-evaluation processes to collect data such as research incomes, numbers of publications, research employment and so on is problematic. It is at best liable to error and at worst vulnerable to manipulation by those completing the self-evaluation forms. It is useful, therefore, whenever possible to use quality-assured statistical sources wherever these exist. That has the additional positive effect of lightening the evaluation burden on the research-performing institutions.

Countries differ greatly in the way they connect research assessment to funding via a funding formula. Experience suggests that a PRFS that governs only a fairly modest proportion of institutional funding can have significant effects on behaviour and performance. Those that allocate a dominant fraction of institutional funding risk causing instability. The funding formulae themselves can be structured so as to encourage system-wide performance improvements or to concentrate resources on the highest performers, depending on the policy need. The UK PRFS was originally introduced in order to focus resources on a minority of research-performing universities. In contrast, the Norwegian PRFS was introduced to raise quality across the whole system, leading in practice to a small reallocation of resources from established to newer universities.

PRFS can in some cases bring a number of unexpected and undesired consequences because they operate directly on research-performing institutions' incentives. Some of the perverse consequences discussed in the literature are: discouraging interdisciplinary research; discouraging 'blue skies and 'transformative' research; promoting orthodox rather than heterodox theory and methods; undervaluing applied research; reducing researcher autonomy; undermining non-research functions of a university; under-valuing research not published in English; discouraging performance of the third mission and the popularisation of science. Not all PRFS promote all these effects – it depends upon the specifics of the design and the interaction between the PRFS and other incentive systems. But as far as possible, these need to be considered in PRFS design.

Specific characteristics of the next RAE

A PRFS is a policy instrument. Its design and implementation should therefore be guided by policy needs. Table 5 summarises such needs identified in this report and indicates which could be addressed via a PRFS. Italicised entries indicate indirect or secondary effects. Other policies and instruments needed in parallel are shown separately in the final column of the table.

Table 5 Suitability of PRFS for addressing research policy needs

Research Policy Needs	PRFS	Other Policies and Instruments
De-fragmentation among research institutions	Encouraged by other PRFS incentives	Merger incentives already in place
Reform HEI governance	Encouraged by other PRFS incentives	Specific reform policy needed
Increase number of HEI researchers	–	Additional funding needed
Raise research quality	PRFS quality incentive	Continue to provide external, competitive funding
Improve HR management to tackle generational shift	PFRS 'environment' incentive	HEI reforms and programmes aimed at young researchers
Introduce better academic career structure	PRFS 'environment' incentive	Needs complementary tenure track policy
Increase research funding, especially institutional funding	–	Increase institutional funding, some of which should be driven by the PRFS
Improve research-industry links; focus more on 'third mission'	PRFS 'impact' incentive	Complementary programmes such as competence centres

Increase absorptive capacity in business and government	PRFS 'impact' incentive	Educate industry-relevant manpower, manpower placement schemes, direct support for company innovation
Increase entrepreneurial culture in HEIs	PRFS 'impact' incentive	HEI reforms, commercialisation incentives and support
Increase internationalisation of research	Internationalisation could be a PRFS parameter	Support participation in Framework programme and other international collaborations

The analysis in Table 5 suggests that, if a PRFS is used, it should incentivise quality, research impact, the adequacy and quality of the 'environment' in which the research takes place and potentially internationalisation. The first three were key assessment dimensions of the 2014 RAE (which was not directly linked to funding). Internationalisation was not an assessment dimension in 2014. We suggest the following approach.

The RAE should be based on peer review and should incorporate site visits. At the current stage of development, the formative dimension offered by peer review will be helpful and the site visits will make it possible to obtain a better judgement of the research environments than was possible earlier. Panels should be international. Where Latvian language is needed, care should be taken in ensuring that panellists do not have a conflict of interest in doing assessments.

The method should be an evolution of the 2014 approach, using self-assessments to allow research groups to present themselves and their work but relying on official sources for all data that can be collected outside the self-assessment in order to minimise errors and the reporting load on those evaluated. This will improve the quality of the data used but avoid demanding that those evaluated learn new things in order to participate in the RAE.

Increasing institutional funding for research should be a policy objective, given its low level in Latvia. The block funding component of institutional funding should cover a large part of the institutional cost of research, having in mind the existing size of the activity that needs to be supported and factors such as scientific discipline which drive cost. It should provide a basis for planning. The PRFS component of institutional funding for research should be sufficiently large to trigger behavioural and organisational changes but at the same time not be so large as to cause dangerous instability in funding levels. Two approaches could be

considered, both of which tend to generate enough certainty to allow institutions to plan while at the same time exerting competitive pressure

- Set aside a minority of the institutional funding for research to be allocated through the PRFS. We suggest that this could be up to 20% of the whole but could be set at a lower level that policymakers believe is sufficient to trigger change
- If the government is prepared to increase the level of institutional funding for research over time, the PRFS could allocate all or part of that increase

Typically, external funders do not pay the full costs of the research they fund. The fact that institutional money is a low proportion of Latvian universities' total research income makes it particularly difficult for those universities that obtain a lot of external research funding to cover their costs. Hence, there is an argument for allocating some of the PRFS-driven funding in a way that addresses this problem.

Hence, MoES could usefully divide the PRFS budget into two parts. One part would be based on peer review of past research performance, irrespective of the source of funds involved. The second could be allocated to universities pro rata their share of those forms of external funding the government wishes to promote, such as industrial research income and income from the EU Framework Programme. Deciding the precise funding formula is partly an exercise in judgement and partly requires a level of calculation and simulation of alternatives that goes beyond what is possible here. However, an example of a possible funding formula could be as follows.

PRFS	100%		
Peer review-based part		80%	
Scientific quality and impact			55%
Societal relevance and impact			15%
Research environment			10%
Research funding based part		20%	
Framework Programme income			10%
Income from national and international industry			10%

6. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

This chapter summarises the five main recommendations, each of which is broken down to a more specific level. For more details see the preceding chapters.

- The structure and governance of state organisations should be streamlined to meet national needs
- Higher education governance should be further modernised
- Investment by private and public businesses in innovation should be increased and broadened
- Funding for research and innovation should increase, especially from national sources
- Competitively-won research funding should increase, in order to meet national needs

6.1. The structure and governance of state organisations should be streamlined to meet national needs

- The Latvian authorities should seek to build platforms for routine cooperation among the ministries on research and innovation, starting at the level of ministers.
- There should be a clear separation between the policymaking function of the ministries and the implementation tasks of the agencies.
- All spending ministries should be making policy based on knowledge and should therefore be empowered to ensure that they can obtain the knowledge needed as well as to contribute to national research and innovation policy. A first step would be to require the ministries to develop research strategies and to provide with their own research budgets or failing that to increase the size of the state research programmes to the point where they are large enough to meet policy needs and reinforce the consultation and coordination process through which the MoES currently programmes them.
- Research and innovation funding is fragmented across multiple organisations
    - Latvia should reduce the number of organisations involved in research and innovation funding and to allow a smaller number to develop capacities that at present are lacking or in small supply
    - Operationally, there is a need to stop separating nationally resourced and structural funds-based policies and instruments

- Agencies need to be able to tackle their tasks in an holistic way and to build capacity, otherwise they will be inefficient and ineffective. Thus, tasks should not be fragmented across two or more agencies

-

- Given Latvia's small size, peer review should be centralised into a single competent organisation (e.g. building on the competence of the LCS) that can provide a peer review service to others as necessary.
- Latvia needs a stronger and more integrated innovation agency. We argue that there is value in combining this function with research funding – especially if Latvia decides to take up the important challenge of funding research as well as innovation activities relevant to industry.
- The Latvian authorities should consider the role and function of the Latvian Academy of Science and support their efforts to turn into a learned society. The Academy should no longer have the right to determine the governance of the LCS. Rather, the head of the LCS should be appointed by an appropriately staffed board and should in turn recruit panel members and peers from the research community.
- There is a need to simplify or clarify procurement procedures so that small purchases are not subject to the same stringent rules and documentation requirements as large pieces of infrastructure.

6.2. Higher education structure and governance should be further modernised

- MoES needs to continue to drive the process of institutional consolidation in the research sector, reallocating resources from weak to strong performers as necessary in order to achieve this.
- MoES should continue the process of modernisation of institutional governance in tandem with promoting rationalisation. The involvement of external stakeholders in universities' decision making bodies should be increased. Universities should be required to establish governing bodies with a majority of external representatives and the responsibility for appointing rectors and handling key budgeting and strategic functions.
- The Latvian authorities should consider making academic appointments permanent and introducing a tenure track system in the universities.
- The national accreditation agency was created very recently, and it is not member of the European Association of Quality Assurance Agencies (ENQA) or the European Quality Assurance Register for Higher Education (EQAR). Both networks provide a kind of legitimation to quality procedures in European higher education system. Being part of these networks should be a priority in Latvia for the international recognition of national degrees.

6.3. *Investment by private and public businesses in innovation should be increased and broadened*

- Measures are needed that address the development of absorptive capacity in industry, in addition to direct stimuli to in-company innovation. These could include instruments such as graduate placement schemes, technology audits, R&D partnership programmes and support to firms' close-to-market R&D.
- The Latvian authorities should consider requiring the state-owned firms to spend an appropriate portion of their income on R&D, alone or in partnership with the research system and with other firms.
- Measures to strengthen absorptive capacity need to be matched by increasing the amount of 'boundary work' done by the research performing organisations with a view to maintaining research-industry links. The government should explicitly consider how to create an organisation or network that provides innovation-related translational work, such as that done by RTOs in other countries. Existing organisations which already fulfil some RTOs´ functions such as the competence centres, LIAA or technology transfer offices should be part of the creation of such an organisation or network.

6.4. *Funding for research and innovation should increase, especially from national sources*

- Latvia's research and innovation system is small and under-funded, as a result of which its performance is not only poor in international comparison but also inadequate to national needs for knowledge and skills to support economic and social development. While we recognise the economic constraints, state expenditure on research and innovation policy should increase in order to drive performance and growth.

  The communication plan foreseen in the "Science, Technology and Innovation Development Guidelines" should be put in place. The Latvian authorities should consider the best way to generate and promote an overall vision articulating the role of research and innovation in future development. This should include a specific national exercise to improve policy coordination, obtain a better balance among instruments and to adjust the division of labour in the structure and governance of research and innovation policy.
- The national authorities should aim to achieve a better funding balance between national and structural funds, bearing in mind the fact that money is fungible and that structural funds are a temporary expedient.

6.5. *Competitively-won research funding should increase, in order to meet national needs*

- A new Research Assessment Exercise (RAE) is due soon and should this time explicitly be connected to resource allocation. At the same time, there is a need to ensure that such research-related incentives do not unbalance the system by taking attention away from education or the 'third mission'.
- The new RAE should focus on incentivising performance improvements needed in policy. On the one hand it should encourage increased scientific quality and impact as well as the development of the research environment in the universities themselves. On the other, it should support internationalisation and cooperation with both domestic and international industry.
- Both the scale and the scope of competitive, external research funding schemes should increase, in order to meet national needs for both 'bottom-up' and thematically orientated research.

7. APPENDIX A: BIBLIOGRAPHY

Arnold, E. (2004). Evaluating innovation and research policy: A systems world needs systems evaluations. *Research Evaluation, 13*(1).

Arnold, E., & Giarracca, F. (2012). *Getting the Balance Right: Basic Research, Missions and Governance for Horizon 2020.* Brussels: European Association of Research and Technology Organisations.

Arnold, E., Arnulf, G., Jacobsson, C., Romanainen, J., Smith, K., & Viliūnas, G. (2010). *Policy Mix Peer Review, Latvia Peer Review Outcome Report.* Brussels: European Commission.

Arnold, E., Bell, M., Bessant, J., & Brimble, P. (2000). *Enhancing policy and institutional support for industrial technology development in Thailand: The overall policy framework and the development of the industrial innovation system.* Bingkok: NSTDA.

Arnold, E., Knee, P., Angelis, J., Giarracca, F., Grinice, E., & Jávorka, Z. (2014). *Latvia Research Assessment Exercise: Summary report.* Riga: Ministry of Education and Science of Latvia.

Arrow, K. (1962). Economic welfare and the allocation of resources for innovation. In R. R. Nelson, *The Rate and Direction of Innovative Activity: Economic and Social Factors* (pp. 609-626). NBER Press.

Becker, B. (2015). Public R&D policies and private R&D investment: a survey of the empirical eidence. *Journal of Economic Surveys, 29*(5), 917-942.

David, P. A., Hall, B. H., & Toole, A. A. (2000). Is public R&D a complement or substitute for private R&D? A review of the econometric evidence. *Research, 29*, 479-829.

ESF. (2011). *European Peer Review Guide. Integrating Policies and Practices into Coherent Procedures.* Strasbourg: European Science Foundation.

Estermann, T., & Nokkala, T. (2009). *University Autonomy in Europe I: Exploratory Sudy.* Brussels: European University Association.

EUREK. (2011). *European Universities for Entrepreneurship - their Role in the Europe of Knowledge.* Brussels: European Commission.

European Commission. (2006). *Delivering on the Modernisation Agenda for Universities: Education, Research and Innovation COM(2006) 208 final.* Brussels: European Commission.

European Commission. (2011). *Supporting growth and jobs – An agenda for the modernisation of Europe's higher education systems. COM (2011) 567 final.* Brussels: European Commission.

European Commission. (2017). *European Innovation Scoreboard 2017.* Brussels: European Commission.

European Commission. (2017). *European Semester Country Report Latvia 2017.* Brussels: European Commission.

European Commission. (2017). *Modernisation of Higher Education in Europe: Academic Staff.* Brussels: European Commission.

European University Association. (2011). *Financially Sustainable Universities II. European universities diversifying income streams. Brussels: European University Association.* Brussels: European University Association.

EUROSTAT. (2013). *High-technology and meium-high technlogy industries main drivers of EU-27's industrial growth. Statistics in Focus.* Luxembourg: EUROSTAT.

Freeman, C. (1987). *Technology Policy and Economic Performance: Lessons from Japan.* London: Frances Pinter.

Goddard, J. (2011). *Connecting Universities to Regional Growth: A Practical Guide.* Brussels: European Commission DG Regio.

Godin, B. (2000). *Measuring science: Is there 'basic research' without statistics?' .* Montreal: Project on the History and Sociology of S&T Indicators, Paper No 3, Montreal: Observatoire des Sciences et des Technologies INRS/CIRST.

Griniece, E., & Nausedaite, R. (2017). *Latvian Research Funding System - Background Report.* Brussels: European Commission DG-RTI Policy Support Facility.

Hall, B., Mairesse, J., & Mohnen, P. (2010). *Measuring the Returns to R&D.* Maastricht: UNI-MERIT.

Kuļikovskis, G., Petraitytė, D., & Stamenov, B. (2017). *RIO Country Report 2016: Latvia.* Luxembourg: JRC.

Kuhlmann, S., & Arnold, E. (2001). *RCN in the Norwegian Research and Innovation System, Background Report No 12 in the Evaluation of the*

Reseach Council of Norway. Oslo: Royal Norwegian MInistry of Education, Research and Church Affairs.

Kulikovskis, G., Petraityte, D., & Stamanov, B. (2016). *RIO Country Report Latvia 2015.* Luxembourg: European Union.

Lundvall, B. Å. (1992). *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning.* London: Frances Pinter.

Martin, B. R., & Tang, P. (2007). *The Benefits from Publicly Funded Research; SEWP 161.* Brighton: SPRU, Sussex University.

Ministry of Economics. (2013). *Guidelines on National Industrial Policy for 2014-2020.* Riga: Ministry of Ecocomics.

Ministry of Economics. (2016). *The National Economy of Latvia: Macroeconomic Review.* Riga: Ministry of Economics.

Mora, J. G., & Vieira, M. J. (2011). Managing university-business partnerships. In P. Temple (ed), *Universities and the Knowledge Economy.* London: Routledge.

Mora, J. G., Detmer, A., & Vieira, M. J. (2010). *Good Practices in University-Enterprises Partnership.* Brussels: European Commission DG0EAC.

Nelson, R. R. (1959). The simple economics of basic scientific research. *Journal of Political Economy, 67*, 297-306.

Nelson, R. R. (1993). *National Innovation Systems.* New York: Oxford University Press.

OECD. (1997). *National Innovaton Systems.* Paris: OECD.

OECD. (2017a). *Education at a Glance.* Paris: OECD.

OECD. (2017b). *R&D Tax Incentive Country Profiles 2016: Latvia. Measuring R&D Tax Incentives.* Paris: OECD.

Patel, P., & Pavitt, K. (1994). The nature and economic importance of National Innovation Systems. *STI Review, 14*.

Sörlin, S., Arnold, E., Andersen, B., Honoré, J., Jørnø, P., Leppävuori, E., & Storvik, K. (2009). *A Step Beyond: Evaluation of the GTS Institute System in Denmark.* Copenhagen: Forsknings- og innovationsstyrelsen.

Schwaag-Serger, S., Wise, E., & Arnold, E. (2015). *National Research & Innovation Councils as an Instrument of Innovation Governance VA 2015:07.* Stockholm: Vinnova.

Shattock, M. (2008). *Entrepreneurialism in Universities and the Knowledge Society.* Milton Keynes: Open University Press.

Stokes, D. (1997). *Pasteur's Quadrant: Basic Science and Technological Innovation,.* Washington DC: The Brookings Institution.

World Bank. (2014). *International Trends and Giood practices in Higher Education Internal Fnding and Governance. World Bank Reimbursable Advisory Service on Higher Education Financing in Latvia.* Washington DC: World Bank.

World Bank. (2016). *International Trends and Good Practices in Higher Education Internal Funding and Governance.* Washington DC: World Bank.

Other statistical sources

CSB (Centralas statistikas parvaldes datubazes). (2017). Science and technology data. Riga. http://data.csb.gov.lv/pxweb/lv/zin/zin__zin/ZI0030_euro.px/table/tableViewLayout2/?rxid=cdcb978c-22b0-416a-aacc-aa650d3e2ce0

European Commission, Eurostat. (2017). Statistics on research and development. Luxembourg. http://ec.europa.eu/eurostat/web/science-technology-innovation/data/main-tables

8. APPENDIX B: RESEARCH, INNOVATION AND BUSINESS SUPPORT POLICY INSTRUMENTS

Funding instrument and source	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	**Recipients**
Institutional funding for research National budget	27m (2017) 27m (2016) 22m (2015)	Ensure institutional stability and continuity of research activity	Formula based on input and output indicators Annual allocation	Allocated to scientific institutions with min. research staff 25 FTE, to other HEIs with 10 FTE, and to HEIs specialising in arts with 5 FTE Minimum RAE score 3 + 10 % for RAE scores 4-5	Central planning by MoF Direct administration for calculation and allocation to performers by MoES	State-established scientific institutes and HEIs registered in the Register of Scientific Activity
State Research Programmes National budget	8.9m (2017) 5.7m (2016) 6.2m (2015)	High-impact, industry-relevant research in priority areas of national development	Open call and selection every 4 years Annual allocation per programme 14 programmes in 2014-2017	Corresponds to national priorities Scientific and practical relevance Scientific novelty	Central planning by MoF Selection and supervision by MoES Expertise by LCS Administration by SRA	State-established scientific institutes and HEIs
Fundamental and applied	1m (2017) 4.4m (2016) 4.4m (2015)	Scientific and technological advances, solutions in	Competitive, project-based Open call and selection every 4 years	Scientific potential and quality	Central planning by MoF	State-established scientific institutes, HEIs, individual

Funding instrument and source	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	**Recipients**
research grants National budget		topical research areas	Annual allocation per project	Impact and international competitiveness Scientific novelty	Appropriation by MoES Selection and supervision by LCS Administration by SRA	scientists and groups of scientists

Funding instrument and source	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
Practically oriented research grants ERDF	14.3m (total 86.1m)	Innovative solutions for practical socio-economic challenges, improving inter-sectoral collaboration and knowledge transfer in RIS3 areas, focus on high commercialisation potential	Open call and selection every year Max 600k, min 30k per project Public funding intensity for non-commercial entities – 92.5 %, for commercial entities 25-85 %	Project scientific quality and correspondence with RIS3 goals Economic and social impact Quality and efficiency of implementation	Central planning by MoF Supervision by MoES Administration by CFCA	Scientific institutions and enterprises
Support for Post-doctoral Research ERDF	10.6m (total 64m)	Postdoc research projects in RIS3 areas, competence building, international mobility and networking, tech-transfer activities	Open call and selection every year The max amount of the grant is EUR 133 806 for three years	Project scientific quality and correspondence with RIS3 goals Economic and social impact Quality and efficiency of implementation	Central planning by MoF Supervision by MoES Administration by SEDA	Scientific institutions and enterprises employing PhD holders
Innovation grants for students ERDF	5.6m (total 34m)	Student research and innovation projects, particularly in STEM areas, life sciences and creative industries	First call 2018	tbd	Central planning by MoF Supervision by MoES Administration by MoES	HEIs and scientific institutes of HEIs

Funding instrument and source	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
Support for international cooperation projects in science and technologies ERDF	5.4m (total 32.5m)	ERA bilateral and multilateral research cooperation project development, networking, strengthening capacity of H2020 national contact points	First call opened 2017		Central planning by MoF Supervision by MoES Administration by MoES	Scientific institutions and HEIs registered in the Register of Scientific Activity, enterprises, researchers, H2020 national contact points
Development of the R&D Infrastructure in Fields of Smart Specialisation and Strengthening of Institutional Capacity of Scientific Institutions ERDF	20m (total 120m)	Elaboration of institutional development strategies, research programmes and human resource plans RDI infrastructure development that is required by developing RDI activities in RIS3 areas, implementation of measures for research system consolidation and increase in scientific excellence and competitiveness	One-off restricted call for a targeted purpose	Allocated to 13 scientific institutions that received RAE scores 4 and 5 Project scientific quality and correspondence with RIS3 goals Economic and social impact Quality and efficiency of implementation	Central planning by MoF Supervised and administered by MoES	Scientific institutions and HEIs registered in the Registry of Scientific Institutions

NB: Indication of the ERDF funding source means the total funding also includes national co-financing (in most cases 15 %)

Funding instrument	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
CIT R&D Tax allowances national budget	Will be cancelled in 2018 (tax reform	Promote new product and technology development in local enterprises and attracting FDI in research-intensive sectors	The applied value coefficient for eligible expenses is 3	The eligible costs include: • R&D personnel • Services from scientific institutions • Services of accredited certification, testing and calibrating institutions	Budgetary oversight by MoF Operational oversight by MoE Administration by State Revenue Service	Enterprises that invest in R&D
Support to development of new products and technologies within competence centres ERDF	9.18m (total 64.3m, 3 calls for proposals)	Individual and cooperative research projects, including industrial research, experimental development, technical and economic feasibility studies for research projects	Funding allocated in four stages: • 1st stage – MoES organises governance, monitoring and dissemination activities • 2nd and 4th stage – calls for competence centre project implementation • 3rd stage – tbd	Development of a competence centre in RIS3 sub-specialisation areas Competence centre must comprise at least five unrelated commercial entities in the sector	Central planning by MoF Supervision by MoE Administered by CFCA	Science and business cooperation platforms – competence centres

Funding instrument	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
Support to implementation of new products into production ERDF	8.57m (total 60m, 2 calls for proposals)	Implementation of new products into production to increase business productivity and foster business R&D	Open calls	Alignment with RIS3 goals Experience with R&D projects and product development New R&D jobs created Project sustainability	Central planning by MoF Supervision by MoE Administered by CFCA	Enterprises that invest in R&D

Funding instrument	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
Technology-transfer system and innovation vouchers; Support to technology-orientated start-ups – attraction of highly skilled workers ERDF	8.5m (total 40.6m plus 3.5m)	Establish a common technology-transfer centre to foster interest and develop cooperation between research institutions and potential IPR commercialisation entities, ensure the functions of research commercialisation and patenting fund, manage innovation voucher support to SMEs	Restricted call to a consortium of scientific institutions	Contribution of the common technology-transfer centre in reaching RIS3 goals	Central planning by MoF Supervision by MoE Administered by LIAA and CFCA	Latvian Investment and Development Agency Consortiums of HEIs and scientific institutions
Innovation motivation programme ERDF	0.81m (total 5,7m)	Informative and consultative support to students, business idea authors, potential start-ups on innovation-related issues to raise awareness and improve related business skills	Restricted call to LIAA	Experience and technical support Clear strategy for proposed activities Coherence with RIS3 goals	Central planning by MoF Supervision by MoE Administered by LIAA and CFCA	Latvian Investment and Development Agency Final beneficiary enterprises, start-ups, self-employed, NGOs, students
Support for employee training to increase business	2.50m (total 18m, 2 calls for proposals)	Employee training to improve skills in enterprises to promote introduction of new or	Open calls	Experience with implementation of similar projects	Central planning by MoF	Sectoral associations

competitiveness and innovation ERDF		improved products or technology development and increase in labour productivity		Evaluation of skills needs in the sector has been performed Training supply-and-demand analysis	Supervision by MoE Administered by CFCA	

Funding instrument	Average annual allocations (EUR)	Aim of the intervention	Funding allocation method and periodicity	Criteria and conditions	Operator(s)	Recipients
Support for training to improve ICT skills, capacities for non-technological innovation and attracting foreign investment ERDF	1m (total 6.9m)	Employee training to improve ICT skills, capacities for non-technological innovation and attracting foreign investment	Restricted call to Latvian Information and Communication Technology Association, Chamber of Commerce and LIAA	Competence in ensuring training in ICT, non-technological innovation and attracting investment	Central planning by MoF Supervision by MoE Administered by CFCA	LICT, Chamber of Commerce, LIAA Final beneficiary enterprises and self-employed
Cluster programme ERDF	1m (total 6.2m)		Consortiums, associations Final beneficiary enterprises	Business angel co-investment	Central planning by MoF Supervision by MoE Administered by CFCA	SMEs
Support to technology-oriented start-ups* National budget	Tax relief	Support the creation and growth of technology-oriented start-ups through adjustments in social security payment rules, tax breaks and support for attracting highly qualified labour force	tbd	tbd	Budgetary oversight by MoF Operational oversight by MoE Administration by State Revenue Service	Technology- and innovation-oriented start-ups

*Include only main support instruments by MoE; other ministries, such as the Ministry of Agriculture, also have measures associated with the goal of increasing capacity for innovation

Funding instrument	Average annual allocations (EUR)	Operator(s)	Recipients	Funding instrument	Average annual allocations (EUR)	Operator(s)	Recipients
Support to improvement of production infrastructure and equipment ERDF	11-12m	Central planning by MoF Supervision by MoE Administered by CFCA	Enterprises, associations and port authorities	Loan guarantees and mezzanine loans ERDF	8m	Central planning by MoF Supervision by MoE Administered by ALTUM	All enterprises (SMEs for loan guarantees)
Business incubator support programme ERDF	4-5m	Central planning by MoF Supervision by MoE Administered by LIAA and CFCA	LIAA Final beneficiary regional incubators and creative industry incubators	Seed capital funds ERDF	4-5m	Central planning by MoF Supervision by MoE Administered by ALTUM	Start-ups, micro enterprises and SMEs
Support to international competitiveness ERDF	8-9m	Central planning by MoF Supervision by MoE Administered by LIAA and CFCA	LIAA Final beneficiary enterprises	Technology accelerator ERDF	2-3m	Central planning by MoF Supervision by MoE Administered by ALTUM	SMEs, including start-ups

*Include only main support instruments by MoE; other sectoral ministries such as the Ministry of Welfare and Ministry of Environment and Regional Development also have measures associated with the goal of increasing business competitiveness

Getting in touch with the EU

IN PERSON

All over the European Union there are hundreds of Europe Direct Information Centres. You can find the address of the centre nearest you at: http://europa.eu/contact

ON THE PHONE OR BY E-MAIL

Europe Direct is a service that answers your questions about the European Union. You can contact this service

– by freephone: 00 800 6 7 8 9 10 11 (certain operators may charge for these calls),
– at the following standard number: +32 22999696 or
– by electronic mail via: http://europa.eu/contact

Finding information about the EU

ONLINE

Information about the European Union in all the official languages of the EU is available on the Europa website at: http://europa.eu

EU PUBLICATIONS

You can download or order free and priced EU publications from EU Bookshop at: http://bookshop.europa.eu. Multiple copies of free publications may be obtained by contacting Europe Direct or your local information centre (see http://europa.eu/contact)

EU LAW AND RELATED DOCUMENTS

For access to legal information from the EU, including all EU law since 1951 in all the official language versions, go to EUR-Lex at: http://eur-lex.europa.eu

OPEN DATA FROM THE EU

The EU Open Data Portal (http://data.europa.eu/euodp/en/data) provides access to datasets from the EU. Data can be downloaded and reused for free, both for commercial and non-commercial purposes.

KI-AX-18-002-EN-N

To support countries in reforming their research and innovation systems, the Directorate-General for Research & Innovation (DG RTD) of the European Commission set up a Policy Support Facility (PSF) under the European Framework Programme for Research & Innovation 'Horizon 2020'. It aims to support Member States and associated countries in improving their national science, technology and innovation systems.

The Latvian government requested specific support from the PSF, as a basis for reforming and improving the quality of the way it funds research and innovation.

The PSF panel of four independent experts supported by two national peers worked from January to December 2017, including two missions to Riga to consult stakeholders and discuss potential recommendations. This final report was formally presented to the Latvian government in Riga during February 2018. The panel's recommendations focus on

- The need to devote more budget from national sources to research and innovation
- How to streamline the structure and governance of state organisations involved in research and innovation funding
- The need for further organisational integration and governance reforms in the higher education sector
- Exposing more of the needed increased investment in research to competition
- Taking steps to support business to invest more in research and innovation

Publications Office

doi: 10.2777/3392
ISBN: 978-92-79-79921-1